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ABSTRACT

This document, which is intended for Ohio agriculture teachers, contains lesson plans for an eight-unit competency-based course in agriscience. Each lesson plan contains some or all of the following items: (1) unit title; (2) competency/terminal performance objective; (3) competency builders/pupil performance objectives; (4) list of applied academics competencies covered in the lesson; (5) list of necessary equipment, supplies, references, and other resources; (6) intended student audience; recommended teaching procedures (interest approach/teaching methods) cross-referenced to specific directions for teachers; (7) one or more problem-based learning activities along with worksheets, handouts, and other materials required for lessons; (8) guidelines for helping students apply concepts, principles, and skills; (9) suggestions for evaluating student learning; and (10) data record and observation sheet. The unit topics and selected lesson topics are as follows: (1) agricultural safety (maintain a safe work environment, apply safe work habits); (2) research technology (use scientific method to solve problems; use the English and metric systems to measure objects); (3) environmental science (manage soil, investigate factors affecting nitrates in groundwater); (4) business technology (maintain business records, examine the role of marketing); (5) plant science (explain plant chemical processes); (6) animal science (determine animals' nutritional requirements); (7) mechanical power; and (8) personal development. (MN)

Ohio Agriscience Summit

Ohio Agriscience

Lesson Plans

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Program **AGRISCIENCE**

Unit **1-Agricultural Safety**

Maintain Safe Work Environment

Competency/Terminal Performance Objective

1.0.1 Given a laboratory activity, maintain a safe work environment according to school policies.

Competency Builders/Pupil Performance Objectives

1.0.1.1 Given a case situation involving safe work environment information, read and follow safety information according to criteria used in assessment instrument.

1.0.1.2 Given a case emergency plan of action, follow the emergency plan in chronological order.

1.0.1.3 Given a laboratory situation, maintain a clean and safe environment using criterion assessment instrument.

1.0.1.4 Given a labeled material, identify the hazardous material based on criteria used in assessment instrument.

1.0.1.5 Given an equipment manual, comply with equipment safety rules based on criteria given in assessment instrument.

1.0.1.6 Given a safety checklist, identify safety hazards and take corrective action as specified in safety code.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.5 Identify details such as who, what, why, where, when, or how
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
2.0.19 Use appropriate punctuation and capitalization
3.0.1 Demonstrate effective listening skills
3.0.3 Communicate appropriately with co-workers, clients, and supervisors
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Safety

1. Protect eyes by wearing safety goggles
2. Use a chemical-resistant apron
3. Use proper water cleansing procedures to remove chemicals.

Equipment, Supplies, References, and Other Resources

1. Eye safety goggles
2. Chemical-resistant apron
3. Bunsen burner, matches
4. Shallow metal or glass collection pan or kitchen counter dish drain mat
5. Small diameter, non heat-resistant beaker.
6. Beaker
7. Tongs
8. Water
9. *Flinn Scientific Science Supply Catalog* (source of information for laboratory chemical disposal requirements)

Situation

Use this activity with Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Prepare the laboratory safety demonstration. Place a Bunsen burner in or over a shallow collection pan, such as a counter top dish drain mat. Fill a small diameter, non heat-resistant beaker half full with water. See that all students have goggles in place and are not too close to experiment.	**Interest approach** Have the class conduct the following experiment in the laboratory you have set up: • Heat liquids in glassware by using the heat from a Bunsen burner. a. Put on safety goggles and a chemical-resistant apron. b. Using the tongs, pick up the half-filled beaker and hold it over the unlit Bunsen burner. c. Light the burner and place the beaker of water in the flame. Within a few seconds the beaker will break, and the glass and water will spill in the collection pan or dish drain mat.
Help the students clarify what really happened; why it happened; what safety hazards it caused; and what can be done to prevent this type of hazardous situation in the laboratory. Use the Situation-to-Be-Improved form on pages 1.0.1-4 to 8 and 1.0.1-9 (student copy).	Now ask the class the following questions: 1. Why did the beaker break? 2. What hazards could result if the beaker had contained chemicals and there was no collection pan to catch the liquids when the beaker broke? (*possible responses*) • The chemicals could splash onto other chemicals, contaminating them or causing an unwanted reaction. • The chemicals could splash anyone close by and cause injury. 3. If you had not been wearing goggles and an apron, what hazards could have resulted? (*possible responses*) • The chemicals could splash and injure you. • Broken glass could injure you. 4. How did your safety goggles and apron help prevent you from being harmed by the accident? 5. What do you need to know or do to make sure that this type of accident does not occur when you heat chemicals in glassware? 6. Are there other procedures in the laboratory that may be a safety hazard if not done correctly? 7. What are some safety procedures which we need to improve?

• **Situation-To-Be-Improved** •

Problem-Solving Technique

Define the problem

There have been some chemical spills and accidents in the agriscience laboratory that could have injured students. What do we need to do differently so the agriscience laboratory is a safer place for student learning?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
1. Appropriate lab safety items are worn by students at all times in the agriscience laboratory.	Many chemicals, as well as the vapors from chemicals, can be very toxic and damaging to the skin and eyes. There is always the danger that an accident or spill can occur and result in chemical contamination of the skin or eyes.	All students wear safety goggles, but no chemical-resistant aprons or other protective clothing. Student clothing has been chemically contaminated during lab work.	Continue the policy that no student works in the laboratory without wearing safety goggles. Increase the laboratory fee to include purchase of a chemical-resistant apron. Require any student working with chemicals to wear the apron.
2. Lab facilities provide for immediate and continuous irrigation with water for the eyes or skin in case of chemical contamination of these areas.	The harmful effects of chemicals on the skin or in the eyes can be lessened by immediate flooding of the contaminated area with cool water. The larger the volume of water and the longer it irrigates the exposed area, the better the chances of neutralizing the damage from the chemical. Delaying irrigation allows chemicals more time to be absorbed into body tissues and increases their harmful effects; e.g., possible blindness or severe skin damage.	There is a large laboratory sink with a high-rise faucet, but no eye-wash appliance.	Have instructor submit a request for an eye-wash appliance and install it next to the laboratory sink. Instruct students on its use in case of chemical contamination of the eyes.

Define the problem *(continued)*

There have been some chemical spills and accidents in the agriscience laboratory that could have injured students. What do we need to do differently so the agriscience laboratory is a safer place for student learning?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
3. The instructor's permission is always secured by students before any experiments are performed or matches are used in the laboratory.	Chemical interaction can create explosive or dangerous situations. Certain chemicals or chemical interactions can produce fumes which can be ignited by an open flame such as a match. By knowing what chemicals are to be used now and in the future, the instructor can avoid potentially harmful situations.	Most students wait for the teacher's instructions and OK before starting experiments. However, a few students will begin on their own if the instructor is busy with others.	Provide each student with a checklist for doing each lab activity. Have a line at the top for the instructor's signature and the time approval was given for beginning the laboratory experiment.
4. All glassware and glass utensils are free of cracks. Heat-resistant glassware is available for experiments where glassware is to be heated.	Cracked utensils can leak chemicals causing contamination or dangerous situations. Non heat-resistant glassware will break when heated, spilling the contents.	The laboratory has a selection of both heat-resistant and non heat-resistant glassware stored together in the cabinets. Several utensils have chips or cracks.	Reorganize storage cabinets so the heat-resistant and non heat-resistant glassware are each in a separate, designated compartment. Clearly mark each compartment. Instruct students to check each piece of glassware before applying heat to it and ensure that it is heat resistant. Continue to report and dispose of cracked glassware.

Define the problem *(continued)*

There have been some chemical spills and accidents in the agriscience laboratory that could have injured students. What do we need to do differently so the agriscience laboratory is a safer place for student learning?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
5. All accidents are reported to the instructor.	Take care of accidents immediately and properly. The instructor must know when an accident has occurred in order to take appropriate action, especially if there are injuries. If the accident involves broken equipment or spilled chemicals, the instructor must see that chemical spills are cleaned up and broken equipment is taken care of properly.	The instructor observes or is informed of most accidents. However, there are times when accidents are not obvious to the instructor and others; therefore, the instructor is not informed.	Have the class review the importance of procedures which help avoid or reduce the occurrence of accidents. Before each lab activity or experiment, the instructor should review any special hazards of the activity and the appropriate safety procedures to follow. Have the class discuss the importance of reporting all accidents to the instructor.
6. There is no "horse play" or distracting conversation with students at other lab stations.	The agriscience laboratory contains equipment and utensils which are easily broken. Injuries can also result when chemicals are spilled. Distracting behavior in the lab can lead to damaged or broken equipment as well as spilled chemicals.	Students generally do not visit and talk with other students during lab activities. There is seldom any seriously distracting behavior.	Students must continue to avoid social visiting and talking with students at other laboratory stations. They should strive to maintain a distraction-free lab environment.

Define the problem *(continued)*

There have been some chemical spills and accidents in the agriscience laboratory that could have injured students. What do we need to do differently so the agriscience laboratory is a safer place for student learning?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
7. Chemicals are not poured back into their bottles, but disposed of according to lab and school policy.	Chemicals may become contaminated after they have been removed from the supply bottle. Consequently, they will contaminate the supply bottles when poured back into them. Returning materials to bottles also increases the chance that a chemical may be returned to the wrong bottle. Many chemicals used in the agriscience lab can contaminate the environment or ground water supplies unless correct disposal procedures are followed closely.	Some chemicals are poured out, unused, and returned to the bottle or container. Others are poured down the laboratory sink drain.	Make a clear laboratory policy that **NO** chemicals are to be returned to the bottles after they have been poured out. Before beginning the activity, students should accurately determine the amount of chemicals needed for the lab activity. They should not pour out more than this amount. Post information by the sink telling what materials should be poured into the lab sink. Make available appropriate disposal containers with labels clearly indicating which chemicals should be placed in each.
8. No food or drink is consumed in the agriscience laboratory.	Chemical residues may get on the hands when handling chemicals in the lab. These residues may transfer to food as it is eaten, resulting in transfer to the digestive track. Depending on the chemical ingested, illness can result.	Students do not consume food or drink during the laboratory period.	Continue the policy and practice of no food or drink brought into the laboratory area.

Define the problem *(continued)*

There have been some chemical spills and accidents in the agriscience laboratory that could have injured students. What do we need to do differently so the agriscience laboratory is a safer place for student learning?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
9. Hands are always washed after the experiment is completed.	Chemical residues should be washed off the hands immediately after handling the chemicals. Otherwise the chemicals may be absorbed or transferred to the face, eyes, or other skin areas resulting in irritations, burning, or other problems.	Some students do not wash hands until the end of the lab period, even if their hands are contaminated early in the lab period. Most, if not all of the students, wash their hands at the end of lab period.	Have students review the importance of washing the hands before chemicals can be absorbed into them or transferred to the eyes, face, or other skin areas. Display by the work stations posters which emphasize cleaning hands as soon as possible when contaminated with lab chemicals, especially caustic ones. Continue the policy that all students also wash their hands at the end of the lab period.

• Situation-To-Be-Improved •

Problem-Solving Technique

Define the problem

There have been some chemical spills and accidents in the agriscience laboratory that could have injured students. What do we need to do differently so the agriscience laboratory is a safer place for student learning?

Characteristics to Be Considered	What	Why	Current Situation	Recommendations

Helping Students Apply Concepts/Principles/Skills

Review with the students the nine areas of safety they helped define as important in making the agriscience laboratory a safer environment. Ask them to help develop a checklist form to use in rating the students on their performance in these areas.

Have students periodically complete the checklist form and rate themselves on a "how am I doing" basis for lab safety procedures. Ask the students to compare and discuss their progress, or lack of it, on the rated items.

Evaluating Student Learning

Prepare a pre-test on safe vs. non-safe laboratory practices. The test should sensitize the students to the correct laboratory safety practices and procedures that, if followed, make the laboratory a safer place for them. Return the pre-test results to the students, discussing with them as a class where their understanding or use of safety practices needs improvement for a safer environment.

Evaluate students through observation to determine how well they are following safe lab procedures. At the conclusion of an agriscience laboratory unit, have students take a written test measuring how much they understand. Also conduct a student self-evaluation of increased awareness of safety procedures occurring since the pre-test.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 1 - Agricultural Safety

Apply Safe Work Habits

Competency/Terminal Performance Objective

1.0.2 While conducting a laboratory activity, apply safe work habits according to school policies.

Competency Builders/Pupil Performance Objectives

1.0.2.1 Given a product label, follow label information based on criteria outlined in assessment instrument.

1.0.2.2 Given a simulated injury situation, administer basic first aid as specified in American Red Cross criteria.

1.0.2.3 Given a laboratory situation, wear protective clothing and equipment based on performance criteria list.

1.0.2.4 Given a laboratory situation, use safe lifting and carrying methods according to OSHA standards and an assessment instrument.

1.0.2.5 Given sample signs, interpret information on signs according to an assessment instrument.

1.0.2.6 Given a piece of equipment, maintain and use slow-moving vehicle signs when operating vehicles on road according to an assessment instrument.

1.0.2.7 Given a piece of equipment, keep riders off mobile equipment following manufacturer's equipment safety standards.

1.0.2.8 Given a hazardous material, observe safety precautions when handling and storing hazardous materials according to OSHA standards and an assessment instrument.

1.0.2.9 Given a hazardous situation, follow procedures for personal cleanup after handling hazardous materials according to OSHA standards and an assessment instrument.

1.0.2.10 Given a case situation, dispose of hazardous materials and containers in compliance with OSHA standards and an assessment instrument.

1.0.2.11 Given a laboratory situation, handle living material safely based on performance criteria list.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.5 Identify details such as who, what, why, where, when, or how
1.0.8 Define words used in context
2.0.3 Record observations

Applied Academics Competencies

Communications *(continued)*

2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
2.0.19 Use appropriate punctuation and capitalization
3.0.1 Demonstrate effective listening skills
3.0.3 Communicate appropriately with co-workers, clients, and supervisors
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

3.1.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. *Applying Pesticides Correctly -- A Guide for Private and Commercial Applicators*, Ohio State University Extension, Bulletin 825. The Ohio State University and Information Impact in cooperation with the Extension Service, U.S. Department of Agriculture, and the Office of Pesticide Programs, U.S. Environmental Protection Agency
2. *Greenhouse Pesticide Safety Training* -- Floriculture Greenhouse Industry Alliance, 1994
3. *Greenhouse Pesticide Safety Training* video -- Floriculture Greenhouse Industry Alliance, 1994
4. *Protective Clothing for Pesticide Users* -- Ohio State University Extension, Bulletin 750. National Agricultural Chemical Associates, U.S. Dept. of Agriculture, U.S. Environmental Protection Agency. 3/94-3M-11515
5. Copies of pesticide labels from various pesticide formulations including fumigants EC or other oil-based formulations, and those of various toxicity ranges
6. Long-legged trousers
7. Long-sleeved work shirt
8. One-piece cotton coveralls
9. Chemical-resistant boots
10. Chemical-resistant gloves
11. Goggles
12. Respirator

Situation

Conduct this activity with Level I Agriscience Students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Gather various pieces of protective clothing and equipment to present to the class.	**Interest Approach** Show students a variety of work clothes and other examples of protective equipment which are recommended or required for working where pesticides are used. Point out that clothing and equipment worn to protect the body from exposure to pesticides are called "personal protective equipment" or PPE. PPE can include work shirts, pants, and shoes; boots; gloves; aprons; coveralls, protective suits; respirators; headgear; and protective equipment for the eyes. Ask the students the following questions: 1. Why are these items called personal protective equipment? 2. Are all types of clothes and protective equipment appropriate for use with any pesticide? 3. How can we know what clothing or protective equipment is needed for a given situation? 4. What are examples of non-chemical-resistant personal protective equipment and clothing which are recommended when dealing with certain pesticides?
Pass out copies of *Applying Pesticides Correctly* - pages 6-3 through 6-9 (pesticide exposure), and 7-3 through 7-10 (PPE).	**Supervised Study** Have the students study the handouts covering the hazards of pesticide exposure and the description of common PPE. These handouts also include charts identifying acceptable PPE for each chemical pesticide labeling statement. Ask the class the following question: • After non-chemical-resistant items such as cotton, cotton/polyester, denim, and other absorbent materials are exposed to pesticides, what needs to be done to prevent exposure from contaminated clothing?
Ask a student to write the problem statement on the board. Use the information presented on pages 1.0.2-5 and -6 (student copy).	***WHAT ARE THE STEPS TO FOLLOW WHEN CLEANING CONTAMINATED CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT?***

Define the problem

What are the steps to follow when cleaning contaminated clothing and personal protective equipment?

What to Do (Steps)	How to Do It (Key Points)
1. Clean chemical-resistant gloves or boots.	Using detergent and water, wash the outside of rubber, vinyl, or plastic gloves or boots while you are still wearing them.
2. Remove boots and gloves.	After thoroughly washing the outside of boots and gloves, remove them, and wash them inside and out with detergent and water. Rinse them thoroughly with water and hang in a well-ventilated area to dry.
3. Remove clothing.	Immediately remove all work clothes: coveralls, shirts, pants, socks, or any clothing that may have become contaminated by pesticides. Handle the contaminated clothes as little as possible.
4. Keep contaminated clothes separate from family laundry.	Place clothes in a container separate from any other clothes.
5. Wash up.	If you cannot take a shower right away, use a mild liquid detergent and warm water to wash your face, hands, forearms, and any other area that may have come into contact with pesticides. As soon as you can (no later than the end of the work day), thoroughly wash your hair and entire body with a mild liquid detergent and plenty of water.
6. Change into clean clothes.	Maintain a change of clean clothes at the work place or laboratory area for each work period during which pesticide contamination is possible. Change into clean clothes after washing your body.
7. Pre-rinse contaminated clothing.	Use one of the following methods: spray or hose off contaminated clothing outdoors; pre-soak in a suitable container such as a large tub or bucket; run the clothes with detergent through the pre-wash cycle of an automatic washer
8. Wash clothes.	Wash only a few contaminated garments at a time in an automatic washer with heavy-duty detergent and hot water. For EC and other oil-based pesticide formulations, use a heavy-duty liquid detergent. Set the washer at the highest water level and use the regular or super wash cycle. Run each batch of garments through at least two (2) complete wash and rinse cycles.
9. Rinse the washer.	Using hot water and detergent, run the empty washer through another entire cycle.
10. Dry the clothes.	To avoid pesticide residue in the dryer, line dry the clothes outdoors or in a well-ventilated area.

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

What are the steps to follow when cleaning contaminated clothing and personal protective equipment?

What to Do (Steps)	How to Do It (Key Points)

Helping Students Apply Concepts/Principles/Skills

As students work in and around the greenhouse where pesticides have been applied, they should wear the appropriate PPE described in the labeling statement of the pesticide(s) being used. The students should locate the central posting station and check it daily for the chemicals used in the areas where they will be working. They should also maintain a minimum of two (2) sets of non-chemical resistant work clothes so one set can be washed while the other is worn; thereby ensuring clean work clothes for every day. Conversely, after every day that work clothes are exposed to pesticides, the work clothes should be removed for washing. Students should wash the work clothes according to the steps presented in this lesson, or make sure the person washing the clothes follows the correct procedure.

Evaluating Student Learning

Use a written quiz to measure each student's understanding of acceptable PPE using the labeling statement for PPE and the recommended steps for cleaning non-chemical-resistant PPE. Also evaluate student learning by observing the student's use of centrally posted chemical application information and the practices followed when using and cleaning PPE.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

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PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**1 - Agricultural Safety**

Operate and Maintain Equipment

Competency/Terminal Performance Objective

1.0.3 Given a laboratory activity, operate and maintain equipment according to manufacturer's recommended standards.

Competency Builders/Pupil Performance Objectives

1.0.3.1 Given a piece of equipment, follow safety rules for equipment operation according to standards outlined in the operator's manual.

1.0.3.2 Given a laboratory situation, comply with equipment safety zones according to industry standards on an assessment instrument.

1.0.3.3 Given a case situation, operate equipment defensively according to all steps in the operator's manual.

1.0.3.4 Given safety symbols, interpret safety symbols with an accuracy of 100% on an assessment instrument.

1.0.3.5 Given an equipment manual, maintain safety shields on all equipment according to standards outlined in the operator's manual.

1.0.3.6 Given a piece of power equipment, shut down power equipment before servicing according to the operator's manual.

1.0.3.7 Given a laboratory situation, report potential equipment safety hazards to supervisor according to school policy.

1.0.3.8 Given a piece of equipment, follow manufacturer's service recommendations according to manufacturer's specifications on an assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials

1.0.4 Determine solutions to problems

1.0.5 Identify details such as who, what, why, where, when, or how

1.0.8 Define words used in context

2.0.3 Record observations

2.0.4 Prepare written report(s)

2.0.9 Write legibly

2.0.13 Use correct grammar

2.0.14 Use correct spelling

2.0.15 Write complete sentences

Applied Academics Competencies

Communications *(continued)*

2.0.19 Use appropriate punctuation and capitalization

3.0.1 Demonstrate effective listening skills

3.0.3 Communicate appropriately with co-workers, clients, and supervisors

3.0.6 Follow directions

4.0.3 Participate in discussions

4.0.12 Use appropriate language

Mathematics

3.1.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. Copies of *Safe Operation of Agricultural Equipment - Student Manual*, Hobar Publications, Silletto/Hull
2. Model farm tractors (with loader bucket, if possible)
3. One-dollar bill
4. Dimes
5. *Chart of Hand Signals* for operators of farm tractors and equipment
6. Farm tractors or machinery to identify various types of guards and shields which manufacturers use
7. Operator's manuals for tractors and machinery students may be operating

Situation

Conduct this activity with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Place questions and student responses on chalkboard or on overhead projector.	**Interest Approach** 1. How important is it to you to prevent accidents when operating farm tractors and machinery? (*possible student responses*) a. If you caused an accident that hurt or killed somebody else, you might be sued and lose everything you have. b. You could get hurt so seriously that you might be crippled for life. c. The tractor or equipment might be damaged so it is not operational, or it will cost a lot of money to repair. d. If the machinery was damaged during a busy time, like planting or harvesting, you might not get the work done when it should be, making you lose lots of income. e. If you were hurt in an accident, you might not be able to do your work or participate in sports and other activities. 2. What are some of the problems or reasons that operators of tractors and farm equipment have accidents while operating them? (*possible student responses*) a. They don't read the operator's manual and don't always know what could be dangerous. b. They get careless and don't think that an accident will happen to them. c. They get in a hurry and take chances that they shouldn't. d. Some don't realize how quickly a thing like a PTO shaft can grab them and get them wrapped up. e. They may be new operators and haven't been shown how to do things safely. f. The operator may think it's cool to drive a tractor and show off to others watching. **Supervised Study** Have students read "Tractor Stability" on pages 47-49 of *Safe Operation of Agricultural Equipment - Student Manual.*
Bring a model tractor to class for the demonstration.	Ask the students to use the model tractor to demonstrate how a tractor is affected by forces in addition to gravity which result in roll-overs and flip-overs.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Discuss the following forces: 1. **Centrifugal force** induced by short turns 2. **Rear axle torque** causing front wheels to lift when tractor is pulling hard and has good traction 3. **Leverage force** from drawbar hitched too high which causes front end to lift
	Ask the class the following questions:
Refer the students to Figure 5-7 in the Supervised Study.	1. How much reaction time might an operator have in a backward tractor tip? 2. How fast is your reaction time?
	Activity No. 1
Bring a new, one-dollar bill to class for the demonstration. Use the Data Record and Observation Sheet on pages 1.0.3-13 to 14.	1. Straighten out a new, one-dollar bill and hold it by one end. 2. Ask a student to hold his or her thumb and forefinger around the bill without touching it. The student's finger should be extended 1/2 inch from Washington's picture and the thumb is extended 1/2 inch from the other side of the bill. 3. Ask the student to keep his or her hand at that level and to grab the dollar bill when you let it go. 4. Let go of the bill without warning. 5. If the student catches the bill, the reaction time was less than 1/2 second.
	Activity No. 2
Bring several dimes to class for the demonstration. Use the Data Record and Observation Sheet on pages 1.0.3-13 to 14.	1. Have two students sit on chairs facing each other. 2. One student sits with his or her feet 18 inches apart. 3. The other student holds a dime above and between the first student's feet. (use various heights, see no. 5 below.) 4. The student holding the dime drops it without warning. 5. The first student attempts to get a foot under the dime before it drops to the floor. Getting a foot under the dime when it is dropped from a specific height indicates the following reaction times: a. from 24" = 1/2-second reaction time b. from 30" = 3/4-second reaction time c. from 36" = 1-second reaction time

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Ask students to discuss and compare their typical reaction times with the turnover time of the tractor in Figure 5-7 on page 49 of the Supervised Study. How does this information relate to the findings of the Iowa study indicating that out of 1,327 fatal tractor accidents, 818 or 62% were caused by tractor upsets, either to the side or to the rear? Ask the students this final question:
Use the Situation-to-Be-Improved form on pages 1.0.3-6 to 10 and 1.0.3-11 (student copy).	• What do we need to know or be able to do to help prevent farm tractor and machinery accidents? (*possible student responses*) a. What the operator's manual says about safe operating procedures for the equipment we are operating b. Which dynamic forces can cause a tractor to upset backwards or sideways c. What planning procedures to follow so operations are not rushed to the point of making bad decisions leading to accidents d. How to develop a "safety attitude" e. Causes and ways to prevent pinch-point accidents.

Define the problem

The rate of injury or death from farm tractor and machinery accidents is quite high. What general safety practices can we follow to decrease the chances of being injured while operating farm tractors and machinery?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
1. Have correct attitude about safety.	Accidents often occur because of an incorrect attitude or belief that "It can't happen to me" or "I'll just take a chance."	Some students are not properly preparing machines for work or not operating them in a safe manner. This may indicate safety carelessness or a lack of safety attitude.	Use a variety of means to develop a positive safety attitude in all students; for example – viewing films and videos on machinery safety; safety training and certification for each student; increasing use of safety posters and signs; inviting guest speaker for class - someone who has been the victim of a machinery accident; encouraging students to give speeches on the value of machinery safety; and using safety checklists when operating machinery.
2. Keep children away from and off of tractors and implements while in operation.	Children often do not realize the dangers of moving machinery. They too often approach a machine at a point from which they cannot be seen by the operator. Children can easily fall from tractors and be run over by the tractor or pulled implement.	Some of the students, as well as their parents, let children ride on tractors or implements.	Each student should make it a firm practice to NEVER ALLOW children on or near operating equipment. Whenever possible, children should be taught to always stay in view of the tractor or machinery operator.

Define the problem *(continued)*

The rate of injury or death from farm tractor and machinery accidents is quite high. What general safety practices can we follow to decrease the chances of being injured while operating farm tractors and machinery?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
3. Wear appropriate clothing when working around farm machinery.	Unfastened jackets, untucked shirt tails, and flared trouser legs are examples of loose, floppy clothing which easily gets caught by moving machine parts – often causing injury, amputations, and sometimes death.	In some cases, students will work around operating equipment with loose or hanging clothing.	Only properly fitted clothing should be worn when operating equipment. Shirts should be kept tucked into trousers and jackets, shirt buttons, and sleeves should be kept zipped or buttoned.
4. Be able to use hand signals to communicate with co-workers around farm machinery.	Many accidents involving farm machinery occur because communication breaks down between two workers. Also, distance between co-workers, machine noise, or noise-reducing tractor and machinery cabs all negatively affect voice communication.	Only a small percentage of the students know any hand signals.	Each student should be able to sign the basic hand signals (approximately 11) for starting, stopping, and moving equipment. Also, each student should be able to accurately interpret the hand signals signed by others. Provide charts to students and have them pair up to practice signing and interpreting the hand signals. Encourage students to educate the people they work with about the use of hand signals.

Define the problem *(continued)*

The rate of injury or death from farm tractor and machinery accidents is quite high. What general safety practices can we follow to decrease the chances of being injured while operating farm tractors and machinery?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
5. Maintain an alert and highly responsive mental condition.	As fatigue increases, so does reaction time and the risk of personal injury.	Students recognize that fatigue and lack of rest are factors when they are in the busy farming season or when they are very involved in other school activities.	Machinery operators should consider their fatigue level before and during machinery operation. They should try to get adequate rest, alternate jobs whenever possible, and take breaks from jobs that require constant alertness and quick response to conditions.
6. Regularly maintain equipment.	Serious personal injury can be caused by improper equipment maintenance; for example – loose wheels, cracked hydraulic line fittings, or unsecured mounting pins. Machine failure is less likely to occur with regular maintenance checks.	Some students have developed a pattern of consistently checking machinery for condition of parts prior to operating. Most students do not perform a thorough maintenance check on a regular basis, especially when they are busy and in a hurry to complete the work.	Each operator should develop a checklist for the items which require regular checks of maintenance and safety items. Students should record the completion of each safety and maintenance check until they can go through the process without a checklist. Also, each student should record any maintenance or safety problems which they have identified. Develop a class chart showing maintenance or safety problems identified by students for various farm machinery.

Define the problem *(continued)*

The rate of injury or death from farm tractor and machinery accidents is quite high. What general safety practices can we follow to decrease the chances of being injured while operating farm tractors and machinery?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
7. Keep safety devices working properly and in their correct location.	If shields, guards, fire extinguishers and other safety devices are not kept in place or are not operating properly, accidents and injuries are more likely to occur.	Some students have equipment with missing safety devices causing exposed pinch points; mostly on older equipment. Another major problem is PTO shields which have been removed or PTO shaft guards which are not operating properly.	Replace any guards or shields which have been removed. Be especially cautious around areas of moving parts where no shields or guards are in place due to the machine's age or poor design.
8. Operate equipment in a planned, deliberate manner.	Many accidents are caused by hurrying to get as much done as possible in a given time. Rushing through jobs often does not give enough time to think, plan ahead, and identify and prevent hazardous situations.	Some machine operations have been rushed causing undesirable outcomes; although, so far, no injuries have resulted.	Include in the safety training program, the additional negative aspects of accidents or injuries resulting from rushing a job; for example – medical bills, replacement labor costs, machinery repair costs, physical pain/ suffering, and loss of the use of a limb.

Define the problem *(continued)*

The rate of injury or death from farm tractor and machinery accidents is quite high. What general safety practices can we follow to decrease the chances of being injured while operating farm tractors and machinery?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations
9. Use equipment only as intended and limit operation to within machine capabilities.	Machine operators put themselves in hazardous situations when they force a machine beyond its intended capabilities; for example – trying to lift or carry a heavier load than equipment was designed to lift or carry. Also, many accidents are caused by equipment instability, resulting in tractor/equipment roll-over or flip-over.	Some students are pushing the limits of loading capacities. They don't always check or follow the operator's manual safety recommendations – especially regarding tractor stability.	Each student should read and become thoroughly familiar with the safety recommendations in the operator's manual for the tractor/machinery they will be operating. They should follow the manual's recommendations for load capacities, operating on a slope, breaking and turning at road speeds, operating with raised loader buckets, and similar tractor stability hazards.

Define the problem *(continued)*

The rate of injury or death from farm tractor and machinery accidents is quite high. What general safety practices can we follow to decrease the chances of being injured while operating farm tractors and machinery?

Characteristics to Be Considered	What and Why	Current Situation	Recommendations

Helping Students Apply Concepts/Principles/Skills

Applying the safety practices covered in this lesson will be very important for students as they operate tractors and/or machinery in their agricultural experience programs and job placements. Following this lesson, each student should develop a satisfactory plan of practice for safe machinery operation for all the experiences expected in their programs. Through on-site supervision of their programs, the instructor should work with parent or employer, as well as the student, to observe and reinforce the concepts covered in this lesson.

Evaluating Student Learning

Each student who will be operating a tractor should successfully complete the tractor operator certificate program. A written test should be used to evaluate the student's understanding of safe and unsafe practices. Students should be evaluated by the instructor, parent, and/or employer through observation of their practices while operating equipment in their supervised agricultural experience or agriculture job placement.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 2 - Research Technology

Use Scientific Method to Solve Problems

Competency/Terminal Performance Objective

2.0.1: Given a set problem, use the scientific method to solve problem using all steps of scientific research.

Competency Builders/Pupil Performance Objectives

2.0.1.1 Given sample research problems, list steps of the scientific method used in solving the problem.

2.0.1.2 Comparing use with non-use of the scientific method to solve a set problem, describe purpose of using the scientific method in problem solving.

2.0.1.3 Given a selected task with materials to set up a demonstration, follow steps of the scientific method in testing a hypothesis.

2.0.1.4 Using results from an experiment, determine whether the results solve hypothesis of the problem according to the scientific method.

2.0.1.5 Given a sample hypothesis and theory, differentiate hypothesis and theory using criteria of an assessment instrument.

2.0.1.6 Using information gathered from an experiment, determine whether further research is needed to solve the problem using an assessment instrument.

2.0.1.7 Given material needed to apply scientific method to a research problem, demonstrate all steps of the scientific method in a written report according to an assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems
2.2.2 Compute using appropriate units of measurement
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4 Estimate measurements
3.2.6 Use problem-solving techniques
4.2.4 Use formulas
5.2.2 Find surface areas and volumes of applicable geometric figures

Equipment, Supplies, References, and Other Resources

Procedure #1

1. 2 jars
2. paper towels
3. 40 radish seeds
4. 2 plastic bags
5. 4 labels
6. aspirin tablet
7. water
8. graduated cylinder

Procedure #2

Group A

1. wood blocks of different types (e.g., pine, oak, ash, balsa)
2. metric ruler
3. balance, beam

Group B

4. wood dowel pieces
5. graduated cylinder or beaker
6. water
7. balance, beam

Situation

This experiment is to be conducted with a class of Level I Agriscience students.

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures: Interest Approach/Teaching Methods</th></tr>
<tr><td>Use this activity to help the students see that certain elements must be in place for experiments to have valid results.

Use the information on pages 2.0.1-7 and -8 (student copy).

Divide the class into small groups of two or three students to design an experiment to test the effects of aspirin on seed germination. Use the information pages 2.0.1-9 and -10 (student copy). After the work is completed (5-10 minutes), have the students present their designs to the class.</td><td>Interest Approach
"It has been reported that aspirin improves seed germination." Could this assertion possibly be true? How could you test this?

Procedure #1
Prepare seeds for testing:
1. Count 20 radish seeds.
2. Place these seeds in a jar. Use a graduated cylinder to measure 20 ml of water. Add this water to the jar.
3. Label the jar with your name and the word "water."
4. Count another 20 radish seeds.
5. Place these seeds in a second jar. Use a graduated cylinder to measure 20 ml of water. Add this and one aspirin tablet to the second jar.
6. Label the jar with your name and the word "aspirin."
7. Soak all the seeds overnight.
8. The following day remove the seeds from the jar marked "water" and place them between two wet paper towels. Fold the edges of the paper towel and slide the towel into a plastic bag.
9. Label the bag with your name and the word "water."
10. Remove the seeds from the jar marked "aspirin" and place them between two wet paper towels. Fold the edges of the paper towel and slide the towel into a plastic bag.
11. Label the bag with your name and with the word "aspirin."
12. Allow both bags to remain undisturbed for two days.
13. After two days, open both bags and examine the seeds for evidence of growth. Those seeds that are growing will show signs of a small root extending from the seed. Those not growing will show no root.</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure #1 *(continued)* 14. Count the number of seeds from the bag marked "water" that are growing, and those that are not. Record these numbers in Table 1. 15. Count the number of seeds from the bag marked "aspirin" that are growing, and those that are not. Record these numbers in Table 1. 16. Use class totals of all seeds used. Record the numbers growing and not growing.
Record data on pages 2.0.1 - 11 and -12.	**Data Summary and Analysis** Record your observations.
	Key Terms 1. *experimental research* - research conducted to establish cause and effect relationships 2. *independent variable* - also referred to as a treatment variable, is the variable being manipulated by the researcher 3. *dependent variable* - the variable where outcome measures from a treatment are observed 4. *extraneous variable* - factors which may impact the effect on the dependent variable 5. *manipulate* - to alter or change in some manner, in research a treatment is a manipulation

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Refer to page 2.0.1 - 13 when conducting the research study. Refer to pages 2.0.1 - 14 and - 15 (student copy) when proposing investigative methods.	**Interest Approach** Show students two blocks of wood which are identical in size and shape and have been similarly painted. Tell them that although the two blocks look identical, they are actually two different kinds of wood, and they must conduct a research study to identify each type of wood. Display the equipment students will use for this lab and have students propose different procedures for investigating the research problem.
Record data in a chart similar to the one on page 2.0.1 - 16. Use page 2.0.1 - 17 to illustrate the proper use of a balance.	**Procedure #2 - Group A** 1. Use a metric ruler to find the length, width, and height of a block of wood. Measure in centimeters. 2. Record data in a chart similar to the one provided in the next section. 3. Calculate the block's volume. Volume equals length x height x width and volume units are expressed as cubic units (measured in centimeters, the volume of the wood cube would be cm^3). 4. Use a beam balance to find the mass in grams of the block and record this value. 5. Calculate the density of the wood. Remind students that density equals mass divided by volume and units used to express density are g/cm^3 (if using grams for mass and centimeters for volume). 6. Repeat Steps 1-5 for a block of different type of wood.
	Procedure #2 - Group B 1. Obtain a piece of wood dowel. 2. Determine its mass in grams. Record this value in a chart. 3. Determine its volume. Because its shape is irregular, you cannot measure it with a metric ruler. Use a technique for determining the volume of water displacement. a. Fill a graduated cylinder to the 100 ml mark with water. b. Drop the wood dowel into the cylinder, and hold below the water level with the end of a pencil. Reread the new volume. c. Subtract the original volume (100 ml) from this new volume and record this number as the volume for the wood dowel. Use ml units.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Record the data in a chart similar to the one on page 2.0.1 - 16.	**Procedure #2 - Group B** *(continued)* 4. Calculate the density of the piece of wood. Record this value using the units for density as g/ml. **Note:** the wood dowel will float in the water. Therefore, to determine its correct volume, use a pencil to push the wood dowel below the water's surface as you read its volume on the graduated cylinder.
	Data Summary and Analysis Record your observations.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

What are the steps to solve a problem?

What to Do (Steps)	How to Do It (Key Points)
Identify a problem	
Review related literature	
Develop hypothesis	
Design the experiment	
Prepare an experiment proposal	
Collect the data	
Form conclusions	
Write and/or present a research report	

• Steps/Key Points •

Problem-Solving Technique

Define the problem

What are the steps to solve a problem?

What to Do (Steps)	How to Do It (Key Points)

• Forked Road •

Problem-Solving Technique

Define the problem

Does aspirin improve seed germination?

Factors to Consider	Choice one	Choice two
	Control	Aspirin

Decision/Recommendation

The treatment with aspirin will retard seed germination. There will be fewer seeds growing than for the control group which was given only water.

• Forked Road •

Problem-Solving Technique

Define the problem

Does aspirin improve seed germination?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

Data Record and Observation Sheet

Title ____________________

Name ____________________ Date __________ Period ________

Objective(s) ____________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Scientific Method of Investigation

- Identify a problem
- Review related literature
- Develop hypothesis
- Design the experiment
- Prepare an experiment proposal
- Collect the data
- Form conclusions
- Write and/or present a research report

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What type of wood is this?

Factors to Consider	Possibilities (Possible Solutions)			
	Sample A	**Sample B**	**Sample C**	
Mass				
Volume				
Density				

Decision/Recommendation

Sample A is ____________________.
Sample B is ____________________.
Sample C is ____________________.

Listed below are appropriate densities of various kinds of wood.

	DENSITY	
Species	**Green**	**Air-Dry**
Red maple	.49	.54
Southern red oak	.52	.59
White oak	.59	.67
Loblolly pine	.47	.51
Longleaf pine	.54	.59
Shortleaf pine	.47	.51
Black locust	.66	.69
Eastern hemlock	.38	.40
Western hemlock	.42	.45
Redwood (young growth)	.34	.35
Tamarack	.49	.53
Sitka spruce	.37	.40
Ponderosa pine	.38	.40
Eastern white pine	.34	.35

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What type of wood is this?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Data Sheet - Density of Wood

Group A

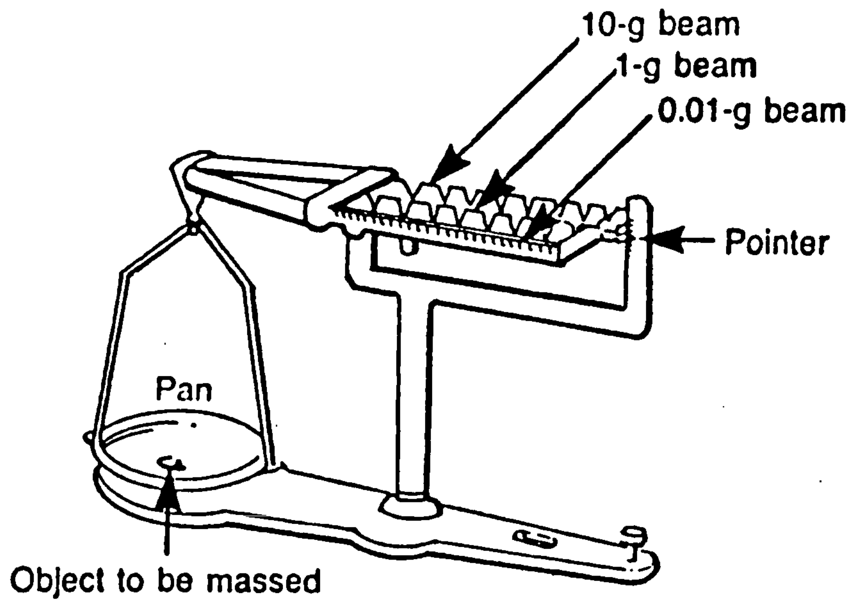
Wood Type	A Length	B Width	C Height	D Volume (A x B x C)	E Mass	F Density (E/D)

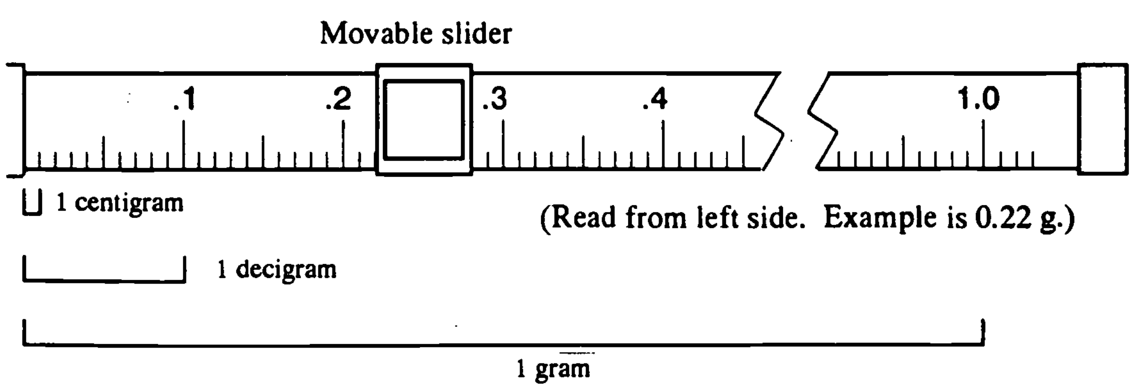
Group B

Wood Type	A Mass	B Volume	C Density

Proper Use of a Balance

Most student balances look like the one shown. The object to be massed is placed on the pan. Move the masses along the three beams until the pointer at the right comes to rest at the center line. Be sure the riders along the back two beams rest exactly in notches. Total the masses on all three beams to determine the total mass of the object. Your answer will be in grams. The first beam gives readings to the centigram. Note how this beam is read.





Be sure the balance is properly leveled and zeroed before beginning.

Helping Students Apply Concepts/Principles/Skills

During the past 20 years, agricultural production has increased dramatically despite decreasing acreage and a shrinking farm population. In 1910, a farmer produced enough food for 8 people; in 1990 a farmer produces enough food for 112 people. The labor requirements to produce our food are also considerably less today. In 1930 it took 6-8 hours of labor to produce an average of 40 bushels of corn on one acre of land. Today 100 bushels of corn can be produced on one acre of land with only 30-45 minutes of labor required. This increased efficiency can be attributed to improved technologies developed from scientific agricultural research. In agriculture, scientific research programs have resulted in such improvements as new plant cultures, chemicals for weed and insect control, numerous labor-saving devices, and better fertilization practices. Each improvement was possible because scientists began with similar procedures for solving a problem. These procedures are known as the scientific method. The scientific method consists of eight different steps. Identify a problem; review related literature; develop a hypothesis; design the experiment; prepare an experiment proposal; collect the data; form conclusions; and write or present a research report. In this lesson you will conduct a research procedure to solve a problem.

The U.S. Federal Government supports basic and applied scientific research in agriculture through the system of State Agricultural Experiment Stations. Private industry also conducts agricultural research. Seed and chemical companies develop new products for growers use only after significant time and expense is invested in the research and development process. Present research studies in biotechnology and genetic engineering by federal and private sources are likely to have a profound effect on the future technologies in animal and crop production.

Ideas for Additional Experiments

Any other experiment with a quick turn-around time can be easily used to illustrate the basic principles of scientific method.

1. Duplicate the first experiment with other pain killers or kitchen compounds.
2. Compare the densities of wood blocks of unequal sizes. (**Note**: the density of an object is the same regardless of how much or little you have of the object.)

Evaluating Student Learning

After the students have completed these activities, have them record their data and observations on pages 2.0.1-20 and -21 and develop a research paper using the outline on page 2.0.1-22.

This activity was adapted from *Biological and Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ____________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Research Paper

I. **Title Page**
name, school, course name, date

II. **Table of Contents**
major sections and sub-headings

III. **Purpose**
This section should be no more than one-half page or one paragraph in length. The hypothesis should be included here.

IV. **Review of Literature**
This section is a summary of background information which you read or located by other means. It should be written in your own words with proper credit given to any authors or researchers when their work or reports were referenced.

V. **Methodology**
This section is a summary of materials used, methods, and procedures.

VI. **Results**
This section reports the data gathered and is summarized with the use of tables, graphs, pictures, etc.

VII. **Conclusion**
This section reports, in your own words, what you have learned or discovered as a result of your experiment. It can include recommendations for further research.

VIII. **Bibliography**
This section lists your sources of information. It is complete enough so others can locate your references.

Program AGRISCIENCE

Unit 2 - Research Technology

Measure Object Using English and Metric Systems

Competency/Terminal Performance Objective

2.0.2 - Given various objects measure objects using English and metric systems within half of the smallest unit of the measurement device.

Competency Builders/Pupil Performance Objectives

2.0.2.1 Given various measurements, identify units of length, volume, mass, and temperature according to International System of Units (SI) within half of the smallest unit of the measurement device.

2.0.2.2 Given an object and measuring device, determine surface area of that object within half of the smallest unit of the measurement device.

2.0.2.3 Given various objects and measuring device(s), determine object weights within half of the smallest unit of the measurement device.

2.0.2.4 Given various objects and measuring device(s), determine calculated liquid and solid volumes within half of the smallest unit of the measurement device.

2.0.2.5 Given various physical media and temperature measuring device(s), measure temperatures of media within half of the smallest unit of the measurement device.

2.0.2.6 Given a set of criteria standards for temperature ranges in various media, estimate temperatures of those media within a range based on the media requirements.

2.0.2.7 Given examples of the effects of tension, compression, and shearing forces on objects, contrast these forces, based on a set of definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies (continued)

Mathematics

2.2.1 Convert, compare, and compute with common units of measurement within and/or across measurement systems
2.2.2 Compute using appropriate units of measurement
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4 Estimate measurements

Equipment, Supplies, References, and Other Resources

1. various measuring tools calibrated in SI units (e.g., metric ruler, metric stick, beakers, thermometers, scales, etc.
2. items to measure

Situation

This experiment is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use the information on pages 2.0.2-4 and -5 (student copy).	**Interest Approach** Obtain a sample of grain (corn). Pretend that it represents a 1,000-bushel bin full of grain which is owned by the class. However, there are insects in the grain and the 1,000 bushels must be sold immediately. You can sell the corn to the local elevator for $2.25 per bushel or to an export company for 10 cents per kilogram. Which buyer is offering the most money?
Distribute the handout on pages 2.0.2-6 and -7. Show transparency on page 2.0.2-8. Use the information on pages 2.0.2-9 through 14.	**Procedure** 1. Discuss the handout on SI measurement. 2. Record measurements of items collected for this lab. Remeasure as necessary for accuracy. Refer to the sample conversion problems when converting the SI measurements to English units. This activity is to improve understanding of the SI system. Future labs will use the SI system whenever possible.
Show transparency on page 2.0.2-15.	**Key Terms** *International System of Measurement (SI)* - system for measuring volume, weight (mass) and temperature based on units of 100. The SI unit of length is the meter; unit of volume is the cubic meter; unit of weight is the newton; unit of mass is the gram; and the unit of temperature is in degrees Kelvin.

• Forked Road •

Problem-Solving Technique

Define the problem

What is the International System of Measurement/ Why is it used in reporting results of agricultural research?

Factors to Consider	Choice one	Choice two
	English	Metric

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

What is the International System of Measurement/ Why is it used in reporting results of agricultural research?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

International System of Measurement

The International System of Measurement is based on units of 100 which can best be compared to our money system of dollars and cents. Different units are used for measuring length, volume, weight (mass), and temperature. Converting units within SI is extremely simple since changes are made by moving the decimal point. Initially it is essential to learn the metric prefixes and the units used for measuring length, volume, weight, and temperature.

Length

Length is the distance from one point to another. The SI unit of length is the **meter**. When making measurements, it is often more convenient to report length in terms which signify a portion or combination of meters. The following prefixes are used with the main unit - *meter* - to specify measurements of length.

Prefix	Symbol	Meaning
kilo-	km	1,000 meters
hecto-	hm	100 meters
deca-	dam	10 meters
meter		
deci-	dm	0.1 meter
centi-	cm	0.01 meter
milli-	mm	0.0001 meter

Volume

Volume is the amount of space a substance occupies and is based on measurements of length (i.e. length x width x height). The SI unit of volume is the **cubic meter**. However, this measurement is too large for most scientific work so scientists normally use cubic decimeters $(0.1 \text{ of a meter})^3$ to measure volume. One cubic decimeter $(1 \text{ dm})^3$ is equal to 1 liter (1). The following prefixes are used with the main unit - *liter* - to specify measurements of volume.

Prefix	Symbol	Meaning
kilo-	kl	1,000 liters
hecto-	hl	100 liters
deca-	dal	10 liters
liter		
deci-	dl	0.1 liter
centi-	cl	0.01 liter
milli-	ml	0.0001 liter

Weight

Weight is a measure of the pull of gravity on an object. The SI unit of weight is the **newton.** Since the pull of gravity differs when you leave the earth, and experiments are now conducted in space, scientists commonly measure the *mass* of an object (how much matter is contained in an object). For example, the moon's gravity is approximately one-sixth the earth's gravity. The SI unit of mass is the **gram**. The following prefixes are used with the main unit - *gram* - to specify measurements of mass.

Prefix		Symbol	Meaning
kilo-		kg	1,000 grams
hecto-		hg	100 grams
deca-		dag	10 grams
	gram		
deci-		dg	0.1 gram
centi-		cg	0.01 gram
milli-		mg	0.0001 gram

Temperature

Temperature is the amount of heat in an object. The SI unit for measuring temperature is **degrees Kelvin.** One degree Kelvin is equal to one degree Celsius which is the common unit of measurement for the metric system. The metric system of measuring temperature is also based on 100. In this case there are 100° between the freezing and boiling points of water. Common temperature measurements in Celsius are 18° Celsius – room temperature and 37° Celsius – body temperature.

Area

Area is based on measurements of length (i.e. length x width). The SI unit for area is the **square meter** (m2). However, when measuring plots of land for agricultural purposes, the **hectare** (ha) is normally used instead of the square meter. One hectare = 10,000 square meters.

International System of Measurement

Prefix	Main Units	Symbol	Meaning	
kilo-		k	1,000	thousand
hecto-		h	100	hundred
deca-		da	10	ten
	gram	g		
	meter	m		
	liter	l		
deci-		d	0.1	tenth
centi-		c	0.01	hundredth
milli-		m	0.001	thousandth

• Steps/Key Points •
Problem-Solving Technique

Define the problem

How are measurements made using the International System of Measurement?

What to Do (Steps)	How to Do It (Key Points)
Example 1: 15 in = _?_ cm STEP 1: Realize that your outcome unit is **cm**. STEP 2: Structure your derived equation so that the units cancel out leaving only the desired outcome unit. in x cm/in = cm STEP 3: Place the numbers into the derived equation using the equivalents that you have learned. At least one volume, length, and weight equivalent should be committed to memory. The most commonly used equivalents are 1 gallon = 3.79 liters, 1 inch = 2.54 cm, and 1 pound = .45 kg. This method allows any conversion by knowing only one equivalent conversion and understanding prefixes. $15 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} =$ **Note**: Place the equivalent in the equation as a proportion. STEP 4: Perform the mathematical task as indicated by the equation. **Note**: In mathematics the term "per" refers to division as 2.54 cm per inch. $15 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 38.1 \text{ cm}$ therefore, 15 in = 38.1 cm This method works equally well within either system as shown in the examples on the following pages.	

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How are measurements made using the International System of Measurement?

What to Do (Steps)	How to Do It (Key Points)
Example 2: 15 in = ? yd STEP 1: The desired outcome unit is **yd.** STEP 2: Derive an equation that will yield the desired outcome unit. $\text{in} \times \frac{\text{yd}}{\text{in}} = \text{yd}$ STEP 3: Place the numbers into the derived equation placing the appropriate equivalent in the proportion position. $15 \text{ in} \times \frac{1 \text{ yd}}{36 \text{ in}} = .42 \text{ yd}$ (rounded off to nearest tenth)	

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How are measurements made using the International System of Measurement?

What to Do (Steps)	How to Do It (Key Points)
Example 3: 15 m = _?_ cm STEP 1: The desired outcome unit is **cm**. STEP 2: The derived equation would be $m \times cm = \frac{cm}{m}$ STEP 3: Placing the numbers into the equation, we must understand the prefixes of the metric system. $15\,m \times \frac{100\,cm}{1\,m} = 1500\,cm$ **Note**: When converting within the metric system, one is really only multiplying as in the example above, or dividing by some multiple of ten. This makes conversion within (intersystem) very simple. Many times several conversions can be done at the same time using a combination of simple derived equations put together. For instance, what if you knew that 2.54 cm equaled an inch, but initially your problem was using feet? The example on the following page shows how an equation could be derived.	

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How are measurements made using the International System of Measurement?

What to Do (Steps)	How to Do It (Key Points)
Example 4: 15 ft = ? cm STEP 1: The desired outcome unit is **cm**. STEP 2: This time the derived equation will have two proportions in it. $ft \times \frac{in}{ft} \times \frac{cm}{in} = ?\ cm$ **Note**: The two proportions are inches to feet and centimeters to inches. STEP 3: Place the numbers and equivalents into the equation. $15\ ft \times \frac{12\ in}{1\ ft} \times \frac{2.54\ cm}{1\ in} = 457.2\ cm$ therefore, 15 ft = 457.2 cm **Note**: Using a computer, these calculations can be done extremely fast once the derived equation has been set up.	

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

How are measurements made using the International System of Measurement?

What to Do (Steps)	How to Do It (Key Points)
Example 5: A recent research report found a significant yield increase in corn when a certain micronutrient was added at the rate of 20 kg per hectare. No gains were noted below this rate, and toxicity levels occurred at higher rates decreasing yields. Your fertilizer spreader is calibrated in pounds per acre. Can you make this conversion accurately?	
STEP 1: The desired unit is pounds and acres.	
STEP 2: The derived equations $\text{kg} \times \frac{\text{lb}}{\text{kg}} = \text{lb}$	
STEP 3: Place the numbers and equivalents in the equations.	
Equation 1 $20\text{ kg} \times \frac{1\text{ lb}}{.45\text{ kg}} = 44.4\text{ lb}$	
Equation 2 $1\text{ ha} \times \frac{1\text{ acre}}{.4\text{ ha}} = 2.5\text{ acres}$	
therefore, $\frac{20\text{ kg}}{1\text{ ha}} \begin{array}{l} = 44.4\text{ lb} \\ = 1\text{ acre} \end{array}$	
Practice makes perfect, therefore, several simple metric and English conversions are listed in order to develop speed and accuracy.	
Note: Many people have mental blocks about the metric system, yet, once it is learned it is a much easier and exact system and is used internationally.	

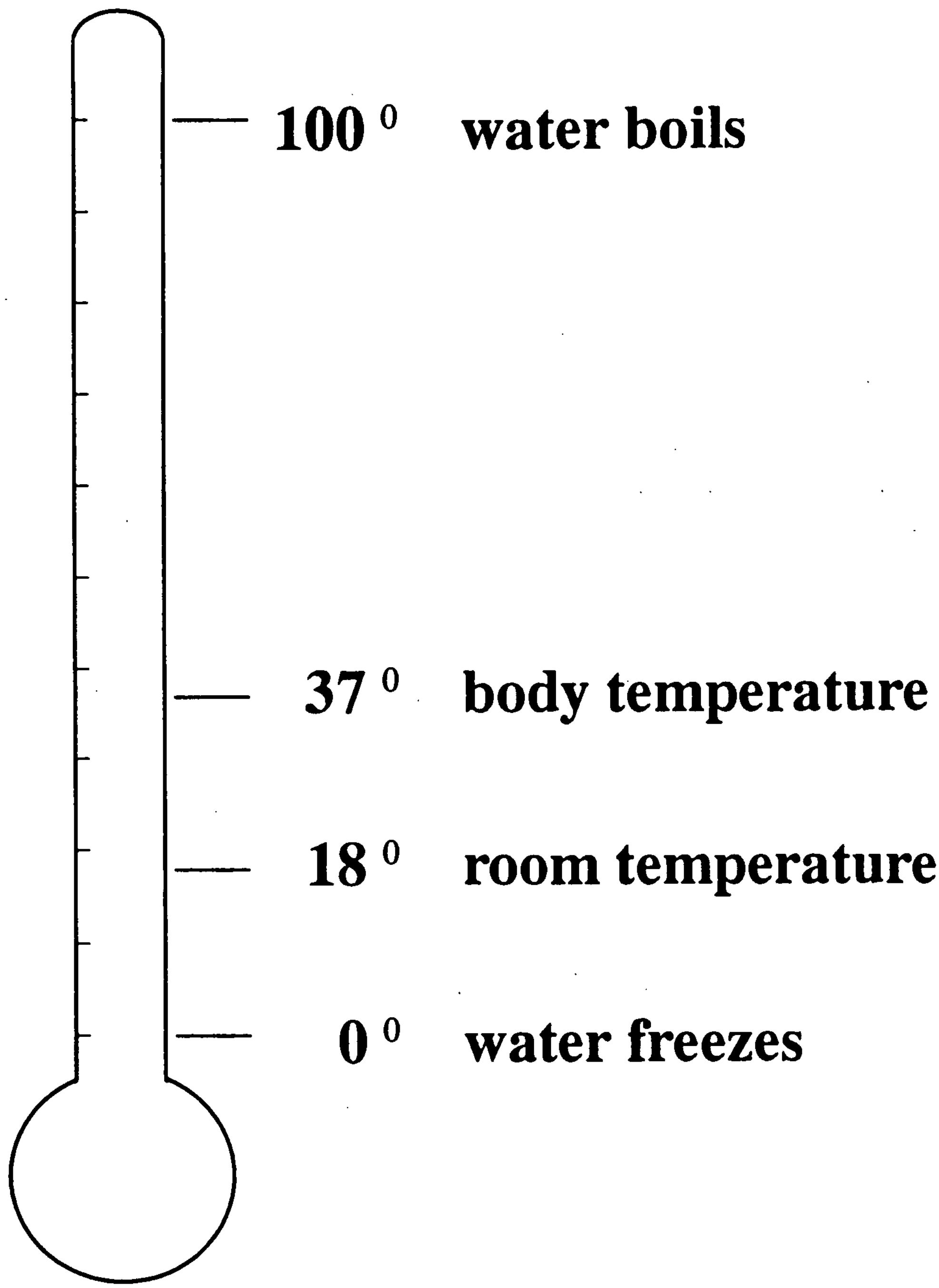
• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

What to Do (Steps)	How to Do It (Key Points)

The Celsius Scale



Helping Students Apply Concepts/Principles/Skills

The United States is the last major country in the world to convert to metric measurement. Over 90% of the world's population currently uses metric units. The United States is slowly changing to the metric system of measurement. This new system is based on the **International System of Measurement** (Sl units). Changing to the International System of Measurement will require changes in the language we use to describe our agricultural industry. However, changes in our vocabulary are already customary units for most of the rest of the world's agricultural producers. To compare agricultural production in the United States with production in most of the world it is necessary to understand the International System of Measurement. Read the following description of a European farm and an American farm. Then answer the questions.

A farmer in Western Europe owns 200 hectares of land. On 121 hectares he raises corn. The average yield is 6,271 kilograms per hectare. On 20 hectares of land he raises oats with an average yield of 2,509 kilograms per hectare. The rest of his land is used for livestock production. This farmer raises hogs. When they weigh 110 kilograms, he markets them. Normally it takes 6 months for his hogs to be ready for market.

A farmer in the United States owns 300 acres of land. On 200 acres he raises corn. The average yield is 150 bushels per acre. On 50 acres of his land he raises oats with an average yield of 50 bushels per acre. This farmer also raises hogs and markets them when they weigh 220 pounds. Normally it takes 6 months for his hogs to be ready for market.

1. Which farmer owns the most land?
2. Which farmer raises the best crop of corn?
3. Which farmer raises the most oats?
4. Which hogs are heavier at 6 months of age?

Ideas for Additional Exercises

Depending on students' accuracy in first exercises, organize additional exercises for students to gain practice using the SI system of measurement.

Evaluating Student Learning

After students have completed these activities, have them record their results and observations on pages 2.0.2-18 and -19.

This activity was adapted from ***Physical Science Applications in Agriculture***, **Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.**

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 2 - Research Technology

Examine Methods of Reporting Research Results

Competency/Terminal Performance Objective

2.0.3: Given various research examples, examine methods of reporting results. Identify all elements of the report.

Competency Builders/Pupil Performance Objectives

2.0.3.1 Given a research report and list of components needed in a research report, identify those components based on a set of standards using the scientific method.

2.0.3.2 Given a research report with charts and/or graphs, summarize data of a similar report using charts or graphs according to standards provided in sample report.

2.0.3.3 Given a research report with summarized data, draw conclusions from those data and compare to standards provided in sample report.

2.0.3.4 Given a research report, prepare an abstract for that report containing all elements as identified in sample report.

2.0.3.5 Using a research experiment, prepare a research report for that experiment containing all elements as identified in sample report provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

2.2.3 Read scale on measurements device(s) to nearest mark and make interpolations where appropriate.

Equipment, Supplies, References, and Other Resources

1. wood dowel pieces
2. 100 ml graduated cylinder
3. balance
4. graph paper
5. water

Situation

This experiment should be conducted with a Level I class of Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Collect samples of various research summaries from the local cooperative extension office.	**Interest Approach** Study the research summaries obtained from the Cooperative Extension office. Analyze the way they are prepared. List the components of a good research report. Discuss the steps in preparing a research report.
See page 2.0.3-4 for example. Use page 2.0.3-5 for student's copy.	**Procedure** *Note*: The purpose of this lab is to collect data which can be used for a graphical determination of density. 1. Weigh a piece of dowel rod on the balance (one for each student). 2. Record the mass (weight) of each dowel. 3. Fill a graduated cylinder half full of water and read the volume to the nearest 0.5 cm^3. (1 cm^3 = 1 ml) 4. Place the dowel rod piece in the graduated cylinder until it is completely covered with water. (Hold it under the water with the point of a pencil). 5. Read the new volume to the nearest 0.5 cm^3. 6. Record the initial and final volumes of water. 7. Share your data with the rest of the class.
Use the information on pages 2.0.3-6, -7, and -8. Use the information on page 2.0.3-7.	**Data Analysis and Summary** Record your data. Calculate the volume of the dowel rod piece by subtracting the initial volume of water in the cylinder from the final volume of water with the dowel rod piece in the cylinder. Using graph paper, plot the mass of the dowel on the y-axis (ordinate) and the volume of the dowel on the x-axis (abscissa) for each trial. After the points are located and marked on the graph, draw a straight line so that as many points as possible will be on the line. Points may fall on both sides of the line due to experimental error. Determine the x and y values of two points on the line and calculate the slope - m - of the line. ($m = \Delta y / \Delta x$. Δ means the change in or the difference between the two values). $m = (y_2 - y_1) / (x_2 - x_1)$ Determine the density of the dowel rod piece using the data collected in the individual trial. Density = mass of dowel / volume of water displaced

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Data Analysis and Summary ***(continued)*** Compare the value of the slope of the line with the density calculated for a single piece. Have students calculate the percent error for their individual trials. Percent error is 100 times the absolute value of the density of one trial minus the average density (the slope of the line). $\% \text{ error} = 100 \times \dfrac{(\text{density of trial - average density})}{\text{average density}}$
Use the information on pages 2.0.3-9 and -10.	Prepare a lab report including suggestions for alternative ways to design a experiment which would decrease experimental error.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the density of a solid object(s)?

Factors to Consider	Possibilities (Possible Solutions)			
	Trial 1	**Trial 2**	**Trial 3**	**Trial 4**
Mass of dowel (y)				
Final volume of H_2O and dowel				
Initial volume of H_2O in cylinder				
Volume of dowel				
Density				

Decision/Recommendation

The density of any material can be calculated if the mass and volume are known. The volume of solid objects can be measured with a ruler or by water displacement. The slope of the line estimates the average density of the wood dowel.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the density of a solid object(s)?

Factors to Consider	Possibilities (Possible Solutions)			

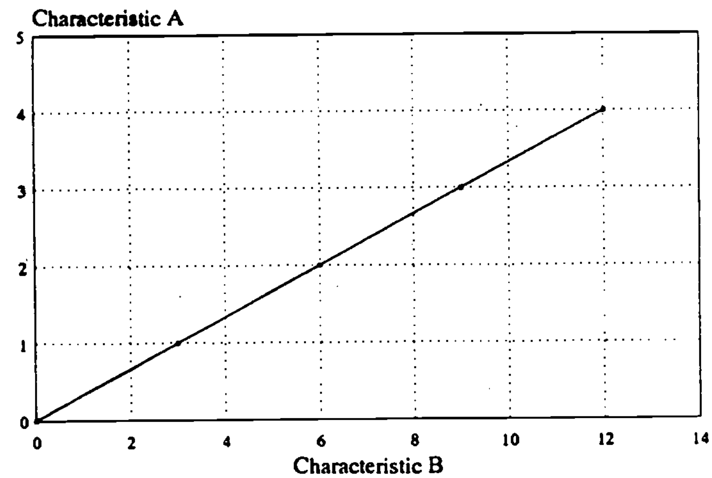
Decision/Recommendation

Graphing Experimental Data

Graphing the results of an experiment involving two variables helps to make the relationship of the variables more obvious. Consider the following graph for the direct relationships between the mass and volume of an object.

Data

Characteristic A Mass (g)	Characteristic B Volume (cm^3)
1	3
2	6
3	9
4	12
5	15

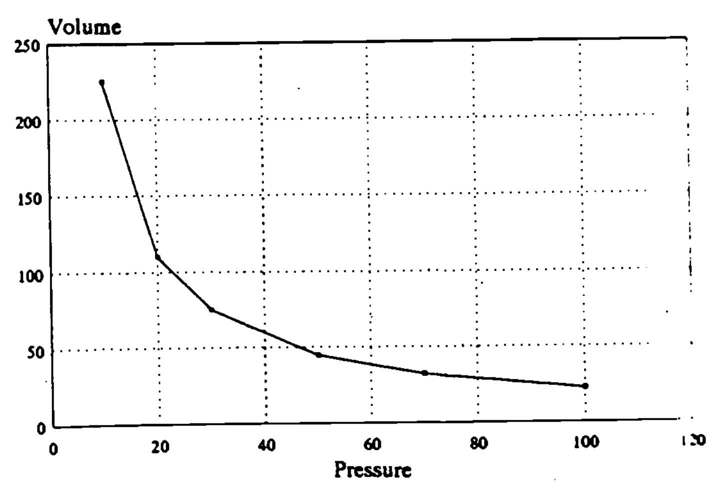


A 1 g change in A causes a 3 cm^3 change in **B**. If the graph is constructed with enough care, related values can be read directly from the graph. For example, the volume of a 3.5 g object would be 10.5 cm^3. The two variables in the example are represented by a straight line.

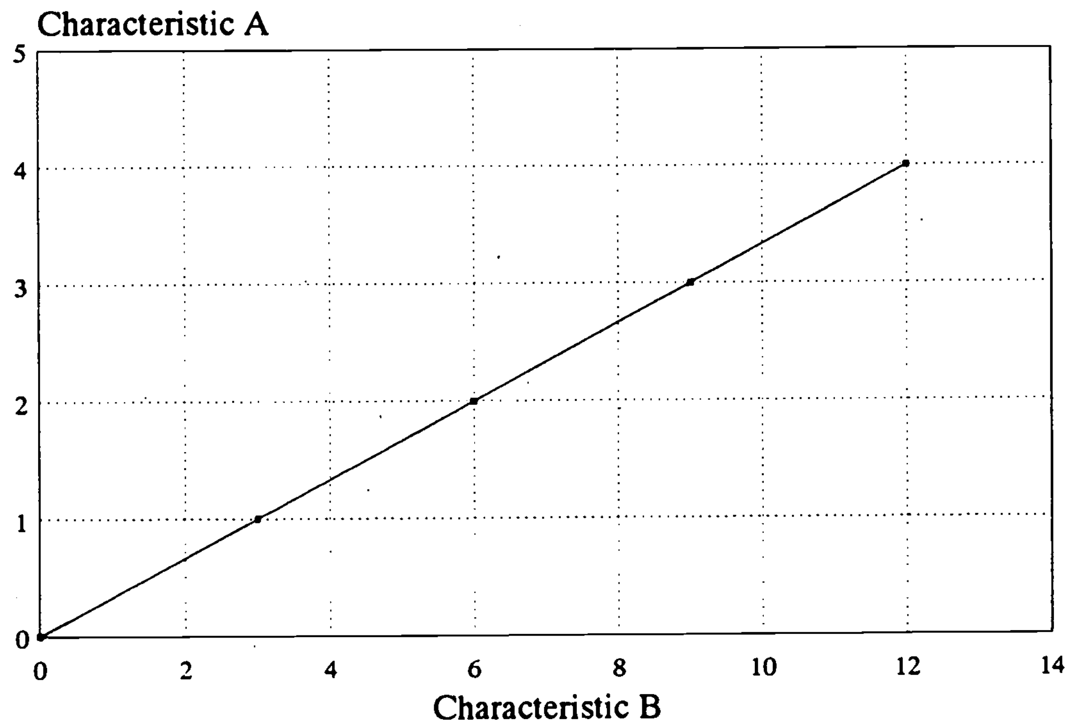
The relationship between two variables may be represented by shapes other than a straight line. In the example below the graph of the relationship between the pressure and volume of a gas forms a curve.

Data

Pressure (kPa)	Volume (dm^3)
10	225.0
20	110.0
30	74.9
50	44.6
70	32.0
100	22.4



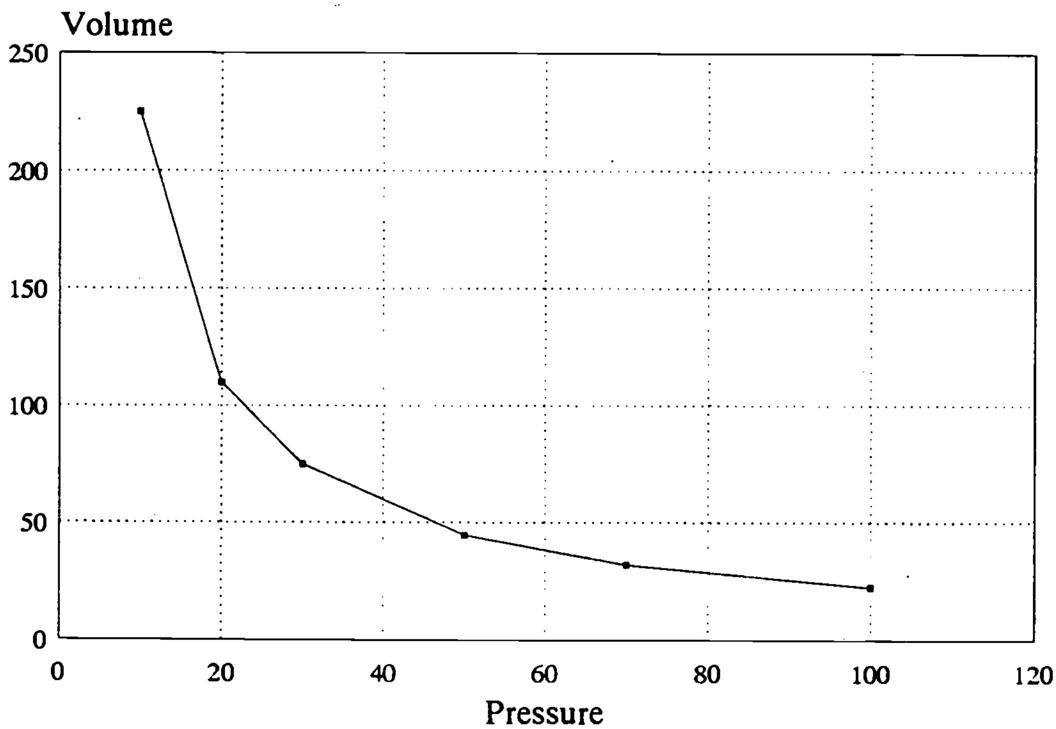
Relationship between Mass and Volume



Data

Characteristic A Mass (g)	Characteristic B Volume (cm^3)
1	3
2	6
3	9
4	12
5	15

Relationship between Pressure and Volume



Data

Pressure (kPa)	Volume (dm^3)
10	225.0
20	110.0
30	74.9
50	44.6
70	32.0
100	22.4

Format for a Laboratory Report

I. **Title of Experiment**

II. **Purpose or Objective**

This is the reason for conducting the experiment. What is the problem you are researching?

III. **Procedure**

This section lists the important activities done during the experiment - summarized in your own words.

IV. **Results**

This section reports the data collected during the experiment and is summarized using tables, graphs, pictures, etc.

V. **Conclusion**

This section reports, in your own words, what you have learned or discovered as a result of your experiment. It should include an answer to the research problem written as your conclusion to the experiment

Format for a Scientific Research Paper

Scientific research papers are more complicated than laboratory reports. A good scientific research paper contains the following information.

I. **Title Page**
name, school, course name, date

II. **Table of Contents**
major sections and sub-headings

III. **Purpose**
This section should be no more than one-half page or one paragraph in length. The hypotheses should be included here.

IV. **Review of Literature**
This section is a summary of background information which you read or located by other means.

V. **Methodology**
This section is a summary of materials used, methods, and procedures.

VI. **Results**
This section reports the data gathered and is summarized with the use of tables, graphs, pictures, etc.

VII. **Conclusion**
This section reports, in your own words, what you have learned or discovered as a result of your experiment. It can include recommendations for further research.

VIII. **Bibliography**
This section lists your sources of information. It is complete enough so others can locate your references.

Helping Students Apply Concepts/Principles/Skills

Most people view agricultural researchers as scientists who spend their time investigating agricultural problems and developing solutions to those problems. However, agricultural researchers are also authors as well as investigators. For research to be useful it must be shared with others. Reporting research is as important as conducting research, even though research results do not lead to a solution of the problem. However, other researchers studying the same problem will know what **not** to study. Most of the major breakthroughs in agricultural research - such as gene manipulation - were accomplished after years of eliminating unsuccessful procedures.

Agricultural researchers regularly attend meetings and read scientific journals to learn about research other scientists are conducting. An important step in the research process is literature review. Researchers try to discover all that is already known about the problem they wish to study. Agricultural researchers now use computers to immediately access hundreds of summaries of studies conducted throughout the world for any crop or species of livestock. The great productivity of United States agriculture is dependent on the reporting of agricultural research as well as conducting research.

Ideas for Additional Experiments

Determine the densities of other objects. Plot the data on a graph and compare average densities by studying the line slopes.

Evaluating Student Learning

After the students complete the experiments, have them record their data and observations on pages 2.0.3-12 and -13.

This activity was adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	Results

NOTES

Conclusions

Program AGRISCIENCE

Unit 2 - Research Technology

Examine Nature of Current Agricultural Research

Competency/Terminal Performance Objective

2.0.4: Given various current research reports, examine the nature of current agricultural research, identifying all categories, terms and definitions.

Competency Builders/Pupil Performance Objectives

2.0.4.1 Given examples of science and technology research, distinguish between science and technology, based on a set of definitions provided.

2.0.4.2 Given current agricultural research magazines, describe types of current agricultural research, based on a set of categories provided.

2.0.4.3 Given current agricultural research examples, describe general procedures for conducting agricultural research, based on the scientific method.

2.0.4.4 Given examples of current technology, assess risks and benefits of this technology to agriculture, based on criteria provided.

2.0.4.5 Given examples of current technology, assess risks and benefits of this technology to society, based on criteria provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

- The labs for this lesson are limited to analysis of research activities in plant agriculture. No special equipment is needed. Copies of current agricultural magazines containing articles describing research in plant agriculture should be obtained prior to beginning this lesson.

Situation

This activity is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	INDIVIDUAL ACTIVITY ***Evaluate the Benefits of Agricultural Research*** **Problem:** Is the cost of agricultural research offset by the benefits it provides? Federal and state governments and private companies invest many dollars in agricultural research which has resulted in new plants, machines, technologies and other helpful products for farmers. The Agricultural Research Service of the United States Department of Agriculture is a major supporter of agricultural research programs. *Is the cost of agricultural research programs offset by the benefits they provide?* Use library sources such as magazines and newspapers to describe recent research efforts and their benefits. For more information about current ARS projects you may also write directly to: **USDA, ARS** Information Staff Room 305, Bldg. 005 BARC-WEST Beltsville, MD 20705 *Do you think the United States should keep spending so much money on agricultural research?* Support your opinion with facts.
Duplicate the list of risks on the student information sheet or dictate it to the students. Also use the information on pages 2.0.4-4 and -5 (student copy).	**CLASS ACTIVITY** Complete the "Am I At Risk?" questionnaire on page 2.0.4-6.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

Am I at risk? (weighing benefits and risks of personal activities)

What to Do (Steps)	How to Do It (Key Points)
STEP 1: Read each item listed on page 2.0.4-6 and, based on your own opinion, rank as high risk (10), to low risk (1), or no risk (0). If the item needs further restriction or clarification, write the modification and then rank the item.	
STEP 2: Consider each item. If it is a risk you take, place a negative sign (-) in front of it. If you never take the risk, place a positive sign (+) in front of it. If you have no control over the risk being present in your life, leave a blank space in front of it.	
STEP 3: Add up the number of risks you take whether they are daily or less frequent occurrences. Record the results. Circle the risk which would be the easiest to eliminate. Behind each item you have listed as a risk, write briefly the consequences of taking that risk. For example: crossing the street without looking both ways – possible broken bones or death.	
STEP 4: Write what "risk" means to you. Describe your attitude and feelings toward risk. One last question, but don't answer it now. Think about it. To what extent can risk be eliminated?	
STEP 5: Relate risks and benefits from agricultural research to risks and benefits taken in personal activities on a daily basis.	

• Steps/Key Points •

Problem-Solving Technique

Define the problem

Am I at risk? (weighing benefits and risks of personal activities)

What to Do (Steps)	How to Do It (Key Points)

Am I at Risk?

Student Information Sheet

Ranking	Risk Taken

RISKS

1. Driving or riding in a car without a seat belt.
2. Riding a two-wheel bicycle
3. Flying as passenger on a commercial airline
4. Riding a motorcycle
5. Being in a nuclear war
6. Smoking cigarettes
7. Littering
8. Cutting class
9. Eating red meats
10. Washing outside windows on a high-rise building
11. Driving through an intersection on a yellow light.
12. Joining the armed services
13. Mountain climbing
14. Breathing
15. Jogging

[1]10 = high risk, 1 = low risk
[1](-) if it is not a risk you take,
(+) if you take the risk.

Helping Students Apply Concepts/Principles/Skills

Plant Agriculture of the Future

Technology will have an enormous impact on plant agriculture in the future. Biotechnology is advancing rapidly and will add an important new dimension to crop improvement. For example, desirable genes from wild species and other plant species and genera will be introduced into crops that cannot be crossed naturally by conventional plant breeding techniques. As a result, genetic variability will increase. Furthermore, biotechnology will permit desired traits to be introduced into plants. These traits include greater resistance to diseases, insects, herbicides, and environmental stresses. Because many of these traits are controlled by single genes, they can be modified by genetic engineering much more easily than complex traits (such as yields), which are controlled by multiple genes.

For decades, plant breeders have introduced genes into crop plants to improve them, but the procedure takes many years. Frequently, several undesirable traits accompany the desired trait, thus yields might increase, but the new variety may be susceptible to a disease. Many generations of back-crossing are then required to eliminate the undesirable traits.

Evaluating Student Learning

After students complete these activities, have them record their data and observations on pages 2.0.4-8 and 9.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 2 - Research Technology

Examine Effects of Agricultural Research

Competency/Terminal Performance Objective

2.0.5: Given examples of current agricultural research, examine the effects of agricultural research, identifying categories and standards.

Competency Builders/Pupil Performance Objectives

2.0.5.1 Given examples of current agricultural technology, describe its effect on labor requirements for food production, based on standards provided.

2.0.5.2 Given examples of current agricultural research, identify major thrusts of technology, based on the number and types of new technology researched.

2.0.5.3 Given examples of current agricultural technology, identify six benefits of technology to producers and consumers, based on standards provided.

2.0.5.4 Given examples of current agricultural technology, identify six social consequences of that technology, based on standards provided.

2.0.5.5 Given examples of current agricultural technology, identify the impact of technology on agricultural communities, based on standards provided.

2.0.5.6 Given examples of current agricultural technology, compare three of its risks and three of its benefits to producers and consumers, based on standards provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics:

1.2.1 Round and/or truncate numbers to designated place value.
3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

Two readings are provided in this lesson which describe the impact of mechanization in agriculture. The readings take opposite perspectives of the benefits which have come from increased mechanization.

Situation

This activity is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring a sample of wheat or corn to class. Make copies of the enclosed readings: *Agricultural Mechanization: Who Wins? Who Loses?* and *Agricultural Mechanization: Who Loses? Who Wins?* (see pages 2.0.5-6 through 2.0.5-9) Use USDA tables on page 2.0.5-10. Use information on pages 2.0.5-4 and -5 (student copy).	**Interest Approach** During the past 100 years, has more progress been made in increasing **yields** of corn and wheat, or in increasing the **production efficiency** for corn and wheat? Estimate the changes in yields versus the changes in man-hours necessary to produce an acre of corn or wheat for the past century. (Answers are provided in the USDA tables included in this lesson.) **Procedure** 1. Divide the class into two debate teams and give each team copies of one of the two readings. 2. Have each team prepare an oral summary of their reading and present their case regarding the advantages or disadvantages of increased mechanization and its effect on agriculture. 3. Discuss the benefits and risks associated with the introduction of technology made possible through scientific research. 4. Following the debate, conduct a class vote on whether there are more winners or losers from increased mechanization in agriculture.
	Data Summary and Analysis Prepare a short summary on the impact of mechanization on the local community. Has it been positive or negative?
	Key Terms 1. *agricultural research* - the application of scientific principles to agricultural problems. 2. *agricultural technology* - the tools and processes used to produce agricultural products and prepare them for use by consumers.

• Effect-Cause •
Problem-Solving Technique

Define the problem

How have producers (people who work in agriculture) and consumers been affected by the increase of mechanization in the agricultural industry?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

As a consequence of technological changes, agricultural production in the United States in the past 50 years has increased approximately threefold, while output per person working on the farm has increased over eight-fold.

• Effect-Cause •

Problem-Solving Technique

Define the problem

How have producers (people who work in agriculture) and consumers been affected by the increase of mechanization in the agricultural industry?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

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Agricultural Mechanization: Who Wins? Who Loses?

Public support for research in agricultural mechanization has helped farmers to maintain a profitable business providing an abundant supply of food for the American consumer. Producing that food requires less labor today than in the past because of farm mechanization. What are the major thrusts of mechanization and who benefits? Read the remainder of this article to find out. Do you think public support for agricultural research and increased mechanization is good or bad?

"The first major thrust of mechanization is to reduce the drudgery of repetitive tasks. The plow has replaced the spade. The combine has replaced the scythe and flail. While mechanization has relieved man from the mindless drudgery of hand agriculture, it has at the same time enhanced his productivity. Because of that greater productivity, today's American farmer enjoys basically the same standard of living as his urban cousin.

The second major thrust of mechanization is to develop stability in the food production system. Crops must be planted and harvested within narrow time slots - commonly one or two weeks. Planting and harvesting traditionally are very labor-intensive; all available manpower must be thrown into the task. Yet the rest of the year the demand for that labor force is quite low. This creates instability in the food system itself. It is not uncommon that, in years of abundance, crops which must be harvested by hand will rot in the fields for lack of an adequate labor supply.

Mechanization of planting and harvesting allows one person to do the work of many. For example, the harvesting of process tomatoes in California, which has been mechanized, requires only 8% of the total labor force required for hand harvesting. With the crop not dependent on an uncertain labor supply, the crops can be planted and harvested in a stable and timely way.

Eliminating the frantic migrations of people seeking seasonal farm jobs has made possible a more stable work pattern for US industry. That harvesting machine had to be manufactured. The steel had to be produced. Coal had to be mined all year because steel can be smelted all year and those harvesters can be assembled all year. The net result is that people are now employed indirectly in the food system as well as directly, and that indirect employment is yearly rather than seasonal.

The third major thrust of mechanization is to produce more food. When food supplies are ample, retail prices are reasonable. Our highly productive industrial economy is based first and foremost on a stable and low-cost food supply and secondly on the labor freed from the need to produce food.

Agricultural Mechanization: Who Wins? Who Loses?

(continued)

Not only are our manufacturing industries serviced by laborers who have left the farm - and who now may receive at least twice the wages they would have received on the farm - but the professions are amply endowed with people from the rural areas.

The fourth major thrust of mechanization is to solve specific production problems of the independent farmer. There appears to be a common assumption that the benefits of agricultural mechanization accrue mainly to the large manufacturer or to the large corporate farms. The tomato harvester, the electrostatic sprayer, and the large round baler are recent examples of machines developed through public research; then built first by small manufacturers and later, after a nation or international market appears assured; by the larger manufacturers. Most public mechanization research is oriented toward high-risk farm problems which do not interest the major manufacturers.

The economic and social forces which have decreased the number of farms and increased farm size are not a unique consequence of mechanization. Lettuce, which is totally hand harvested, had a decrease in number of farms in California from 1,710 in 1949 to 33 in 1973. Therefore the economics of size affect labor-intensive crops as well as mechanized crops. Public mechanization research does not accrue benefits specific to the major manufacturers of farm equipment or to the large management-oriented farm units. Rather, it responds to the needs of individual farmers and enhances their capability to maintain a viability in the food production system.

A fifth thrust of mechanization is to enable the US to continue to produce certain labor-intensive crops at a competitive price. Without continuing research support through the USDA-Land Grant network, some high-labor crop production will move to Mexico and to other nations where labor costs are low. Other high-labor crops which continue to be produced in the US inevitably will cost more. At this time of concern over the US balance of foreign payments, it appears particularly critical not to sacrifice production of a particular crop sought by the US consumer.

A sixth thrust of mechanization is to aid the undernourished peoples of the world to achieve a more adequate diet. The US and other nations with more highly developed agricultural systems can help in two ways: by supplying surplus food and by helping farmers in developing nations realize greater food supplies from available farm lands.

Who wins when agricultural mechanization progresses? Everyone! Who loses when agricultural mechanization is halted? Everyone!"

Condensed from: *Agricultural Mechanization: Who Wins? Who Loses?,* W.E. Splinter, Agricultural Engineering, Volume 61, No. 5, May, 1980.

Agricultural Mechanization: Who Loses? Who Wins?

Public support for research in agricultural mechanization has helped farmers to maintain a profitable business providing an abundant supply of food for the American consumer. Producing that food requires less labor today than in the past because of farm mechanization. What are the major thrusts of mechanization and who benefits ? Read the remainder of this article to find out. Do you think public support for agricultural research and increased mechanization is good or bad ?

" 'On December 13, 1979, Bob Bergland, then U.S. Secretary of Agriculture, said at a news conference in Fresno, California, I do not think that federal funding of (research into) labor-saving devices is a proper use of federal money. This is something to be left to private enterprise and to the state universities . . . I will not put federal money into any project that results in the saving of farm labor. The economic incentives in the market place should be powerful enough so that kind of research work can be done by private enterprise.' Later, in a prepared statement, he wrote 'we will not put federal money into research where other factors being equal or neutral - the major effect of that research will be the replacing of an adequate work force with machines.' "

It is currently a public concern that some agricultural workers who are willing to engage in farm work at the going wages are forced out of farm work by agricultural mechanization. Workers may lose their jobs when mechanization is adopted to reduce costs of production or to reduce risks associated with agricultural production. Agricultural mechanization usually requires new specialized skills. Workers who have the skills and who remain in employment may find conditions and remuneration improved, but workers who lack the skills and whose services are not needed must seek employment elsewhere. Some become temporarily or permanently unemployed.

Laborers are not the only farm persons displaced by machines and equipment. Because mechanization often makes it possible for an individual operator to manage larger units, it contributes also to consolidation of farm units, resulting in displacement of some farm operators and hired farm managers and nonreplacement of others. The release of workers from the agricultural sector into urban labor markets has also created problems. Many of the workers released in the past had only limited skills and were ill-equipped to compete for other jobs. Some of these workers now constitute an urban under-class, locked in by their lack of job-related skills and positive work attitudes.

Many of the communities experiencing population declines over the past 40 years have been heavily involved in agriculture. Where there is no compensating local source of nonfarm employment or influx of population from other areas, the decline in agricultural employment and in population leads to changes in community institutions and to pessimism about the communities' future.

Agricultural Mechanization: Who Loses? Who Wins?

(continued)

One of the first local institutions affected by depopulation is the local school district. Surplus classroom space develops, and schools are closed or consolidated. This in turn leads to a decline in open-county neighborhoods and in morale for small communities, which no longer have a school and athletic teams with which to identify.

Another place in which declines in agricultural employment are felt is in small-town trade centers. Particularly hard hit are those units supplying inputs to farm families - small grocery stores, feed stores, implement dealers, hardware stores, dry goods and clothing stores, and other types of farm-supply stores. The most vulnerable businesses seem to be the smaller ones and those catering to a small-farmer clientele.

The rural church has been the most important institution integrating the life of the rural community. Population declines lead to poor attendance, fewer services, and abandonment of country churches. Closing of churches does not necessarily lead to transfer of membership. As a result, abnormally high proportions of rural people in declining population communities are unchurched. The fate of the rural church is symbolic of the general flavor of community activity in rural communities with declining populations. Social organization life tends to wither and fade away. The quality of community leadership declines, and community and civic organizations become inactive. The community becomes less able to provide the services and satisfactions that make it a good place to live.

The decrease in agricultural employment over the years has affected many agricultural communities. Most of the out-migration occurred among young people just entering the labor force. The eventual consequences of this depopulation include closing and consolidation of schools, decline in community morale, closing of small-town businesses, abandonment of country churches, withering of social organizations, inactivity of community and civic organizations, and a decline in relative value of property in affected communities.

Who loses when agricultural mechanization progresses? Rural communities and small family farmers. Who wins when agricultural mechanization is halted? Those same communities.

Excerpts from: *Agricultural Mechanization: Physical and Societal Effects, and Implications for Policy Development* Council for Agricultural Science and Technology, Report No. 96, February 1983. (Note: The complete report emphasizes both positive and negative aspects of mechanization.)

Labor Requirements to Produce Wheat Using Typical U.S. Systems of the Period

Date	Man-Hr per Acre	Man-Hr per Bushel	Average Yield (bu/ac)	Production Systems
1830	50 - 60	2.5 - 3	20	Walking plow, brush for harrow, hand broadcast of seed, side and flail.
1895	8 - 10	0.4 - 0.5	20	Gang plow, seeder, harrow, binder, thresher, wagons, and horses
1932	3 - 4	0.15 - 0.2	20	3-bottom gang plow, tractor, 10-foot tandem disc, harrow, 12-foot combine, trucks
1968	1.5	0.05	30	Tractor, 12-foot one-way plow, 14-foot drill, 14-foot self-propelled combine, trucks
1990	0.25	0.007	35	4-wheel drive tractor, 50-foot field cultivator, 36-foot drill, 24-foot self-propelled combine, trucks

Labor Requirements to Produce Corn Using Typical U.S. Systems of the Period

Date	Man-Hr per Acre	Man-Hr per Bushel	Average Yield (bu/ac)	Production Systems
1750	60 - 70	3 - 3.5	20	Till with hoe, cultivate with hoe, hand plant, hand harvest
1894	14 - 16	0.35 - 0.4	40	Horse-drawn 2-bottom gang plow, disc, peg tooth harrow, 2-row planter, hand harvest
1932	6 - 8	0.15 - 0.2	40	Horse drawn 2-bottom gang plow 7-foot tandem disc, 4-section harrow, 2-row planter, 2-row cultivator, 2-row picker
1965	1 - 2	0.0125 - 0.025	80	5-bottom plow, 15-foot tandem disc, 8-row cultivator, 8-row planter, 4-row combine
1990	0.5 - 1	0.005 - 0.01	100	4-wheel drive tractor, 10-bottom plow, 24-foot tandem disc, 16-row planter, 8-row corn combine

Source: USDA

Helping Students Apply Concepts/Principles/Skills

Mechanization is one of the three technologies which have greatly transformed agriculture over the past 50 years. The other two areas of technology are usually referred to as agronomic and biological-chemical. Agricultural mechanization and the other technologies affect the quantity, quality, organization, location, and stability of production. As a consequence of technological changes, agricultural production in the United States in the past 50 years has increased approximately threefold, while output per person working on the farm has increased over eight-fold.

Concerns have been expressed about the effects of agricultural mechanization upon family farms, the rural community, and society in general. Should mechanization be encouraged or does it threaten the jobs of agricultural workers and the rural communities where they live? In this lesson you will be learning about the balance between benefits and risks which are part of the adoption of new technologies.

Ideas for Additional Activities

1. Have students interview older adults in the community to discover changes which have occurred in agricultural production methods as a result of mechanization.
2. Visit or invite an antique collector to your class to discuss implements used in agriculture in the early 1900s.

Evaluating Student Learning

After students complete this activity, have them record their observations on pages 2.0.5-12 and -13.

This activity was adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**2 - Research Technology**

Differentiate Elements, Compounds, and Mixtures

Competency/Terminal Performance Objective

2.0.6 Given scientific definitions, differentiate aspects of elements, compounds, and mixtures, using definitions provided.

Competency Builders/Pupil Performance Objectives

2.0.6.1 Given diagrams of atoms and molecules, compare and contrast them based on definitions provided.

2.0.6.2 Given various chemical reactions, describe these reactions based on definitions provided.

2.0.6.3 Given examples of matter in different physical states, describe these physical states based on definitions provided.

2.0.6.4 Given diagrams of covalent and ionic bonds, distinguish between these two kinds of bonds based on definitions provided.

2.0.6.5 Given examples of physical and chemical changes in matter, distinguish between these kinds of changes based on definitions provided.

2.0.6.7 Given examples of physical and chemical properties of matter, distinguish between these properties based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.5 Identify details such as who, what, why, where, when, or how
1.0.8 Define words used in context
1.0.14 Explain cause-and-effect relationships
2.0.3 Record observations
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
2.0.19 Use appropriate punctuation and capitalization
3.0.1 Demonstrate effective listening skills
3.0.3 Communicate appropriately with co-workers, clients, and supervisors
3.0.4 Identify sources of information
3.0.6 Follow directions
3.0.8 Draw inferences and/or conclusions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.1.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations

1.1.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers

1.1.5 Set up, solve, and apply ratios and proportions

1.1.6 Solve problems and make applications involving integers, fractions, decimals, percentages, ratios, and proportions

2.1.1 Convert, compare, and compute with common units of measurement within and/or across measurement systems

2.1.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate

3.1.6 Use problem-solving techniques

4.1.4 Use formulas

Equipment, Supplies, References, and Other Resources

1. Two large test tubes
2. Table salt
3. Sugar
4. Bunsen burner
5. Periodic table
6. One-quart mixing bowl
7. All-purpose flour
8. Filter paper (for filtering and funneling mixtures into jar)
9. Two-quart water pan
10. Heat source for water in pan
11. Agricultural pesticide chemical in wettable powder form
12. Agricultural pesticide that mixes into a solution
13. Three, one-quart jars with lids
14. Copies of *Data Record and Observation Sheet* on pages 2.0.6-9 and -10.

Situation

Conduct this activity with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
List the name and chemical symbols for these common elements on the chalkboard or a transparency.	**Interest Approach** Discuss with the class the name and chemical symbols for various common elements. Include in this list examples of the three forms of matter: 1. **Solid** – e.g., gold, copper, iron, aluminum, or lead 2. **Liquid** – e.g., mercury 3. **Gas** – e.g., oxygen, nitrogen, or hydrogen **Note**: All of these are classified as elements. Now ask the students these questions:
Make 3 columns on the board labeled **solid**, **liquid**, and **gas**.	1. Why are these forms of matter classified as elements? 2. Which elements under normal conditions are solid? liquid? gas?
Show the chemical symbol for water (H_2O). Explain that water is two hydrogen atoms and 1 oxygen atom combined to form a water molecule.	3. Can you give an example of two or more elements combining to create a new substance? (H_2O) 4. What term is used to describe substances formed by the combination of two or more elements? (*compound*)
	Supervised Study Ask the students to develop a definition for a *compound* during a class discussion. Mention that compounds have properties all their own, usually quite different from those of the elements from which they are formed. Use water is an example -- water, a liquid compound which cannot ignite, is made up of hydrogen, an element that burns readily, and oxygen, an element that supports burning. Salt, a solid compound which is an important substance in our diet, is another good example. It is made of sodium -- a soft, silvery, white metal in its *elemental form* -- and chlorine -- a greenish poisonous gas. Now ask the class these questions: 1. What happens to each of the compounds, salt and water, when the two are mixed together? 2. What term describes this mixture? (*solution*) 3. Does the same thing happen when wheat flour and water are mixed together? 4. What is different about the two mixtures?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Ask a student to write the problem statement on the board.	***WHAT CHARACTERISTICS CATEGORIZE A SUBSTANCE AS AN ELEMENT, COMPOUND, MIXTURE, OR SOLUTION?***
Ask the students to record their results on the *Data Record and Observation Sheet.*	**Activity 1** *Make a Solution* 1. Fill a test tube 1/2 to 2/3 full with water. 2. Add some salt and shake the tube to dissolve the salt. 3. Keep adding salt until no more will dissolve in the water. 4. Taste the solution to determine that the salt has not vanished, but is in a solution with the water. 5. Heat the test tube over a flame -- now more salt will dissolve in the water. Keep adding salt until no more will dissolve. **Observations** After conducting Activity 1, discuss the following observations with the class: 1. Water molecules move into the salt crystals and break them down into salt molecules. Therefore, the salt seems to disappear into the water when forming the solution. 2. **Definition of a solution** -- a mixture of two or more substances which blend together and appear to be a single substance (*homogeneous mixture*). The original substances are altered by a physical change which does not create any new substance. In this case, the salt crystals are reduced to salt molecules (physical change) which remain separate and do not chemically react with the water molecules to form a new substance. The solution is a mixture of salt molecules (sodium chloride) and water molecules (hydrogen and oxygen). Water is the solvent; salt the solute. 3. Only a given amount of salt will go into solution with a given amount of water.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Ask the students to record their results on the *Data Record and Observation Sheet.*	**Activity 2** Repeat Activity 1, using sugar instead of salt for the mixture. **Observations** 1. Sugar goes into solution with the water. 2. Much more sugar than salt dissolves in a given amount of water.
Ask the students to record their results on the *Data Record and Observation Sheet.*	**Activity 3** *Comparison of Solution and Mixture* 1. In a bowl, mix together equal amounts of salt and flour until they produce a white powder. 2. Fill the bowl with hot water and stir. 3. Allow this combination to settle. 4. Dip your finger into the water and taste it. **Observations** 1. The salt formed a mixture with the water producing a solution (*homogeneous mixture*). 2. The flour settled to the bottom of the bowl. Since the water and flour can still be identified as separate substances, the water and flour combination is considered a *heterogeneous mixture*. **Definition of a mixture** (heterogeneous) -- the substances in these mixtures remain identifiable, such as the stones and sand in a concrete mixture, or the nuts and chocolate in a nut-chocolate candy bar.
Make paper, funnel-shaped filters for use in this activity. Ask the students to record their results on the *Data Record and Observation Sheet.*	**Activity 4** *Recovering the Substances in the Mixture* 1. Pour the salty water and flour from Activity 3 through the filter into a container. 2. Drip a little hot water through the filter. 3. Spread out the filter paper to dry. (*Flour added to the mix will be collected on the filter paper.*) 4. Boil the remaining solution in a pan until the water evaporates. (*Salt will remain in the pan.*)

• **Possibilities - Factors** •

Problem-Solving Technique

Define the problem

What characteristics categorize a substance as an element, compound, mixture, or solution?

Factors to Consider	**Possibilities (Possible Solutions)**			
	Element	***Compound***	***Mixture***	***Solution***
Composed of identical atoms and cannot be broken down by chemical means into anything simpler.	**X**			
Composed of two or more elements which form a substance with charac-teristics different from the individual elements making up the substance.		**X**		
Composed of two or more elements or compounds in which one causes a physical (not chemical) change in the other so that visually they appear as one substance.				**X**
Composed of two or more substances which make no physical or chemical changes in the other substance(s). As a result the substances can still be individually identified after mixing.			**X**	

Decision/Recommendation

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What characteristics categorize a substance as an element, compound, mixture, or solution?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Agricultural occupations involve the use of numerous chemicals. Likewise, in the school laboratory, chemical substances are used in demonstrations and research activities to help students better understand the principles involved in using these substances. Understanding the definition of elements, compounds, mixtures, and solutions is the basis of using chemical substances safely and effectively. Students should apply this knowledge as they interpret the information on chemical labeling. They should also realize shortcomings or strengths when choosing mixtures or solutions for chemical application, and adapt application procedures to match the type of mixture or solution.

Ideas for Additional Learning Activities

1. Demonstrate the differences between a wettable powder and a solution used in pesticide sprays.
2. Provide samples of wettable powder and solution which are typically used on agricultural pests (use lowest toxicity materials possible).
3. Use small vials or jars for mixing representative ratios of pesticide to water as called for in tank mix label information.

   Safety - Demonstrate the procedures and type of protective clothing used when handling these pesticides. (e.g., face shield, chemical-resistant gloves, and apron) Assure adequate ventilation.

   a. Agitate the containers to assure thorough mixing.
   b. Let mixtures stand and have students record observations.
   c. Have students describe the unique spray techniques that may be necessary to maintain a constant ratio of pesticide to water over the total application time when using wettable powder (mixture).

Evaluate Student Learning

Each student should correctly define the following terms: element, compound, mixture, and solution.

Given a substance from any of the four categories, the student should correctly categorize the substance.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**3 - Environmental Science**

Maintain Air Quality

Competency/Terminal Performance Objective

3.0.1 Students will be able to evaluate the importance of air quality according to criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

3.0.1.1 Given a blank sheet of paper, students will be able to define air and its three major components.

3.0.1.2 Given a blank sheet of paper, students will be able to analyze, in their own words, the importance of air to living organisms.

3.0.1.3 Given a blank sheet of paper, students will be able to list, in their own words, the qualities of clean air.

3.0.1.4 Given a blank sheet of paper, students will be able to describe six major threats to air quality.

3.0.1.5 Given a Home Air Quality Test Sheet, students will be able to list agricultural practices done on their own farms (or homes) that improve air quality.

Applied Academics Competencies

Communications

1.0.4 Determine solutions to problems.

1.0.8 Define words used in context.

1.0.15 Summarize material.

1.0.16 Paraphrase material.

1.0.17 Interpret organizational patterns of writing.

1.0.20 Identify main idea and supporting details.

2.0.3 Record observations.

2.0.7 Edit written material.

2.0.13 Use correct grammar.

2.0.14 Use correct spelling.

2.0.15 Write complete sentences.

2.0.18 Use written language.

2.0.19 Use appropriate punctuation and capitalization.

2.0.21 Use transitional words and phrases effectively.

Applied Academics Competencies *(continued)*

Communications *(continued)*

3.0.4 Identify sources of information.

3.0.6 Follow directions.

3.0.8 Draw references and/or conclusions.

3.0.10 Organize ideas.

Safety

3. Prevent lung and eye damage.

6. Prevent conditions causing chemical contamination of the environment.

Equipment, Supplies, References, and Other Resources

1. Home radon test kit
2. Glass jar with a sealable lid
3. Matches
4. Balloon
5. Handout – *Home Air Quality Test Sheet*
6. Toy tractor

Situation

First or second year high school vocational agricultural students

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach Ask the class these questions: 1. Have you ever wondered about the air you breathe? 2. How do you know the air is safe? 3. Have you ever thought about the air being dangerous? 4. What kind of air is hazardous to your health? (*air containing carbon monoxide, radon gas or asbestos*) 5. Have you ever thought about how important clean air is? 6. What do you think our problem statement is today?
Have a student write the problem statement on the board.	***HOW DO WE MAINTAIN AIR QUALITY?*** **Discussion** Begin a discussion on the problem statement by asking the class the following questions: 1. What is air? (*colorless, odorless, and tasteless mixture of gases*) 2. Air is made of what? Who can name one component of air? 3. What gas do we need to survive? (*Oxygen – air contains about 21 percent oxygen.*)
Ask a student to blow up and tie off a balloon.	4. Who can name another component of air? For example – what is inside this balloon? (*Carbon dioxide – air contains less than one percent of this gas.*) 5. What is another component of air? This one makes up 78 percent of the air we breathe. (*nitrogen*) 6. What are the remaining components of air? They make up less than one percent of the air mixture. (*argon, neon, helium, carbon monoxide, and radon*) **Activity** The students already know that air is necessary to sustain life. Without air, most life forms would die. *For example –* 1. If we placed a mouse in a jar and put the lid on, it would survive for a short time. However, as soon as the mouse breathes in all the oxygen and breathes out carbon dioxide, what happens to the mouse? (*It suffocates.*)

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures: Interest Approach/Teaching Methods</th></tr>
<tr><td>You need a glass jar with a sealable lid. Light a match, drop it into the open jar and seal the lid.</td><td>2. If we put a burning match into a jar with the lid on, the match will burn for a short time. When the fire consumes all the oxygen in the jar, the fire will extinguish.
3. For people to survive, what percentage of the air must be made up of oxygen? (Air containing 21 percent oxygen and very few pollutants is considered clean.)
4. If you stop breathing and no life support systems are available, how long do you have until your brain begins to die? (four to six minutes) Air is very important to all forms of life. Even the brain depends on the oxygen that it gets through the blood stream.

POLLUTION

Discuss the following characteristics of pollution:
1. There are rivers and streams of water moving all over the earth. What happens when pollution is put into this water supply? (The pollution spreads and contaminates other areas.)
2. Air also moves like water; there are rivers and streams of air moving all over the earth. If pollution gets into the air supply, what happens? (The pollution moves and contaminates other areas, too.)

Activity

Who can name some causes of air pollution? Lead the class in a discussion of the following pollutants:</td></tr>
<tr><td>Light a second match and let a student carefully smell the odor when the match ignites.</td><td>1. Sulfur
Ask for a volunteer and light a second match. Let the student carefully smell the odor when the match ignites. Ask the following questions:
a. What does the match smell like? (rotten eggs.)
b. What causes this odor? (sulfur)
c. What are some sources of sulfur pollution? (coal, crude oil, smoke from factories and homes, and exhaust from cars)
d. After this sulfur gets into the air, what happens to it? (creates acid rain) This phenomenon has frequently made the news in the past few years because it damages buildings and crops.</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	2. ***Hydrocarbons*** a. What is a source of pollution in Los Angeles? (*smog*) b. What causes **smog**? (*car exhaust systems*) This type of pollution is caused by hydrocarbons. They are by-products of combustion and burning. c. What are some things we are doing to control hydrocarbons? (*We put scrubbers on factory smoke stacks; use ethanol and natural gas in cars; and install crankcase ventilation, air injection, and exhaust gas recirculation in cars.*)
Display toy tractor.	3. ***Nitrous Oxide and Lead*** a. How many of you use a tractor on your farm? b. What kind of gasoline do you put in it? (*Some students may say diesel. There are two kinds of gas: leaded and unleaded.*) c. Why do we have two kinds of gas? d. Can you use regular unleaded gas in your tractor? (*no*) Why not? (*Only machines with catalytic converters can use unleaded gas.*) Catalytic converters clean up emissions. They break down the lead and nitrous oxide into harmless gases.
This concludes the lesson for day one.	4. ***Carbon Monoxide*** • Who can name one more kind of poisonous gas from cars? (*carbon monoxide*) This is a colorless, odorless, **highly poisonous** gas. The best way to reduce this kind of gas emission is to keep your engines well tuned.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Begin lesson for day two at this point.	**Interest Approach** Begin the discussion by asking the following questions: 1. Is the air you are breathing in this classroom safe? 2. Could the air in this room be dangerous? 3. How would you determine if the air is safe to breathe?
Conduct a quick review of yesterday's material with the students.	Explain to the class that later in today's lesson you will conduct a scientific test to detect the presence of dangerous gases. But first you must review the following dangerous gases and materials: **DANGEROUS GASES AND MATERIALS** Lead a class discussion on the following types of dangerous gases and materials: 1. ***Radioactive Dust and Materials*** Sometimes radioactive material can release radioactive particles. If these are in the air supply they can harm us. This concern has led to a reduction in the number of nuclear plants generating electricity. 2. ***Chlorofluorocarbons*** a. How many of you have air conditioners at home or in your car? b. How many of you use aerosol cans? Both of these release chlorofluorocarbons into the air. When chlorofluorocarbons are in cans or in cooling systems, they are harmless. However, they cause problems when released into the air. These gases float up into the atmosphere and remain there for almost 100 years before they decompose. During this time they damage the **ozone layer**. c. What is the ozone layer? (*layer of atmosphere that protects us from ultraviolet radiation*) With a damaged ozone layer, the number of cases of skin cancer increases. Consequently, when out in the sun, you should apply a sun block lotion to your skin to protect it from harmful ultraviolet radiation.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	3. ***Pesticides*** • Who can explain what pesticides are? (*sprays that kill insects, diseases, weeds, rodents, and similar pests*) Not all pesticides are pollutants. In order to be a pollutant, a pesticide must contain a poison or be harmful to more than one kind of organism. Sometimes it is the way in which the pesticide is used that makes it dangerous. This is why it is extremely important to follow the directions on the label when using a pesticide. 4. ***Asbestos*** At one time this material was thought to be a wonderful product. It was heat and friction resistant and used for brake and clutch linings, house siding, construction, hot water pipe insulation, and much more. However, it was discovered that when asbestos decomposes, its fibers can get into our lungs and cause disease or death. Use of asbestos is now forbidden and it must be removed from previous installations. 5. ***Radon*** This colorless, radioactive gas is formed during the decomposition of radium. It seeps up through the ground. a. What happens if a house or building is located over a place where radon is leaking? (*Radon seeps into the structure and can harm the people living or working there.*) Radon can seep through cracks in basements, floors, or walls. One way to stop radon is to seal up the leaks. b. Would you like to know if there is radon gas in this room? If so, we must conduct a radon test.
Conduct the home radon test. Follow the instructions on the kit. Distribute problem-solving sheet on pages 3.0.1-10 to -11. *This concludes day two of this lesson.*	**Supervised Activity** At this point conduct the radon test. Have the students read the directions, conduct the test, and interpret the results. (Provide your assistance, if needed) Distribute the handout – *Home Air Quality Test.* Ask the students to make a check of the air quality in their homes. They should fill out the sheets and bring them to the next class. (Parental assistance may be necessary during this assignment.)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Begin the lesson for day three at this point.	**Discussion** Discuss the results of the *Home Air Quality Test Sheets* in class. Ask the following questions: 1. How many of you were surprised at the results? 2. What could you do differently at home to improve air quality?

Helping Students Apply Concepts/Principles/Skills

Use discussions, independent and supervised activities, integration of applied academic competencies, and situation-to-be-improved problem-solving techniques to apply concepts in maintaining air quality.

Evaluating Student Learning

Give the students each a blank sheet of paper. Have them answer the following questions:

1. What is the definition of air?
2. What are the major components of air?
2. Why is air important to living things?
3. What are the qualities of clean air?
4. What are the six major threats to air quality? (Describe them.)

This activity was submitted by Darrell Rubel and Terri Porter, Agricultural Education Department, The Ohio State University, Columbus, Ohio.

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Home Air Quality Test

Define the problem: What is the air quality where you live?

Characteristics to Be Considered	**Current Situation** *(Student Information)*	**Ideal Situation**	**Recommendations** *(Student Responses – given gap between ideal and current situation.)*
1. Do you have aerosol products containing chlorofluorocarbons (e.g., spray cans, cooling units)?		Listed in plain view: all aerosol products containing chlorofluorocarbons	
2. What kinds of ventilation systems are in your buildings? Are the work areas used for painting well ventilated? Does the kitchen have an exhaust fan to remove cooking oil fumes?		Well-ventilated fans - present and working	
3. Have your home and buildings been checked for radon gas?		Yearly check for radon gas	
4. How regularly do you clean and service your furnaces, air conditioners, and ventilation systems?		Yearly check	
5. How clean are your work areas? Are they free of dust and sawdust? Are the paint cans firmly covered?		Clean work area: no excess dust or sawdust, firmly closed paint cans	

Home Air Quality Test

(continued)

Define the problem	What is the air quality where you live? *(continued)*		
Characteristics to Be Considered	**Current Situation** *(Student Information)*	**Ideal Situation**	**Recommendations** *(Student Responses – given gap between ideal and current situation.)*
6. How is gasoline stored? Are the containers air-tight?		Stored in well-ventilated area away from furnaces or water heaters	
7. Are your gasoline and diesel engines properly tuned (e.g., small motor engines, automobiles and machinery)?		Regularly tuned small engines	
8. Do you observe outdoor burning laws?		Yes	
9. Do you follow label directions when using pesticides?		Yes	
10. Additional observations			

How did you rate? (Air quality where student lives based on student responses in recommendation column.)

Ratings:

Excellent = 8 to 10 characteristics which match the ideal situation
Good = 6 to 7 characteristics which match the ideal situation
Satisfactory = 4 to 5 characteristics which match the ideal situation
Unsatisfactory = 4 or fewer characteristics which match the ideal situation

Program AGRISCIENCE

Unit 3 - Environmental Science

MAINTAIN WATER QUALITY

Competency/Terminal Performance Objective

3.0.2 - Given examples, describe how to maintain water quality using criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

3.0.2.1 - Using references, define "water" and identify its components based upon criteria outlined in assessment instrument.

3.0.2.2 - Using references, describe the hydrologic cycle using criterion assessment instrument.

3.0.2.3 - Given a case situation involving agricultural practices, identify agricultural practices affecting water quality according to criteria outlined in assessment instrument.

3.0.2.4 - Using the local situation and references, list threats to water quality based upon definitions and notes provided.

3.0.2.5 - Given a case situation involving groundwater quality, identify factors affecting groundwater quality according to criteria outlined in assessment instrument.

3.0.2.6 - Given examples, list water conservation practices based upon definitions and notes provided

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. 2-liter clear plastic container
2. pump sprayer from a bottle of all-purpose cleaner
3. small piece of nylon fabric
4. masking tape or rubber band
5. transparent straws
6. small rocks
7. clean sand
8. red food coloring
9. spray container with water
10. disposable syringe

Situation

This experiment is to be conducted with a class of Level I Agriscience students.

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures: Interest Approach/Teaching Methods</th></tr>
<tr><td>Prepare two water samples for the class to observe. One sample should be cloudy, the other sample relatively clear. The cloudiness can be produced by the oversaturation of sugar or salt. The clear glass should contain impurities found in water such as trace elements or waste.
Use the information on pages 3.0.2-5 and -6 (student copy).</td><td>Interest Approach
Identify which water sample appears to be better for drinking. Discuss the impurities found in each sample. Answer the question, "How do impurities enter our drinking water?"</td></tr>
<tr><td>Directions for Flow Model Construction
1. Secure a piece of nylon over the end of the pump sprayer with masking tape or a rubber band. The nylon will act as a pump screen.
2. Cut the top off the plastic 2-liter container.
3. Fill the container one-third full with small rocks. (See page 3.0.2-7.)
4. Insert the pump sprayer into the rocks and hold vertically while filling the container with sand to within two inches of the top.
5. Insert a straw into the sand so it is near the outside of the container.</td><td>Procedure
1. Slowly add water to the flow model to saturate the sand and rocks. Observe the water table. Discuss how the addition of precipitation affects the level of the water table. (The sprayer represents a well which will be used to lower the water table.)
2. Use the pump sprayer to withdraw water from the flow model. Observe the cone of depression and the water which gradually fills in the depression.
3. Add food coloring to the syringe water and inject this "pollutant" into the top layer of sand.
4. Use the pump sprayer to withdraw water from the model and observe the movement of the pollutant.
5. Draw the water level below the top of the sand. Spill pollutant (food coloring) on top of the sand. (When water is withdrawn at this time, pollutant will not reach well water unless water level is over sand.)
6. Spray water on the sand to simulate rain and draw water from the model with the pump. Observe action of the pollutant.</td></tr>
<tr><td>Refer to pages 3.0.2-8 and -9.</td><td>Data Summary and Analysis
Sketch the movement of the pollutant. Record observations when water is added to the flow model.</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *atmosphere* - the gaseous layer that surrounds the earth (air) 2. *biosphere* - all living organisms (plant and animal life) 3. *calorie* - the amount of heat required to raise the temperature of one gram of water one degree centigrade 4. *consumption* - water that is actually consumed, transpired, or incorporated into new products as it is used 5. *evapotranspiration* - the loss of water to the atmosphere from land and water surfaces by evaporation and from plants by transpiration 6. *hydrologic cycle* - the circulation of water within the earth's system through evaporation, condensation, precipitation, runoff, groundwater storage and seepage, and re-evaporation into the atmosphere. 7. *hydrosphere* - water held in oceans, rivers, lakes, glaciers, groundwater, plants, animals, soil, and air 8. *latent heat* - the heat absorbed or released as water changes between the gas (water vapor), the liquid (water droplets), and the solid (ice) states 9. *lithosphere* - a general term for the outer layer of the earth 10. *surface runoff* - the flow of water from the land to the oceans or interior basins by overland flow and stream channels. 11. *withdrawal* - water withdrawn from the surface and groundwater sources for various human uses

• Effect-Cause •
Problem-Solving Technique

Define the problem
How do pollutants move into groundwater resources?

Possible Causes	Related Facts	Accept/ Reject Cause
Landfill		
Precipitation		
Surface runoff		

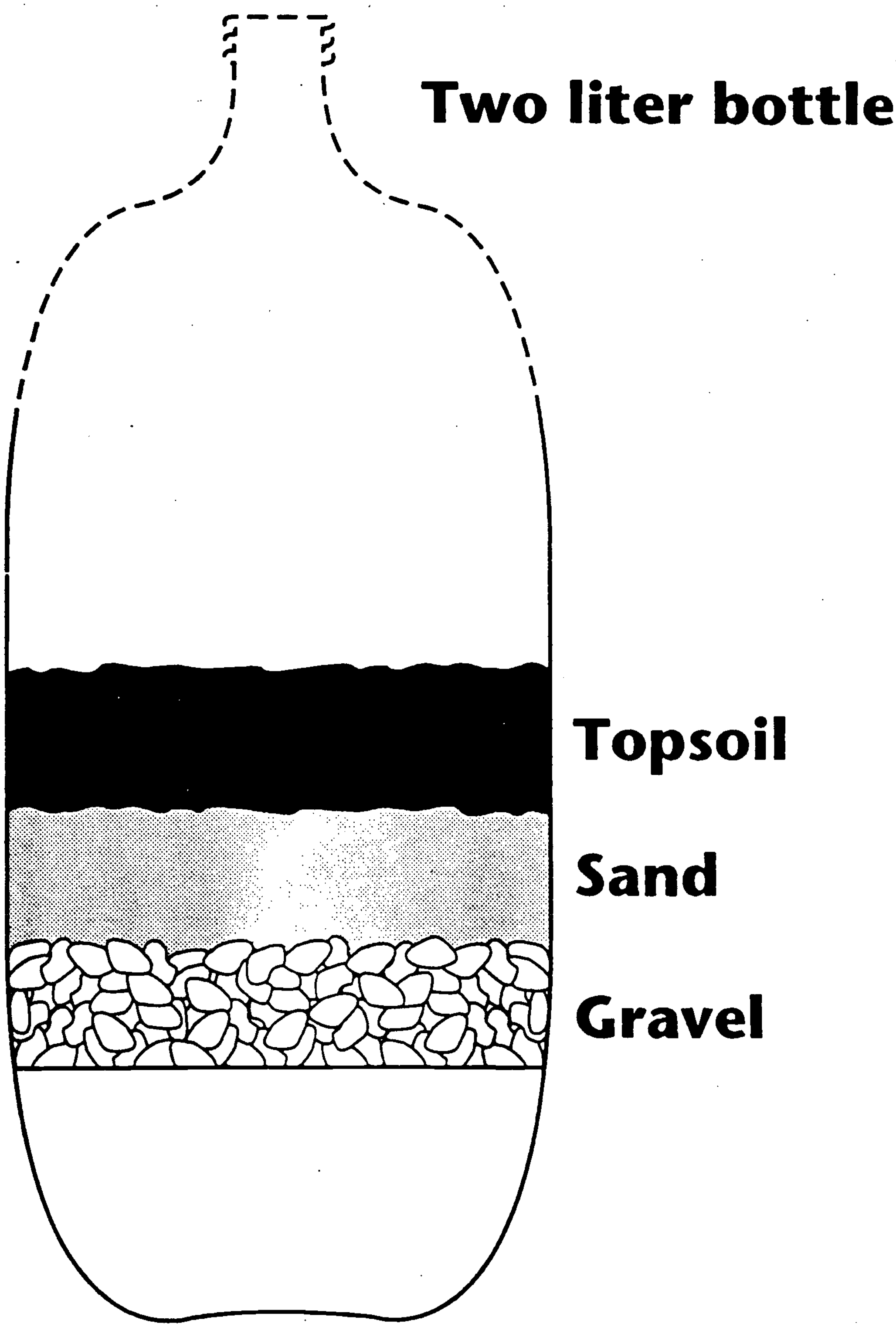
Decision/Recommendation
The "pollution" (red food coloring) moves in the direction of the flow of water as it is withdrawn from the model.

• Effect-Cause •
Problem-Solving Technique

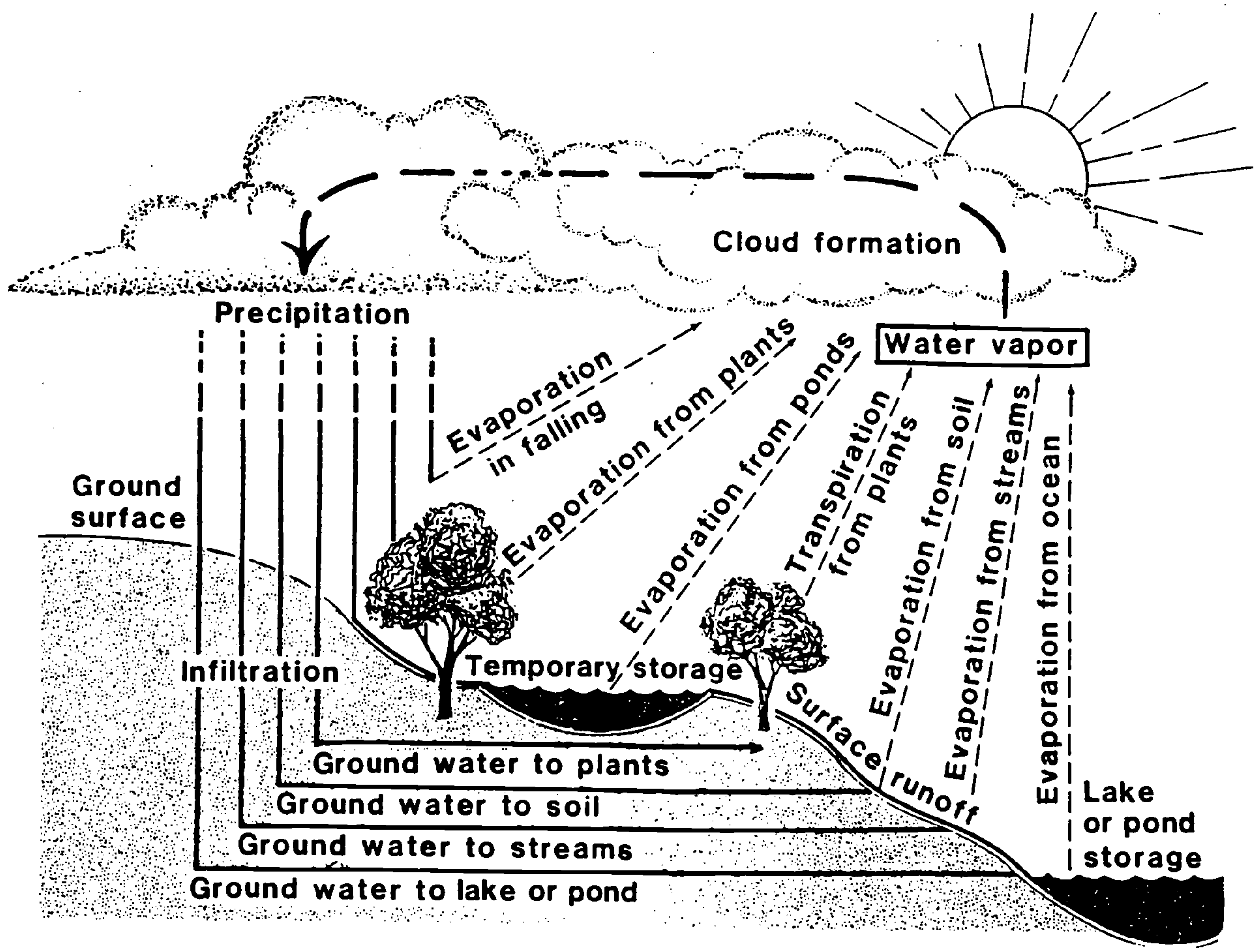
Define the problem
How do pollutants move into groundwater resources?

Possible Causes	Related Facts	Accept/ Reject Cause

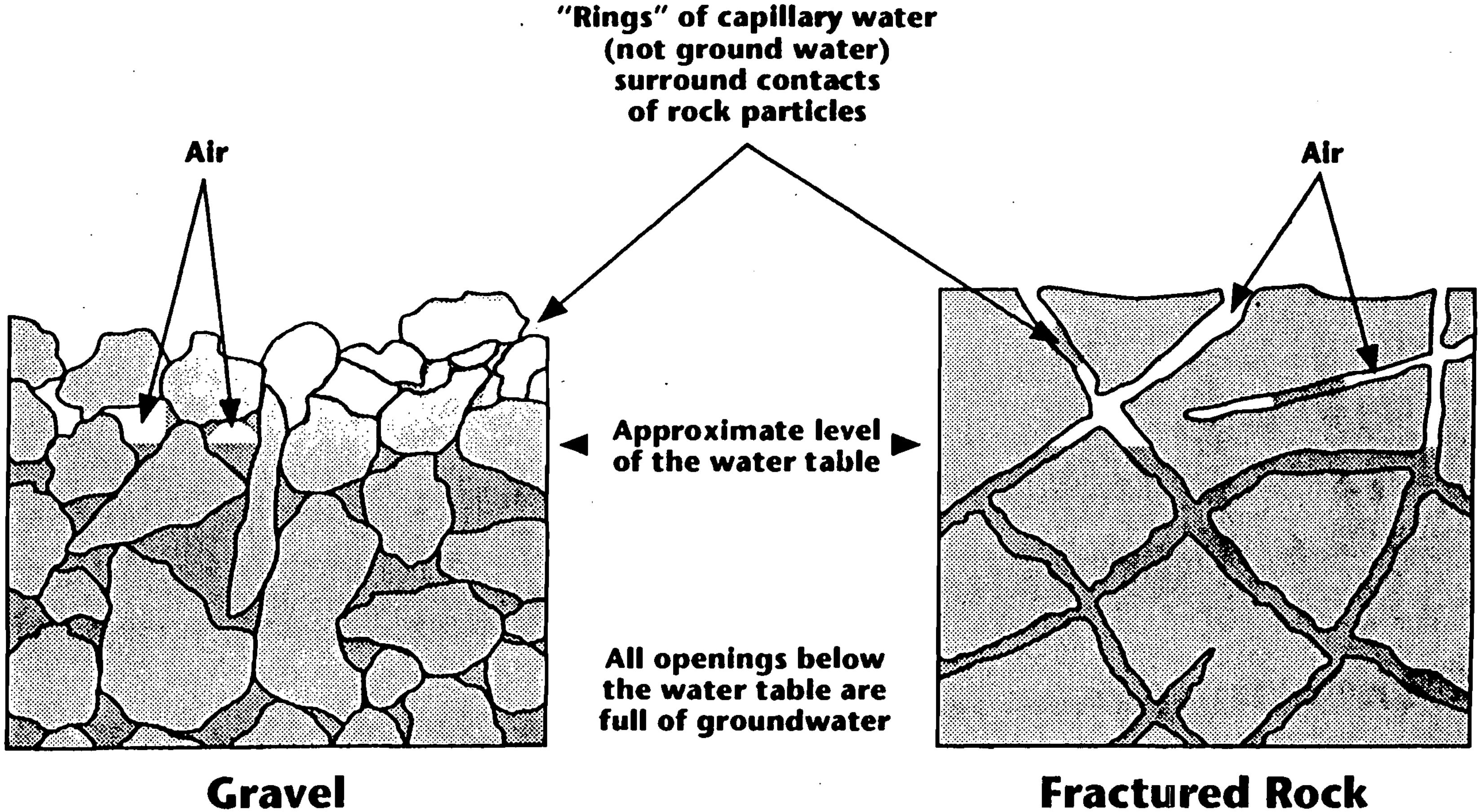
Decision/Recommendation


Two liter bottle
Topsoil
Sand
Gravel

The Hydrologic Cycle



How Groundwater Occurs in Rocks



Source: American Institute of Professional Geologists

Helping Students Apply Concepts/Principles/Skills

Agriculture is the largest consumer of water in the United States due to the vast quantities used for irrigation purposes. It is also the largest nonpoint source of water pollution in the United States with damage costs estimated at $2 - $16 billion per year. Most of agricultural water pollution is caused by sediment deposition. Sediment carries excess nitrates and phosphates from fertilizer applications. These nutrients stimulate excessive algae growth in lakes and streams causing an increase in bacteria which feed off the algae and decrease the amount of oxygen available to higher order plants and animals.

The extensive use of crop protection chemicals in agriculture has also affected the quality of our water supply. The Environmental Protection Agency has estimated that over 100 labeled pesticides have the potential for appearing in groundwater in certain conditions. Groundwater surveys are being conducted in several states to determine the extent of groundwater contamination.

Ideas for Other Experiments

Investigate how different soils, such as clay, influence the rate of groundwater flow by replacing the sand and rocks in the flow model with clay or other types of soil.

Evaluating Student Learning

After students complete this experiment, have them record their data and observations on pages 3.0.2-11 and -12.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____________________

Name ____________________ Date __________ Period ________

Objective(s) ____________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 3 - Environmental Science

Manage Soil

Competency/Terminal Performance Objective

3.0.3: Given examples, demonstrate ability to manage soil, using criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

3.0.3.1 Given examples, define soil using definitions provided.

3.0.3.2 Using soil samples, classify soil types according to data on the soil triangle.

3.0.3.3 Given examples, identify soil conservation practices, using criterion assessment instrument.

3.0.3.4 Given the proper tools and directions, take soil samples from land laboratory, based on performance criteria list.

3.0.3.5 Given a case situation, interpret soil test data, according to criteria given in assessment instrument.

3.0.3.6 Given a case situation involving soil nutrients, describe soil nutrient interactions according to criteria given in assessment instrument.

3.0.3.7 Using examples provided, describe drainage systems, based on criteria given in assessment instrument.

3.0.3.8 Given examples, differentiate erosion and weathering, based on definitions provided.

3.0.3.9 Given a case situation, analyze soil samples, according to criteria given in assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems
2.2.2 Compute using appropriate units of measurement
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4 Estimate measurements
3.2.6 Use problem-solving techniques
4.2.4 Use formulas
5.2.2 Find surface areas and volumes of applicable geometric figures

Equipment, Supplies, References, and Other Resources

Activity 1

1. soil samples
2. quart jar with lid
3. 8% Calgon solution (6 TBSP Calgon per quart of water
4. metric ruler
5. measuring cup
6. tablespoon

Activity 2

1. soils of varying types/textures
2. two 2-liter plastic bottles
3. water
4. timer

Activity 3

1. 1 soil test kit
2. toothpicks
3. paper towels
4. test tubes
5. test tube racks

Activity 4

1. 8 plastic cups
2. small nail to use as a punch
3. several stopwatches
4. sand
5. loam soil
6. clay
7. gravel
8. measuring cup
9. food coloring
10. water

Activity 5

1. 1 liter of hydrochloric acid
2. droppers
3. safety glasses and gloves
4. products containing calcium: antacid tablets, calcium supplement vitamins, dried milk, soil samples (of varying pH)
5. small cups
6. paper towels

Activity 6

1. 2 liter/hour, 4 liter/hour, and 8 liter/hour drip emitters
2. drip tubing and assorted connectors
3. soils of varying textures
4. outdoor field location or a glass-fronted soil box, approximately 2' high x 2' wide x 2' deep - an aquarium may be used

Situation

These experiments are to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 1
Prepare two or more soil samples of varying textures - display to class. Examples of soil separates (sand, silt, and clay) may need to be prepared for student comparison. (See page 3.0.3-12.)	**Interest Approach** Ask students to estimate the percent sand, silt, and clay in the samples by observing them. Have one or more students try performing a ribbon test on a portion of each sample to estimate its texture. Introduce the sedimentation test as another way of determining soil texture.
See pages 3.0.3-13 and -14 (student copy).	**Procedure** 1. Place about 1/2 cup of soil in the jar. Add 3 1/2 cups of water and 5 tablespoons of the Calgon solution. 2. Cap the jar and shake for 5 minutes. Leave the jar on the desk and let settle for 24 hours. 3. After 24 hours, measure the depth of settled soil. All soil particles have settled, so this is the TOTAL DEPTH. Write it down and label it. 4. Shake for another 5 minutes. Let stand 40 seconds. This allows sand to settle out. Measure the depth of the settled soil and record as SAND DEPTH. 5. Do not shake again. Let the jar stand for another 30 minutes. Measure the depth, and subtract the sand depth to get the SILT DEPTH. 6. The remaining unsettled particles are clay. Calculate clay by subtracting silt and sand depth from total depth to get CLAY DEPTH.
Have students classify the soil as either fine, medium, or coarse using the soil texture triangle. Use the information on pages 3.0.3-15 and -16.	Calculate the percentage of each soil separate using the following formulas $\% \text{ sand} = \frac{\textbf{sand depth}}{\text{total depth}} \times 100$ $\% \text{ silt} = \frac{\textbf{silt depth}}{\text{total depth}} \times 100$ $\% \text{ clay} = \frac{\textbf{clay depth}}{\text{total depth}} \times 100$

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* Lab reports should contain answers to the following questions: 1. How does soil texture affect density and permeability? 2. How does soil texture affect root penetration of growing crops?
	Key Terms 1. *bulk density* - mass of oven-dried soil per unit volume, expressed as pounds per cubic foot or grams per cubic centimeter. 2. *clay* -1) the class of smallest soil particles, smaller than 0.002 millimeter in diameter; 2) the texture class highest in clay content. 3. *coarse texture* - a soil texture with traits largely set by the presence of sand. Includes sands, loamy sands, and sandy loams. 4. *consistence* - characteristics of a soil in its response or resistance to pressure, as described at various soil moisture contents. Characteristics include stickiness, plasticity, hardness, or friability. 5. *fine texture* - soil with a large amount of clay. Usually includes clay, sandy clay, clay loam, silty clay, and silty clay loam. 6. *loam* - a medium soil texture class with sand, silt, and clay contributing almost equally to soil properties. 7. *medium-textured soil* - soils half way between fine- and coarse-textured soils. Includes loam, fine sandy loams, silt loam, and silt 8. *particle density* - the mass per unit volume of soil particles, excluding pore space. Most mineral soils have a particle density of about 2.65 grams/cubic centimeter. 9. *pore space* - portion of soil not occupied by solid material, but filled with air or water. 10. *sand* -1) largest of soil separates, between 0.05 and 2.00 millimeters in diameter; 2) coarsest texture class. 11. *silt* - medium-sized soil separate: particles between 0.05 and 0.002 millimeters in diameter.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms *(continued)* 12. *soil separates* - classes of mineral particles less than 2.0 millimeters in diameter - include clay, silt, and several sizes of sand. 13. *soil structure* - the arrangement of soil particles into aggregates or peds. 14. *texture* - the relative proportion of soil separates in a soil.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach Instruct students to observe/remember the effects of spring rains and standing water on a newly planted crop. If the water is not removed in a short period of time, the crop will die. Ask the students: "How can we prevent the death of a crop?" Use the information on pages 3.0.3-18 and -19 (student copy).	**ACTIVITY 2** **Procedure** 1. Cut the bottles as shown on page 3.0.3-22. 2. Cover the opening of the upper bottle with screening or similar filtering material that allows water to pass through it. 3. Position the bottles as shown page 3.0.3-22. 4. Add enough soil to fill the upper bottle one-half full. Add water to a level above the soil. 5. Continue to add water until the soil sample is saturated. When the soil is saturated begin a one-hour timed test (as close to one hour as possible). **Note**: The water level must be above the soil surface at all times and at a constant depth. 6. After one hour, note the water level in the lower bottle. Compare your results with the permeability rates shown on page 3.0.3-20.
Use the information on page 3.0.3-20.	**Data Summary and Analysis** 1. Record the amount of water passing through each soil sample at the completion of the one hour test (in inches/ centimeters in the lower bottle and in ounces/milliliters). 2. Calculate gallons per day per square foot of soil area. Use Unit Factor Method for calculations. 3. Compare the findings with data shown on page 3.0.3-20. 4. Discuss the effects of soil type/texture on permeability and drainability. Prepare a chart or graph of soil type/texture vs. permeability rates. Describe the relationships.
	Key Terms 1. *drainage* - removal of gravitational or free water that is not directly available to the plant. 2. *hydraulic conductivity* - rate at which water moves through the soil. 3. *permeability* - movement of water through the soil; synonymous with hydraulic conductivity and drainability. 4. *saturation* - filled to capacity; fully soaked with water. 5. *water holding capacity* - amount of moisture able to be held by the soil that is available to plants; field capacity.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 3 **Interest Approach** Ask the class if they have ever grown any vegetable crops at their home. How much fertilizer do we apply to get optimum growth of our vegetable plants? Is there a way to determine this? How? Show the class pictures of various vegetables that did not receive any fertilizer and some that did. What is the difference in some of these vegetables? **Procedure**
See page 3.0.3-21.	1. Perform a soil test by carefully following the instructions in the soil test kit.
Use pages 3.0.3-22 and -23 (student copy).	2. Record all results on a data sheet.
See page 3.0.3-24.	3. Send the samples to a local soil testing laboratory for testing.
Refer to page 3.0.3-25.	4. Discuss why N, P, and K fertilizers are applied to soil and how soil tests interpret what nutrients are contained in the soil.
	Data Summary and Analysis 1. Have students interpret the soil test reports. 2. When results are sent back, compare the lab results with your results. 3. Discuss the proper way to calculate fertilizer needs.
	Key Terms 1. *adsorption* - bonding of an ion or compound to a solid surface. In soil, cations are adsorbed on clay and humus particles. 2. *adhesion* - force of attraction between two different substances. In soil it is the force that attracts water to soil particles. 3. *cation exchange* - exchange between a cation in solution and one adsorbed on a soil colloid. 4. *cation exchange capacity* - total number of exchangeable cations a soil can adsorb. Expressed as milliequivalents per 100 grams of soil. 5. *mass flow* - movement of nutrients by movement of soil water. 6. *micelle* - an individual particle of silicate clay. 7. *micronutrients* - essential elements used in small quantities by plants. 8. *macronutrients* - essential elements used in large amounts by plants, including nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use information on pages 3.0.3-26 and -27 (student copy).	**ACTIVITY 4** **Interest Approach** To illustrate to the students that water actually moves through soil in spaces which we can't even see, put a measured amount of water in a container containing a piece of sandstone. After a few hours, remove the piece of sandstone and measure the amount of water remaining. The "missing" water has been absorbed by the piece of sandstone. After step 2, designate teams of two students: one to work the stopwatch and the other to pour. With one student ready with the stopwatch, have the other student quickly pour in 25cc of colored water. The student with the stopwatch should start the watch as soon as all the water has been poured in the cup and stop the watch when the first drop of colored water appears. Record the times for each cup. **Procedure** 1. Punch four small holes in the bottom of each cup. Then fill each cup with a different earth material or mixture of materials as follows: Cup 1: clay Cup 2: sand Cup 3: gravel Cup 4: soil Cup 5: 1/2 gravel and 1/2 sand Cup 6: 1/2 soil and 1/2 gravel Cup 7: 1/2 soil and 1/2 sand Cup 8: 1/3 soil and 1/3 gravel and 1/3 sand For each of the cups requiring a mixture (cups 5 - 8) the materials should be mixed thoroughly before they are put into the cups. Each cup should then be filled with the required material so that the level of the material is one inch from the lip of the cup. Identify each cup according to the material it contains. 2. Pour in enough water to thoroughly saturate the material in each cup. After the cups have been filled with water, let them drain through the holes for about ten minutes. Discard the water that drains out. (It is important to make sure all the material in the cup is saturated, otherwise the "thirsty" earth materials might retain some of the water from the second pouring. Your reading would be inaccurate when timing how fast the excess water travels through the material).

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Data Summary and Analysis Record your data in the chart below. Answer the following questions: 1. Which material was the most permeable? Why? 2. Which material was the least permeable? Why? 3. How did the cups with the soil mixtures compare with the cups with only one type of material?
	Key Terms 1. *adhesion* - force attraction between two different substances. In soil, used to define the force that attracts water to soil particles. 2. *capillary rise* - movement of water upward through soil capillaries. 3. *cohesion* - the force attracting similar substances. In soil science, this term is applied to the attraction of water to itself. 4. *gravitational flow* - movement of water downward through the soil due to gravity. 5. *hydraulic conductivity* - a trait of soil, related to the ease of water movement. For example, the finer the soil texture, the lower its hydraulic conductivity. 6. *saturation* - all or most soil pores filled with water.

DATA SUMMARY AND ANALYSIS

Record data in the following chart.

clay = ____________________ seconds

sand = ____________________ seconds

gravel = ____________________ seconds

soil = ____________________ seconds

gravel + sand = ____________________ seconds

gravel + soil = ____________________ seconds

soil + sand = ____________________ seconds

soil + sand + gravel = ____________________ seconds

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 5
Bring to class a jar filled with ground limestone and some pictures of lime being spread on a field.	**Interest Approach** Have you ever seen limestone being applied to a field? If so, share your story with the class. What is so important about this powdery substance? What does it do for the soil? Observe the ground limestone in the jar. Why is it composed this way? Does the composition or type of limestone (ie., liquid, dry, pellets) make a difference in its effectiveness? Why?
Use the information on pages 3.0.3-28 and -29 (student copy).	**Procedure** 1. Place 3 of the products in separate cups. 2. Put on safety glasses and gloves. 3. Using a dropper, carefully place a drop of acid on each of the products. What happens? Why? 4. Record all results on a data sheet.
Refer to pages 3.0.3-30 and -31.	**Data Summary and Analysis** 1. Discussion why bubbles did or did not occur. 2. Compare the number of bubbles produced by each product.
	Key Terms 1. *percolation* - the downward movement of water through the soil. 2. *cation exchange* - exchange between a cation in solution and one adsorbed on a soil colloid. 3. *cation exchange capacity* - total number of exchangeable cations a soil can adsorb. 4. *mass flow* - movement of nutrients by movement of soil water. 5. *residual acidity* - soil acidity that is neutralized by lime or other alkaline materials, but cannot be replaced by an unbuffered salt solution. 6. *percent base saturation* - the extent to which the cation exchange capacity is saturated with alkali (sodium and potassium) and alkaline earth (calcium and magnesium) cations. Expressed as a percentage of the cation exchange capacity and measured at a particular pH.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use the information on pages 3.0.3-32 and -33 (student copy).	**ACTIVITY 6** **Interest Approach** Pour equal amounts of water on soils of varying textures. Observe what happens to the water. Discuss possible reasons for what happens. Identify ways to experimentally determine what is happening. **Procedure** 1. Install on the soil surface a lateral line with emitters, connecting it to a water source of appropriate pressure. (Pressure will depend on emitter; tap pressure is usually sufficient.) 2. Run the system for a prescribed length of time. A 4-liter emitter will drip 4 liters in one hour. Time will vary depending on the type of soil and emitter. 3. Observe the wetted pattern by measuring the wetted surface diameter, and by digging beneath the surface of the diameter to determine the extent of subsurface water movement (if using a glass-fronted box, simply observe subsurface movement). Observations may also be made using a tensiometer if available. 4. Repeat the procedure using different soil textures, emitters, and application rates.
Refer to page 3.0.3-34.	**Data Summary and Analysis** 1. Measure the wetted diameter and draw the shapes of the wetted patterns for varying soil types and textures (i.e., clay, sand, loam) and for varying application rates. 2. Analyze the measurements and shapes. Describe the relationships between soil type, application rate, and wetted pattern.
	Key Terms 1. *application rate* - amount of water applied in liters or gallons per hour. 2. *capillary flow* - upward and lateral flow caused by molecular forces in some liquids. 3. *emitter* - microirrigation device metering the amount of water discharged. 4. *infiltration* - process whereby water moves into a soil. 5. *wetted pattern* - shape produced by infiltrated water into a soil. 6. *tensiometer* - device measuring water tension; will describe wetted pattern.

Soil Separates

Separate	Diameter (mm)	Comparison	Feel
Very coarse sand	2.00 - 1.00	36"	Grains easily seen, sharp, gritty
Coarse sand	1.00 - 0.50	18"	
Medium sand	0.50 - 0.25	9"	
Fine sand	0.25 - 0.10	4 1/2"	Gritty, each grain barely visible
Very fine sand	0.10 - 0.05	1 3/4"	
Silt	0.05 - 0.002	7/16"	Grains invisible to eye, silky to touch
Clay	< 0.002	1/32"	Sticky when wet, dry pellets hard, harsh

The United States Department of Agriculture System of Soil Separates. The diameter of particles is in the millimeters. The comparison shows the differences by setting a very coarse sand grain equal to three feet in size.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the texture of soil?

Factors to Consider	**Possibilities (Possible Solutions)**			
	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**
Total depth				
Sand depth				
Depth after 30 minutes				
Silt depth				
Total silt and sand depth				
Clay depth				
Percent (%) sand				
Percent (%) silt				
Percent (%) clay				

Decision/Recommendation:

The texture of the samples will vary depending upon the mixtures created for this experiment.

• Possibilities - Factors •

Problem-Solving Technique

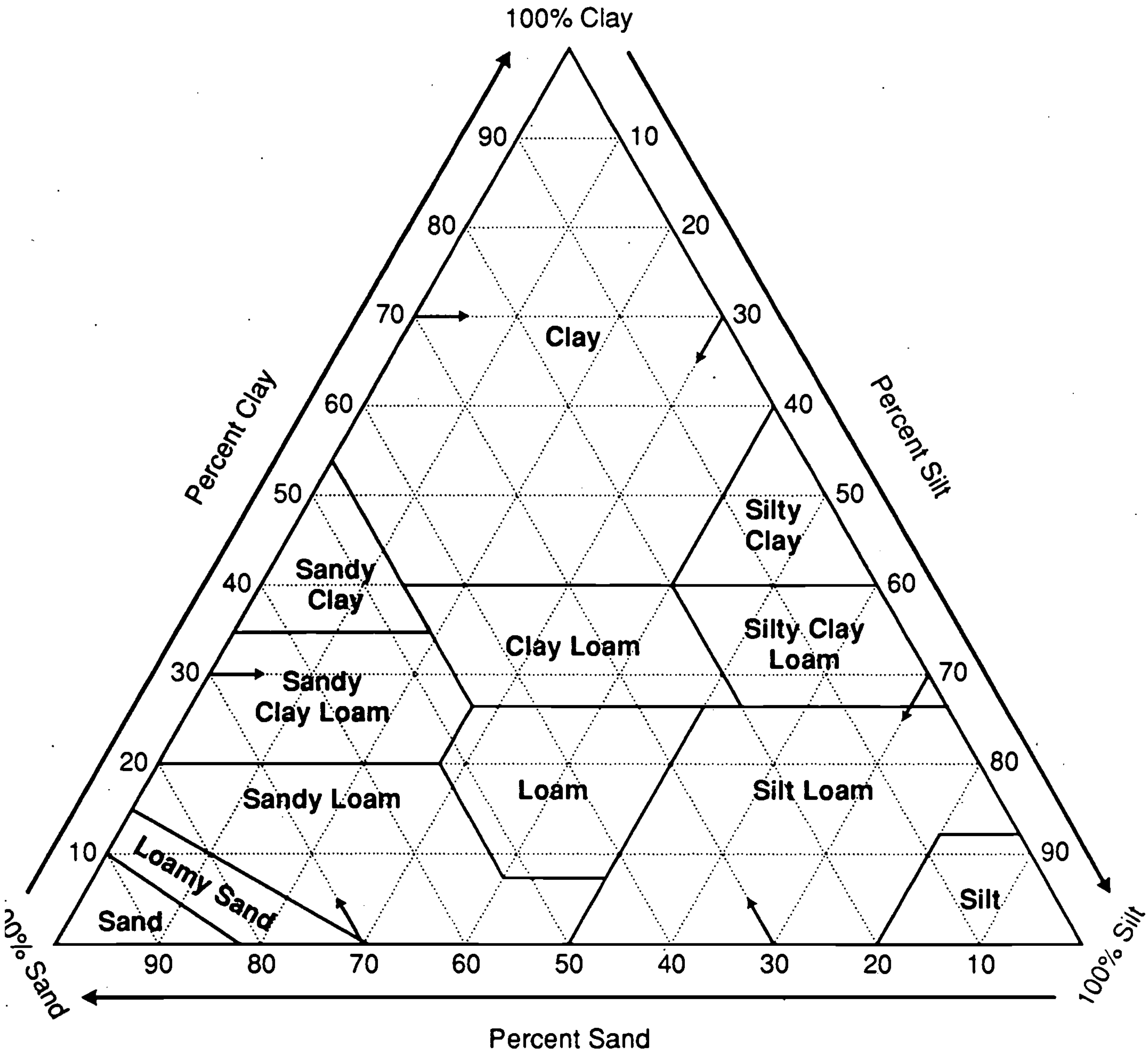
Define the problem

What is the texture of soil?

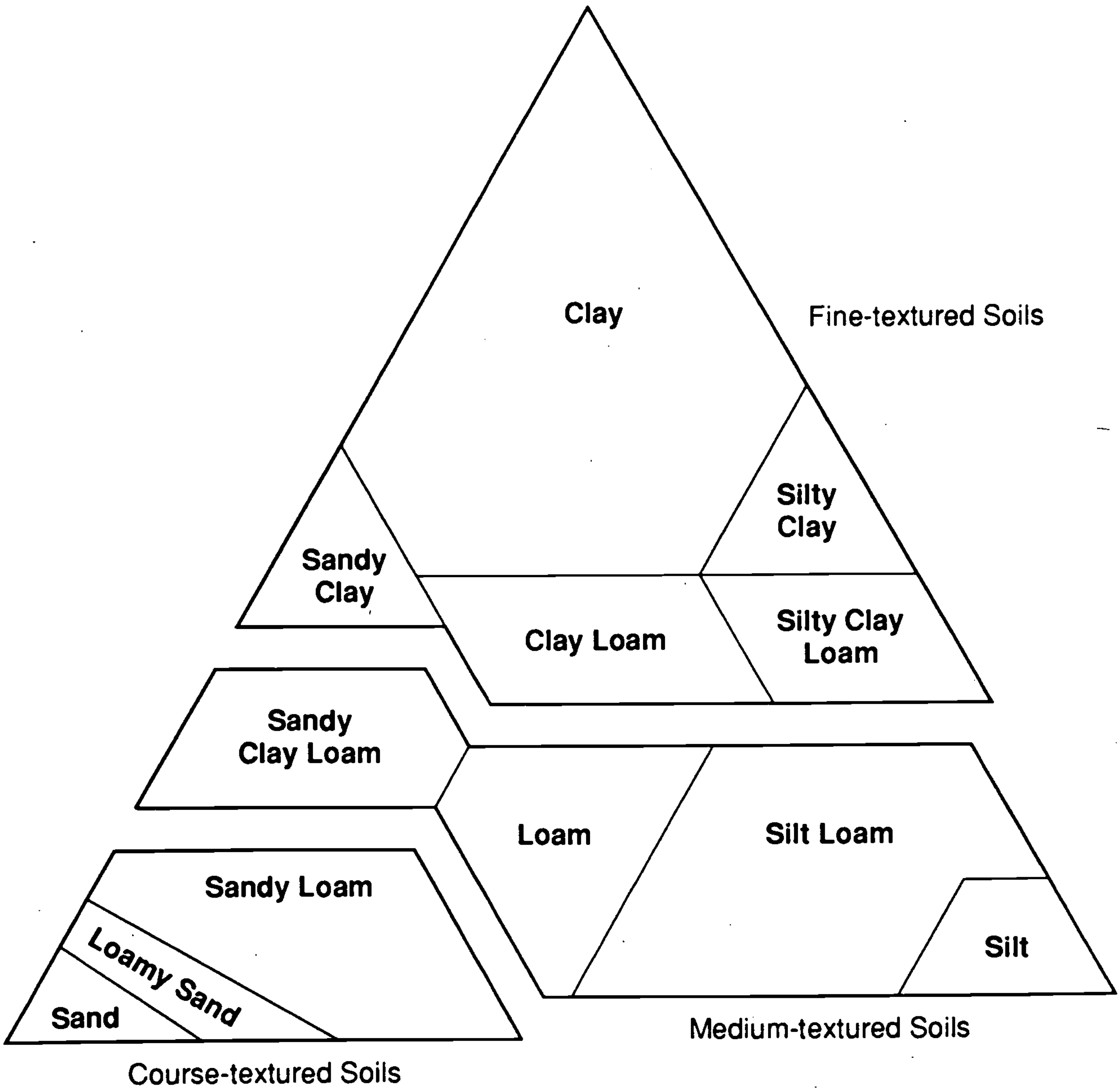
Factors to Consider	Possibilities (Possible Solutions)			

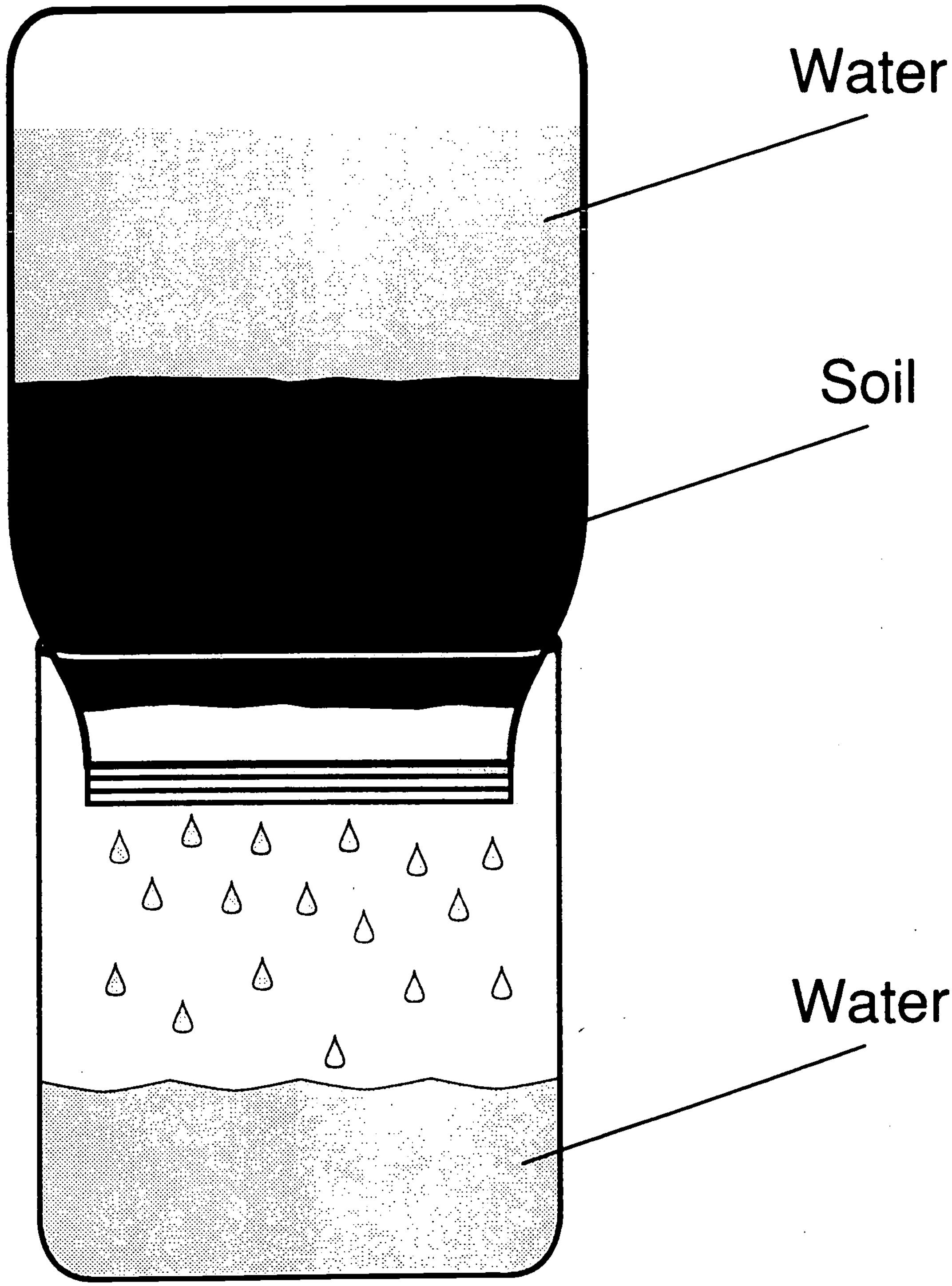
Decision/Recommendation

Textural Triangle



Textural Classification of Soils




Water
Soil
Water

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How does permeability (drainability) differ by soil type?

Factors to Consider	Possibilities (Possible Solutions)			
[redacted]				
Particle size				
Permeability				
Permeability rate/ percolation rate				
Permeability (gal/day/ft^2 soil area)				

Decision/Recommendation

As texture becomes more coarse, permeability and drainability will increase. This has implications for spacing, depth and sizing of subsurface drains.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How does permeability (drainability) differ by soil type?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

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Soil Separate	Particle size Diameter (mm)	Permeability	Permeability Rate/ Percolation Rate (inches/hour)	Permeability (gal/day/ft² soil area)
Clay	Below 0.002	Very slow	Less than 0.05	0.025
Silt	0.05 - 0.002	Slow	0.05 - 0.2	0.5
Very fine sand	0.10 - 0.05	Moderately slow	0.2 - 0.8	50
Fine sand	0.25 - 0.10	Moderate	0.8 - 2.5	100
Medium sand	0.5 - 0.25	Moderately rapid	2.5 - 5.0	250
Coarse sand	1.0 - 0.5	Rapid	5.0 - 10.0	2500
Very coarse sand	2.0 - 1.0	Very rapid	10.0 and over	> 2500

Gathering Soil Samples

The first step in testing soil is obtaining a soil sample. The sampling procedure may be summarized as follows:

1. Gather many topsoil subsamples from random spots in the field. Avoid collecting samples from odd areas such as fencerows, dead furrows, fertilizer spills, and other spots with unusual conditions. Large areas need 15 subsamples, smaller areas need fewer.

2. Scrape away surface litter at each testing spot and remove a sample of the soil. Augers, soil sampling tubes, and spades can be used to collect the sample. Each soil sample should include soil from the entire testing depth. Drop each soil sample in a **clean plastic** bucket as it is collected.

3. Mix all subsamples from one sampling area, and remove about one cup of soil. This composite sample represents the average soil in the field. Label the composite sample and let it dry in the air. **Do not** oven-dry the sample. This could change the testing results by causing normally unavailable nutrients to be measured (by killing microorganisms).

4. Fill a mailing container with the dried composite sample. Mark the container according to the instructions provided by the testing center. Complete the sampling sheet which should include the intended crop, production goals, cropping history, and other necessary information.

5. Mail the samples to the laboratory. The sample containers and information sheets can be obtained from the soil laboratory or extension agent.

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

How do you determine the level of nutrients available in the soil for plant growth?

What to Do (Steps)	How to Do It (Key Points)
(see soil test kit)	

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

How do you determine the level of nutrients available in the soil for plant growth?

What to Do (Steps)	How to Do It (Key Points)

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Soil Test Form - W-1

Liming Recommendations

Remarks: ______________________________

Phosphorus ($P_2 0_5$) Recommendations

Remarks: ______________________________

Potassium ($K_2 0$) Recommendations

Remarks: ______________________________

Plant Nutrient Requirements

Name	Symbol	Ionic Form	Ionic Name
Macronutrients			
Primary			
Nitrogen	N	NO_3^-, NH_4+	Nitrate, ammonium
Phosphorus	P	HPO_4^{-2}, $H_2PO_4^-$	Orthophosphates
Potassium	K	K^+	—
Secondary			
Calcium	Ca	Ca^{+2}	—
Magnesium	Mg	Mg^{+2}	—
Sulfur	S	SO_4^{-2}	Sulfate
Micronutrients			
Boron	B	BO_4^{-2}	Borate
Copper	Cu	Cu^{+2}	—
Chlorine	Cl	Cl^-	Chloride
Iron	Fe	Fe^{+2}, Fe^{+3}	Ferrous, ferric
Manganese	Mn	Mn^{+2}	Manganous
Molybdenum	Mo	MoO_4^{-2}	Molybdate
Zinc	Zn	Zn^{+2}	—

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What factors affect the rate at which water moves through soil?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

The speed of flow will vary depending upon the texture of the soil. The cups with soil mixtures are less permeable than some of the single-material cups. This is because the large pore spaces that would have existed between larger soil particles have been filled in by the smaller particles.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What factors affect the rate at which water moves through soil?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

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• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How does lime neutralize the acidity of soil?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Products such as the antacid tablets, vitamins, and dried milk will produce bubbles and fizz when the acid is applied. The soil samples, however, may or may not cause bubbles depending on the current pH of the soil.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How does lime neutralize the acidity of soil?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Why Soils Become Acidic

In humid regions, soils either are acid or are becoming acid when the content of calcium and magnesium is naturally low, is being removed, or is being neutralized.

— Acid parent materials are naturally low in calcium and magnesium.

— Acid rainfall, moving through the soil, leaches calcium and magnesium out of root zone.

— Harvested crops deplete the soil of calcium and magnesium.

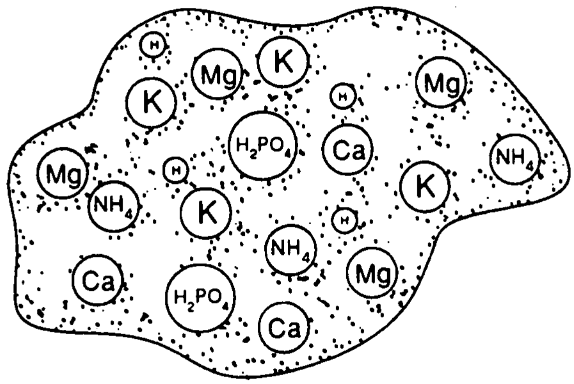
— Most fertilizers are acid-forming, and the most popular ones are the most acid.

— Erosion removes surface soils that contain calcium and magnesium.

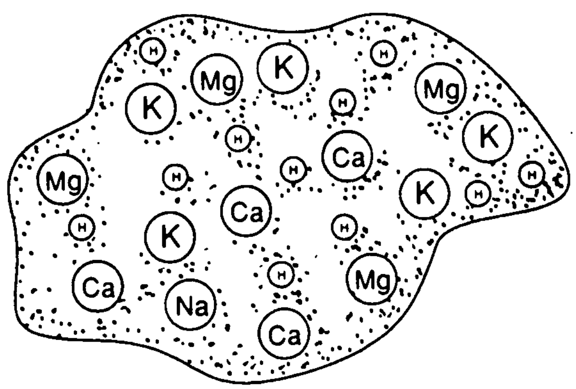
To decrease the alkalinity (or lower the pH) of a soil, aluminum sulfate is added.

To decrease the acidity (or raise the pH) of a soil, some form of lime is added.

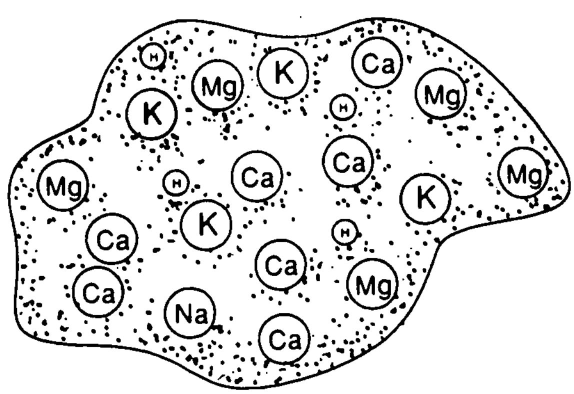
Acid and Alkaline Soils



The nutrients held on the surface of a soil particle are adsorbed.



A soil particle with mostly hydrogen ions tests acid.



A soil particle with mostly basic ions tests alkaline.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the relationship between soil type/texture, infiltration rates, water application rates, and wetted patterns. How do these relationships impact microirrigation design?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

When tested at the same application rates, wetted pattern in heavier clay soils will increase in diameter and decrease in depth; wetted pattern in looser sandy soils will increase in depth and decrease in diameter.

• Possibilities - Factors •

Problem-Solving Technique

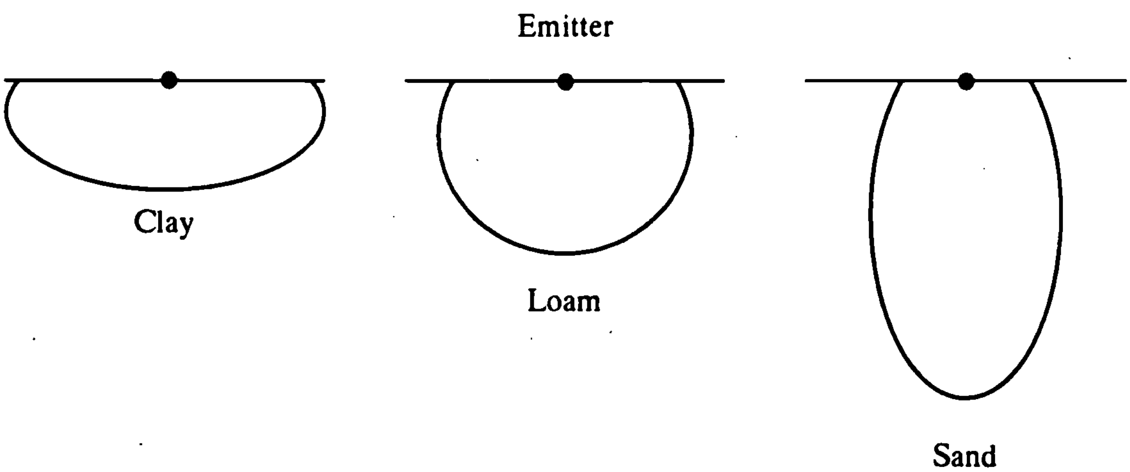
Define the problem

What is the relationship between soil type/texture, infiltration rates, water application rates, and wetted patterns. How do these relationships impact micro irrigation design?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Wetted Pattern by Soil Texture at a Given Application Rate



Helping Students Apply Concepts/Principles/Skills

ACTIVITY 1

Physical properties of the soil are characteristics which a grower can see or feel. These properties include texture, structure, consistence, and tilth. How we use the land often depends upon its physical characteristics. Physical properties can influence the supply of air, water, and nutrients available for plant root growth. A knowledge of soil physical properties is important in production agriculture.

In most cases it is impractical to change the physical properties of a soil except in small quantities such as potting soil for a greenhouse operation. Instead, growers must either select crops to fit a particular soil or purchase land which contains a soil type suitable for the crop they wish to raise. Management decisions regarding tillage operations and irrigation schedules can be influenced by physical properties of the soil. For example, soil texture influences how water behaves in the soil. Coarse soils dry out faster in the spring than fine soils, but are more prone to drought - possibly requiring irrigation.

Ideas for Additional Experiment

Have students perform the ribbon test for soil texture and compare findings with the results of the sedimentation test. Which test is more accurate and/or reliable?

ACTIVITY 2

The amount of water available for plant use is the difference between the water holding capacity of the soil and the wilting point of the plant. Water in excess of capacity will drain from the soil due to gravitational pull.

The draining of gravitational water does not negatively affect plants since gravitational water is not usable by the plant. In fact, if allowed to remain for any length of time, gravitational water can be detrimental to the plant. Drainage becomes vitally important. For drainage to occur, water must pass through the soil. This process is called permeability.

Ideas for Other Experiments

Using a similar apparatus, an investigation of the effects of soil type/texture on percolation rates could be conducted to study percolation and implications for plant growth and subsurface irrigation.

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 3

Soil fertility is the ability of a soil to supply nutrients for plant growth. The soil acts as a storehouse of plant nutrients. Nutrients are stored in many forms with some nutrients available to plants, while others are not. The concept of soil fertility includes the quantity of nutrients a soil contains, the ability to protect nutrients from leaching, the availability of the nutrients for plant use, and how easily roots can absorb the nutrients for plant growth. When discussing soil fertility, we must first have an understanding of plant nutrients. Plant nutrients are **essential elements** needed for plant growth. Some plants contain elements not needed for plant growth.

Scientists have identified 16 elements that are essential for plant growth. Of the 16, three (carbon, oxygen, and hydrogen) represent about 95% of a plant's nutrient needs. These three elements come from the air and water. The remaining 13 elements are obtained from the soil. The three primary **macronutrients** are usually not available in large enough amounts for plants to grow effectively and are added to the soil by fertilization. The amount of fertilizer to apply is usually indicated by a soil test. Calcium, magnesium, and sulfur, however, are considered secondary macronutrients because they are supplied by most soils and usually not added to the soil in fertilizers.

The remaining seven nutrients are called **micronutrients** or **trace elements** because they are required in smaller amounts. Iron, for example, plays a vital role in the formation of chlorophyll. Without chlorophyll, photosynthesis is slowed, which results in a decline in plant growth. It is crucial that plant/crop growers make effective use of fertilizer. Soil testing is the best tool for growers to decide how much fertilizer is needed. Soil testing is vital so that the grower can avoid under and over-fertilizing.

Ideas for Other Experiments

1. Grow three groups of potted corn plants under three different soil moisture conditions. Grow one group in dry soil, one in moist soil, and one in fairly wet soil. Conduct a soil test on the three soil groups. Will there be a difference in the tests?
2. Devise a way to test the effect of cold soil on nutrient uptake.
3. Using molecular model kits, construct models of silica tetrahedra and alumina octahedra. Try to construct a portion of a clay layer.

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 4

The industry of agriculture is the largest consumer of water. The power industry may use more water on a daily basis. However, its use is primarily for cooling or electrical generation purposes, and the water is immediately returned to its original source. In agriculture, the water used is actually consumed; it goes back into the hydrologic cycle through evapotranspiration. Evapotranspiration includes all of the water that returns to the atmosphere from evaporation and from plant transpiration. The amount of water needed to grow the food for one person's meal is between 500 and 2,000 gallons.

In several agricultural areas, water is the most important factor for growing crops. Growers must manage water carefully in order to have a crop to harvest. Knowing the physical properties of water's action in the soil is important. Hydraulic conductivity is a measure of the rate of water movement through the soil. Knowing how fast water will move through the soil is important when planning irrigation schedules. Hydraulic conductivity of the soil can affect the timing of irrigation as well as the amount of water which should be applied at one time. Since irrigation is an expensive input, growers are constantly searching for ways to optimize plant utilization of the water applied.

Ideas for Additional Experiments

Vary the soil mixtures and compare the samples by graphing the rate of water flow through the soil samples.

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 5

Agricultural lime is a soil conditioner containing calcium carbonate, magnesium carbonate, and other materials that neutralize soil acidity and furnish calcium and magnesium for plant growth. Liming acid soils has been and continues to be an important agricultural practice. One of the most important benefits of liming is that liming soils actually improve crop response to fertilizers by improving the uptake of primary nutrients. Liming makes possible the best crop yields from the dollars invested in fertilizers. Liming acid soils also removes aluminum toxicity and promotes important activities of desired organisms such as the *Rhizobia* bacteria that fix nitrogen for legumes. Certain limes also supply magnesium, which is important to many acid sandy soils.

How does lime work? Lime neutralizes soil in two ways. First, calcium replaces hydrogen and aluminum ions on exchange sites by mass action. In doing so, liming raises the percent base saturation. Second, lime converts hydrogen to water. A simple way to detect the presence of lime is by placing small droplets of a strong acid on a substance that might contain lime (calcium). If calcium is present, the substance will fizz and bubbles will form.

Ideas for Other Experiments

1. Mix finely ground lime, sulfur, and gypsum into separate samples of soil in pots. Keep them warm and moist for several weeks. Check the pH using litmus paper. Try adding different forms or fineness of lime. What is the pH in each pot?
2. Mix well granulated soil samples in pots. Treat one with table salt (NaCl), another with ice melting salt (CaCl), and leave one pot untreated. Keep the soil in pots warm and moist. Don 't allow drainage water to carry off the salts. Check to see how readily water will drain through the pots. Why is there a crust on the surface?

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 6

Microirrigation systems are transportation systems delivering water to the plant in or near the root zone. The soil is a vital part of this transportation system - the bridge between the irrigation system and the plant. The soil's physical properties determine its ability to transport and store water and nutrients.

When water is applied slowly to the soil at a single point, it is acted upon by the downward force of gravity and capillarity (radially and upwards), producing a wetted pattern characteristic of the soil type/texture.

In addition to soil texture, the application rate affects the shape of the wetted pattern. It is possible to alter the shape of the wetted pattern by varying application rates. Much can be learned about soil/water relationships by applying measured amounts of water to an area and observing its downward and lateral movement – the shape of the wetted pattern.

Ideas for Other Experiments

Investigate other soil and plant variables (water holding capacity, evapotranspiration) relating to soil/water relationships impacting microirrigation.

Evaluating Student Learning

After students complete each experiment, have them record their data and observations on pages 3.0.3-40 and -41.

This activity was adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Office Hours M-F: 7:30 am to 4:30 pm

Data Record and Observation Sheet

Title ______________________________

Name ____________________ Date __________ Period ______

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 3 - Environmental Science

Investigate Factors Affecting Nitrates in Groundwater

Competency/Terminal Performance Objective

3.0.4: Given examples, investigate factors affecting nitrates in groundwater using an assessment instrument.

Competency Builders/Pupil Performance Objectives

3.0.4.1 Given examples, explain the nitrogen cycle, based on criteria listed.

3.0.4.2 Given examples, identify sources of chemical nitrogen fertilizers, based on criteria given in assessment instrument.

3.0.4.3 Given examples, relate use of nitrogen fertilizer to groundwater contamination, based on criteria given in assessment instrument.

3.0.4.4 Given examples, identify practices that increase nitrogen efficiency, based on practice list provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems
2.2.2 Compute using appropriate units of measurement
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4 Estimate measurements
3.2.6 Use problem-solving techniques
4.2.4 Use formulas

Equipment, Supplies, References, and Other Resources

Activity 1

1. samples of cultivated (inoculated) legume roots
2. samples of wild legume root systems (vetch, seet clover, etc.)
3. single-edged safety razor
4. root samples from various legumes (alfalfa, clover, vetch, peas, soybeans, peanuts, garden beans, bird's-foot trefoil, etc.)

Activity 2

1. potting soil
2. 2 large flats
3. soybean seeds
4. corn seeds
5. soil test kit (commercial kit which includes a test for nitrogen)

Activity 3

1. eight 2-liter plastic bottles
2. soil samples with varying texture and organic matter
3. commercial fertilizer
4. ryegrass (or other plant seeds)
5. nitrate test kit

Activity 4

1. Two clear plastic quart containers or liter bottles
2. Plant fertilizers with various nitrogen levels
3. Pond water (preferred) or aged tap water (let sit 48 hours).
4. Good light source
5. Photographs of water bodies with algal problems and eutrophication (optional).
6. Nitrogen test strips (Quantofix available through Carolina Biological Supply and others) (Optional)

References:

Environmental Resource Guide from the Air and Waste Management Association. P.O. Box 2861, Pittsburgh, PA 15230.

Nitrogen and the Hydrologic Cycle (AEX-463) The Ohio State University Agricultural Engineering Department. 590 Woody Hayes Drive, Columbus, OH 43210.

NVATA Groundwater Project: *A Hidden Treasure*. The National FFA Foundation, 310 N. Midvale Blvd. Suite 308, P.O. Box 5117, Madison Wisconsin 53205.

Current articles regarding nitrates and groundwater.

Fertilizer safety references.

Situation

These experiments are to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring in two samples of inoculum (available from farm supply stores and biological supply companies), each containing a different strain of rhizobia. Use information on pages 3.0.4-13 and -14 (student copy).	ACTIVITY 1 **Interest Approach** Ask students what is inside each packet. Open the packets and pass around a small sample of the inoculum from each packet. Ask students if they see any living material in the samples. The inoculum is alive! (Prepare a slide so students can see the bacteria contained in the inoculum packet.) See if anyone can explain why we inoculate legume seed. How does the inoculum work ? Why don't we inoculate all legume seeds or all crop seeds? **Procedure** 1. Collect the legume samples as specified. Plants must be in the active growing stage. Samples from deep rooted crops, such as alfalfa, must be taken when soil moisture is high. Otherwise, the nodules are likely to be scraped off when removing the plant from the soil. An alternative is to grow several samples in the greenhouse. In this case the root ball can be removed from the pot and the nodules easily seen. 2. Compare the root nodules on various plant species in terms of size, shape, and number. 3. Compare the root nodules on several plants of the same species. 4. Compare the root nodules on cultivated versus wild legume plants. 5. Using a safety razor, slice open the nodules on several legume roots and compare. Inefficient strains of rhizobia produce nodules that are relatively small, widely dispersed, and green, white, or brown inside. Efficient rhizobia strains produce nodules that are relatively large and red or pink inside.
Follow this activity with one or more of the experiments listed later in this lesson outline. Use the information on pages 3.0.4-15 and -16.	**Data Summary and Analysis** Record descriptive notes about the size, shape, and number of nodules on each of the plants examined. Include a description of the plant in terms of species, growing conditions, stage of maturity, and similar factors. From these descriptive notes generate concluding statements about legume nodules and their efficiency.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *autotrophic* - making its own food, such as photosynthesis in green plants or chemosynthesis in bacteria 2. *bacteria* - single-celled microorganisms that can be seen only with a microscope 3. *cortex* - an outer layer of tissue in the roots of dicotyledonous plants located between the stele and epidermis 4. *fixed* - when a compound resists decomposition 5. *inoculation* - bulk treatment of leguminous seeds with rhizobia 6. *legume* - a pod-bearing member of the Leguminosae family; one of the most important and widely distributed plant families; includes many valuable food and forage species 7. *nitrification* - the biochemical oxidation of ammonium to nitrate, predominantly by autotrophic bacteria 8. *nitrogen fixation* - the biological conversion of elemental nitrogen (N_2) to forms readily used in biological processes 9. *rhizobia* - a species of soil-inhibiting bacteria which causes excessive growth in the form of nodules on the cortex of the roots of legumes 10. *symbiosis* - the living together of two dissimilar organisms in a condition of mutual benefit

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use the information on pages 3.0.4-17 and -18 (student copy).	ACTIVITY 2 **Interest Approach** Research current prices for various forms of nitrogen fertilizer for use in agricultural operations. Calculate the cost of applying nitrogen fertilizer to a corn crop when the desired yield is 150 bushels/acre. Assume that if soybeans were planted in the field during the previous year, the grower would need to apply 40 lb/acre less nitrogen. How many dollars per acre does the producer save by planting a legume crop prior to planting corn? **Procedure** 1. Prepare enough soil to fill two flats to a depth of four inches. 2. Perform a soil test for nitrogen on the prepared soil. 3. Divide the soil equally into the two flats. 4. Plant one flat with soybeans and one with corn seeds. (Spacing between seeds should be one to two inches apart.) 5. Water and care for plants for three weeks. 6. Remove the plants from the soil and compare the root structure of corn and soybeans. 7. Test the soil in both flats for the level of nitrogen present. Compare the amounts of nitrogen found.
Use the forms on pages 3.0.4-19 and -20.	**Data Summary and Analysis** 1. Record the results of the soil test prior to planting and then again at the end of the experiment. Compare the levels of nitrogen present in the soil for each crop. 2. Examine and make a sketch of the root structure for the corn plants and soybean plants. Record differences in root structure.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *nitrification* - the conversion of ammonium ions into nitrates through the activities of certain bacteria. 2. *legume* - plant member of the family LEGUMINOSAE, with the characteristic capability to fix atmospheric nitrogen in nodules on its roots with proper bacteria. 3. *nitrogen assimilation* - the incorporation of nitrogen into organic cell substances by living organisms. 4. *nitrogen fixation* - the conversion of atmospheric nitrogen into oxidized forms that can be assimilated by plants. Certain blue-green algae and bacteria are capable of biochemically fixing nitrogen.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 3
Interest Approach Obtain from ConAgra Technologies the educational pack for nitrate testing of groundwater. Have students collect well water samples from home and test them for nitrates. If nitrates are present in any samples, investigate potential sources of the nitrates. Use the information on pages 3.0.4-21 and -22 (student copy).	**Procedure** Cut the tops off of eight 2-liter plastic containers. On these containers remove only the top 1/3 of the bottle. Drill small drain holes in the bottom of these bottles. These bottles will be for growing plants in various soil media and with varying treatments of nitrogen. Cut an equal number of additional bottles approximately 1 inch above the base. The shorter containers will be used to catch water which may contain leached nitrates. *Effect of Soil Composition on Nitrate Leaching* 1. Prepare soil samples of varying composition (gravel, sand, loam, etc.) and fill a prepared 2-liter container with each sample. **Note:** It is best to put some small rocks in the bottom of each container to facilitate drainage. 2. Place approximately 1 cup of the soil sample in a separate container which has holes punched in the bottom. 3. Thoroughly saturate the soil sample in the container and catch some of the water that drains out. 4. Test the water for the presence of nitrates with the nitrate test kit. 5. Mix 1/4 cup of commercial fertilizer into each soil sample in the 2-liter containers. 6. Plant ryegrass in each container. 7. Thoroughly water each container until water drains out the bottom. 8. Test the drained water for nitrate levels each time the container needs watering. Record the results of the nitrate test. (Be sure to water each container similarly.)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)*
Use the information on pages 3.0.4-23 and -24 (student copy).	***Effect of Fertilizer Placement on Nitrate Leaching*** 1. Prepare enough of one type of soil to fill two 2-liter containers. 2. Thoroughly mix 1/4 cup of fertilizer in one container. Place 1/4 cup of fertilizer in a single band approximately 3 inches from the bottom in the second container. 3. Plant ryegrass in each container. 4. Thoroughly water each container until water drains out the bottom. 5. Test the drained water for nitrate levels each time the container needs watering and record the results of the nitrate test. (Be sure to water each container similarly.)
Use the information on pages 3.0.4-25 and -26 (student copy).	***Effect of Plant Material on Nitrate Leaching*** 1. Prepare enough of one type of soil to fill two 2-liter containers. 2. Thoroughly mix 1/4 cup of fertilizer into each container. 3. Plant ryegrass in one container. 4. Thoroughly water each container until water drains out the bottom. 5. Test the drained water from both containers for nitrate levels each time the container with the ryegrass needs watering. Record the results of the nitrate test. (Be sure to water each container similarly)
Refer to page 3.0.4-27 and -28.	**Data Summary and Analysis** Record your data for each container. Include answers to the following questions: 1. What factors affect the presence of nitrates in the drain water? 2. What management practices should producers follow to minimize the chances that nitrates will leach into groundwater?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *ammonium fixation* - tie up of ammonium form of nitrogen onto the clay structures in the soil. 2. *ammonium nitrogen* - a colorless salt used in fertilizers. 3. *available nutrient* - that portion of any element or compound in the soil that can readily be absorbed and assimilated by growing plants. 4. *blue-baby syndrome* - blood related condition found in babies due to nitrate poisoning. 5. *denitrification* - the reduction of nitrates, with nitrogen gas evolved as an end product. 6. *leaching* - removal of soluble material in solution from the soil by percolating water. 7. *nitrification* - two-step process of ammonium (NH_4) changing to nitrite (NO_2) then to nitrate (NO_3). 8. *nitrite (NO_2)* - first product in the nitrification process in the conversion of ammonium to nitrate. 9. *nitrogen cycle* - continuous cycle in which atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, processed by bacteria and plants, and returned to the atmosphere by organic decomposition. 10. *nitrogen-fixation* - the conversion of elemental nitrogen from the atmosphere to organic combinations or to forms readily used in biological processes. Normally carried out by bacteria living in legumes or by free-living soil bacteria. 11. *nutrients* - fertilizer, particularly phosphorus and nitrogen, the two most common components that run off in sediment. 12. *root zone* - the depth of soil penetrated by crop roots.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Prior to presenting the lesson plan, the teacher will need to collect or develop water in one container which contains algae blooms.	**ACTIVITY 3** **Interest Approach** Hold up two clear containers of water, one of which has algae blooms growing on the water, the other clear. Compare the two containers with the students as to how the two waters are different, and why. **Procedure** 1. Through review of the hydrologic cycle, develop questions and answers as to how the water containing the algae growth developed into this situation? 2. List possible answers on board. a. What is algae? A plant. b. What do plants need to grow? Nutrients, nitrogen, phosphorus, potassium, and the like. c. Which major nutrient do you believe abundantly promotes plant growth? Nitrogen. d. Which container would you expect the nitrogen level to be higher in, the container of water containing algal blooms or container of water which is clear? Why or why not. Instructor or students may wish to test the two water samples for nitrogen levels. e. Where does the nitrogen come from, and how could it affect water resources? 3. Develop answers from the students by having students complete the nitrogen cycle and compare its relationships with the hydrologic cycle.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* 4. Distribute worksheet (Page 3.0.4-29) on the nitrogen cycle. Have students complete worksheet as each section is discussed. 5. EXPERIMENT: "Fertile Green" from the Air and Water Management Association's *Environmental Resource Guide Nonpoint Source Pollution Prevention*. Pgs. 19-22. **Note**: Experiment takes one month for complete observations. Could tie experiment in as a follow-up to studies of the hydrologic cycle (3.0.2). 6. EXPERIMENT: "Manure Matters" from the Air and Water Management Association's *Environmental Resource Guide Nonpoint Source Pollution Prevention*. Pgs. 23-26. **Note**: Experiment takes 48 hours for complete observations. Experiment is also based on working with *E. coli* bacteria. Could tie experiment in as a follow-up to studies of the hydrologic cycle (3.0.2). 7. *Assignment:* Research and write a brief essay how the use of fertilizer nitrogen could contaminate the groundwater, and what problems could occur if too much nitrate leaches into the groundwater? 8. What management practices would increase nitrogen efficiency? a. Worksheet/Transparency on "Seven steps to increasing Nitrogen Efficiency While Reducing Environmental Risks. (NVATA Groundwater Project, Unit 4, Page 12) b. Worksheet/Transparency on "Best Management Practices for Natural Fertilizers. (NVATA Groundwater Project, Unit 4, Page 17)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *Ammonium fixation:* Tie up of ammonium form of nitrogen on to the clay structures in the soil. 2. *Ammonium nitrogen:* A colorless salt used in fertilizers 3. *Available nutrient:* That portion of any element or compound in the soil that can be absorbed an assimilated by growing plants. 4. *Blue-baby syndrome:* Blood related condition found in babies due to nitrate poisoning. 5. *Denitrification:* The reduction of nitrates, with nitrogen gas evolved as an end product. 6. *Eutrophic lake:* A lake that has a high level of plant nutrients, a high level of biological productivity, and a low oxygen content. 7. *Nitrate (NO3):* An important plant nutrient and type of inorganic fertilizer (most highly oxidized phase in the nitrogen cycle). In water, the major sources of nitrates are septic tanks, feed lots, and fertilizers. 8. *Nitrification:* Two-step process of ammonium (NH4) changing to nitrite (NO2) then to nitrate (NO3). 9. *Nitrite (NO2):* First product in the nitrification process in the conversion of ammonium to nitrate. 10. *Nitrogen Cycle:* Continuous cycle where atmospheric nitrogen is compounded, dissolved in rain, deposited in the soil, processed by bacteria and plants, and returned to the atmosphere by organic decomposition. 11. *Nitrogen-fixation:* The conversion of elemental nitrogen from the atmosphere to organic combinations or to forms readily used in biological processes. Normally carried out by bacteria living in legumes or by free-living soil bacteria. 12. *Nutrients:* Fertilizer, particularly phosphorous and nitrogen, the two most common components that run off in sediment. 13. *Root Zone:* The depth of soil penetrated by crop roots. (From *A Hidden Treasure;* NVATA Groundwater Project. Unit 4, page 10).

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the nature of legume root nodules? What factors affect their presence and efficiency?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

The size and number of nodules should be greater on cultivated plants, as opposed to wild legume plants. Number and size of nodules vary according to the stage of plant growth, species, and general plant health.

• Possibilities - Factors •

Problem-Solving Technique

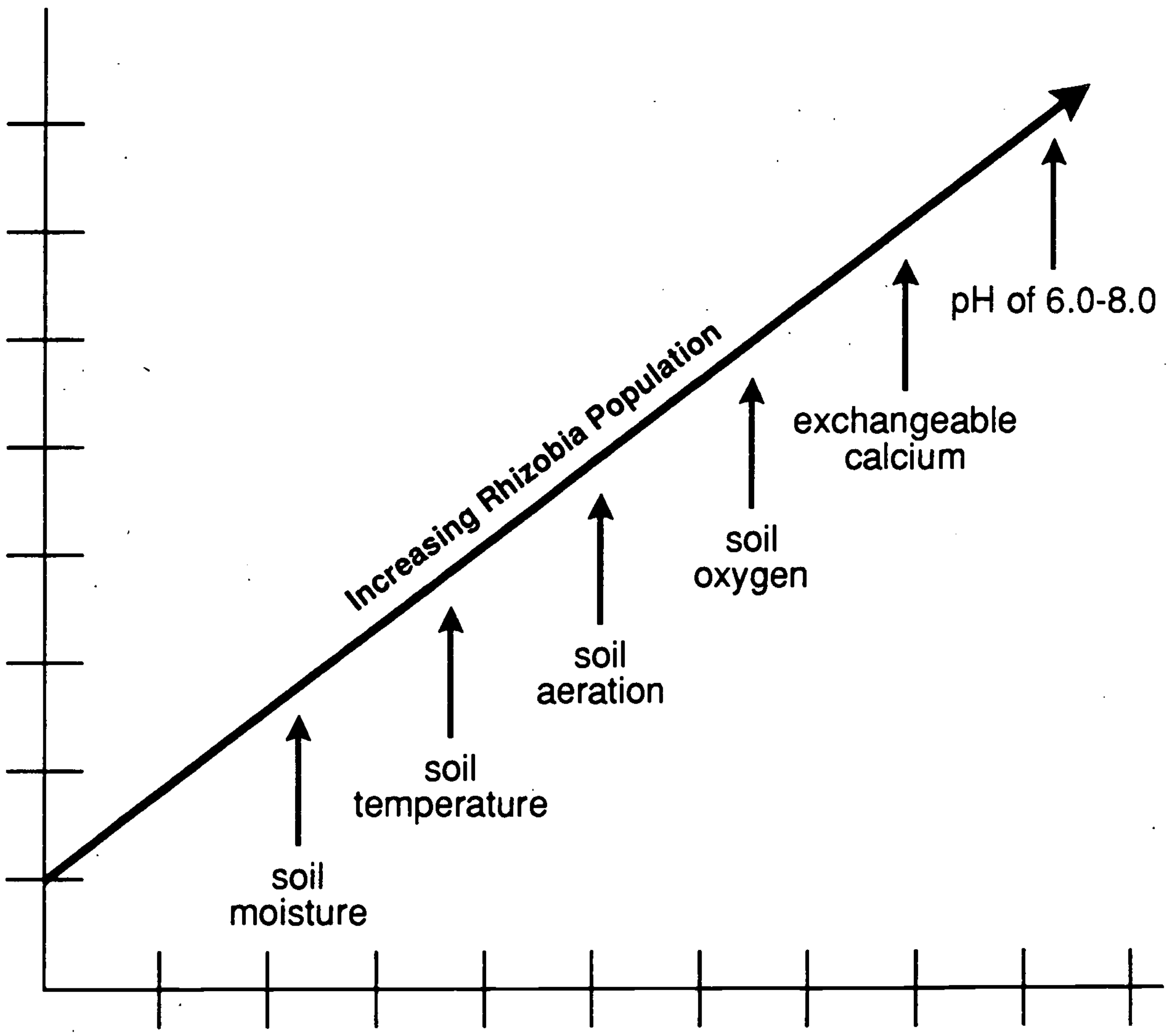
Define the problem

What is the nature of legume root nodules? What factors effect their presence and efficiency?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Factors That Affect Rhizobia Population in the Soil



Biological Nitrogen Fixation in Plants

$$N_2 \longrightarrow NH_3 \longrightarrow NH_4^+ \longrightarrow NO_2^- \longrightarrow NO_3^-$$

N_2	NH_3	NH_4^+	NO_2^-	NO_3^-
Dinitrogen (atmospheric nitrogen)	Ammonia	Ammonium	Nitrite	Nitrate (usable form of nitrogen by plant)

218

219

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

Which crop fixes more nitrogen in the soil – corn or soybeans?

Factors to Consider	Possibilities (Possible Solutions)			
	Corn	**Soybeans**		
Root structure of plants				
Amount of nitrogen present in soil prior to planting				
Amount of nitrogen present in soil at the end of the experiment				

Decision/Recommendation

The soil test for nitrogen will reveal more nitrogen present in the soil where soybeans were grown for corn. Nitrogen is actually added to the soil through biological fixation.

• Possibilities - Factors •

Problem-Solving Technique

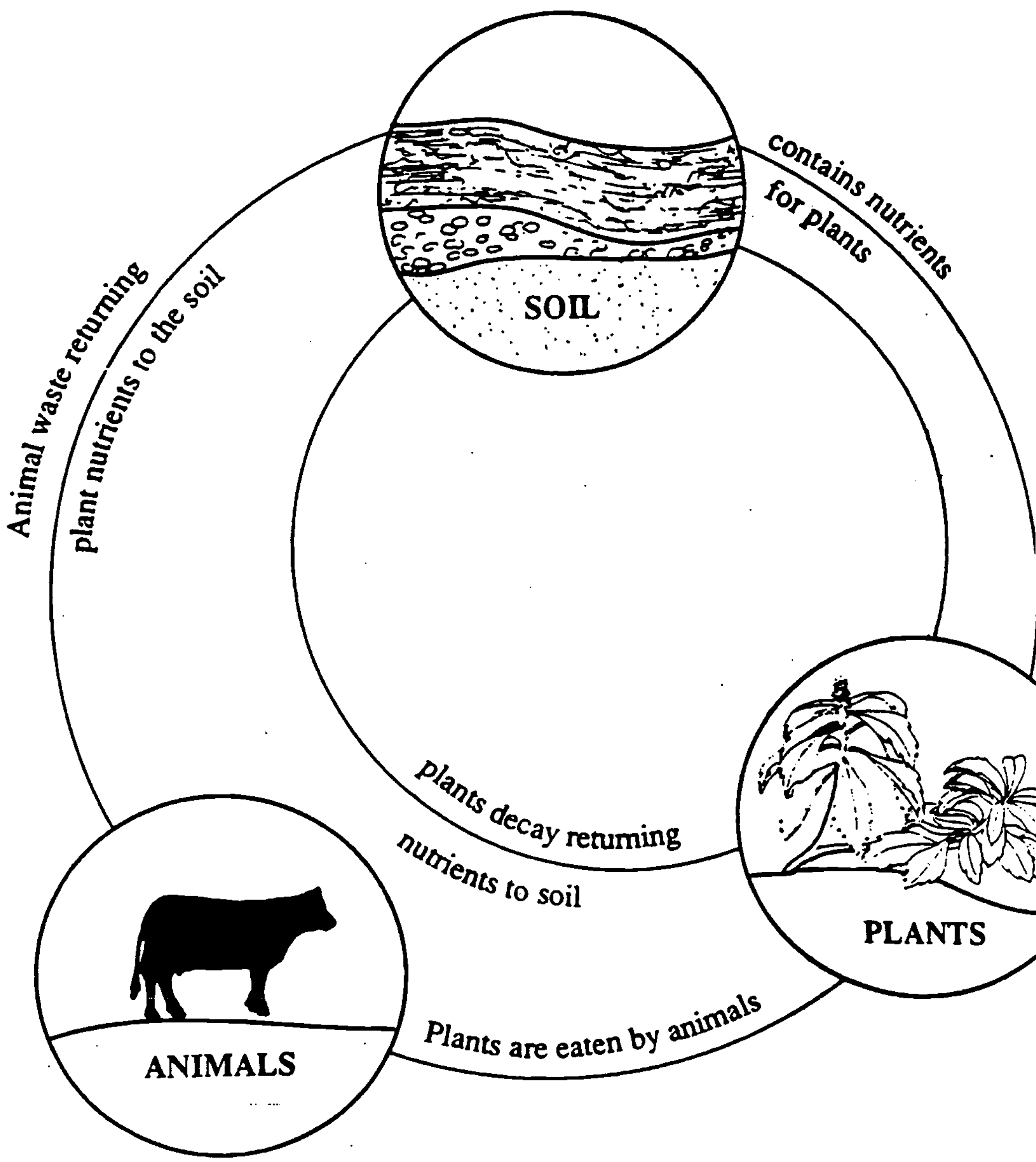
Define the problem

Which crop fixes more nitrogen in the soil – corn or soybeans?

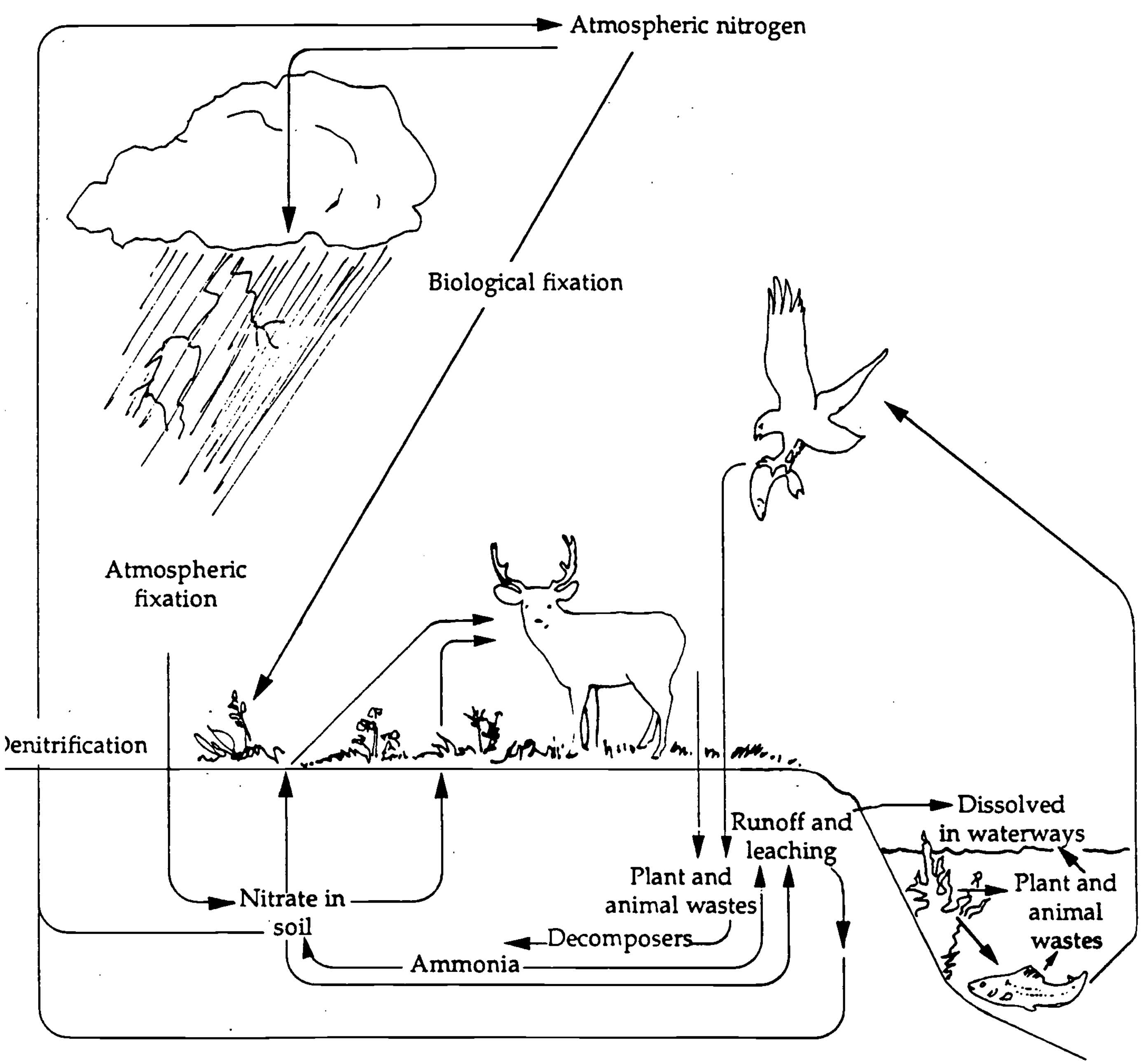
Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation:

The Original Source of Nutrients for Plants and Animals Is the Soil



The Nitrogen Cycle



• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What effect does soil composition have on nitrate leaching?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Coarse soils will tend to leach nitrogen into the water more readily than fine soils.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What effect does soil composition have on nitrate leaching?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

What effect does fertilizer placement have on nitrate leaching?

Factors to Consider	Choice one	Choice two
[redacted]		

Decision/Recommendation

The single band of fertilizer will leach more readily and cause higher nitrate levels in the drain water.

• Forked Road •

Problem-Solving Technique

Define the problem

What effect does fertilizer placement have on nitrate leaching?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

What effect does plant material have on nitrate leaching?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

The ryegrass will utilize some of the nitrogen after 2+ weeks of growth, causing lower levels of nitrates to occur in the drain water.

• Forked Road •

Problem-Solving Technique

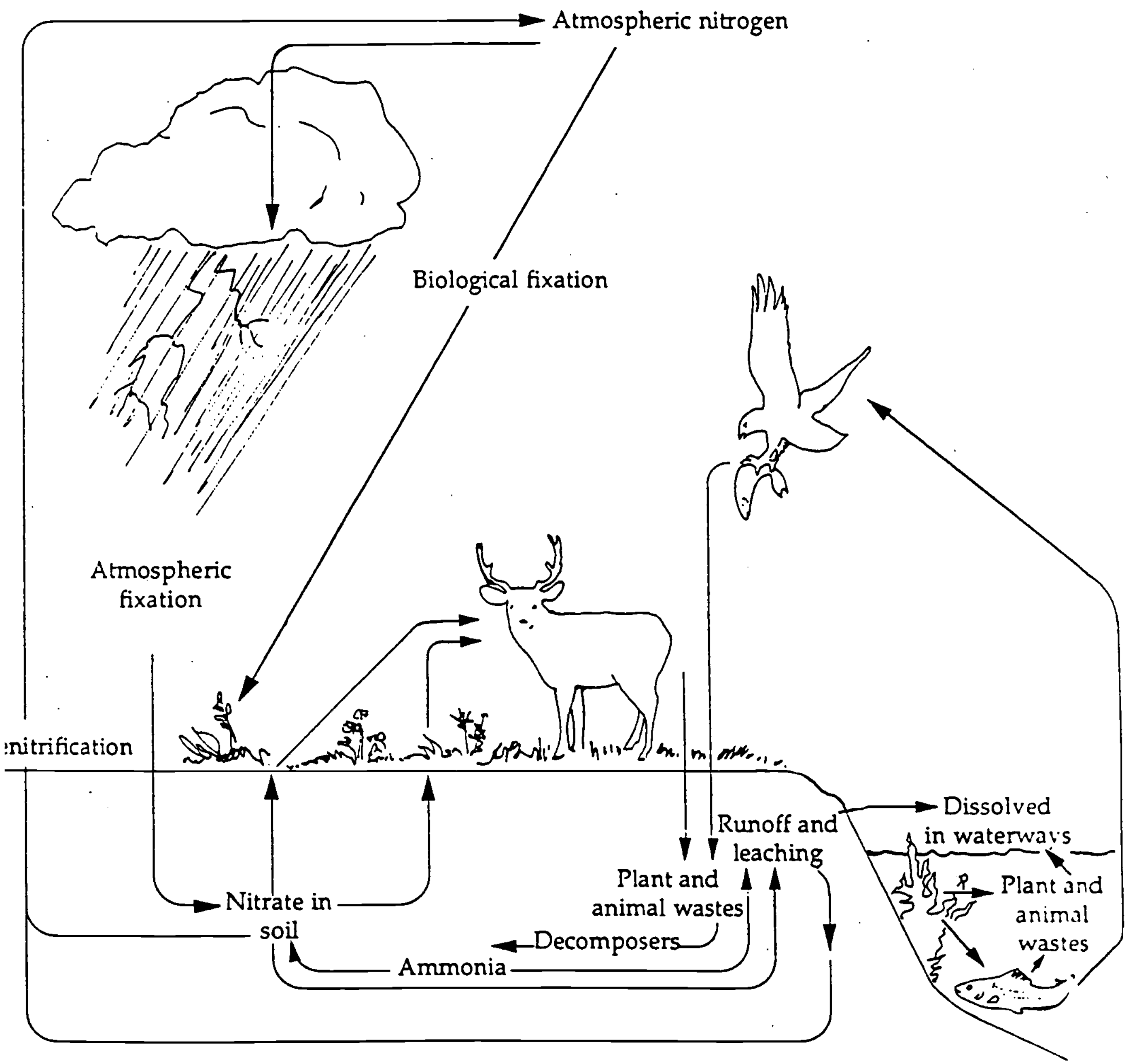
Define the problem

What effect does plant material have on nitrate leaching?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

The Nitrogen Cycle



Container Description:			
Treatment:			
Day	**Amount of Water added**	**Nitrate Level in Drain Water**	**Other Observations**

COMING TO TERMS WITH THE NITROGEN CYCLE

Worksheet #1

Ammonium fixation:

Ammonium nitrogen:

Available nutrient:

Blue-baby syndrome:

Denitrification:

Eutrophic lake:

Nitrate (NO_3):

Nitrification:

Nitrite (NO_2):

Nitrogen Cycle:

Nitrogen-fixation:

Nutrients:

Root Zone:

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 1

Conventional farming systems depend heavily on the use of chemical fertilizers for increasing crop yields. From 1940 to 1970, the use of commercial fertilizers in the United States increased eight fold. Since 1970, the rate of increase has not been as great, but chemical fertilizers still remain as the most expensive input for the production of many field crops.

One important primary nutrient for plant growth is nitrogen. In the past farmers "grew" much of their nitrogen fertilizer by plowing under legume crops. The legume crop, such as alfalfa, had been inoculated with bacteria which fix atmospheric nitrogen biologically. Animal manures were also a nitrogen source.

Today, the most important source of nitrogen is the synthetic fixation of atmospheric nitrogen gas. However, rising costs for producing this form of nitrogen makes this input expensive. More attention is being given to utilizing nitrogen from legume plants as a nutrient source for grasses. In the Midwest, this usually means rotating between corn and soybeans or alfalfa to take advantage of the nitrogen added to ghe soil from the legume plants.

Ideas for Additional Experiments

1. Replicate the experiment using other legume plants and grass plants and compare the effects on soil nitrogen.

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 2

The application of nitrogen fertilizer is one of the most expensive aspects in the production of most field crops. All growing plants, including cereal grains, forages, turf, vegetables, and flowers need relatively large amounts of supplemental nitrogen in order to ensure a healthy, productive plant. However, the supplemental nitrogen requirements are remarkably less for many legumes, as compared to grasses. This difference is due to the legume plant's ability to manufacture nitrogen through the action of special bacteria contained in the root system. Fixation rates of 44 lb/acre/year are common, and rates of up to ten times that amount have been found to occur.

Many legumes, such as alfalfa and clover, have efficient, nitrogen-fixing bacteria in their plant roots. These types of legume seeds are inoculated prior to planting with an appropriate strain of bacteria. This practice has been shown to improve the ability of the plant to meet its own nitrogen needs. The economic benefits of nitrogen fixation by legume plants are very significant for legume crops like alfalfa. Although nearly all legume plants have nitrogen-fixing capabilities, not all legume plants have been shown to positively respond to seed inoculation. Soybeans are an example of a legume where seed inoculation prior to planting is no longer recommended, due to negligible effects of inoculation upon nitrogen fixation in soybean roots.

Ideas for Additional Experiments

(*Note:* These can be done in the field or greenhouse.)

1. Examine the general effects of rhizobia inoculum on root nodule development and plant growth.
2. Test the effects of various rhizobia strains on one or more legume species.
3. Determine the effects of the amount of inoculum added to legume seed on nodule development and plant growth.
4. Examine the effects of harvest on the presence of nodules. (On some plants, nodules tend to slough off during harvest and return several days after harvest.)

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 3

Nitrogen is an important element for plant growth. Plants need a lot of nitrogen because it is a major component of chlorophyll and protein. When adequate nitrogen is available, crops will grow vigorously, appear dark green in color, and have a higher protein content. This makes them a better food source for animals or humans. Plants also use water best when they have ample nitrogen.

Too much nitrogen provided to crops, however, can be harmful. Plants can be harmed by over-fertilization, resulting in soft weak growth which is more prone to lodging and disease. Overly rapid growth can also slow maturity of some crops. Too much nitrogen, in the form of nitrates, can also be harmful to humans. Nitrates can move into water supplies because the nitrate form of nitrogen is repelled by soil particles. High concentrations of nitrates (above 10 milligrams of nitrate-nitrogen per liter of water, 10 ppm,) can be harmful to infants and young farm animals.

Nitrates have always been present in the soil due to the natural breakdown of organic matter and the application of nitrogen which is the most widely used commercial fertilizer. Today, producers attempt to gain optimum benefit from nitrogen fertilizer with minimal impact on the environment by applying management techniques for maximizing economic yields (MEY). Making the right management decisions requires a thorough understanding of how nitrogen is stored in the soil. In this experiment, you will be investigating the physical properties of nitrogen and examining factors which can affect its leaching into groundwater.

Ideas for Other Experiments

1. Several factors, such as amount of nitrogen added to each container, the brand of nitrogen purchased or the form of nitrogen added, could be investigated using these research procedures.
2. Plant material other than grasses could also be used for this experiment.

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 4

The hydrologic cycle explains the various routes which water may travel as it flows throughout the world. Just as water moves throughout the environment, so does nitrogen, in several various forms. The nitrogen cycle is a simple representation of what happens to nitrogen, and the various interactions and reactions that it has throughout the environment.

Applying too much, fertilizer can wash into the rivers and lakes and supply aquatic plants with too many nutrients, causing an increase in algae growth. Algal blooms can reduce the supply of oxygen in the water because oxygen is required for algal respiration and further growth. When the algae die, bacteria which decompose the algae also tie up oxygen in the water, further depleting the oxygen available to fish, causing fish kill in the water, and additional decomposing of organic matter. All of the decaying matter gradually fills in the bottom of the pond with sediment. This process is called eutrophication, and is sped up when excess nutrients and sediment are added to the water body.

Evaluating Student Learning

After students have completed the activities, have them record their data on pages 3.0.4-35 and -36.

Also see attached evaluation sheet (3.0.4-37)

Portions of this activity were submitted by Dave Stiles, Agricultural Education Instructor, Indian Valley High School, Box 130, Gnadenhutton, OH 44629. Other portions were adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Nitrogen Cycle Test

100 points Name ______________________________

1. List three forms or types of chemical nitrogen fertilizers (3 points each).

   A. Solid:
   B. Liquid:
   C. Gas:

2. Briefly explain three other ways otehr than by adding chemical fertilizers that nitrogen may be added to the soil (3 points each)

   A.
   B.
   C.

3. Explain how the following conditions and environments affect the nitrogen cycle. (3 points each)

   A. temperature:
   B. soil moisture:
   C. anhydrous ammonia:
   D. carbon/nitrogen ratio:
   E. soil type (amount of clay):

4. Which two forms of nitrogen are highly toxic to humans: (3 points each)

   A.
   B.

5. Why is the nitrate form of nitrogen the most unstable form in the soil? (3 points each)

6. Idetify three ways that nitrogen leaves the soil when it is in the nitrate form. (2 points each)

   A.
   B.
   C.

7. According to E.P.A. guidelines, at what concentration level of nitrate in the water must the suppliers issue a nitrate alert to its users. (4 points)

8. Write a brief essary or paragraph explaining how the agronomic practices of spreading manure on frozen ground, or adding more nitrogen than crops or plants need, would cause the following problems. (6 points each)

   A. Fish kill in a nearby pond:
   B. "Blue-baby" disease
   C. Acid soils:

Program AGRISCIENCE

Unit 3 - Environmental Science

Describe Environmental Interrelationships

Competency/Terminal Performance Objective

3.0.5: Given examples, describe environmental interrelationships using list of criteria.

Competency Builders/Pupil Performance Objectives

3.0.5.1 Given examples, identify current environmental issues on criterion assessment instrument.

3.0.5.2 Given examples, describe relationship between wildlife and habitat, based on definitions provided.

3.0.5.3 Given examples, explain organism interaction, based on definitions provided.

3.0.5.4 Given a case situation involving respiration, distinguish between anaerobic and aerobic respiration, according to criteria given in assessment instrument.

3.0.5.5 Using references and worksheet provided, describe effects of pollution on living organisms and write a relevant essay to that topic as presented in lecture.

3.0.5.6 Using examples, describe effects of waste on the environment, according to criteria given in assessment instrument.

3.0.5.7 Given examples, describe methods of waste management, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

2.2.4 Estimate measurement
3.2.6 Use problem-solving techniques
5.2.2 Find surface areas and volumes of applicable geometric figures

Equipment, Supplies, References, and Other Resources

1. 10 small pots or cups
2. 100 seeds (radish or other garden seed)
3. soil or vermiculite
4. detergents: one soap-based - e.g., *Ivory Snow*; one anionic surfactant - e.g., *Surf*; one containing Boron - e.g., *Borateem* or *Borax*; one liquid laundry detergent - e.g., *All* with phosphorous

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Students will probably suggest nuclear by-products, petroleum products, pesticides, etc., as the most dangerous pollutants. It is not likely they would identify common household detergents as pollutants. However, in this exercise they will observe and compare the harmful effects various detergents can have on plant growth. Use the information on pages 3.0.5-4 and -5 (student copy).	**Interest Approach** List on the board the most dangerous pollutants in our environment. Discuss the potentially harmful effects to both animals and plants. **Procedures** 1. Make up solutions of each detergent according to the manufacturer's recommendations. 2. Using two planting containers for each detergent being tested, fill the containers with soil or a soil-vermiculite mix. Also include two containers as a control. 3. Punch drainage holes in the bottom of each container. 4. Thoroughly moisten the containers using a different detergent solution for each pair. Moisten the control containers with plain water. Allow containers to drain. 5. Plant 10 radish seeds in each container. Keep the soil or soil-vermiculite mix as moist as necessary for germination. Be certain each planting container receives the same detergent solution at each subsequent watering. 6. After the seeds have germinated, remove the weakest plants – leave the five healthiest plants in each container. 7. Continue watering with the proper solutions. Record subsequent plant growth. 8. Continue recording plant growth until the plants are either too large for the containers or almost dead.
	Data Summary and Analysis Every 2 to 3 days record the height of the plants and the leaf color for each detergent tested and the control group. Construct a chart.
	Key Terms 1. *assimilation* - the transformation of organic and inorganic materials into protoplasm. High concentrations of certain ions in water can prevent assimilation from occurring. 2. *toxicity* - something that is harmful to plant growth.

• Effect-Cause •
Problem-Solving Technique

Define the problem

Does the common everyday practice of washing clothes release pollutants into the environment which are harmful to plant growth?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

All of the detergent solutions will have a negative effect on plant growth. Depending on the strength of each solution, the detergents will eventually kill the plants.

• Effect-Cause •
Problem-Solving Technique

Define the problem
Does the common everyday practice of washing clothes release pollutants into the environment which are harmful to plant growth?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Growers optimize plant growth and crop yields by providing the proper amounts of essential mineral elements needed by plants. This control of mineral nutrition in either a soil or soilless medium is one of the basic technologies of agriculture which has helped ensure an adequate food supply for a growing world population.

Usually, growers supplement deficient nutrients by applying commercial fertilizers. Nutrients are also supplied through crop residues, animal manure, and natural minerals. The actual source of the nutrient is unimportant as long as it is available in the proper quantity. With the increasing cost of commercial fertilizers, growers are considering using fertilizer alternatives such as sewage sludge. However, application of sludge produces mixed results. Sometimes this procedure harms plants by providing an *overabundance* of certain mineral elements. This demonstrates that an element essential for plant growth can be toxic at higher levels. Toxic levels of minerals can occur in the sludge produced by washing clothes. Common detergents can become pollutants adversely affecting plant growth. Growers must carefully analyze non-traditional fertilizers to be certain pollutants are not present which could harm plants.

Ideas for Additional Experiments

1. Test additional laundry aids or detergents for their effects on plant growth.
2. Write to the companies which produce the detergents being tested for information regarding their biodegradability. Prepare the detergent solutions as suggested to degrade the detergents - then duplicate the experiment.

Evaluating Student Learning

After students have completed the experiment, have them record their data on pages 3.0.5-7 and -8.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

Ohio Agricultural Education Curriculum Materials Service
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Office Hours M-F: 7:30 am to 4:30 pm

Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 4 - Business Technology

Budget Finances

Competency/Terminal Performance Objective

4.0.1: Given record keeping system examples, budget finances based on criteria outlined in assessment instrument.

Competency Builders/Pupil Performance Objectives

4.0.1.1 Given specific examples, identify budgeting process, according to definitions and criteria given in assessment instrument.

4.0.1.2 Given specific examples, prepare budget(s), according to criteria given in assessment instrument.

4.0.1.3 Given specific examples, develop agreement, according to criteria given in assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
1.2.2 Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
1.2.5 Set up, solve, and apply ratios and proportions
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7 Translate written and/or verbal statements into mathematical expressions
1.2.8 Estimate answers
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

Equipment

1. play money (optional)
2. calculator (optional)
3. Food - candy or pop (optional)
4. *Agricultural Education Enterprise Record Books* (budget pages)

References

R. Kirby Barrick, *Teacher Guide for the Vocational Agriculture Record Keeping System,* Ohio Agricultural Education Curriculum Materials Service, 1988.

Ralph J. Woodin, *Budgeting and Spending,* Ohio Agricultural Education Curriculum Materials Service, 1977.

The Ohio State University Extension *Enterprise Budgets*

Situation

This activity is to be conducted with a class of Level I Agriscience students. The students should have chosen a Supervised Agricultural Experience Program prior to this lesson.

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures: Interest Approach/Teaching Methods</th></tr>
<tr><td>
Teachers may use play money or the worksheet (page 4.0.1-7) that is provided to complete the budget for the interest approach.
If you have pop or candy to simulate the food they need to buy, it will help keep their interest in playing the game.
By using the play money the students will practice their money managing skills.
Be sure to ask the students how much they think items will cost. Feel free to collect more for certain items if the students are willing to pay for them.
The object is to make the students spend more than they earn, so they realize the importance of money management and budgeting their money.
</td><td>
Interest Approach
Situation Role Playing
Ask the students how much money they would need to make a year, for them to live on, after they have graduated from high school.
Have them decide on $20,000/year or less.
Now explain that they will be living on their own in their own apartment or house, and they still owe $5,000 on a car loan. They will not receive any gifts or money from their parents.
1. Start by giving each student 1 month's pay. (Have the students calculate the pay)
$20,000 / 12 months = $1666.67 / month - gross pay
2. Collect taxes (Federal, state, local, social security, etc.) approximately 30%.
$1666.67 X 30% = $500.00
$1666.67 - $500.00 = $1166.67 - Net pay
3. Now ask the students what things will they need, and what bills will need to be paid. Also, ask how much they think these things will cost per month:
A. Food - (If you have some candy or drinks available, have the students purchase the food for $100.00 / piece of candy or drink). Collect $100.00 for food. (minimum)
B. Rent - Collect $275.00 for rent. $375.00 for furnished.
C. Clothes - Ask how much they spend on clothes a month? Collect $50.00 for clothes.
D. Car payment - Collect $200.00 for car payment.
E. Gas and maintenance (Includes oil changes, new tires, etc.) Collect $125.00 for gas.
F. Car insurance - Collect $50.00 for car insurance. (Liability only) Collect $75.00 for full coverage.
G. Health insurance - Collect $75.00 for health insurance.
H. Entertainment - (Movies, restaurants, tapes or CD's, video games, etc.) Collect $50.00 for entertainment.
I. Cable television - Collect $25.00 for basic cable. Collect $35.00 for full cable (movie channels).
J. Telephone bill - Collect $35.00 for telephone.
</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
You may want to assign a banker to help collect the money.	K. Television - \$300.00 television (90 days same as cash) \$100.00 for 1st month. L. Furniture, refrigerator, stove, microwave, stereo - loan for \$10,000 monthly payments are approximately \$300.00 M. Electric bill - collect \$50.00 for electric. N. Sewer and water bill - Collect \$25.00 per month. O. Garbage bill - \$5.00 per month. P. Heating bill - \$600.00 per year, collect \$50.00 for one month's bill. Q. Life insurance - Collect \$50.00 for life insurance. R. Speeding ticket - Collect \$50.00 for speeding ticket. S. How much do you have left for your savings account? 1. Why did you run out of money? 2. What items could you have done without in order to afford your electric, water, and heating bills? 3. How would you pay for emergency items like the speeding or parking ticket, or major repairs to your car or appliance? 4. What could we use to help us manage our money more wisely? *A budget*
Discuss the characteristics of a good budget before completing the SAEP budget.	Listed below are some important characteristics of a good budget: 1. The budget should include a specific time period or periods. For your projects it would be best to do a yearly budget January 1 to December 31. 2. Your budget should give an accurate, realistic estimate or your expected income from all sources. 3. All of your expected expenses should be listed for the time period. Accurate and realistic figures must be used and revised in light of necessary changes. 4. Your own personal goals should be the basis for your budget, these goals may need to include long-range needs, such as a home, further education, or providing for a family. 5. A plan for systematic savings which will permit you to reach your goals at a desired time should be included. You might have a goal of having \$10,000 for a home payment in seven years. This would require savings of about \$100.00/month. 6. Your budget must be simple to adjust and to operate: setting up a budget that plans for every last penny and that requires hours of figuring each day is just too much.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	7. You must be thoroughly sold on your budget. It will be hard to stick to your budget at times,. Unless you are convinced that you really want the goals you have set up for yourself, a budget will not help. The difficulty with most budgets is in following them once they are set up.
Start the lesson with a discussion of SAE projects. Continue the discussion utilizing transparencies (4.0.1-8)and worksheet "What is a budget?"(4.0.1-9)	**Lesson #1 - What is a budget and how do I use it?** (Group Discussion) All of you should have some idea as to what type of supervised agricultural experience project you are going to take this year. Ask each student what type of SAEP they are going to take. Before you start your projects you should ask yourself some important questions: A. Do you have the facilities? B. Do you have the knowledge and expertise? C. Do you have the money or capital for your project? How can you tell if you have the money to finance your project? Can you determine how much profit you will make before you start your project? If you knew you would lose money before you start your project, will you still want to do the project? *EXAMPLE:* If you pay $1000.00 for a feeder steer, and you know the average selling price at your fair is $100.00 / pound, and you estimate your steer will weigh 1200 pounds - how much profit will you make? Did you figure your feed cost? Did you figure your equipment and supply cost? Did you figure your veterinarian bills? Did you figure your building rental, and electric bills? Did you figure your transportation cost? Now how much profit did you make? Would you pay that much for your feeder steer? In our example what did we just make? *Answer:* A budget

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use transparency (see page 4.0.1-8).	**What is a budget?** A budget is plan for using your money. A budget is a simple estimate of the balance of your expenses and income. A. A budget helps you to live within your income. B. A budget helps you to fit your spending to your income. C. A budget helps you to make wise choices in spending. D. A budget make you look ahead to your future spending. How do you know if you have a good sound budget?

"How much money do you need?"

Name: ______________________ Month of ______________

Estimated income for one year	=	________	Gross income
Taxes - _____ percent	=	________	
Net Income	=	________	
Income per month	=	________	

Balance

Income per moth $ ______________

Estimated Expenses:

Item:	Cost/month	

How much money do you have for savings? Total +/- ______________

What is a budget?

A budget is a plan for using your money.

A budget is a simple estimate of the balance of your expenses and income.

What does a budget do?

1. A budget helps you live within your income.,
2. A budget helps you to fit your spending to your income.
3. A budget helps you to make wise choices in spending.
4. A budget makes you look ahead to your future spending.

WORKSHEET #2

What is a budget?

Name: ______________________________

1. What is a budget?

2. A budget helps or makes you do what?

   A.

   B.

   C.

   D.

3. How do you know if you have a good sound budget?
   Characteristics of a good budget:

   A.

   B.

   C.

   D.

   E.

   F.

   G.

Helping Students Apply Concepts/Principles/Skills

Practice setting up a budget using a copy of the budget pages from the SAEP Record Books (Students may work on individual project budgets or the budget many be completed as a group.)

Utilize enterprise budgets developed by The Ohio State University Extension staff for references.

Proceed step by step through the budgets one line at a time, giving as many examples of different projects as possible.

Evaluating Student Learning

See attached evaluation sheet (4.0.1-11)

This activity was submitted by Steve Foster, Agricultural Education Instructor, Upper Scioto Valley High School, South Courtright Street, McGuffey, Ohio 45859.

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WORKSHEET #2

What is a budget?

Name: ______________________________

1. What is a budget?

2. A budget helps or makes you do what?

   A.

   B.

   C.

   D.

3. How do you know if you have a good sound budget?
   Characteristics of a good budget:

   A.

   B.

   C.

   D.

   E.

   F.

   G.

Program	**AGRISCIENCE**
Unit	**4- Business Technology**

Perform Accounting Functions

Competency/Terminal Performance Objective

4.0.2 Given accounting system samples, perform accounting functions based on criteria outlined in assessment instrument.

Competency Builders/Pupil Performance Objectives

4.0.2.1 Given specific conceptual examples, apply accounting concepts, principles, and procedures based on criterion assessment instrument.

4.0.2.2 Given example analysis records, prepare cost and revenue analysis based on criterion assessment instrument.

4.0.2.3 Given specific examples and student information, prepare net worth statement according to criterion assessment instrument.

4.0.2.4 Given specific examples, summarize financial reports based on criteria assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials

1.0.4 Determine solutions to problems

1.0.5 Identify details such as who, what, why, where, when, or how

1.0.8 Define words used in context

1.0.15 Summarize material

2.0.3 Record observations

2.0.9 Write legibly

2.0.10 Organize facts, details, and examples in logical order

2.0.13 Use correct grammar

2.0.14 Use correct spelling

2.0.19 Use appropriate punctuation and capitalization

3.0.3 Communicate appropriately with co-workers, clients, and supervisors

3.0.4 Identify sources of information

3.0.6 Follow directions

4.0.3 Participate in discussions

4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.1.1 Round and/or truncate numbers to designated place value
1.1.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.1.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
2.1.2 Compute using appropriate units of measurement
3.1.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. Copies of blank net worth statements
2. Copies of handouts –
   Definition of Assets
   Definition of Liabilities
   Data Record and Observation Sheet

Situation

This activity is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach Begin a class discussion about the need for financial aid to acquire equipment or other cost items necessary to begin a business. Point out that sometimes a bank loan is the best way -- or in some cases, the only way -- to acquire the necessary finances. Mention that one of the items banks generally require before approving a loan request is the customer's **net worth statement**.
Write the students' responses on the board.	Ask the students the following questions: 1. What does a net worth statement report? (*possible student responses*) a. All the money we have b. How much money we have after taxes c. What our possessions are worth d. How much money we need to borrow e. How much money is left after we pay our bills Continue class discussion on the meaning of **assets**, **liabilities**, and **current market value**. Present examples of assets students may typically possess. After discussing what liabilities are, ask the students to list any liabilities they may have. Point out that an item's value is based upon what one could reasonably expect to receive from selling it.
Write the students' responses on the board.	2. Why is your net worth statement important for securing a loan? (*possible student responses*) a. It shows the banker how much you need to cover your costs. b. Banker must know if you owe money to other people. c. If you already have lots of money, they won't give you a loan. d. If you show that you can manage money, you can get a loan. e. It shows the banker you will have enough money to pay back the loan.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Write the students' responses on the board.	3. What questions should we ask when determining our net worth? (*possible student responses*) a. What items should be included as something we own? b. How do we determine how much our items are worth? c. What items should we list as liabilities? d. How do we list items for which we have only a share of the ownership? e. How do we determine how much something is worth if we don't plan to sell it?
Write the problem statement on the board. Distribute handouts – *Definition of Assets* and *Definition of Liabilities* on pages 4.0.2-7 and -8.	***HOW DO YOU COMPLETE A NET WORTH STATEMENT?*** Use the information on pages 4.0.2-5 and -6 (student copy).

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How do you complete a net worth statement?

What to Do (Steps)	How to Do It (Key Points)
1. List all your assets.	List all your assets and group them as current, intermediate, or long-term. Refer to handout – *Definition of Assets.*
2. Establish a value for all your assets.	List the amount you could reasonably expect to receive for each asset if you were to sell it.
3. Determine total value of all your assets.	Total the dollar value of all the assets on your list.
4. List your liabilities and determine the value of each.	List all your liabilities and group them as current, intermediate, and long-term. Refer to handout – *Definition of Liabilities.*
5. Determine total value of all your liabilities.	Total the dollar value of all the liabilities on your list.
6. Determine your net worth.	Subtract total liabilities from total assets.

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem	
How do you complete a net worth statement?	
What to Do (Steps)	**How to Do It (Key Points)**

Definition of Assets

Current Assets

1. **Cash on Hand** - a physical count of all cash
2. **Amount in Checking Account** - balance in checkbook, without regard to checks which are still outstanding
3. **Amount in Savings Account** - current balance on deposit, including interest to date
4. **Accounts Receivable** - money to be received within 12 months for products already sold and delivered or services provided
5. **Products Produced on Hand for Sale** - value of products and goods on hand that were produced for sale, but have not been sold
6. **Supplies on Hand** - cost of supplies on hand that are to be used at a later date
7. **Prepaid Expenses (paid for, unused supplies)** - value of supplies paid for which are associated with future income, such as three-year insurance coverage, or payment for fertilizer to be applied the next fall
8. **Notes** - amount of note held that can be easily turned into cash
9. **Securities** (readily marketable) - value of securities held that can be easily turned into cash
10. **Market Animals** - value of all animals on hand which are anticipated to be sold in the next 12 months, including breeding animals which will be sold in the next 12 months

11-12. **Other** - list and indicate value of all other assets which can be turned into cash readily, including personal accounts receivable and cash invested in a growing crop

Intermediate Assets

1. **Equipment and Machinery** - the current market value of equipment and machinery - usually original cost minus accumulated depreciation to the present
2. **Securities** (not readily marketable) - value of stock that cannot be turned into cash easily, such as co-op stock, PCA shares
3. **Automobile** - current market value of automobile or "book value"
4. **Personal Goods and Equipment** - an estimate of the current value of personal belongings and equipment
5. **Cash Value of Life Insurance** - the amount that can be borrowed from the insurance company with the policy used as collateral, usually determined from a table printed in the policy -- not the face value, since face value is received only upon maturation of some policies or upon the death of the insured
6. **Breeding Animals** - current market value of all breeding animals (excluding animals under item 10 above)
7. **Other** - value of other assets that cannot be turned into cash easily

Long-term Assets

1. **Land and Improvements to Land** - market value of land and improvements owned
2. **Buildings and/or Fences** - current value of buildings and/or fences owned
3. **Other** - list and indicate value of all other long-term assets

Definition of Liabilities

Current Liabilities

1. **Accounts Payable** (unpaid bills due within one year) - accounts and bills that are payable, but not paid, and due within one year
2. **Short Term Notes Due within One Year** - principal due on a note to be paid within one year
3. **Credit Card** - current credit card charges which have not been paid
4. **Principal Payments Due within One Year** - principal due within one year on debts extending beyond one year
5. **Estimated Accrued Interest** - amount of interest due on all notes within one year or beyond one year, if the notes were paid off on the day the net worth statement is completed
6. **Estimated Accrued Taxes** - amount of taxes due at the time the statement is completed, even though the taxes may be billed at a later date
7. **Accrued Rent** - amount of rent due at the date of the statement, even if rent is not to be paid until a later date, such as at the end of the lease or crop year
8. **Pledges Promised** - amount of money pledged, to be paid at a later date, such as for church or charitable organizations
9. **Other** - list and indicate amount of other current liabilities

Intermediate Liabilities

1. **Machinery and Equipment Loans of 1-10 Years** - total amount of principal due on loans of 1 to 10 years (interest due is included under item 5 of current liabilities)
2. **Notes to Be Paid on Items between 1 and 10 Years** - total amount owed on a loan or note, not including interest (item 5 above)
3. **Other** - list and indicate amount of other intermediate liabilities

Long-term Liabilities

1. **Loans on Land and Buildings** - amount of loan or mortgage on land and buildings
2. **Other** - list and indicate amount of other long-term liabilities

Helping Students Apply Concepts/Principles/Skills

Each student should complete a net worth statement when he or she enters the agricultural education program, or at least by the start of the new calendar year of the first year in agricultural education. Students should also complete subsequent net worth statements on at least an annual basis. The comparative net worth can be used to determine financial progress (or lack of) during the agricultural education program.

Completing the net worth statement is a life skill that will be valuable to the student in both personal and business situations.

Evaluating Student Learning

Have each student complete a net worth statement. Check for completeness and accuracy. Use a quiz about the net worth statement to test the student on terms used in determining net worth and how to group assets and liabilities as current, intermediate, and long-term. Ask the student to demonstrate how a reasonable market value is derived for various assets and liabilities.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ______

Objective(s) ____________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program **Agriscience**

Unit **4 – Business Technology**

Maintaining Business Records

Competency/Terminal Performance Objective

4.0.3 Maintain business records.

Competency Builders/Pupil Performance Objectives

4.0.3.1 Identify reasons to maintain savings and checking accounts.
4.0.3.2 Calculate simple and compound interest.
4.0.3.3 Maintain Supervised Agricultural Experience Program (SAEP) records.

Applied Academics Competencies

Communications

1.0.4 Determine solutions to problems
1.0.8 Define words used in context
2.0.10 Organize facts, details, and examples in logical order

Mathematics

1.2.2 Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7 Translate written and/or verbal statements into mathematical expressions

Equipment, Supplies, References, and Other Resources

1. Chalkboard/ overhead projector
2. Handouts
   - *Planning Your Future*
   - *What Is a Check?*
   - *How Do We Save Money?*
   - *Let's Save Some Money -- Simple Interest*
   - *Let's Save Some Money -- Compound Interest*
   - *Watch Your Money Grow*
   - *I Need Money -- Compound Interest Loan*
   - *I Need Money -- Simple Interest Loan*
3. Calculator
4. *Monopoly* money
5. Student SAEP Record Books

Situation

You are teaching a business technology lesson to an Agriscience class of 8 to 20 students. So far you have covered finances and accounting. Now your students are ready to begin their future financial planning.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach Begin the class by asking the following questions:
Write the students' responses on the chalkboard/overhead. Distribute handout -- *Planning Your Future* on page 4.0.3-5 and *Monopoly* money.	1. Imagine that you have graduated from high school or college. What career will you be entering? 2. What will be your starting salary in that career? Allow the class to pinpoint an average starting salary -- probably \$25,000 to \$30,000. After the salary has been determined, calculate what the take home pay will be every month. *For example:* Yearly Salary: \$25,000 Monthly: \$25,000/12 = \$2,083.33 Monthly after taxes: \$2,083.33 x 0.68 = \$1,416.67
Sometimes a real-life budget makes more sense to a class. Consider showing them a budget similar to your own.	Give each student *Monopoly* money that approximates the amount listed above. Then, have the students list the costs associated with living on their own. Some of the costs will include the following: • Rent • Food • Car payment • Car fuel • Utilities (telephone, water, electric, gas, sewer) • Cable TV • Credit cards • Furniture • Clothing • Pets • Insurance (car, home, life) • Entertainment, hobbies Allow the students to figure their expenses and collect that money from the students. Have each student calculate any leftover money. Now ask the students these questions:
Lead the students' answers toward *checks*. (no. 4) Lead the students' answers toward a *savings account*. (no. 5)	3. Will you always pay cash for these expenses? 4. How will you be paying for these expenses? 5. What will you do with your leftover money?

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures:
Interest Approach/Teaching Methods</th></tr>
<tr><td></td><td>Activity
CHECKING ACCOUNT</td></tr>
<tr><td>Distribute the handout -- What Is a Check? on page 4.0.3-6.</td><td>After the class realizes the need for using checks in the home and a business setting, demonstrate the following basic steps of writing a check:
1. Date
2. Pay to the order of
3. Money spent
4. Signature</td></tr>
<tr><td>Distribute the handout -- How Do We Save Money? on page 4.0.3-7.</td><td>Now discuss the use of deposit tickets and demonstrate the following basic steps of writing a deposit ticket:
1. Date
2. Deposit section (currency, coin, checks)
3. When to use a signature</td></tr>
<tr><td></td><td>SAVINGS ACCOUNT
Discuss with the class the importance of savings accounts. Also, compare the following benefits of a certificate of deposit to those of a savings account:</td></tr>
<tr><td>Many of these terms can be discussed as part of the lesson. Use the problem-solving forms on pages 4.0.3-8 and 4.0.3-9 (student copy).</td><td><table>
<tr><th>Certificate of Deposit</th><th>Savings Account</th></tr>
<tr><td>1. Long-term investment</td><td>1. Unlimited term investment</td></tr>
<tr><td>2. Larger interest rate</td><td>2. Limited interest rate</td></tr>
<tr><td>3. Not readily accessible</td><td>3. Easy accessibility</td></tr>
<tr><td>4. Large investment needed</td><td>4. Minimal investment needed</td></tr>
<tr><td>5. Fixed interest rate</td><td>5. Flexible interest rate</td></tr>
</table></td></tr>
<tr><td></td><td>CALCULATING SIMPLE AND COMPOUND INTEREST ON SAVINGS ACCOUNTS
Explain to the students that there are two types of savings accounts: a simple interest account and a compound interest account. Lead a discussion regarding which is the better interest plan.</td></tr>
<tr><td>Distribute the handouts -- Let's Save Some Money - Simple Interest, Let's Save Some Money - Compound Interest, and Watch Your Money Grow on pages 4.0.3-10 to -13.</td><td>Work through the example of the simple interest account and give the students time to complete the three examples.

Now work through the example of the compound interest savings account. Give the students time to complete the example.

After discussing the differences between a simple and a compound interest plan, discuss the importance of saving money. Use the handout as a guide.</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Distribute the handouts - *I Need Money -- Compound Interest Loan* and *I Need Money - Simple Interest Loan* on pages 4.0.3-14 to -17.	*CALCULATE SIMPLE AND COMPOUND INTEREST ON A LOAN ACCOUNT* Pose the following situation to the class: Ask the students to imagine that they are 16 years old, in high school, and want to purchase a vehicle. The particular car in which they are interested is used and costs \$3,500. They have \$500 and need to borrow \$3,000 from the bank. Therefore, they decide to take out a three-year loan with an interest rate of 9.5 percent. Ask the class the following questions: 1. Is it important to have a down payment for a loan? 2. Is a short-term loan better than a long-term loan? Why or why not? 3. Which is better -- simple or compound interest? Work through the example of the compound interest account. Then give the students time to complete the two examples of compound interest. When the class has finished their compound interest calculations, complete the example and problems on the simple interest loan accounts. **Review - Simple and Compound Interest** Review the following questions with the class: 1. Is it important to start a savings account in high school? 2. Why would a high school student borrow money? 3. What is financial responsibility?
	Maintain Supervised Agricultural Experience Program Records
Distribute student record books.	Ask the students to turn to page 4 of their *General Record Book* and determine all profits from the previous year(s). Then ask them to look at pages 10 to 11 (Net Worth Statement) of their *General Record Book* and determine where they have invested their money. Lead a discussion on the following questions: 1. Have you invested your profits wisely? 2. What are wise investments? 3. How can you make more money in the future?

Planning Your Future

1. When you graduate from high school, what will be your income during the first year on the job?

2. How much will you make per month during that first year on the job?

3. How will you spend that money?

EXPENSE	AMOUNT

Total Spent

4. What will you do with your leftover money?

What Is a Check?

501 $

DATE 19

TO

FOR

	DOLLARS	CENTS
BAL FOR'D		
DEPOSITS		
TOTAL		
THIS CHECK		
OTHER DEDUCTIONS		
BAL FOR'D		

AMERICAN HIGH SCHOOL
ATHENS, U.S.A.

501

01-1/510

19

PAY TO THE ORDER OF $

DOLLARS

PRACTICE,
NON-NEGOTIABLE

The Huntington National Bank

Huntington Banks

:0000"0000: 01"48"1378"

502 $

DATE 19

TO

FOR

	DOLLARS	CENTS
BAL FOR'D		
DEPOSITS		
TOTAL		
THIS CHECK		
OTHER DEDUCTIONS		
BAL FOR'D		

AMERICAN HIGH SCHOOL
ATHENS, U.S.A.

502

01-1/510

19

PAY TO THE ORDER OF $

DOLLARS

PRACTICE,
NON-NEGOTIABLE

The Huntington National Bank

Huntington Banks

:0000"0000: 01"48"1378"

503 $

DATE 19

TO

FOR

	DOLLARS	CENTS
BAL FOR'D		
DEPOSITS		
TOTAL		
THIS CHECK		
OTHER DEDUCTIONS		
BAL FOR'D		

AMERICAN HIGH SCHOOL
ATHENS, U.S.A.

503

01-1/510

19

PAY TO THE ORDER OF $

DOLLARS

PRACTICE,
NON-NEGOTIABLE

The Huntington National Bank

Huntington Banks

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How Do We Save Money?

American High School

Athens, U.S.A.

CURRENCY		
COIN		
CHECKS		
TOTAL FROM OTHER SIDE		
TOTAL		
LESS CASH RECEIVED		
Total Deposit		

000-00
000

DEPOSIT TICKET

PLEASE ITEMIZE ADDITIONAL CHECKS ON REVERSE SIDE

DATE ______________________________ 19____

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS INSTITUTION'S COLLECTION AGREEMENT.

The Huntington National Bank

Huntington Banks

PRACTICE CHECKSET
NON-NEGOTIABLE

____
SIGN HERE ONLY IF CASH RECEIVED FROM DEPOSIT

⑆0000⑉0000⑆ 01⑉48⑉1378⑈

American High School

Athens, U.S.A.

CURRENCY		
COIN		
CHECKS		
TOTAL FROM OTHER SIDE		
TOTAL		
LESS CASH RECEIVED		
Total Deposit		

000-00
000

DEPOSIT TICKET

PLEASE ITEMIZE ADDITIONAL CHECKS ON REVERSE SIDE

DATE ______________________________ 19____

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS INSTITUTION'S COLLECTION AGREEMENT

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Huntington Banks

PRACTICE CHECKSET
NON-NEGOTIABLE

____
SIGN HERE ONLY IF CASH RECEIVED FROM DEPOSIT

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American High School

Athens, U.S.A.

CURRENCY		
COIN		
CHECKS		
TOTAL FROM OTHER SIDE		
TOTAL		
LESS CASH RECEIVED		
Total Deposit		

000-00
000

DEPOSIT TICKET

PLEASE ITEMIZE ADDITIONAL CHECKS ON REVERSE SIDE

DATE ______________________________ 19____

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE TERMS AND CONDITIONS OF THIS INSTITUTION'S COLLECTION AGREEMENT

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Huntington Banks

PRACTICE CHECKSET
NON-NEGOTIABLE

____
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• Forked Road •

Problem-Solving Technique

Define the problem

Should I invest my money in a certificate of deposit or a savings account?

Factors to Consider	Choice one	Choice two
	Certificate of Deposit	*Savings Account*
1. Length of investment	Long term	Unlimited term
2. Interest rate	Higher	Limited
3. Accessibility	Not readily accessible	Easily accessible
4. Start-up investment needed	Large	Minimal
5. Type of interest rate	Fixed	Flexible

Decision/Recommendation

The choice between a certificate of deposit or a savings account is based upon the factors listed above and the specific situation.

• Forked Road •

Problem-Solving Technique

Define the problem

Should I invest my money in a certificate of deposit or a savings account?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

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Let's Save Some Money!

Simple Interest

Example

Amount put in savings account on May 1	$1000.00
Interest rate	5 percent
Amount of interest paid in 12 months	$1000.00 x .05 = $50.00
Total amount in account in 12 months	$1000.00 x $50.00 = $1050.00

1. Amount to be saved $300.00
Interest rate 3.5 percent
a. What is the amount of interest paid to you in 12 months? ________________
b. What is the total amount you will have in your account in 12 months? ________________

2. Amount to be saved $800.00
Interest rate 4.5 percent
a. What is the amount of interest paid to you in 12 months? ________________
b. What is the total amount you will have in your account in 12 months? ________________

3. Amount to be saved $1400.00
Interest rate 4.0 percent
a. What is the amount of interest paid to you in 12 months? ________________
b. What is the total amount you will have in your account in 12 months? ________________

Notes

Let's Save Some Money!

Compound Interest

Example

Amount put in savings account on May 1 — $1000.00

Interest rate — 5 percent

Step 1: $1000.00 x .05 = $50.00

Step 2: $50.00/12 months = $4.17 interest for 1st month

Step 3: $1000.00 + $4.17 = $1004.17 in account after the 1st month

PRACTICE PROBLEM

On June 1, you have $1004.17 in your account

Step 1: $1004.17 x .05 = $50.21

Step 2: $50.21/12 months = $4.18 interest for 2nd month

Step 3: $1004.17 + $4.18 = $1008.35 in account after the 2nd month

On July 1, you have ____________ in your account:

Step 1: ____________ x .05 = ________________

Step 2: ____________ / 12 months = ____________ for the 3rd month

Step 3: ____________ + _________ = ______________ in account after the 3rd month

On August 1, you have ________________ in your account:

Step 1: ____________ x .05 = ________________

Step 2: ____________ / 12 months = ____________ for the 4th month

Step 3: ____________ + _________ = ______________ in account after the 4th month

On September 1, you have _____________ in your account:

Step 1: ____________ x .05 = ________________

Step 2: ____________ / 12 months = ____________ for the 5th month

Step 3: ____________ + _________ = ______________ in account after the 5th month

On October 1, you have _______________ in your account:

Step 1: ____________ x .05 = ________________

Step 2: ____________ / 12 months = ____________ for the 6th month

Step 3: ____________ + _________ = ______________ in account after the 6th month

On December 1, you have ______________ in your account:

Step 1: ____________ x .05 = ________________

Step 2: ____________ / 12 months = ____________ for the 7th month

Step 3: ____________ + _________ = ______________ in account after the 7th month

Let's Save Some Money!

Compound Interest *(continued)*

On January 1, you have ______________ in your account:
Step 1: ____________ x .05 = _________________
Step 2: ____________ / 12 months = ____________ for the 8th month
Step 3: ____________ + ________ = ______________ in account after the 8th month

On February 1, you have ______________ in your account:
Step 1: ____________ x .05 = _________________
Step 2: ____________ / 12 months = ____________ for the 9th month
Step 3: ____________ + ________ = ______________ in account after the 9th month

On March 1, you have ________________ in your account:
Step 1: ____________ x .05 = _________________
Step 2: ____________ / 12 months = ____________ for the 10th month
Step 3: ____________ + ________ = ______________ in account after the 10th month

On April 1, you have ____________ in your account:
Step 1: ____________ x .05 = _________________
Step 2: ____________ / 12 months = ____________ for the 11th month
Step 3: ____________ + ________ = ______________ in account after the 11th month

On May 1, you have ____________ in your account:
Step 1: ____________ x .05 = _________________
Step 2: ____________ / 12 months = ____________ for the 12th month
Step 3: ____________ + ________ = ______________ in account after the 12th month

1. How much interest did you earn using the simple interest plan?

2. How much interest did you earn using the compound interest plan?

3. What payment plan benefited you the most?

4. How do you maximize your savings?

Watch Your Money Grow

Savings computed daily, compounded weekly at 5 percent interest

	If you save per week:	You would accumulate:	Part which is Interest:
In 1 year:	5.00	266.73	6.73
	10.00	533.47	13.47
	15.00	800.20	20.20
	20.00	1,066.94	26.94
	25.00	1,333.67	33.67
In 5 years:	5.00	1,478.00	178.00
	10.00	2,955.00	355.00
	15.00	4,433.00	533.00
	20.00	5,910.00	710.00
	25.00	7,388.00	888.00
In 10 years:	5.00	3,375.00	775.00
	10.00	6,749.00	1,549.00
	15.00	10,124.00	2,324.00
	20.00	13,498.00	3,098.00
	25.00	16,873.00	3,873.00
In 15 years:	5.00	5,810.00	1,910.00
	10.00	11,620.00	3,820.00
	15.00	17,430.00	5,730.00
	20.00	23,240.00	7,640.00
	25.00	29,050.00	9,550.00

I Need Money

Compound Interest Loan

Example

You found a stereo you wish to purchase. To purchase the stereo, you need to borrow $1000.00. You plan to take out a one-year loan at 9 percent interest.

Amount borrowed on May 1	$1000.00
Interest rate	9 percent
Length of Loan	1 year

Step 1: $1,000.00 x 9 percent = $90.00

Step 2: $1,000 + $90.00 = $1,090.00

Step 3: $1,090/12 months = **$90.83** payment per month for 1 year

1. As a high school student, you have turned 16 and hope to purchase a vehicle. You have selected a used vehicle that will cost you $3,500. You have $500 and need to borrow $3,000 from the bank. You decide to take out a three-year loan with an interest rate of 9.5 percent.

- What is your monthly payment for the loan? ____________________

2. As a high school student, you wish to purchase 5 acres of land to start a sweet corn business. Your neighbor will sell you the land for $3,000 per acre totaling $15,000. You have $1,000 and need to borrow $14,000 from the bank. You decide to take out a five-year loan with an interest rate of 11.0 percent.

- What is your monthly payment for the loan? ____________________

Terms to Know

1. Principal
2. Interest
3. Annual Percentage Rate

I Need Money

Simple Interest Loan

Example

You found a stereo you wish to purchase. To purchase the stereo, you need to borrow $1000.00. You plan to take out a one-year loan at 9 percent interest.

Amount borrowed on May 1	$1,000.00
Interest rate	9 percent
Length of loan	1 years

Step 1: $1,000.00 x 9 percent = $90.00

Step 2: $90.00/12 months = $7.50 interest payment

Step 3: $1,000/12 months = $83.33 principal payment
This will be your principal payment each month

Step 4: $7.50 + $83.33 = $90.83 total payment for 1st month

Step 5: $1000.00 - $83.33 = $916.67 left on the principal payment

PRACTICE PROBLEM

On June 1, you have $916.67 left to pay on the principal.

Step 1: $916.67 x 9 percent = $82.50

Step 2: $82.50/12 months = $6.87 interest payment for the 2nd month

Step 3: $6.87 + $83.33 = $90.20 total payment for 2nd month

Step 4: $916.67 - $83.33 = $833.34 left on the principal payment

On July 1, you have ____________ left to pay on the principal.

Step 1: ____________ x .09 = ________________

Step 2: ____________ / 12 months = ____________ interest payment

Step 3: ____________ + $83.33 = ____________ total payment for month

Step 4: ____________ - $83.33 = __________________ left on the principal payment

On August 1, you have _______________ left to pay on the principal.

Step 1: ____________ x .09 = ________________

Step 2: ____________ / 12 months = ____________ interest payment

Step 3: ____________ + $83.33 = ____________ total payment for month

Step 4: ____________ - $83.33 = __________________ left on the principal payment

On September 1, you have ____________ left to pay on the principal.

Step 1: ____________ x .09 = ________________

Step 2: ____________ / 12 months = ____________ interest payment

Step 3: ____________ + $83.33 = ____________ total payment for month

Step 4: ____________ - $83.33 = __________________ left on the principal payment

I Need Money

Simple Interest Loan *(continued)*

On October 1, you have ______________ left to pay on the principal.

Step 1: ___________ x .09 = ________________

Step 2: ___________ / 12 months = ___________ interest payment

Step 3: ___________ + $83.33 = ___________ total payment for month

Step 4: ___________ - $83.33 = __________________ left on the principal payment

On November 1, you have ____________ left to pay on the principal.

Step 1: ___________ x .09 = ________________

Step 2: ___________ / 12 months = ___________ interest payment

Step 3: ___________ + $83.33 = ___________ total payment for month

Step 4: ___________ - $83.33 = __________________ left on the principal payment

On December 1, you have ____________ left to pay on the principal.

Step 1: ___________ x .09 = ________________

Step 2: ___________ / 12 months = ___________ interest payment

Step 3: ___________ + $83.33 = ___________ total payment for month

Step 4: ___________ - $83.33 = __________________ left on the principal payment

On January 1, you have ______________ left to pay on the principal.

Step 1: ___________ x .09 = ________________

Step 2: ___________ / 12 months = ___________ interest payment

Step 3: ___________ + $83.33 = ___________ total payment for month

Step 4: ___________ - $83.33 = __________________ left on the principal payment

On February 1, you have _____________ left to pay on the principal.

Step 1: ___________ x .09 = ________________

Step 2: ___________ / 12 months = ___________ interest payment

Step 3: ___________ + $83.33 = ___________ total payment for month

Step 4: ___________ - $83.33 = __________________ left on the principal payment

I Need Money

Simple Interest Loan *(continued)*

On March 1, you have ________________ left to pay on the principal.

Step 1: ____________ x .09 = ________________

Step 2: ____________ / 12 months = ____________ interest payment

Step 3: ____________ + $83.33 = ____________ total payment for month

Step 4: ____________ - $83.33 = ___________________ left on the principal payment

On April 1, you have ____________ left to pay on the principal

Step 1: ____________ x .09 = ________________

Step 2: ____________ / 12 months = ____________ interest payment

Step 3: ____________ + $83.33 = ____________ total payment for month

Step 4: ____________ - $83.33 = ___________________ left on the principal payment

On May 1, you have ____________ left to pay on the principal.

Step 1: ____________ x .09 = ________________

Step 2: ____________ / 12 months = ____________ interest payment

Step 3: ____________ + $83.33 = ____________ total payment for month

Step 4: ____________ - $83.33 = ___________________ left on the principal payment

Discussion Questions

1. What interest did you pay in both methods?

2. With what method did you save money?

3. How do you maximize your savings?

Helping Students Apply Concepts/Principles/Skills

Record keeping has been taught in many other competencies as part of the individual student program. As part of this competency, maintaining SAEP records can be taught by having the students bring their record book to class for evaluation. To encourage record keeping, use the following motivational tools:

1. Make the record book grade the student's exam grade.
2. Make record books 10 to 20 percent of the student's final grade.
3. Give record keeping awards at the FFA Banquet.

Evaluating Student Learning

Set a goal to evaluate each student's records at least four times a year. Many successful programs evaluate student records on a monthly basis.

This activity was submitted by Dan Schroer, Agricultural Education Instructor, London High School, London, Ohio.

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Data Record and Observation Sheet

Title ____________________

Name ____________________ Date __________ Period ________

Objective(s) ____________________

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

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Program AGRISCIENCE

Unit 4 - Business Technology

Examine Role of Marketing

Competency/Terminal Performance Objective

4.0.4: Given various marketing examples and studies, examine the role of marketing, identifying all categories, definitions, and terms provided.

Competency Builders/Pupil Performance Objectives

4.0.4.1 Given examples of current agricultural marketing options, identify markets, based on set of categories provided.

4.0.4.2 Given examples of current agricultural marketing functions, describe market functions, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
1.2.2 Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
1.2.5 Set up, solve, and apply ratios and proportions
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7 Translate written and/or verbal statements into mathematical expressions
1.2.8 Estimate answers
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. *Farm and Ranch Business Management* - John Deere
2. Film on cash and futures from Chicago Board of Trade & Chicago Mercantile Exchange (Contact Education Department at 1-800-THE-CBOT.)
3. DTN (Data Transmission Network)
4. Access to local grain elevator
5. Handout from *Wall Street Journal* or DTN depicting corn/soybean quotes.

Situation

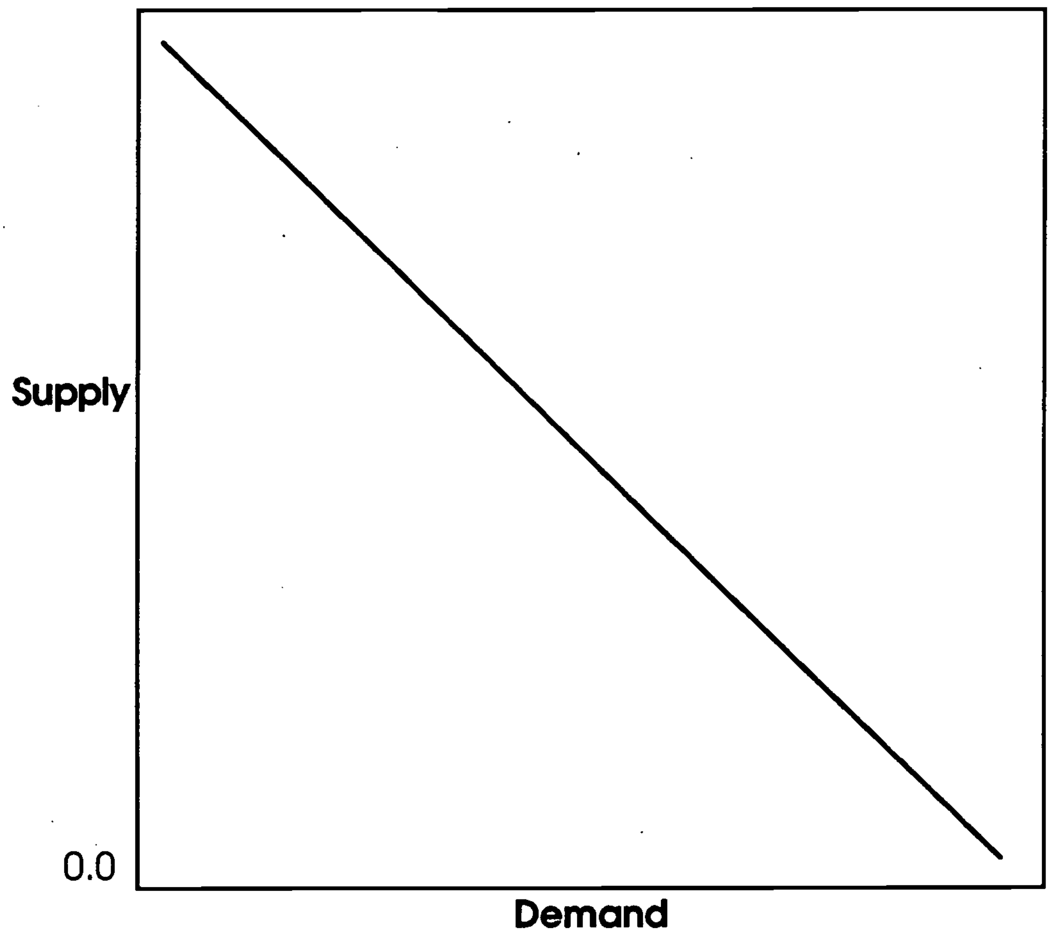
This activity is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach
Have ready popcorn pre-popped and excessively salted.	1. Give each student a generous helping of salted popcorn. Hold a contest to see who can eat the most popcorn in 3 minutes.
Make sure you have hidden enough pop for the entire class. See that the bidding gets very high. Collect and secure the money.	2. When 3 minutes are up, display one ice-cold can of soda pop. Have an auction - offer the can of pop to the highest bidder. 3. Sell the pop to the highest bidder and collect the money.
Encourage the class to respond to your questions. This leads to a discussion of selling products on the market.	4. When the sale is complete, display enough pop for the entire class and begin the bidding again. Ask the questions "What's the value of the pop now?" "Do you understand the process involved in bidding for the pop before and now?" "Now suppose we have 5,000 bushels of corn in a grain bin on the school farm. After seeing what happened when we bid on the pop, what are we going to do with the grain? Do we have a problem?"
	Procedure
Write on market transparency (4.0.4-5).	5. After the discussion begins, ask "What type of markets are available for our corn?"
Show supply/demand transparency on page 4.0.4-6.	6. Discuss supply and demand. Use the pop auction as an example: When the supply was low, demand was high and the price was high. However, as the supply increased, the demand decreased and the price was lowered.
Write on blank transparency.	7. Identify the three types of markets: a. Cash b. Futures c. Barter (trade)
Provide phone number and handout for price collection and name of contact person.	8. Assign as homework the task of calling a local grain elevator to find out the current cash prices and futures prices for corn.
Encourage students to respond regarding the different prices. Use transparency on page 4.0.4-7.	9. (Next day) Have students turn in assignments. Ask the following questions: "What did you find out?" "Why is there is a difference in price?"

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)*
	10. Teach cash pricing – define it as a simple exchange of a product for money. These certain standards are needed: 1) quality 2) location 3) form With each standard, use examples that students can relate to (e.g., baseball cards).
	11. Teach futures – teach time value. Distribute handout depicting corn/soybeans from *Wall Street Journal* or DTN and explain meaning of quotes.
Be certain to have relevant items for trade.	12. Teach trading/barters – Have students trade items made available by the teacher. Who profits the most? Relate this to selling corn
Encourage students to say "No." Have students take notes on the film.	13. Ask "Is this applicable?" 14. Show the film from CBOT/CME.
Encourage students to list these five factors. List the following factors. a. profit b. distance c. handling ease d. education of producer e. local availability of markets Stress to students that use of cash/futures depends on the situation.	15. After viewing the film, complete the Possibilities • Factors sheet. (See pages 4.0.4-8 and -9.)

Which Markets Are Available for Our Corn?

Supply and Demand



Cash and Futures Pricing

CASH:

Corn ______________________________

FUTURES:

Dec. ______________________________

March ______________________________

May ______________________________

July ______________________________

Sept. ______________________________

Contact ______________________________

Phone No. ______________________________

• **Possibilities - Factors** •

Problem-Solving Technique

Define the problem

What types of markets are available for our corn?

Factors to Consider	Possibilities (Possible Solutions)			
	Cash	**Futures**	**Trade/ Barter**	
Profit				
Distance				
Handling ease				
Education of producer				
Local availability of markets				

Decision/Recommendation

Use the cash market.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What types of markets are available for our corn?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

SAE - Students with production enterprises will be able to market their products more effectively after completing this lesson.

FFA - This lesson will aid in the preparation of students for the Grain Merchandising Contest.

Career - Students will understand how and why all businesses must be able to identify their markets.

Evaluating Student Learning

See attached evaluation sheet (4.0.4-11)

This activity was submitted by Douglas E. Bahnsen, Agricultural Education Instructor, River Valley High School, 1267 St. Rt. 98, Marion, OH 43302, and Dan Schroer, Columbus, OH.

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Marketing

Name ____

1. Define supply and demand.

2. Draw and label the supply/demand curve.

3. Identify 2 local agricultural products and their markets.

4. What 5 factors must be considered when determining the type of market available for a specific product?

   a.
   b.
   c.
   d.
   e.

5. What 3 standards are needed for all producers at the time of exchange?

Program AGRISCIENCE

Unit 4 - Business Technology

Develop Global Perspectives of Nations and Peoples of the World

Competency/Terminal Performance Objective

4.0.5: Given current examples of world socio-economic trends, develop global perspective of nations and peoples of the world, based on definitions and studies provided.

Competency Builders/Pupil Performance Objectives

4.0.5.1 Given cultural diversity examples, determine the value of cultural diversity, based on criterion assessment instrument.

4.0.5.2 Given historical examples, describe interdependency of nations and peoples of the world, based on definitions and study provided.

4.0.5.3 Given various current examples, analyze consequences of world issues, identifying issues and consequences provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. Food from foreign countries
2. Access to library
3. Agriculture and news periodicals

Situation

These experiments are to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Be certain to have food items ready	1. *Food for Thought* (p. 35-39)
Assign the demonstrations a week ahead of time	2. When students bring in food items, have each student prepare a demonstration covering the following: a. Country of origin b. Cultural impact c. Impact on U.S. d. Do U.S. citizens eat this food? Why or why not?
Encourage students to discuss. Ask this question when all food presentations are complete.	3. After each presentation, discuss other students' knowledge of that food and country.
Ask this question when all food presentations are completed.	4. Ask the question "Has there ever been a time when relations with other countries have affected agricultural production?" (e.g., production of corn vs. wheat) List the following examples on the board: a. embargoes b. Soviet crisis c. Chinese crisis d. Gulf war e. European economy f. GA
Locate periodicals before class or conduct this class in the library.	5. Distribute periodicals and handouts about the crisis. Divide students into groups of 2 to 3 students. Have students determine 5 to 10 reasons why it impacts our food industry.
Use all students in discussion, not just one spokesperson.	6. Bring students together for discussion. 7. Evaluation

Helping Students Apply Concepts/Principles/Skills

Career - After completing this activity, students will better understand cultural diversities that will be useful in future employment situations.

Evaluating Student Learning

Use the form on page 4.0.5-4.

This activity was submitted by Douglas E. Bahnsen, Agricultural Education Instructor, River Valley High School, 1267 St. Rt. 98, Marion, OH 43302, and Dan Schroer, Columbus, OH.

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Global Agriculture

Name ____

1. Name five foods from other nations.

    a.

    b.

    c.

    d.

    e.

2. Name one agricultural product that other countries depend upon from the U.S.

3. Name 4 recent world events that have affected crop production in the U.S.

Program AGRISCIENCE

Unit 5 - Plant Science

Describe Plant Anatomy and Physiology

Competency/Terminal Performance Objective

5.0.1: Given examples, describe plant anatomy and physiology, using criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.1.1 Using samples, identify plants, based on performance criteria list.

5.0.1.2 Given examples, identify functions of flowers, fruit and seeds, based on criterion assessment instrument.

5.0.1.3 Given examples, identify functions of roots, stems and leaves, based on performance criteria list.

5.0.1.4 Given examples of leaf structures, relate photosynthesis and respiration to leaf structure, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

2.2.4 Estimate measurements
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

Activity 1

1. flowers, complete (from local flower shop, specimens from crop plants if available)
2. hand lens
3. glass slides and coverslips razor blade (single edge)
4. tweezers
5. dissecting needle
6. microscope
7. thionin solution

Activity 2

1. *Agriscience: Fundamentals and Applications Laboratory Manual*, Delmar Publishers
2. Clear glass jars (to serve as a terrarium)
3. planting medium (equal parts perlite, peat moss, and sterilized soil)
4. seeds (e.g., bean)
5. planting containers with no drainage hole
6. potato, carrot
7. house plant, tomato plant, etc.
8. plastic bag
9. water

Situation

This experiment is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 1
Have flowers ready before class begins.	**Interest Approach** Obtain a large assortment of flowers from a local flower shop. Older flowers may be obtained free or at low cost and will be suitable for this laboratory exercise. Pass out one flower to each student (as many different kinds as possible) and have students individually write down as many characteristics of the flower as possible. Compile a class list of similar characteristics. Allow students to view flowers with a magnifying lens but not dissect the flowers. Use the class list to introduce the topic of structure of the reproductive system in plants.
Show transparencies on pages 5.0.1-8 and 9.	**Procedure** 1. Count the petals on your flower and record the number. 2. Count the stalks on your flower and record the number. 3. Remove one of the stalks with a razor blade and examine with a hand lens. 4. With a dissecting needle, puncture the anther and remove some grains of pollen. 5. Put one or two drops of water on a slide and carefully add the pollen. 6. Add one or two drops of thionin stain and place a coverslip on the slide. 7. Examine the pollen on low and high settings of the microscope. 8. Diagram what is viewed under the microscope. 9. Remove the ovary and style from the flower using the razor blade and examine with a hand lens. 10. Cut the ovary and style in half with a razor blade to observe the inside. 11. Make a sketch and write a description of each flower part examined. Estimate the size of each flower part.
	Data Summary and Analysis Have students record the number of different reproductive structures found in their specimen flower and describe each flower part. Compare results for different flowers examined.

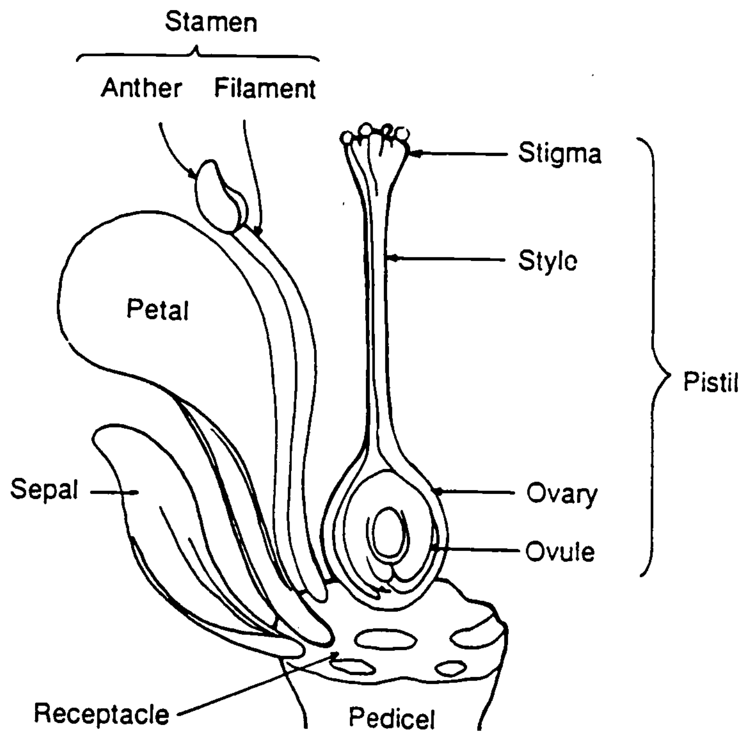
	Key Terms 1. *anthesis* - the point at which a flower is fully open 2. *incomplete flower* - lack one or more of these flower parts, sepals, petals, stamens, and pistils 3. *photoperiodism* - the growth response of a plant to the length of day or more precisely the length of light and dark periods; photoperiodism is known to effect the onset of flowering 4. *phytochrome* - a reversible protein pigment occurring in the cytoplasm of green plants. It is associated with the absorption of light that affects growth, development, and differentiation including flowering of a plant, independent of photosynthesis 5. *pistillate flower* - a female flower having pistils but no stamens 6. *staminate flower* - a flower having stamens but no pistils 7. *vernalization* - in reference to flowering, the process by which floral induction in some plants is promoted by exposing the plants to a chilling for a certain length of time

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 2 **Interest Approach** Display 2 plants - one with flowers, leaves, fruit, etc. the other plant with only a bar stem. Pose the following questions: "What is missing on the second plant?" "Why does the plant need these parts?"
Bring to class leaf samples (e.g., pine, sycamore, carmellia, and nardina). Describe the leaves by color, size, general shape, venation, etc. Prepare slides or use prepared slides of cross-sections, surfaces, and undersides of leaves.	**Procedure** *SEEDS AND PLANTS* 1. Fill a clear glass jar (e.g, terrarium) with planting medium. 2. Place a bean seed against the glass and 1/2 to 3/4 inch below the surface of the planting medium. 3. Water as needed for germination. 4. Observe the seed daily. Identify seed and plant parts. *LEAVES* 5. At this point conduct exercise #20 in *Agriscience: Fundamentals and Applications Laboratory Manual.* 6. Observe different leaves under a microscope. Draw a simple leaf and a compound leaf. Label the parts of each leaf.
Bring to class a plant stem (e.g., black walnut). Remove the leaves and point out the various parts of the stem.	*STEMS* 7. Observe and draw a plant stem. Label the parts of the stem. *INTERNAL ANATOMY* 8. At this point conduct exercise #21 in *Agriscience: Fundamentals and Applications Laboratory Manual.*

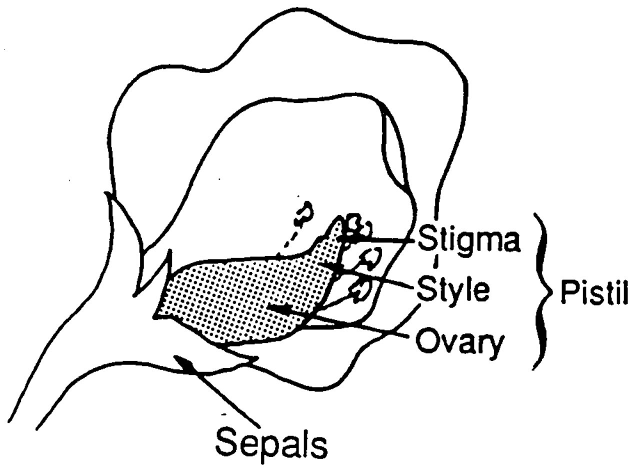
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)*
Bring to class the fruit of a plant (e.g., tomato or cranberry). Point out the parts of the fruit.	*FRUIT* 9. Observe and draw a plant fruit. Label the parts of the fruit.
Bring to class perfect flowers (e.g., buttercup, daffodil, or tulip). Also bring imperfect flowers (e.g., hollies, willow); complete flowers (e.g., fuchsia); and incomplete flowers (e.g., poinsettia or bottlebrush). Point out the parts of each flower.	*FLOWERS* 10. Observe and draw various plant flowers (i.e., perfect, imperfect, complete, and incomplete). Label the parts of each flower. *SUPPLEMENTAL* 11. Perform exercise #24 in *Agriscience: Fundamentals and Applications Laboratory Manual.* 12. Discuss the functions of plant parts.
	SEED ANATOMY 13. Perform Exercise #25 in *Agriscience: Fundamentals and Applications Laboratory Manual.*
	ROOT FUNCTION 14. Hollow out the top of a carrot so it will hold water. The carrot will grow because the tap root is providing stored food to the top. 15. Cut the top two inches off another carrot. Put the top in water. It will root using the food stored in the carrot top. 16. Perform exercise #23 in *Agriscience: Fundamentals and Applications Laboratory Manual.*
	LEAF FUNCTIONS 17. Place a piece of opaque paper over part of a leaf. Paper clip it in place. Record your observations.
	STEM FUNCTION 18. Cut out an eye of a potato with some potato still attached. 19. Plant this piece with the eye facing up in sterile planting medium. Record your observations.

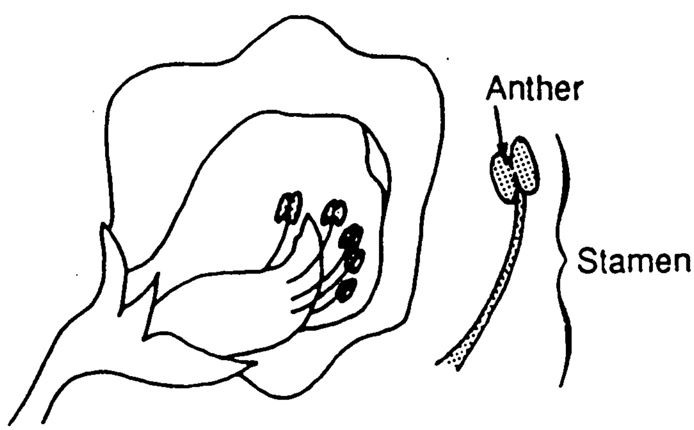
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Have students group all the plants they have seen into annuals, biennials, and perennials. Provide resources such as the *Sunset Western Garden Book.*	**Procedure** *(continued)* *CLASSIFICATION OF PLANTS BY LIFE CYCLE* 20. Make a list of the all the plants you have used in these experiments. Include how long you think each plant lives. (one season, indefinitely, etc. - annuals, biennials, perennials)

Diagram of Flower Parts



Complete Flower





Helping Students Apply Concepts/Principles/Skills

ACTIVITY 1

The process of fruit and seed production begins with flower induction and initiation. In the production of most floral crops and flowering shrubs, the flower itself is the desired product. Plants may flower within weeks of sprouting or in the case of fruit trees, it may be several years before flowers develop. In mature plants, flowers develop as a reaction to conditions of the environment. Two known conditions which influence flowering in some species are photoperiodism (daylength) and vernalization (any temperature treatment which induces flowering).

The majority of agricultural crops are self-inductive for flowering, meaning they initiate or form flowers at almost any photoperiod and without vernalization. Garden annuals are examples of plants which flower when they reach a certain maturity. However, many species of floral crops can be grown under controlled conditions in the greenhouse and be made to flower when either daylength or temperature is varied by the grower. This practice allows for a continuous supply of flowers for the market. Examples of flowers which respond to changes in the length of the daily light period include chrysanthemums, poinsettias, and violets.

The influence of the photoperiod on the flowering of plants is an important topic of research for the United States Department of Agriculture. Although the exact stimulus which causes the apical meristem to change from a vegetative to a flowering state is unknown, research has allowed scientists to classify plants by stimuli necessary for flower induction. Growers use that information and regulate environmental conditions to control the flowering process.

Idea for Additional Experiments

Bring incomplete, staminate, and pistilate flowers in for dissection and have students compare and contrast their findings.

Evaluating Student Learning

After students have competed the experiment, have them record their data on pages 5.0.1-12 and -13.

Portions of these activities were submitted by Lori Heiby, Agricultural Education Instructor, Old Fort High School, P.O. Box 64, Old Fort, OH 44861, and Ashley Swonger, Agricultural Education Instructor, Ridgedale High School, 3165 Hillman-Ford Road, Morral, OH 43337.

Other portions were adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 5 - Plant Science

Explain Plant Chemical Processes

Competency/Terminal Performance Objective

5.0.2: Given examples, examine plant chemical processes, based on criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.2.1 Given examples, describe photosynthesis, based on criteria given in assessment instrument.

5.0.2.2 Given examples, describe respiration, based on criteria given in assessment instrument.

5.0.2.3 Given examples, describe transpiration, based on criteria given in assessment instrument.

5.0.2.4 Given examples, describe absorption, based on criteria given in assessment instrument.

5.0.2.5 Given examples, identify management practices enhancing plant chemical processes, based on criteria given in assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems
2.2.2 Compute using appropriate units of measurement
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4 Estimate measurements
3.2.6 Use problem-solving techniques
4.2.4 Use formulas
5.2.2 Find surface areas and volumes of applicable geometric figures

Equipment, Supplies, References, and Other Resources

Activity 1

1. green potted plant or outdoor plant
2. variegated coleus, geranium, or philodendron
3. black cardboard or construction paper
4. Lugol's iodine solution
5. cornstarch
6. sugar
7. test tubes
8. ethyl alcohol
9. wide-mouth jar or beaker
10. pan
11. pan
12. hot plate or Bunsen burner
13. petri dishes
14. Vaseline or petroleum jelly
15. eye protection

Activity 3

1. 4 graduated cylinders (if graduated cylinders are not available, large test tubes or vials with a metric ruler taped to the side will be satisfactory)
2. 4 corks or stoppers (or modeling clay will work well)
3. 4 cuttings from a large-leaved plant (geranium, corn, sunflower, etc.)
4. water
5. fan

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
Use transparency on page 5.0.2-10.	**ACTIVITY 1** **Interest Approach** Write the chemical equation for photosynthesis on the board and discuss the components that are inputs and products of this reaction. Discuss the consequences if any of the components required for photosynthesis are lacking. In this laboratory exercise the students will test each of the inputs required for photosynthesis.
Use information on page 5.0.2-11 and -12.	**Procedures** *Necessity of Light* 1. Cut a piece of black cardboard about twice the size of a leaf from the potted plant and fold it in half so that it can be used to enclose the leaf like the covers of a book. 2. Cut an irregular hole in the cardboard that is to cover the top of the leaf. 3. Place the cardboard around the leaf and fasten with paper clips. 4. Place the plant in a location where it will receive good light . Leave it for 1-2 days. 5. Remove the cardboard and determine if there is a difference in appearance between the covered and uncovered portions of the leaf. *Testing for Starch* 6. Place a pinch of cornstarch in a test tube with about one inch of water. Shake and add a drop of iodine solution. Note the color that appears. 7. Repeat the cornstarch test but substitute a pinch of sugar for the cornstarch. Note the color that appears. 8. Extract the chlorophyll from the covered leaf by immersing the leaf first in boiling water and then in boiling alcohol. **Caution**: Alcohol will burn and is likely to catch fire if heated over an open flame. To avoid this, place a beaker of alcohol in a pan of boiling water. Since alcohol boils at a lower temperature than water, it will boil freely when the water is not hot enough to boil. The alcohol will turn green as the chlorophyll is extracted. 9. Remove the leaf from the boiling alcohol (when it has lost its green color) and place it in a petri dish. Flood the leaf with Lugal's iodine solution. 10. Compare the portion of the leaf which was exposed to light with the covered portion. 11. Record your observations.

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
Use the information on page 5.0.2-13 and -14.	*Necessity of Carbon Dioxide* 1. Coat both the top and bottom surfaces of one half of a leaf from your stock plant with petroleum jelly and leave the plant in ample light for 1-2 days. This procedure can be conducted simultaneously with the steps for determining the necessity of light for photosynthesis. 2. Remove the leaf and test for the presence of starch following the same procedure as listed above. The hot water and alcohol will remove the Vaseline so that it does not interfere with the accuracy of the results. 3. Compare the portion of the leaf coated with Vaseline with the portion that was not. 4. Record your observations.
Use the information on page 5.0.2-15 and -16.	*Necessity of Chlorophyll* 1. Remove a leaf from the variegated plant specimen and sketch which portions contain chlorophyll (green) and which do not. 2. Remove the chlorophyll from the leaf following the previous described procedures. 3. Test the leaf for the presence of starch. 4. Sketch the leaf again, shading those areas which show a positive starch reaction. 5. Compare the two sketches.
Use the information on page 5.0.2-17 and -18.	*Necessity of Water* 1. Withhold water from a potted plant until the leaves begin to wilt. Keep the plant in plenty of light so that the leaves remain green. 2. Remove one of the wilted leaves and test for the presence of starch following the previously described procedures. 3. Record your observations.
	Data Summary and Analysis *Necessity of Light* 1. Draw the leaf prior to testing for the presence of starch and shade the pattern which was left exposed to sunlight. 2. Draw the leaf after iodine treatment. Shade the portion of the leaf which turned dark. 3. Compare the two drawings.

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
	Data Summary and Analysis *(continued)* *Necessity of Carbon Dioxide* 1. Draw the leaf which was used to test for the necessity of carbon dioxide. Shade the portion of the leaf which was not covered with Vaseline. 2. Draw the leaf after the iodine test and shade the area that indicates presence of starch. 3. Compare the two drawings. *Necessity of Chlorophyll* 1. Sketch the variegated leaf before removing the chlorophyll. Shade the areas which are green and label. 2. Sketch the same leaf after the iodine treatment. 3. Compare the drawings. *Necessity of Water* 1. Draw the leaf after the iodine treatment and compare the presence of starch in this leaf with other specimens you have previously examined.
	Key Terms 1. *adenosine diphosphate (ADP)* - a nucleotide composed of adenine and ribose with two phosphate groups attached 2. *adenosine triphosphate (ATP)* - has three phosphoric groups attached and is the phosphorylated condition of ADP. It conveys energy needed for metabolic reactions, then loses one phosphate group to become ADP. 3. *C3 cycle* - the Calvin-Benson cycle of photosynthesis in which the first products after C02 fixation are three-carbon molecules 4. *C4 cycle* - the Hatch-Slack cycle of photosynthesis in which the first products after C02 fixation are four-carbon molecules 5. *carbon dioxide fixation* - the addition of H+ to C02 to yield a chemically stable carbohydrate. The H+ is contributed by NADPH, produced in the noncyclic phase of the light reactions of photosynthesis. The H+ originally comes from the photolysis of water.

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
	Key Terms ***(continued)*** 6. *photolysis* - the splitting of a water molecule into hydrogen and oxygen 7. *photosynthesis* - the process in which carbon dioxide and water are transformed, in the presence of light into carbon-containing, energy-rich, organic compounds 8. *respiration* - the oxidation of food by plants and animals to yield energy for cellular activities

<table>
<tr><th>(Directions for the Teacher)</th><th>Teaching Procedures:
Interest Approach / Teaching Methods</th></tr>
<tr><td></td><td>ACTIVITY 2
Interest Approach:
Have students list on the board different forms of chemical energy used by living things, including humans. Try to include examples of solids, liquids and gases.
ACTIVITY
Grow plants under green light, "gro-lights" and regular fluorescent tubing. Compare the differences in growth. Have the students do a simple lab write-up including.
1. procedure
2. results
3. possible explanations for their observations.</td></tr>
<tr><td>See Supplemental Handout (page 5.0.5-19)</td><td>ACTIVITY
1. Select 3 coleus or geranium plants, making sure the foliage is dry, and the soil is well watered.
2. Place a clear dry plastic bag over each, and tie them off around the base of the stalk, place one plant in the sun, another in an enclosed or dark area and the other in open shade.
3. Students should record observations, after one half hour, after another half hour, then again in 24 hours.
4. Plan discussions about the effect of temperature and light on transpiration and/or have students write a summary of their observations.
ACTIVITY
1. Have students use colored food dye to show the translocation of water. Put white carnations in warm water and add a colored dye. The flowers will change color.
2. Have the students observe the progress of the dye through the flower, measure the length of the stems and record the length of time it takes the dye to reach the blooms. Calculate how fast water is translocated through the stems.</td></tr>
</table>

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
	ACTIVITY 3 **Interest Approach** Bring in two or three plants of varying sizes (small, medium, and large). (**Note**: These could be potted plants or vegetable or field crop samples that have been brought into class.). Ask students to estimate the amount of water needed during a single growing season by each of the plants. Why is this amount of water needed? What is it used for? Where does it go? Will the water requirements be different for each plant? Why?
Use the information on page 5.0.2-20 and -21.	**Procedures** 1. Cut four stems of similar size from your stock plants. Two of the stems should contain one healthy leaf each and the other two stems should contain three to four healthy leaves of approximately the same size (leaf surface area). 2. Make a hole in each cork or stopper to fit the stem of your plant cutting. The stem must fit snugly in the hole to minimize evaporation through the opening. As an alternative, the plant stems can be inserted into the tubes or vials, with modeling clay then carefully packed in the tube opening and around the stem to prevent evaporation losses. 3. Push the cutting through the hole in the stopper and cut off the end of the stem under water to prevent air pockets in the stem. 4. Insert the stopper with the stem into the graduated cylinder with the stem well below the water line. 5. Record the water level for all four plants. 6. Place two of the stems (one with one leaf, the other with multiple leaves) in front of a fan operating on a low setting which provides a breeze but does not disturb the plant. Place the other two plants in the same environment, but away from the fan. 7. Record the water level daily for one week. 8. Compare the rates of transpiration for the four different cuttings.

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
	Data Analysis and Summary Students should record the volume of water in each tube at the beginning of the experiment and daily for the next seven days. Water levels should then be graphed by day for each of the four plants. Have students develop a set of conclusions based upon the charted and graphed data.
	Key Terms 1. *endodermis* - the innermost tissue of the cortex of most plant roots; functions to control the movement of water into and out of the xylem and other stele tissues 2. *epidermis* - the outermost layer of cells of the plant 3. *evaporation* - to pass off in the form of a vapor 4. *evapotranspiration* - the combined loss of water from a given area, and during a specified period of time, by evaporation from the soil surface and by transpiration from plants 5. *humidity* - the amount or degree of moisture in the air 6. *relative humidity* - the amount of moisture in the air as compared with the maximum amount that the air could contain at the same temperature, expressed as a percentage 7. *stomata* - a microscopic opening in the epidermis of plants which is surrounded by guard cells and allows gaseous exchange 8. *transpiration* - the process of water loss through the leaves of a plant into the atmosphere 9. *xylem* - the principal water-conducting tissue and chief supporting tissue of higher plants

The Manufacture, Use and Storage of Food in Plants

1. Definition of Photosynthesis

2. Requirements of Photosynthesis

3. Photosynthesis Chemical Equation

$6CO_2$	+	$12H_2O$	+ Light	$\rightarrow$	$C_6H_{12}O_6$ +	$6H_2O$	+	$6O_2$
Carbon Dioxide		Water			Glucose	Water		Oxygen

4. Two Processes of Photosynthesis

   a. Photochemical
   b. Synthesis of Glucose

5. Definition of Respiration

6. Result of Respiration

7. Respiration Chemical Equation

$C_6H_{12}O_6$	+	60_2	$\rightarrow$	$6C0_2$	+	$6H_20$	+	Energy
Glucose		Oxygen		Carbon Dioxide		Water		

8. Food Storage

   a. Carbohydrates
   b. Proteins
   c. Fats or Oils

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Light	**No Light**

Decision/Recommendation

Necessity of Light

The iodine solution will turn dark in the presence of starch. The leaf will have a dark spot in the shape of the irregular hole in the cardboard which indicates that starch was manufactured in the area exposed to sunlight. The absence of starch in the covered area indicates the necessity of light for photosynthesis.

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Light	**No Light**

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Carbon Dioxide	No Carbon Dioxide

Decision/Recommendation

Necessity of Carbon Dioxide
Carbon dioxide was prevented from entering the plant in the area covered by petroleum jelly. The iodine test will be negative for starch produced in this portion of the leaf and positive for the portion left exposed to air.

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Carbon Dioxide	No Carbon Dioxide

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Chlorophyll	No Chlorophyll

Decision/Recommendation

Necessity of Chlorophyll

The area of the leaf which is green will show a positive test for starch indicating the action of photosynthesis in this part of the leaf. The sketches made form the color variations in the leaf will correlate with the sketches made from the starch test.

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Chlorophyll	no Chlorophyll

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Water	no Water

Decision/Recommendation

Necessity of Water

Water supplies the hydrogen necessary for photosynthesis. A plant that lacks sufficient water (wilted) even though it receives plenty of light and is still green will show a decrease in photosynthesis. The iodine test will show a lack of starch in the wilted leaf. When water is lacking, photosynthesis will also be suppressed by a deficiency of carbon dioxide caused by the closing of the guard cells which control the amount of air that passes into and from the leaf.

• Forked Road •

Problem-Solving Technique

Define the problem

What factors are necessary for photosynthesis to occur in plants?

Factors to Consider	Choice one	Choice two
	Water	no Water

Decision/Recommendation

SUPPLEMENTAL HANDOUT #1

COMPARISON OF PHOTOSYNTHESIS AND RESPIRATION

Photosynthesis	Respiration
Requires Carbon Dioxide and Water	Requires Oxygen and Carbon Compounds (CHOs)
Produces Oxygen and Carbohydrates (CHOs)	Produces Carbon Dioxide and Water
Light Energy Trapped by Chlorophyll	Energy Released
Takes Place in Light Only	Takes Place in Both Light and in Darkness
Occurs Only in Cells With Chlorophyll	All Living Cells Respire (animals and plants)

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How do moisture losses through plant tissues occur, and what factors affect the rate of moisture loss?

Factors to Consider	Possibilities (Possible Solutions)			
	Stem 1	Stem 2	Stem 3	Stem 4

Decision/Recommendation

All four plants will lose water through transpiration. The stems with multiple leaves will lose more water than those with a single leaf because more surface area exists for transpiration to occur. The stems placed in front of the fan will lose more water than the other stems because air movement accelerates transpiration in the leaf.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How do moisture losses through plant tissues occur, and what factors affect the rate of moisture loss?

Factors to Consider	Possibilities (Possible Solutions)			
	Stem 1	Stem 2	Stem 3	Stem 4

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 1

All living organisms require a constant supply of energy from some external source. Plants, also known as autotrophs, convert sunlight into chemical energy in a process called photosynthesis. Plants are the source of all food, either directly as grains, fruits, and nuts or indirectly through animals, such as meat, eggs, and dairy products. Human survival is dependent upon the cultivation of plants for food. Researchers are constantly seeking ways to increase plant productivity. Increasing the process of photosynthesis is one focus of research.

Only a small amount of the total energy received on earth from the sun is captured by plants. The average solar energy conversion for normal agricultural cropping systems is about 2 percent. The remaining 98 percent of the sun's energy (rays) is lost by reflection and re-radiation into the atmosphere. Energy for increasing plant productivity is readily available; the key is to develop plants which can convert the sun's energy into larger quantities of chemical energy.

In many plant species, photosynthesis declines when plants flower or seeds set. The proteins in the leaves of the plant are degraded to amino acids and are transported to the developing seeds for storage. When the seeds of most field crops are totally mature, foliar photosynthesis stops altogether, the foliage dies and the crop is ready for harvest. Increasing foliar photosynthetic rates can result in increased crop yields and a more abundant food supply for a growing world population.

Ideas for Other Experiments

Expose plants to varying levels of the factors studied in this laboratory exercise and compare the presence of starch found in the leaves for the different treatments.

Helping Students Apply Concepts/Principles/Skills

ACTIVITY 3

Maintaining adequate soil moisture is a critical management practice in plant growth for both indoor and outdoor growing conditions. For greenhouse crops, watering is probably the most time-consuming task required in growing a given crop. Fortunately, the high labor costs of maintaining proper moisture levels is somewhat offset by the relatively low cost of water as an input for greenhouse crops.

In outdoor growing conditions, including vegetables, turf, and field crops, soil moisture fluctuates much more and reaches more extreme levels than in more controlled, indoor environments. Thus, maintaining adequate soil moisture levels in outdoor conditions is much more of a challenge, due to weather factors beyond the grower's control. Soil moisture levels are increased either through natural means (rainfall) or artificially via irrigation. Moisture losses occur primarily through the evaporation of water from the upper soil layers and through the loss of water through leaf surfaces and other plant parts (transpiration). The rate of water loss as a result of transpiration is primarily dependent upon weather (i.e., temperature and humidity). Thus, growers must seasonally adjust their crop schedules according to the water intake and loss responses of the plants being grown.

Ideas for Additional Experiments

1. Examine the effects of additional environmental factors, such as light intensity, temperature, and humidity on the rate of transpiration in plants.
2. This experiment can also be conducted by measuring the amount of water uptake by the roots as a result of transpiration. In this case the roots must be enclosed in a glass tube to view the level of water as it is lost from the plant.
3. Examine the rate of transpiration in plants which are growing under various degrees of soil moisture.
4. Determine how rate of transpiration varies by plant species and leaf characteristics (older vs. younger leaves, size of leaf, etc.).

Evaluating Student Learning

After students complete these experiments, have them record their data and observations on pages 5.0.2-25 and -26.

Portions of these activities were submitted by Ashley Swonger, Agricultural Education Instructor, Ridgedale High School, Morral, OH 43337. Other portions were adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 5 - Plant Science

Explain Plant Reproduction

Competency/Terminal Performance Objective

5.0.3: Given examples, explain plant reproduction, based on criteria given in criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.3.1 Using specimens, identify plant cells and cell structure, based on performance criteria instrument.

5.0.3.2 Given specific examples, describe the fertilization process, based on criteria given in assessment instrument.

5.0.3.3 Given examples of each, compare mitosis and meiosis, based on definitions provided.

5.0.3.4 Given examples, describe the reproductive cycle in seed plants, based on criteria given in assessment instrument.

5.0.3.5 Given examples and definitions of each, describe the basic function of DNA and RNA, based on criteria given in assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. 30 F_2 corn seeds with a lethal recessive gene for albinism
2. potting medium
3. planting flat
4. marking pencil
5. plastic bag with a twist-tie

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Obtain product literature from several seed companies (e.g. corn) which describes the superior qualities of seed. Use the information on pages 5.0.3-5 and -6 (student copy). **Note**: Since the seeds take about one week to sprout, prepare the flat early in the week. This provides more opportunity for the activity to begin the following week.	**Interest Approach** Using the available literature, compile a list of superior traits for any crop. Consider the questions: "How do seed companies develop varieties of plants which possess the qualities described in the literature? What is the ideal plant? Why hasn't one superior variety been developed?" Discuss the principles of heredity. **Procedure** Approximately one week before data is to be recorded, perform the following tasks: 1. Partially fill a planting flat with potting medium. 2. Scatter the 30 F_2 corn seeds with a layer of potting medium. Water the seeds thoroughly. Label the flat with your class, grade, room number, and teacher's name. 3. Place the flat inside a plastic bag. Close the plastic bag with a twist tie. Place the flat in a warm place in the classroom. 4. Check the flat daily for any seed sprouting. When sprouting begins, remove the plastic bag and place the flat in a sunny place in the classroom. Add water when needed to prevent the soil from drying out. 5. Make a sketch of the position of the seeds in the flat. Note the color of the seedlings. Record the number of the seedlings of each color. Do a new sketch each day with a clean worksheet. 6. Observe the growth of the seedlings for several weeks. Note which seedlings thrive and which die. **Note**: After sprouting begins, be certain to open or remove the plastic bag. If the contents stay too moist, plants may "damp off" and develop a harmful fungus.
Use the form on page 5.0.3-7.	**Data Summary and Analysis** Sketch the position of the seeds in the flat. Note the color of the seedlings. Record the number of seedlings of each color and indicate if they live or die.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *albino* - a plant or part of a plant lacking chlorophyll. Albinism is usually lethal in higher plants. 2 *allele* - one of a pair or a series of factors that occur at the same locus on homologous chromosomes. 3. *chromosome* - a specific, highly organized body in the nucleus of the cell that contains DNA. 4. *cultivar* - international term denoting certain cultivated plants that are clearly distinguishable from others by any characteristic and that when reproduced retain their distinguishing characters. 5. *diploid* - refers to two sets of chromosomes. 6. *dominant*- referring to the gene that when present in a hybrid with a contrasting gene, completely dominates in the development of the character. 7. *gene* - a group of base pairs in the DNA molecule in the chromosome that determines or conditions one or more heredity characters. 8. *hybrid* - the offspring of two plants or animals differing in one or more characters. 9. *zygote* - a protoplast resulting from the fusion of gametes. The beginning of a new plant in sexual reproduction.

• Effect-Cause •
Problem-Solving Technique

Define the problem
How do offspring inherit traits from the parents in corn plants?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation
Answers will vary depending on the total number of seeds which sprout in each planting flat. Of those seeds that sprout, approximately one-fourth will be white and fail to thrive; three-fourths will be green and remain healthy. The white plants lack chlorophyll and cannot convert the sun's energy to food for the plant. They were able to sprout and grow for a short period of time because the seed was able to provide the necessary energy to that point.

• Effect-Cause •
Problem-Solving Technique

Define the problem
How do offspring inherit traits from the parents in corn plants?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Planting Flat Sketch

Name ______________________________ Day _______ of Observation

Color	Number	Live or Die

Helping Students Apply Concepts/Principles/Skills

The abundant food supply in our nation is partially a result of public and private plant breeding programs which have produced superior cultivars for almost all cereal, vegetable, forage, fruit and ornamental crops. Public plant breeding programs have been in existence for over a century at state agricultural experiment stations in the nations land-grant colleges and universities. Private plant breeding programs are conducted by seed companies with the goal of developing better agronomic, vegetable, and flower cultivars. In the mid-1980's there were 66 companies with corn breeding programs, 46 with vegetable and fruit programs, 21 with wheat breeding, 13 with cotton and other fiber crops, 13 with forage and turf, and nine with flower and ornamental breeding programs.

Innovations by plant breeders include the development of Fl hybrids for many agronomic crops with increased vigor and insect and disease resistance. By developing plants with strong resistance to insects and disease, the need for insecticides and fungicide is being reduced.

Ideas for Other Experiments

Consult the *Carolina Biological Catalog* for other seeds which possess recessive traits and can be easily grown in a laboratory.

Evaluating Student Learning

After students complete this experiment, have them record their data and observations on pages 5.0.3-9 and -10.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 5 - Plant Science

Explain Plant Chemical Processes

Competency/Terminal Performance Objective

5.0.4: Given examples of plant reproduction types, describe factors influencing plant reproduction, based on definitions provided.

Competency Builders/Pupil Performance Objectives

5.0.4.1 Given plant type examples, describe sexual and asexual reproduction in plants, based on definitions provided.

5.0.4.2 Given examples, describe differences between self-pollination and cross-pollination in plants, based on definitions provided.

5.0.4.3 Given example conditions, identify environmental conditions influencing plant reproduction, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems
2.2.2 Compute using appropriate units of measurement
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4 Estimate measurements
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. pollen (from tomato or cucumber plants)
2. controlled temperature chambers (10°, 21°, 38° C)
3. culture media - 10 percent sucrose + 100 ppm Boron (from boric acid)
4. magnifying lens
5. microscope
6. microscope slides
7. petri dishes
8. filter paper
9. dissecting needles
10. thionin stain (available from scientific chemical supply companies)

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
	Interest Approach Inform the class that during July and early August corn growers are concerned about two aspects of weather - rainfall and temperature. Have the class suggest reasons for the concern. Rainfall is most obvious because water is necessary for photosynthesis. Hotter temperatures are actually good for plant growth, not harmful. Discuss the life cycle of the corn plant during the growing season. Students should reason that hot temperatures probably have a harmful effect on plant reproduction. The effect of temperature on reproduction, specifically pollen germination and growth, is the topic of this laboratory exercise.
Use information on pages 5.0.4-5 and -6 (student copy).	**Procedures** 1. Split the anthers of the flower with the needle. Collect pollen on the tip of a dissecting needle. (The pollen is clearly visible with the aid of a magnifiying lens.) 2. Place 2-3 drops of culture media on a slide and carefully add the pollen. 3. Place the slides on moist filter paper in petri dishes and put into temperature chambers. 4. Observe the pollen germination after 1/2, 1, 2, and 3 hours. (Pollen tubes can be seen more easily by adding 1 or 2 drops of thionin stain to the slide.) 5. Record the number of pollen grains that have germinated. Show evidence of pollen tube growth. Also, record the number aborted (burst without tube growth) and number not germinated for each temperature. 6. Compare the rate of growth of the pollen tubes for each temperature.
Use information on pages 5.0.4-7, -8, and -9.	**Data Summary and Analysis** Have students record the number of pollen grains that germinate under the varying temperature conditions. Also, record the number of aborted (burst) pollen grains and number not germinated. Compare the rate and percent of growth. What impact could a reduced pollen germination have on the yield of a plant? Why?

(Directions for the Teacher)	Teaching Procedures: Interest Approach / Teaching Methods
	Key Terms 1. *self-pollination* - the transfer of pollen within the same flower or to any flower on the same plant or clone 2. *cross-pollination* - the transfer of pollen to a flower on another plant which is likely to have a different genetic make-up 3. *fertilization* - the union of an egg and sperm to form a zygote 4. *monoecious* - stamens and pistils occur in separate flowers on the same plant 5. *dioecious* - staminate and pistillate flowers may be born on different plants. 6. *incompatibility (self-sterility)* - physiological mechanism that prevents self-fertilization. Genetic factors prevent pollen tubes produced by a plant from growing in the style of the same plant; examples are alfalfa, cabbage, tobacco, and apple 7. *parthenocarpy* - formation of fruit without the stimulation of pollination and fertilization; no seeds are produced as is the case with navel oranges

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What affect does temperature have on pollen germination and pollen tube growth?

Factors to Consider	Possibilities (Possible Solutions)			
	10°C	21°C	38°C	
Number of Pollen Grains				
Number Germinated				
Number Not Germinated				
Number Aborted				
Length of Pollen Tubes				

Decision/Recommendation

There will be fewer pollen grains germinated and evidence of pollen tube growth at the hotter temperature.

• Possibilities - Factors •

Problem-Solving Technique

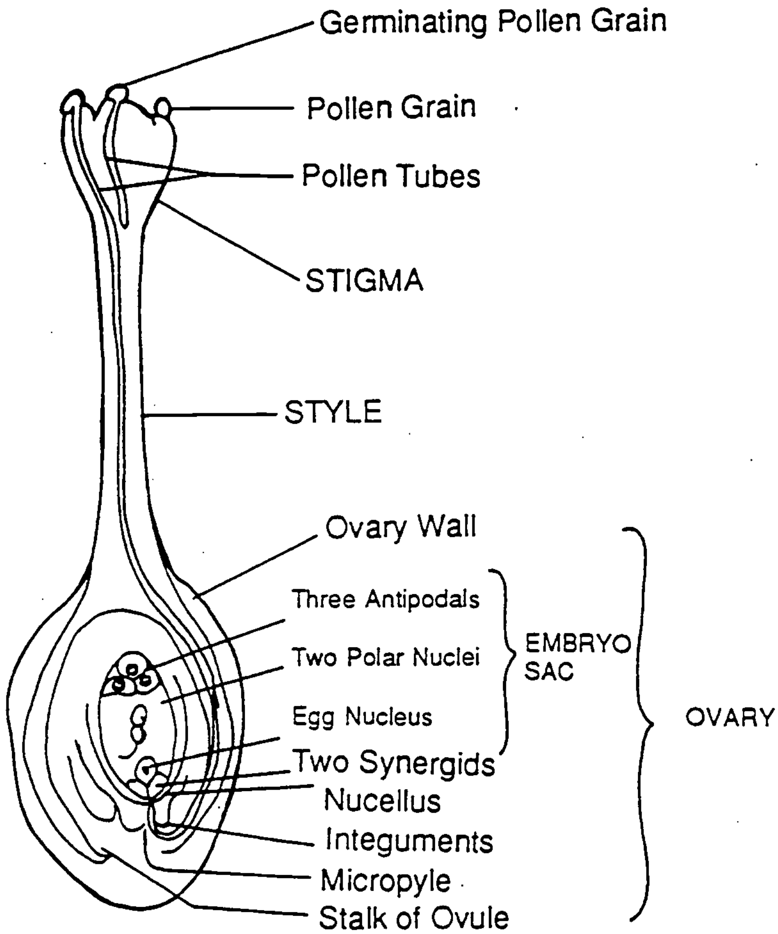
Define the problem

What affect does temperature have on pollen germination and pollen tube growth?

Factors to Consider	Possibilities (Possible Solutions)			

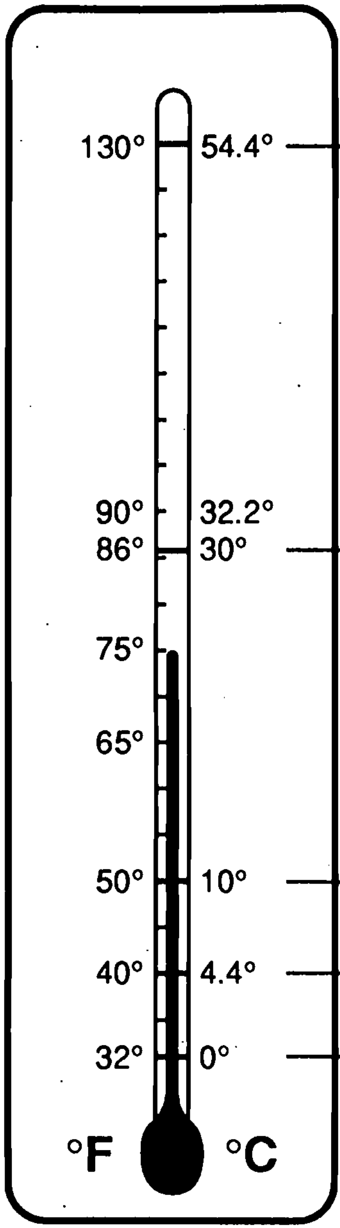
Decision/Recommendation

Pistil of a Flower following Pollination and just before Fertilization



A longitudinal section through the pistil of a flower following pollination and just before fertilization.

Temperature Variations Affect Plant Growth



Plants die above this temperature

The enzyme system of the plant breaks down. Growth slows and, in the upper part of the range, stops.

Maximum temperature for optimal growth of corn and most plants

Optimal crop growth range

Base temperature for optimal growth of corn

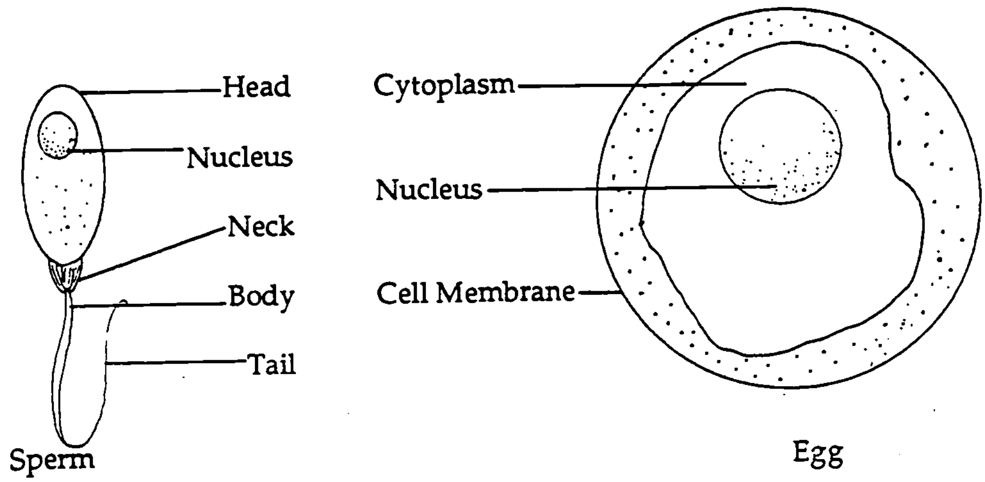
Base temperature for optimal growth of many plants

Freezing

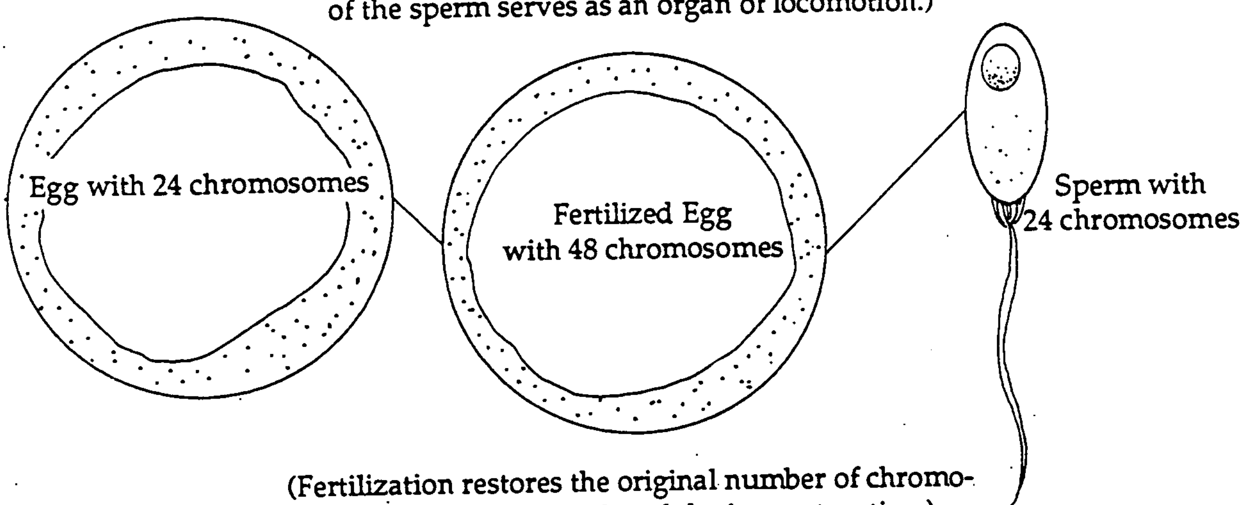
362

363

Fertilization



(Eggs are usually much larger than the sperm. The tail of the sperm serves as an organ of locomotion.)



(Fertilization restores the original number of chromosomes, which was reduced during maturation.)

Helping Students Apply Concepts/Principles/Skills

Pollination is the transfer of pollen from the anthers to the stigma. This transfer is often aided by insects - chiefly honeybees - for fruit crops, vegetables, and legume forages. Wind aids pollination for plants with inconspicuous flowers such as grasses, cereal grains and forest tree species. Adequate pollination is critical for optimum seed set and is influenced by environmental conditions at the time the pollen is released. In order for a seed to develop there must be pollination, fertilization, and growth to maturity.

Hot and humid conditions which people find uncomfortable are ideal conditions for plants. However, temperatures too hot at the beginning of the reproductive phase can be harmful to the formation of the seed. Temperatures that are too high at this critical period are often responsible for crop failures when pollen grains, damaged by the excessive heat, are unable to fertilize the ovary. In fruit crops, low temperatures can be just as damaging to the fertilization process and subsequent fruit setting.

Growers are unable to control the environment for most major agronomic crops and successful pollination is largely a factor of nature. In some cases, when growing conditions seem ideal with hot temperatures and plenty of moisture, plants look healthy but seed production may be less than optimum. Often this is due to the effect of temperature on pollen germination and growth.

Ideas for Other Experiments

1. Replicate the procedures at varying temperatures to further investigate the influence on pollen germination and tube growth.
2. Replicate the procedures using pollen from a different host plant and compare results.

Evaluating Student Learning

After students complete these experiments, have them record their data and observations on pages 5.0.4-11 and -12.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 5 - Plant Science

Describe Conditions Affecting Seed Germination and Seedling Growth

Competency/Terminal Performance Objective

5.0.5: Given various conditions, describe those that affect seed germination and seedling growth, based on criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.5.1 Given examples, identify seed parts, based on criterion assessment instrument.

5.0.5.2 Given seed types, describe seed germination, based on notes provided.

5.0.5.3 Given seed parts, explain the role of seed parts in germination and seedling growth, based on criterion assessment instrument.

5.0.5.4 Given examples, determine effect of seed quality on germination, based on standards set.

5.0.5.5 Given example seed types and conditions, explain seed germination process and conditions influencing it, based on criteria given in assessment instrument.

5.0.5.6 Given seed types and growing conditions, demonstrate seed germination test, using scientific method as given in criterion assessment instrument.

5.0.5.7 Given various management practices, identify those that influence seed germination and seedling growth, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
1.2.2 Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
1.2.5 Set up, solve, and apply ratios and proportions
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7 Translate written and/or verbal statements into mathematical expressions
1.2.8 Estimate answers
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

Activity 1

1. grains of wheat or barley (25 grains of each per experiment)
2. 12 or more petri dishes with lids and filter papers
3. gibberellic acid solution (can be purchased from a biological supply company or the pure chemical in dry powder form is available) - Stock solution can be made by mixing 10 mg. of the dry powder in 2 ml. of ethanol, then diluting with 100 ml. of water. Dilute the stock solution by mixing 1 ml. of solution with 300 ml. of water for use in this experiment
4. iodine solution (for starch test)
5. gelatin or agar starch

Activity 2

1. Fridline C.R., and C. Miller. *Plant Growth and Development* - Student Manual, Teacher Guide, and transparency masters. Columbus, OH: Ohio Agricultural Education Curri-culum Materials Service, 1989.
2. *Agronomy Guide*. Columbus, OH: Ohio Cooperative Extension Service, The Ohio State University (current issue).
3. Hybrid corn seeds with an initial tag germination of 90 percent or above. Four classes of seed; current year, one year-old, two years old, and three years old. Twenty-five seeds per seed class per group.
4. Tray - 1" x 8" x 12" (two trays per group)
5. Eight 12-ounce cups per group
6. Twenty-five pounds of blasting sand or other suitable growing medium
7. Soil/air thermometers
8. Ruler or other linear measuring device.

Situation

These experiments are to be conducted with a class of Level I Agriscience students. Some have plant experiences of their own. Some of the students' families grow plants in their place of business, but most students have not been involved in describing germination.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 1
Use the information on pages 5.0.5-9 and -10.	**Interest Approach** Show students some samples of cereal grain seed that have a large number of cracked or broken seeds. Ask the following questions: What are some probable causes of this seed damage? If a large amount of this sample were sold as seed or grain, would a lower than normal price be paid the seller? Why? What if this grain were produced for seed; would germination rate be lower than seed with no damage? Why?
	Procedure
	1. Select 25 uniform, cereal grain seeds, and cut 15 of them transversely into halves. Discard the embryo halves and keep the endosperm halves.
	2. Place five half-seeds in a petri dish (keep them dry) and cover.
	3. Place five half-seeds in a petri dish containing filter paper and approximately 8 ml. of gibberellic acid solution.
	4. Place five half-seeds in a petri dish containing a filter paper and 8 ml. of water only.
	5. Place ten whole grains of seed in a petri dish containing a filter paper and water only.
	6. Label the bottoms of the petri dishes with the treatments that have been applied in each case.
	7. Store the dishes at room temperature for three days which should allow sufficient time for the whole seeds to begin to germinate.
	After the three day period:
	8. Prepare starch-gelatin or starch-agar plates by mixing 10 percent gelatin solution or one percent agar in hot water with .5 percent starch. Pour the mixture into petri dishes using approximately 15 ml./dish.
	9. Place one or more half-seeds from each of the treatments into separate quadrants of the petri dish. Cut the whole grain transversely into halves and place one or more endosperm halves in the fourth quadrant. Label the treatments on the bottom side of the dish. The following illustration suggests possible placement and labeling of treatments on the starch plate.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 1 *(continued)* -GA3 dry seed -embryo -GA3 | +GA3 +embryo | -embryo 10. Allow to stand overnight (or at least six hours). 11. Flood the plate with iodine solution and observe where the presence of starch turns the iodine from purple to blue and areas where no starch is present (clear or amber). 12. Record observations.
Use pages 5.0.5-11 and -12.	**Data Summary and Analysis** Record the color of the starch plate in each quadrant. Record data for each replication of the experiment. Examine and chart the consistency of findings across replications.
	Key Terms 1. *aleurone layer*- a very thin tissue in endospermic seeds that lies between the endosperm and the seed coat 2. *amylase* - an enzyme that converts food reserves (starch) in plants to soluble sugars 3. *diffusion* - the random movement of molecules or particles from a region of higher concentration to a region of lower concentration, resulting in uniform distribution 4. *endosperm* - storage tissue in the seeds of gymnosperms 5. *enzyme* - one of numerous complex proteins that speeds up a chemical reaction without being used up in the reaction 6. *gibberellin* - one of a group of naturally occurring plant hormones that have a variety of effects on growth, especially known for promoting elongation of stems 7. *hydration* - the process of combining with water 8. *hydrolysis* - a chemical reaction with water so as to be changed into one or more other substances, as starch into glucose

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms ***(continued)*** 9. *metabolism* - the sum of all interrelated chemical processes occurring in a living organism 10. *micropyle* - a tiny pore or opening in the seed coat 11. *osmosis* - a special type of diffusion that takes place only in the presence of a semipermeable membrane, that is, one permeable to water alone 12. *protease* - an enzyme that digests proteins 13. *soluble* - capable of being dissolved

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
(Teacher to Students)	**ACTIVITY 2** **Interest Approach** Assume you are a corn grower. Since it stayed wet so long last year, you could not plant your corn; you decided to plant soybeans instead. Therefore, you now have some seed corn remaining from last year. Rather than buy all new seed corn, you wonder if you could plant the old seed. The decision you need to make, then, is: "Should I use the year-old seed, or use all new seed for planting this year's corn crop?"
(Write the problem statement on the board.) (Teacher to students)	**Procedure** "In order that we may make a wise decision, what factors should we consider in deciding which type of seed to use - the old or the new?"
(Develop a chart on the board below the stated problem or decision to be made.) See page 5.0.5-13 (A chart similar to the one on page 5.0.5-14 will evolve, using student suggestions as to factors to consider, plus factors that are identified during supervised study.)	Record the students' suggested factors. Then, use *supervised study* to check for additional factors to consider, using as references the *Ohio Agronomy Guide* and *Plant Growth and Development - Student Manual.* For example, what is the cost of the old seed versus the new? The following questions should be the type to ask to get students to determine the data for each of the two choices, that is, old seed versus new seed. These questions can be placed on the chalkboard and be required entries in student notebooks. Leave space below the chart for the written decision.
(After developing chart containing all factors to be considered that students can identify based on their present knowledge, plus that gained from supervised study, use class time to obtain the related information concerning each factor.) (To help answer this question, you may want to conduct the following epxeriment. Also, additional seed germination and vigor tests can be done.)	1. How costly would it be to purchase all new seeds? On an acre basis? On a farm basis? *Subquestions* a. Seed corn is sold in what units? b. How many seeds are in one of these units? c. How many units are required per acre? 2. What would happen to production if a lower percentage of the seeds grew? 3. How can we determine the germination percentage of the old seeds?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
According to this activity the experiment will require approximately 20 days. Therefore, the decision as to whether old seed can be used or new seed should be purchased cannot be made until the germination percentage is determined via the experiment. (During the duration of the experiment, develop understandings, attitudes, and skills pertaining to other factors listed in the chart. The following class activities should be used to obtain the related information that pertains to each factor as it relates to each of the two choices. Record the information in the chart.)	**Research Activity** a. Develop understanding of seed germination and growth processes. Discuss why some seeds germinate and others do not. b. Show the following *Plant Growth and Development* transparencies: 5.0.5-15 - Comparing Monocots and Dicots 5.0.5-16 - Parts of a Corn Seed 5.0.5-17 - Requirements for Seed Germination 5.0.5-18 - Corn Germination and Seedling Growth 5.0.5-19 - Seed Label 5.0.5-20 - Effect of Seed Vigor on Relative Corn Yields c. Have students study pages 1 through 5 of Unit 1 - "Seed Germination and Seedling Growth," *Plant Growth and Development - Student Manual.* d. The following terminology should be developed during the discussion and study time: embryo — endosperm seed coat — cotyledon coleoptile — epicotyl hypocotyl — radical coleorhiza — pericarp monocoltyledon — dicotyledon respiration — growing point seminal roots — germination germination percentage (seed quality) — absorption e. Have students determine what the appropriate germination percentage would be for the year-old seed. f. Other experimental activities can be conducted during the time the seeds are germinating. Suggested activities can be found in the publication, *Plant Growth and Development - Student Manual.*

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
(The experiment is set up on the first day. During the next three to four days the seeds germinate. During this time the soil and air temperatures are monitored to detect any conditions that could cause germination failure. (On each subsequent day 15 minutes are needed to record observations. This continues until two full leaves are fully extended on each seedling.)	**Procedure** Plant four different classes of corn seeds in styrofoam cups. Also plant a second set of cups in the same manner to serve as a replication. Allow all the seeds to germinate and produce seedlings. Record growth data until the seedlings have two fully extended leaves. Count the number of seedlings and compare to the number of seeds planted. Calculate the germination percentage of each seed class. Record observations and discuss the results. 1. Fill four styrofoam cups with planting medium to within one inch of rim. Water the medium until saturated, but do not oversaturate. 2. Place 25 seeds on top of the planting medium in each cup. Arrange them so they can be quickly counted. 3. Cover all seeds with planting medium to within 1/2 inch of cup rim. After covering the seeds, firm the medium to provide good seed-to-soil contact. This provides adequate conditions for germination. 4. After planting, label each cup with the seed class, number of seeds planted, and time and date planted. Record this information on page 5.0.5-21. 5. Place each cup in the aluminum tray. 6. Now repeat steps 1 through 5 to replicate the experiment. 7. After 24 hours check the air and soil temperatures for both experiments. Record data on page 5.0.5-22. Also check the surface of the planting medium in each cup. If it is dry, add water to the bottom of the tray. 8. From this point on, check both experiments every 24 hours until seedlings emerge from the planting medium. Record the time and date of emergence on page 5.0.5-21. 9. Continue to record observations until each seedling completely unfolds two leaves. 10. Record the number of seedlings in each cup in the original experiment. Compare this number with the number of seeds planted in each cup. Calculate the germination percentage for each seed class. Also record this same data for the replication. 11. To obtain a more accurate germination percentage for each seed class, add the number of seedlings in each class for both cups in the original experiment and the replication. Compare this sum to the total number of seeds planted in both cups. Calculate a single germination percentage for both cups. Record this information on page 5.0.5-21.

• Effect-Cause •
Problem-Solving Technique

Define the problem

How does seed condition affect germination potential? How do the major parts of a seed interact to stimulate the germination process?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Amylase diffuses from the grain into the starch plate and hydrolyzes starch to sugar. There will be a clear area around the half-seeds containing amylase (why?) Two treatments synthesized amylase - the half-seeds treated with gibberellic acid and the whole seeds that were germinated. Thus, the embryo plays an essential role in germination by releasing gibberellin, which initiates enzyme synthesis so food reserves can be converted to energy.

• Effect-Cause •
Problem-Solving Technique

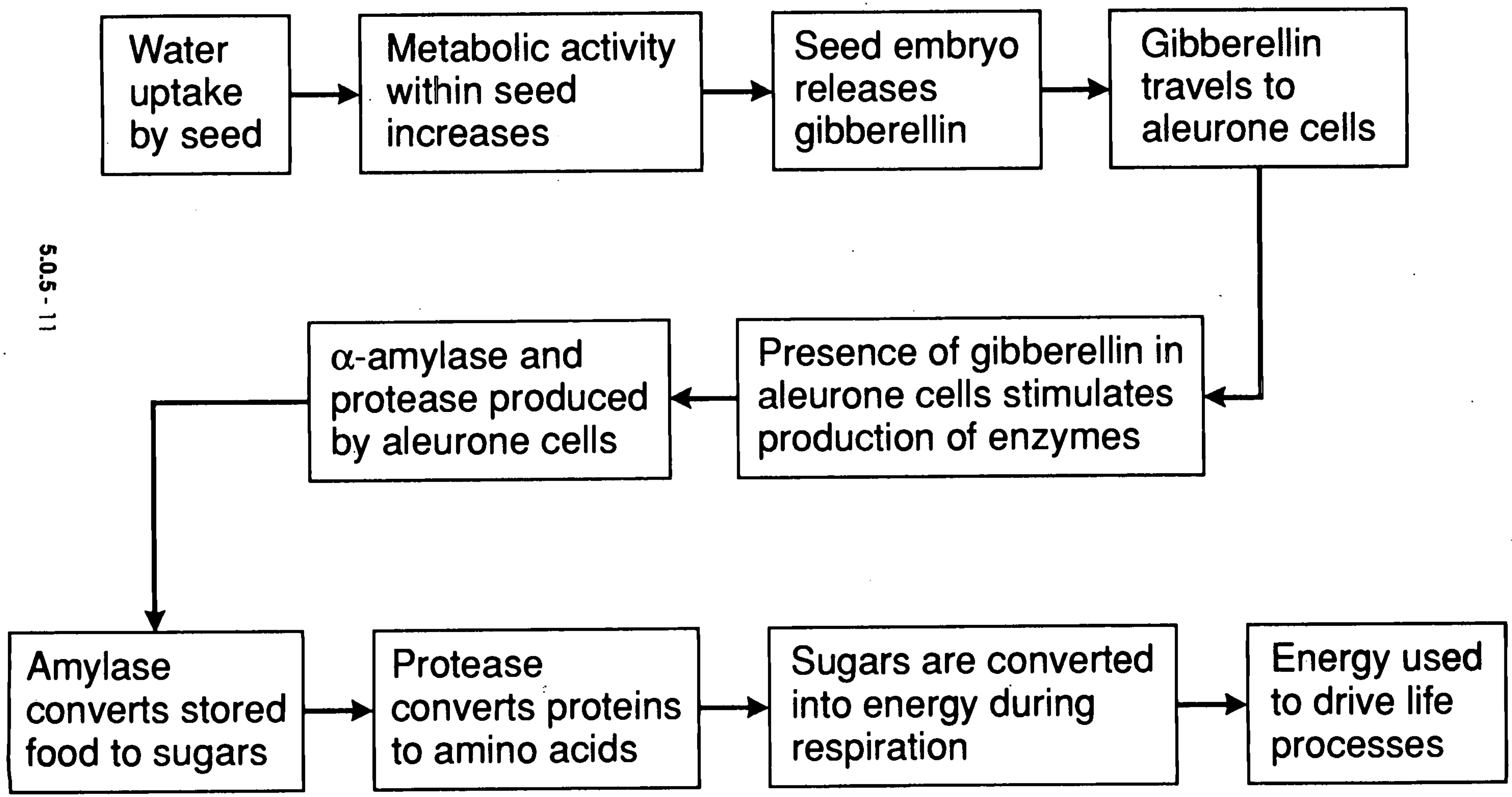
Define the problem

How does seed condition affect germination potential? How do the major parts of a seed interact to stimulate the germination process?

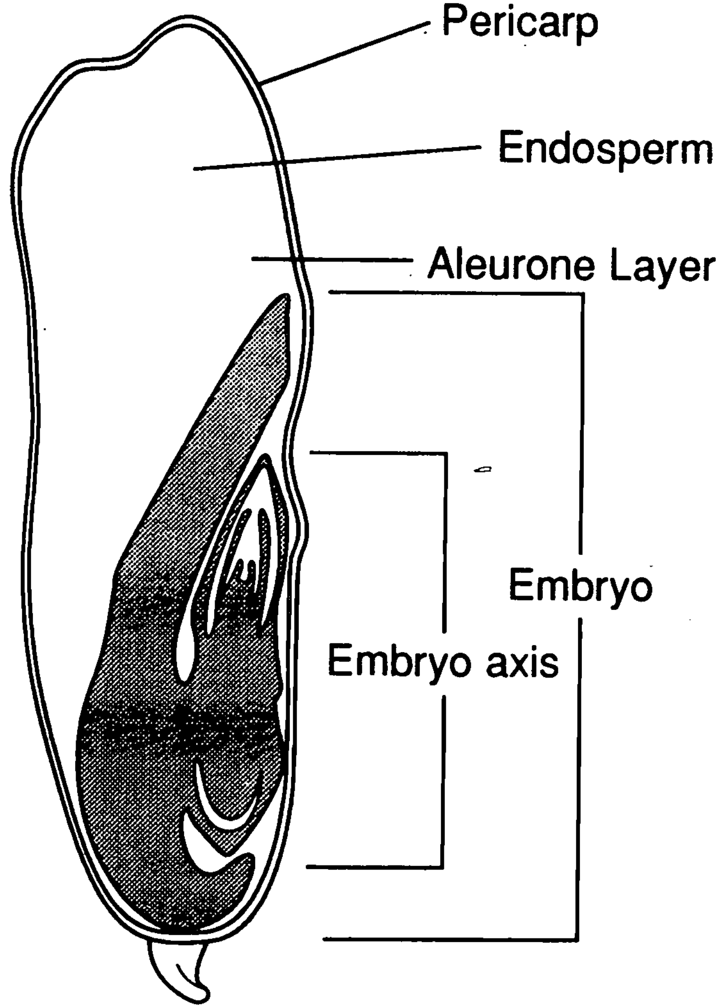
Possible Causes	Related Facts	Accept/ Reject Cause

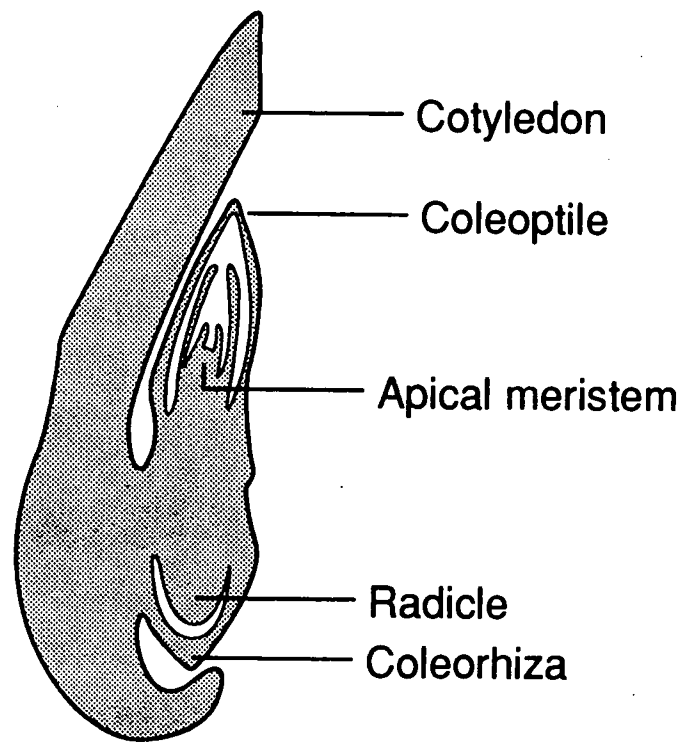
Decision/Recommendation

How Enzymes are Produced During Germination



Corn Seed and Embryo





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• Forked Road •

Problem-Solving Technique

Define the problem

"Should I use the year-old seed, or use all new seed for planting this year's corn crop?"

Factors to Consider	Choice one	Choice two
[redacted]		

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

"Should I use the year-old seed, or use all new seed for planting this year's corn crop?"

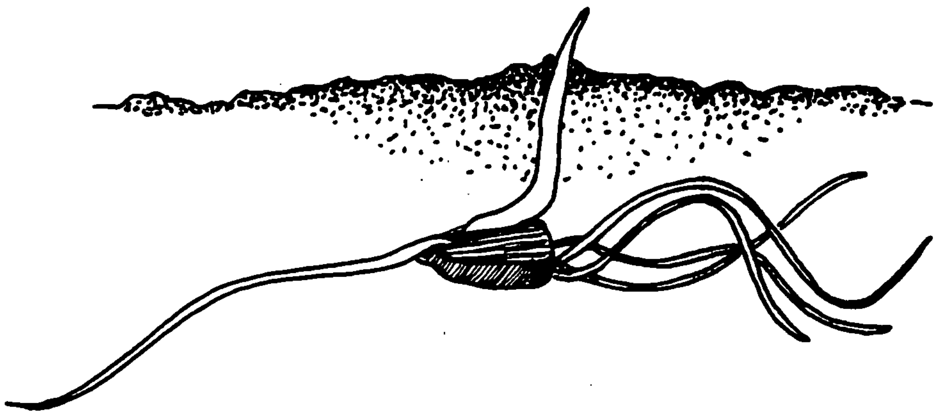
Factors to Consider	Choice one	Choice two
	Use Old Seed	Buy All New Seed
a. Cost of new seed		
b. Germiniation % of new seed		
c. Recommended germination %		
d. Germination of old seed		
e. Amount of seed to sow if old seed is used		
f. Amount of old seed on hand		
g. Soil and planting conditions needed to achieve optimum germination and seedling growth		

Decision/Recommendation

"(I) should choose the ____________ seed to plant. I will need to sow _______________ kernels per acre of new seed, or ________________ kernels per acre if I sow the old seed. The seeding rate for old seed is based on the ________________ percent germination of the old seed as determined by the experiment."

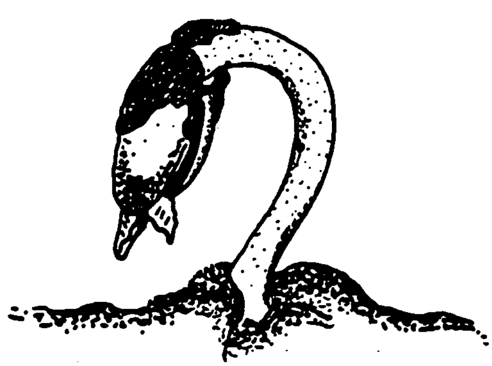
COMPARING MONOCOTS AND DICOTS

Monocotyledon



- One seed leaf per seed
- Leaves long and narrow, usually with parallel veins
- Growth from a single growing point and usually upright
- Food stored in endosperm of the seed

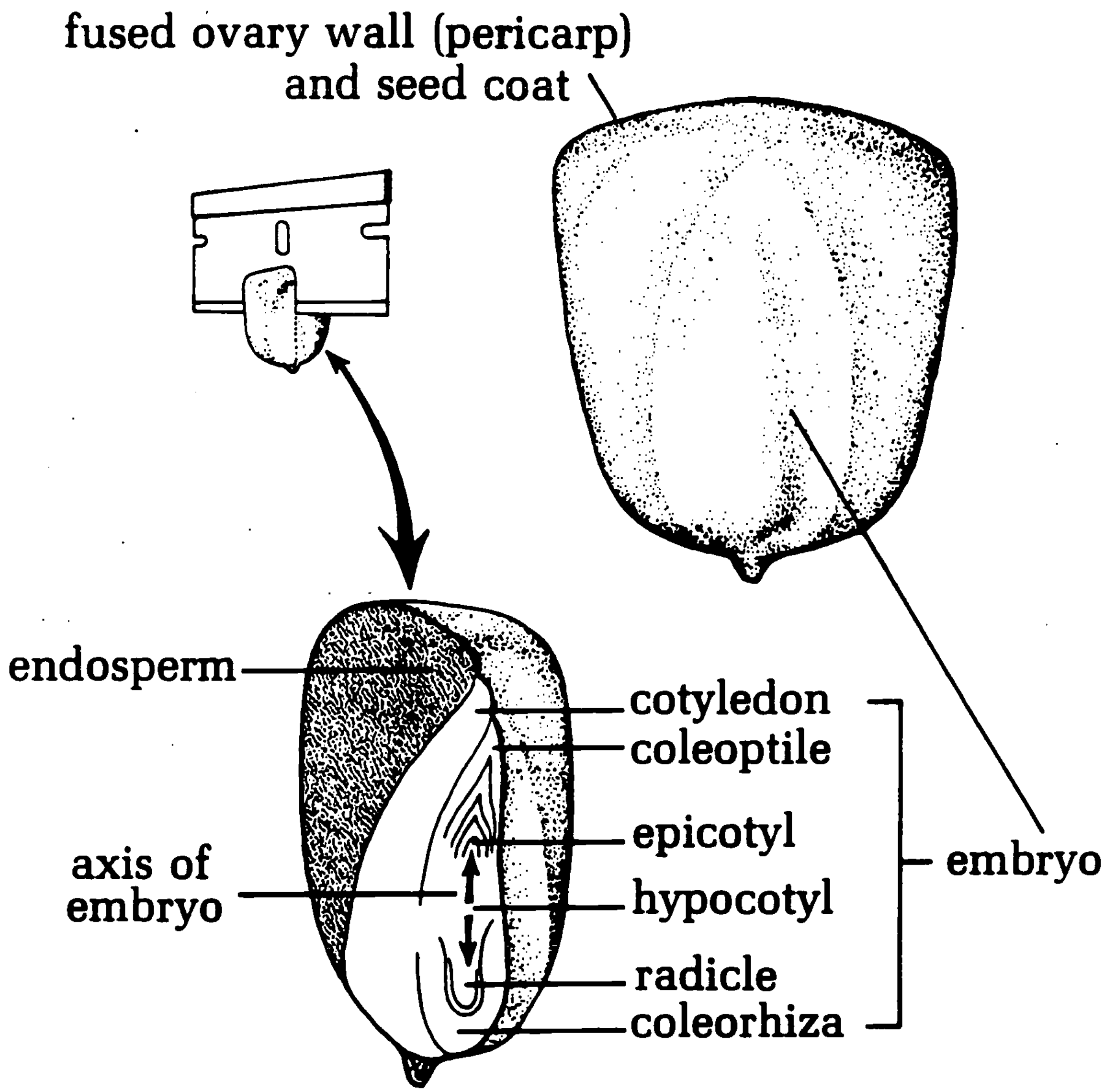
Dicotyledon



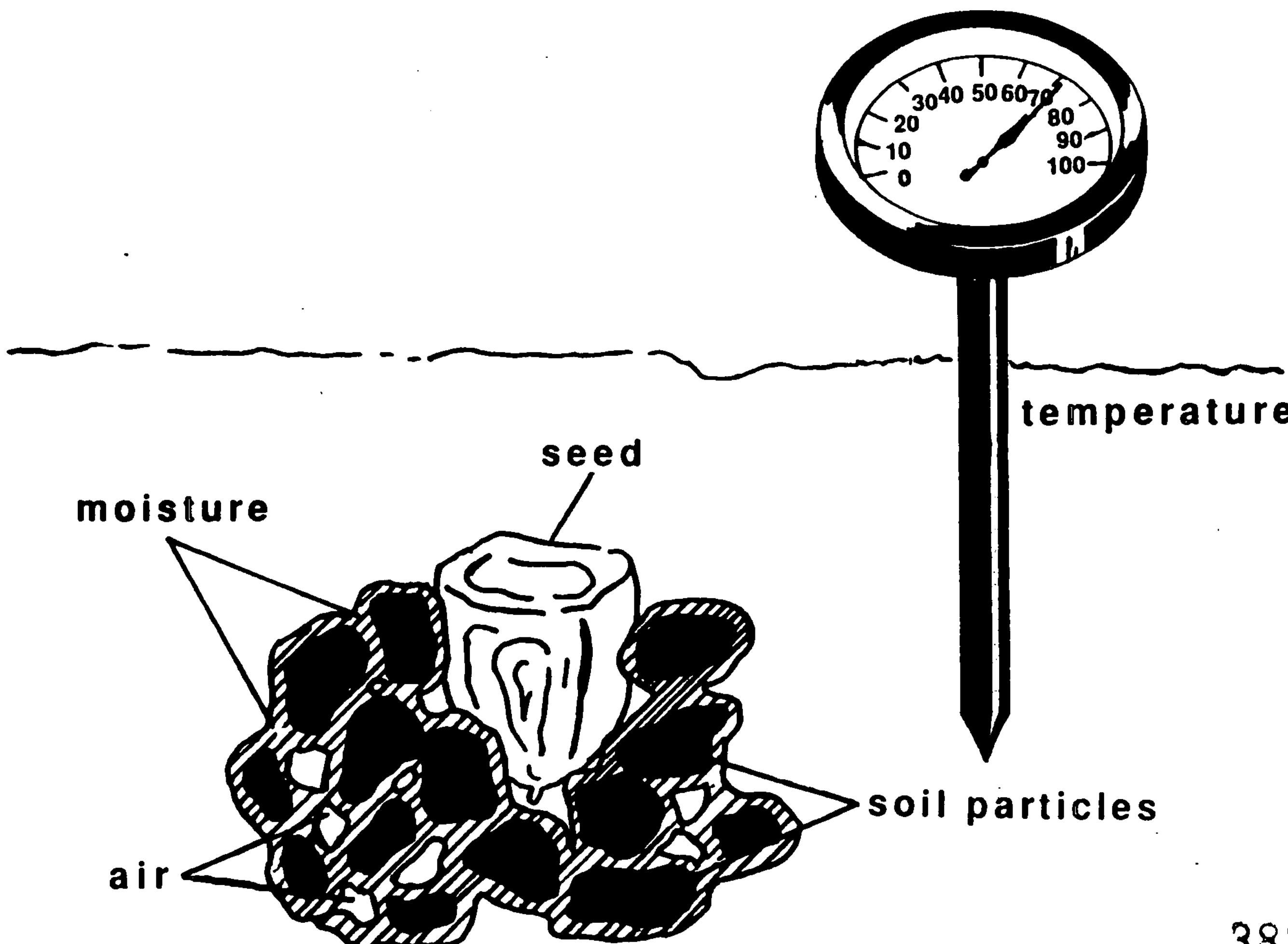
- Two seed leaves per seed
- Leaves of various shapes – oval, round, oblong – and net-veined
- Growth originating at buds in leaf axils and terminal stems
- Food stored in cotyledons of the seed

Plant Growth and Development Student Manual (1989 revision), pages 1-2

PARTS OF A CORN SEED



REQUIREMENTS FOR SEED GERMINATION



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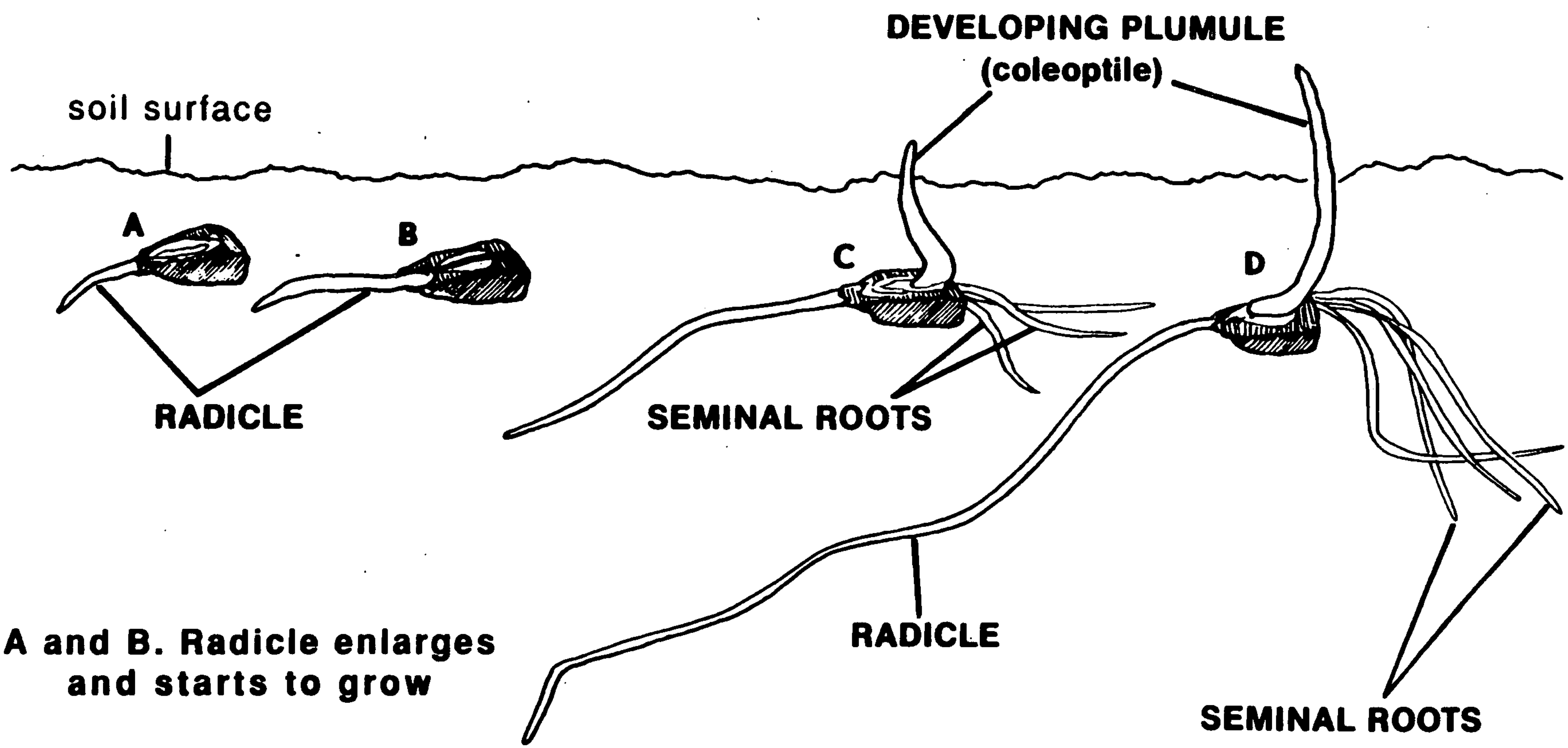
CORN GERMINATION AND SEEDLING GROWTH



A and B. Radicle enlarges and starts to grow

C and D. Plumule and seminal roots start to develop

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SEED LABEL

Kind Variety Lot No.

Origin

Purity % Weed Seed % Inert Matter %

Other Crop Seed % Germ.Test Date

Germ. % Hard Seed %

Name and No. Noxious Weeds per oz.

LABELER

Address

EFFECT OF SEED VIGOR ON RELATIVE CORN YIELDS

STORAGE CONDITIONS		GERMINATION	VIGOR LEVEL	RELATIVE YIELD*
Temperature	Moisture			
77° F	11%	96%	High	100
77° F	14%	96%	Medium	98
77° F	17%	93%	Low	93

* Yields based on an equal number of plants per plot.

Data from Don F. Grabe, Crops and Soil Magazine

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DATA AND OBSERVATION SHEET

Using Seed Germination Percentage and Age to Determine Seed Viability

Name ____________________ Date ____________ Period ________

Seed Class and Date Planted	Original Experiment						Replication					
	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours	24 Hours	48 Hours	72 Hours	96 Hours	120 Hours	144 Hours
Current Year	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.
One Year Old	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.
Two Years Old	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.
Three Years Old	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.	Air Temp. Medium Temp.

DATA AND OBSERVATION SHEET

Using Seed Germination Percentage and Age to Determine Seed Viability

Name ______________________ Date ____________ Period ________

Seed Class and Time and Date Planted	Original Experiment				Replication				Combination of Original Experiment and Replication		
	Time/Date of Emergence	Number of Seeds Planted	Number of Seeds Germinated	Germination Percentage	Time/Date of Emergence	Number of Seeds Planted	Number of Seeds Germinated	Germination Percentage	Number of Seeds Planted	Number of Seeds Germinated	Germination Percentage
Current Year Time/Date Planted ________											
One year old Time/Date Planted ________											
Two years old Time/Date Planted ________											
Three years old Time/Date Planted ________											

Helping Students Apply Concepts/Principles/Skills

Activity 1

When a seed reaches maturity, it usually contains 5-10% moisture. All seeds have an embryo and a seed coat, and many seeds have stored energy in a third seed part called the endosperm. Seed that is to be used for future planting must be harvested at just the right stage of maturity. The harvesting, handling, and storing of seed must be done carefully, so as not to cause physical damage to the seed. The embryo contains the living tissue in the seed. Seed that is harvested or stored improperly, or seed that is cracked or broken may lose a significant amount of its germination potential.

During the seed germination process, the enzyme amylase is produced. The production of amylase in grain determines the usefulness of grain for processing. Flour for bread making must contain little or no amylase. However, rain at harvest may cause the wheat grain to germinate in the head and the amount of amylase rises. Such sprouted grain produces flour high in sugar, which promotes mold growth on the bread. Also, the structure of the bread will be poor. Conversely, barley used in the brewing industry must have the capacity to produce high levels of amylase. High amylase is necessary for complete conversion of starch to sugars needed for the yeast to make alcohol.

Ideas for Additional Experiments

1. Use two or more cereal grains and compare the rates of amylase production (measured by rate of starch hydrolysis) between grains.
2. Vary the time (e.g., 2, 4, hours, etc.) for flooding the agar plate with iodine to detect how rapidly amylase converts starch to sugar. (**Note**: You should be able to see effects in as little as 30 minutes.)
3. Compare the rates of amylase production as the moisture level for germinating seed is varied. Examine the effects of other environmental factors (temperature, etc.) on the rate of amylase production.
4. Examine the effects of gibberellic acid amount and/or concentration on speed and percentage of germination. (**Note**: Studies have shown that the more gibberellin present, the more amylase produced by the aleurone cells.)

Helping Students Apply Concepts/Principles/Skills

When the results of the experiment are known, the students should be directed to the making of a decision concerning which seed to use: old or new.

Complete the chart as to the related information. Help the students give appropriate "weight" to each factor. Place the collective class decision on the board (in their notebooks the decision will be written below the developed chart in the "reserved" place).

Ideas for Additional Experiments

See pages 5.0.5-25 through 5.0.5-28

SUPPLEMENTAL ACTIVITIES

Following are alternative procedures to use for determining seed germination and seed vigor. One of these may be appropriate to do in addition to or in place of the previous research activities. The cold test and primary root length test can be used to measure seed vigor. These tests can be conducted individually or as a classroom activity. A form is included on page 23 that can be used for filling in data collected from these tests.

Additional information on these tests can be found on pages 14 through 19 of the *Plant Growth and Development Student Manual*.

Warm Germination Test

MATERIALS

- Obtain a supply of corn, soybean, oat, and wheat seeds. If all four crop seeds are tested at the same time, comparisons can be made regarding time required for germination and appearance of the seedling. The amount of seeds required depends on the number of seeds used in the test (10, 20, 50, or 100) and the number of tests planned.
- A roll of paper towels or strips of absorbent cloth 12 inches wide and 12 to 36 inches in length is needed. The length of cloth strips can be determined by the number of seeds to be tested.
- A bucket, tub, or other suitable container is also required to hold the paper or cloth rolls containing the seeds.

PROCEDURE

1. Select a predetermined number of seeds to be tested (10, 20, 50, or 100).
2. Place the seeds between moistened layers of paper towels or cloths. Seeds should be spaced an inch apart for easier counting later.
3. Roll up the moistened towels or cloths and place in a suitable container. Keep rolls moist throughout the test period and the temperature between 60 and 70°F (15.6 and 21.1°C).
4. If more than one lot of seed of the same kind is to be tested, mark each roll with an identifying number or letter.
5. Check each roll for germination after three days. Count and record the number of seeds that show root or stem sprouts or both. Repeat the above procedure after five days.
6. At the end of seven days, count all seeds showing strong stem and root sprouts.
7. Calculate the germination percentage by dividing the number of germinated seeds by the total number used in the test (and multiplying by 100).

Conclusions: From your observations, write your conclusions concerning the germination capabilities of the seed and its desirability for use in planting.

Primary Root Length Test

PROCEDURE

1. From any warm germination test (completed in seven days), count the number of seeds showing the longest primary roots. With corn and soybeans, only primary roots over one inch in length are counted.
2. Calculate the percentage by dividing the number of seeds showing the longest primary roots by the total number of seeds in the test (and multiply by 100).

Conclusions: Observe the results of the test and make your conclusions.

Cold Test

MATERIALS

- About one gallon of soil-sand mixture (75% soil, 25% sand) is needed for each test to be made.
- A roll of heavy-duty paper towels (made specifically for germination tests) or strips of absorbent cloth 12 inches wide and 2 to 4 feet long are needed.
- The amount of corn or soybean seeds used will depend on the number needed for the test. If a comparison between warm germination and cold tests is to be made, the seeds for both tests should come from the same lot.
- A refrigerator where the temperature can be kept at 50°F (10°C) is also required.

PROCEDURE

1. Select the seeds to be tested.
2. Place the seeds on the paper towels or cloth strips about one inch apart. Sprinkle the moistened soil-sand mixture over the seeds, barely covering them. Cover the seed and soil mixture with another paper towel and roll up. Place in a suitable container and keep rolls moist throughout the test period.
3. For one week, place the seed and soil-sand mixture in a refrigerator set at 50°F (10°C).
4. Remove from the refrigerator to a warmer area of 65-70°F (18.3-21.1°C) for one week to permit germination.
5. Count the germinated seeds and make the same calculations as described with the warm test.

Conclusions: Observe the results of the test and make your conclusions.

MATERIALS

- You will need a supply of corn and soybean seed (although tests can be run on oats, wheat, rye, and sorghum, too). For comparison purposes, seeds from the same lots used in the warm and cold germination tests should be used.

- Obtain a small supply of the chemical 2,3,5-triphenyl tetrazolium chloride. This can usually be obtained from the Seed or Crop Improvement Association of your state. If not, the Association can provide you with information as to a source of supply.

PROCEDURE

1. Soak seeds in warm water at a temperature of 85-100°F (29.4-37.8°C) for about two hours. (A longer period will do no harm.) This soaking will soften the seeds and activate the enzymes inside them.
2. Cut the seeds to be tested lengthwise through the center to expose the full length of the germ. Seeds are easily cut with a sharp, single-edged safety razor blade.
3. Place halves of the sectioned seeds in a 1.0% solution of TZ. Then warm the solution to between 85 and 100°F (29.4-37.8°C) or leave at room temperature - 75°F (23.9°C). Leave the seed halves in the solution for two hours at 85-100°F or four hours at 75°F.
4. Remove seed halves from the solution and examine with a magnifying lens for color changes. All actively respiring parts of the germ become red or deep pink. The endosperm and all dead parts of the germ do not change color. When the entire germ of the seed turns red, the seed is alive and capable of germinating (see Figure 1).

Conclusions: Observe the results of the test and make your conclusions.

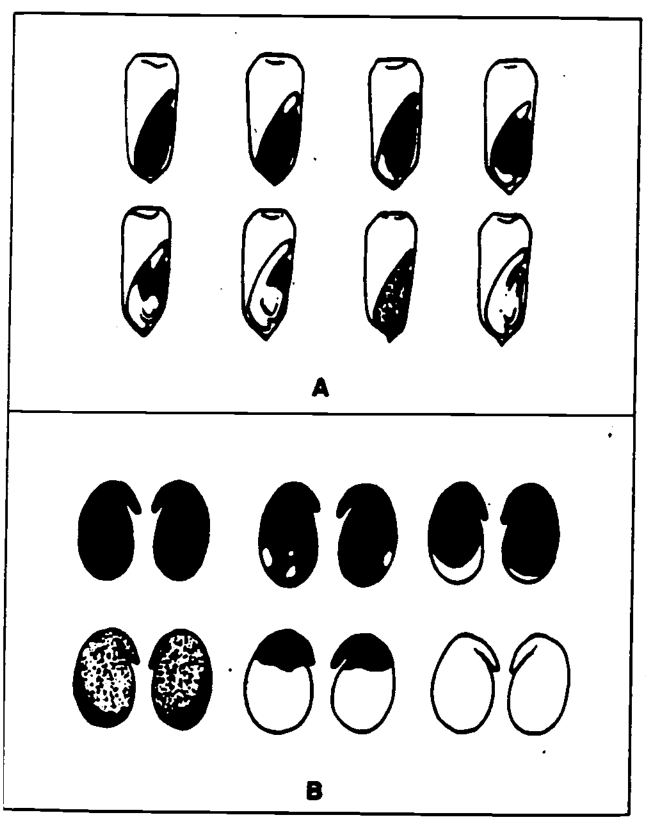

FIG. 1. The results of a TZ test on corn and soybeans. The more the staining, the higher the degree of enzyme activity. Both corn seeds (A) and soybean seeds (B) show progressively less enzyme activity from the upper left to none in the lower right row. In cold, wet soil conditions, the low-activity seeds would not emerge.

DATA SHEET FOR GERMINATION TEST

KIND OF SEED AND LOT NO.	WARM TEST			PRIMARY ROOT LENGTH TEST			COLD TEST			T Z TEST		
	Number of Seeds in	Number Germinated	%	Number of Seeds in Test	Number with Longest	%	Number of Seeds in Test	Number Germinated	%	Number of Seeds in Test	Number of Seeds Red Staining	%

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Evaluating Student Learning

After completing each activity, have students record their data on pages 5.0.5-30 and -31.

Students will be evaluated on their level of performance concerning the competencies in the objective statements. The attached written tests will be given (see pages 5.0.5-32 through 5.0.5-35.

These activities were submitted in part by Don R. Galleher, Agricultural Education Instructor, Buckeye Valley High Schol, Delaware, OH 43015. Other portions were adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____

Name ______________________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

TEST 1

Seed Structures and Germination

Answers on page 20

MULTIPLE CHOICE

In the following *multiple choice* questions, five possible answers are provided. Select the correct answer and mark an **X** in the blank provided.

1. The part of the embryo in the seed which forms the primary root is the–

   ________ a. plumule
   ________ b. radicle
   ________ c. hypocotyl
   ________ d. cotyledon
   ________ e. endosperm

2. The part of the seed which provides nourishment for the corn seedling is the–

   ________ a. endosperm
   ________ b. plumule
   ________ c. hypocotyl
   ________ d. radicle
   ________ e. dicotyledon

3. The part of the embryo which forms the stem and leaf structures of monocots is the–

   ________ a. hypocotyl
   ________ b. radicle
   ________ c. endosperm
   ________ d. cotyledon
   ________ e. plumule

4. The part of the embryo of monocots that first penetrates the soil surface is the–

   ________ a. coleoptile
   ________ b. hypocotyl
   ________ c. endosperm
   ________ d. plumule
   ________ e. radicle

5. The part of the embryo which forms the base part of the stem is the–

   ________ a. hypocotyl
   ________ b. radicle
   ________ c. endosperm
   ________ d. plumule
   ________ e. coleoptile

6. The part of the seed of dicots which provides nourishment for the seedling is the–

    ________ a. endosperm
    ________ b. radicle
    ________ c. cotyledons
    ________ d. plumule
    ________ e. coleoptile

7. The tests used to determine seed vigor are—

    ________ a. cold test and primary root length test
    ________ b. warm test and TZ test
    ________ c. seed purity and hard seed tests
    ________ d. TZ and seed purity tests
    ________ e. hard seed and warm tests

8. Seeds that grow under cold, wet soil conditions have–

    ________ a. low enzyme activity
    ________ b. a seed coat highly permeable to water
    ________ c. high seed vigor
    ________ d. a high percentage of hard seeds
    ________ e. no use to the crop producer

9. The most common test used to determine germination percentage of seeds is the–

    ________ a. cold test
    ________ b. TZ test
    ________ c. primary root length test
    ________ d. warm test
    ________ e. hard seed test

10. The germination test which determines high enzyme activity in seeds with red staining of the seeds is the–

    ________ a. primary root length test
    ________ b. TZ test
    ________ c. red dye #2 test
    ________ d. cold test
    ________ e. warm test

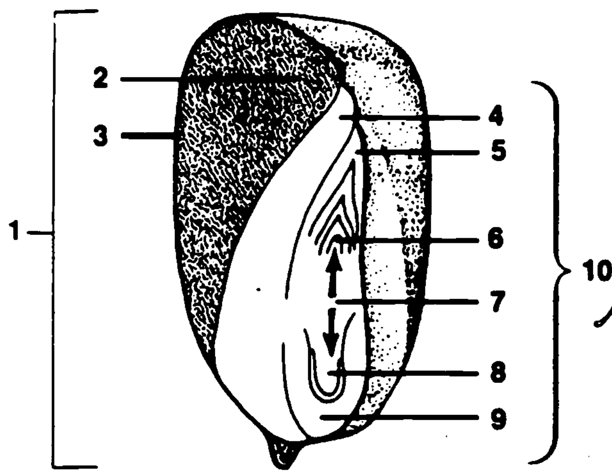
TEST 2

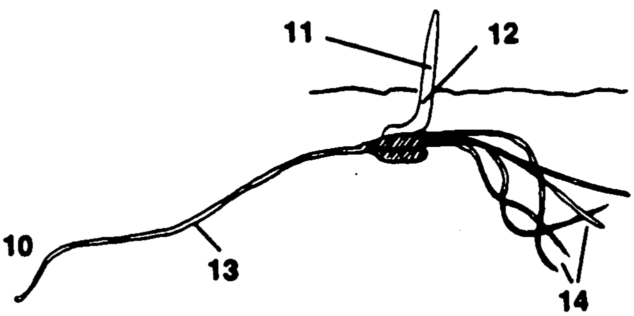
Germination and Seedling Growth of Corn

Answers on page 19

MATCHING

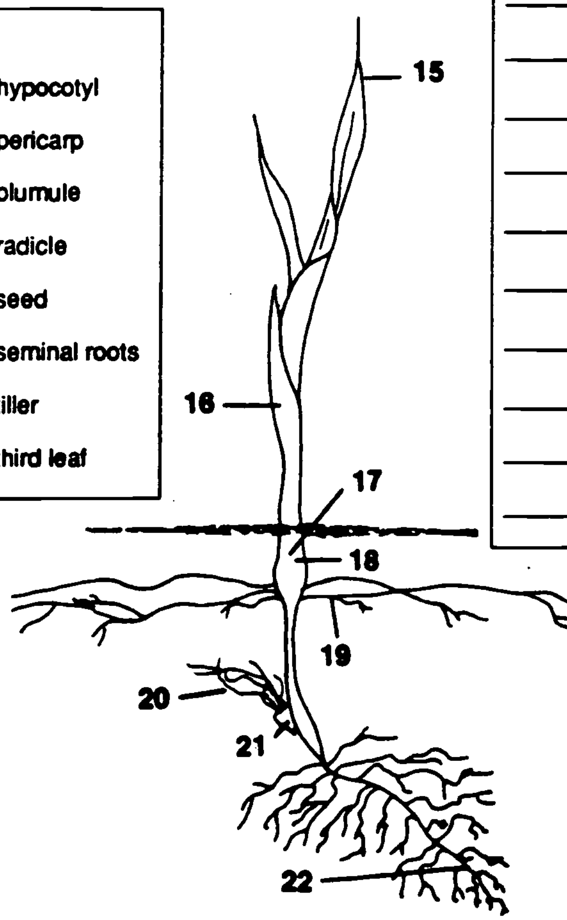
In column A find the correct name for each plant structure labeled by number in the diagrams below. Write the appropriate letter in column B. (*Note*: A term may be used more than once.)





Column A

a. coleoptile	i. hypocotyl
b. coleorhiza	j. pericarp
c. cotyledon	k. plumule
d. crown roots	l. radicle
e. embryo	m. seed
f. endosperm	n. seminal roots
g. first leaf	o. tiller
h. growing point	p. third leaf



Column B

______	1.	______	12.
______	2.	______	13.
______	3.	______	14.
______	4.	______	15.
______	5.	______	16.
______	6.	______	17.
______	7.	______	18.
______	8.	______	19.
______	9.	______	20.
______	10.	______	21.
______	11.	______	22.

Answer Key to Test Questions

TEST 1. Seed Structures and Germination

1. b	6. c
2. a	7. a
3. e	8. c
4. a	9. d
5. a	10. b

TEST 2. Germination and Seedling Growth of Corn

1. m	12. h
2. f	13. l
3. j	14. n
4. c	15. p
5. a	16. g
6. k	17. h
7. i	18. a
8. l	19. d
9. b	20. n
10. e	21. m
11. a	22. l

Program	**AGRISCIENCE**
Unit	**5 - Plant Science**

Determine Effect of Temperature on Plant Growth

Competency/Terminal Performance Objective

5.0.6 Using the information and resources provided, students will be able to explain the vegetative growth of plants under limited conditions.

Competency Builders/Pupil Performance Objectives

5.0.6.1 Given a handout with the answers blanked out, students will identify and describe the principle vegetative growth stages of plants, scoring a 70 percent average or higher.

5.0.6.2 Given a blank sheet of paper, students will, in their own words, describe the influence of light on plant growth processes.

5.0.6.3 Calculate cumulative temperature influence on plant growth and maturation.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials.
1.0.4 Determine solutions to problems.
1.0.6 Make predictions about information.
1.0.8 Define words used in context.
2.0.3 Record observations.
2.0.4 Prepare written report(s).
2.0.9 Write legibly.
2.0.13 Use correct grammar.
2.0.14 Use correct spelling.
2.0.15 Write complete sentences.
3.0.1 Demonstrate effective listening skills.
3.0.4 Identify sources of information.
3.0.6 Follow directions.
4.0.3 Participate in discussions.
4.0.12 Use appropriate language.

Mathematics

1.2.1 Round and/or truncate numbers to designated place value.
2.2.2 Compute using appropriate units of measurement.
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.
2.2.4 Estimate measurements.
3.2.6 Use problem-solving techniques.
4.2.4 Use formulas.

Equipment, Supplies, References, and Other Resources

1. Actual plants or pictures representing the following stages of growth:
   a. apical meristem growing point
   b. two-leaf stage
   c. six-leaf stage
   d. ten-leaf stage
   e. fourteen-leaf stage
2. Actual plants or pictures representing effects of the following temperatures:
   a. optimal temperature – 65° to 75° F
   b. above optimal temperature – 86° to 129° F
   c. base temperature – for corn - 50° F, and many other plants - 40° F
   d. freezing – 32° F
3 One clipboard per away team
4. Transparency Masters –
   Vegetative Growth Stages of Corn
   Vegetative Growth Stages of Soybeans
   Vegetative Growth Stages of Wheat
   Rates of Photosynthesis and Respiration Affected by Temperature
   Temperature Variations Affect Plant Growth
5. Handouts –
   Plant Growth Data Collection Sheet
   Regional Description Information - Temperature Influence on Plant Growth - blank and examples
   Example for Calculating Growing-Degree Days

Situation

This activity is to be conducted with Level I and Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach Present this scenario to the class: "You are Agriscience Specialists on board the *U.S.S. Enterprise-D* (from the television show *Star Trek: The Next Generation*). The Federation sent you in response to a plea from a planet whose entire *non meat-eating* population is starving. Our mission is to help save the planet by devising a method to feed this planet's population. I, as the captain of the ship, have decided to send away teams to the planet to investigate the problem."
Write the problem statement on the board. Divide the students into "away teams" consisting of three students. Each away team should have a leader and a recorder. The third student can be an "observer" and take measurements and readings for plant analysis. BRIEFING - tell the students that in order to research the starving planet's problems, they must be briefed on plant growth. Distribute or project the handout/transparency master – *Vegetative Growth Stages of Corn* on page 5.0.6-13.	***HOW DO PLANTS GROW?*** In order to find a solution to this problem, the students must answer the following questions: 1. What can this planet's population eat? 2. Since this population has little experience with agriculture, what do they need to know about plants? **PLANTS – Corn** Discuss with the class the handout/transparency – *Vegetative Growth Stages of Corn*. Review the following key terms. (**Note:** The italicized words are an optional analogy between a plant and a growing child.) **Key Terms and Concepts** 1. **Apical meristem growing point** – Point on the tip of the seedling from which all of the leaves and tassel develop. Growing point is usually underground until the plant is four weeks old. Plants at this stage of development are usually not permanently damaged by frost or hail. 2. **Two-Leaf Stage** – Usually occurs two weeks after the plant sprouts. Until then, the plant depends upon food stored in the endosperm. At this stage, the plant is almost ready to take in food for itself. (*At this stage, the plant acts like a small child from birth to two years old. It has emerged and is beginning to feed itself; but it is still quite young and easily damaged.*)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms and Concepts *(continued)* 3. **Six-Leaf Stage** – Roots and leaves develop rapidly at this stage. The root hairs begin to develop and the plant absorbs more water and nutrients from the earth. Two weeks after the plant sprouts, it begins to sprout the tassel from the stem which is still underground. Nodule roots also begin to form. (*Just like a small child, the plant begins to develop small hairs on its roots. Like a six-year old child, the plant is growing rapidly and is able to "eat" more diverse foods.*) 4. **Ten-Leaf Stage** – This stage is marked by rapid leaf development. The tenth leaf should be completely emerged after the fifth week of sprouting. Now the plant needs even more nutrition and must be able to photosynthesize and absorb water. (*Like a ten-year old child, rapid growth rates are common. They are becoming increasingly independent and more self-sufficient.*) 5. **Fourteen-Leaf Stage** – The stalk and yet-to-be-seen tassel develop rapidly between the ten- and fourteen-leaf stage. Small ears of corn begin to develop at each node (where the leaf attaches to the stalk). Although there are several ears of corn beginning to form, usually only the ear on the highest node matures. At this stage, the potential number of kernels on the ear is determined. Any lack of moisture or nutrition seriously affects kernel production. Photosynthesis, respiration and absorption processes must all be fully and efficiently functioning from this point until the ear is fully developed. In the final part of this stage the tassel emerges. (*At this point in the plant's life, it is ready to mature. Just as in a fourteen-year old child, the plant is ready to become fully mature. All growth processes must be fully functional and operational for the plant to be mature and robust.*)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Set up stations with the appropriate plants or plant models. Each station should represent a single plant growth and development stage. Randomly order the stations so they do not appear in order of development (e.g., Station A – Ten-leaf stage; Station B – the Two-Leaf stage, and so on). Distribute the handout – *Plant Growth Data Collection Sheet* on page 5.0.6 - 18.	**Supervised Activity** Inform the students that it is time for the away teams to investigate the situation on the planet's surface. Ask them to visit each of the corn plant stations set up in class. Ask the teams to identify the plant growth and development stage represented at each station. They should record the stage and any other observations on the *Plant Growth Data Collection Sheet*. When they have completed this task, it is time for the "debriefing." Ask the students to report their findings to you (the captain).
MORE BRIEFING – Distribute or project the handout/transparency master – *Vegetative Growth Stages of Soybeans* on page 5.0.6-14.	**PLANTS – Soybeans** Discuss with the class the handout/transparency – *Vegetative Growth Stages of Soybeans*. Review the following key terms. **Key Terms and Concepts** In soybeans, most of the vegetative growth and reproductive organ development occur at the same time. The flowers and seed pods form before the leaves and stem finish growing. Most of the soybean varieties grown in the Midwest have this characteristic. 1. **Two-Leaf (Unifoliate) Stage** – The first true leaves of soybeans are single and grow almost opposite of each other on the stems. These leaves are located just above the cotyledons and develop about one week after the cotyledons emerge from the soil. Before the leaves develop, the young soybean plant depends upon food stored in the cotyledons. If the young plant is damaged below the cotyledons, it dies. 2. **Single Trifoliate (Three-Leaf) Stage** – Plants at this stage are usually four to six inches tall. There are three leaves at the end of each leaf stalk (hence the name *trifoliate*). A trifoliate leaf develops on each node joint of the plant. During this stage the first trifoliate leaf completely emerges while the second set of trifoliate leaves develops. The earlier in the growing season the leaves emerge to capture sunlight, the greater soybean yields can be.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	3. **Fourth Trifoliate (Three-Leaf) Stage** – The fourth set of trifoliate leaves emerges when the plant is about nine inches tall and about four weeks old. Branch roots of the plant begin to develop more rapidly and the plant requires more photosynthesis. It also begins to absorb more moisture and nutrients. As the plant matures, the upper leaves begin to shade the lower leaves, reducing photosynthesis by the lower leaves.
	Supervised Activity
Again, set up stations with the appropriate plants or plant models. Distribute the handout – *Plant Growth Data Collection Sheet* on page 5.0.6 - 18.	Inform the students that it is time for the away teams to again visit the planet's surface and investigate the situation. Ask them to visit each of the soybean plant stations set up in class. They should identify the plant growth and development stage represented at each station, and record this and any other observations on the *Plant Growth Data Collection Sheet.* When they have completed this task, it is time for the "debriefing." Ask the students to report their findings to you (the captain).
MORE BRIEFING – Distribute or project the handout/transparency master – *Vegetative Growth Stages of Wheat* on page 5.0.6-15.	**PLANTS – Small Grains** Discuss with the class the handout/transparency – *Vegetative Growth Stages of Wheat*. Review the following key terms. **Key Terms and Concepts** Although corn and soybeans are grown in warmer weather (May through September), most small grain crops (in the Midwest) are grown in cooler seasons. Planting of small grain crops usually takes place in September or October, and harvesting usually takes place in July. This means that most plant growth occurs in colder weather with fewer hours of sunlight. 1. **Tillering (Stooling) Stage** – At this stage in the crown (area just below the soil surface) the stem is very short and compressed and the nodes are still very close together. Both the tillers (side shoots) and roots develop from buds from the underground nodes. Growing points are located at each of these nodes.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms and Concepts *(continued)* 1. **Tillering (Stooling) Stage** *(continued)* These growing points eventually elongate and increase plant height. If frost or hail damages the plant, it is beneficial if some nodes are still underground. Small grain crops can survive extensive leaf damage if all growing points are not killed. However, plant maturing is delayed if the leaves are extensively damaged. *CONDITIONS AFFECTING TILLER GROWTH* a. *Planting depth* – If the seed is planted at the normal depth of 1 to 1 1/2 inches, the second or third node usually produces the tillers. If the seed is planted deeper – more than 3 inches – the second and third nodes usually remain dormant. b. *Planting rates* – Seeds planted too closely together result in reduced tillering. c. *Seed size* – Plants grown from larger seeds may produce more tillers than plants grown from smaller seeds. d. *Variety* – Some plant varieties genetically produce more tillers. e. *Planting time* – Cooler, early-season soil and air temperatures generally produce more tillers. f. *Soil moisture* – Sufficient soil moisture increases tillering, and dry soil reduces tillering. 2. **Jointing Stage** – This stage is marked by rapid growth. Internodes (just above the nodes) begin growing: the lowest internode elongates first, and the remaining internodes follow in order. Combined growth of these internodes causes the leaves to spread apart along the stem. The plant is very delicate at this stage and can be damaged by hail or freezing temperatures. 3. **Boot Stage** – The plant continues to grow rapidly. Leaves are comprised of two parts – the *blade* or *flag* (upper part) and the *boot* or *leaf sheath* (lower part). The boot surrounds the emerging seed head. Later, the flag leaf surrounds the seed head as it grows. When the flag leaf surrounds the seed head, plant growth is almost complete.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Again, set up stations with the appropriate plants or plant models. Distribute the handout – *Plant Growth Data Collection Sheet* on page 5.0.6 - 18.	**Supervised Activity** Inform the students that it is time for the away teams to investigate the situation on the planet's surface. Ask them to visit each of the small grain plant stations set up in class. Ask the teams to identify the plant growth and development stage represented at each station. They should record the stage and any other observations on the *Plant Growth Data Collection Sheet*. When they have completed this task, it is time for the "debriefing." Ask the students to report their findings to you (the captain). **Interest Approach** At this point, remind the class that they are still acting out the following scenario: "You are Agriscience Specialists on board the *U.S.S. Enterprise-D* (from the television show *Star Trek: The Next Generation*). The Federation sent you in response to a plea from a planet whose entire *non meat-eating* population is starving. Our mission is to help save the planet by devising a method to feed this planet's population. I, as the captain of the ship, have decided to send away teams to the planet to investigate the problem."
Write the problem statement on the board. Again, divide the students into "away teams" consisting of three students with the same responsibilities as before. BRIEFING - The teams must be briefed on the influence of temperature on plant growth. Distribute or project the handouts/ transparencies *Rates of Photosynthesis and Respiration Affected by Temperature* and *Temperature Variations Affect Plant Growth* on pages 5.0.6-16 and -17.	***HOW DOES TEMPERATURE INFLUENCE PLANT GROWTH?*** Now discuss the following questions with the class: 1. Now that we know how plants grow, what role do you think climate plays in determining which plants grow on the planet below? 2. Since this planet's population has little experience with agriculture, what do they need to learn about temperature? **PLANTS THEMSELVES – Corn and other Plants** Discuss with the class the handouts/transparencies – *Rates of Photosynthesis and Respiration Affected by Temperature* and *Temperature Variations Affect Plant Growth*. Review the following key terms.

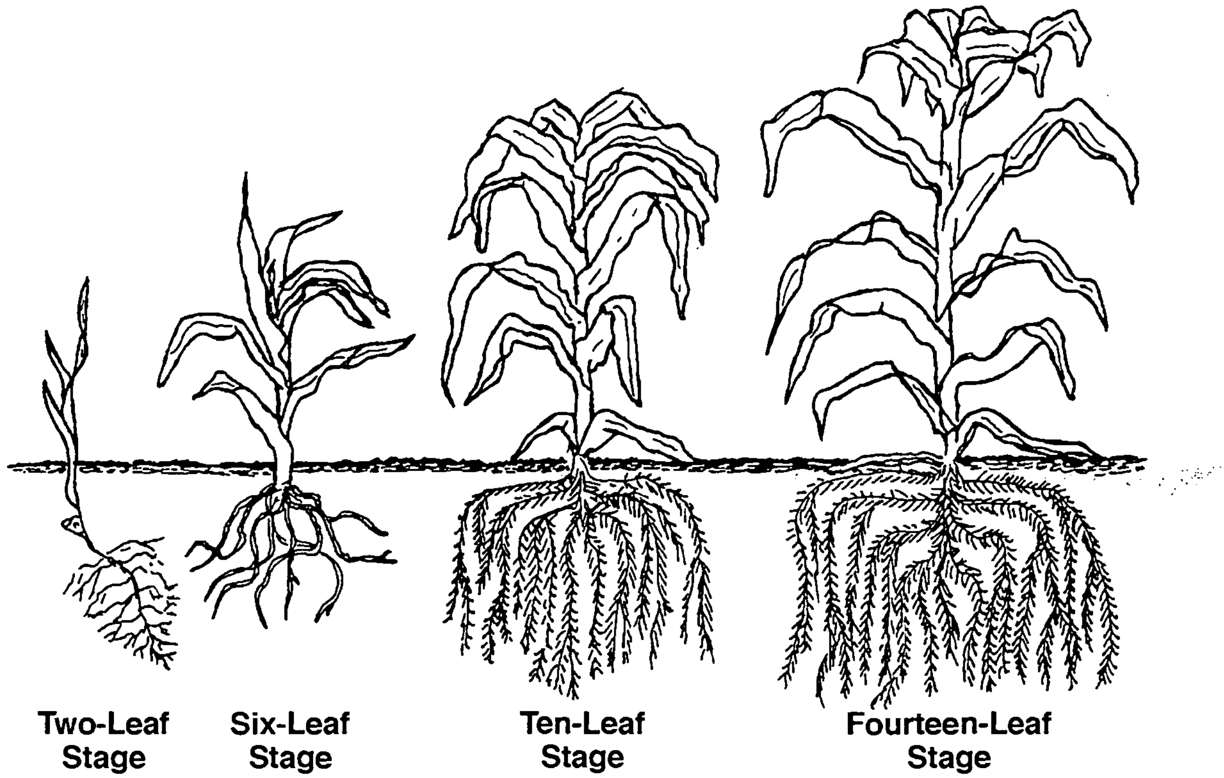
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms and Concepts Both air and soil temperatures affect the rate at which plant processes take place. Air temperature affects the rates of photosynthesis, respiration, and transpiration. Soil temperature affects the rates of respiration and root absorption. 1. **Photosynthesis** – Process in which the chlorophyll in green plants enables them to use light as an energy source to manufacture sugar from carbon dioxide and water. 2. **Respiration** – Process in which living cells take in oxygen and give off carbon dioxide. 3. **Temperature Affects the Rates of Photosynthesis and Respiration** – Plants grow rapidly at certain times and little, if any, at others. Temperature and sunlight affect *when* plants grow and *at what rates*. The plant growth steps are controlled by the rates of photosynthesis and respiration, which are influenced by temperature. Plant growth is most affected during daylight hours when the temperature is between 55 and 85°F. During this time photosynthesis takes place at a rapid rate. Although photosynthesis and respiration both take place at the same time during the day, respiration is slower. Only respiration occurs during the nighttime hours. During the day more food is manufactured through photosynthesis than is used by respiration, thus the plant grows. However, during the night, no food is manufactured, but respiration continues. Therefore, the plant decreases in weight. But plant growth during the day is greater than weight loss during the night because the respiration process is slower than the photosynthesis process between 55 and 85°F. During hours of darkness, only respiration occurs. If the temperature is 85 - 95°F, the plant could use up all the food it manufactured during the daylight hours. In order for growth to occur during the daylight hours, the "break even" rate of photosynthesis must be four times that of respiration. To have enough "extra" food to overcome the continuous use by respiration, the rate of photosynthesis must be eight times that of respiration.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms and Concepts *(continued)* 4. **Transpiration** – Process in which a plant loses water vapor. 5. **Temperature Affects the Rate of Transpiration** – High temperatures have a major effect on transpiration rates in plant leaves. The amount of moisture available and the leaf characteristics (stomatal action) also determine the rate of transpiration. 6. **Absorption** – Process of taking in or sucking up: a sponge-like action. 7. **Temperature Affects the Rate of Absorption** – For most plants, soil temperatures below 55°F greatly slow the rate at which plant roots absorb water from the soil. This occurs because low temperatures increase resistance to water movement through the roots. This resistance is caused by the following: a. lower permeability of the roots b. increased viscosity (thickness) of the soil solution c. lower rates of respiration (respiration is necessary for absorption to take place) 8. **Growing-Degree Units** – This is a system used for measuring the heat (thermal) units available for crop growth. The traditional method of rating corn hybrids is "days of maturity." When this is calculated, you know approximately when to harvest a crop. However, temperatures can affect the growth rates of certain hybrid plants. So, a hybrid rated for 120 days may be ready sooner in one part of a state than in another part. These "growing-degree units" represent more accurately the development of a crop from one region to another. *Note:* this system is not as accurate during very hot, dry weather. A large number of growing-degree days are produced during this type of weather; but without enough water, corn plants cannot take full advantage of them.

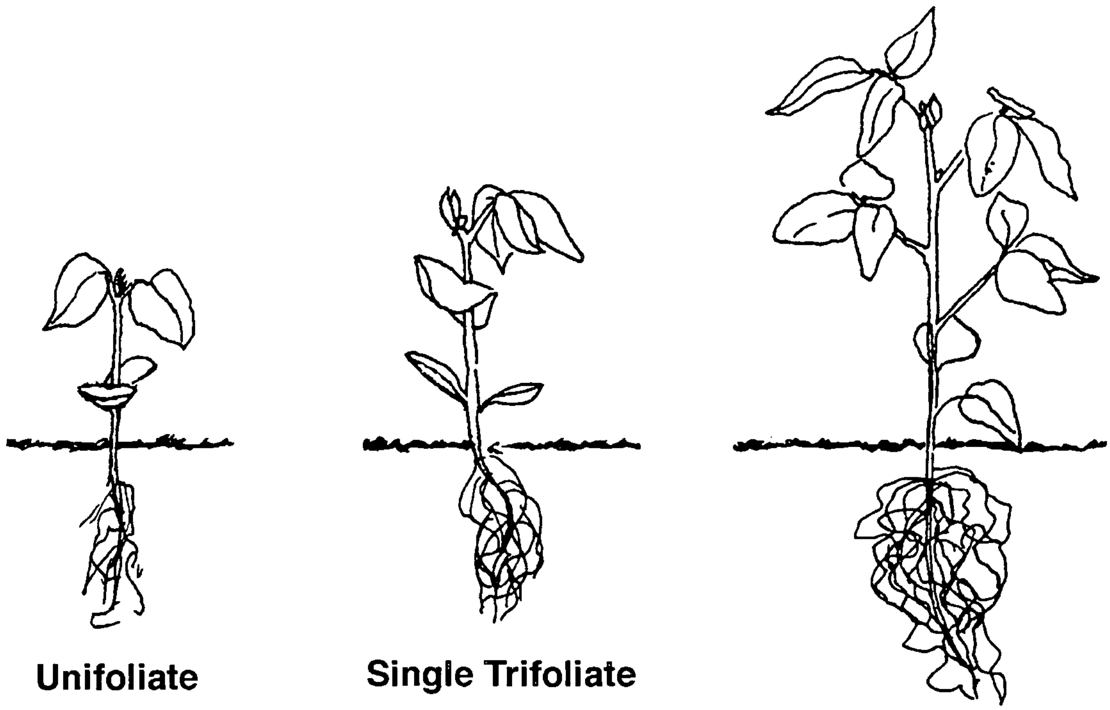
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms and Concepts *(continued)*
Show the transparency – *Temperature Variations Affect Plant Growth* on page 5.0.6-17.	9. **Importance of Temperature to the Plant** – Temperature affects the functioning of enzyme systems in growing plants. At low temperatures, enzyme systems do not function; thus, no growth occurs. At high temperatures, enzyme systems break down; thus, growth stops again. At extremely high temperatures (above 130°F) the plant dies. Growth completely stops when the maximum or minimum temperature is passed.
The briefing continues with more information concerning the tasks the away teams face. Set up one station for each different region on the planet. Each region is known for its varied climate (e.g., U.S. Midwest or West Coast) Use *Regional Description Information - Temperature Influence on Plant Growth* handouts on pages 5.0.6-21 to -25. Use the appropriate plants or plant models. You can add or delete information related to the regional description. There is also a blank sheet provided on page 5.0.6-19. Also include a brief description of the region at each station. Include the high and low temperature for a 24-hour period. The formula for calculating growing-degree days must be at each station (see handout – *Example for Calculating Growing-Degree Days* on page 5.0.6-20.)	**Additional Information** ***Facts*** – The inhabitants of the planet are starving. They have been given corn seed to plant. This must sustain them until other seeds are transported from another planet. The "Federation" has two additional unknown types of seed available. These seeds have an optimal growth base temperature of 40. They want the seeds identified by the time the away teams return with their reports. These unknown seeds must not be used by the planet inhabitants unless the planet's growing-degree days and regional descriptions match those needed by these particular types of seed. Therefore, the away teams must calculate the growing-degree days for the unknown seeds. They have a time limit – the following mission must be completed in one day: "*Seek all information available. Calculate and determine which region on the planet is most suitable to the rapid growth of corn. Accuracy is essential. All away teams are to travel to each station (region) on the planet and record their findings.*"

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
After the students have visited the stations, recorded their observations, and made their recommendations, collect the information sheets and grade them as a cooperative group activity. *OR* Draw conclusions to questions using Possibilities Factors problem-solving approach (do not use template as a handout).	**Activity** Ask the away teams to visit all the stations and record their observations on the Regional Information Sheets. Inform them that an oral debriefing is required upon completion of the mission. At that time the away teams must come to an agreement regarding which plants can be successfully grown on the planet and in which region.

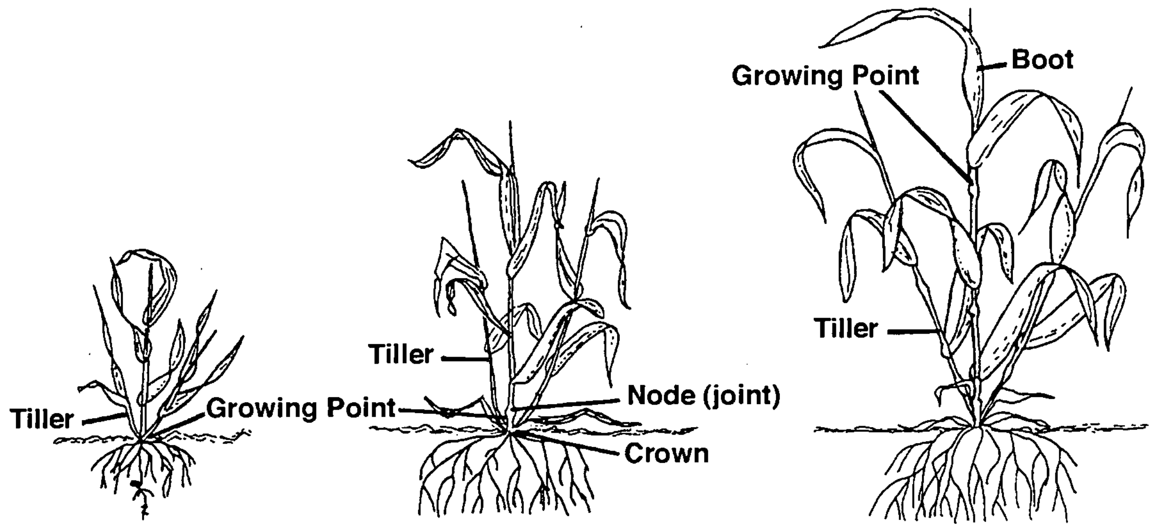
VEGETATIVE GROWTH STAGES OF CORN



VEGETATIVE GROWTH STAGES OF SOYBEANS

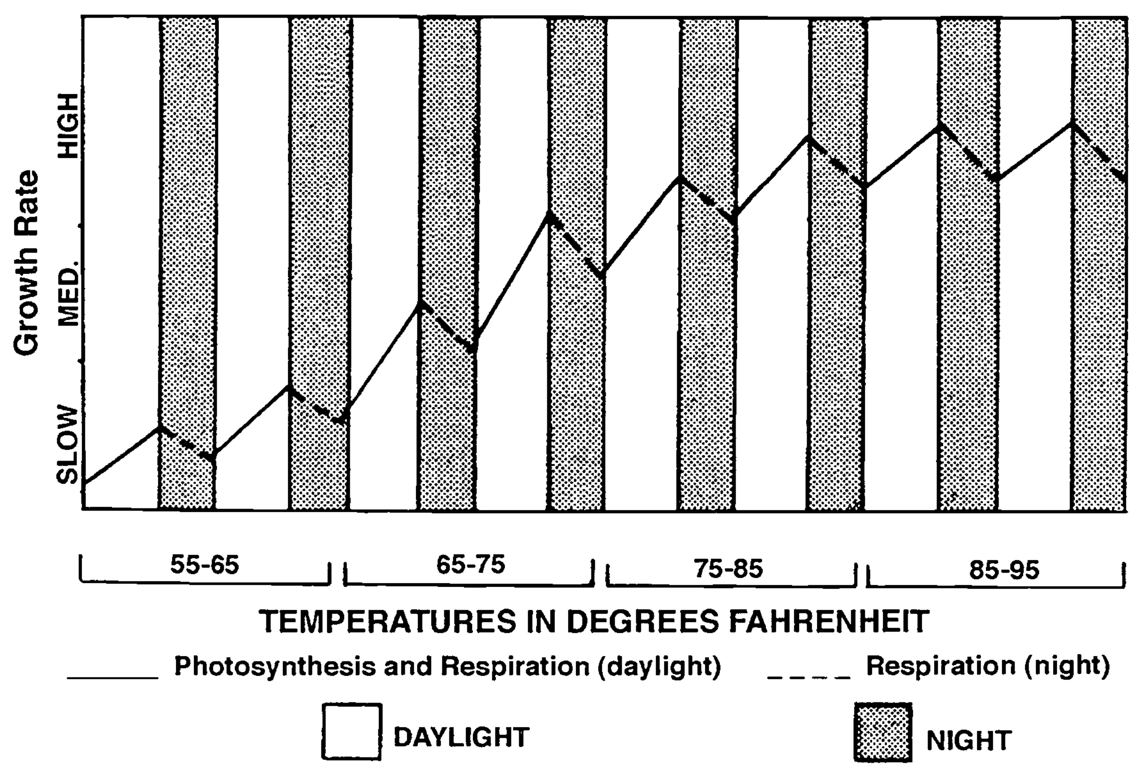


VEGETATIVE GROWTH STAGES OF WHEAT

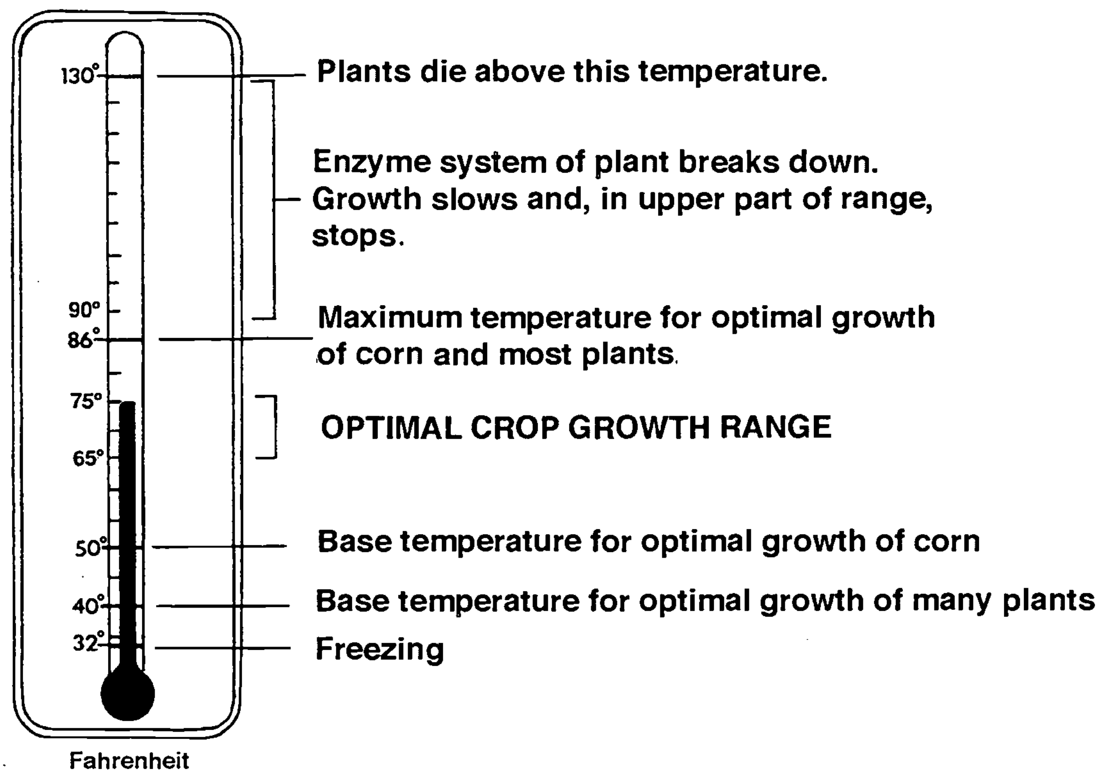


TILLERING STAGE   JOINTING STAGE   BOOT STAGE

RATES OF PHOTOSYNTHESIS AND RESPIRATION AFFECTED BY TEMPERATURE



TEMPERATURE VARIATIONS AFFECT PLANT GROWTH



Plant Growth Data Collection Sheet

STATION # ________ AWAY TEAM # ______

1. Type of plant encountered

2. Plant height

3. Number of leaves

4. Description of leaves present

5. Description of existing root system

6. Additional observations

Regional Information Sheet

Temperature Influence on Plant Growth

STATION # ________ **AWAY TEAM #** ____

1. Potential seeds to be planted in region
   - *Corn*
   - *Unknown #1* ________________________________
   - *Unknown #2* ________________________________

2. Temperature for 24-hour period

3. Observations of the region *(give brief description)*

4. Calculations – Growing-Degree units *(days)*

Calculation for Corn	**Calculation for Unknown #1**	**Calculation for Unknown #2**
Base Temperature = _____	Base Temperature = _____	Base Temperature = _____

5. Findings and Recommendations

430

Example for Calculating Growing-Degree Days

STATION # ________ AWAY TEAM # ____

Growing Degree Units for Corn

Growing-degree units are used as a measure of corn growth and maturity because corn is greatly affected by temperature during the growing season. Growing-degree units reflect both temperature and time.

The following procedure is used to calculate growing-degree units for corn.

1. Record the highest and lowest temperatures for a 24-hour (one-day) period.

   (Note: Most agronomists suggest restricting high and low temperature calculations for growing-degree units to a high of 86°F and a low of 50°F)

   When calculating growing-degree units with temperatures above 86°F, use the number 86. When calculating growing-degree units with temperatures below 50°F (in early spring), use the number 50.

2. Add the highest and lowest temperatures and divide by 2. This is the mean (average) temperature for the day.

3. Subtract the base temperature from the mean temperature.

   (For example, if the crop is corn, subtract 50 for the 50°F base temperature for corn.)

   EXAMPLE (for corn)

   Calculations for growing-degree units for a 24-hour period when the temperature is:

   High = 80°F

   Low = 60°F $\qquad \frac{80 + 60}{2} = 70$

   70 - 50 = **20** growing-degree units or growing-degree **days**

Regional Description Information

Temperature Influence on Plant Growth

STATION # 1 **AWAY TEAM # ____**

1. Potential seeds to be planted in region
   - *Corn*
   - *Unknown #1*____
   - *Unknown #2*____

2. Temperature for 24-hour period: *92°F high, 62° low*

3. Observations of the region: *Region resembles central Ohio.*

Regional Description Information

Temperature Influence on Plant Growth

STATION # 2 **AWAY TEAM # ____**

1. Potential seeds to be planted in region
   - *Corn*
   - *Unknown #1*______________________________
   - *Unknown #2*______________________________

2. Temperature for 24-hour period: *60°F high, 44°F low*

3. Observations of the region: *Temperate climate. Adequate to over-abundant rainfall for most plants. Can rain for periods of 3 to 4 days at a time. Region is subject to abrupt weather changes caused by offshore winds.*

Regional Description Information

Temperature Influence on Plant Growth

STATION #3 **AWAY TEAM # ____**

1. Potential seeds to be planted in region
   - *Corn*
   - *Unknown #1*____________________________________
   - *Unknown #2*____________________________________

2. Temperature for 24-hour period: *122°F high, 75° low*

3. Observations of the region: *Mountains surround region. It is arid with little water. Plants tolerate long periods without rain; snow during cold season supplies most of the water.*

Regional Description Information

Temperature Influence on Plant Growth

STATION #4 **AWAY TEAM # ____**

1. Potential seeds to be planted in region
   - *Corn*
   - *Unknown #1*________________________________
   - *Unknown #2*________________________________
2. Temperature for 24-hour period: *52°F high, 22° low*
3. Observations of the region: *Region is covered with snow nine months of the year. Weather pattern is affected by the jet stream. Rainfall is abundant. Region is very lush and green during the hot season. Climate is humid when hot. There is lots of moisture in the air.*

Regional Description Information

Temperature Influence on Plant Growth

STATION #5 **AWAY TEAM # ____**

1. Potential seeds to be planted in region
   - *Corn*
   - *Unknown #1*________________________________
   - *Unknown #2*________________________________
2. Temperature for 24-hour period: *72°F high, 40° low*
3. Observations of the region: *Tropical region with lots of rain. Temperature is stable throughout the year, it stays within 20°F of high and low range. Region is surrounded by lakes, valleys, and rolling hills.*

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How does temperature influence plant growth?

(Use Away Team Activity to gather data.)

Factors to Consider	Possibilities (Possible Solutions)				
	Station 1	**Station 2**	**Station 3**	**Station 4**	**Station 5**
Types of Seed(s) 1. Corn 2. Unknown #1 3. Unknown #2					
Temperature *(See calculation on page 5.0.6-20.)*					
Regional Observations					

Decision/Recommendation

Which stations(s) are the most likely regions to optimally grow plants?

Helping Students Apply Concepts/Principles/Skills

Use cooperative groups and experiment data observations/collection to enable learners to apply the concepts and principles presented in this lesson. Also incorporate lectures, discussions of methods, and problem-solving technique to reinforce lesson content.

Evaluating Student Learning

After learners have identified and described principles of vegetative growth stages of plants and described the influence of light on plant growth, ask them to calculate temperature influence on plant growth presented in data collection handouts.

This activity was submitted by Darrell Rubel, Department of Agricultural Education, The Ohio State University, Columbus, Ohio.

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Office Hours M-F: 7:30 am to 4:30 pm

Program AGRISCIENCE

Unit 5 - Plant Science

Describe Effects of Tropisms on Plant Growth

Competency/Terminal Performance Objective

5.0.7: Given examples of each, describe the effects of tropism on plant growth, based on criteria outlined in assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.7.1 Given example conditions, predict plant growth patterns under specific conditions, based on criterion assessment instrument.

5.0.7.2 Given examples of mechanisms, describe those that enable plants to respond to stimuli, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

Activity 1

1. corn seeds
2. 4 light-proof cardboard boxes
3. 2 cardboard boxes open at the top
4. 2 pcs. of medium mesh screen wire (4" x 4")
5. small piece of cardboard (approximately 5" x 5")
6. four 4" pots
7. chlorine bleach, 5 percent solution
8. straight pins
9. plastic bags
10. absorbent cotton or paper towels

Activity 1

1. *Wisconsin Fast Plant Manual,* Investigation II
2. 5-day-old R.C.B. seedlings
3. planting containers with planting media
4. light bank for growing plants
5. dark area for growing plants (e.g., solid-sided cooler)
6. science flow chart and illustration of plant

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 1 **Interest Approach** Show students plants and/or root systems of plants that have shown tropism responses. For example, show several young tomato plants that have grown toward window light. Why does the plant grow toward the light? What causes the plant to bend? How do plants respond to light, water, and gravity? If time permits, grow an indoor plant in a large container for one to two months. During this time, water only one side of the plant/soil mixture. After several months, remove the plant from the soil and examine the root system. Be sure to notice how the plant was positioned in the container. Ask students why the root system of this plant developed as it did.
See page 5.0.7-7 for example. Use page 5.0.7-8 for student's copy.	**Procedure** *Geotropism* 1. Soak corn seeds in a 5 percent solution of bleach for 30 minutes to kill any mold spores attached to the seeds. 2. Soak the seeds in water overnight. 3. Select four seeds and pin to a piece of cardboard so the point of one seed is down, one has the point to the right, one to the left, and one up. 4. Label the cardboard and place in a plastic bag with two folded, moist paper towels at the bottom. 5. Hang the bag in a dark place to avoid any influence of light. 6. After germination has begun (two days), inspect the card daily. 7. Record your observations of the direction of growth of both the root and the stem.
Use the information on page 5.0.7-9.	**Data Summary and Analysis** For the geotropism experiment have students sketch the orientation of roots and shoots at 2, 5, and 7 days after germination.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
See page 5.0.7-10 for example. Use page 5.0.7-11 for student copy.	**Procedure** *Phototropism* 1. Plant several corn seeds in four small pots and allow to grow until the shoots are visible. 2. Take four light-proof boxes and make a small window at a different place in each box (top, bottom, right, and left side). Line each box with black paper or spray with black paint. 3. When the corn shoots have emerged, place one pot in each of the four boxes. 4. Observe the plants every two days. 5. Record notes on the size, orientation, color and leaf shapes of the plants.
	Data Summary and Analysis For the phototropism experiment observations should be recorded in a table similar to the one on Page 5.0.7-?. Record observations every two days.
See page 5.0.7-12 for example. Use page 5.0.7-13 for student's copy.	**Procedure** *Hydrotropism* 1. Make a hole in the bottom of a box and place screen wire over it. 2. Put 1/2 inch of soil in the box and plant two or three corn seeds. 3. Cover with 1/2 inch of soil and keep moist. 4. Place the box over a dry dish or saucer. 5. Prepare a second box by duplicating steps 1-3. 6. Place the box over a dish of water so that the water comes to within a quarter inch of the screen. 7. Compare the direction of growth of the roots for each box. 8. Record your observations.
	Data Summary and Analysis For the hydrotropism experiment students should observe the screens daily to mark when roots of the germinating seeds grow through the screen. The roots should be observed every two days thereafter and notes made on root size and shape. The final observation should be made on day seven.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *amyloplasts* - colorless subcellular particles containing starch grains that influence the direction of plant growth 2. *apex*- the pointed tip of a leaf 3. *auxin* - a growth-regulating substance produced either naturally by plants or synthetically 4. *coleoptile* - a protective sheath surrounding the emerging shoot of grass seedlings 5. *geotropism* - growth response of a plant to the force of gravity 6. *homeostatic* - having a relatively stable state of equilibrium between different but interdependent elements of an organism 7. *hydrotropism* - orientation involving growth or movement of a plant organ, especially the roots, in response to the presence of water 8. *phototropism* - a growth-mediated response of a plant to stimulation by visible light 9. *pigment* - any coloring matter in plants 10. *statocytes* - plant cells that function to control the direction of growth by perceiving gravitational forces; contain amyloplasts 11. *tropism* - response of a plant organ or part to an external stimulus, usually in the direction of the stimulus

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Refer to *Wisconsin Fast Plant Manual*, "Investigation II." Set up light and dark growing areas (e.g., light bank and solid-sided cooler). Provide a science flow chart to assist students in following the science principles. Use it as the assessment instrument. Show a transparency illustrating cell elongation as it relates to gravity.	ACTIVITY 2 **Procedure** Consider the question "Why do plants grow upwards?" 1. Devise an experiment that will answer this question. Be certain to include a hypothesis. 2. Plant each seedling in a container filled with planting media. 3. Place two plants in a light growing area (light bank); place two plants in a dark growing area (cooler). Water as needed. 4. Check the plants 24 hours later. Use a protractor to measure the degree of tropism effect.
See page 5.0.7-14 for example. Use page 5.0.7-15 for student copy.	**Data Summary and Analysis** Record your observations. Answer the question "Why did the plants respond in this way?" Draw a diagram depicting how tropism affects cell elongation and consequently plant growth.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How do germinating seeds and plants respond to gravitational forces?

Factors to Consider	Possibilities (Possible Solutions)			
	Seed 1	Seed 2	Seed 3	Seed 4
2 days				
5 days				
7 days				

Decision/Recommendation

Geotropism

Plant roots are positively geotropic while stems are negatively geotropic. Regardless of the position of the embryo (located at the pointed end of the kernel), the roots will grow down and the stems up. In this experiment light must be controlled so that phototropic effects are not present.

• Possibilities - Factors •

Problem-Solving Technique

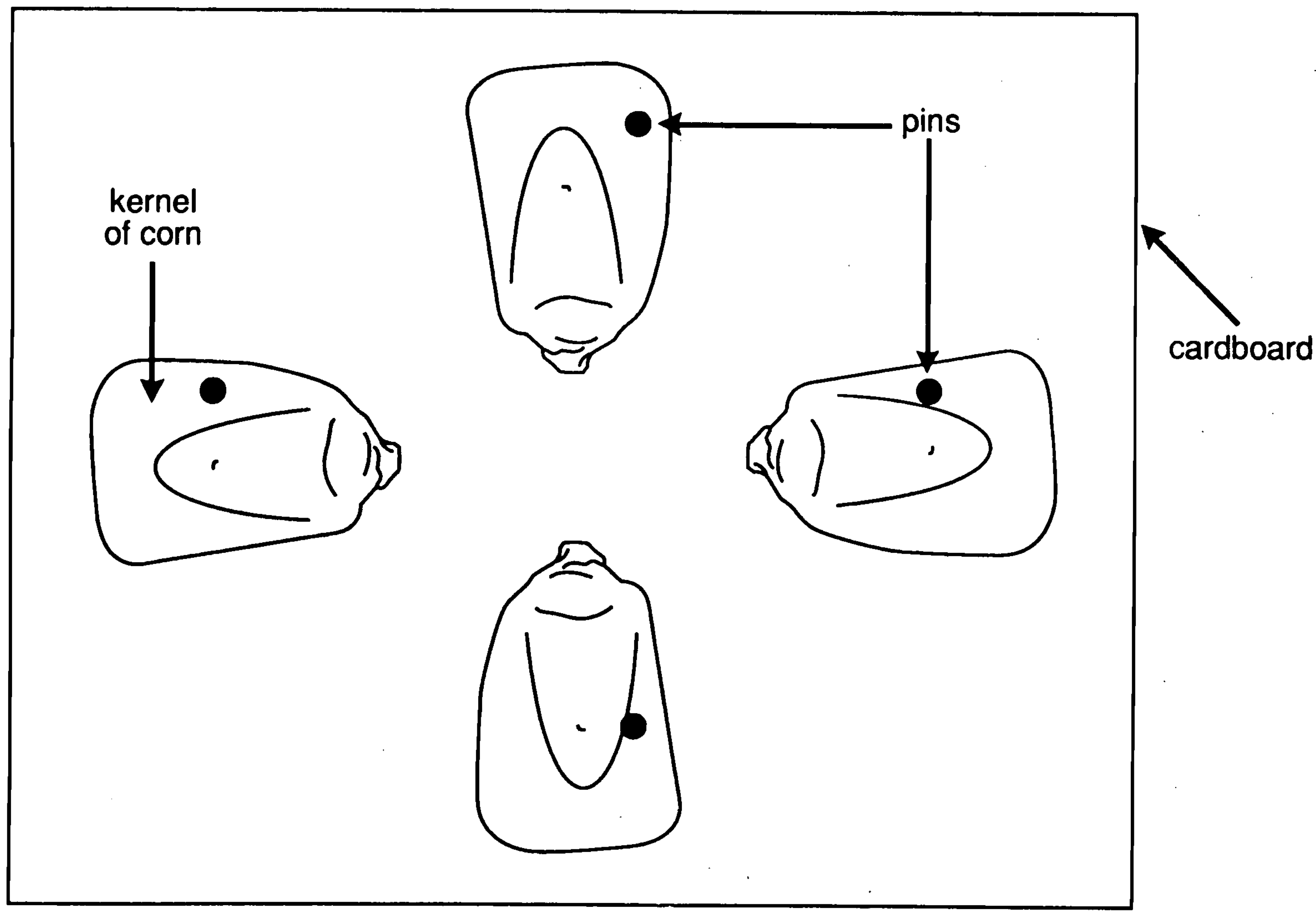
Define the problem

How do germinating seeds and plants respond to gravitational forces?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Geotropism Experiment



• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How do germinating seeds and plants respond to light sources?

Factors to Consider	Possibilities (Possible Solutions)			
	Pot 1	Pot 2	Pot 3	Pot 4
Postion of Light Source				
Size				
Orientation				
Color				
Shape				

Decision/Recommendation

Phototropism

Plants are positively phototropic – they grow toward a source of light. The shoots of corn will bend in the direction of the opening on the box that allows light to enter.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How do germinating seeds and plants respond to light sources?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

• Forked Road •

Problem-Solving Technique

Define the problem

How do germinating seeds and plants respond to water sources?

Factors to Consider	Choice one	Choice two
	Box 1	**Box 2**

Decision/Recommendation

Hydrotropism

The roots will start growing downward in the normal way in response to the pull of gravity, geotropism. However, when the roots placed over the dry dish have grown through the screen they turn to the side seeking water. The roots in the box placed over the dish of water will grow downward into the water. This experiment illustrates that the attraction of roots towards water is greater than the attraction of gravity. In other words, hydrotropic responses are greater than geotropic responses.

• Forked Road •

Problem-Solving Technique

Define the problem

How do germinating seeds and plants respond to water sources?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

• Effect-Cause •
Problem-Solving Technique

Define the problem
Why do plants grow upwards?

Possible Causes	Related Facts	Accept/ Reject Cause
Light reaching plant from top and sides (light bank)		
Light reaching plant from top only (solid-sided cooler)		

Decision/Recommendation
The foliage on the plants growing in the light bank will spread out, growing in all directions toward the light source. The foliage on the plants growing in the dark area will stretch upwards, toward the light source.

• **Effect-Cause** •
Problem-Solving Technique

Define the problem
Why do plants grow upwards?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Activity 1

Both the aerial and underground parts of a plant have been found to respond to certain environmental stimuli. Placement of seed in soil or growing media is primarily a question of spacing and depth. The grower need not worry about the orientation of the seed (right side up, sideways, etc.). Seeds will adjust the direction of growth of shoots and roots to align with gravitational forces. However, other forces may be stronger, causing the direction of growth to be altered.

Plants also grow toward light sources, if the light provided does not illuminate the entire plant. Fortunately, in outdoor growing conditions the sun provides a source of light that strikes practically all foliage parts of the plant during a single day. In greenhouse settings the artificial lighting used must replicate the coverage ability of natural sunlight as much as possible, or undesirable plant growth patterns will result. The same is true for houseplants that receive artificial light or that are placed near windows. In a similar way, plant roots tend to grow toward water, which has important implications for growers. Watering anywhere in and around the root zone of a plant will ensure that the plant will take up available moisture from the soil. Thus, watering sites need not be so precise for most plants or irrigated crops. Further, in dry conditions, healthy plants will be more apt to survive, because their root systems will be more likely to seek out and absorb available soil water.

Ideas for Additional Experiments

1. Further investigation of geotropism can be conducted by rotating the cardboard with mounted seeds. Try rotating one quarter turn every two hours. Vary the time between rotations and use multiple cardboard mounts to observe geotropic responses for all mounts simultaneously. Use of some damaged seed will also provide interesting results.
2. The light sensing point of the plant is another dimension that can be investigated. For a number of seedlings place opaque material (paper) around various locations of the shoot, from the tip down to the soil surface. Place all seedlings in the same location, where the same light source is received by all plants. Observe the phototropic responses of the seedlings.
3. The location and spacing of light sources in the greenhouse can be varied to determine the effects on plant growth patterns.
4. Try other experiments on hydrotropism by altering the location of the water and the distance from the plant root system.

Helping Students Apply Concepts/Principles/Skills

Activity 2

The ability to describe the effects of tropism on plant growth is relevant in today's horticulture field because indoor and outdoor plantscapes are affected by light and gravity. For example: plant caretakers must continually rotate plants away from the light source to keep the plant from bending and to keep the attractive part of the plant toward the viewer.

Evaluating Student Learning

After students have competed the experiment, have them record their data on pages 5.0.7-18 and -19.

Portions of this activity were submitted by Ashley Swonger, Agricultural Education Instructor, Ridgedale High School, Morral, OH 43337. Other portions were adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	Results

NOTES

Conclusions

Program AGRISCIENCE

Unit 5 - Plant Science

Identify Plant Nutrient Requirements

Competency/Terminal Performance Objective

5.0.8 Given standard elemental nutrients, identify plant nutrient requirements based on criteria outlined in assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.8.1 Given standard elemental nutrients, provide all names and chemical symbols of plant nutrients according to criterion assessment instrument.

5.0.8.2 Given specific nutrients, identify nutrient functions and their effects on plant growth based on functions outlined in notes provided.

5.0.8.3 Given nutrient groups, classify nutrients according to amounts used by plant based on nutrient group definitions provided.

5.0.8.4 Given example deficiencies, identify major plant nutrient deficiencies as outlined in the notes provided.

5.0.8.5 Given nutrient requirements, identify plant nutrient sources filling those requirements on an assessment instrument.

5.0.8.6 Given major mineral types, identify mineral functions associated with plant nutrition based on criterion assessment instrument.

5.0.8.7 Given examples of mineral sources, identify mineral sources based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative material
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
1.0.11 Differentiate facts and opinions
1.0.14 Explain cause-and-effect relationships
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
2.0.18 Use written language to express oneself clearly
2.0.19 Use appropriate punctuation
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
3.0.8 Draw inferences and conclusions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.1.1 Round and/or truncate numbers to designated place value

1.1.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations

1.1.3 Compare order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)

1.1.4 Estimate, apply, and solve problems involving fractions, decimals, percentages and real numbers

1.1.5 Set up, solve, and apply rations and proportions

1.1.6 Solve problems and make applications involving integers, fractions, decimals, percentages, ratios, and proportions

1.1.7 Translate written and/or verbal statements into mathematical expressions

1.1.8 Estimate answers

2.1.2 Compute using appropriate units of measurement

2.1.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate

3.1.1 Interpret and use tables, charts, maps, and/or graphs

3.1.2 Identify patterns, note trends, and/or draw conclusions from tables, charts, maps and/or graphs

3.1.3 Collect and organize data into tables, charts, and/or graphs

3.1.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. Chalkboard or overhead projector and blank transparencies
2. Plant specimens: some with visible nutritional deficiencies; some with no visible deficiencies. Color photographs or 35 mm slides can be substituted.
3. Wisconsin Fast Plants™, *Brassica rapa* seeds, or radish seeds
4. Growing containers or growing bottles and associated items
5. Complete nutrient and nutrient minus N, P, K and trace element packets
6. Vermiculite potting media
7. Fluorescent light source
8. Plant container labels
9. Forms for recording growth characteristics and conditions
10. *The Nursery Worker - Student Manual* – Available from the Curriculum Materials Service
11. *Field Crop Nutrition - Student Manual* – Available from the Curriculum Materials Service

Situation

Conduct this activity with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Prepare various plant samples: some with obvious nutritional deficiencies, some healthy without deficiencies. Color photographs or slides can also be used.	**ACTIVITY 1** **Interest Approach** Present the plant specimens, photographs, or slides to the class. Ask the students to compare the healthy specimens to those with nutrient deficiencies. Discuss the differences in size, color, and general appearance between the deficient and non-deficient plants. Explain that plants – like people and animals – must receive a diet containing certain foods (nutrients) to be healthy. If this diet does not contain the needed nutrients, the plants may become sick or diseased, not grow properly, and in extreme cases – die.
On the chalkboard or overhead projector, list the students' responses to question 3. Use this list as the beginning of a Possibilities-Factors chart (see page 5.0.8-5) and student chart (see page 5.0.8-6).	Ask the class these questions: 1. What are some nutrients that humans or animals need to be healthy and grow well? 2. What nutrients may have been deficient in the plants we observed? 3. What nutrients do plants need to prevent deficiency? (*possible responses*) a. fertilizer b. nitrogen c. water d. phosphorus e. potassium f. minerals **Presenting the Lesson** *Define the Problem*
Discuss the certain characteristics or conditions which are present in healthy people or animals (e.g., appropriate growth, high level of energy, or no disease symptoms). Also discuss the conditions or characteristics present in plants receiving the proper nutrition. List these factors on the chalkboard or overhead projector as part of the factors in the Possibilities-Factors chart.	Ask the class this question: 1. What plant characteristics or conditions indicate that the plant is receiving the proper nutrition? (*possible responses*) a. healthy appearance b. good color c. fast growth rate d. appropriate growth height e. high seed production f. hardy – thrives in spite of unfavorable weather conditions

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Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Now ask the class this question: 2. How can we be sure that our list of nutrients needed by plants is complete?
Write the problem statement on the chalkboard or overhead projector. (Parts of this supervised study can be conducted during the following student activity.)	*WHAT NUTRIENTS DO PLANTS NEED?* **Supervised Study** Ask the students to locate the list of essential plant nutrients in the *Field Crop Nutrition* student manual or *The Nursery Worker* student manual. Then ask them to develop a chart of plant nutrients which answers these questions:
See *Field Crop Nutrition* student manual - page 2 and *The Nursery Worker* student manual - page 67.	1. How many essential nutrients are there? 2. What is the elemental name for each nutrient? 3. How can the nutrients be organized according to the relative amount of each needed by plants? 4. What is the source of each nutrient? 5. What is the chemical symbol for each essential element? Now ask the students to develop a second chart which answers these questions:
See *Field Crop Nutrition* student manual - pages 5 to 7 and *The Nursery Worker* student manual - pages 68 to 69.	1. What are the major functions of each essential nutrient? 2. What are the plant deficiency symptoms when nutrients are inadequate or missing?
	ACTIVITY 2 **Student Activity**
For economy, radish seeds can be used with similar results.	At this time, have the class conduct a study of the effects of various nutritional diets on the growth of Wisconsin Fast Plants™, or *Brassica rapa*. *Directions* 1. Establish 5 different nutritional systems in which to place the plants or seeds. One of these systems contains all the essential nutrients. The other four are each lacking a different essential nutrient or group of trace nutrients. 2. Place the plants or seeds in each nutritional system. 3. As the plants grow, record their characteristics or conditions for each of the five systems at various stages of the plants' life cycle. 4. Record data in the Data Record and Observation Sheet on pages 5.0.8-7 to -8. Summarize the data at the completion of the plants' life cycle. Enter these findings in the Factors-Possibilities chart.

Define the problem

What nutrients are needed by the plant for best growth, health, and reproduction?

Factors to Consider	Possibilities (Possible Solutions)				
	Complete Solution (control)	**Solution minus N**	**Solution minus P**	**Solution minus K**	**Solution minus Trace Nutrients**
% Germination (@ 4 days after planting) (Number of plants growing ÷ by seeds planted)					
Plant height (@ 14 days)					
Number of leaves or vegetative mass (@14 days)					
Days to 1st flowering					
Number of seeds produced					

Decision/Recommendation

Ask the students to summarize the effects of the various nutrient systems on plant growth characteristics and conditions.

Ask the students to arrive at one conclusion regarding the nutrient needs of plants. Then answer this question: how do these results relate to information presented in the student manuals used during the supervised study?

• **Possibilities - Factors** •

Problem-Solving Technique

Define the problem

What nutrients are needed by the plant for best growth, health, and reproduction?

Factors to Consider	Possibilities (Possible Solutions)				
	Complete Solution (control)	Solution minus N	Solution minus P	Solution minus K	Solution minus Trace Nutrients

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Have each student plan the nutrient requirements of plants grown as part of an SAE, work experience, or school laboratory project. Use soil test recommendations to determine the nutrient needs of each student's growing media for his or her specific crop. Have each student keep records of the plant growth and production outcomes. Also have the student compare the results with industry standards and explain how well he or she did or did not meet the plant's nutrient requirements.

Evaluating Student Learning

Test each student's ability to describe the 16 essential plant nutrients – by name, chemical symbol, and category of *macro* or *micro*. Each student should also be able to describe the primary function(s) of the essential nutrient and the deficiency symptoms of each.

For a long range evaluation, observe how each student makes use of plant nutrient information when growing plants in an SAE, work experience, or school laboratory project. Each student should be able to provide nutrients to the plants as recommended by soil tests or sources. He or she should also recognize and describe plant nutrient deficiencies when they occur in learning or occupational activities.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**5 - Plant Science**

Demonstrate Hydroponic Plant Growth

Competency/Terminal Performance Objective

5.0.9: Given various hydroponic set-ups, demonstrate hydroponic plant growth, based on conditions described in examples given in assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.9.1 Using data provided, compare growth of plants grown hydroponically with those grown in soil, based on criterion assessment instrument.

5.0.9.2 Given example situations, identify conditions necessary for plant growth in hydroponic solution, based on growth requirements given in assessment instrument.

5.0.9.3 Given specific plant examples, explain advantages of growing plants hydroponically, based on notes provided.

Applied Academics Competencies

Communications:

1.0.2 Select and use appropriate reference sources and illustrative materials.
1.0.4 Determine solutions to problems.
1.0.6 Make predictions about information.
1.0.8 Define words used in context.
2.0.3 Record observations.
2.0.4 Prepare written report(s).
2.0.9 Write legibly.
2.0.13 Use correct grammar.
2.0.14 Use correct spelling.
2.0.15 Write complete sentences.
3.0.1 Demonstrate effective listening skills.
3.0.4 Identify sources of information.
3.0.6 Follow directions.
4.0.3 Participate in discussions.
4.0.12 Use appropriate language.

Applied Academics Competencies *(continued)*

Mathematics:

1.2.1 Round and/or truncate numbers to designated place value.

2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems.

2.2.2 Compute using appropriate units of measurement.

2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.

2.2.4 Estimate measurements.

3.2.6 Use problem-solving techniques.

4.2.4 Use formulas.

5.2.2 Find surface areas and volumes of applicable geometric figures.

Equipment, Supplies, References, and Other Resources

1. aquarium
2. aerator
3. polystyrene (foam board) - one inch thick
4. fertilizer (any complete water-soluble fertilizer with minor elements such as *Rapid-Grow* or *Miracle-Grow*)
5. *Jiffy-7* pellets
6. seeds (small vegetable seeds such as lettuce or spinach)
7. plastic tray (approximately same area as aquarium)
8. soil

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods

Interest Approach

Begin class with a discussion of the problems associated with growing food in outer space to sustain a space station or colony. Have the class make an estimate of the area of land that would be needed to grow enough food to sustain just one person. Calculate the volume of soil necessary to grow that food if conventional methods of growing plants were used in space. Next, calculate the weight of the soil that would need to be boosted into space by weighing a specific volume and multiplying by the total amount of soil. Consider the savings if plants were grown without soil.

In this lab exercise, students will discover that plants can be successfully grown by hydroponics. NASA is currently studying growing wheat hydroponically for applications in microgravity (on space stations).

Procedure

1. Cover the sides of the fish aquarium with a dark material to prevent light from entering. This will prevent algae growth in the nutrient solution.
2. Set the aquarium in a south window to allow the plants to receive full light.
3. Fill the aquarium with nutrient solution. Follow the instructions on the packet label when mixing the nutrient with water.
4. Record the amount of water placed into the aquarium at the beginning and throughout the growth period.
5. Use the aerator to supply the water with oxygen.
6. Expand the *Jiffy-7* pellets by adding water. They will also expand if set in a pan of nutrient solution.
7. Cut holes in the polystyrene board about 6 - 7 inches apart to hold the *Jiffy-7* pellets. Float the polystyrene on top of the solution.
8. Insert the pellets firmly into the holes in the polystyrene board. Plant two seeds in each pellet. If both seeds germinate, pull out one seedling, leaving the healthier one to grow.
9. Keep the tank filled with nutrient solution. The plants will use very little when they are small.
10. Plant the same number of seeds in a plastic tray or second aquarium containing soil.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* 11. Care for the plants by providing proper water and fertilizer. Record the amount of water used during the growth period. 12. Observe plant growth weekly. Record observations such as height, color, etc. 13. Compare plant growth under each condition. Also, compare the amount of water used in each case (be sure to subtract the amount of water left in the aquarium at the end of the experiment).
Use the information on pages 5.0.9-5 and -6 (student copy).	**Data Summary and Analysis** Record plant growth for both the soil and soilless cultures. Record plant height, amount of water added, and plant color. Compare plant growth under each condition.
	Key Terms 1. *water culture* - growing plants hydroponically a. *raceways* - plants float on top of the nutrient solution (or are periodically dipped into it). b. *nutrient film technique* - roots are contained in a plastic film (or trough) through which flows a thin film of nutrient solution. c. *aeroponics* - plants are suspended and a mist of nutrient solution is sprayed at their roots. 2. *gravel culture* - plants are grown in channels that are sub-irrigated from the bottom or in open systems that are trickle irrigated. The gravel is only a plant support medium. 3. *sand culture* - an open system (nutrient solution is not caught and recycled) in which plants are grown in nutrient-free sand and fed by trickle irrigation. 4. *rockwool* - an inert fibrous material produced from heating volcanic rock, limestone, and coke. It is used as a non-recycling system that is trickle fed. Comes in a variety of sizes and forms - the most extensive form of hydroponics.

• Forked Road •

Problem-Solving Technique

Define the problem

Can plants be grown successfully without the use of soil if proper nutrition is maintained in the growing solution?

Factors to Consider	Choice one	Choice two
	Soil Culture	*Soilless Culture*

Decision/Recommendation

In winter it will take 10 to 14 weeks for plants to grow to edible size. In summer, it will take only 6 weeks due to the greater number of daylight hours. To hasten winter growth, an artificial light source may be desirable.

• Forked Road •

Problem-Solving Technique

Define the problem

Factors to Consider	Choice one	Choice two

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Hydroponics is the growing of plants in aerated water containing all the essential mineral nutrients. Most agronomic crops are grown in soil, and plant roots absorb most of their nutrients from the soil as ions. Necessary ions are added to the soil when fertilizers are applied. Dry fertilizers are salts - compounds which ionize in solution. This ionization process is necessary for plants to benefit from fertilizer application.

All mineral nutrients and ions can actually be supplied to the plant in a solution without the presence of soil. In fact, the presence and concentration of essential elements can be more carefully regulated when using a solution of plant nutrients instead of soil. Most hydroponic systems are found in controlled environments - glass or plastic covered greenhouses - which provide temperature control. Several systems have been devised and may vary as to the type of aggregate used and the frequency of nutrient solution use. Some hydroponic systems use the solution once (*open system*) whereas other systems recycle the nutrient solution (*closed system*). Because of the equipment expense, hydroponics is currently used for growing mostly high volume horticultural crops on a limited scale. However, some large installations have been constructed in desert locations in oil-rich countries where cost is not the main consideration.

Ideas for Other Experiments

1. This lab can be expanded by calculating costs associated with the experiment in both situations and researching costs of commercial systems for growing plants hydroponically.
2. Prepare a second tray of soil and water with the nutrient solution used in the hydroponic experiment. Compare with plant growth under the other conditions.

Evaluating Student Learning

After students complete this experiment, have them record their data on pages 5.0.9-8 and -9.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Title ______________________________

Name ______________________ Date __________ Period ______

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 5 - Plant Science

Demonstrate Plant Tissue Culture

Competency/Terminal Performance Objective

5.0.10: Given examples, demonstrate plant tissue culture process, based on conditions described in examples given in assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.10.1 Given example process, explain plant tissue process, based on definitions provided in assessment instrument.

5.0.10.2 Given example situation, perform plant tissue culture, based on procedures given in assessment instrument.

5.0.10.3 Given example hormones, describe effects of growth hormones on plant tissue culture, based on definitions provided.

Applied Academics Competencies

Communications:

1.0.2 Select and use appropriate reference sources and illustrative materials.
1.0.4 Determine solutions to problems.
1.0.6 Make predictions about information.
1.0.8 Define words used in context.
2.0.3 Record observations.
2.0.4 Prepare written report(s).
2.0.9 Write legibly.
2.0.13 Use correct grammar.
2.0.14 Use correct spelling.
2.0.15 Write complete sentences.
3.0.1 Demonstrate effective listening skills.
3.0.4 Identify sources of information.
3.0.6 Follow directions.
4.0.3 Participate in discussions.
4.0.12 Use appropriate language.

Applied Academics Competencies

Mathematics:

1.2.1 Round and/or truncate numbers to designated place value.
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems.
2.2.2 Compute using appropriate units of measurement.
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.
2.2.4 Estimate measurements.
3.2.6 Use problem-solving techniques.
4.2.4 Use formulas.
5.2.2 Find surface areas and volumes of applicable geometric figures.

Equipment, Supplies, References, and Other Resources

1. alcohol (70% solution - ethanol)
2. apple seeds
3. cheesecloth
4. bleach solution (10% solution)
5. *Joy* detergent
6. clear plastic bags (large)
7. distilled water
8. razor blades or scalpels
9. lima bean agar (available from science supply stores)
10. prepare tissue culture medium (available from science supply stores, some contain growth regulators)
11. test tubes
12. petri dishes
13. African violet

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring an African violet to class.	**Interest Approach** Have students pretend they are managing or working in a growing operation. Tell them that you received an order for 1,000 plants like the African violet displayed in class. What methods could be used to produce this number of plants? What problems/challenges would this present for the grower? Can biotechnology play a part in helping us respond to this request? How?
All equipment used in this experiment must be sterilized by autoclaving prior to the class. This can be accomplished by using a pressure cooker at the same rate used for cooking meat or by taking the equipment to an autoclave.	**Procedure** 1. Prepare tissue culture medium (agar) according to directions. Place in test tubes (at least six are needed). 2. Wash hands thoroughly to the elbows with soap. Rinse but do not dry. Swab hands and workplace with 70% alcohol solution (ethanol). 3. Extract six seeds from an apple; wrap them in cheesecloth; place them in a plastic bag; and soak them for five minutes in a 10% bleach solution. 4. Rinse the seeds for five minutes in distilled water to wash away the bleach. 5. Scrape the seed coat from three apple seeds using a single-edge razor blade. Be careful not to cut the pointed end (embryo) of the seed. 6. Soak the scraped seeds in 1% bleach solution for five minutes and rinse in distilled water for five minutes. 7. Transplant the seeds onto sterile lima bean agar, putting one seed in each test tube. 8. Observe the test tubes for five days and record your observations. 9. Prepare tissue culture medium according to directions. 10. Remove one of the shoots from the lima bean agar and place in the tissue culture medium. 11. After roots are formed, transfer the plant to sterile soil. 12. Put transplanted plant into plastic bag to keep the shoots from drying out. 13. Observe plant growth.
Use the information on pages 5.0.10-5 and -6 (student copy).	**Data Summary and Analysis** Observe plant growth in each of the six test tubes for one to two weeks. Record observations every two days. Focus on both qualitative and quantitative data.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *adventitious growth* - growth of new shoots, roots, buds, or leaves from unusual locations 2. *agar* - a gel high in sugar concentration derived from certain algae 3. *callus* - an unorganized, proliferating mass of cells 4. *clone* - plants produced asexually from a single plant 5. *explant* - the part of the plant that is removed and placed in tissue culture 6. *in vitro* - in glass 7. *micropropagation* - plant propagation by tissue culture 8. *plantlets* - small plants developed from tissue culture that are capable of developing into complete plants 9. *sterile* - a bacteria- and fungus-free condition 10. *subculture* - a group of cultured cells or tissues that is transferred to a fresh medium 11. *tissue culture* - the aseptic growth of cells, tissues, or organs in artificial media 12. *totipotence* - the capability of a single cell to develop into an entire plant under proper conditions

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Problem-Solving Technique

Define the problem

How are plants propagated using tissue culture techniques?

Factors to Consider	Choice one	Choice two
	With Coats	*Without Coats*

Decision/Recommendation

Apple seed coats contain compounds which inhibit seed germination until the seed is stored in the cold. This mechanism prevents seeds from sprouting in early autumn and being killed by the winter cold. Seed dormancy is broken by cold temperatures and seeds will germinate in the spring. For example, if the apple used in this experiment has not been exposed to temperatures cold enough to break dormancy, the seeds *with* coats will not germinate, but the seeds *without* coats should germinate in a few days. If the apple was stored for more than a few weeks, then both seeds should germinate at about the same rate.

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Problem-Solving Technique

Define the problem

How are plants propagated using tissue culture techniques?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Plant tissue culture is one form of biotechnology that has already had a dramatic impact on agricultural practice. Theoretically, one piece of plant tissue can produce an infinite number of new plants. Because tissue culture requires a minimum amount of plant material to start with, significant savings can be realized by reducing investments in stock plants and growing facilities. With tissue culture, growers can produce large numbers of stock plants in months instead of years. Development of new crop varieties usually takes four to six years, due to the time required to produce test plants in actual field or growing conditions. Certain trees take up to 10 years to begin producing seed that can then be used in plant breeding efforts.

Plant tissue culture has become an important part of plant breeding programs. As a supplement to traditional plant breeding programs, tissue culture allows scientists to clone the most desirable plants, set these plants in growing areas, and breed them with the complementary parent. The result is a more cost-effective hybrid ready for marketing much sooner. For many years, plants have been cloned by rooting cuttings, layering and grafting. Tissue culture produces the same result with one major advantage: multiplication in tissue culture is much more rapid. Regenerating plants from cells by tissue culture makes it possible to manipulate millions of cells in the laboratory instead of growing millions of plants in the field. Scientists can select superior plants by viewing the genetic material in a cell instead of growing the whole plant. Tissue culture, unlike some other advances in biotechnology, has already become important commercially. For example, tissue culture has been used to eliminate a wide variety of viruses from lilies, carnations, citrus, potatoes, and berries.

Ideas for Additional Experiments

1. Tissue culture can be achieved using other plant parts besides shoots which have been started from seed. You may wish to replicate steps 10 - 14 of the experiment using shoot tips or root tips.
2. Compare the success of the tissue culture as the culture medium is varied.
3. Examine the success of tissue culture using a variety of plant species.

Evaluating Student Learning

After students complete this experiment, have them record their data on pages 5.0.10-8 and -9.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**5 - Plant Science**

Determine Results of Genetic Crosses

Competency/Terminal Performance Objective

5.0.11: Given examples with modes of inheritance, determine results of genetic crosses, based on definitions provided in criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

5.0.11.1 Given example reproduction types, explain relationship between reproduction and plant improvement, based on improvement criteria given in assessment instrument.

5.0.11.2 Given example genetic crosses, recognize relationship between dominant and recessive genes, based on definitions provided.

5.0.11.3 Given trait examples, differentiate hereditary and non-hereditary traits, based on definitions provided.

5.0.11.4 Given specific traits desired, compare selection process, based on criterion assessment instrument.

5.0.11.5 Given example crosses, predict probable results of single- and multiple-trait crosses, based on heritability descriptions given in criterion assessment instrument.

Applied Academics Competencies

Communications:

1.0.2 Select and use appropriate reference sources and illustrative materials.
1.0.4 Determine solutions to problems.
1.0.6 Make predictions about information.
1.0.8 Define words used in context.
2.0.3 Record observations.
2.0.4 Prepare written report(s).
2.0.9 Write legibly.
2.0.13 Use correct grammar.
2.0.14 Use correct spelling.
2.0.15 Write complete sentences.
3.0.1 Demonstrate effective listening skills.
3.0.4 Identify sources of information.
3.0.6 Follow directions.
4.0.3 Participate in discussions.
4.0.12 Use appropriate language.

Applied Academics Competencies *(continued)*

Mathematics:

1.2.1 Round and/or truncate numbers to designated place value.
1.2.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations.
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages).
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers.
1.2.5 Set up, solve, and apply ratios and proportions.
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions.
1.2.7 Translate written and/or verbal statements into mathematical expressions.
1.2.8 Estimate answers.
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems.
2.2.2 Compute using appropriate units of measurement.
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.
2.2.4 Estimate measurements.
3.2.6 Use problem-solving techniques.
4.2.4 Use formulas.
5.2.2 Find surface areas and volumes of applicable geometric figures.

Equipment, Supplies, References, and Other Resources

- Genetic corn (two ears for each group) - 1 ear from a first generation cross between homozygous parents, 1 ear from a second generation cross for two traits

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures:
Interest Approach/Teaching Methods</th></tr>
<tr><td>Interest Approach
Invite a representative from a seed company to speak to the class about the use of progeny information in making plant breeding decisions to develop new varieties of seed.

Use the information on pages 5.0.11-4 and -5 (student copy).</td><td>Procedure
1. Obtain an ear of genetic corn (first generation cross) and identify the varying trait of interest. (e.g., purple and white kernels).
2. Count and record the number of kernels of each color on the ear.
3. Calculate the ratio of expression for the traits being examined.
4. Obtain an ear of genetic corn from a second generation cross and identify the varying traits of interest (e.g., purple, white, starchy, and sweet kernels).
5. Record the number of kernels of each type and color on the ear.
6. Calculate the ratio of expression for the traits being examined.</td></tr>
<tr><td></td><td>Data Summary and Analysis
Have students construct a table for recording the kernel counts for the traits under investigation. Combine group data and calculate class averages for the expression of the traits being investigated.</td></tr>
<tr><td></td><td>Key Terms
1. allele - dominant or recessive form that a gene may take.
2. Chromosome Theory of Heredity - genes are located on chromosomes.
3. dominant trait - genetic trait that dominates or prevents the expression of the recessive trait.
4. gametes - sex cells, sperm, and eggs.
5. gene - unit responsible for transmitting hereditary traits.
6. zygote - fertilized egg resulting from the union of a sperm and egg.</td></tr>
</table>

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Problem-Solving Technique

Define the problem

How are traits inherited from parents to offspring?

Factors to Consider	Choice one	Choice two
	First Generation Cross	*Second Generation Cross*

Decision/Recommendation

Answers will vary for each ear of corn examined. The approximate ratio of the expression of the dominant trait over the recessive trait will be 3:1.

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Problem-Solving Technique

Define the problem

How are traits inherited from parents to offspring?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

The development of hybrid corn was a significant advancement in the effort to produce more food. Before hybrid seed was available, farmers saved their own seed each year. Now, practically all corn grown in the United States is a hybrid which has been developed for a certain location and environmental condition. Hybrid corn varieties have boosted yields from 50 - 60 bushels per acre in the 1940's to more than 150 bushels per acre on many farms in the 1990's.

Several botanical varieties of corn are grown in the United States and have broad usage and economic importance. The principal commercial feed type corn grown in the United States is dent corn. White kernel corn is becoming increasingly popular as a food crop for people. Sweet corn and popcorn are also important crops grown for human consumption. New varieties of corn developed through plant breeding programs and biotechnology are constantly being perfected at land-grant research institutions and by private industry.

Ideas for Additional Experiments

- Several variations of genetic corn are available from scientific supply companies and can be used to demonstrate the properties of inheritance.

Evaluating Student Learning

After students have completed this experiment, have them record their data on pages 5.0.11-7 and -8.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	Results

NOTES

Conclusions

Program AGRISCIENCE

Unit 6 - Animal Science

Describing the Animal Industry

Competency/Terminal Performance Objective

6.0.1 Describe the animal industry – given background information – in a five-minute informative, oral presentation.

Competency Builders/Pupil Performance Objectives

6.0.1.1 Given a blank sheet of paper, students will correctly describe animal domestication in their own words.

6.0.1.2 Given a blank sheet of paper, students will correctly identify five types of animals and identify four out of five uses of animals.

6.0.1.3 Given a blank sheet of paper, students will select three types of animals and, in their own words, explain the importance of three economic traits they possess.

Applied Academics Competencies:

Communications

2.0.1 Use word processing, graphics, and/or desktop publishing as aids for writing.

2.0.2 Revise written material.

2.0.4 Prepare written report(s).

2.0.5 Prepare first draft.

2.0.8 Develop main idea(s) supported by details and examples.

2.0.9 Write legibly.

2.0.10 Organize facts, details, and examples in logical order.

2.0.11 Use language appropriate for audience, purpose, and subject.

3.0.1 Demonstrate effective listening skills.

3.0.5 Identify main idea(s).

3.0.6 Follow directions.

4.0.1 Present a researched topic.

4.0.2 Use nonverbal messages.

4.0.6 Organize presentation.

4.0.9 Give formal and informal talks and speeches.

4.0.10 Give clear explanations.

4.0.11 Demonstrate techniques of speech delivery.

4.0.12 Use appropriate language.

4.0.13 Use visual media.

Applied Academics Competencies *(continued)*

Mathematics

1.6.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers.

1.6.8 Estimate answers.

3.6.6 Use problem-solving techniques.

Science

2. Explain that the genetic makeup of the parents affect their offspring.

Equipment, Supplies, References, and Other Resources

1. Monopoly money or other fake currency – $2,000 per student plus money for the "bank"
2. Equal number of cards with "$" and "–" signs on them
3. *Livestock and Poultry Breeding Student Manual* – available from the Ohio Agricultural Education Curriculum Materials Service
4. Handout – *Animal Economic Traits Game*
5. Handout – *Animal Economic Traits Game Key*

Situation

This activity is to be used with Level I and Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach Ask the class the following questions: 1. Have you ever thought what life would be like without animals? 2. Do any of you have pets? 3. What would your life be like without pets? 4. Do you depend on your pets for anything? (*Some of the students may respond that pets provide them with affection or security.*) 5. How do you think people first got the idea to use animals? People depend on animals for much more than affection or security. Let's take a look at how people first began to use animals.
Answers to the questions in this discussion are found in *Livestock and Poultry Breeding - Student Manual*, pages 1-2.	**Discussion** Begin a discussion by asking the following questions: 1. What is the term used to indicate that animals which once were wild have been tamed by humans? (*domestication*) 2. What are some qualities of **domestication**? In other words, what must animals do to be considered domesticated? a. *Live with or near people* b. *Be controlled in a way which benefits people's needs* c. *Able to reproduce in captivity* 3. What are (and were) animals used for? What products, services, and benefits do we get from animals? a. ***Food** – During early history, people learned that animals were edible. Animals were and are a reliable source of protein.* b. ***Clothing and shelter** (building materials) – People learned that animal hides could be used to keep them warm in colder climates. For example – Native Americans used deer and bison not only as a food source, but also for clothing. Studies show that Ice Age people also used the bones of mammoths to build their houses. The bones served as frames and the mammoth hides were stretched across them*

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	c. *Service – Animals have been used for services such as transportation, plowing fields, protection, hunting food, and companionship. Dogs, cats, and some types of birds can also fall into the service category; for example – carrier pigeons were used for communication purposes. Animals used in other cultures include elephants, llamas, and camels.*
	4. What types of animals are used on farms? The common term for these animals is **livestock**. *Cattle (beef and dairy), poultry, swine, sheep, and horses. Due to the growing diversity of animals being raised on farms, you may get many different answers like fish (through aquaculture), rabbits, bison, ostriches, and emu (which are used for food and their hides).*
	5. What other characteristics do animals have which allow producers to develop certain genetic qualities? *Selective breeding – Over time, livestock producers began to notice that certain individual animals possessed more desirable traits than other animals within their species. Examples of such characteristics are good milk or egg production, wool and meat production, size, muscle quality, and similar traits.*
This is the conclusion of the lesson for day one.	6. Do you think animal genetics can earn money for you as a producer? During the next class we will play a high-stakes game in which you will have a chance to profit from your animals.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Begin the lesson for day two at this point.	**Supervised Activity** Review the previous lesson with the class. Ask the students to recall the last important trait of domesticated animals that was covered in class. (*People can selectively breed animals for desirable genetic traits.*)
Distribute the handout – *Animal Economic Traits Game* on page 6.0.1-7. You will need the following materials: fake currency, enough for $2,000 per student with extra for the "bank," and index cards with "$" (profit) or "–" (loss) signs on them.	After distributing the handout – *Animal Economics Traits Game*, review the directions for the game and encourage the students to think creatively. Explain that the economic traits of animals can translate to bigger bank accounts or bankruptcy for farmers. Students must use the handout to tell you why the traits are economically important. These explanations should be in their own words. Conduct the game; after each round discuss the value of each trait by using the information on the handout – *Animal Economic Traits Game Key*.
After completing each round of the game, discuss the value of each trait by using the information in the handout – *Animal Economic Traits Game Key* on page 6.0.1-8 to -10.	**Review** Review the information presented in this lesson and clarify any misunderstandings the students may have.
Use the problem-solving technique on page 6.0.1-11 in conjunction with this activity.	

Helping Students Apply Concepts/Principles/Skills

Use discussions, supervised practice, and the application of acquired background information to enable each learner to make a five-minute informative oral presentation.

Evaluating Student Learning

Ask each student to select three types of animals (i.e., dairy cattle, beef cattle, sheep, swine, poultry, or horses). Next, on a blank sheet of paper, have each student write three economic traits for each type of livestock. Then, in his or her own words, explain why each trait is important and how it affects the animal' s health and the owner's profits.

This activity was submitted by Darrell Rubel and Terri Porter, Department of Agricultural Education, The Ohio State University, Columbus, Ohio.

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Animal Economic Traits Game

Scenario
Give each student $2,000 in fake currency for his or her "bank account." Each student owns a fictional farm and raises one herd of each of the following: dairy cattle, beef cattle, sheep, swine, poultry, or horses. Each herd is treated as one unit and all the animals in each herd possess the same traits. That is – a trait occurring in one dairy cow also occurs in the rest of the animals in that same herd.

Money
Money is added or subtracted per herd unit ($200/herd). You (the teacher) serve as the "bank" and can give the students additional money for the profits they earn. You can also collect the money they lose due to owning animals with undesirable economic traits.

Scoring
The students make either a profit or a loss per trait. *For example* – "$" for a dairy cow herd without mastitis, add $200 to the student's profits; "–" for a dairy cow herd with mastitis, subtract $200 from the student's profits. To determine whether or not the student makes a profit or a loss, have available equal numbers of index cards, half with "$" (profit) signs and half with "–" (loss) signs.

Directions
After you read a trait, have each student take an index card. Based on the card the student has drawn, add or subtract the money value listed on the *Animal Economic Traits Game Key*. Using a calculator, keep track of each student's "bank account." After completing the first round in the game, have the students follow along on their trait handout sheets. They should explain, in their own words, why the animal's traits are important to the economic success of the farmer. Discuss only one trait at a time. After students have determined the importance of the first trait, move on to the next round (trait) in the game.

Animal Economic Traits Game Key

Trait	Importance of Trait
Reproductive Performance (proficiency) $300 profit or loss	The more offspring born, the greater the chance the farmer will profit. In meat-producing livestock, this single trait increases profit more than any other trait. More offspring also means an increase in the gene pool, which is helpful for improving genetic traits.
Maternal Ability $200 profit or loss	Milk production by the mother affects the number of animals weaned and the weaning weight of the offspring.
Mothering $100 profit or loss	The better the animal's mothering ability, the better the animal will be able to care for and protect her offspring. This increases offspring survival rates.
Growth Rate $300 profit or loss	Faster growth rates mean that the animals reach market weight sooner. Therefore, the farmer saves money on labor, equipment, and buildings. Faster-growing animals usually convert feed to meat faster than slower-growing animals and also produce higher quality meat.
Feed Efficiency $200 profit or loss	Feed is usually the highest cost involved in raising livestock. Therefore, the more efficiently an animal uses feed to grow, the more money the farmer saves.
Carcass Quality $200 profit or loss	This trait concerns the ratio of muscle to fat and bone. It determines the animal's market grade, which relates directly to market price. Weight gain due to muscle is cheaper than weight gain due to fat.
Face Cover and Skin Folds $50 profit or loss	Excessive face cover and skin folds adversely affect production.
Length of Breeding Season (sheep) $200 profit or loss	A longer breeding season can permit the birth of more offspring during a ewe's life span. There is also more flexibility in the time in which the lambs are sent to market.

Animal Economic Traits Game Key

(continued)

Trait	Importance of Trait
Wool Quantity and Quality (sheep) $100 profit or loss	Wool weight, length, and diameter impact the price the farmer receives for the wool. It makes up 1/5 to 1/3 of the gross income from raising sheep. Due to an increase in wool substitutes, wool is less valuable today than in years past.
Milk Production and Butterfat Production (dairy cattle) $300 profit or loss	The primary income and profit from dairy cattle comes from high levels of milk and butterfat production.
Size and Shape of the Teats and Udder (dairy cattle) $50 profit or loss	The size and shape of the teats and udder affect how mechanical milking equipment functions on cows. These traits also determine the amount of damage done to the teats and udder during milking.
Speed of Milking $100 profit or loss	A faster milking time decreases labor costs and causes less damage to the teats and udder.
Resistance to Mastitis $200 profit or loss	Mastitis (a hardening of the udder and teats) causes great losses in milk production. If animals have a high resistance to the disease, the costs of prevention and treatment procedures are lower.
Longevity (dairy and beef cattle) $400 profit or loss	Compared to swine and sheep, cattle have a lower reproduction rate. They also are more expensive to bring to the maturity stage at which the farmer begins to profit from the animals. Therefore, the longer the animal remains productive (i.e., healthy and producing offspring), the longer the farmer will profit from it. An animal with a strong bone and muscle structure tends to lead a longer and healthier life.

Animal Economic Traits Game Key

(continued)

Trait	Importance of Trait
Egg Quantity (poultry) $200	The more eggs a hen lays, the more profit the farmer makes.
Egg Quality (poultry) $100	The color and size of an egg determine its USDA grade.
Disease Resistance (poultry) $300	Disease-resistant birds lower the costs of egg production, broiler production, and bird replacement.
Broiler Quality (poultry) $100	Body shape, fat covering, and the amount of meat on a bird all affect its USDA grade.
Conformation (horses) $400	Body shape and part arrangement are related to a horse's work and show performance, as well as its overall value.
Disposition (horses) $300	An animal's disposition affects its overall ease of handling.
Intelligence $200	Intelligence in horses is inherited; therefore, some bloodlines are preferred over others.

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Problem-Solving Technique

Define the problem

Which animal trait characteristics represent profitability?

Factors to Consider	Choice one	Choice two
	Profit	**Loss**
1. Reproductive performance	More offspring are born.	Fewer offspring are born.
2. Maternal ability	Milk production is higher, more animals are weaned, weaning weights are higher.	Milk production is lower, fewer animals are weaned, weaning weights are lower.
3. Mothering	More offspring survive.	Fewer offspring survive.
4. Growth rate	Faster rate produces animals which reach market weight sooner.	Slower rate produces animals which reach market weight later.
5. Feed efficiency	Animal uses feed to grow efficiently.	Animal uses feed to grow inefficiently.
6. Carcass quality	Muscle to fat and bone ratio is good.	Muscle to fat and bone ratio is poor.
7. Face cover and skin folds	Animal has very little face cover and skin folds.	Animal has excessive face cover and skin folds.
8. Length of breeding season	Breeding season is long.	Breeding season is short.
9. Wool quantity and quality	Wool weight, length, and diameter are high in quality and quantity.	Wool weight, length, and diameter are low in quality and quantity.
10. Milk and butterfat production	Production levels are high.	Production levels are low.
11. Size and shape of the teats and udder	Teats and udder are well placed and proportional.	Teats and udder are misplaced and malfunctioning.
12. Milking speed	Milking speed is fast.	Milking speed is slow.
13. Resistance to mastitis	Mastitis resistance is high.	Mastitis resistance is low.
14. Longevity	Productivity span is long.	Productivity span is short.

Decision/Recommendation

Program	**AGRISCIENCE**
Unit	**6 - Animal Science**

Determine Animal Nutritional Requirements

Competency/Terminal Performance Objective

6.0.2: Given specific animal types, determine animal nutritional requirements, based on criteria given in assessment instrument.

Competency Builders/Pupil Performance Objectives

6.0.2.1 Given examples of each system type, compare animal digestive systems, based on definitions and descriptions provided.

6.0.2.2 Given examples of animal systems, explain basics of animal physiology, based on systems provided in assessment instrument.

6.0.2.3 Given specific nutrients, determine how animals use nutrients, based on use and system given in assessment instrument.

6.0.2.4 Given major nutrients, identify nutrient classes and sources, based on definitions provided.

6.0.2.5 Given example deficiencies, identify nutrient deficiency symptoms, according to criteria given in assessment instrument.

6.0.2.6 Using specific feed additive - animal group correlation, explain the role of feed additives, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies *(continued)*

Mathematics:

1.2.1	Round and/or truncate numbers to designated place value
2.2.1	Convert, compare, and compute with common units of measurements within and/or across measurement systems
2.2.2	Compute using appropriate units of measurement
2.2.3	Read scale on measurement device(s) to nearest mark and make interpolations where appropriate
2.2.4	Estimate measurements
3.2.6	Use problem-solving techniques
4.2.4	Use formulas
5.2.2	Find surface areas and volumes of applicable geometric figures

Equipment, Supplies, References, and Other Resources

1. chicks from hatching experiment
2. commercial chick feed (pelleted)
3. ground corn
4. soybean meal supplement
5. scales or balance

Situation

This experiment is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Make arranagements for a brood of chicks to be available in the classroom.	**Interest Approach** Conduct a contest to guess the number of days it will take the first chick in the brood to double its birth weight. For a tie breaker, also guess the average consumption of feed needed to produce one pound of gain. (Answers: chicks normally double their birth weight in five days, and consume two pounds of food for each pound of gain.) **Procedure** *General note:* There are several possible experiments which can be conducted to investigate the effect of diet on poultry growth and development. The specific treatment (feed ration) chosen for study may be a factor of what is readily available from a local supplier. Following are the procedures for two treatments: the effects of protein supplement concentration, and the effects of feed preparation (mash or pelleted) on poultry growth. **ACTIVITY 1 -** ***Effects of Supplemental Protein*** 1. Select two groups of chicks that are as identical as possible in number, size, and weight.
Use the form on page 6.0.2-9.	2. Weigh each chick and record the total starting weight. 3. Obtain two commercially prepared rations of chick feed with different protein concentrations. One ration should contain recommended levels of protein for starter chicks; the other ration should be for older poultry. If identical rations (except for protein) are not available, you can mix your own rations with different amounts of soybean meal added as the protein supplement. 4. Feed equal amounts (by weight) of the rations. Weigh the amount of new feed provided daily to each group and any day-old feed remaining in the feeder. Provide an ample supply so some feed remains each day. 5. Weigh the chicks weekly. 6. Continue this experiment as long as feasible. 7. Analyze the weight gain and feed efficiency for each group.
Use the information on pages. 6.0.2-5 and -6 (student copy). Use the form on page 6.0.2-9.	**Data Summary and Analysis** Record data on forms provided. Discuss results and make conclusions.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use the form on page 6.0.2-10	**Procedure** *(continued)* **ACTIVITY 2 - *Effects of Feed Preparation*** 1. Select two groups of chicks that are as identical as possible in number, size and weight. 2. Weigh each chick and record the total starting weight. 3. Obtain a commercially prepared pelleted feed ration. Grind one-half of the pellets into a mash. 4. Feed equal amounts (by weight) of the ration. Weigh the amount of new feed provided daily to each group and any day-old feed remaining in the feeder. Provide an ample supply so some feed remains each day. 5. Weigh the chicks weekly. 6. Continue this experiment as long as feasible. 7. Analyze the weight gain and feed efficiency for each group.
Use the information on pages. 6.0.2-7 and -8 (student copy). Use the form on page 6.0.2-10.	**Data Summary and Analysis** Record data on forms provided. Discuss results and make conclusions.
	Key Terms 1. *nutrients* - substances used by an animal for growth and development of its cells, organs and tissues. There are more than 40 nutrient chemicals, including amino acids, minerals, and vitamins. 2. *growth* - an increase in the size of bones, muscles, internal organs, and other body parts. 3. *anabolism* - process by which nutrient molecules are used as building blocks for the synthesis of complex molecules. Anabolic reactions require the input of energy into the system. 4. *catabolism* - nutrient oxidation which releases energy to meet the body's immediate demands. 5. *protein* - complex organic compounds made of carbon, hydrogen, oxygen, and nitrogen in the form of amino acids.

• **Effect-Cause** • Problem-Solving Technique

Define the problem

How does supplemental protein affect the growth rate of chicks?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Higher protein levels are needed by starter chicks for optimum growth and development. The starter ration with higher protein will produce faster weight gains.

• Effect-Cause •
Problem-Solving Technique

Define the problem

How does supplemental protein affect the growth rate of chicks?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

• Effect-Cause •
Problem-Solving Technique

Define the problem

How does feed preparation affect the growth rate of chicks?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Older birds usually consume more pelleted ration than mash. The pelleted ration will produce faster weight gains.

• Effect-Cause •
Problem-Solving Technique

Define the problem

How does feed preparation affect the growth rate of chicks?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Poultry Nutrition Experiment

ACTIVITY 1

Group Identification ____

Treatment Variable ____

(Record Weight in Grams)

Date	Feed Provided	Old Feed Removed	Net Feed Consumed	Total Weight of Chicks	Starting Weight	Net Gain	Feed Conversion Ratio

Poultry Nutrition Experiment

ACTIVITY 2

Group Identification ____

Treatment Variable ____

(Record Weight in Grams)

Date	Feed Provided	Old Feed Removed	Net Feed Consumed	Total Weight of Chicks	Starting Weight	Net Gain	Feed Conversion Ratio

Helping Students Apply Concepts/Principles/Skills

Efficient feed use is important to poultry producers since feed costs account for 50 to 75 percent of the expense of raising poultry. Poultry can be fed a variety of feedstuffs - a combination of corn and protein supplements is the most widely used ration. However, poultry can also be fed animal by-products from dairy, fish, and breweries. Commercially prepared rations for specific weights and ages of chicks are common feeds. This feed may be ground as a mash, pelleted, or crumbled by rolling the pellets. Pellets and crumbles cost slightly more, but increase feed efficiency.

Nutrients provide maintenance and growth; therefore, providing a balanced diet is essential, especially for young birds. They consume more feed per unit of body weight, have a higher protein requirement, require an easy-to-digest diet, and are more subject to nutritional deficiencies. Proper nutrition is necessary for efficient growth and egg production. Also, poultry digestion, respiration, and circulation are more rapid than in other farm animals. Consequently, the growth and maturation rates of poultry are more rapid. Broilers reach market weight in six to seven weeks and commonly consume two pounds of feed for each pound of gain. Research on the availability of necessary amino acids for proper growth has resulted in new rations which optimize profitability. Minerals and vitamins are also commonly added to poultry feed to maximize growth and prevent disease.

Evaluating Student Learning

After completing these experiments, have students record their data and observations on pages 6.0.2-12 through -15.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Office Hours M-F: 7:30 am to 4:30 pm

Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Data Record and Observation Sheet

Title ____

Name ____________________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program **AGRISCIENCE**

Unit **6 - Animal Science**

Explain Animal Reproduction

Competency/Terminal Performance Objective

6.0.3 Given examples of reproductive systems, explain animal reproduction based on descriptions provided in assessment instrument.

Competency Builders/Pupil Performance Objectives

6.0.3.1 Given a handout or a male reproductive tract and a scalpel, students will be able to identify and describe 70 percent of the parts and functions of the male reproductive system.

6.0.3.2 Given a handout or a female reproductive tract and a scalpel, students will be able to identify and describe 70 percent of the parts of the female reproductive system.

6.0.3.3 Given a blank sheet of paper, the student will be able to describe in his/her own words, the role of the estrous cycle in ten minutes.

6.0.3.4 Given a blank sheet of paper, students will be able to compare mitosis with meiosis in five minutes.

6.0.3.5 Given a blank sheet of paper, students will be able to identify the basic functions of DNA and RNA in fifteen minutes.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials

1.0.4 Determine solutions to problems

1.0.6 Make predictions about information

1.0.8 Define words used in context

1.0.15 Summarize material

1.0.16 Paraphrase material

1.0.17 Interpret organizational patterns of writing (e.g., cause and effect, comparison and contrast, simple listening)

2.0.3 Record observations

2.0.4 Prepare written report(s)

2.0.5 Prepare first draft

2.0.8 Develop main idea(s) supported by details and examples

2.0.9 Write legibly

2.0.13 Use correct grammar

2.0.14 Use correct spelling

2.0.15 Write complete sentences

2.0.19 Use appropriate punctuation and capitalization

2.0.20 Use transitional words and phrases effectively

Applied Academics Competencies

Communications *(continued)*

3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
3.0.10 Organize ideas
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
1.6.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
3.6.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. DNA Extraction Kit (complete for use by 30 students) - available from Carolina Biological Supply Company
2. hot plate
3. beaker
4. water
5. Male reproductive system from either a bull, ram, or boar. (Check with local slaughter house or butcher shop.) Have at least two systems to display so all students will be able to observe.
6. Female reproductive system from either a cow, ewe, or sow. (Check with local slaughter house or butcher shop.) Have at least two systems to display so all students will be able to observe.
7. Rubber gloves, one pair per person
8. Handouts –
   Male Reproductive System
   Inside a Testis
   Path the Sperm Travel through the Male's Body
   Male Reproductive System in Poultry
   Female Reproductive System
   A Follicle Forms on the Ovary
   Corpus Luteum Replaces the Follicle
   Progesterone Prepares the Uterus for Pregnancy
   The Egg Travels to the Uterus
   Female Reproductive System in Poultry
   Egg Formation and Fertilization in Poultry
   Obtaining a Tissue Sample
   Common Cell Shapes
   DNA Code Sheet
   DNA Helix

Equipment, Supplies, References, and Other Resources

(continued)

9. Scalpels
10. Flathead toothpicks
11. Rubbing alcohol and paper towels
12. 4 compound microscopes for 4 different lab stations (suggested)
13. Blank slides and cover slips for skin cells
14. Slides of skin, muscle, white blood, and nerve cells

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Solicit help from the home economics teacher for the bread baking demonstration.	**ACTIVITY 1** **Interest Approach** The earliest applications of biotechnology may have begun over 4,000 years ago when Egyptians used yeast to make bread. To demonstrate this process, prepare two loaves of bread using identical ingredients; however, bake one loaf *with* yeast and one loaf *without* yeast. Have students sample the bread. Note the differences and suggest possible reasons for the differences. Explain the application of biotechnology in making bread.
	Procedure Follow procedures described in the DNA Extraction Kit.
Use the information on pages 6.0.3-17 and -18 (student copy).	**Data Summary and Analysis** Record the procedures for extracting DNA from the *E. coli*. Also note properties of the spooled DNA. Include answers to the following questions: 1. What effect did the detergent have on the cell membrane? 2. What are three properties of DNA demonstrated by the lab? 3. Why does DNA appear flexible when it is actually a very rigid structure?
	Key Terms for ACTIVITY 1 1. **Bioprocess** – Process in which living cells are used to create a product 2. **Chromosome** – Filamentous structure found either in the cytoplasm or nucleus of cells. Chromosomes are composed of DNA. Units of the chromosomes are called genes. 3. **Cytoplasm** – Material inside the cell membrane that surrounds the nucleus 4. **DNA (deoxyribonucleic acid)** – Large, double-stranded, complex molecule which is the basic genetic material found in all cells. DNA provides the blueprint for making protein and transfers hereditary information from one generation to the next. DNA is universal for all forms of life and can be transferred between organisms. 5. **E. coli** – Bacterium commonly found in the human intestine and used in DNA research 6. **Eukaryote** – Cell with a membrane around its genetic material found in a structure called the nucleus

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	7. **Gene** – Smallest unit of inheritance. Genes are DNA sequences that code for a single protein. 8. **Genetic code** – Code that stores information for all genetically determined characteristics. The code is a sequence of nucleotides in groups of three and expressed through protein synthesis. 9. **Genome** – Amount of genetic material needed to replicate an entire organism 10. **Nucleotide** – Basic building blocks of DNA and RNA. Nucleotides consist of a nitrogeneous base, a pentose sugar, and phosphoric acid. 11. **Prokaryote** – Organism without a membrane around its genetic material (e.g., *bacteria*) 12. **RNA**– Complementary, single-stranded, nucleic acid to DNA that is mostly used to make proteins 13. **Yeast**– General term for single-celled fungi. Some yeast can ferment carbohydrates and are important in brewing and baking.
Interest Approach *Materials needed:* Actual male reproductive system from cattle, sheep, or swine. The students will be able to see better if you have at least two systems on display. *Helpful hint:* to prevent odor, keep the systems frozen until just prior to class. Provide one pair of rubber gloves per student. You may get some giggles during this discussion. Don't worry – this can be a difficult subject to present.	**ACTIVITY 2** **Discussion** Pose the following questions to the class: 1. What is the process called in which two animals mate and successfully produce offspring? (*reproduction*) 2. There is much more involved in reproduction than just having offspring. Do you know what actually takes place? How do all the sexual organs work together to make reproduction work? (At this point display the animal's reproductive system.) 3. Here is the male reproductive system of a "*name of specific type of animal.*" Can you correctly identify all the parts of this reproductive system? What is the function of each of these parts? 4. What do you think our problem statement is today?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Have a student write the problem statement on the board.	*HOW DO WE IDENTIFY THE PARTS AND FUNCTIONS OF THE MALE REPRODUCTIVE SYSTEM?*
Distribute handouts – *Male Reproductive System* and *Inside a Testis* on pages 6.0.3-19 and -20.	**Key Terms for ACTIVITY 2** Distribute the handouts and have the students follow along as they learn about the reproductive parts and their functions. 1. **Sperm cells** – Ask the students what the male sex cells are called and which cells do males produce that fertilize the egg cells (*sperm cells*). Discuss the route that sperm cells travel on their way to fertilize the egg. 2. **Testes** – Ask the class which part of the reproductive system produces sperm cells (*testicles or testes*). Have students find the testes on the sample reproductive system presented in class. Make sure they have found the correct body part before proceeding. Explain that the testes are actually up inside the body cavity before the animal is born. They descend after the animal is born. If the testes do not descend properly, the sperm cells they produce may be malformed, or they may not produce enough sperm cells. **Note:** In poultry, the testes remain internal. They also produce seminal fluid in addition to the sperm. Now examine the inside of the testes. You or the students can cut open the testes on the sample reproductive system, or you can discuss the handout. 3. **Semeniferous tubules** – Explain to the class that these are small, coiled tubes and the sperm are formed inside these tubes. Surrounding the tubes is the interstitial tissue, which produces testosterone - the male sex hormone. Now pose this question to the students: • What happens to the sperm after they have been produced and stored in the testes? 4. **Scrotum** – Ask the students where the testes are located. What contains them? What is the name of this body part? (*scrotum*) Have the students locate the scrotum on the sample displayed in the classroom. If the sample does not have a scrotum, locate it on the handout.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	4. **Scrotum** *(continued)* Explain that the scrotum actually raises and lowers the testes. Its function is similar to a thermostat – keeping the testes at the correct temperature. The scrotum tries to keep the testes five to seven degrees cooler than the rest of the body. The testes must remain at this temperature to make healthy sperm cells and the correct number of sperm cells. 5. **Epididymis** – Explain to the students that the function of this duct is to collect and store the sperm. Sperm cells must mature before they can fertilize an egg. Have the students locate the epididymis on the sample reproductive system or on the handout. 6. **Vas deferens** – This is the duct or canal which carries the sperm cells to their next stop – the accessory glands. Have the students locate the vas deferens on the sample reproductive system or on the handout.
Distribute the handout – *Path the Sperm Travel through the Male's Body* on page 6.0.3-21.	7. **Accessory glands area** – Discuss with students the following three glands which are located in this area: a. *Seminal vesicles* – These two glands secrete seminal fluid which <u>transports</u> and <u>protects</u> the sperm. The sperm cells are carried in this fluid until they reach the egg. b. *Prostate gland* – This gland produces a thick, milky fluid which mixes with seminal fluid to <u>nourish</u> the sperm cells. c. *Cowper's gland* – This gland secretes a fluid which looks similar to seminal fluid. The difference is that this fluid <u>cleanses</u> and neutralizes the <u>urethra</u> (the duct that also carries urine out of the body through the penis). This canal must be cleansed because the urine could potentially kill the sperm cells. **Note:** In poultry, there are no seminal vesicles, prostate glands, or Cowper's glands. These are replaced by **vascular bodies** near the end of the vas deferens. 8. **Urethra** – This is the duct which transports the semen, as well as urine, through the penis and out of the body. Have the students locate the urethra on the sample reproductive system or the handout. The urethra is located on the underside of the penis.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	9. **Penis** – This organ transfers semen to the female during mating. Have the students locate the penis on the sample reproductive system or on the handout.
Distribute the handout – *Male Reproductive System in Poultry* on page 6.0.3-22.	**Note**: Poultry do not have a penis. It is replaced by the **cloaca** and the **papillae**. Sperm are carried through the vas deferens to the cloaca – an enlarged area that joins the reproductive and digestive tracts – before leaving the body through the vent. The papilla are located just inside the cloaca. Mating is accomplished when the male and female join cloacae long enough for semen to move out of the male and into the female.
	Evaluation Ask each student to identity the parts of the male reproductive system and their functions. Use either the unlabeled figures in the handouts or the sample reproductive system. An adequate score is a 70 percent accuracy rate.
	Discussion The old saying "it takes two to tango" also holds true in reproduction as well. Without females, reproduction would not be possible. Discuss the following questions with the class: 1. What do you think the male's function is during reproduction? (*producing sperm cells*) 2. What do you think the female's functions are during reproduction? • *Producing eggs* • *Carrying the fetus inside her body until it is born* • *Producing milk to feed her offspring* (mammals) Ask the class how they think all these things are accomplished.
Ask a student to write the problem statement on the board.	***WHAT ARE THE PARTS AND FUNCTIONS OF THE FEMALE REPRODUCTIVE SYSTEM?*** As discussed earlier, the female produces a sex cell called an egg. An egg is much larger than a sperm cell because it contains **cytoplasm** to nourish the egg after it is fertilized. Actually, an egg is about the size of a period at the end of a sentence (.). In mammals, it would take at least two million eggs to fill a thimble. However, because they contain much more cytoplasm, poultry eggs are larger than mammal eggs.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Before discussing the reproductive system itself, explain to the class that female animals are not always ready to mate. They mate only when their eggs are ready to be fertilized. Ask if anyone knows what this stage is called. (*heat or estrus*) **Note:** There is no estrous cycle in poultry. Ask the class to name some signs of estrus in female animals. Write the answers on the board. ***Signs of Estrus in a Female Animal*** 1. Attempts to "ride" or mount other animals 2. Allows other animals to mount her 3. Has mucous discharge from the vulva 4. Has swollen vulva 5. Urinates frequently 6. Is nervous
Distribute the following handouts: *Female Reproductive System*, *A Follicle Forms on the Ovary*, *Corpus Luteum Replaces the Follicle*, *Progesterone Prepares the Uterus for Pregnancy*, and *The Egg Travels to the Uterus* on pages 6.0.3-23 to -27. You may also wish to blank out the labels and ask students to write in the part names. Display at least two female reproductive systems. *Helpful hint:* Keep the systems frozen until just prior to class. Provide one pair of rubber gloves per student.	Females **ovulate** (release eggs) only at certain times. For some animals the amount of time they are in heat differs from other animals. For example – some types of animals are in heat for only a few hours, while others are in heat for a few days. In addition, some animals are in heat during only one part of the year. This is called a **seasonal estrous cycle**. The estrous cycle occurs when the female animal's blood contains a high level of the hormone **estrogen**. As the level of estrogen increases, the level of estrus also increases. Consequently, as the level of estrogen decreases, so does the level of estrus. Now that the animal is in heat, let's look at what happens to an egg before it can be fertilized. Have the students locate the following terms on the female reproductive system or on the handout: **More Key Terms for ACTIVITY 2** 1. **Ovary** – Eggs are formed and stored here. 2. **Follicles** – Growths inside the ovaries which produce estrogen and store eggs. The estrogen level rises until one follicle ruptures and an egg is released. Then the follicle collapses. After the follicle collapses, it is called a *yellow body* because its color is dark yellow.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
If you are using an actual tract, have students cut open the ovary and attempt to find a follicle and a yellow body	2. **Follicles** *(continued)* The yellow body then produces the hormone progesterone which does the following: a. Reduces uterine movement b. Stops the ovary from developing another follicle **Note**: If the egg is not fertilized, the uterus will secrete **prostaglandin** which causes the yellow body to stop producing progesterone. 3. **Infundibulum** – Funnel-like opening to the oviducts or fallopian tubes 4. **Oviducts/fallopian tubes** – Tubes the eggs travel through to reach the uterus. Here in the fallopian tubes the sperm cells from the male find the egg and fertilize it. 5. **Uterus** – Organ that holds and nourishes the fertilized egg (embryo) until birth 6. **Uterine horn** – Area of the uterus in which the embryo attaches to the uterine wall 7. **Cervix** – Muscular, tube-like passage that joins the uterus to the vagina 8. **Vagina** – Canal that leads from the uterus to the external parts of the female reproductive system. Semen is deposited here during mating, and the fetus uses this canal to exit during birth. 9. **Vulva** – External part of the female's reproductive system **Evaluation** 1. Give students an unlabeled copy *of The Female Reproductive System* or the actual female reproductive tract used in class. Have each student identify, with 70 percent accuracy, the parts and functions of the female reproductive system.

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Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Distribute the handouts – *Female Reproductive System in Poultry* and *Egg Formation and Fertilization in Poultry* on pages 6.0.3-28 and -29. Display at least two female poultry reproductive systems. *Helpful hint*: Keep the systems frozen until just prior to class. Provide one pair of rubber gloves per student.	2. Give students a sheet of paper. Have them explain, in their own words, the estrous cycle. Give them 10 minutes to complete this task. **Female Reproduction in Poultry** Explain to the students that the female reproductive system in poultry may have the same names as those of other livestock, but some of their functions are quite different. Using the handouts or an actual reproductive tract, review the following key terms and information: **More Key Terms for ACTIVITY 2** 1. **Germinal disk** – Contains the female nucleus 2. **Yellow yolk** – Nourishes the developing embryo within the egg. 3. **Albumin** (egg white) – Protein within the egg used as nourishment for the developing embryo 4. **Outer shell and shell membrane** – Protect the embryo inside the egg 5. **Ovary, oviduct, cloaca, and vent** – Egg passes through these to reach the outside. **Note:** It takes 23 to 27 hours for a hen to produce one egg. Now follow the process of producing and laying an egg:
Have students locate the ovary on the handout or on the reproductive tract. Students may need to use the scalpel to dissect the ovary. Ask them to locate the remaining parts of the female poultry reproductive system.	1. The ovary produces the germinal disc and the yolk with a membrane. 2. Next, the infundibulum (funnel) receives the egg from the ovary. This is where the sperm cells from the male are stored and the egg is fertilized. 3. Then the egg passes through the oviduct to the magnum. It is here that the egg white -- albumin -- is secreted around the egg. This process takes about 3 hours.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	4. Now the egg moves into the isthmus. At this point, the yolk and egg white are surrounded by two shell membranes. This takes about 1 hour and 15 minutes. 5. Next, the egg moves into the uterus. Here the thin, white, outer membrane is added. The egg remains here for 20 hours. 6. Finally, the egg moves into the vagina where the exterior egg coat is added. It is expelled through the vent. **Evaluation** Review the main points with the students. Give them an unlabeled handout or the actual reproductive tract used in class. Ask them to provide the names and functions of the reproductive system with at least 70 percent accuracy. **Interest Approach** Ask the students the following questions: 1. Are any of you pet owners? If so, describe some of your pets' physical characteristics. *(male, female, tall, short, long ears, short ears, and similar features)* 2. How do animals differ from one another? *(gender, body parts)*
Give hints by leading the students to look at their skin, bones, and muscle.	3. Who can name the major body parts of an animal? *(muscle, skin, blood, nerves, and bone)* 4. What comprises skin, bone, muscle and blood? *(cells)* 5. Who can define "cell"? Is there one type of cell related to the gender characteristic? *(reproductive cells)* 6. What is the difference between body cells and reproductive cells? *(**Meiosis** occurs in the reproductive cells -- a process the body undergoes in order to reproduce another living organism; **mitosis** occurs in the body cells -- a process the body undergoes in order to reproduce itself.)*

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Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Activity Have the students divide into groups of three "scientists" -- one recorder and two specialists. The recorder should note observations, comparisons, and decisions made by the group. All students should record personal observations and comparisons in a notebook.
Distribute toothpicks, slides, and cover slips. Instructions for obtaining a tissue sample appear on page 6.0.3-30.	**Experiment** Ask the students to obtain tissue samples and place them on slides. They should observe these under a microscope and compare them to the instructor's sample. Next, examine each type of cell -- skin, muscle, white blood, and nerve -- and provide the following information: 1. Description -- include cell shape and nucleus location 2. Approximate number of cells in a specified area 3. Function of each cell
Distribute the handout – *Common Cell Shapes* on page 6.0.3-31.	Ask the students to draw a picture of what they are observing through the microscope. They should describe the difference in appearance of the various cell types.
	Discussion Ask a student to write the definitions of meiosis and mitosis on the board. Discuss the handout and compare each type of cell (*body* and *reproductive*). Determine which cells would undergo meiosis and which would undergo mitosis.
Conduct the activity as described on page 6.0.3-32. Some of the students may be stumped at this point. That's OK; this exercise will help later in this lesson. Follow the directions on the code sheet. *Hint:* you may wish to give a reward to the team that cracks the code first.	**Interest Approach** Divide the class into groups of 3 to 4. Explain to the students that each group must crack the code and decipher the message so it makes sense and can be accurately duplicated. **Discussion** After the code has been deciphered, ask the class the following questions: 1. How did you feel when you were trying to break the code? 2. Was it frustrating? 3. When did it start to make sense or get easier?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	4. Where do we find codes in animal reproduction? *(genetics)* 5. What is a key item in genetic reproduction? *(DNA)* 6. How does this information get replicated?
Write the problem statement on the board.	***HOW DOES DNA REPRODUCE ITSELF?*** **Discussion** Discuss the following questions and have a student write the answers on the board: 1. What does DNA stand for? (*deoxyribonucleic acid*) 2. What is DNA? (*DNA is a double helix that carries the genes. It is a blueprint for life and indicates what an organism will be and what traits it will possess.*) 3. What comprises DNA?
Distribute the handout -- *DNA Helix* on page 6.0.3-33.	*DNA is made of two strands (double helix).* Each of these strands is a long chain made up of segments called nucleotides. Each of these nucleotides contains three ingredients: a. deoxyribose -- a sugar b. phosphate group c. one of four kinds of chemical bases: adenine (A), cytosine (C), guanine (G), and thymine (T). These bases are the key to the genetic code. Each DNA molecule contains one complete set of instructions (genetic code). The four chemical bases are like the letters of the alphabet. They are used to make specific genetic "words" and the way they are arranged makes "sentences." These sentences communicate specific genetic information; for example - *"Sally will have blue eyes; she will be exactly 5'6"*. **Note**: G (guanine) always pairs with C (cytosine); T (thymine) always pairs with A (adenine). The code deciphered earlier in this lesson was one complete set of instructions, but each piece was needed to determine the entire code. If part of a code is missing, you probably won't be able to decipher it correctly. Now imagine how many codes are in DNA! Since DNA is stored within each cell, as each cell dies its DNA dies too. So, DNA may replicate up to 50 billion times in a lifetime! Now you see why DNA **must** replicate correctly.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	4. How important is it that each **complete** DNA code get passed on? 5. How do you think this is accomplished when the cells divide? *(mitosis)* 6. How many of you know how money is made? First, very precise, detailed engraving plates are made. These plates are never used to print money. Instead, copies of the plates -- called printing plates -- are used in presses to actually print the money. Imagine how closely these original, extremely valuable plates are safeguarded. Our bodies treat DNA in much the same way. DNA is much too valuable to be used for making copies. So, the body finds something else to use for this purpose (similar to printing plates). That's where RNA comes into play. 7. What does RNA stand for? *(ribonucleic acid).* RNA is a little like DNA; for example, it is made of nucleotides arranged in strands. 8. What are the differences between DNA and RNA? a. The sugar in RNA is different: ribose is used. b. RNA is found only in single strands. c. Although RNA does have four chemical bases, it does not contain thymine; it contains uracil (U) instead. Whenever RNA finds thymine in DNA, it substitutes uracil. d. RNA is unstable and breaks down quickly after it completes its job. e. There are three kinds of RNA: messenger, ribosomal, and transfer. 9. What is RNA's job? *It transcribes DNA using the following process:* a. First, the DNA builds a strand of RNA using the correct bases that correspond with its parts. Remember the four chemical bases? G always bonds with C and T always bonds with A. So we get a DNA strand C-C-C-A on one side of the helix which bonds with G-G-G-T on the other side of the helix.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	The DNA helix begins to unzip, just like you would unzip your jacket. As it unzips, it builds up the corresponding RNA to bond with it. So the C-C-C-A strand makes a G-G-G-U RNA strand. (Remember that RNA replaces T with U.) b. Then the DNA sends the messenger RNA (mRNA) from the nucleus and into the cytoplasm. Its job is to find its complements (G, A, C, U). c. Next, the mRNA finds the ribosomal RNA which acts like a printing press. d. Now the transfer RNA (tRNA) bounces around in the cytoplasm. It finds the "spare parts" (chemical bases) that the ribosomal RNA needs and connects them to the correct bases. When finished, all the amino acids found by the tRNA are connected at the right places. Now you have a new strand of DNA! This whole process takes about 2 minutes from start to finish. When the class was trying to decipher the DNA code earlier in this lesson, the instructor acted like the DNA and the student groups acted like the RNA. That is, the instructor knew the complete code and replicated it exactly so the message would be accurately reproduced. The student groups acted like RNA. Each group member retrieved specific information that was used by the group to decipher the code and obtain all the information. Each group would then verify the information and decipher the code; therefore replicating what the instructor already knew.
Note: This is difficult material and may require up to three class sessions to complete.	**Review** 1. What does DNA do? (*It holds the genetic code.*) 2. What does it look like? (*a double helix*) 3. What is its state? (*It is stable.*) 4. What does RNA do? (*It replicates the DNA.*) 5. What does it look like? (*a single strand*) 6. What happens to it when its job is done? (*It breaks up.*) **Evaluation** Ask the students to describe the functions of DNA and RNA. Give them 15 minutes to complete the task.

• Forked Road •

Problem-Solving Technique

Define the problem

What are the physical and chemical properties of DNA?

Factors to Consider	Choice 1	Choice 2
	Physical	*Chemical*

Decision/Recommendation

The DNA molecule is extremely long and acidic in nature and the strands can bend without breaking. This flexible property of DNA allows it to spool on the rod.

• Forked Road •

Problem-Solving Technique

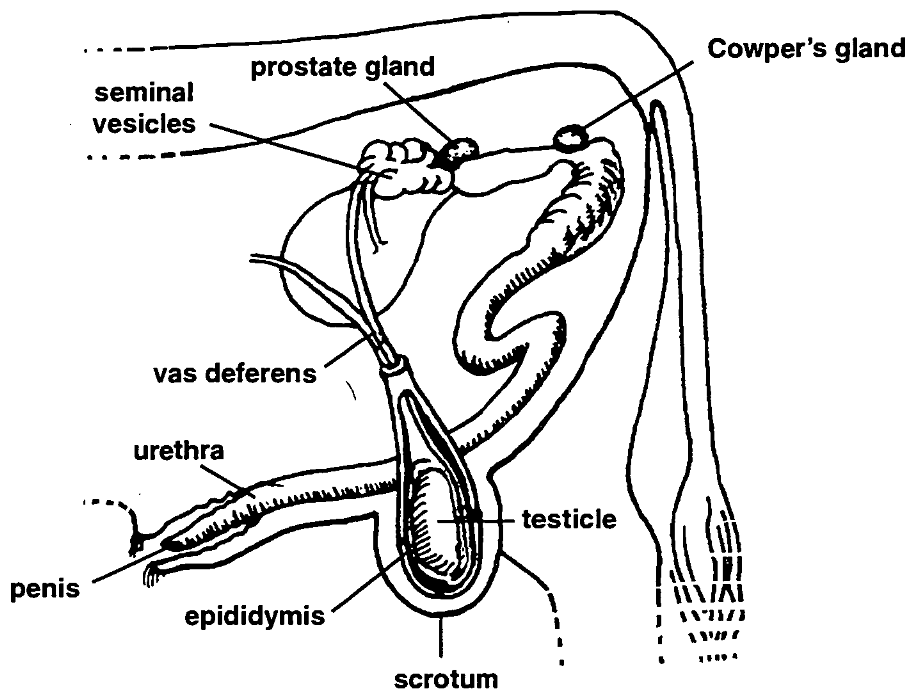
Define the problem

What are the physical and chemical properties of DNA?

Factors to Consider	Choice 1	Choice 2
	Physical	*Chemical*

Decision/Recommendation

Male Reproductive System



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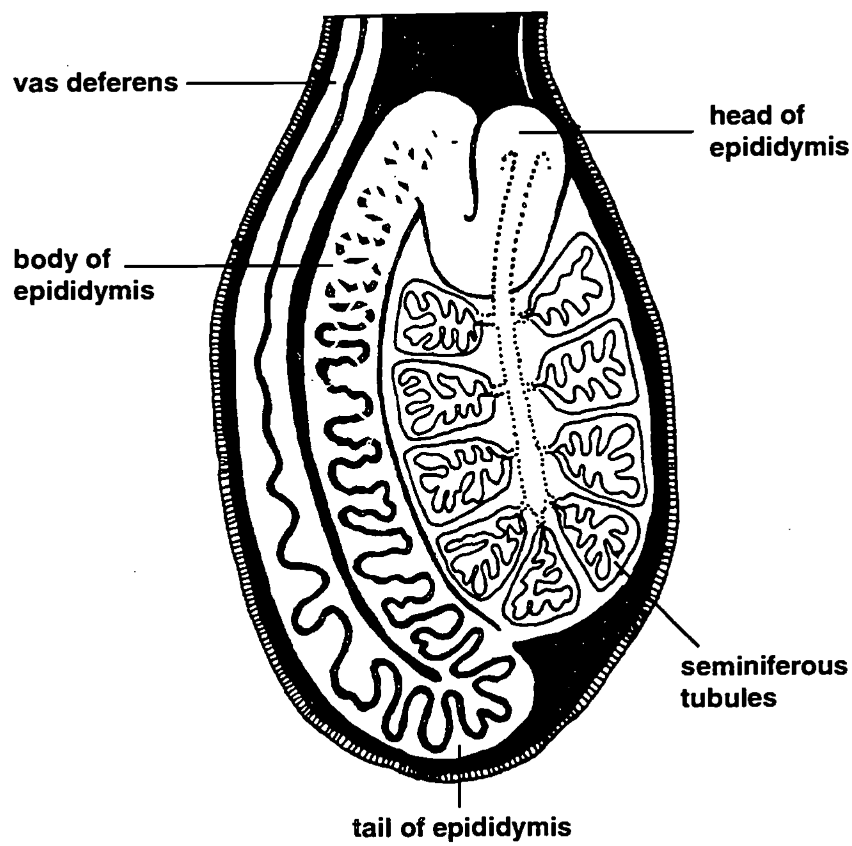
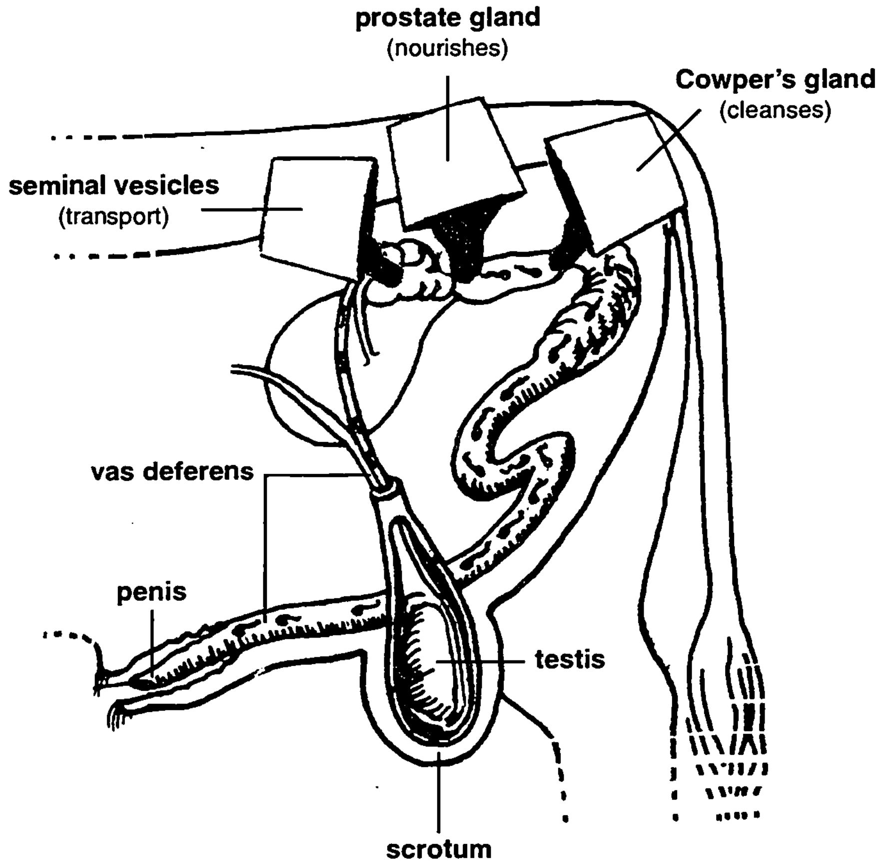
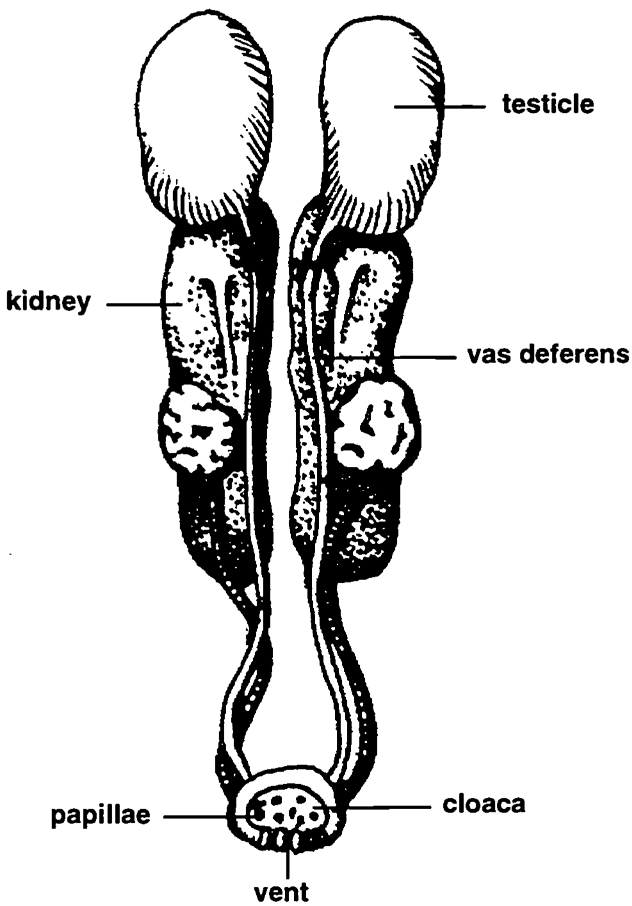
Inside a Testis



Path the Sperm Travel through the Male's Body



Male Reproductive System in Poultry



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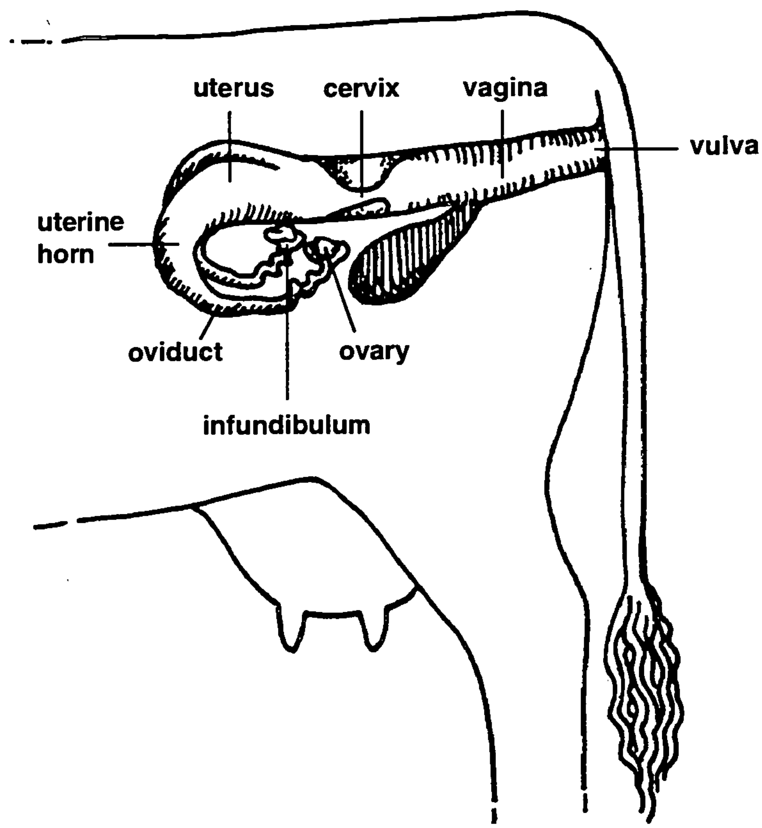
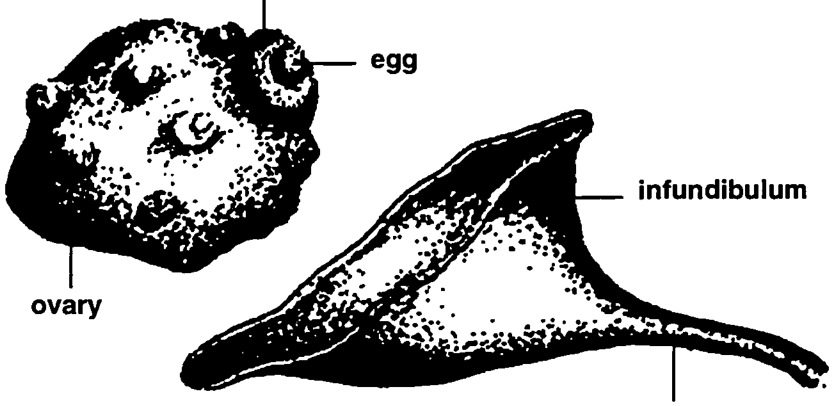
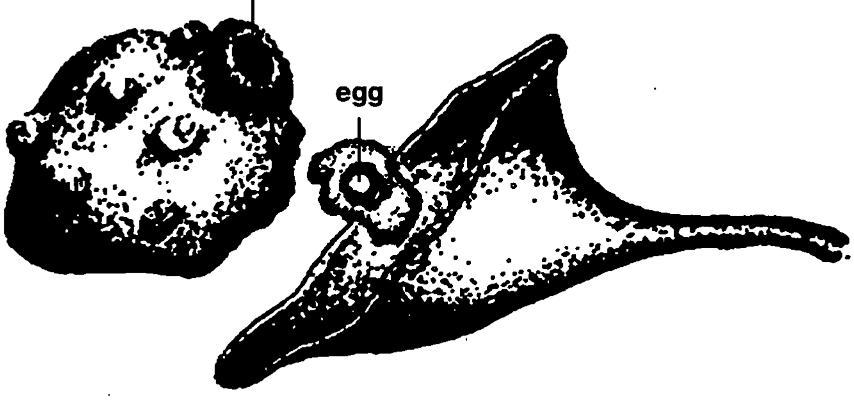
Female Reproductive System



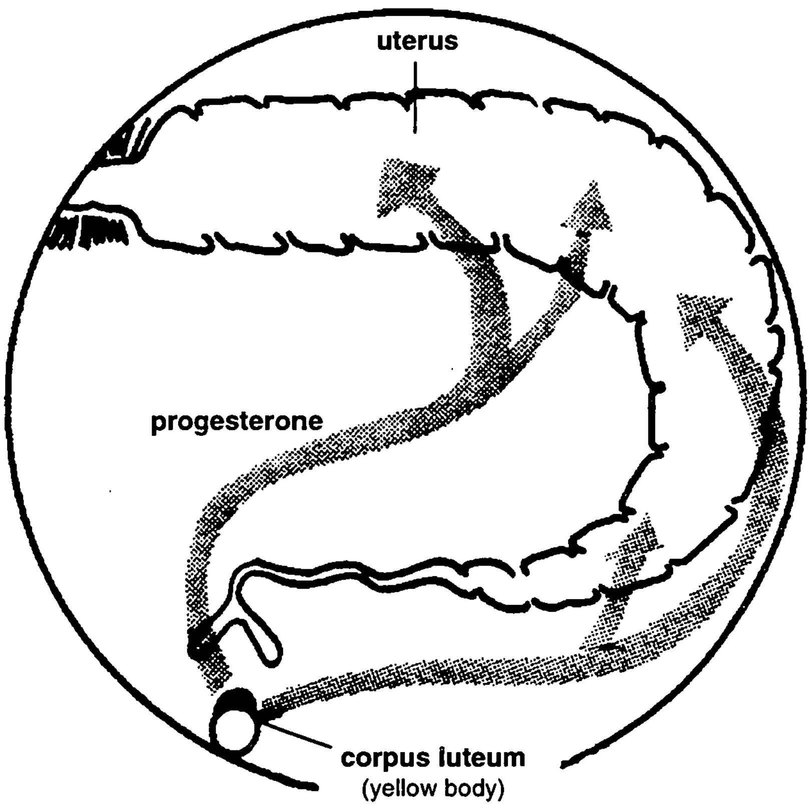
A Follicle Forms on the Ovary



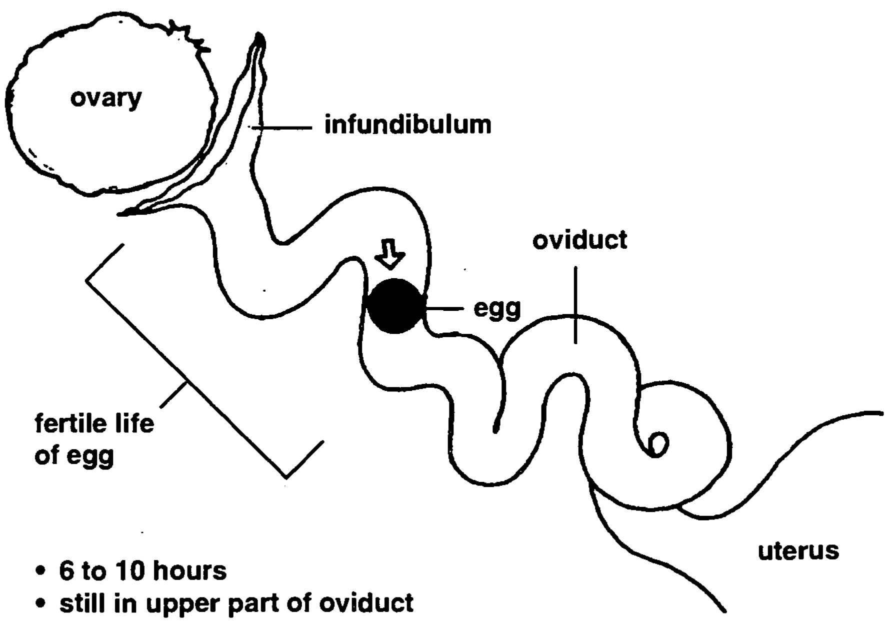
Corpus Luteum Replaces the Follicle



Progesterone Prepares the Uterus for Pregnancy



The Egg Travels to the Uterus



- 6 to 10 hours
- still in upper part of oviduct

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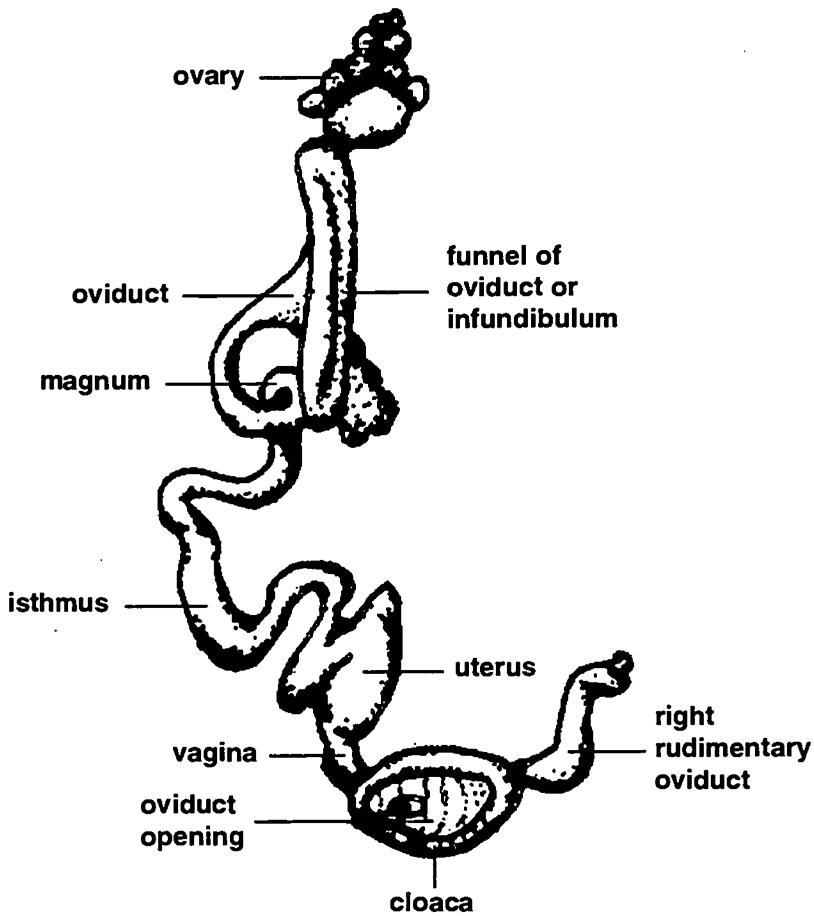
Female Reproductive System in Poultry



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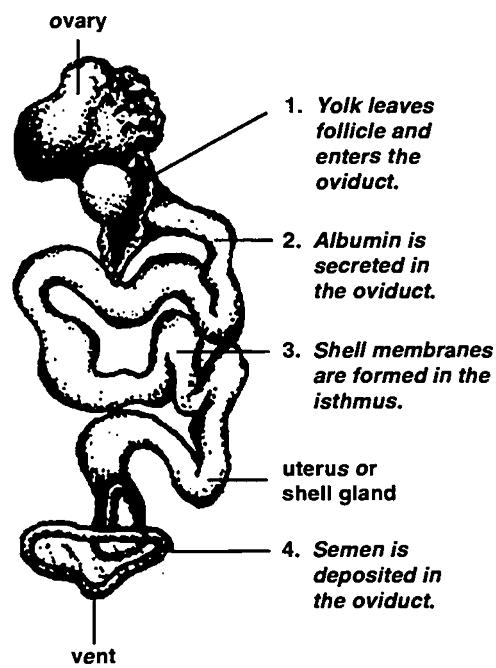
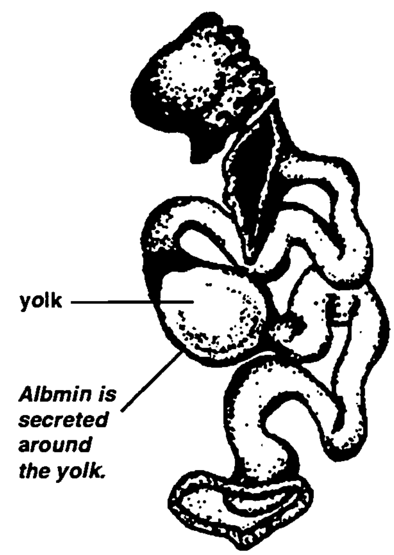
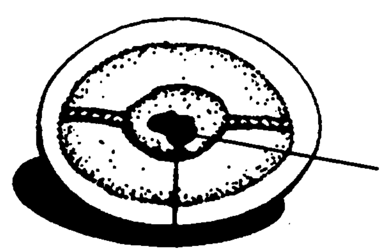
Egg Formation and Fertilization in Poultry







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Obtaining a Tissue Sample

• **Steps/Key Points** •

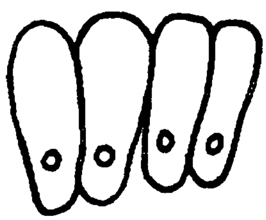
Problem-Solving Technique

Define the problem

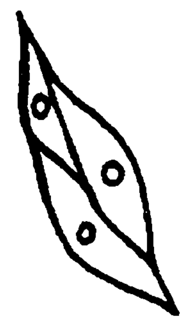
How do you take a tissue sample?

What to Do (Steps)	How to Do It (Key Points)
1. Clean work area and assemble equipment.	Wipe table or counter with rubbing alcohol and towel to disinfect. Place flathead toothpicks, clean slide, and clean cover slip on clean tissue or paper towel on the disinfected surface.
2. Gather tissue sample.	Using one hand, gently pinch the outside of your cheek and pull to the side; hold this position. Next, using the other hand, carefully and lightly scrape the inside of the pinched cheek (inside your mouth) with the flat side of the toothpick.
3. Place tissue sample on slide.	Gently roll the toothpick from side to side on a clean blank slide until the tissue sample is transferred onto the slide. Place the right or left side of a clean cover slip on the slide at a 45° angle. Gently place the cover slip over the tissue sample.
4. Check for completeness of tissue sample.	Make sure the cover slip completely covers the tissue sample and adheres with no bubbles.

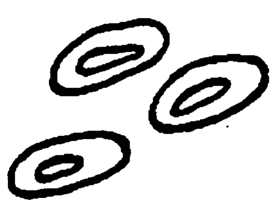
Common Cell Shapes



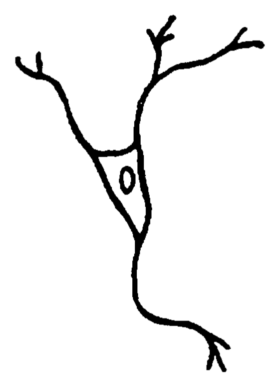
skin cells



muscle cells



white blood cells



nerve cells

DNA Code Sheet

Teacher Instructions

Clue 1

141523, 251521, 111423, 2085, 31545

Divide the class into groups of three to four students. Write this code on the board and ask the students in each group to copy it on a sheet of paper (one per group). Ask them to decipher the message (give them a couple of minutes). This will be difficult because the students will be unable to distinguish the correct number of single- and two-digit numbers.

Clue 2

14-15-23, 25-15-21, 11-14-23, 20-8-5, 3-15-4-5

Now announce that you will begin to decipher the code. Ask each student in each group to come up to your desk at least one time to gather more information about the code (i.e., one student per trip per word in the code). Each time a student approaches you, place dashes in his/her message to separate the numbers. Do this without talking so the other groups will not hear your descriptions. For example: 141523 now becomes 14-15-23. Give them a little time between trips to decipher the message.

Clue 3

Now write this information on the board: A = 1, B = 2, C = 3, and D = 4.

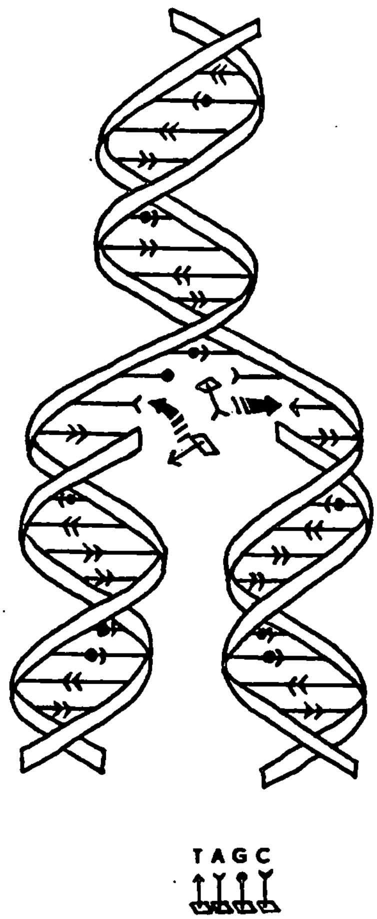
Give them more information as they need it (see below).

A = 1	J = 10	S = 19
B = 2	K = 11	T = 20
C = 3	L = 12	U = 21
D = 4	M = 13	V = 22
E = 5	N = 14	W = 23
F = 6	O = 15	X = 24
G = 7	P = 16	Y = 25
H = 8	Q = 17	Z = 26
I = 9	R = 18	

This last clue should give them sufficient information to complete the coded message. Have each group bring their completed message up to you to verify its correct translation.

Translation: "Now you know the code."

DNA Helix



Helping Students Apply Concepts/Principles/Skills

Biotechnology has the potential to greatly affect future animal agriculture. The word biotechnology can be divided into its root words: **bio** which means life, and **technology** which means applying science to solve a problem. Biotechnology is the collection of techniques that use living organisms to make products or solve problems. The most common techniques include genetic engineering, diagnostics, and cell/tissue culture.

Biotechnology is currently being used in animal science to improve reproduction and animal health, create useful products from animal waste, and increase lean meat and milk production. Before biotechnology, producers utilized selective breeding to improve performance. With biotechnology animal scientists can save, store, and even split valuable embryos, thus reproducing genetically identical offspring. Biotechnology is also being used to eliminate the harmful side effects of vaccines and to develop disease resistance in animals.

Bioprocessing uses biotechnology to convert livestock waste into beneficial products. Leaner meat and increased milk production is also a reality today with the development of growth hormones that increase gain and feeding efficiency. Animal products are made more nutritionally desirable through biotechnology techniques which result in less fat.

The application of biotechnology in animal agriculture will continue to grow as more is learned about the genetic make-up of animals. Although the fundamental genetic material -- DNA -- is well understood (you will extract it from *E. coli* cells), the complexity of multi-gene traits makes them difficult to engineer or control.

Ideas for Other Experiments

Similar procedures can be used to extract DNA from other organisms, particularly plants (e.g., an onion).

Evaluating Student Learning

After the students have completed this experiment, have them record their data and observations on pages 6.0.3-35 and -36.

This activity was submitted by Darrell Rubel and Terri Porter, Department of Agricultural Education, The Ohio State University, Columbus, Ohio. It was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

____

PLAN	ACTUAL
Experimental Design	**Procedure**

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PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**6 - Animal Science**

Determine Outcome of Genetic Crosses

Competency/Terminal Performance Objective

6.0.4: Given examples of modes of inheritance, determine outcome of genetic crosses, based on definitions provided in criterion assessment instrument.

Competency Builders/Pupil Performance Objectives

6.0.4.1 Given examples of genetic crosses, recognize relationship of dominant and recessive genes, based on definitions provided.

6.0.4.2 Given specific traits desired, compare selection processes, according to criterion assessment instrument.

6.0.4.3 Given examples of genetic crosses, determine phenotype for dominance, blending (no dominance), additive (no dominance), and epistasis gene actions, according to definitions provided.

6.0.4.4 Given examples of gene actions, describe how dominance, blending (no dominance), additive (no dominance), and epistasis gene actions affect animals, based on definitions provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies *(continued)*

Mathematics:

1.2.1 Round and/or truncate numbers to designated place value.

1.2.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations.

1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages).

1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers.

1.2.5 Set up, solve, and apply ratios and proportions.

1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions.

1.2.7 Translate written and/or verbal statements into mathematical expressions.

1.2.8 Estimate answers.

3.2.5 Use elementary notions of probability

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. piece of round cardboard 8" in diameter
2. plastic spinner
3. marker
4. pencil and eraser

Situation

This activity is to be conducted with a class of Level II Agriscience students.

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures: Interest Approach/Teaching Methods</th></tr>
<tr><td>Make arrangements for students to interview local animal producers.</td><td>Interest Approach
Have students interview a local animal producer. They should ask questions about his/her breeding and genetics program. For example: what traits the producer would like to improve, and how he or she intends to do this. Does the producer use crossbreeding? Why or why not? Does the producer artificially inseminate the animals?</td></tr>
<tr><td>Use the information on pages 6.0.4-5 and -6 (student copy).</td><td>Procedure
1. Using the marker, divide a piece of cardboard into 4 equal sections so it resembles a punnet square.
2. Place the plastic spinner in the center of the cardboard circle.
3. Using a pencil, write on the cardboard the symbols for the sample problems listed at the end of this section.
EXAMPLE: homozygous traits - Spider syndrome is a genetic problem in sheep. Sheep develop a Roman nose and the legs bend inward. These sheep generally do not live to be more than 2 or 3 years of age. Spider syndrome is a homozygous recessive trait. If a ram with this syndrome is mated to sheep carrying this syndrome, but not showing its physical characteristics, what are the genotypic and phenotypic ratios in the offspring?
n - represents the gene for spider syndrome
N - represents the normal dominant gene
4. Spin the spinner 4 times, once for each offspring. The anticipated results of this particular example are 2Nn and 2nn, therefore producing the genotypic ratio of 1:1. Perform a similar routine for the phenotype.
Sample Problems
• White Bengal tigers lack some pigment. The Brookfield Zoo has a white, male Bengal tiger (ww). He was mated to 4 homozygous dominant females (WW) who are all orange. What will the offspring look like? What will the genotypic ratio be?
• In guinea pigs, short hair (L) is dominant over long hair (1). Two heterozygous short-haired guinea pigs are mated. Determine their genotypic and phenotypic ratios.</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* **Sample Problems** • A roan-colored (Rr) cow has a combination of red and white hairs; its phenotype is a codominant color. A red bull (RR) is mated to 5 roan (Rr) females and 3 white females (rr). Determine the genotypic and phenotypic ratios for each of these matings. • The creeper syndrome in chickens results in the severe shortening of legs. A chicken producer mates a rooster (Cc) to 5 hens that are carrying the creeper gene also (Cc). What are the genotypic and phenotypic ratios of the offspring?
	Data Summary and Analysis Record data and discuss results.
	Key Terms 1. *probability* - ratio of the number of specified events to the total number of events. 2. *phenotype* - the external appearance or other physically observable or measurable characteristics. 3. *genotype* - the genetic make-up of an individual. 4. *codominance* - the phenotype of a heterozygote is different from the phenotype of either homozygous class. 5. *testcross* - crossing an individual with a homozygous recessive to determine the genetic make-up (i.e., to determine if an animal has an undesirable trait such as spider syndrome in sheep). 6. *lethal gene* - an animal carrying the lethal gene dies at birth or shortly thereafter. It is the homozygous recessive genotype. 7. *dominant* - refers to the gene that is expressed in the presence of another (recessive) gene. 8. *recessive* - refers to the gene that is not expressed when in the presence of another (dominant) gene. 9. *homozygote* - an individual who has a chromosome pair with the same gene at a specific locus (WW). 10. *heterozygote* - an individual who has a chromosome pair with 2 different genes at the same locus (Ww).

• Four Question •
Problem-Solving Technique

Question 1: How important is this competency?

Question 2: What problems have we had with this competency?

Question 3: What do we need to know or be able to do in order to correct or prevent these problems?

Question 4: What is the specific related information we need about these "things" we said we need to know or be able to do?

• Four Question •

Problem-Solving Technique

Question 1: How important is this competency?

Question 2: What problems have we had with this competency?

Question 3: What do we need to know or be able to do in order to correct or prevent these problems?

Question 4: What is the specific related information we need about these "things" we said we need to know or be able to do?

Helping Students Apply Concepts/Principles/Skills

Animal producers use genetics to improve their herd or flock mainly through reproduction. By breeding particular animals with each other, producers can improve a particular quality or trait, eliminate unwanted characteristics, and improve overall animal production. Researchers have linked several animal diseases to genetic inheritance; for example, spider syndrome in sheep, D.U.M.P.S. in cattle, and creeper syndrome in chickens. By understanding genetic principles, animal producers can continually improve their animals' production levels. Producers are also able to formulate breeding programs to produce the best traits in their animals. For example, in dairy cows, producers can mate a high milk-producing female with a male who has a good progeny record and high-producing parents. Using this method with their own cows, producers can increase their herds' milk production.

Another advantage of understanding genetic principles is **crossbreeding**. By mating two different breeds in a species, producers can combine the positive traits of each breed. In beef cattle, mating an Angus male to a Brahman female is a good example of crossbreeding. Producers can take advantage of the heat tolerance and parasite resistance qualities of the Brahman breed, but still maintain the carcass qualities and mothering ability of Angus cattle.

Evaluating Student Learning

After completing this activity, have students record their data and observations on pages 6.0.4-8 and -9.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**6 - Animal Science**

Determine How to Maintain Animal Heath

Competency/Terminal Performance Objective

6.0.5: Given specific animal type, use, and environment, determine how to maintain animal health, based on criteria given in assessment instrument.

Competency Builders/Pupil Performance Objectives

6.0.5.1 Given specific examples, identify signs of good and poor health, according to criterion assessment instrument.

6.0.5.2 Given specific examples of health problems, identify symptoms of diseases and parasites, according to criterion assessment instrument.

6.0.5.3 Given possible health problems, describe methods for preventing health problems, based on industry standard.

6.0.5.4 Given various health problems, explain methods of treating health problems, based on description of methods provided.

Applied Academics Competencies

Communications:

1.0.2	Select and use appropriate reference sources and illustrative materials
1.0.4	Determine solutions to problems
1.0.6	Make predictions about information
1.0.8	Define words used in context
2.0.3	Record observations
2.0.4	Prepare written report(s)
2.0.9	Write legibly
2.0.13	Use correct grammar
2.0.14	Use correct spelling
2.0.15	Write complete sentences
3.0.1	Demonstrate effective listening skills
3.0.4	Identify sources of information
3.0.6	Follow directions
4.0.3	Participate in discussions
4.0.12	Use appropriate language

Applied Academics Competencies *(continued)*

Math:

1.2.1	Round and/or truncate numbers to designated place value.
2.2.1	Convert, compare, and compute with common units of measurements within and/or across measurement systems.
2.2.2	Compute using appropriate units of measurement.
2.2.3	Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.
2.2.4	Estimate measurements.
3.2.6	Use problem-solving techniques.
4.2.4	Use formulas.
5.2.2	Find surface areas and volumes of applicable geometric figures.

Equipment, Supplies, References, and Other Resources

1. rectal thermometer
2. petroleum jelly
3. 1 stethoscope per group
4. 1 dog per group
5. tissues

Situation

This activity is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Interest Approach
Use the chart on page 6.0.5-7 to explain normal vital signs for various species.	Have students who live on farms or have pets check the vital signs of their own livestock. Note the variations within species. Discuss the normal readings for various species.
	Procedure
Make proper arrangements for the dogs to be brought to class.	1. Ask students to bring in their own dogs or arrange to have dogs brought in from the local humane society.
	2. After obtaining the dogs, proceed with the physical exams.
	3. First, get acquainted with each "patient." This helps to calm the dog and make it much easier to work with the animal. Remember the dog may not appreciate what is taking place.
Use the information on pages 6.0.5-5 and 6 (student copy).	4. Assess the overall condition of each animal (i.e., is it excited and wagging its tail, or lethargic?). How does its coat look – shiny or dull? Are the eyes bright and responsive, or dull and glazed over?
	5. Next, check the CRT (capillary refill time). Raise the dog's upper lip and press on the gums. In a healthy animal the gums will turn white and then return to their original pink. The normal response time is 1 to 3 seconds. If the gums stay white for more than 3 seconds, this indicates the animal is in or going into shock.
	6. Next, check each dog's temperature. Take this rectally by following these steps: a. Shake down the thermometer. b. Dip the thermometer in petroleum jelly. Lift the dog's tail and insert the thermometer 1 1/2 to 2 inches into the rectum. Leave the thermometer in this position for one minute and then remove it. Wipe the thermometer with a tissue and note the temperature. The normal temperature for a dog is 101°-102.5° F.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* 7. Next, measure the heart rate. Since the heart rate and pulse are the same, this can be accomplished in several ways. Feel the heart beat on the left side caudal and dorsal to the elbow of a standing dog. The pulse can be felt on the inside of the dog's thigh and level with the knee. Count the number of beats in one minute. This number is the resting heart rate and pulse. A stethoscope can also be used to listen to the heart. By placing the stethoscope in different areas on the left and right side of the dog's chest, you can hear the various valves of the heart. 8. Take the respiration rate by counting the number of breaths per minute. A stethoscope can also be used to listen to lung sounds.
Complete the chart on page 6.0.5- 8.	**Data Summary and Analysis** Make a table to record results. When you are finished, compare your results to normal vital signs.
	Key Terms 1. *pulse* - the rhythmic expansion of an artery. Can be felt with a finger and correlates with the heart rate. 2. *respiration* - the exchange of oxygen and carbon dioxide between the atmosphere and body cells. This takes place in the alveoli of the lungs. 3. *capillary refill time (CRT)* - the amount of time it takes for blood to refill into the capillaries after pressure is applied to the area.

• Forked Road •

Problem-Solving Technique

Define the problem

What are the vital signs of a healthy dog?

Factors to Consider	Choice one	Choice two
Rectal Temperature (° F)		
Average & Normal Range (° F)		
Average Respiration Rate, per minute		
Average Heart Rate, per minute		

Decision/Recommendation

The animals brought to class will probably be healthy and have normal vital signs.

• Forked Road •

Problem-Solving Technique

Define the problem

What are the vital signs of a healthy dog?

Factors to Consider	Choice one	Choice two

Decision/Recommendation

Normal Vital Signs of Various Species

	Cattle	Swine	Horses	Sheep
Rectal Temperature (° F)	101.5	102.5	100.0	102.3
Average & Normal Range (° F)	100.4-102.8	101.6-103.6	99.1-100.8	100.9-103.8
Average Respiration Rate, per minute	30	16	12	19
Average Heart Rate, per minute	50	60	45	75

Vital Signs of Dogs

	Normal	Actual
Temperature	102	
Heart Rate/Pulse	100/130	
Respiration Rate	22	

Helping Students Apply Concepts/Principles/Skills

A large portion of the agricultural industry involves raising and researching animal health. Drug companies are continually investing money in new antibiotics, vaccines, and other drugs for the improvement of animal health. Recognizing the normal vital signs of a healthy animal is very important. It is difficult to assess a health problem without knowing what is normal for a particular animal.

Ideas for Other Experiments

1. Have students check the vital signs of other animals they have at home (e.g., pets and farm animals).
2. Check the vital signs of animals that are under stress. Compare the results to normal readings.

Evaluating Student Learning

After completing this activity, have students record their data and observations on pages 6.0.5-9 and 10.

This activity was adapted from *Biological Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	Results

NOTES

Conclusions

Program	AGRISCIENCE
Unit	7 - Mechanical Science

Explain Electrical Current

Competency/Terminal Performance Objective

7.0.1: Given electrical components and an explanation of terms and laws, explain electrical current, according to criterion assessment.

Competency Builders/Pupil Performance Objectives

7.0.1.1 Given examples, identify common conductors and insulators, according to criterion assessment instrument.

7.0.1.2 Given examples, describe components of complete circuit by constructing a working circuit.

7.0.1.3 Given examples, explain how electricity flows along a complete circuit, by constructing or drawing a working circuit.

7.0.1.4 Provided with examples, identify sources of electricity production, based on criterion assessment instrument.

Applied Academics Competencies

Communications:

1.0.2 Select and use appropriate reference sources and illustrative materials.
1.0.4 Determine solutions to problems.
1.0.6 Make predictions about information.
1.0.8 Define words used in context.
2.0.3 Record observations.
2.0.4 Prepare written report(s).
2.0.9 Write legibly.
2.0.13 Use correct grammar.
2.0.14 Use correct spelling.
2.0.15 Write complete sentences.
3.0.1 Demonstrate effective listening skills.
3.0.4 Identify sources of information.
3.0.6 Follow directions.
4.0.3 Participate in discussions.
4.0.12 Use appropriate language.

Applied Academics Competencies *(continued)*

Mathematics: *(continued)*

1.2.1 Round and/or truncate numbers to designated place value.
1.2.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations.
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages).
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers.
1.2.5 Set up, solve, and apply ratios and proportions.
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions.
1.2.7 Translate written and/or verbal statements into mathematical expressions.
1.2.8 Estimate answers.
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems.
2.2.2 Compute using appropriate units of measurement.
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.
2.2.4 Estimate measurements.
3.2.6 Use problem-solving techniques.
4.2.4 Use formulas.
5.2.2 Find surface areas and volumes of applicable geometric figures.

Equipment, Supplies, References, and Other Resources

ACTIVITY 1

1. power supply, DC
2. 3 wires for connections
3. switch, SPST (single pole, single throw)
4. lamp - 6 volts
5. lamp socket
6. 2 clips for holding test strips
7. iron wire - 3 1/2" long
8. copper wire - bare, 3 1/2" long
9. aluminum strip - 5" x 3/4"
10. carbon strip - 5" x 3/4" or pencil lead - 3 1/2" long
11. plastic rod - 5" x 1/4"
12. dowel rod - 5" x 1/4"
13. piece of paper - 4" x 1/4"
14. string - 4" long

Equipment, Supplies, References, and Other Resources *(continued)*

ACTIVITY 2

Equipment Needed for All Experiments in Activity 2 and Interest Approach

1. 1-0-1 mA, DC meter
2. test leads with alligator clips on both ends
3. wires for connections (No. 18 and 20, flexible)
4. citrus fruit - orange, lemon, or grapefuit

Additional Equipment for each Experiment

EMF by Chemical Reaction

1. voltmeter, 0-10, DC
2. electrode set
3. saltwater solution - pint
4. sal ammoniac solution - pint
5. voltaic cell unit

EMF by Magnetism

1. magnet - permanent, bar type, at least 5" long
2. insulated wire
3. directional compass

EMF by Heat

1. candle
2. wire - copper, bare, 5" long
3. wire - iron, 5" long

EMF by Solar Radiation

- solar cell

Situation

These experiments are to be conducted with a class of Level II Agriscience students.

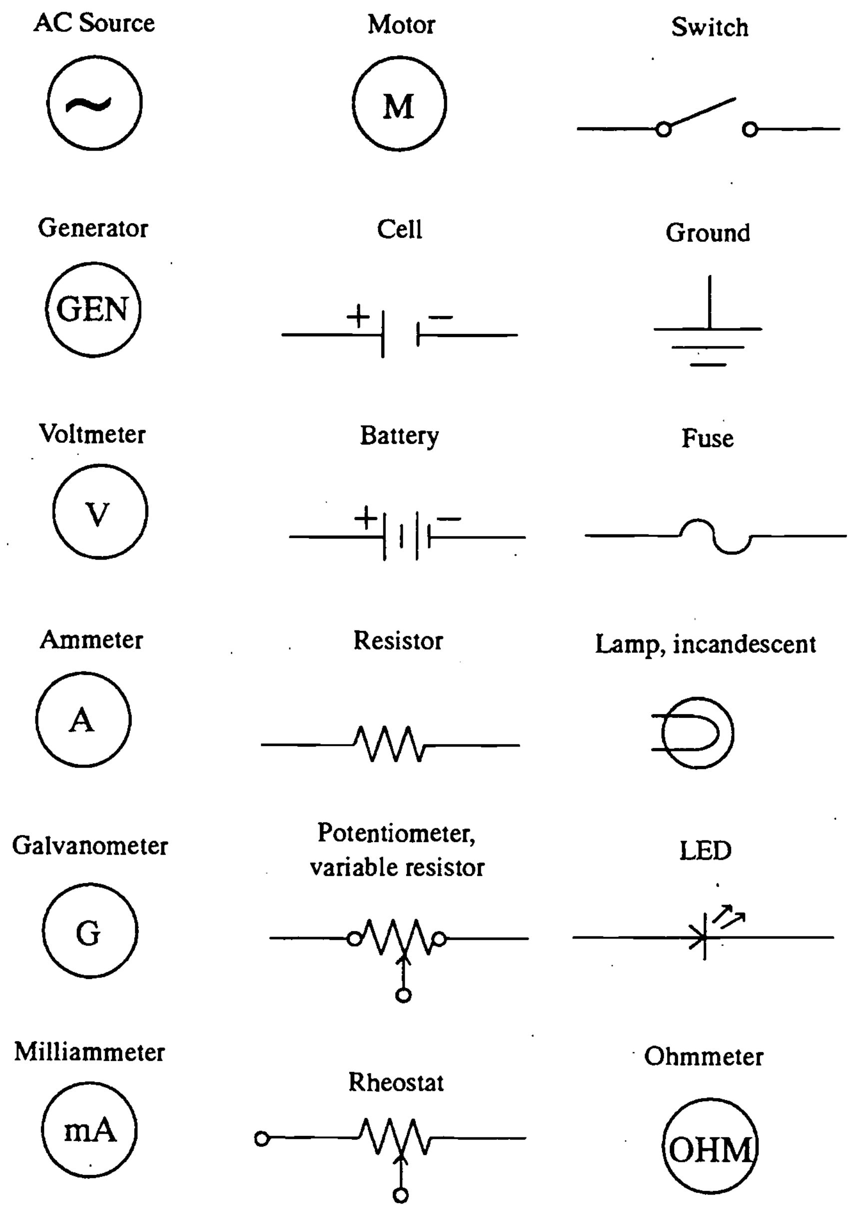
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring to class samples of common electrical cords and cable with varying insulation materials. Use samples which have markings identifying the type of material/conductor in the cable and type of insulation. Use information on pages 7.0.1-8 and -9. Use information on page 7.0.1-10.	**Interest Approach** Display samples of common electrical cords and cable with varying insulation materials. Have students identify the materials used in these cords/cables. Discuss why these materials are good insulators or conductors. **ACTIVITY 1** **Procedure** 1. Connect the circuit shown on page 7.0.1-10. (Be sure the power supply is OFF). 2. Place the switch in the OFF position and turn on the power supply. Adjust the output to 6 volts. 3. Turn the switch ON and observe the light. 4. Turn the power supply off, remove the connections to the switch, and attach test clips to the wires in place of the switch. 5. Attach the test clips to the various materials, turn on the power supply for each test, and note if the lamp glows. 6. Conclude whether the material is an insulator or a conductor. 7. Turn off the power supply, disconnect the circuit, and store the materials.
Use the information on pages 7.0.1-11 and -12 (student copy).	**Data Summary and Analysis** Have students record their results. Laboratory reports should include answers to the following questions: 1. What is necessary to have a complete circuit? 2. Why are some materials conductors and others insulators?
	Key Terms 1. *circuit* - a path for electrons to move through components and wires. 2. *complete circuit* - a path for electrons to flow from the power source to the consuming device and back to the power source. 3. *current* - movement of electrons in a negative-to-positive direction along a conductor. 4. *conductor* - solid, liquid or gas that permits flow of electrons. 5. *direct current* - current that flows in one direction only; abbreviated DC. 6. *insulator* - nonconducting material lacking a sufficient supply of free electrons to allow for movement.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring to class 1-0-1 mA DC meter, 1 copper nail, 1 galvanized nail, 2 connection wires or clip leads, and 1 citrus fruit.	**Interest Approach** Ask students what is needed to produce electricity. Could electricity be produced with two nails and a piece of fruit? Conduct the following demonstration to produce an electromotive force (emf). Connect the copper nail to the positive side of the meter and the galvanized nail to the negative side of the meter using the connection wires or clip leads. Touch the nails together and observe results. Push the two nails into half a lemon, orange, or grapefruit making sure that the nails do not touch. Observe results. **ACTIVITY 2** **Procedure** *EMF BY CHEMICAL REACTION* 1. Set up a cell unit by attaching a copper strip and a zinc strip to the unit. 2. Fill the glass two-thirds full of salt water solution and lower the electrodes into the solution. 3. Set the voltmeter to read 0 - 5 volts DC and connect the meter to the terminals of the cell. 4. Record the voltage output of the cell. 5. Remove the electrodes from the salt water solution and pour the solution back into the jar. 6. Rinse off the electrodes and glass to remove any salt water solution. 7. Fill the cell unit two-thirds full of sal ammoniac solution. 8. Connect the meter to the terminals and record the voltage. 9. Remove the electrodes from the solution and rinse to clean. 10. Remove the copper strip and replace it with the carbon strip. 11. Place the electrodes in the sal ammoniac solution and connect the meter to the cell. 12. Record the voltage output of the cell.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* *EMF BY MAGNETISM* 1. Wrap a piece of insulated wire around your hand to form a coil. 2. Connect each end of the coil to a clip lead. 3. Connect the leads to a 1-0-1 mA DC meter. 4. Find the N end of the magnet using a compass. 5. Push the N end of the magnet into the coil and observe the action of the meter. 6. Hold the magnet stationary in the coil and observe action of meter. 7. Push the S end of the magnet into the coil and observe the action of the meter. 8. Quickly withdraw the magnet from the coil and observe action of the meter. *EMF BY HEAT* 1. Cross the copper and iron wires together about 2 inches from one end. 2. Twist the wires together for the remainder of their lengths. 3. Wrap the twisted wires around a pencil to compress the length of the section. Remove the pencil. 4. Connect the copper wire to the positive terminal of a 1-0-1 mA DC meter and the iron wire to the negative terminal of the meter. 5. Light the candle and heat the twisted section of the wire. 6. Observe the action of the meter. *EMF BY SOLAR RADIATION* 1. Connect a solar cell to a 1-0-1 mA DC meter. 2. Bring a strong light source to the solar cell. 3. Record the deflection of the meter.
Use the table on page 7.0.1-13. Use the information on pages 7.0.1-14 and -15 (student copy).	**Data Summary and Analysis** *EMF by Chemical Reaction* 1. Record the voltage and polarity of each pole. 2. Compare the polarity of the electrodes and the voltage outputs for the copper and zinc strips in salt water solution, sal ammoniac, and the carbon and zinc strips in sal ammoniac solution. 3. As a result of your findings, how can you justify the use of zinc, carbon, and sal ammoniac as the active elements in commercial dry cells?

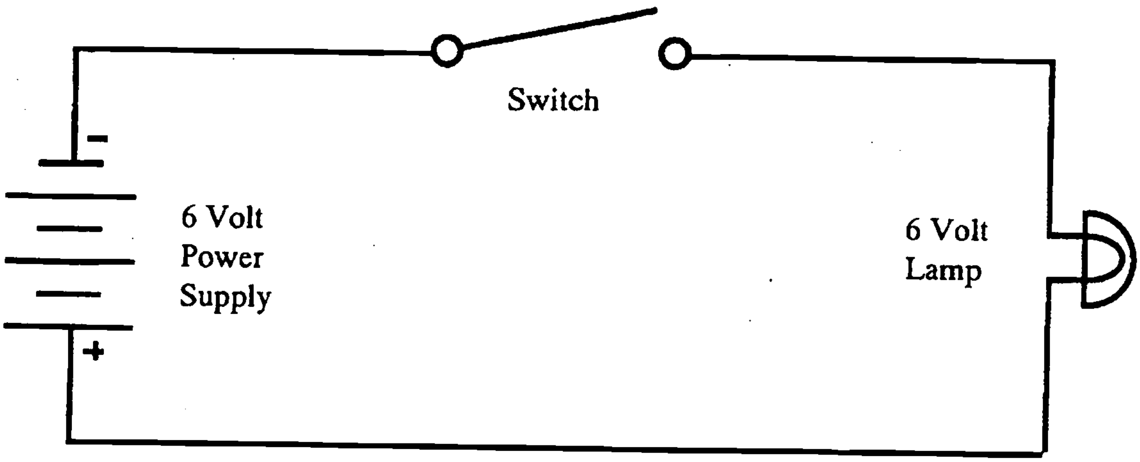
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Data Summary and Analysis *(continued)* *EMF by Magnetism* 1. Record the direction of meter deflection as the magnet's position and movement are changed. 2. When the magnet is pulled out of the coil, which direction does the meter move? 3. What happens when the magnet is inserted into the coil and left there without moving? *EMF by Heat* 1. Record the voltage output for this apparatus. 2. Is the method of generation as efficient as the chemical method? *EMF by Solar Radiation* 1. Record the meter deflection for this apparatus. 2. Does the meter deflection indicate more or less generation of an emf when the light source is brought near the solar cell?
	Key Terms 1. *ammeter* - device used to measure current in a circuit. 2. *cell* - a device that produces an electromotive force by chemical action. A cell is usually made from 2 electrodes and an electrolyte. 3. *conductor* - a solid, liquid, or gas that permits flow of electrons. 4. *electricity* - form of energy present when electrons move through a complete path. 5. *electromotive force* - force that causes electrons to move through a conductor; abbreviated EMF. Also referred to as voltage. 6. *electron* - negatively charged atomic particle that normally revolves around the nucleus of an atom. 7. *magnetic field* - forces present around the ends of a magnet. 8. *solar cell* - cell that turns light energy into electrical energy.

Schematic Symbols



Common Insulation Materials, Cables, and Flexible Cords Used in Electric Wiring

Material	Type Letter	Description	Use
INSULATIONS			
Rubber	RH & RHH	Heat-resistant rubber	Dry locations
Latex rubber	RUW	Moisture-resistant latex rubber	Dry and wet locations
Thermoplastic	T	Thermoplastic	Dry locations
CABLES			
Nonmetallic	NM	Fibrous, flame-retardant, and moisture-resistant sheath	Exposed and concealed work in normally dry locations - may be installed or fished into air voids in masonry block or tile walls not exposed or subject to excessive moisture or dampness
Service-entrance cable	SE	Flame-retardant, moisture-resistant cover	Generally as a service-entrance conductor on the outside of building, carrying power to service panel inside; also as branch circuit or feeder if all conductors are insulated with rubber or thermoplastic.
Flexible cables			
All thermoset parallel cord	SP-l, SP-2	Thermoset insulated, thermoset covered, with no fabric braid	Pendant or portable cords in damp places - not with hard usage - SP-2 available in #18 and #16; SP-l, #18 only - typical household extension cord
Lamp cord	C	Thermoset insulated, with cotton braid on each conductor	Pendant or portable uses in dry places not with hard usage - available in #18-10 sizes
Junior hard service cord	SJ	Thermoset insulated and covered, no fabric braid	Pendant or portable uses in damp places not with hard usage
	SJO	Thermoset insulated, oil-resistant thermoset cover, no fabric braid	Same as above
Hard service cord	S	Thermoset insulated and covered, no fabric braid	Pendant or portable use in damp places with extra hard usage


Switch
-
6 Volt
Power
Supply
+
6 Volt
Lamp

• **Effect-Cause** •
Problem-Solving Technique

Define the problem
How is electricity controlled for the purpose of doing useful work?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation
If the lamp glows when the material is placed between the clips, the material is a conductor; if not, the material is an insulator.

• Effect-Cause •
Problem-Solving Technique

Define the problem
How is electricity controlled for the purpose of doing useful work?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Cell Unit	Solution	Electrode Polarity	Voltage Output
Zinc Copper	Salt water	Zinc _______ Copper _______	
Zinc Copper	Sal Ammoniac	Zinc _______ Copper _______	
Zinc Copper	Sal Ammoniac	Zinc _______ Copper _______	

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is an electromotive force? How is it produced?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

EMF by Chemical Reaction

1. The copper electrode will be positive and the zinc electrode negative.
2. The solution of sal ammoniac with the carbon and zinc electrodes will generate a greater emf than either the zinc and copper electrodes in salt water or sal ammoniac solution.

EMF by Magnetism

1. The meter is deflected in a positive direction when the north end of the magnet is inserted into the coil.
2. The deflection stops if the magnet is not moved within the coil.
3. The meter is deflected again as the magnet is pulled from the coil.

EMF by Heat

- The voltage output for this apparatus is less than the voltage produced by the chemical reaction.

EMF by Solar Radiation

- As the light source is brought nearer the solar cell, the meter deflection increases.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is an electromotive force? How is it produced?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Agriculture is an industry which uses large quantities of energy. Energy from petroleum-based fuels is used to operate machinery for planting and harvesting crops; energy from the sun is necessary for photosynthesis which is fundamental for the growth of all crops; and energy in the form of electricity is used for lighting and heating buildings and doing many other jobs using electric motors.

The introduction of electricity into rural areas of the United States in the 1930's is another example of a technology which has transformed agriculture. Like other technologies used in agriculture, electricity is a labor saving device. Electricity from batteries replaced the hand crank needed for starting tractors. Electric motors have also replaced many tasks which were once done by hand. Today, we consider electricity a vital tool for modern agriculture.

Most tools used in agriculture can be seen. You can understand how they work because you can see what happens when they operate. Understanding electricity however can be more difficult. To understand electricity it is best to start with some of the basics.

To effectively and safely use electricity, it is important to understand some of its basic principles. Electrical devices used for agricultural purposes require current - the flow of electrons along a conductor. Current electricity flows to devices through a complete circuit. These circuits commonly consist of a source of power; a path for the electrical current to follow; and a load which converts electrical energy into heat, light, or power.

Electricity flows through conductors which are usually wrapped in a material called an insulator. Safety is a primary concern when using electricity for agricultural purposes. Normally, wet or damp conditions exist where electricity is being used on the farm. Animals are naturally grounded and are more likely to experience electrical shocks than are humans. While electricity can be very useful, it can also be deadly. Protecting animals and humans from contact with electricity is as important as using it for saving labor.

Ideas for Additional Experiments

1. Allow students to bring other materials to class to determine if they are insulators or conductors.
2. Have students hold the leads on an ohmmeter (with a good meter, a difference in emf produced by each student will be detected).
3. Use a different gauge and length of conductor to introduce the concept of voltage drop.
4. Compare the structure of a dry cell battery to the primary cell constructed for this laboratory exercise.
5. Develop a list of applications for the electricity generated by each source in this laboratory exercise.
6. Place different colors of plastic film between the solar cell and the light source and observe the deflection of the needle on the milliampere DC meter.

Evaluating Student Learning

After the students complete these experiments, have them record their data on pages 7.0.1-18 through -19.

This activity was adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 7 - Mechanical Science

Evaluate Series and Parallel Circuits

Competency/Terminal Performance Objective

7.0.2: When presented components, laws, and functions, evaluate series and parallel circuits. Items on assessment instrument must match established criteria.

Competency Builders/Pupil Performance Objectives

- 7.0.2.1 Provided with conductors and component, connect working series and parallel circuit, based on performance criteria list.
- 7.0:2.2 Provided with a series and parallel circuit, explain advantages and disadvantages of each by listing them in an assessment instrument.
- 7.0.2.3 Given a diagram and circuit, explain relationships existing in circuits containing more than one resistor, based on criteria specified in assessment instrument.
- 7.0.2.4 Given a circuit and measuring instrument, determine total current flowing through series and parallel circuits, based on performance criteria list.
- 7.0.2.5 Given a circuit and measuring instrument, determine voltages for resistors in series and parallel circuit, based on performance criteria list.
- 7.0.2.6 Given laws, state Ohm's law in its three various forms on criterion assessment instrument.
- 7.0.2.7 Given a wiring schematic with values, use Ohm's law in calculating current, resistance, or voltage for circuits on criterion assessment instrument.
- 7.0.2.8 Given specific law, explain significance of Ohm's law when planning wiring systems, by designing a circuit which complies with National Electric Code.

Applied Academics Competencies

Communications:

- 1.0.2 Select and use appropriate reference sources and illustrative materials.
- 1.0.4 Determine solutions to problems.
- 1.0.6 Make predictions about information.
- 1.0.8 Define words used in context.
- 2.0.3 Record observations.
- 2.0.4 Prepare written report(s).
- 2.0.9 Write legibly.
- 2.0.13 Use correct grammar.
- 2.0.14 Use correct spelling.
- 2.0.15 Write complete sentences.
- 3.0.1 Demonstrate effective listening skills.
- 3.0.4 Identify sources of information.
- 3.0.6 Follow directions.
- 4.0.3 Participate in discussions.
- 4.0.12 Use appropriate language.

Applied Academics Competencies *(continued)*

Mathematics:

1.2.1 Round and/or truncate numbers to designated place value.
1.2.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations.
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages).
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers.
1.2.5 Set up, solve, and apply ratios and proportions.
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions.
1.2.7 Translate written and/or verbal statements into mathematical expressions.
1.2.8 Estimate answers.
2.2.1 Convert, compare, and compute with common units of measurements within and/or across measurement systems.
2.2.2 Compute using appropriate units of measurement.
2.2.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate.
2.2.4 Estimate measurements.
3.2.6 Use problem-solving techniques.
4.2.4 Use formulas.
5.2.2 Find surface areas and volumes of applicable geometric figures.

Equipment, Supplies, References, and Other Resources

ACTIVITY 1

1. power supply, 6 volts DC
2. voltmeter, 0-10 DC
3. meter, 1-0-1 mA DC
4. resistor, 5,000 ohms, ±5%, l-watt
5. resistor, 10,000 ohms, ±5%, l-watt
6. resistor, 15,000 ohms, ±5%, l-watt
7. 5 wires for connections

ACTIVITY 2

1. meter, 1-0-1 mA DC
2. resistor, 10,000 Ohms, ±5%, l-watt
3. resistor, 15,000 Ohms, ±5%, l-watt
4. voltmeter, DC, 0-10 volts
5. power source, capable of delivering 6 volts DC and 7.5 volts DC
6. 3 wires for connections

Situation

These experiments are to be conducted with a class of Level II Agriscience students.

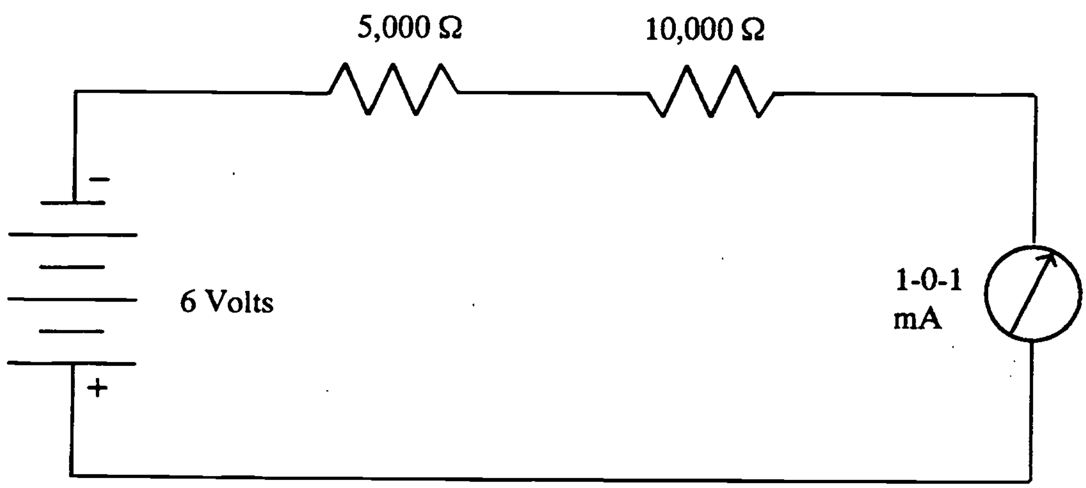
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring to class an old string of Christmas lights which are connected in a series circuit, and a set of lights which are connected in parallel.	**Interest Approach** Christmas tree lights offer good examples of series and parallel circuits. They can be used to illustrate advantages of the parallel circuit over a series circuit. First, ask students if they have ever had problems with lights. Next, ask students to identify which set of lights are connected in series and which are parallel. Have them do this without plugging the lights in or removing a bulb (the series lights will have only one wire). Plug the lights in, remove bulbs from the circuits, and discuss the differences between the circuit configurations.
	ACTIVITY 1 **Procedure** *SERIES RESISTANCE*
Use information on pages 7.0.2-8 and -9.	1. Connect the circuit shown on page 7.0.2-8. Refer to key to electrical symbols on page 7.0.2-9. 2. Set the voltage control to the lowest output. Turn on the power supply. Advance the voltage control to an output of 6 volts. 3. Record the current as indicated on the meter. 4. Set the voltmeter to read in the 0-10 volts scale. Read the voltage across the 5,000 ohm resistor being careful of polarity. 5. Read the voltage across the 10,000 ohm resistor. 6. Turn off the power supply and disconnect the circuit. 7. Calculate the current flowing through the circuit using Ohm's Law. 8. Calculate the voltage using Ohm's Law and the value for the current as indicated on the meter.
Use information on page 7.0.2-10.	*PARALLEL RESISTANCE* 1. Connect the circuit shown on page 7.0.2-10. 2. Set the voltage control to the lowest output and turn on the power supply. Advance the voltage control to an output of 6 volts. 3. Record the current as indicated on the meter. 4. Set the voltmeter to read in the 0-10 volts scale. Read the voltage across the 10,000 ohm resistor being careful of polarity. 5. Read the voltage across the 15,000 ohm resistor. 6. Turn off the power supply and disconnect the circuit.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Procedure *(continued)* 7. Calculate the total resistance in the circuit using the formula for parallel resistance. 8. Calculate the current flowing through the circuit using Ohm's Law. 9. Calculate the voltage using Ohm's Law, the resistance calculated in step 7, and the value for the current as indicated on the meter.
Use information on page 7.0.2-11.	*COMBINATION SERIES AND PARALLEL RESISTANCE* 1. Connect the circuit shown on page 7.0.2-11. 2. Set the voltage control to the lowest output and turn on the power supply. Advance the voltage control to an output of 6 volts. 3. Record the current as indicated on the meter. 4. Use the voltmeter to measure the source voltage. 5. Set the voltmeter to read in the 0-10 volts scale. Read the voltage across each resistor being careful of polarity. 6. Turn off the power supply and disconnect the circuit. 7. Calculate the total resistance in the circuit using the formula for parallel resistance for R_2 and R_3 and adding that total to the resistance of R_1. 8. Calculate the current flowing through the circuit using Ohm's Law. 9. Calculate the voltage using Ohm's Law, the resistance calculated in step 7, and the value for the current as indicated on the meter.
Use the information on pages 7.0.2-12 and -13 (student copy).	**Data Summary and Analysis** *Series Resistance* Have students summarize their data. Lab reports should include answers to the following questions: 1. What happens to the voltage in a series circuit? 2. What happens to the current in a series circuit? 3. What happens to total resistance of a series circuit when another resistor is added? 4. Do all resistors in a series circuit have the same current flowing through them? Why?

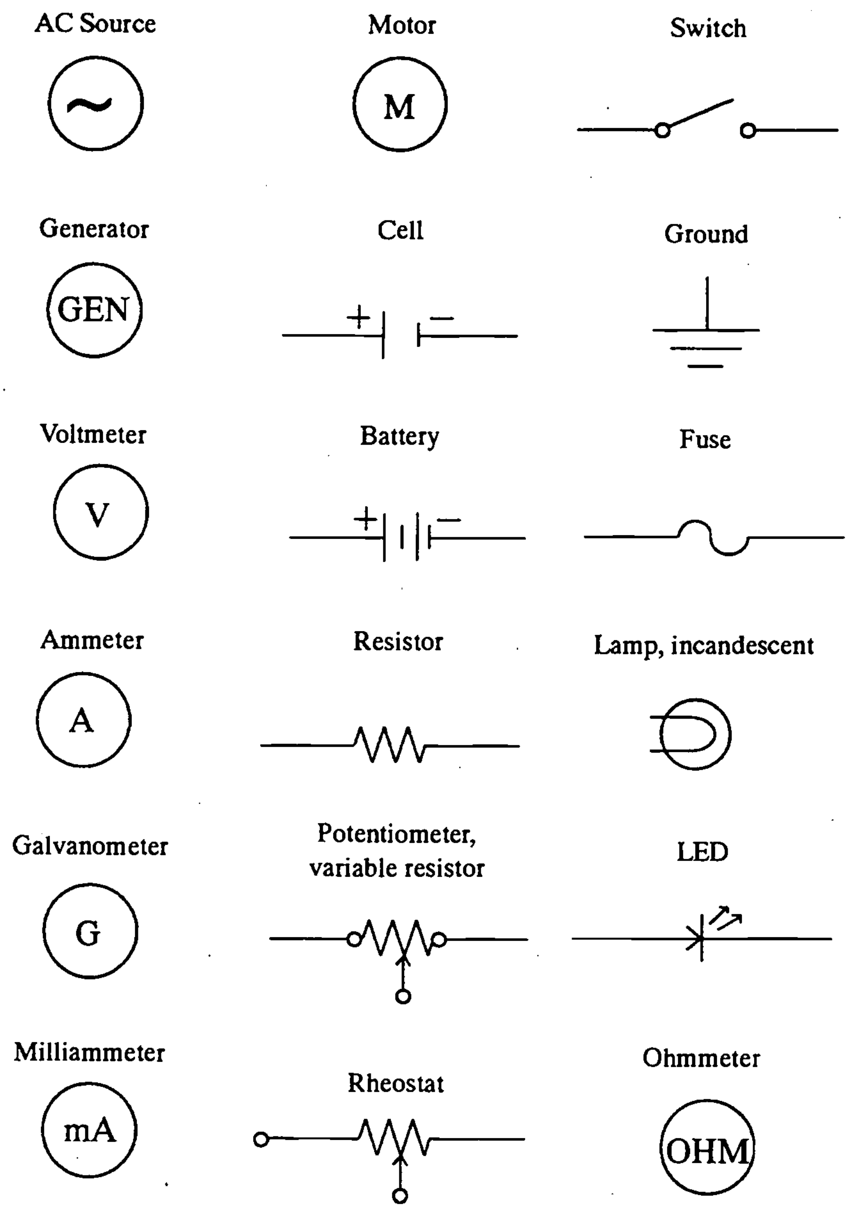
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Data Summary and Analysis *(continued)* *Parallel Resistance* Have students summarize their data. Lab reports should include answers to the following questions: 1. What happens to the voltage in a parallel circuit? 2. What happens to the current in a parallel circuit? 3. What are the two formulas for finding total resistance in a parallel circuit? *Combination Series and Parallel Resistance* Have students summarize their data. Lab reports should include an answer to the following question: • How did the values of current and voltage in the experiment prove the rules of current and voltage in the series and parallel circuits?
	Key Terms 1. *Kirchhoff 's First Law* - current entering a junction is equal to the current leaving the junction. 2. *Kirchhoff's Second Law* - the sum of the voltage drops around a complete circuit loop is equal to the applied voltage. 3. *Ohm 's Law* - basic electrical law stating the relationships of voltage, current, and resistance: current in a circuit is equal to the voltage divided by the resistance. 4. *parallel* - term for circuit in which resistors or capacitors are connected so as to allow current to divide and flow through each individual device, then to combine and flow back to the source. 5. *series* - electrical connection method in which current flows in sequence through all devices in a circuit. 6. *series-parallel circuit* - circuit that has at least one resistor in series with at least two in parallel.

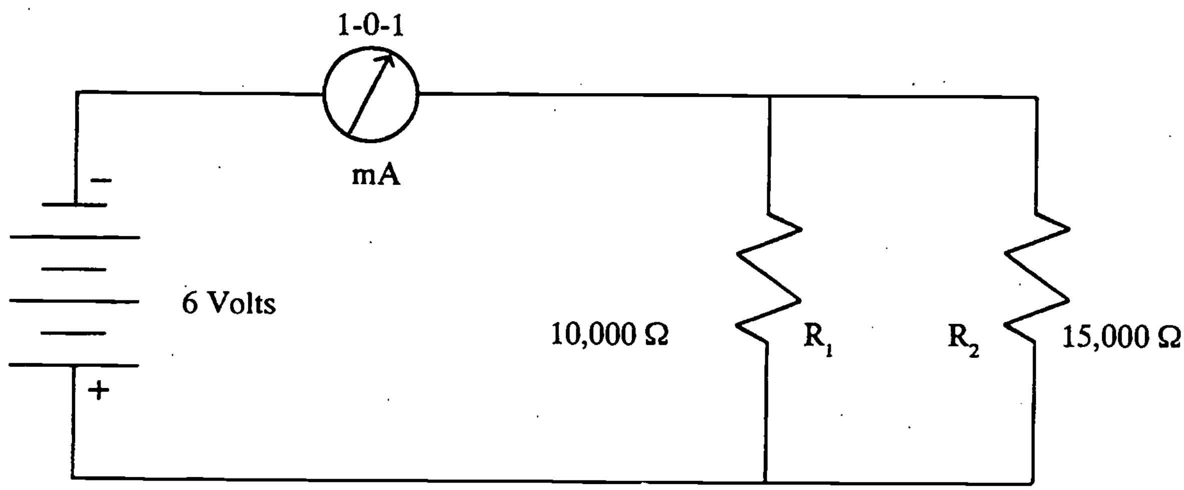
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Bring different sizes of wiring to class.	**Interest Approach** Display different sizes of wiring and ask students to suggest common uses for the wires. Compile a list of these uses and have the students examine the list for similar uses. For example, larger wires are for carrying electricity over long distances or for carrying large amounts of current. Pose the question: "Why is a large wire used by power companies to bring electricity to your home when only a small wire is needed to carry that same electricity to an appliance?"
	ACTIVITY 2
	Procedure
Use information on pages 7.0.2-9 and -14.	1. Connect the circuit shown on page 7.0.2-14. Refer to key to electrical symbols on page 7.0.2-9. 2. Set the voltage control to minimum output and turn on the power supply. Increase the power supply to 6 volts. 3. Record the level of current flowing through the circuit as indicated on the meter. 4. Using Ohm's Law, calculate the level of current which should be flowing through the circuit. 5. Turn off the power supply and replace the 10,000 ohm resistor with a 15,000 ohm resistor. 6. Turn the power supply on and adjust the output to 7.5 volts. 7. Record the level of current flowing through the circuit as indicated on the meter. 8. Reduce the voltage to 6 volts and record the level of current flowing through the circuit as indicated on the meter. 9. Calculate the level of current which should be flowing through the circuit at the 6 and 7.5 volt settings using Ohm's Law. 10. Compare the meter readings with the calculations using Ohm's Law. 11. Disconnect the circuit and return the equipment to the proper storage place.

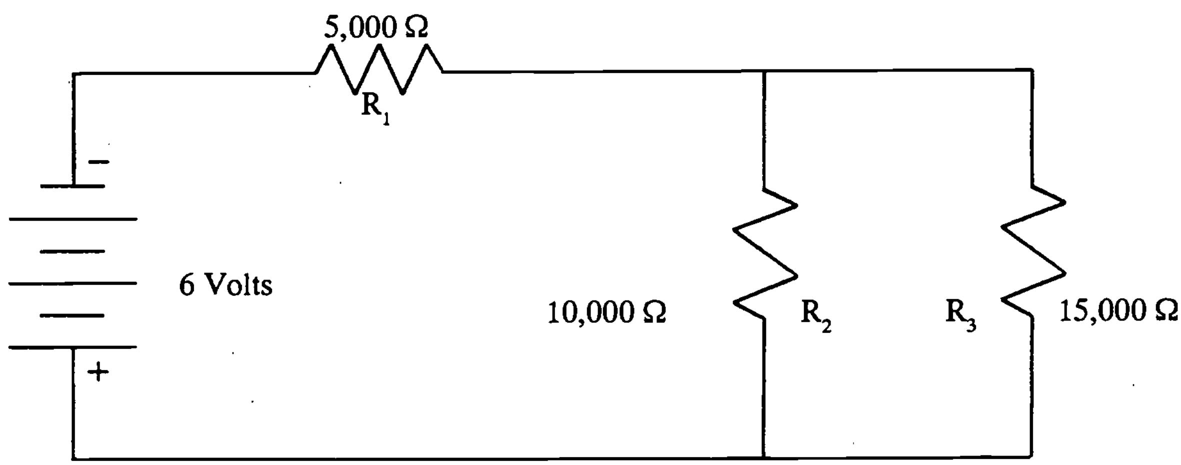
Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use the sample data sheet on page 7.0.2-15. Use the information on pages 7.0.2-16 and -17 (student copy).	**Data Analysis and Summary** Have students record the results of this experiment. Lab reports should include answers to the following questions: 1. What happens to the current in a circuit when the voltage remains the same and the resistance to the circuit is increased? 2. What happens to the current in a circuit when the resistance remains the same and the source voltage is increased?
	Key Terms 1. *ampere* - basic unit of electric current. One ampere is 6.28×10^{18} electrons flowing past a given point in one second. 2. *load* - anything that may draw current from an electrical power source. 3. *ohm* - unit of measure for electrical resistance; abbreviated with the Greek letter omega (Ω). A circuit has a resistance of 1 ohm when 1 ampere flows through it with a pressure of 1 volt. 4. *ohmmeter* - device used to measure electrical resistance in ohms. 5. *Ohm's Law* - basic electrical law stating the relationships of voltage, current, and resistance. The current in a circuit is equal to the voltage divided by the resistance. 6. *resistance* - opposition to the movement of electrons; measured in ohms. 7. *volt* - unit of measurement of electromotive force (pressure); abbreviated V.


5,000 Ω
10,000 Ω
6 Volts
1-0-1
mA

Schematic Symbols




1-0-1
mA
−
+
6 Volts
10,000 Ω
R1
R2
15,000 Ω


5,000 Ω
R1
6 Volts
10,000 Ω
R2
R3
15,000 Ω

• Effect-Cause •
Problem-Solving Technique

Define the problem

How does placement of an electrical consuming device (resistor) affect the total resistance within a circuit?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

SERIES RESISTANCE

The total resistance is equal to the sum of the individual resistances:

$R_T = R_1 + R_2 + R_3 + \ldots$

PARALLEL RESISTANCE

The total resistance must be calculated mathematically. The formula is

$R_T = 1(1/R_1 + 1R_2 + 1/R_3 + \ldots)$

COMBINATION SERIES AND PARALLEL CIRCUITS

The total resistance is obtained by calculating the resistance for the parallel units, then by treating the entire circuit as a series circuit.

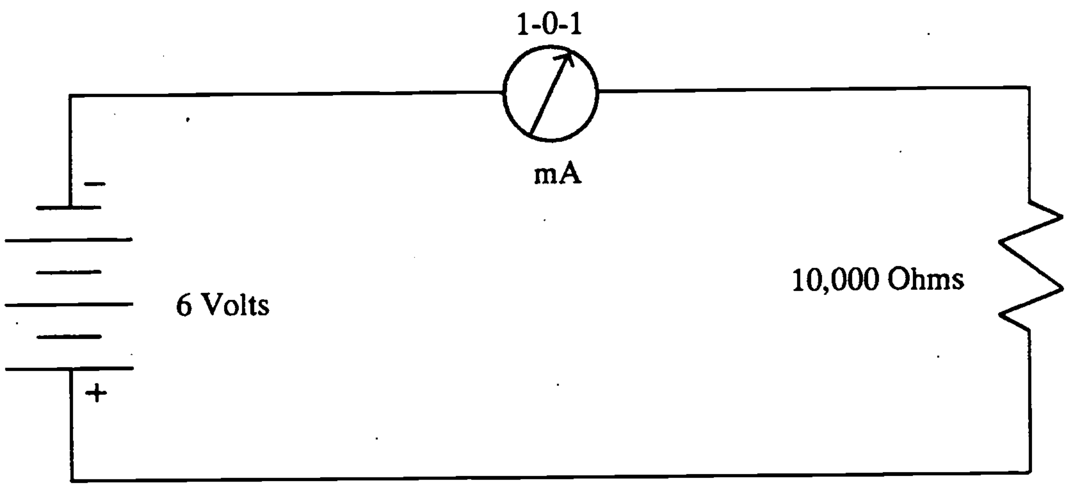
• Effect-Cause •
Problem-Solving Technique

Define the problem

How does placement of an electrical consuming device (resistor) affect the total resistance within a circuit?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation


1-0-1
mA
−
6 Volts
+
10,000 Ohms

Data Sheet

Voltage (E)	Resistance (R)	Current from Meter (I)	Current from Ohm's Law - I
6 volts	10,000 ohms		
7.5 volts	15,000 ohms		
6 volts	15,000 ohms		

• Effect-Cause •
Problem-Solving Technique

Define the problem

How is electrical current in a circuit affected by a change in the resistance within the circuit?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

- When the circuit includes 6 volts of power and one 10,000 ohm resistor, the current will be .0006 amperes or .6 mA. The meter measures current in milliamperes (mA).
- When the circuit includes 7.5 volts of power and one 15,000 ohm resistor, the current will be .0005 amperes or .5 mA.
- When the circuit includes 6 volts of power and one 15,000 ohm resistor, the current will be .0004 amperes or .4 mA.

• Effect-Cause •
Problem-Solving Technique

Define the problem

How is electrical current in a circuit affected by a change in the resistance within the circuit?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

There are three basic components of an electrical circuit: **voltage**, **current**, and **resistance**.

Voltage is a measure of the pressure of an electromotive force. In agricultural settings, the pressure or source of alternating current is usually the power company. Voltage is carried over power transmission lines to a central point at the home or farm. Batteries are common sources of direct current voltage needed to start engines on agricultural equipment.

Current is the flow of electrons through a conductor. Common conductors are copper or aluminum wire. Most metals are good conductors of electricity - copper and aluminum are the most economical.

The third component of a circuit is **resistance** which is measured in ohms. Resistance is any device which consumes electricity. Common consuming devices in agriculture include motors, lights, and heaters. The starter on a car is an example of a consuming device. Most electrical circuits in agricultural settings contain several consuming devices. These devices (resistors) may be located in a circuit in configurations known as either series or parallel. The main circuit from the central power transmission pole is normally a *series* circuit, but most circuits within a building - such as a home or barn - are *parallel* circuits. The advantages and disadvantages to both series and parallel circuits were discussed in this lab.

An adequate electrical wiring system is essential for maintaining most agricultural enterprises in an efficient, safe, and productive manner. The system must provide sufficient electricity for present and future needs. The buildings of a farmstead are generally spread over long distances which can make it difficult to provide ample electrical power without excessive voltage drop. Voltage drop must be considered when selecting the size of wire to run from the main service entrance to other buildings. In many cases wire size must be increased to reduce voltage drop. Voltage drop can be calculated using Ohm's Law.

Voltage drop can be costly to agricultural producers in two ways. Part of the power paid for is wasted by overcoming resistance in the circuit and is not available for use at the appliance or load. Loss of power also means a loss in operating efficiency for equipment. A 5 percent voltage drop produces a 10 percent loss of heat in a heating appliance, a 17 percent loss of light from an incandescent light bulb, or a 10 percent loss in power output from a motor. The National Electrical Code recommends that voltage drop be held to not more than 3 percent for farm power or heating loads, and not more than 1 percent for lighting loads or a combination of lighting, power and heating loads.

Ideas for Additional Experiments

1. Use a wiring panel to construct series and parallel circuits as they are found in the home. Give students examples of different loads and have them calculate current using Ohm's Law.
2. Vary the resistance and source voltage in the circuit and calculate the level of current flowing through the circuit.
3. Use Ohm's Law to calculate current flowing through common household circuits.

Evaluating Student Learning

After students complete these experiments, have them record their data on pages 7.0.2-20 and -21.

This activity was adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program **AGRISCIENCE**

Unit **7 - Mechanical Power**

Define Power

Competency/Terminal Performance Objective

7.0.3 Define power.

Competency Builders/Pupil Performance Objectives

7.0.3.1 Given example condition, determine horsepower based on performance criteria list.

7.0.3.2 Given example condition, determine watts based on performance criteria list.

7.0.3.3 Given sample problems, convert horsepower and watts based on performance criteria list.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials

1.0.4 Determine solutions to problems

1.0.5 Identify details such as who, what, why, where, when, or how

1.0.8 Define words used in context

1.0.14 Explain cause-effect relationships

2.0.3 Record observations

2.0.9 Write legibly

2.0.13 Use correct grammar

2.0.14 Use correct spelling

2.0.15 Write complete sentences

3.0.1 Demonstrate effective listening skills

3.0.3 Communicate appropriately with co-workers, clients, and supervisors

3.0.6 Follow directions

4.0.3 Participate in discussions

4.0.12 Use appropriate language

Mathematics

1.1.1 Round and/or truncate numbers to designated place value

1.1.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations

1.1.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers

1.1.5 Set up, solve, and apply ratios and proportions

Applied Academics Competencies

Mathematics *(continued)*

1.1.6 Solve problems and make applications involving integers, fractions, decimals, percentages, ratios, and proportions

2.1.2 Compute using appropriate units of measurement

2.1.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate

4.1.3 Use order of operations to solve problems

4.1.4 Use formulas

Safety

- Students should be careful when running the steps to prevent injury by stumbling or straining muscles.

Equipment, Supplies, References, and Other Resources

1. Stopwatch
2. Bathroom scale
3. Fifty-foot tape measure
4. Three or four flights of stairs or one very long staircase (e.g., as in a gymnasium)
5. Copies of *Data Record and Observation Sheet* on pages 7.0.3-8 and -9

Situation

This activity is to be conducted with Level I Agriscience Students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Write the question "What does 'power' mean?" on the board or a transparency.	**Interest Approach** Ask the class the following questions: 1. What does "power" mean? a. Strength b. Force c. Energy d. Ability to work e. ________________
Write the formula on the board.	2. Does anyone know the formula for work? work done ÷ time = power 3. How could the example of a person climbing a stairway explain the formula for power? What additional information about the formula must we know to answer the question? a. Definition or example of work done. b. Definition of a 'unit of work done' or how it is measured. c. How to determine the amount of time to use in the formula. d. Measurement or unit used for power. e. ________________________
Write the problem statement on the board.	*HOW DO WE CALCULATE POWER?* **Supervised Study** Ask the students to find information about the power formula and the meaning of its components.
Write the findings on the board.	Summarize the resulting information as follows: The amount of work done is the result of two things: 1. How far (distance in feet) a weight is lifted 2. How much weight (pounds) is lifted

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Multiplying "feet lifted" by "weight lifted" is expressed as (foot-pounds) of work done. *Example* **Weight Lifted X Distance = Work Done** 1 lb. — 1 ft. — 1 ft.-lb. 2 lb. — 3 ft. — 6 ft.-lb. 3 lb. — 2 ft. — 6 ft.-lb. Finally, to solve the equation for power, the amount of work done (foot-pounds) per second must be determined. This is done by dividing the number of foot-pounds by the time in seconds.
Use the information on pages 7.0.3-5 and -6 (student copy). Distribute handout - *Data Record and Observation Sheet* on pages 7.0.3-8 and -9. Ask students to record their information on this form.	*Example* 120-lb. weight is lifted 10 ft. in 6 seconds $\frac{120 \text{ lb. x } 10 \text{ ft.}}{6 \text{ seconds}} = \frac{1{,}200 \text{ ft.-lb.}}{6 \text{ seconds}} = 200 \text{ ft.-lb./second}$ Now, list the steps for calculating power using the example of a person (students) climbing a flight of stairs.

Define the problem

How do we calculate power?

What to Do (Steps)	How to Do It (Key Points)
1. Determine **weight** to be lifted.	Weigh each student. Record weights.
2. Determine **height** to which weight will be lifted.	Measure height of the stairs and record in feet. Record results.
3. Determine **foot-pounds** involved.	Multiply each student's weight by the height of the stairs. Record results.
4. Determine **time** involved.	Use a stopwatch to determine how much time in seconds it takes each student to reach the top of the stairs. Have the timers positioned at the top of the stairs. (Assign just one runner to each timer.) At the start command, have the students run as fast as they can to the top of the stairs. Record the results.
5. Determine **foot-pounds per second** (power). At this point we know the power produced (foot-pounds per second) when climbing the stairs. How can we convert this to horsepower -- a more familiar measure of power? The formula is: 1 horsepower = 550 foot-pounds/second	Divide the foot-pounds by the seconds it took each student to run up the stairs. Record the results.
6. Determine the horsepower generated.	Divide the foot-pounds per second by 550. Record results.
7. Determine the equivalent of Watts generated.	Multiply the horsepower by 746. Record results.

Most individuals generate 1/2 to 3/4 hp while running up stairs. Several runs can be made to get an average time. Use the following table:

Run No.	Weight	Vertical Distance	Time	HP
1				
2				
3				

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

How do we calculate power?

What to Do (Steps)	How to Do It (Key Points)

Decisions/Recommendations

Helping Students Apply Concepts/Principles/Skills

Have students compare their personal horsepower rating with that of various rated pieces of equipment. Ask them to describe the significance of completing work with equipment such as a 12 hp riding lawn mower compared to completing the same work manually with a push mower at their own hp rating.

Ask students to select a motor and its related appliance or piece of machinery. Have them explain the power formula using the operation and rated hp of the machinery.

Have students use the following formula for calculating **drawbar horsepower**, a term relating to the pulling power of farm equipment.

$$\text{Drawbar horsepower} = \frac{\text{Implement's lb. of draft* x speed (mph)}}{375}$$

*pounds needed to pull an implement

Evaluating Student Learning

Students should be able to write the formula for power and describe how each component of the formula is determined.

Also, students should be able to describe how the operation of a specific motor, the rated hp of the motor, and the work done by the motor relates to the power formula.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ____________________

Name ____________________ Date __________ Period ________

Objective(s) ____________________

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**7 - Mechanical Science**

Describe Mechanical Power Transmission

Competency/Terminal Performance Objective

7.0.4: Given a source of power and an output requirement, describe mechanical power transmission process, based on criteria specified in the assessment instrument.

Competency Builders/Pupil Performance Objectives

7.0.4.1 Given an example of force, torque, work, power, and energy, define each, based on criteria specified in assessment instrument.

7.0.4.2 Given sample problem, determine how diameter and number of teeth on gear or sprocket relate to speed and torque, according to performance criteria list.

7.0.4.3 Given examples of power, torque, and speed, determine their relationship, based on definitions provided.

7.0.4.4 Given problems, apply law of energy conservation to power, torque, and speed, based on criteria specified in assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
1.2.2 Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers

Applied Academics Competencies

Mathematics *(continued)*

1.2.5 Set up, solve, and apply ratios and proportions
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7 Translate written and/or verbal statements into mathematical expressions
1.2.8 Estimate answers
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

Activity 1

1. 10-speed bicycle
2. rule
3. 2-inch/pound spring scales
4. clamps

Activity 2

1. galvanometer
2. copper and zinc plates
3. volt meter
4. lemon or potato
5. small battery
6. large magnet
7. generator
8. thermocouple
9. wire
10. photo voltaic cell

Situation

These experiments are to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	**Teaching Procedures: Interest Approach/Teaching Methods**
Use the information on pages 7.0.4-9 and-10 (student copy). Refer to Data Tables A and B on page 7.0.4-4.	**ACTIVITY 1** **Interest Approach** Identify an agricultural application using mechanical power (identify applications beyond commercial production, emphasizing applications and occupations in urban environments, aquaculture, food engineering, etc.). For each application discuss the location of the power source and where the power is applied at the rear axle. Also ask if the speed and direction of the applied power is the same as that of the source. **Procedure** 1. Clamp the bicycle upside-down on a flat work surface. 2. Measure diameter of the large pedal sprocket (D_1) and the smallest wheel sprocket (D_2). Compute the ratio D_1/D_2 and record ratio 3. Count the number of teeth on the large pedal sprocket (N_1) and the smallest wheel sprocket (N_2). Compute the ratio N_1/N_2 and record. 4. Count the number of revolutions of the smallest wheel sprocket (RPM_2) for one revolution of the large pedal sprocket (RPM_1). Compute the ratio RPM_1/RPM_2 and record. 5. Determine all possible speed ratios and record them in increasing or decreasing order. 6. Using 2 inch/pound spring scales (one at the pedal crank and one at a wheel spoke farthest from the wheel axle) apply a given force to the pedal crank (e.g. 100 inch-pound). Measure and record the resultant force at the wheel for all speed ratios and record.
Refer to Data Tables A and B on page 7.0.4-4.	**Data Summary and Analysis** 1. Compare D_1/D_2 to N_1/N_2, and D_1/D_2 to RPM_1/RPM_2. What can be concluded from the comparison? 2. Observe data in Table B on page 7.0.4-4. What speed ratio has the greatest wheel speed? Which speed ratio has the greatest torque? 3. Based on these observations, what can be concluded about the relationship between power, torque, and speed? How does the law of conservation of energy apply to mechanical power transmission?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Refer to page 7.0.4-11.	**Key Terms** 1. *force* - mass x acceleration. 2. *work* - force through a distance. 3. *torque* - a rotating force; force x length of the radius of rotation. 4. *power* - force x distance/time; rate of doing work.

Data Table A

D_1	D_2	D_1/D_2
N_1	N_2	N_1/N_2
RPM_1	RPM_2	RPM_1/RPM_2

Data Table B

		Applied Torque ________ in-lb
Ratios	Calculated Ratios	Resultant Torque
N_6/N_5		

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 2
Ask probing questions to stimulate interest. Write answers on board. Define the problem: State that many of the students seem to have a problem with some common terms related to power (e.g., force, torque, work, power, and energy).	**Interest Approach** 1. How do we determine who has the most powerful car? 2. How do we determine the size of a tractor? (In the U.S. we determine the size based on horsepower and in other countries on kilowatts.) 3. If we buy a piece of farm equipment, how do we know what size tractor it takes to pull it? 4. Given a piece of mechanical equipment, how do we size an engine to it? 5. What is power and how is it measured? (Power is the measurement of the amount of work that can be done in a given period of time.) 6. What is work and how is it measured?
Have students provide the types of energy. Define them.	7. What is **energy**? There are five types of energy. They are the following: • *mechanical energy* - any physical movement • *chemical energy* - created during a chemical reaction between compounds such as mixing a strong acid with water. The solution gets very hot. When a battery is built a chemical reaction between two dissimilar metals and an electrolyte produce electrical energy. • *heat energy* - the friction between rapidly moving and bombarding molecules • *light energy* - a form of heat energy in the visible spectrum • *electrical energy* - the flow of electrons
Distribute handout "Types of Energy and Ways to Convert from One to the Other" on pages 7.0.4-12 (student copy) and -13 (teacher copy).	See handout - "Types of Energy and Ways to Convert from One to the Other." **Procedure** *Convert mechanical energy into electrical energy.* 1. Hook one loop of wire to each terminal of a galvanometer. Quickly pass the loop of wire through the field of a strong magnet. 2. Hook a telephone generator to a light bulb or volt meter. Turn the crank. Notice the many wires and magnets.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 2 *(continued)*
Explain that a chemical reaction takes place between the two dissimilar metals causing electrons to flow from one to the other over a load. The more active metal is consumed and plated onto the less active metal. (Notice the appearance of the electrodes after a few days.)	*Convert chemical energy into electrical energy.* 1. Insert two dissimilar metal electrodes (e.g., zinc and copper) in a lemon, apple, potato, orange etc. Place a voltmeter across the leads. This will yield about 1.5 volts DC. 2. Place 2 metal electrodes in a beaker full of acetic acid or vinegar. Hook the electrodes to a volt meter. This will produce a 1.5 volt battery. 3. Obtain three glass jars and six pieces of lead. Put two pieces of lead in each jar separated by a form of dielectric. Then hook one plate of each jar to one plate of another jar. This should leave one plate in each jar without an electrode. Fill each jar with sulfuric acid. Then charge with a small tricle charger set on six volts. When one plate in each jar has changed to a light brown (lead peroxide) then the battery is fully charged. You may discharge through a small six-volt lantern battery.
	Convert heat energy into electrical energy. • Take two dissimilar metals and attach them at one end. Hook the two remaining ends to a galvanometer. (This device is called a thermocouple and is used to convert heat to electricity.) Place the end of the thermocouple that is fastened together into a flame. Watch the meter climb.
End demonstration. In the following cases, just explain the instruments used to convert energy. • electric motor • electrolysis • resistive heater • light bulb	*Convert light energy into electrical energy* • Connect a photo voltaic cell to a galvanometer and shine a light on it. *Convert electrical energy into mechanical energy* *Convert electrical energy into chemical energy* *Convert electrical energy into heat energy* *Convert electrical energy into light energy*

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 2 *(continued)* 1. Turn a ten speed bike upside down. Crank and shift the gears. When is the crank the hardest to turn? When is the tire revolving the fastest? Is the crank the easiest to turn when the tire is going the fastest? What is the difference between the diameter of the crank gear compared to the diameter of the tire gear? Is it the diameter of the gears, the relationship between the gears, the number of teeth, or the relationship between the number of teeth that determines this? It appears there is a mathematical relationship between the size (diameter or number of teeth of a sprocket or pulley in relation to speed). We need to explore this relationship. The product of the teeth or diameter of one pulley and its speed is directly proportional to the product of the second pulley's speed and diameter. $T_1 \times RPM1 = T_2 \times RPM_2$ or $D_1 \times RPM1 = D_2 \times RPM_2$ T = the number of teeth on a sprocket or gear, RPM = revolutions per minute, D = diameter usually in inches. (However, if both gears are measured with the same units it does not matter.)
Distribute handout "Determining How Diameter and Number of Teeth Affect Speed." Rearrange numbers and diameters on handout and use as a test (see pages 7.0.4-14 through -18).	2. Complete handout "Determining How Diameter and Number of Teeth Affect Speed." 3. Build one working model of a transmission. Demonstrate that the mathematical results are the same as actual results. 4. Count the number of teeth on the crank of the ten speed bike. Turn the crank at a certain speed and see if calculated results and actual results are the same.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Key Terms 1. *force* - an applied pressure which causes or tends to cause motion or a change in motion 2. *torque* - an applied force in a twisting or rotational motion 3. *work* - a force acting through a distance. If a force is applied to an object and it moves, work is done. Work is measured in units of foot-pound (ft-lb), British thermal unit (BTU) or Metric in Joule (J), erg, calorie (cal), Kilowatt hour (K-W-h) Work = Distance x Force W= D x F One joule of work done in one second equals one watt 4. *power* - the ability to do work in a given period of time and is measured in horsepower or watts. One horsepower = 33,000 ft. x lb/ min. = 746.5 watts 5. *energy* - the measurement of a system's ability to do work. Energy is what is transferred when work is done.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the relationship between HP, torque, and RPM?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

D_1/D_2, N_1/N_2, and RPM_1/RPM_2 should be equal. Any numerical differences observed are a function of measurement error.

Diameter and number of teeth on sprockets are inversely related to speed. As diameter increases, speed decreases. Diameter and torque are directly related.

Torque and speed are inversely related at a constant power. Speed must be sacrificed for torque, torque must be sacrificed for speed. This energy balance is governed by the law of conservation of energy.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

What is the relationship between HP, torque, and RPM?

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Concepts of Force, Torque, Work, Power, and Energy

TERMS

Energy

Force

Torque

Power

Work

Types of Energy and Ways to Convert from One to Another

LAW – **Energy can neither be created nor destroyed.** It may only be converted from one form to another.

Type of Energy	Conversion Method	Type of Energy
1. Mechanical energy		Electrical
2. Chemical energy		Electrical
3. Heat energy		Electrical
4. Light energy		Electrical
5. Electrical energy		Electrical
6. Electrical energy		Mechanical
7. Electrical energy		Chemical
8. Electrical energy		Heat
9. Electrical energy		Light

Statement: **Most forms of energy eventually are converted into ___________ form of energy.**

Types of Energy and Ways to Convert from One to Another

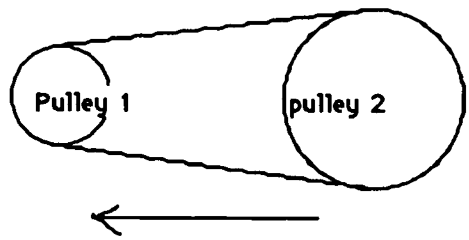
LAW – **Energy can neither be created nor destroyed.** It may only be converted from one form to another.

Type of Energy	Conversion Method	Type of Energy
1. Mechanical energy	Generator/Alternator	Electrical
2. Chemical energy	Battery	Electrical
3. Heat energy	Thermocouple	Electrical
4. Light energy	Photovoltaic cell (photo cell)	Electrical
5. Electrical energy	No conversion	Electrical
6. Electrical energy	Induction motor	Mechanical
7. Electrical energy	Battery charging or electrolysis	Chemical
8. Electrical energy	Resistive heater	Heat
9. Electrical energy	Light bulb	Light

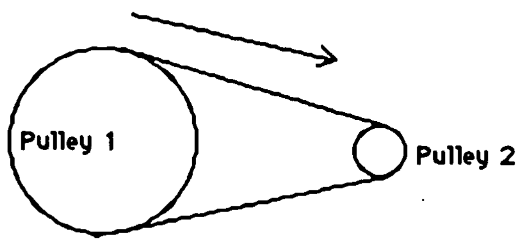
Statement: **Most forms of energy eventually are converted into __HEAT__ form of energy.**

Determining How Diameter and Number of Teeth Affect Speed

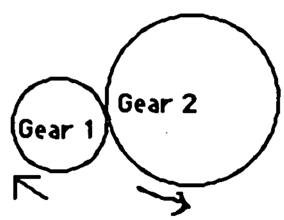
Name____



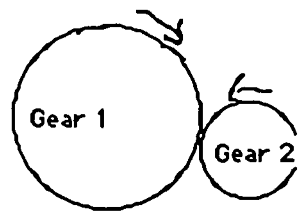
1. If pulley #1 is 6 inches in diameter and pulley #2 is 12 inches in diameter and pulley #1 is traveling 100 rpm, what is the speed of pulley #2?



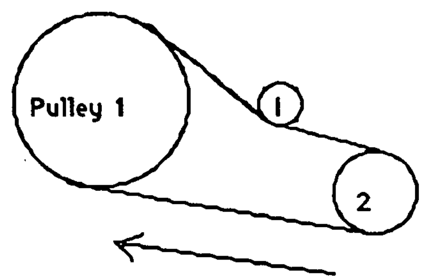
2. If pulley #1 is 10 inches in diameter and pulley #2 is 3 inches in diameter, what is the speed of pulley #2 if pulley #1 is traveling at 33 rpm?



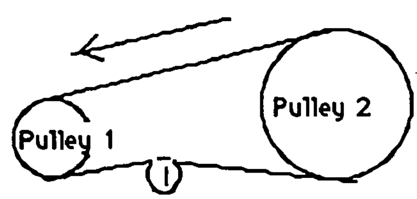
3. In this diagram there are two gears in mesh with each other. Gear #1 has 13 teeth and gear #2 has 40 teeth. If gear #1 is traveling 20 rpm, what is the speed of gear #2 ?



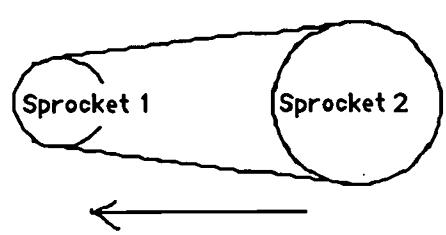
4. If gear #1 has 125 teeth and gear #2 has 50 teeth and gear #1 is traveling at a speed of 10 rpm, what is the speed of gear #2?



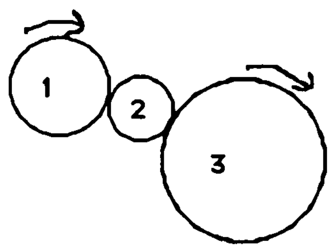
5. Notice in this diagram that there is an idler pulley in the slack side of the belt. This idler pulley has no effect on speed torque or direction; however, it does serve to keep the belt tight and from slipping. It also may provide a convenient way to loosen the belt for changing. If pulley #1 is 20 inches in diameter and traveling at a speed of 20 rpm, and pulley #2 is 3 inches in diameter, how fast is it traveling?



6. If pulley #1 is traveling 100 rpm and is 2 inches in diameter and pulley #2 is 15 inches, how fast is pulley #2 traveling?



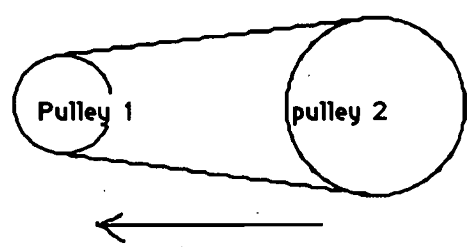
7. Sprockets and chains act in the same manner as belts and pulleys, but they do not slip. The other difference is that we calculate the speed and torque by using the number of teeth in a sprocket instead of diameter. We may also use idler sprockets to keep the chain tight on the slack side of the system. If sprocket #1 has 20 teeth and is traveling 500 rpm, what is the speed of sprocket #2 if it has 45 teeth?



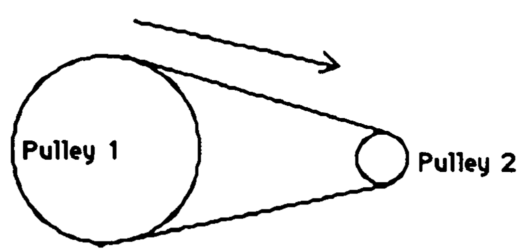
8. In multiple gear drive trains the speed and diameter of each gear must be figured unless two gears have the same number of teeth. The rotation direction of each gear is opposite the one next to it. Therefore if you want to maintain the same direction as the drive gear, then you need three gears. If the gears are of the following sizes what is the speed of gear #3 if gear #1 is traveling 150 rpm ?

    gear #1 has 30 teeth
    gear #2 has 10 teeth
    gear #3 has 45 teeth

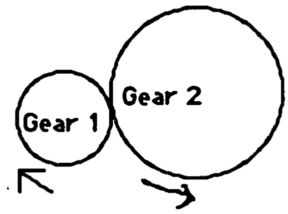
    gear #3 is traveling __________ rpm?



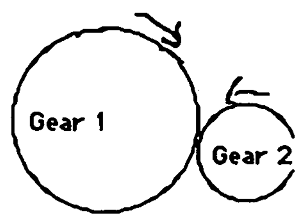
9. If pulley #1 is 6 inches diameter and is traveling 100 rpm, and pulley #2 is traveling 20 rpm, how large is pulley #2 ?



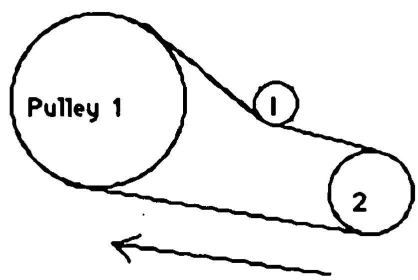
10. If pulley #1 is _________ inches in diameter and pulley #2 is 2 inches in diameter and traveling 1725 rpm, then pulley #1 is how many inches in diameter?



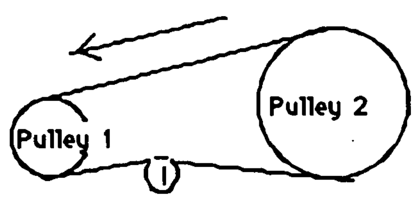
11. If gear #1 is traveling 20 rpm and gear #2 is traveling 85 rpm and has 75 teeth, how many teeth should gear #1 have?



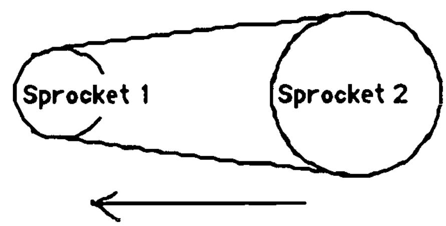
12. If gear #1 makes one rpm and gear #2 makes 5 rpm, how many more teeth does gear #1 have than gear #2?



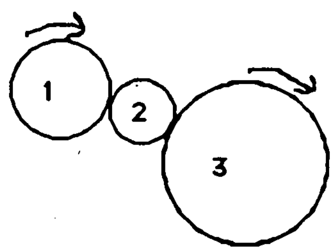
13. Pulley #2 must operate at a speed of 1725 rpm and pulley #2 must travel at a speed of 20 rpm and the diameter of pulley #2 is 4 inches. How large is pulley #1?



14. If pulley #1 is 3 inches in diameter and pulley #2 is 30 inches in diameter and pulley #2 is traveling 3000 rpm, what speed is pulley #1 traveling?



15. If sprocket #1 is traveling at a speed of 1000 rpm and sprocket #2 is traveling at a speed of 3,000 rpm and has 30 teeth, how many teeth does sprocket #1 have?



16. If gear #1 is traveling at 300 rpm and has 25 teeth, gear #2 has 10 teeth, and gear #3 has 45 teeth, how fast is gear #3 traveling?

Helping Students Apply Concepts/Principles/Skills

Activity 1

Machines increase our capacity to do work. Humans can provide approximately one-quarter horsepower for any sustained period of time. With the power supplied by internal combustion engines and electric motors, our power capabilities have increased greatly.

Mechanical power is the hallmark of modern agriculture. All aspects of agriculture from production through processing through distribution require the application of power. For example, an operator mowing a golf course fairway must control the power and transmit the power to various functions performed by the mower. Travel speed (forward and reverse), the speed of the cutter reel, and the height of the cutter reel, are all powered by the same power source, yet require different speeds, torque, and directions of travel. These mechanical operations are accomplished by gears, belts and pulleys, chains and sprockets, rotating shafts, and hydraulics.

Power transmission principles are essential to the understanding of machine operation and the effective and efficient use of power.

Idea for Additional Experiment

- This experiment may be replicated using belts and pulleys and/or geared drive trains.

Evaluating Student Learning

Explain Key Terms and give test on page 7.0.4-20. After students complete these experiments, have them record their data and observations on pages 7.0.4-21 and -22.

Portions of this activity were submitted by Bill Keck, Agricultural Education Instructor, Marysville High School, Marysville, OH 43040. Other portions were adapted from *Physical Science Applications in Agriculture*, Agricultural Education Department, University of Illinois, 124 Mumford Hall, 1301 W. Gregory Drive, Urbana, Illinois.

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Evaluation

Name ____

Fill in the Blank

List the five forms of energy

1. ______________ energy
2. ______________ energy
3. ______________ energy
4. ______________ energy
5. ______________ energy

List four of the devices used to convert a type of energy into electrical energy.

6. A ______________ converts ______________ energy into electrical energy.
7. A ______________ converts ______________ energy into electrical energy.
8. A ______________ converts ______________ energy into electrical energy.
9. A ______________ converts ______________ energy into electrical energy.
10. An applied pressure which causes or tends to cause motion or a change in motion is a ______________.
11. A force which acts in a rotational plane or in a twisting motion is called a ______________.
12. Power is a measurement of the amount of ____________ that can be done in a certain period of ____________.
13. Power is measured in terms of ______________ in the U.S.
14. Power is measured in terms of ______________ in the rest of the world.
15. One horsepower is = to _____________ and is = ____________ watts.
16. Work is measured in terms of ___________ in the metric system.
17. If you have a certain force acting through a distance you have done ________.
18. Work = Force x ___________.
19. If a hay elevator raises one bale of hay weighing 50 lb. 40 ft into the hay loft, how much work did the elevator do?
    a. not very much
    b. 200 ft.-lb.
    c. 200 lb. -ft.
    d. 40 ft.-lb.
    e. 50 ft.-lb.
20. State and explain the Law of Energy Conservation.

Data Record and Observation Sheet

Title ____________________

Name ____________________ Date __________ Period ________

Objective(s) ____________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**7 - Mechanical Science**

Demonstrate Construction Skills

Competency/Terminal Performance Objective

7.0.5 Given various materials, demonstrate construction skills, based on criteria outlined in assessment instrument.

Competency Builders/Pupil Performance Objectives

7.0.5.1 Given examples, describe properties of construction materials specified in assessment instrument.

7.0.5.2 Given plans and diagrams, interpret plans and diagrams according to criteria specified in assessment instrument.

7.0.5.3 Given diagrams, plans, and materials, prepare components for assembly based on criteria specified in assessment instrument.

7.0.5.4 Given materials, assemble into complete product to match criteria specified in performance assessment instrument.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.5 Identify details such as who, what, why, where, when, or how
1.0.8 Define words used in context
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
2.0.19 Use appropriate punctuation and capitalization
3.0.1 Demonstrate effective listening skills
3.0.3 Communicate appropriately with co-workers, clients, and supervisors
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

1.1.1 Round and/or truncate numbers to designated place value
1.1.2 Compute and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.1.6 Solve problems and make applications involving integers, fractions, decimals, percentages, ratios, and proportions

Applied Academics Competencies

Mathematics *(continued)*

1.1.8 Estimate answers

2.1.1 Convert, compare, and compute with common units of measurement within and/or across measurement systems

2.1.2 Compute using appropriate units of measurement

2.1.3 Read scale on measurement device(s) to nearest mark and make interpolations where appropriate

2.1.4 Estimate measurements

5.1.2 Find surface areas and volumes of applicable geometric figures

5.1.3 Recognize, classify, and use properties of lines and angles

5.1.4 Recognize, classify, and use properties of two- and three-dimensional figures (e.g., circles, triangles, rectangles, cylinders)

Equipment, Supplies, References, and Other Resources

1. Six-foot spring joint folding rule
2. Pocket tape rule
3. Carpenter's framing square
4. Try square
5. Combination square
6. Sliding T-bevel
7. Carpenter's pencil
8. Hand crosscut saw
9. Hand rip saw
10. Coping saw
11. Compass saw
12. Keyhole saw
13. Jack plane
14. Smooth plane
15. Block plane
16. Bit brace
17. Set of 12 auger bits from 1/4" to 1"
18. Expansive bit 1" to 3" diameter
19. Countersink bits
20. Hand drill
21. Set of straight shank twist drill 1/32" to 1/4" by 1/64ths
22. Awl
23. Curved claw hammer
24. Nail sets
25. Various sizes of regular blade screw drivers
26. Various sizes of Phillips blade screw drivers
27. Wood clamps for gluing

Equipment, Supplies, References, and Other Resources

(continued)

28. Assortment of common nails 2d - 20d
29. Assortment of finishing nails 2d - 20d
30. Assortment of flat head, round head, and oval head screws from 1/4" to 3 1/2" length and #1 to #16 gauge
31. Set of half-round wood files including rough, bastard, second cut and smoothing double-cut teeth
32. 9" x 11" sheets of closed-surface garnet abrasive paper ranging from #1/2 to 2/0

Situation

Conduct this activity with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Place questions and student responses on the chalkboard	**Interest Approach** Ask the class the following questions: 1. In what way is constructing your own wood project important to you? (*possible responses*) a. Training in job skills. b. Saving labor costs. c. Creating your own design. d. Having pride in self-achievement. e. Enjoying spare time. f. Gaining an appreciation for woodworking skills. g. Learning to follow plans and use tools. 2. What problems have you had when trying to make something out of wood? (*possible responses*) a Couldn't get pieces to fit together right. b. So much waste material remained when project was finished. c. Painted wood project looked crummy – with runs and wrinkles. d. Never knew whether to use nails, screws, or something else to put it together. e. When my wood project for 4-H was finished, my Dad said I should have used some other kind of wood. I'm not sure why. f. When I tried to saw the boards, I couldn't get the saw started without it jumping all around, and I couldn't cut straight. 3. To correct the problems you have had, what must we know how to do? (*possible responses*) a. Read building plans for project. b. Select proper materials. c. Select proper tools. d. Measure accurately. e. Use tools correctly. f. Put the pieces together correctly. g. Select proper materials for firmly fastening the pieces together. h. Paint or varnish correctly.

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

What procedure should we use to construct a wood project?

What to Do (Steps)	How to Do It (Key Points)
1. Select a project.	1. Instructor assigns a project within student capabilities, but which also includes desirable skills. The instructor can also approve one that the student selects from available wood project plans.
2. Interpret the plans for the project.	2A. Interpret the "language" of lines on drawings and blue prints. a. Lines for actual object • solid, heavy lines indicate visible outlines • medium-weight, dashed lines indicate hidden outline b. Lines for measurements and guides • light, solid lines with arrow points identify points of measurement for dimensions • light, solid lines also used as extensions for dimensions c. Lines for center of circular parts – light, dashed, and long or short lines. 2B. Determine from the plans the appropriate type of wood material to use. a. solid versus veneer or pressed particle b. hardwood or softwood c. appropriate finish grade of lumber 2C. Determine the dimension of lumber needed. a. thickness called for in plan, or best for strength and appearance b. if project is made from board stock, number of feet of each width and length of boards needed 2D. If pieces are to be cut from sheet material such as plywood or particle board, determine the size of sheet material needed. • Dimension of lumber selected should be small enough to prevent unnecessary waste, but large enough to allow for some error in cutting (15% excess may be good rule of thumb to use in beginning projects).

Define the problem

What procedure should we use to construct a wood project? *(continued)*

What to Do (Steps)	How to Do It (Key Points)
	2E. Determine the type and amount of fasteners needed. a. screws (round, flat, or oval head; Phillips or regular slot; length and diameter, type of metal) b. nails (length, weight, type of head, type of shank) c. corrugated fasteners (size) d. glue (type)
3. Calculate a bill of materials for the project	3A. List the number and size of pieces of lumber or wood material to order from a lumber yard or other supplier. 3B. List the cost for all pieces of lumber or wood material. Normally, on small projects the supplier prices it per piece ordered. If price is based on board foot, use the formula: thickness in inches X length in inches divided by 144 = 1 board foot 3C. List the number and cost for all needed hardware. 3D. Calculate the total cost for materials on the list of materials.
4. Order the materials.	4. Take a copy of the plans for the project and bill of materials to the supplier to have the order filled. Check to see that what you receive agrees with the bill of materials.
5. Determine the cutting pattern.	5A. Measure and mark the outline of the dimensions for pieces to be cut from the stock material. Use correct measuring instruments to calculate dimensions. a. for lengthy dimensions - folding or tape rule b. for shorter lengths and squaring work - framing or try square 5B. Select the correct reading in whole feet, inches, and fractions of an inch. • for laying out angles - sliding T-bevel

Define the problem

What procedure should we use to construct a wood project? *(continued)*

What to Do (Steps)	How to Do It (Key Points)
6. Cut stock material into the project assembly pieces.	6A. Select appropriate saw. a. hand saws for straight-line cutting • cross cut for sawing with the grain • ripping for cutting across the grain - more teeth per inch equals slower, smoother cutting b. hand saws for circular- or curved-line cutting • compass saw • coping saw c. power tools for straight-line cuts • table saw • radial arm saw d. power tools for circular- or curved-line cutting • jig saw • saber saw 6B. Place board to be cut on sawhorses. Position saw to cut on waste side of line and straight with the line. Start the first stroke by drawing lightly over the edge of the board until the teeth have made a saw kerf in the board. Use long, even strokes after cut is firmly started. 6C. Support the piece being sawed off when nearing the end of the cut.
7. Smooth the cut edges.	7A. Choose correct plane. a. jack plane removes material rapidly -- is 14" long with 2" cutter b. smoothing plane -- good for flat and true surfaces - 9" long with 2" cutter c. block plane is best for smoothing end grain -- common size is 6" long with 1 5/8" blade width 7B. Use proper planing techniques. a. When smoothing the edge or end of a board, keep the plane perpendicular or at 90 degrees to the face of the board. b. Wherever possible, plane with the grain of the wood. Hold the work in a bench vice.

Define the problem

What procedure should we use to construct a wood project? *(continued)*

What to Do (Steps)	How to Do It (Key Points)
	c. Hold rear handle with dominant hand and knob with other. d. Bear down firmly on knob when beginning the stroke, and evenly on both knob and handle when in middle of stroke. Lighten the pressure on the knob and bear down on the handle when finishing the stroke. e. Use as long a stroke as possible. f. Frequently check squareness of the edge to the face of the board. g. Take a shaving the full length and width of the edge on the last stroke. h. The wood should be removed down to the mark, but mark should be visible when planing is finished.
8. Check all pieces for correct dimensions and squareness.	8. Using folding or tape rule, framing square, or try square, confirm that all dimensions match those of the plan, and that all squares and angles called for in the plans are accurate on the boards.
9. Complete any cutouts called for in the pieces.	9A. Drill correct holes in project materials. a. Make holes 1/4" to 1" in diameter with auger bits and a brace. b. Use bit gauge where hole is not to penetrate entire piece. c. Stop as soon as screw point penetrates back side. Complete by coming from back side. d. Drill holes 1" to 3" in diameter with an expansive bit and brace. 9B. Use a combination of bits and compass or coping saws to remove larger or irregular-shaped cutouts. 9C. Use round or half-round wood files to shape and smooth the edges of cutouts.
10. Test all parts for fit.	10. Check that parts will fit together as they should in the completed project. Carefully make any adjustment required for a good fit of the parts.

Define the problem

What procedure should we use to construct a wood project? *(continued)*

What to Do (Steps)	How to Do It (Key Points)
11. Smooth the surface.	11A. Use a closed coat abrasive paper of no. 1/2 grade for coarse sanding and a no. 2/0 grade to prepare the surface for finishing. Wrap the abrasive paper around a 3/4" x 3" x 5 1/2" block of wood. 11B. Sand only to smooth the surface, not to take the place of cutting tools. 11C. Complete all wood surfaces.
12. Make holes for wood fasteners.	12A. When screws are to be used as fasteners, drill the hole to accommodate the root diameter of the screw, and a larger hole for the body of screw, and in case of a flat head or oval head screw - a counter bore. A counter bore tool can be used when the screw head is to be plugged. 12B. Nails normally can be driven into soft woods without causing splitting. But drilling small diameter holes, about 1/2 the diameter of the nail, prior to nailing can help prevent splitting in harder or brittle wood - especially when placed close to the end or edge of the piece.
13. Stain the wood.	13. For more even coverage, stain the pieces before assembly. Follow the directions on the stain container. Wait for the stain to dry before proceeding.
14. Assemble project.	14A. Apply glue. a. Apply glue to the surfaces being joined prior to placement of nails or screws. b. Thoroughly wipe off any excess glue immediately with a damp cloth. 14B. Use fasteners to securely attach the parts. a. Check that parts and fastener holes are properly aligned before tightening. b. Turn all screws snub. Over-tightening can cause splits or stripped threads.

Define the problem

What procedure should we use to construct a wood project? *(continued)*

What to Do (Steps)	How to Do It (Key Points)
	c. Drive in nails with a hammer until head is near the surface of the wood. With flat head nails, use lighter blows at the end so the head is flush with the wood, but so the hammer head does not mark the wood. d. With finishing nails, use a nail set on the last strokes to set the head below the wood surface.
15. Apply finish.	15. Use correct application techniques. a. Select paint, varnish, or other finish material and closely follow application directions. b. Do finish work in a clean, dry, dust-free environment. c. Wipe entire surface of project with a tack cloth. d. Apply finish with clean cloth or brush according to container directions.

• Steps/Key Points •

Problem-Solving Technique

Define the problem What procedure should we use to construct a wood project?	
What to Do (Steps)	**How to Do It (Key Points)**

Helping Students Apply Concepts/Principles/Skills

Steps for constructing a basic wood project with hand tools can be used in a variety of projects. The principles of these steps are also basic to the construction of projects with power tools.

Evaluating Student Learning

Evaluate the student primarily on how well the quality of the end product matches the original plans. The student should be able to score 100% on written or oral quizzes regarding safe use of the tools. Also use written quizzes to evaluate the student's understanding of reading blueprints or project plans, calculating bills of materials, using measuring and woodworking tools, and assembling and finishing wood projects.

This activity was submitted by Roger Roediger, Curriculum Materials Service, The Ohio State University, Columbus, Ohio.

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Data Record and Observation Sheet

Title ____

Name ______________________ Date __________ Period ________

Objective(s) ____________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program	**AGRISCIENCE**
Unit	**7 - Mechanical Science**

Examine Small Engine Operation

Competency/Terminal Performance Objective

7.0.6: Given examples, describe principles of engine operation, based on criteria specified in assessment instrument.

Competency Builders/Pupil Performance Objectives

7.0.6.1 Provided examples, identify types of engines, based on performance criteria list.

7.0.6.2 Provided examples of two- and four-stroke engines, identify principles of these engines, based on performance criteria list.

7.0.6.3 Provided examples of different ignition types, explain operation of ignition systems on criterion performance list.

7.0.6.4 Provided examples of lubrication system types, explain principles of lubrication on criterion performance list.

7.0.6.5 Provided examples of cooling system types, explain principles of cooling systems on criterion performance list.

7.0.6.6 Provided examples of fuel system types, explain principles of fuel systems on criterion performance list.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Applied Academics Competencies

Mathematics

1.2.1	Round and/or truncate numbers to designated place value
1.2.2	Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3	Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4	Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
1.2.5	Set up, solve, and apply ratios and proportions
1.2.6	Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7	Translate written and/or verbal statements into mathematical expressions
1.2.8	Estimate answers
3.2.6	Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. 2-stroke engine
2. 4-stroke engine
3. Tecumseh engine
4. Briggs and Stratton Engine
5. Engines to be disassembled (2 and 4 stroke)
6. John Deere FOS Engines Compact Equipment Book
7. Small Engine Mechanics, Crouse and Auglin
8. AAVIM Small Engine Book Vol. I, Vol. II
9. Hard-boiled egg
10. Milk Jug
11. Piece of paper
12. Match
13. Aluminum cans with 1/4" water in them
14. Pan with 1/2" water
15. Hot plate
16. Welding Glove
17. Large strong magnet
18. Small week magnet
19. Insulated copper wire 4-5 feet long
20. Galvanometer
21. 2 coils one with about 220 coils of wire, one with about 440 coils of wire
22. Briggs and Stratton Repair and Service Manual
23. 2 thick (1/2") flat squares of metal
24. Can of motor oil
25. Lawn mower engine with tall oil filler tube
26. Thermometer (regular)
27. Cooling thermometer
28. Pyrometer
29. Tape and paper
30. Liquid cooled engine
31. Lubrication example types
32. Ignition type examples
33. Carburetor type examples
34. Air cleaner type
35. fuel filter
36. Diesel engine
37. ping pong ball
38. golf ball
39. air hose with spray nozzle
40. funnel
41. Glass jar with 3" of water
42. 2 straws

Situation

This experiment is to be conducted with a class of Level II Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Secure a two and four stroke engine.	**ACTIVITY 1** **Interest Approach** Fire up each one of the engines for the class. Ask the class to list as many visual, audio, and physical differences between the two engines that they can. Present both a Tecumseh a and Briggs and Stratton engine and contrast the two makes.
Assemble students in the laboratory after securing a two-stroke engine, four-stroke engine, Tecumseh, and Briggs and Stratton engine.	**Procedure** Fire up each of the engines and have students write down as many differences between the 2 and 4 strokes and the two different companies' engines. Discuss the differences among the class and point out any external differences. You may want to have a student lift the 2 and 4 stroke to compare weights. Discuss prices, power, lubrication/fuel, noise, emissions, rpm's, etc.
1. Secure a four and two stroke engine	1. Present the two and four stroke engines to the class again. Explain to the class that they previously pointed out differences between the two engines. However, ask the class how the engines differ in their internal parts. Also ask why they called 2 and 4-stroke engines.
2. a. Use the information on pages 7.0.6-8 and-9 (student copy). b. Use the information on pages 7.0.6-10 and-11 (student copy).	2. In order to clear up the idea of atmospheric pressure and high pressure/low pressure, a couple of experiments will be used. a. The egg in a bottle trick b. Can crushing trick
	3. Make sure that the experiments correspond with the engine theory so that learners can apply what they learn.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
a. Use the information on pages 7.0.6-12 and-13 (student copy). b. Use the information on pages 7.0.6-14 and-15 (student copy).	**ACTIVITY 2** **Interest Approach** Present an engine to the class (one that has no spark) and ask a student to come forward to try to start it. After several attempts, the student will find that the engine will not start. Have the class suggest reasons why the engine will not start. When they suggest that it may not have any spark, demonstrate to them that it doesn't. Then ask the class why it does not have any spark. Lead them into the understanding that they need to know the parts and functions of the ignition system in order to understand why it doesn't have any spark.
1. Probing Questions	**Procedure** 1. a. What is the ignition system? b. Why do we need the ignition system c. How does the ignition system work?
2. Statement/Problem	2. a. The ignition system basically creates electricity in order to jump the gap of the spark plug. b. The problem we have is that we do not know how the engine creates electricity and delivers it to the spark plug.
3. Encourage learners	3. Ignition systems in a small gas engine are very simple and easy to work on. When we are done learning about the ignition system, I am sure that all of you will be able to adjust, service, & replace your ignition systems.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 3 **Interest Approach** You will need two thick pieces of flat steel and some oil. Pick one of the students from the class and have them lay one of the pieces of metal on top of the other. Then have them begin to slide the top piece around on the bottom one. After a few minutes of doing this, have the students feel the two pieces of metal for the warmth that will have been created. Then have the student squirt a little oil in between the two pieces and rub them together again. Let the students feel the two pieces again after a few minutes of this. Lead students into understanding the importance of proper lubrication for metal to metal contact. **Procedure**
1. Lead Questions	A. After viewing the demonstration, why is proper lubrication (oil) necessary for a small gas engine necessary? -reduce friction -cools -seals -cleans -reduces noise B. What would happen if we had inadequate lubrication for an engine? -Increased Wear -Higher operating temperatures -Improper sealing -Blowby -welding or scuffing of parts -total engine failure C. How does a small engine accomplish lubrication? -Dipper -Barrel & plunger -Slinger -pump -mixed in fuel (2-stroke)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use of Visuals	**ACTIVITY 3** *(continued)*
	2. Using examples of each from an engine, demonstrate and explain how each system works to accomplish lubrication. Use p. 58, of the AAVIM "Small Engines" book vol.1 for visual aid.
Visit a local small engine repair shop and obtain several examples of parts that failed due to inadequate or improper lubrication.	3. Present several small engine parts that have failed due to inadequate or improper lubrication. Have students brain-storm possible solutions as to why the parts failed. Emphasize that parts don't always fail due to low oil but can be due to dirty oil, thin oil, contaminated oil, thick oil, or too much oil.
Problem/Experiment	
Lecture/Discussion	4. We've emphasized that inadequate oil or improper oil can cause damage but too much oil can also cause problems. Perform crankcase vacuum experiment.
Use the information on pages 7.0.6-16 and-17 (student copy).	As you can see, the lubrication system requires much attention and is probably the most important but most neglected area in small engines. Since it is so important, it is also important to understand some things about the substance that is used to do the actual lubrication, that being oil.
Secure a can of motor oil	Present a can of oil to the class and ask students what some of the abbreviations, letters, and numbers stand for. Ask them what is the difference between, for example, SAE 30 oil and 5 W 50 motor oil. Also ask them what is the recommended oil for their small engines. After students begin to realize that there is more to understanding oil then meets the eye, begin to explain what each piece of information on the can means.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	ACTIVITY 4
	Interest approach
	You will need a small engine that is air-cooled, a regular thermometer, a cooking thermometer, and a pyrometer. Run the small engine and measure temperatures at various locations with the two thermometers such as between the cylinder fins, around the head, crankcase etc. Use the pyrometer to measure the exhaust temperature. Then use some tape or paper to block off the air flow from the flywheel to the cylinder fins and head. Measure the temperatures again and note the changes.
Probing questions	**Procedure**
	A. Why did the temperatures change from the first trial run to the second trial run? How is this small engine cooled? Explain that the spinning flywheel creates moving air that is directed up towards the cylinder head and cylinder fins. Because of the design of the fins and the tremendous surface area they have, they are able to dissipate the heat away from the combustion chamber and allow the engine to function properly. As a result, we are able to use 70 degree air to cool the three thousand degree heat that is produced within the combustion chamber. What problems might mud and grass stuck in the fins cause for engine? Is it understandable why the cooling system is an important component of the small engine? But are all small engines cooled by air? How else might a small engine be cooled? Upon the suggestion of liquid cooling present a sample of a liquid cooled small engine. If none is available, use a vehicle to point out the components and their functions. Use p. 4 and 5 of chapter 8 of the John Deere FOS Engines Compact Equipment book as a reference. Components to be demonstrated and discussed should include the radiator (include fins), cap, fan, water pump, water jackets, thermostat, anti-freeze, hoses, belt, shroud, and maintenance.
Use the information on pages 7.0.6-18 and-19 (student copy).	**ACTIVITY 5**
	Procedure
Use the information on pages 7.0.6-20 and-21 (student copy).	In order to illustrate Bernoullis principle, a couple of experiments will be used. a. The floating ball trick b. Water spray trick

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How do we get the egg into the bottle without damaging the egg or the bottle?

What to Do (Steps)	How to Do It (Key Points)
Probing questions	1. a. How can we get this egg in this bottle? b. Have learners try to push egg in bottle. c. Why can't the egg be pushed into the bottle? - pressure in bottle does not allow you to push the egg in. d. So what do we need to do to get the egg in the bottle? Lower the pressure in the bottle. e. How do we lower the pressure in the bottle?
Statement and experiment	2. a. The learners will not be able to answer the above question so start the experiment. b. Peel the Hard boiled egg c. Light a piece of paper on fire and drop it in the milk jug. d. Place the egg on top of the jug. e. The egg will be sucked into the jug (sometimes very quickly)
Probing questions	3. a. Why did this happen? - The gas in the jug was heated with the paper fire. - the gas then expanded due to the heat. - when the egg was place on top of the jug, the flame went out and gases were then cooled and returned to normal size causing a lower pressure inside the bottle. - atmospheric pressure (14.7 psi) then pushed the egg into the bottle. b. The piston in a small gas engine creates this same area of low pressure and in turn the atmospheric pressure pushes the air fuel mixture into the cylinder.
Probing questions	4. a. How do we get the egg out of the bottle? - we need to create an area of higher pressure behind the egg to push it out. b. How do we create this area of higher pressure? - have a learner hold the bottle straight up in the air so that the egg is at the mouth of the bottle and then have the learner blow into the bottle as hard as they can. When they can not blow any more, tell them to stop blowing and take their mouth off the bottle. c. The egg will come out of the bottle very rapidly! d. Have the learners explain why the egg came out.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How do we get the egg into the bottle without damaging the egg or the bottle?

What to Do (Steps)	How to Do It (Key Points)

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How could we crush this can without actually touching it during the crushing procedure?

What to Do (Steps)	How to Do It (Key Points)
1. Material needed	1. a. A pan with about 1/2" of water, preferably cold and possibly with ice in it. b. A couple of aluminum pop cans with about 1/4" of water in the bottom of the can. c. A burner or hot plate to bring the water in the can to a boil. d. A welding glove to handle the hot can.
2. Probing questions and experiment	2. a. How could we crush this can without touching it during the crushing? b. Put the aluminum can on the hot plate or burner and boil the water in the can. c. When steam starts to come out the top of the can, use the welding glove to take the can off and quickly place the can upside down in the pan of cold water so that the opening of the can is under water. d. The can will very rapidly crush. e. How do we lower the pressure in the bottle?
3. Discussion	3. a. Why did the can crush - The gas is expanded when it was heated (steam). - Then the can was put in the water, the gas got smaller again, but the opening was sealed by the water. - The pressure in turn was less inside the can than the atmospheric pressure on the outside of the can. - In turn, the 14.7 psi outside the can pushes or crushes the can in.
4. Review	4. a. Review and have the students explain what happened and why. b. Have the learners apply the experiment to small gas engines and the intake stroke.
5. Another possible solution	5. a. If the can does not crush, then it will be full of water. Why? - The atmospheric pressure pushes the water in the can.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How could we crush this can without actually touching it during the crushing procedure?

What to Do (Steps)	How to Do It (Key Points)

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem

How can we create electricity with a magnet?

What to Do (Steps)	How to Do It (Key Points)
1. Material needed	1. a. large, very strong magnet b. small, weak magnet c. Insulated copper wire about 4 to 5 feet long d. a galvanometer to read very low currents of electricity e. coil - on with about 220 coils of wire and the other with about 440 coils of wire
2. Start the experiment with a discussion	2. a. Is this large magnet is creating a magnet field? b. If I took this wire and passed through the magnetic field, I would have electrons flowing through the wire and thus I would have electricity. - try to measure how much electricity flows through the wire.
3. Perform first part of experiment	3. a. Hook the wire to each lead on the galvanometer b. Pass the wire through the magnetic field of the magnet c. The galvanometer will jump, so make sure the entire class has a chance to see it. d. Now, if we took this wire and made a coil so that two strands of the wire pass through the magnetic field what happens? - The galvanometer will jump twice as far. - The galvanometer will jump three times as far with three coils of wire.
4. Discussion	4. a. What exactly is happening inside of the copper wire? - electrons are flowing around the wire at a very high speed (the speed of light to be exact) b. So, when we have more coils of wire passing through the magnetic field, we have more what? - electrons in motion c. Be sure that the entire class understands this. Use probing questions to make sure everyone understands.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How can we create electricity with a magnet?

What to Do (Steps)	How to Do It (Key Points)

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• Effect-Cause •
Problem-Solving Technique

Define the problem

What is causing the ignition system to not work properly?

Possible Causes	Related Facts	Accept/ Reject Cause
1. spark plug	1. a. If the spark plug is fowled badly it will not work properly b. Check to be sure that the spark plug gap is correct and that there is not any damage to the plug itself	reject
2. Armature gap is wrong	2. a. If the gap is too large, the magnet can not create the electric field in the coil. b. The magnet on the flywheel may not be strong enough. (refer to Briggs and Stratton Guide)	Accept
3. Spark plug wire is bad	3. a. If the plug wire is cut or broken there will be no spark b. There may be only partial or weak spark if the plug wire is not completely cut or broken	reject
4. Breaker points are bad	4. a. If the breaker points are sealed together, there will be no spark. This could have been caused by a faulty condenser	reject

Decision/Recommendation

The ignition system on the engine in class needed to have the armature and flywheel gap adjusted to the proper manufacturer's specifications in order to properly create an electrical current.

• Effect-Cause •
Problem-Solving Technique

Define the problem
What is causing the ignition system to not work properly?

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

• Steps/Key Points •

Problem-Solving Technique

Define the problem

What is crankcase vacuum and what happens when we fill our small engine to full of oil?

What to Do (Steps)	How to Do It (Key Points)
1. Material needed	A. A lawnmower engine mounted on mower deck that has a tall oil filler tube (usually) has a dipstick. B. Some oil
2. Probing questions	What is crankcase vacuum? (When an engine operates, it maintains a vacuum in the crankcase if the breather is functioning properly.) What happens if the breather is not functioning properly or a vacuum is not maintained? (A positive pressure would be created which might blow gaskets or seals. Another problem would be that some burning of oil could occur due to the oil traveling up the valve guide. What would happen if we put a little too much oil in our crankcase? How would this affect our crankcase vacuum?
3. Experiment	Start the mower and demonstrate that the mower engine does not smoke. Then do two things. Fill the engine slightly over full with oil. Also do not tighten the oil filler tube cap, but rather just simply let it rest on the tube. Start the engine and let it run for a while. Soon you should see the engine start to smoke.
4. Discussion	Why did the engine start to smoke? What problems would filling an engine too full with oil cause? What would happen if someone did not tighten the oil filler cap. What other reasons might someone think was creating the problem? (Valves, Rings, Gaskets)
5. Review	Review the important concepts of the experiment.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

What is crankcase vacuum and what happens when we fill our small engine to full of oil?

What to Do (Steps)	How to Do It (Key Points)

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How could we get this ball to float in mid air without creating a vacuum or attaching strings etc.?

What to Do (Steps)	How to Do It (Key Points)
1. Material needed	1. a. One ping pong ball b. Air hose (from laboratory) with a spray nozzle on it c. A funnel that can be put on the end of the air hose
2. Probing questions	2. a. How could we make this ball float in mid air? b. Why would a stream of air hold the ball in the air?
3. Float the ball	3. a. Hold the ping pong ball about 1 1/2" inches above the air hose. b. Slowly start to press the air hose button and increase the velocity of the air coming out of the hose. c. Let the air pick the ping pong ball out of your hand.
4. Lecture/Discussion	4. a. How did this happen? b. Where is the high and low pressures c. Discuss the principles of Bernoulli's law and how it pertains to the experiment and to carburetion. d. Make the sure the students can understand exactly why the experiment works.
5. Additional experiment - Float a ping pong ball in a funnel and also use a golf ball	5. a. Take a funnel and place it on the end of an air hose. b. Place the ball in the bottom of the funnel and turn the air on.
6. Probing questions	6. a. Why did the ball not shoot out of the funnel? b. Why did the golf ball spin? c. Use Briggs and Stratton poster to illustrate this experiment . d. Have learners explain the experiment and apply it to what we have already learned about air pressure.
7. Discussion	7. a. How else would these principles affect us in our daily lives? (air place wing) b. Explain to me what an airplane wing does to make a plane fly
8. Statement	8. So what does this have to do with carburetion? This is a good question and this next experiment will help illustrate to you why this is important in carburetion.

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How could we get this ball to float in mid air without creating a vacuum or attaching strings etc.?

What to Do (Steps)	How to Do It (Key Points)

• Steps/Key Points •

Problem-Solving Technique

Define the problem

How could we get water to travel up through a straw in a cup without sucking on it?

What to Do (Steps)	How to Do It (Key Points)
1. Material needed	1. a. .Air hose (from shop) with a spray tip in it b. Gas, jar, or whatever with about 3 inches of water in it. c. 2 drinking straws
2. Probing questions and discussion	2. a. How could we get the water to come up through the straw without sucking on it? b. Use probing questions to get the learners to think about it. c. The answer is to lower the pressure at the end of the straw by spraying a fluid (air) past the straw quickly which will lower the pressure at the straw tip and then atmospheric pressure will push the water up the straw and spray it preferably all over the class. Do not tell the class this yet.
3. Put the straw in the glass and on the air hose	3. a. Put the straw in the glass of water. You could also use a hose placed in the glass of water. b. Somehow place the other straw on the end of the air hose so that a straight and steady stream of air comes out of it. The idea is to eliminate as much turbulence from the tip of the hose so that a steady stream of air comes from hose. c. You could also take a straw and cut half way in half so that you can bend the straw into a 90° angle. d. Place one end of the straw in the water and the other end on the air hose.
5. Spray away	4. a. Aim the air hose across the straw in the water and at the class. b. Spray the air all over the class. c. Water and air mist should spray out over the class.
5. Probing questions	5. a. How did this happen? b. What caused this to happen? c. Discuss this with the class and have them try to come up with the answers so that they understand what happened. d. Be sure to apply this to carburetors and how the fuel and air are mixed. Talk about Bernoulli's principle and the venturi etc.

• Steps/Key Points •

Problem-Solving Technique

Define the problem	
How could we get water to travel up through a straw in a cup without sucking on it?	
What to Do (Steps)	**How to Do It (Key Points)**

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Helping Students Apply Concepts/Principles/Skills

Ideas for Additional Experiment

- Determining the Effect of Air Pressure on Fluid Flow (See pages 7.0.6-23 through -25)
- Demonstration of Atmospheric Pressure (See pages 7.0.6-26 through -27)
- Demonstration of Bernoulli's Principle (See pages 7.0.6-28 through -35)

Evaluating Student Learning

After students complete these experiments, have them record their data and observations on pages 7.0.6-36 and -37.

Portions of this activity were submitted by Bill Keck, Agricultural Education Instructor, Marysville High School, Marysville, OH 43040, Ed Feasel, Agricultural Education Instructor, Elmwood High School, Bloomdale, OH 44817, Tom Oglesby, Agricultural Education Instructor, Hillsboro High School, Hillsboro, OH 45133, and Rusty Thompson, Student Teacher, Marysville High School, Marysville, OH 43049.

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Agricultural Education Science Activity – No. AEM-1

Determining the Effect of Air Pressure on Fluid Flow

Agricultural Subject

■ Agricultural Engineering and Mechanics

Activity Length

■ One class period

Group Size

■ This activity can be conducted with an entire class or small groups (2 to 3 students).

Science Principle

■ Whenever a gas or liquid flows through a closed flow path, pressure at or near the center of the stream is lower than the pressure at the outer edges of the stream. The greater the flow velocity, the lower the pressure. Thus, whenever the speed of a moving stream of fluid increases due to constriction, the pressure decreases.

Agricultural Application

■ Pressures are used in many ways in agricultual mechanics. For example, pressures exerted on fluids and the effect of atmospheric pressures on fluids are used in equipment operation. Air pressures cause fuel to flow from the carburetor bowl to the carburetor. When working with engines it is necessary to understand the principles that make them work in order to repair and maintain them.

Student Objective

■ To determine the effect of air pressure on fluid flow.

Vocabulary

velocity
carburetor
venturi
gas
atmospheric pressure
carburetor bowl
liquid

Materials Required

1. Container to hold water (bottle or jar)
2. Two drinking straws
3. Air compressor
4. Safety glasses
5. Water
6. Paper and pen

Instructional Strategies and Procedures

■ **Overview:** Fill the jar three-fourths full of water. Position one straw in the water. Using a second straw, force air across the top opening of the first straw. Note what happens to the water in the jar. Record your observations and discuss the results. Discuss how this demonstration is related to carburetor operation.

Safety Note: Prior to the demonstration, discuss the safety precautions to use when working with compressed air and pressures. Insist that students wear safety glasses. Do not direct the air flow toward anyone.

Instructional Strategies and Procedures

(continued)

1. Fill the jar three-fourths full of water (see Figure 1).
2. Place straw 1 into the jar and secure it. Make sure that the straw is positioned vertically in the center of the jar and not touching the bottom (see Figure 2).
3. Hold one end of straw 2 at a right angle to the top opening of straw 1. Using an air compressor, force air into the other end of straw 2 (see Figure 3). If done correctly this process will force air across the top opening of straw 1.
4. Note what happens to the water. Record observations on page 3.
5. Discuss how this process is related to carburetor operation.

■ **Results:** When air is forced over the opening of straw 1 it lowers the pressure in that straw. The atmospheric pressure in the jar is now greater than the lowered pressure in straw 1. Therefore, a **venturi** is created and water is forced from the jar into the air stream in straw 1. If done correctly, this produces a water spray from the top of straw 1.

Key Questions

1. Why does the water move out of the jar and form a spray?
2. Will increasing or decreasing the air flow through straw 2 and over straw 1 affect the water flow out of the jar? If yes, how?
3. What part of an engine uses this principle during operation?
4. Can you think of other ways this principle could be used in agricultural mechanics?

Evaluation

■ Ask students to write a report based on what they have observed.

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1. *Service and Repair Instructions*, Briggs and Stratton Corp., Milwaukee, WI.
2. Cooper, Elmer L. *Agricultural Mechanics: Fundamentals and Applications*. Albany, NY: Delmar Publishers Inc., 1987.
3. Jacobs, Clinton O., and William R. Harrell. *Agricultural Power and Machinery*. New York: Gregg Division, New McGraw-Hill Book Company, 1983.

Demonstration submitted by Tom Oglesby, Production Agriculture Instructor, Hillsboro High School, Hillsboro, OH 45133.

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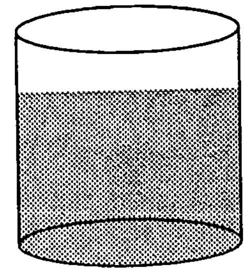


Figure 1. Fill a jar three-fourths full of water.

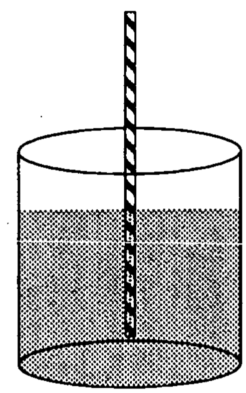


Figure 2. Place straw 1 in the jar.

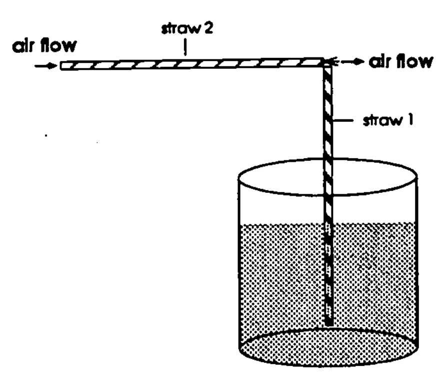


Figure 3. Force air through straw 2 and across the opening of straw 1.

DATA RECORD AND OBSERVATION SHEET

Name ______________________________ Date __________ Period _____

Determining the Effect of Air Pressure on Fluid Flow

Objective

What are you trying to demonstrate?

Procedure

What did you do?

Observations and Results

What did you observe? When did it happen? What caused it to happen?

Conclusions

What principle was demonstrated?

Demonstration of Atmospheric Pressure

Explanation: This demonstration is intended to be a precursor to a demonstration on the venturi affect.

The only way to properly understand why a small engine runs or any engine for that matter is to have a good foundation of the concepts of pressure differential.

Objective : After the conclusion of these demonstrations students will have a thorough understanding of the concept of atmospheric pressure.

Points to consider

1. **Vacuum:** is the absence of anything on the molecular level. It is impossible to achieve an absolutely perfect vacuum, however we often use partial vacuums to achieve our desired outcomes.
2. **Suck, Pull, and vacuum** are all words which we have all used to describe how carburetors work. However these words only help to confuse us as to what is really happening. It would be a good idea not to use these words in describing how a carburetor works, because there are many instances where these words will not accurately describe what is happening.
3. **Atmospheric Pressure** is the pressure of the atmosphere exerted upon all things due to the weight of the atmosphere on top of us. The atmospheric pressure changes constantly and is dependent on the elevation at which one measures it. Atmospheric pressure has been established as being the ability to raise a column of mercury 29.92 inches on a standard day at sea level. On a standard day it will also raise a column of water 33.9 feet and register on a gauge at 14.7 psi actual pressure. All of these figures equal one atmosphere. (A standard day is one in which the temperature is 69 degrees Fahrenheit at sea level with an atmospheric pressure of 29.92 inches of mercury).

   One Atmosphere = 33.9 ft of water = 29.92 inches of mercury, = 14.7 psi gauge.
4. **Law of Fluid Pressure** The (gauge) pressure at any depth in a fluid at rest equals the weight of the fluid in a column extending from that depth to the "top" of the fluid divided by the cross-sectional area of the column.
5. The above law means that for every square inch of surface area there is 14.7 lbs of pressure being applied. This is the weight of the air on top of us. This pressure allows us to breath, maintain a body size, and gives us the ability to do all sorts of things like drink from a straw or pump water from the ground or siphon gas from a car tank.

Demonstration of this fact

There are several ways to demonstrate this physical fact.

A. One method is to build a liquid filled barometer. This requires a tube of any diameter about 36" in length, it must be sealed at one end, filled with mercury and inverted in a pool of mercury. Depending on the day and the present elevation the mercury will rise to around 29.9 inches in the tube above the level of the pool of mercury.

Variations: If this demonstration is used, then one should use different diameter tubes and should also try it using water. However with water it will require a much taller tube.

Problems: Students will still not understand why the mercury stays in the tube. They think it is because of the vacuum at the top of the tube holding the mercury up. Explain that there is no vacuum up there, just a lower pressure. The weight of the atmosphere is pushing the fluid up the tube where there is a lower pressure. They still will not understand so move on to the next demonstration.

Demonstration of Atmospheric Pressure

(continued)

Caution Mercury is very hazardous to human health and in low doses it can cause brain damage (and lord knows there is enough of that going around), convulsions and even death. Mercury should not come in contact with anyone's skin nor should anyone breath any vapors which might be present. Great care should be taken to wear plastic gloves and prevent spills. Wood will absorb some of the mercury and release it later so one should be sure there is some sort of metal or plastic pan under the entire demonstration to prevent an accidental spill from becoming worse.

B. Take a one gallon steel can and put a small amount of water (one cup) in it and then place it on heat source and boil the water. Once the water has come to a boil take it off the heat and put the lid on the can. Observe what happens to the can as it cools. The can will be crushed by the weight of the atmosphere on top of it. If you want more dramatic results put the can on ice cubes or cool in some way. The students should not be led to believe there is a vacuum in the bottle because obviously there was steam coming out of the bottle and therefore there could be no vacuum present.

This should get their attention but there will be some doubting Thomas's and others who think you have just come back from the Houdini School of Magic.

Caution: Make sure that the lid is not on the can when the can is on the heat or you will discover another principle about gases that will be hard to explain to the community when the can blows up.

D. If the students are catching on, take a drinking glass and fill with water and then place a piece of notebook paper on top and invert the glass. The water should stay in the glass for several minutes even upside down. However when the paper becomes saturated then it will let the water go with no warning.

Warning: You may just get wet on this one.

Notes: Practice all of the above mentioned demonstrations until you feel comfortable that they will work for you. They have been tried many times and have never failed but if you do not practice them Murphy's Law will get you. There is nothing less productive than a demonstration that does not go as intended. For one thing the students remember that you failed and not the objective.

Demonstration of Bernoulli's Principle

Explanations: The following demonstrations are designed to demonstrate Bernoulli's Principle and to relate it to a carburetor or other physical phenomenon.

This demonstration should follow the demonstration on Atmospheric Pressure so that the remaining functions of a carburetor may be explained.

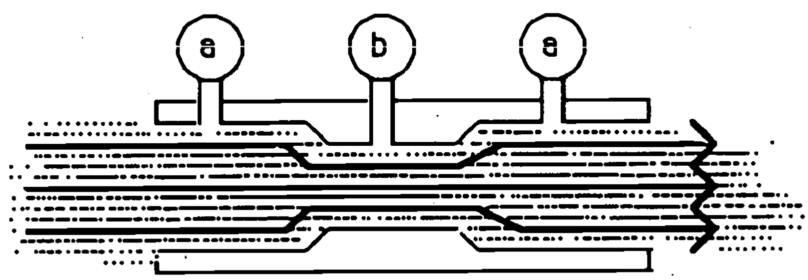
Objective: After the conclusion of these demonstrations students will have a thorough understanding of Bernoulli's Principle and the venturi in a carburetor.

Points to consider

1. **Bernoulli's Principle:** as the velocity of a fluid increases, the pressure of the fluid decreases.

   In English : For a fluid undergoing a steady flow, the pressure is lower where the fluid is flowing the fastest.
2. Steady flow means that there is no random swirling of the fluid and that there are no outside forces increasing or decreasing the rate of flow.
3. Fluid can be a gas or a liquid. Most people do not consider air a fluid, however most scientists do. When we think of fluid dynamics we must consider that these laws almost always work in both liquids and gasses.
4. Venturi is a restriction to the flow of a fluid through some passage way.

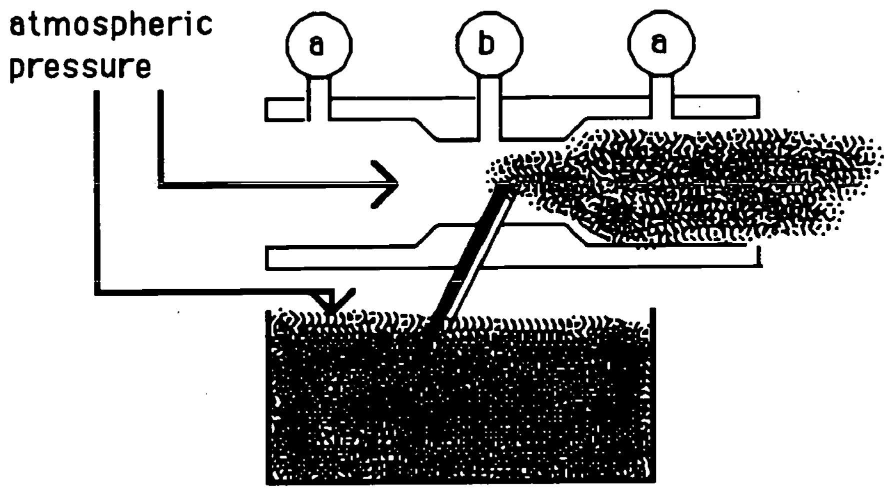
   EX. : As air comes into a carburetor it comes through a fairly large passage way. It then comes to a point that is about 30 percent smaller and then the tube opens back up to its original size. This is a venturi. See the following diagram.



In the above diagram air is entering a tube with a constant velocity until it reaches the venturi (restriction) at that point some of the air molecules must speed up in order to maintain the same flow rate. As they speed up, the pressure of the fluid at pressure gauge b will be lower than at pressure gauge a. In a carburetor we just install a small tube at point b as shown in the following diagram and we stick one end in a pool of gas. The atmospheric pressure, which is stronger than the pressure at gauge b, pushes the fluid up the tube into the air.

Demonstration of Bernoulli's Principle

(continued)



fuel bowl

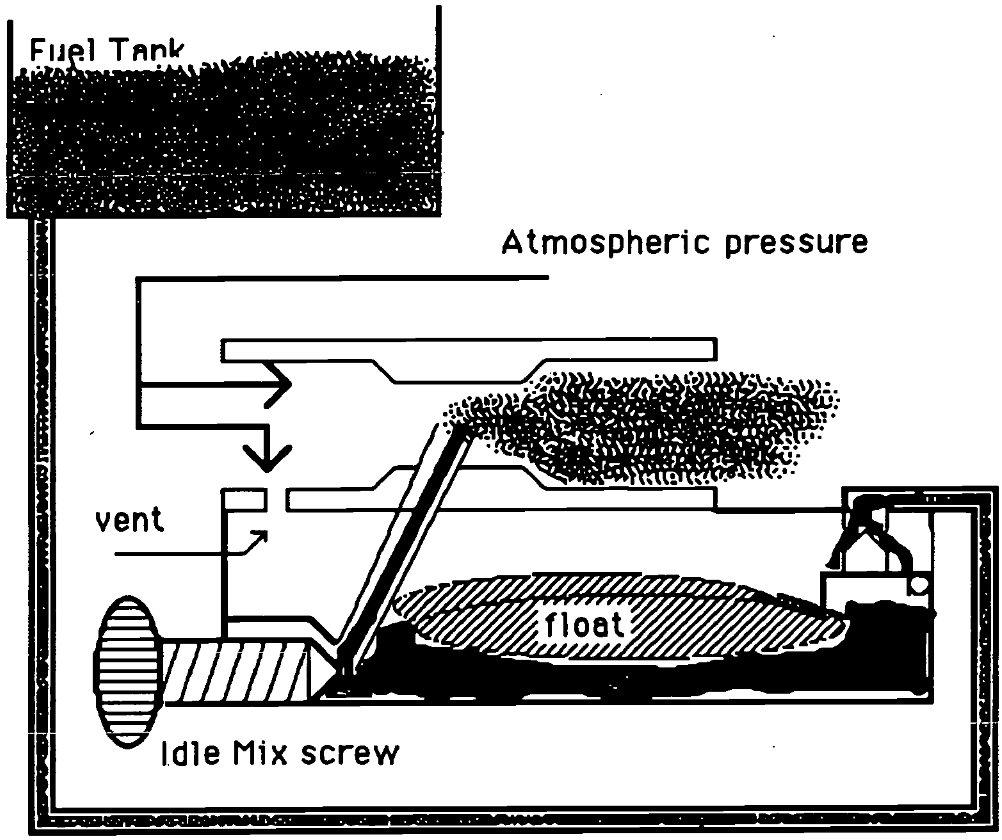
At the point when the fluid being pushed up the tube enters the venturi, it is entering an area of much lower pressure. Therefore, the small particles of the fluid literally explode making extremely small particles which are usually evaporated very quickly due to there large surface area. This process is called atomization. It does not separate the fluid into individual atoms as the name implies but does dramatically reduce particle size. When the gasoline evaporates into the air, the result is a very volatile gas that will burn rapidly when ignited

During the evaporation process, a large amount of heat is absorbed by the gas and carried into the combustion chamber. Vaporization will cool the carburetor to below the freezing point and the warm moist air entering the carburetor will condense and/or freeze on the sides of the carburetor to the point that it causes the engine to quit. This condition is known as **Carburetor ice** and is due to the moisture in the **air, not** in the gasoline.

Carburetor ice is most likely to occur when the temperature is 55-70 degrees F. and the throttle is wide open. Because of this automobile manufacturers eventually put carburetors on top of the engines where they would get all of the engine heat and they used special ways of warming up incoming air. Finally, most automobiles are now using fuel injection. However, this is still a phenomenon that causes in-flight engine failure on small, normally aspirated airplane engines.

Demonstration of Bernoulli's Principle

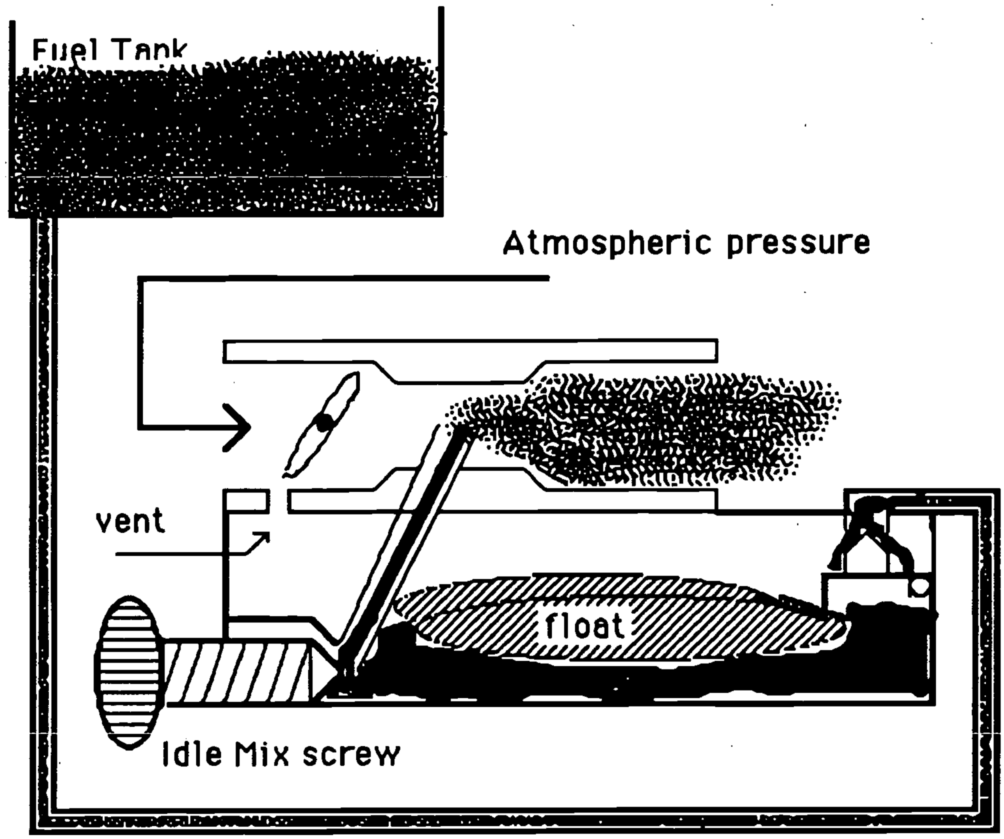
(continued)



The addition of a float maintains a constant level of fuel in the float bowl. There is a needle valve which allows fuel to flow from the fuel tank into the carburetor when the float is down. It stops the flow of fuel when the float is up. This system maintains a constant level of fuel in the float bowl. This in turn maintains a constant amount of fuel being pushed up the tube or main jet for a carburetor. The addition of the idle mixture screw gives more control over the amount of fuel going up the main jet tube. The only reason for this addition is that it allows for a much less accurate float and it allows the operator to make compensation for lower atmospheric pressure due to higher elevation operation. Notice the vent hole. It is a very important part of a carburetor that is often overlooked. If it becomes clogged, fuel will not enter the carburetor nor will it leave the float bowl.

The only thing missing from this primitive carburetor is a throttle plate which has been added to the following picture. The throttle plate allows control over engine speed.

Demonstration of Bernoulli's Principle
(continued)



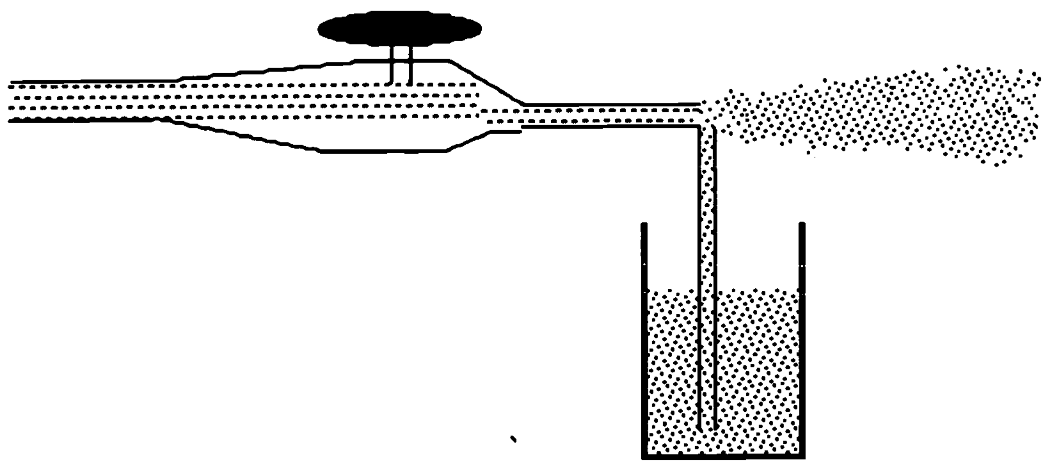
The only thing missing from this carburetor is another jet ahead of the throttle plate that will give a richer mixture during low engine speeds. Another addition would be another butterfly valve used as a choke, which would enrich the mixture for starting purposes.

Demonstrations of the Venturi Effect

1. A good demonstration of the venturi effect is to take a drinking straw and hook it up to a nozzle of compressed air. Then put another drinking straw in a glass of water. Take the first straw as shown in the diagram and place at the mouth of the first straw and blow compressed air across the top of straw. A lower pressure will be created and water will be pushed up the drinking straw into the air stream where it will be atomized. This will be even more effective if it is aimed at the class.

Demonstration of Bernoulli's Principle

(continued)

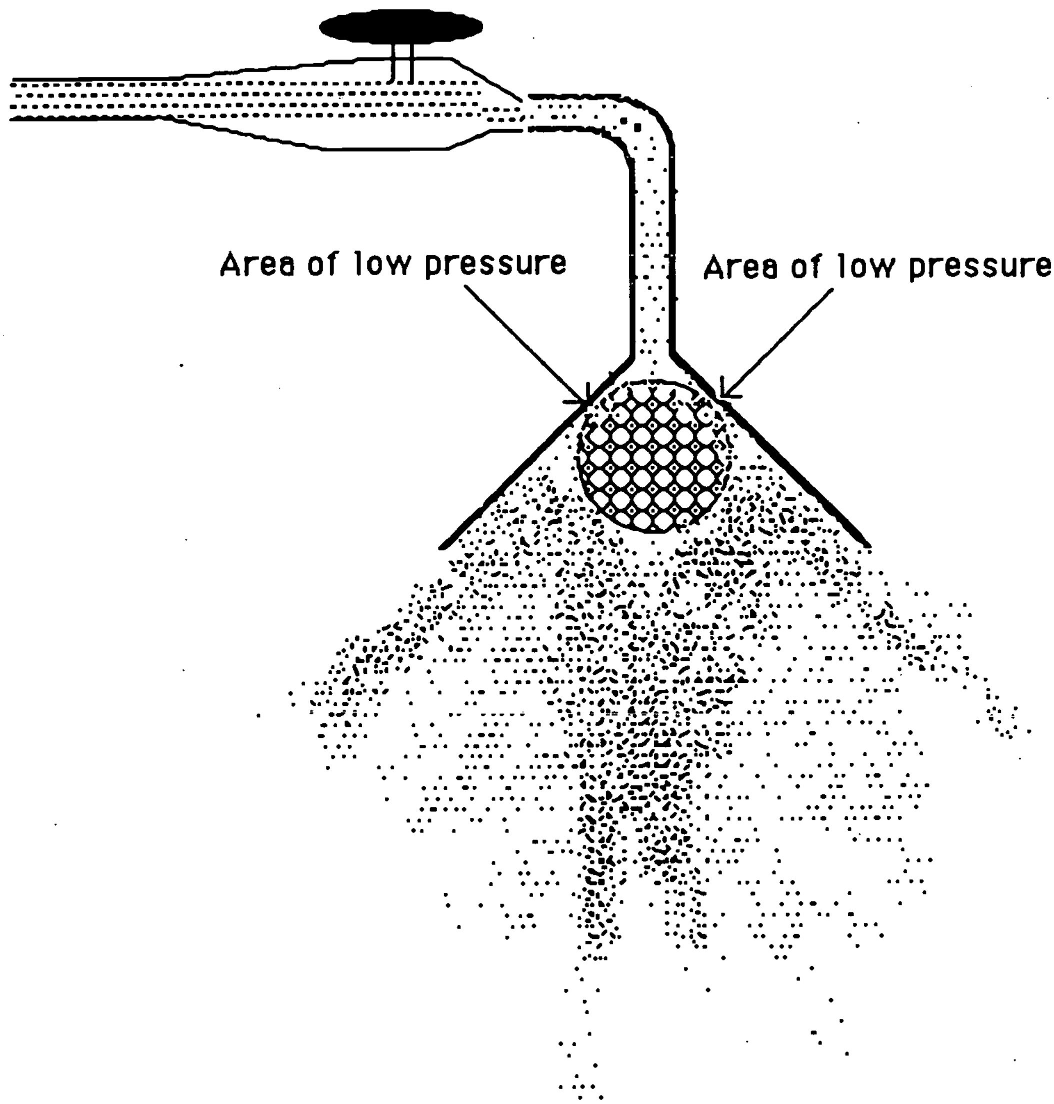


2. The second demonstration should be one that you let the students try to explain. Take a smooth ball such as a ping pong ball and place it in a funnel that is hooked up to compressed air. The ball will be held in the funnel even when it is upside down or in any position as long as the air is on. In fact it will be slightly difficult to remove the ball. The ball is held in that position by the greater atmospheric pressure around it. The ball is seeking the area of lowest pressure. After this, try using a golf ball. It spins at a very high RPM. Why does it spin? Engineers refer to this as coasting of the golf ball through the air. This is what it does when it flies through the air, it gives the ball greater stability and longer flight.

   Caution When you let go of the air button the golf ball will travel very quickly around the room.

Demonstration of Bernoulli's Principle

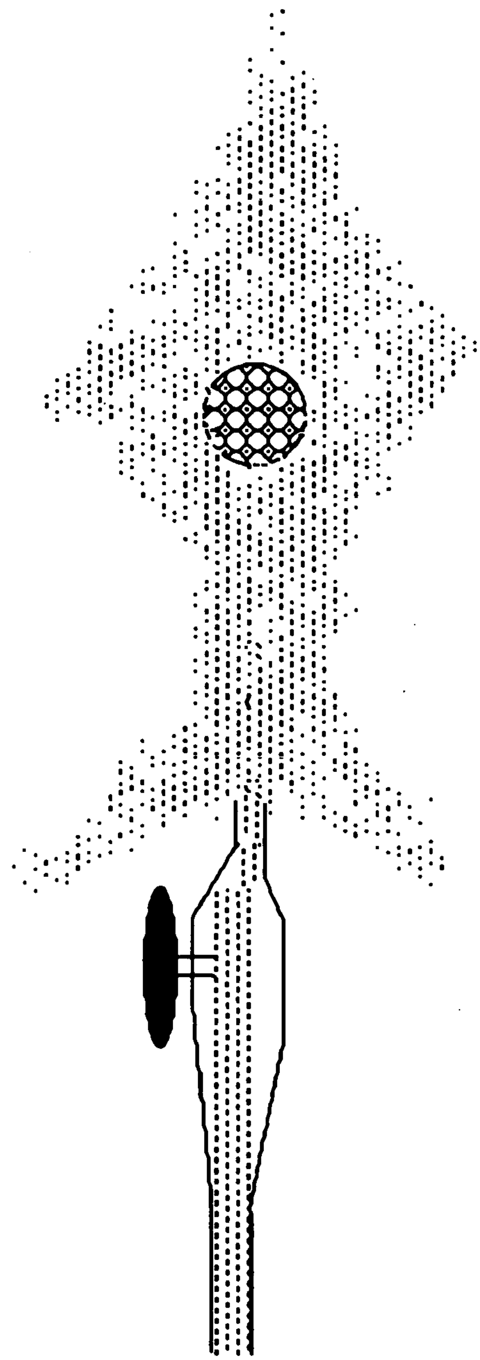
(continued)



3. In this demonstration take a smooth ball and balance it in a stream of air. Why does the ball stay there and not fly away? Try a golf ball with no flaws in it. With a lot of practice one can use an egg. Note it does not matter weather it is hard-boiled or not unless you drop it.

Demonstration of Bernoulli's Principle

(continued)



4. Another demonstration is to take an air hose that has about 40 psi of pressure in it and have a student stand on it. Decide whether or not you are flattening the air hose completely or not. If not ,then depress the air nozzle and notice that when the air is moving through the hose that it goes flat and the air stops flowing. Why is this?
5. Something to think about. Compare the shape of any aircraft wing to the cross sectional view of a venturi. They are the same. Why are they the same and what is the correlation between them?

Demonstration of Bernoulli's Principle

(continued)

Demonstration of the Latent Heat of Vaporization

Have a student dip his or her hand in room temperature water. The student will notice as the water begins to evaporate that his or her hand feels cooler. Then blow a fan over his or her hand and as the evaporation accelerates his or her hand will feel even cooler.

Try this same experiment using rubbing alcohol which evaporates even faster or even try other liquids such as gasoline or starting fluid (either).

Caution Be very careful with gasoline because they are very flammable and also cause skin irritation.

Demonstration of Carburetor Ice

Find an old tractor such as an M Farmall and hook it up to a dynamometer. Run the engine and find maximum output of the tractor. Then on a warm day with the tractor at room temperature and the relative humidity high, start the tractor and as soon as oil pressure will permit, run engine at full power.

In just a few minutes you should see frost on the outside of the carburetor. If the air breather is off you can also see frost and ice forming on the inside. If the conditions are right it will start to affect the engines performance.

The venturi is the heart of the carburetor. The venturi is what causes Bernoulli's principle to work.

Data Record and Observation Sheet

Title ______________________________

Name ______________________ Date __________ Period ________

Objective(s) ______________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	**Results**

NOTES

Conclusions

Program AGRISCIENCE

Unit 8 – Personal Development

Examining Career Options in Agriculture

Competency/Terminal Performance Objective

8.0.1 With the aid of references, identify at least 10 careers available in agriculture.

Competency Builders/Pupil Performance Objectives

8.0.1.1 Given a written test, define agriculture and its major divisions with 80 percent accuracy.

8.0.1.2 Provided with a list of careers, accurately describe opportunities for agricultural careers.

8.0.1.3 When watching a video on agricultural careers, compare the scope of agricultural career opportunities. All criteria must meet the good or excellent level.

8.0.1.4 When provided with information from group discussions, identify at least five activities and opportunities that would assist in agricultural career preparation.

8.0.1.5 Given a written test, identify at least four resources for obtaining agricultural career preparation assistance.

Applied Academics Competencies

Communications

3.0.1 Demonstrate effective listening skills.

3.0.5 Identify main idea(s).

4.0.1 Present a researched topic.

4.0.9 Give formal and informal talks and speeches.

4.0.10 Give clear explanations.

4.0.13 Use visual media.

Mathematics

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector
3. Overhead markers
4. 10 note cards
5. Video – *Food for Thought* available from the Ohio Agricultural Education Curriculum Materials Service (catalog # **905X**)
6. Overheads –

   Agricultural Career Wheel

   Resources for Career Preparation

Equipment, Supplies, References, and Other Resources *(continued)*

7 Handout – *Where Can I Obtain Information on Agricultural Career Preparation?*

8. References –

   Agriscience: Fundamentals and Applications available from the Ohio Agricultural Education Curriculum Materials Service (catalog # **0319X**)

   Career promotional materials, brochures, and similar items

Situation

This activity is to be conducted with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach Before class, write the following agricultural careers on note cards (one on each card): • butcher • vegetable grower • dog groomer • sheep shearer • park ranger • horse rancher • veterinarian • golf course superintendent • farm broadcaster • soil conservationist	**Activity** Ask for 10 volunteers. Give each of them a note card with the name of an agricultural career written on it. Ask them to place the card face down on the desk after looking at it. Now have each of the 10 students describe the responsibilities of the particular career he/she has been assigned. They must not use the name on the card when describing the career. After each student has presented his/her career description, ask the class to guess the name of the career listed on the card. Ask students to share what is on their cards. **Discussion** After completing this activity, discuss the following questions with the students: 1. Were you aware that all of the careers mentioned are considered a part of agriculture? 2. Which of the examples surprised you? 3. Do you know anyone who works in these specific careers? 4. Which of those careers interest you?
Write the problem statement on the board.	***WHAT ARE SOME OF THE CAREER OPTIONS AVAILABLE TO US IN AGRICULTURE?*** Begin by asking the students to define **agriculture**. Ask one student to write the class responses on the board. After they have presented their definitions, offer the following *American Heritage Dictionary* definition: "Agriculture is the science, art, and business of cultivating the soil, producing crops, and raising livestock." Agriculture can also be defined as the "activities involved in the production of plants and animals, and the related supplies, services, mechanics, products, processing, and marketing" (from *Agriscience: Fundamentals and Applications*). Now may also be a good time to define **agriscience**. *Agriscience: Fundamentals and Applications* defines agriscience as "the application of scientific principles and new technologies to agriculture."

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Show the 20-minute video – *Food for Thought.*	**Video** Explain to the students that in order to explore agricultural careers, it is best to look at the agriculture industry in general. Ask the students to view the 20-minute video – *Food for Thought.* **Discussion** After students have viewed the video, discuss the following questions with them: 1. Do you have any questions about the video? 2. What were some careers mentioned on the video that we haven't mentioned yet? 3. What careers are you interested in now as a result of the video?
Show overhead transparency – *Agricultural Career Wheel* (see page 8.0.1-10). At this point, provide the students with books, career promotional materials, brochures, and other items that may assist them in their search for job titles. Allow 15 minutes for group preparation and 5 minutes for each group to make a presentation.	**Activity** Show overhead transparency – *Agricultural Career Wheel.* Divide the class into six groups and assign each group one area of the wheel. (Each member of the group must be involved in this activity.) Ask each group to do the following: 1. Create a list of specific job titles that a person might have in your assigned career area. 2. After you have created the list, decide how you would teach the rest of the class about your particular career area and the opportunities it offers. If necessary, make the following suggestions: 1. Use overhead transparencies, chalkboard, role playing sessions, skits, maps, charts, or dialogues. 2. Encourage students to have fun and make their presentations in good taste. **Discussion** After all the groups have made their presentations, ask the class the following questions: 1. Those of you not involved in group 1, what did you learn from them? 2. What did you learn from group 2? …group 3? …group 4? …group 5? …group 6?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	3. What predictions can you make about your career opportunities by looking at this wheel? 4 How do you feel the job situation will be when you graduate? 5. What differences, if any, will there be in the agriculture industry by the time you graduate? 6. What things can you do now to help prepare you for one of these careers or another career in agriculture? Since the class is aware of some of the career opportunities in agriculture, it's time to look more at some of the activities that may assist them in their agricultural career preparation.
Allow 15 to 20 minutes for this activity.	**Activity** Divide the class into four groups. Ask two of the groups to prepare a three-minute report on agricultural activities in which to participate while in **high school**. Encourage them to include activities outside of school. Ask the remaining two groups to report on agricultural activities in which to participate while in **college**. Encourage them to identify possible involvement in activities, courses, and fields of study at community colleges, as well as four-year institutions. A group representative should present the report to the rest of the class. **Discussion** When the students are finished with their reports, ask the following questions: 1. What did you learn about the activities assisting you in career preparation? 2. Do you feel you are involved in activities now that are helping you prepare for an agricultural career? What are they? 3. What activities are you involved in that may be preparing you for a career other than agriculture? Can you find one way that the career may actually be related to agriculture?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Possibilities-Factors Problem-Solving Technique Lead the students through identifying those factors to consider when selecting a career. Allow the students to identify the possible career choices for themselves. Use the information on pages 8.0.1-7 and -8 (student copy). Show the overhead transparency – *Resources for Career Preparation* (see page 8.0.1-11). Fill in a sample phone number and/or address and contact person for each item listed on the transparency. Distribute handout – *Where Can I Obtain Information on Agricultural Career Preparation?* (see page 8.0.1-12).	**Supervised Activity** The class has learned about the different careers available and which activities and paths are necessary to achieve a particular career. Now ask each student to do the following: 1. Identify some careers in which he or she is personally interested. 2. Evaluate these possibilities by considering the factors involved in career selection. Now that the students have an idea of how to prepare for a career in agriculture, they must now learn where to get more information to help them reach their goals. Show the overhead transparency – *Resources for Career Preparation* and distribute the handout – *Where Can I Obtain Information on Agricultural Career Preparation?* Discuss the overhead transparency with the class and answer any questions they may have. Ask each student to complete the handout using the information provided on the transparency. **Summary** Ask each member of the class to name an agricultural career that he/she learned about today. They should name careers that have not been identified by other classmates. Review the following six areas which comprise the Agricultural Career Wheel: 1. Agricultural production specialists 2. Managers and financial specialists 3. Scientists, engineers, and related professionals 4. Social service professionals 5. Education and communication specialists 6. Marketing, merchandising, and sales representatives Name two possible sources for more information on agricultural careers.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

Based on the factors which are currently important to you, what is a good career choice for you?

Factors to Consider	Possibilities (Possible Solutions) (Each student will have his or her own list of possible careers.)			
	Ag Teacher	**Farmer**	**Farm Broadcasting**	**Golf Course Superintendent**
1. Required education	4 years of college	No college required	College	College
2. Salary	Average	Good	Good	Great
3. Working hours	Good	Flexible	Set	Good
4. How much travel is required?	Some	Not much	Some	Some
5. How will this job affect your family situation?	Good situation	Good situation	Good situation	OK
6. Will you be happy?	Somewhat	No	Somewhat	Not really
7. Opportunities for advancement	Few	Few	Yes	Yes

Decision/Recommendation

Recommend that you seek more information about farm broadcasting and teaching agriculture.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills by using career opportunity references and a video describing and demonstrating different agricultural careers. Also conduct group activities using the career wheel and the problem-solving technique of possibilities-factors.

Evaluating Student Learning

Evaluate students through written tests, oral group discussions, and identification of available careers. Ask the students to compile personal reference sheets listing sources of information regarding agricultural career preparation.

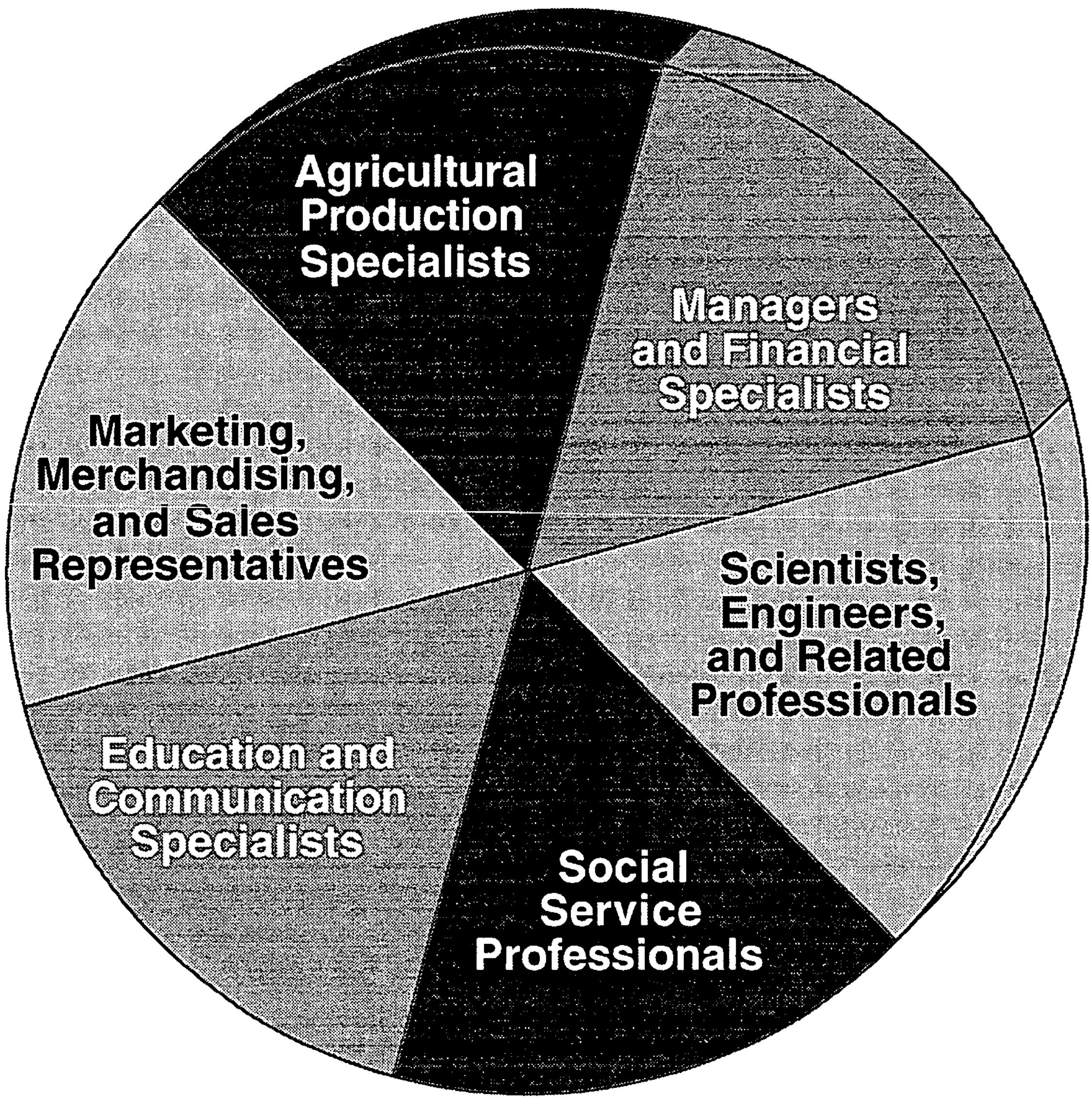
This activity was developed by Shawn Oliver, Agricultural Education Department, Ohio State University, 208 Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, Ohio 43210.

Certain parts were adapted from career promotional materials, brochures, reference books and videos available from the Ohio Agricultural Education Curriculum Materials Service.

Ohio Agricultural Education Curriculum Materials Service
254 Agricultural Administration Building • 2120 Fyffe Road
Columbus • Ohio • 43210-1067

Telephone (614) 292-4848, **FAX** (800) 292-4919 (24 hr, toll-free)
Office Hours M-F: 7:30 am to 4:30 pm

Agricultural Career Wheel



Resources for Career Preparation

1. High school agriculture teacher

2. Local cooperative extension service

3. State cooperative extension service

4. State department of education

5. Community colleges

6. Land-grant university

Where Can I Obtain Information on Agricultural Career Preparation?

1. High School Agriculture Teacher

Name ______________________________

Address ______________________________

____

Phone ______________________________

2. Local Cooperative Extension Service

Address ______________________________

____

Phone ______________________________

Contact Person ______________________________

3. State Cooperative Extension Service

Address ______________________________

____

Phone ______________________________

Contact Person ______________________________

4. State Department of Education

Address ______________________________

____

Phone ______________________________

Contact Person ______________________________

5. Community College

Name of School ______________________________

Address ______________________________

____

Phone ______________________________

Contact Person ______________________________

6. Land-Grant University

Name of School ______________________________

Address ______________________________

____

Phone ______________________________

Contact Person ______________________________

Program AGRISCIENCE

Unit 8 - Personal Development

Set Goals

Competency/Terminal Performance Objective

8.0.2: Given certain objectives, set goals to achieve those objectives, based on criteria provided.

Competency Builders/Pupil Performance Objectives

8.0.2.1 Given example situations, examine importance of setting goals, based on criteria specified in assessment instrument.

8.0.2.2 Given example situations, identify the process for setting and achieving goals, based on criteria specified in assessment instrument.

8.0.2.3 Given example situations, identify resources for achieving goals, based on criteria specified in assessment instrument.

8.0.2.4 Given example situations, identify potential barriers to achieving goals, based on criteria specified in assessment instrument.

8.0.2.5 Given examples of different goals, differentiate short-range goals from long-range goals, based on definitions provided.

8.0.2.6 Given a specific type of objective, establish personal goals to reach that objective, based on criteria provided.

Applied Academics Competencies

Communications

1.0.2 Select and use appropriate reference sources and illustrative materials
1.0.4 Determine solutions to problems
1.0.6 Make predictions about information
1.0.8 Define words used in context
2.0.3 Record observations
2.0.4 Prepare written report(s)
2.0.9 Write legibly
2.0.13 Use correct grammar
2.0.14 Use correct spelling
2.0.15 Write complete sentences
3.0.1 Demonstrate effective listening skills
3.0.4 Identify sources of information
3.0.6 Follow directions
4.0.3 Participate in discussions
4.0.12 Use appropriate language

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. *SAE General Record Book*
2. *SAE Enterprise Record Books*
3. Transparency of the "Goals for this Enterprise" page in the *SAE Enterprise Record Books*.

Situation

This activity is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Display a road map in the classroom.	**DEVELOPING THE NEED** Select a town or location on the map. Locate the selected location on the map, and determine what routes or methods you might use to arrive at your destination. Repeat this procedure with different locations and directions to involve every student. Discuss the question: "What correlation can be made between trying to find the best route to get to a particular location on the map, and trying to get where you are going in life?"
List these **key points** on the board. 1. People have different objectives in life, just as there are different towns and cities on this map. 2. People may not always travel the same roads to get to their objectives. There may be more than one way to reach targets in life, but eventually they arrive at their destinations. 3. Others may not have any distinct direction regarding where they are going, and end up wherever they run out of gas. They have no idea where they are going, how they are going to get there, and what to do when they get there.	**ANTICIPATED GROUP OBJECTIVES:** 1. Why is it important to have objectives in life? • gives direction and meaning 2. How would you define a goal? (list definitions on board) a) a specific objective to accomplish b) an intent or purpose to attain c) something we want d) something we want to accomplish **ANTICIPATED PROBLEMS AND CONCERNS:** What do you need to know to clearly understand and set goals? 1. Why is it important or vital to set goals? 2. How do you set goals? 3. How do you make goals more effective? 4. How do you write goals? 5. Are goals "set in concrete?" **PLANS FOR SOLVING EACH PROBLEM:** ***Problem 1:*** **Why is it important to set goals?** Draw the following diagram on the board: o o o o o o o o o Connect all the dots using only four straight lines, without lifting your pen/pencil from the paper, and without retracing a line after you have drawn it.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
List these **key points** on the board. 1. To set goals, we project a clear, vivid picture of what we want so our subconscious will create ways and means to get us there. 2. Without clearly defined goals, we have no direction. Goals are fundamental in developing methods for determining which roads we need to take to get what it is we want to accomplish. 3. Without goals, we run out of gas, and will probably end up somewhere we don't want to be or where we are not satisfied.	*Why is goal setting so vital?* (list on board) 1. It motivates us to improve. 2. If the goal is clearly defined and written, we commit it to memory immediately. 3. Our imagination works to bring vivid ideas to reality. 4. Goals reduce or eliminate procrastination. They provide incentive to move into action. 5. Goals provide great energy and drive. 6. Goals give us direction and purpose. 7. Goal-setters also deal more effectively with setbacks. ***Problem 2:*** **How Do You Set Effective Goals?** Name two or three students who have been successful in the FFA organization. Why were they successful, and how did they become successful? How do your goals differ from those of students you believe to be successful? What are some rules we can develop for effective goal setting?
List answers on board, then refer to transparency for comparisons and completeness (see page 8.0.2-8).	**RULES FOR EFFECTIVE GOAL SETTING** 1. Balance your goals, take a look at all areas of life. 2. Set priorities. 3. Keep goals constructive and positive. 4. Clearly define goals, write them down. 5. Lock on to the end result and all its parts. 6. Lock out time restrictions. 7. Keep your goals confidential. 8. Update your goals regularly. ***Problem 3:*** **How do we make goals more effective?** List and discuss the following ideas on the board. 1. Clearly picture the goal and lock on to that vivid picture. 2. Eliminate the "I cannot's," "I must not's," and "I have-to's." Don't judge whether or not you have the capacity or the ability to do it now. 3. Have faith in your own creative mechanism. 4. Lock on to the "I can's," "I will's," and "I choose to's." 5. The most important principle in goal setting is that seldom, if ever, does an individual, team, or group exceed their own expectations.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	General Record Book - page 3, paragraph 1 "To receive the greatest benefit from agricultural education, you need to plan to participate in various FFA activities at the chapter, district, state, and if possible, national levels, and also in local, school, and community activities. The activities are listed on pages 12 through 16." 1. The statement "To receive the greatest benefit from agricultural education" means what? • Proficiency awards available, scholarships, etc. 2. The statement "Plans to participate" means what? • Setting goals and putting those goals into action.
	General Record Book - page 3, paragraph 2 "It is important to set target dates for participating in certain activities, applying for degrees, holding offices, or obtaining awards. Your class study will help you discover many of these opportunities, but you must set the target dates." *Why is it important to set target dates for these areas?* 1. There is a time restriction on receiving certain degrees, or applying for proficiency awards. 2. One needs to complete the first steps before advancing towards a higher goal. For example: a member must first receive the Chapter degree before the State degree; and the State degree before the American FFA degree. If they fail the first step, they can't advance to the next.
Stress the importance of having the students make goals high, but realistic for their opportunities. Have students complete goals (in pencil) for their freshman year in each of the columns. Check completed work.	***General Record Book*** - page 3, paragraph 3 "As you become familiar with the FFA organization and the activity program in your school or community and those activities related to your instructional program area, you will discover more things to do and goals to work toward. Start making your plans by asking - Where do I want to go with the FFA and other leadership activities?" 1. The statement "You will discover more things to do and goals to work towards" means what? • Times and aspirations change. We need to allow some flexibility in our goals. We may achieve some goals earlier than expected, and others later or not at all.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	General Record Book - page 3, paragraph 3 *(continued)* 2. Why should you ask yourself "Where do I want to go with the FFA and other leadership activities?" • Remember the road map. If we don't know where we want to go, where will we end up? **Note**: You may find it easier to make plans for only one year in advance. Each year you should indicate your plans for the next year. (This refers to the second paragraph, regarding setting target dates and following the steps to higher goals.) Briefly review each of the columns on page 3 regarding what each one is, and the requirements to meet each one.
Display an overhead of the "Goals for This Enterprise: page from the *SAE Enterprise Record Books*.	GOAL SETTING IN *SAE ENTERPRISE RECORD BOOKS.* Regarding your SAE programs, where else do you think you need to write goals as a part of your program? Find the "Goals for This Enterprise" page in your *SAE Enterprise Record Book.* *When should these goals be established?* 1. Goals should be established at the beginning of the project, if not before the project is actually started. *WHY?* Goals for the project are not goals once the project is completed. 2. Goals should be written as the budget for estimating costs and returns is completed.
Have students begin to plan what goals they might want to attain in their specific enterprises. At this time, students are only to be aware of this page in their *SAE Enterprise Record Books.* Students will complete their SAE enterprise goals when they complete the budget and agreement section of their *SAE Enterprise Record Books.*	*How should goals be written in the enterprise record book?* 1. Goals should be challenging, yet realistic and should include measures of productivity as well as efficiency. 2. Goals should be written in measurable terms. Simply to say "have a good crop" or "make lots of money" are not measurable terms, only relative. Goals should be stated as "produce 125 bushels of corn per acre"or "attain a net profit of $10 per cwt." 3. You may want to check the analysis pages for possible goals for your specific project.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Probe students to give more than just a simple yes or no answer. Insist they support their answers with explanations.	***Problem 4:*** **Are goals set in concrete?** Answer this question and discuss the various responses.
	REVIEW 1. Review each of the questions resulting from your stated problems and concerns. 2. Review the transparency "Rules for Effective Goal Setting." on page 8.0.2-8.

Rules for Effective Goal Setting

1. **Balance your goals.** Look at all areas of your life.

2. **Set priorities.** You want consistency and compatibility

3. **Keep goals constructive and positive.** See what you want – not what you want to avoid.

4. **Clearly define your goals**. Write them down. Be specific.

5. **Lock on to the end result and all of its parts.** See the end result clearly and vividly. At the moment you set your goals, you don't need to know how you're going to get there.

6. **Lock out all time restrictions.**

7. **Keep your goals confidential.** Share them only with people who can help you attain them.

8. **Update your goals regularly.** Success is a journey, not a destination.

Helping Students Apply Concepts/Principles/Skills

Evaluating Student Learning

Have students list their goals on page 3 of the *General Record Book*.

This activity was submitted by Dave Stiles, Agricultural Education Instructor, Indian Valley High School, Gnadenhutten, OH 44629.

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Program AGRISCIENCE

Unit 8 – Personal Development

Planning and Conducting Effective Meetings

Competency/Terminal Performance Objective

8.0.3 Given a simulated situation, correctly identify the steps in planning and conducting effective meetings.

Competency Builders/Pupil Performance Objectives

8.0.3.1 Given the responsibility for an upcoming meeting, plan a meeting according to the guidelines discussed in class.

8.0.3.2 Given a list of motions, demonstrate parliamentary procedure and correctly identify the motions presented.

8.0.3.3 Given a meeting day, set the agenda by correctly identifying the items to be included.

8.0.3.4 Presented with a dialogue to evaluate, correctly identify the factors important in setting and scheduling meetings.

Applied Academics Competencies

Communications

2.0.10 Organize facts, details, and examples in logical order

4.0.11 Demonstrate techniques of speech delivery

4.0.12 Use appropriate language

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector and blank overhead transparencies
3. *Robert's Rules of Order* - 4 copies
4. Index cards (3" by 5")
5. Equipment necessary to conduct an FFA meeting - officer stations
6. Overhead transparency - *Summary of Motions*

Equipment, Supplies, References, and Other Resources *(continued)*

7. Handouts –
   Characteristics of a Good Meeting
   Meeting Evaluation Form
   Equipment Checklist
   Meeting Agenda
   Summary of Motions
   Proper Use of Motions
8. Dialogue – *Scheduling Meetings* (3 copies, one for each speaking part)

Situation

This activity is to be conducted with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Introduction Discuss the following items with the class: 1. What is a vote? 2. Who can be involved in a vote? 3. Raise your hand if you have ever been involved in a vote. 4. Why was voting necessary? 5. How did everyone agree to vote? 6. Was there any discussion before the voting started? 7. Did one person take charge of the voting or more than one person? 8. How did you know who to listen to when the voting was being conducted?
Select a topic for the students to discuss in their role play meeting. Use the following items for ideas: 1. How to get more members involved in meetings 2. Number of students who should be allowed on judging teams Give each participant two index cards, each having one action written on it. Allow five minutes for participants to discuss, agree, and vote on a topic.	**Role Play** Ask for five volunteers to conduct a role play about meetings. One will be president, the other four will be participants in the meeting. Give each of the four participants two index cards, each having one of the following actions written on it: 1. Make a motion. 2. Rise to a point of order. 3. Lay on the table. 4. Refer to a committee. 5. Amend a motion. 6. Take from the table. 7. Comment during meeting – "We are wasting our time." 8. Comment during meeting – "Why do we need a motion to discuss?"
	Discussion Discuss the following questions after the role play session is finished: 1. Participants – how did you feel during the mock meeting? 2. Why were the participants unable to discuss the topic in the allotted time? Ask someone who was not a part of the role play to explain the problem. 3. What do we need to know to have a more successful role play next time?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Write the problem statement on the board.	*HOW DO WE PLAN AND CONDUCT EFFECTIVE MEETINGS?*
	Supervised Study
Allow 10 minutes for the supervised study.	Divide the class into groups of five. Ask them to discuss and identify the characteristics of a good meeting.
	Discussion
Distribute the handout – *Characteristics of a Good Meeting* (see page 8.0.3 - 10).	After the groups have finished their discussions, have one student from each group write on the board his/her group's characteristics of a good meeting. Note the common characteristics listed by the groups. Compare the students' lists with the list provided in the handout – *Characteristics of a Good Meeting*.
	Activity
Distribute the *Meeting Evaluation Form* and the dialogue – *Scheduling Meetings* (see pages 8.0.3 - 11 and 12).	Ask the class to complete the *Meeting Evaluation Form*. Have three students read the dialogue – *Scheduling Meetings*. **Discussion** After the students have finished reading the dialogue – *Scheduling Meetings*, ask them to list items that are important to remember when scheduling meetings. Be certain they include the following: 1. School regulations 2. Meeting times of other organizations 3. Distance traveled by members 4. Times the meeting room is available 5. Other school or community activities
	Supervised Study
Distribute the handout – *Equipment Checklist* (see page 8.0.3 - 13).	Have the students list all the equipment available to conduct chapter meetings for your school. They should refer to the handout – *Equipment Checklist*. Now that they have scheduled a meeting and located the necessary equipment, ask the students what their next step will be. Mention the following items: 1. Will a meeting "just happen" if you have enough members in attendance? 2. Is it necessary to have an agenda or a precise schedule of what will take place in the meeting?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Effect-Cause Problem-Solving Technique Use the information on pages 8.0.3-7 and -8 (student copy).	**Discussion** The effect to be evaluated is the lack of attendance at meetings. Lead the students through the problem-solving approach to offer a recommendation. **Activity** Ask the students to identify those items which should be included in a meeting agenda and rank them in logical order. Write the class responses on an overhead transparency.
Distribute the handout – *Meeting Agenda* (see page 8.0.3 - 14).	Have the class read the handout – *Meeting Agenda*. They should compare their lists with the one appearing in the handout. Discuss and clarify any differences or misunderstandings that may result from comparing the students' lists to the handout. Now that the meeting agenda is prepared, ask the class the following questions: 1. Are the chapter officers the only ones with responsibilities at the chapter meeting? 2. What kinds of responsibilities do all the chapter members have? Have students make a list of the responsibilities for all members. Ask a volunteer to write the list on the board. Be certain the list includes the following items: 1. Being on time for meetings 2. Assisting with arrangement and clean-up activities 3. Dressing neatly and appropriately for the occasion 4. Learning their parts for the opening and closing ceremonies 5. Learning and using correct parliamentary procedure

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Now the students know they must use correct parliamentary procedure in order to participate in a meeting. Discuss the following definition of parliamentary procedure: *"the rules for group discussion and group action"* Ask the class to list the reasons why it is important to have an orderly meeting. If the key to an orderly meeting is parliamentary procedure, why else would it be important?
Distribute the handout – *Summary of Motions* (see page 8.0.3 - 15). Show a corresponding overhead transparency.	Discuss each motion on the handout – *Summary of Motions* – and give examples of each.
Distribute copies of *Robert's Rules of Order* and the form – *Proper Use of Motions* (see page 8.0.3 - 16). Allow 15 minutes for activity.	**Activity** Divide the class into groups of five and give each group a copy of *Robert's Rules of Order*. Have each group use this text to complete the form – *Proper Use of Motions*.
Allow eight minutes for the role play session.	**Role Play** Have students reenact the role play presented earlier in this lesson. The topic of the meeting should be how to get more members involved in their meetings. This time, ask for **four** volunteers. One will be president, the other three will be participants in the meeting. Give each of the three participants two index cards, each having one of the following actions written on it: 1. Make a motion. 2. Rise to a point of order. 3. Lay on the table. 4. Refer to a committee. 5. Amend a motion. 6. Take from the table.
	Discussion After the role play session is finished, ask the class to note the differences between the two meetings. They should give reasons for these differences.
	Summary Discuss the importance of having a knowledge of parliamentary procedure. Ask them if they now have the necessary skills to plan and conduct effective meetings. Review what was covered in this lesson. 1. Setting and scheduling meetings 2. Setting agendas 3. Using correct parliamentary procedure

• Effect-Cause •
Problem-Solving Technique

Define the Problem

What could be the cause for decreased attendance at a meeting?

Possible Causes	Related Facts	Accept/ Reject Cause
1. There is a lack of interest due to outside distractions.	• Many activities are available for people at the high school level. • A large number of students initially signed up and expressed an interest in the meeting.	Reject
2. Meeting times conflict with other activities.	• Lately, meetings have been held when football practice is taking place.	Accept
3. Students are too stressed.	• Students need time for fun and fellowship in addition to studies. • Involvement in extracurricular activities can relieve stress.	Reject

Decision/Recommendation

Reschedule the meetings at times that don't conflict with football practices.

• Effect-Cause •

Problem-Solving Technique

Define the Problem

Possible Causes	Related Facts	Accept/ Reject Cause

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Apply Concept/Principles/Skills by using simulated situations, scripted dialogues, meeting activities, and integration of the applied academics competencies of communications and mathematics.

Evaluating Student Learning

Ask students to identify the steps in planning and conducting an effective meeting. They should also demonstrate these steps.

This activity was developed by Shawn Oliver, Agricultural Education Department, Ohio State University, 208 Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, Ohio 43210. Certain parts were adapted from *Robert's Rules of Order* and career promotional materials available from the Ohio Agricultural Education Curriculum Materials Service.

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Characteristics of a Good Meeting

1. Has a definite purpose and objective
2. Is conducted according to accepted parliamentary procedure
3. Is carefully planned in advance
4. Opens and closes on time
5. Proceeds according to an established order of business
6. Includes well-prepared committee, secretary, and treasurer reports
7. Shows that each officer is familiar with his or her duties and responsibilities
8. Is interesting and fun to participate in
9. Provides for maximum member participation
10. Includes both business and entertainment features
11. Moves along with "snap" and does not waste time
12. Allows ample time for discussion and decision-making
13. Proceeds with a minimum of active participation by the advisor
14. Opens and closes with effective official ceremonies

Meeting Evaluation Form

Instructions

Circle the appropriate number following each description: 5 = always; 4 = nearly always; 3 = sometimes; 2 = not very often; and 1 = almost never. Total your score in the space provided.

		A	NA	S	NVO	AN
1.	Each regular meeting is scheduled well in advance and has the time posted.	5	4	3	2	1
2.	The executive committee meets before each meeting.	5	4	3	2	1
3.	Members attend all meetings regularly.	5	4	3	2	1
4.	The meetings always open and close on time.	5	4	3	2	1
5.	The meetings are fun to attend.	5	4	3	2	1
6.	The advisor does not have to tell everyone what to do.	5	4	3	2	1
7.	The meetings are orderly with correct parliamentary procedure being used.	5	4	3	2	1
8.	An agenda of the meeting is posted well in advance of each meeting or a copy is given to each member prior to the meeting.	5	4	3	2	1
9.	All the officers know their parts and responsibilities regarding the conduct of meetings.	5	4	3	2	1
10.	The meetings are not run by a small group of members; everyone participates.	5	4	3	2	1
11.	The meetings accomplish what they are supposed to accomplish.	5	4	3	2	1
12.	Special meetings are not needed very often.	5	4	3	2	1
13.	There is no "horse play" or "goofing around" during the meetings.	5	4	3	2	1
14.	Committee, treasurer, and secretary reports are given regularly and effectively.	5	4	3	2	1
15.	Non-members who are invited to attend the meetings are impressed by what they see.	5	4	3	2	1
16.	Recreation and entertainment are frequently provided.	5	4	3	2	1
17.	Members are allowed to express their points of view.	5	4	3	2	1
18.	The meetings do not "drag out" over a long period of time.	5	4	3	2	1
19.	Opening and closing ceremonies are used at every meeting and are conducted in an impressive manner.	5	4	3	2	1
20.	The meetings never seem "cut-and-dried."	5	4	3	2	1

TOTAL ___________

Scheduling Meetings

Dialogue

After deciding on the number of meetings to hold in the upcoming year, the executive committee members want to start planning the agenda for the first meeting. However, Archie, Cathy, and Willard know that there are several other items to be considered before they begin planning the agenda.

Archie: "We need to decide on a regular meeting time for each meeting, as well as a meeting place."

Cathy: "Yeah, we also need to look at the room arrangements and paraphernalia. The state officers said these items are important."

Willard: "You're right. I remember last year the chapter meetings were right after school and a bunch of us had a hard time attending because of basketball practice.

We also didn't have some of the station markers at our last meeting; it was kind of embarrassing when we stood up to say the Pledge of Allegiance and we didn't have a flag."

Joe: "I suggest that each regular meeting be set for the first Tuesday of each month at 7:30 p.m. Also, during the months in which we have two meetings, the second meeting could be held the last Tuesday of the month."

Cathy: "I agree. Plus, I think any special meetings should be held during the school's weekly activity period."

The other committee members found these times acceptable; they were agreed upon by a unanimous vote.

Equipment Checklist

		Available	Missing
1.	________________	______	______
2.	________________	______	______
3.	________________	______	______
4.	________________	______	______
5.	________________	______	______
6.	________________	______	______
7.	________________	______	______
8.	________________	______	______
9.	________________	______	______
10.	________________	______	______
11.	________________	______	______
12.	________________	______	______
13.	________________	______	______
14.	________________	______	______
15.	________________	______	______
16.	________________	______	______
17.	________________	______	______

Meeting Agenda

1. Opening ceremony
2. Minutes of the previous meeting
3. Officer reports (e.g., treasurer, secretary)
4. Report on program of activities (vice president)
5. Special features (guest speakers)
6. Unfinished business
7. Committee reports
    a. standing
    b. special
8. New business
9. Degree and installation ceremonies
10. Closing ceremony
11. Entertainment, recreation, refreshments

Summary of Motions

1. Amend
2. Lay on the table
3. Adjourn
4. Appeal
5. Refer to a committee
6. Take from the table
7. Suspend the rules
8. Accept a report
9. Postpone
10. Main motion

Proper Use of Motions

Directions

In the space provided, give the motion(s) that you would use to accomplish each of the following:

1. Bring up an item for consideration.

2. Vote again on a motion.

3. Change the wording of a motion.

4. Point out a parliamentary error.

5. Bring a formal meeting to a close.

6. Obtain a decision on the chairperson's ruling.

7. Stop debate and vote immediately.

8. Check the accuracy of a voice vote.

9. Set aside an item of business for an unspecified period of time.

10. Ask a question concerning parliamentary procedure.

Program AGRISCIENCE

Unit 8 - Personal Development

Enhancing Self-esteem

Competency/Terminal Performance Objective

8.0.4 Identify methods to enhance positive self-esteem of self and others by using real-life case studies. Select all appropriate methods from the class discussion.

Competency Builders/Pupil Performance Objectives

8.0.4.1 While writing ideas about a personal situation dealing with self-esteem, identify the importance of self-esteem. The criteria must be achieved at the good or excellent level.

8.0.4.2 In a simulated situation, identify the importance of personal image as discussed in class.

8.0.4.3 In a simulated situation, identify the factors affecting personal image. List at least five factors.

8.0.4.4 Provided with a discussion on the relationship between self-esteem and positive attitude, identify at least five factors which describe that relationship.

8.0.4.5 Identify strategies to promote positive self-esteem of self and others using real-life scenarios. List at least five strategies.

8.0.4.6 Provided with a definition of value, list personal values which support self-esteem. The list should reflect personal opinions.

Applied Academics Competencies

Communications

2.0.4 Prepare written report(s).

2.0.10 Organize facts, details, and examples in logical order.

3.0.11 Evaluate nonverbal messages.

4.0.3 Participate in discussions.

Mathematics

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector and blank transparencies
3. Modeling dough - create two young male figures
4. Handouts – *Enhance Self-esteem - Story of Jack and Sam*
   Enhancing Self-esteem - Homework Questions
5. Overhead transparencies –
   Possible Characteristics of Someone with a Poor Personal Image
   Bob for Class President
   Relationship between Self-esteem and Positive Attitudes

Situation

This activity is to be conducted with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach Before class, create two young male figures out of modeling dough. Distribute handout – *Enhance Self-esteem - Story of Jack and Sam* (see page 8.0.4 -10). Animate the figures as indicated in the handout. Ask a leader in the community to speak to the class for about 10 minutes (optional). He/she should relate personal success to self-esteem.	**Activity** Ask the class to read the handout – *Enhance Self-esteem - Story of Jack and Sam* – and to watch the actions of the modeling dough figures. When they are finished, ask the guest speaker (optional) to lead the following discussion about the events depicted in the handout. **Discussion** Ask the students the following questions: 1. What may happen to Sam's self-image if he continues to let himself be beaten down by his mistakes? 2. What effect did the negative words have on Sam? 3. How was Jack's reaction different? 4. What is broken in Sam and needs encouragement? – his **self-esteem**.
Write the problem statement on the board.	***HOW DO WE ENHANCE SELF-ESTEEM?*** Begin by looking at a definition of **self-esteem**. *The New American Heritage Dictionary* defines self-esteem as... "...the satisfaction of oneself." Therefore, a low self-esteem is a low satisfaction of oneself. **Discussion** Ask the students why they think self-esteem is important. Use the following suggestions as examples: 1. Self-esteem makes you feel good about yourself. 2. It makes you more pleasant to be around. 3. You offer more positive words to others when you have high self-esteem.
Give the students five minutes to write their descriptions. Stress that this information will be kept **confidential**.	**Supervised Activity** Ask students to write a description of how they feel about themselves. Encourage them to be honest and include both positive and negative feelings. They should circle descriptive key words, phrases, or adjectives. On another sheet of paper, have them list these circled words. Ask them to place a "P" by those words they feel are positive, and an "N" by those words they feel are negative.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Discussion Discuss the following items with the students: 1. Which did you have more of – positive or negative words? (Specific information is to be kept **confidential**.) 2. Why would a person who appears to be confident in who they are, use a lot of negative words when describing themselves?
Show the overhead transparency – *Possible Characteristics of Someone with a Poor Personal Image* (see page 8.0.4 -11).	3. **Personal image** is how a person feels about himself or herself. Characteristics of people with a poor personal image may include the following: • Rebels against authority • Participates in gossip • Is critical or judgmental in nature • Has a non-caring attitude • Performs senseless actions • Feels uncomfortable when alone Now that the students have identified ways a person may act with a poor personal image, have them think of a situation in which a person's personal image was enhanced.
Possibilities-Factors Problem-Solving Technique Show the overhead transparency – *Bob for Class President* (see page 8.0.4-12). Allow 15 minutes for this activity. Use the information on pages 8.0.4 -7 and -8 (student copy).	**Supervised Activity** Divide the class into groups of five. Ask each group to use the problem-solving approach to Bob's situation. They should provide the following information: 1. Identify the possible solutions. 2. Identify factors to consider in enhancing or not enhancing Bob's personal image. Have a student from each group present the group's recommendation for Bob's situation.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Ask a student to record the responses on the board.	**Discussion** After each group has reported their findings, discuss the following items: 1. Why do you feel personal image is important? 2. What are the main factors affecting personal image? Personal image affects many aspects of life. It's important to understand the image you have of yourself and how to improve it.
Show the overhead transparency – *Relationship between Self-esteem and Positive Attitudes* (see page 8.0.4-13).	Some people say - "Oh, just have a positive attitude and your self-esteem will improve." Ask the students how they feel about the relationship between self-esteem and positive attitude. Discuss the overhead transparency – *Relationship between Self-esteem and Positive Attitudes.* Point out that developing a good self-esteem involves much more than developing a positive attitude. However, it may be helpful to some people, as long as they don't use it as a way to hide their true feelings.
	HOW DO I IMPROVE MY SELF-ESTEEM AS WELL AS THE ESTEEM OF OTHERS?
Allow 10 minutes for this activity	**Supervised Study** Ask the students to remain in the same groups and identify 10 to 15 strategies for improving self-esteem (e.g., think of the talents you were born with, accept your defeats). Next, ask each group to identify 10 to 15 strategies to improve the esteem of others (e.g., encourage others, smile at them). Now have a member of each group read both lists to the class.
If necessary, direct each student and give suggestions on how to improve the other's self-esteem.	Since the class has reviewed methods for improving esteem in themselves and others, give them the opportunity to use this knowledge. Ask for two volunteers to come to the front of the classroom. Have them demonstrate how to improve each other's self-esteem by using the methods covered earlier in this lesson. **Discussion** Discuss with the students how they felt after completing the exercise. Did they feel awkward? – strange? – good?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Distribute handout – *Enhancing Self-esteem - Homework Questions* (see page 8.0.4-14).	**Independent Study** The students will need additional time to absorb this lesson, so distribute *Enhancing Self-esteem - Homework Questions*. Ask them to write a paragraph for each of the following questions: 1. How did you feel when your partner was attempting to boost your self-esteem? 2. How did you respond? 3. What could you have done differently when it was your turn to boost your partner's self-esteem?
	Supervised Study Now the class needs to look at the role personal **values** play in supporting self-esteem. According to *The New American Heritage Dictionary*, a **value** is… "… principle, standard, or quality considered inherently worthwhile or desirable." Ask each of the students to make a list of personal values that support self-esteem.
	Summary Review with the students the key words and concepts covered in this lesson. Use the following list as a guide: 1. Self-esteem 2. Personal image 3. Positive attitude 4. Enhancing self-esteem 5. Enhancing esteem of others 6. Establishing personal values to support self-esteem Use the following scenario to summarize this lesson:
Use the modeling dough figure to illustrate Sam's reactions in this scenario.	"Sam has now spent some time during this unit working on improving his self-esteem. He now feels better about himself and who he is as a person. What would happen now if the principal were to approach Sam (hold up Sam figure)? How do you think he would respond? He might still be a little hurt, but he won't be crushed. (Show Sam in an upright position)." Assure the students that the same can be true for them as they work on enhancing their self-esteem.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

As Bob's friend, how do you help him boost his personal image?

Factors to Consider	Possibilities (Possible Solutions)			
	Forget it, it's not your responsibility.	**Invite Bob to socialize with you and your friends.**	**Support another candidate.**	**Run for class president yourself.**
1. Level of commitment	None	High	None	OK
2. Your assurance of Bob's abilities	None	High	None	None
3. Loss of popularity because you support a less popular candidate	Who cares?	Not important to you	High concern	High concern
4. Time	Some	Good	?	Good

Decision/Recommendation

Recommend that Bob spend some time with you and your friends before he runs for class president to help him feel more comfortable with people.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills by using simulated situations and real-life case studies. Using the applied academic competencies, students should communicate with their peers and instructors which problem-solving decisions they made. These decisions will help students when they are communicating personal opinions and choices they made related to self-esteem.

Evaluating Student Learning

Evaluate students by using class discussions and identification of strategies for enhancing self-esteem. Following the exercise regarding strategies for enhancing self-esteem, use exploratory questions to assign independent study.

This activity was developed by Shawn Oliver, Agricultural Education Department, Ohio State University, 208 Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, Ohio 43210.

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Enhance Self-esteem

Story of Jack and Sam

Teacher instructions appear in italics.

Two young men are growing up in the same small community, but they react to life in very different ways.

One boy, **Jack**, *(hold up one of the dough figures)* feels good about who he is; he realizes he makes mistakes, but is OK with that. He encourages other people in their activities. He knows he doesn't always make the right decision, but always seems to bounce back and keep going.

Sam, on the other hand, *(hold up the other dough figure)* doesn't feel very good about himself. In fact, he believes people who tell him he is useless. Consequently, he is often very negative with others. But this still doesn't help him feel better about himself. He has no self-confidence and is always putting himself down.

One day the school principal approached Jack and Sam about breaking a school rule. *(Pick up Jack figure.)* Jack felt bad about what he had done, but still trusted in who he was as a person. He apologized and was willing to face the consequences. *(Push down softly on top of the Jack figure, but make sure the figure remains in the same basic shape.)*

(Pick up the other figure.) Sam, on the other hand, was angry with the principal and tried to place the blame on someone else. He said he didn't care. Then he began to look inside himself: he felt he was always wrong and a bad person. *(Push down hard on top of the Sam figure – crush the figure.)*

Jack and Sam faced the same situation, but their reactions were different. Jack, who generally feels good about who he is, is still whole. Sam, who has the lower self-image, was crushed over the incident.

Possible Characteristics of Someone with a Poor Personal Image

1. Rebels against authority

2. Participates in gossip

3. Is critical or judgmental in nature

4. Has a non-caring attitude

5. Performs senseless actions

6. Feels uncomfortable when alone

Bob for Class President

You have a friend, Bob, whom you believe should run for class president. He is not very talkative, but you know he has some really good leadership abilities. You ask him to run, but he tells you he doesn't want to.

He says "I'm a nobody. No one will vote for me."

What can you say, in a sincere way, to boost Bob's personal image?

Relationship between Self-esteem and Positive Attitudes

When people are positive, but don't really feel good about themselves, it can result in the following:

1. Their good feelings are short-lived.

2. They deal with surface issues only.

3. Their positive attitudes are fake.

4. They use positive attitudes to hide their low self-esteem.

5. They make others around them feel good, while they tear down themselves inside.

6. They start to feel better about themselves.

Enhancing Self-esteem

Homework Questions

After completing the exercise on using strategies for enhancing the self-esteem of your assigned partner, answer the following questions:

1. How did you feel when your partner was attempting to boost your self-esteem?

2. How did you respond?

3. What could you have done differently when it was your turn to boost your partner's self-esteem?

Program AGRISCIENCE

Unit 8 – Personal Development

Applying Communication Skills

Competency/Terminal Performance Objective

8.0.5 In an actual situation, apply the communication skills discussed in class at the good or excellent level.

Competency Builders/Pupil Performance Objectives

8.0.5.1 On a written test, correctly name the means of communication studied in class.

8.0.5.2 In a group situation, refine verbal and nonverbal communication skills using the skills gained in classroom discussion.

8.0.5.3 In an actual situation, demonstrate listening skills according to the criteria outlined in class.

8.0.5.4 In an actual situation, participate in group discussions and meetings to the good or excellent level.

Applied Academics Competencies

Communications

3.0.1 Demonstrate effective listening skills.

3.0.6 Follow directions.

3.0.7 Evaluate spoken communications.

3.0.11 Evaluate nonverbal messages.

4.0.5 Participate in dramatic presentations (e.g., role playing).

4.0.9 Give formal and informal talks and speeches.

4.0.11 Demonstrate techniques of speech delivery.

4.0.13 Use visual media.

Mathematics

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector and blank transparency masters
3. Index cards (3" by 5")
4. Newspaper - front section
5. Copy or live radio farm or news report
6. Agriculture video, TV and VCR
7. Wristwatch

Equipment, Supplies, References, and Other Resources *(continued)*

8. Supplemental text – *The Communicator's Handbook* available from the Ohio Agricultural Education Curriculum Materials Service - The Ohio State University
9. Handouts – *Listening Role Play* (for role play participants only)
   Barriers to Good Listeners
   Group Task Roles
   Group Building and Maintenance Roles
   Destructive Group Roles

Situation

This activity is to be conducted with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach Ask five students to portray the five different types of communication depicted on index cards.	**Activity** Ask five volunteers to go to the front of the room. Give each volunteer an index card listing one of the following behaviors and forms of communication: 1. Write the name of the course and the date on the chalkboard. 2. Read through the front section of the newspaper. 3. Turn on the radio and listen to the farm report. 4. Turn on the TV and watch an agriculture video. 5. Point to your watch and motion for one person to leave with you. Have each student act out the behavior described on his/her index card. **Discussion** Ask the class to describe what they observed. Discuss the following questions: 1. Each student's behavior was an example of what? (answer - communication) 2. What was unusual about the way the five students communicated? 3. Do you think you are able to communicate without saying a word? 4. Why do you think it is important that you always remain aware of how you communicate? 5. What types of communication skills can you learn by being an active member in organizations?
Write the problem statement on the board.	***HOW DO WE APPLY COMMUNICATION SKILLS TO VARIOUS SITUATIONS IN OUR LIVES?*** **Activity** Ask students to identify the various means of communication. Have a volunteer record the responses on the board or on an overhead transparency. Discuss the following items: 1. What is your definition of **nonverbal** communication? 2. What is your definition of **verbal** communication?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Present these facts to the students: Albert Mehrabian's research has shown that 93 percent of the message a person sends is nonverbal; 7 percent is verbal. Draw a pie chart distribution of these facts next to the students' pie chart.	3. Raise your hand if you think people communicate mostly through **nonverbal** means. (Ask a student to record the number of hands raised and calculate what percentage of the whole class is represented by this number.) 4. Raise your hand if you think people communicate mostly through **verbal** means. (Ask a student to record the number of hands raised and calculate what percentage of the whole class is represented by this number.) 5. Ask another student to draw a circle on the board. Assume this circle represents the whole class - 100%. Have a volunteer indicate how much of the circle is represented by the percentages found in items 3 and 4 (a pie chart distribution). 6. Have students "brainstorm" the types of nonverbal communication they have seen used in school and at other activities like football games. *Examples:* smiling, frowning, alertness, sleeping
Divide students into groups of five. Give directions for completing supervised study. Inform students that they will be responsible for sharing their information with the whole class. Allow up to 20 minutes for group interaction.	**Supervised Study** Ask each student to present a two-minute talk to their group and describe his/her favorite family pet or family vacation. They should demonstrate verbal and nonverbal communication skills when making their presentations. Each student must carefully observe the speakers in his/her group. Using the previous information given for verbal and nonverbal communication, have students record the verbal and nonverbal communication skills they see on a sheet of paper (e.g., nonverbal skills on left side, verbal skills on right side). When all group members have presented their talks, each group should discuss which skills were demonstrated and which were not. Ask for one volunteer from each group to record their group's findings on the board. Determine the most frequently used types of verbal and nonverbal communication. (**Circle** the most common types of **verbal** communication; **underline** the most common types of **nonverbal** communication.)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Discussion Discuss the following questions with the students: 1. What common words are used? (verbal) 2. What common gestures or body movements are used? (nonverbal) 3. Which of the circled (verbal) types of communication are positive and which are negative? 4. Which of the underlined (nonverbal) types of communication are positive and which are negative? 5. To determine what a person does to communicate, what do you have to observe closely? 6. What, in addition to observing the person, do you have to do? 7. Why is listening so important? 8. Is listening a form of communication?
Distribute the role play cards to each volunteer (see page 8.0.5-12.) Allow 10 minutes for role play and another 3 to 5 minutes for students to record their observations.	**Role Play** Ask for three volunteers to role play the parts of a story teller and two listeners. Give each volunteer a role play card. As indicated on the role play card, the story teller should describe to each listener how he/she helped an individual in the community clean up the area surrounding a residence. Each listener should respond according to the directions on his/her role play card. Ask the remainder of the class to record their observations on paper.
Write the discussion items on the board. Leave space between each item for student answers.	**Discussion** After the role play is completed, discuss the following items with the students: 1. What were the differences in the listeners' responses? 2. Which person would you rather have listen to you? Why? 3. How did the responses of the first listener make you feel? – the second listener?

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures:
Interest Approach/Teaching Methods</th></tr>
<tr><td></td><td>4. List two examples of each student response that you have personally experienced.

5. Which listener characteristics would be the best to role model to other students? (Make a list of the characteristics of a good listener.)</td></tr>
<tr><td>Effect-Cause Problem-Solving Technique
Use the information presented on pages 8.0.5-9 and -10 (student copy) to conduct this exercise. Distribute Barriers to Good Listening (see page 8.0.5 - 13). Using situation 3, lead the students to discover why Brian is having problems and how he can solve them. The Key to Barriers to Good Listening offers guidelines for this exercise (see page 8.0.5-14).</td><td>Now that the students know how to be a good listener, it's also important they know what could hinder one's ability to listen. Ask the class for examples of things that could inhibit one's listening skills. Read and discuss Barriers to Good Listening and the following questions:

1. In which types of situations or environments do you feel listening is most important?
2. Are there situations in groups where you should listen?
3. Why do you feel listening in group discussions is important?
4. Is it important to listen in meetings?
5. If listening is important in meetings, why can't we simply listen all the time?
6. How should you participate in meetings?
7. Do you know how to participate in meetings?</td></tr>
<tr><td>Write the problem statement on the board.

Distribute Group Task Roles, Group Building and Maintenance Roles, and Destructive Group Roles (see pages 8.0.5 - 15 and 16).

Have a volunteer write each group's findings on the board.</td><td>HOW DO WE PARTICIPATE IN GROUP DISCUSSIONS AND MEETINGS?

Supervised Study
Divide the class into groups of three to four and have them study the handout.

Discussion
Ask the students to discuss the following questions within their groups:

1. As you read the handouts – Group Task Roles and Group Building And Maintenance Roles – did you see a role that you have played in the past? Which one?
2. Can you identify the roles of the other people who were in your group?
3. Are there roles you can identify that were not demonstrated in your group?</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	4. In what situations do you find more negative group roles being displayed? 5. Have you ever been involved with a group in any of these negative situations?
Record group responses on overhead transparency. Allow 15 minutes for activity.	**Supervised Study** Ask the members of each group to "brainstorm" about any situations that have demonstrated negative roles. Have each group pick one of these negative situations and suggest ways to improve it by using the positive roles identified earlier in this lesson. Have them answer the following questions: 1. What can you do to improve the situation? 2. Would you say that a classroom or FFA Chapter is more effective or less effective when individuals demonstrate positive group task roles?
Allow 10 minutes for role play.	**Role Play** Assign one student to serve as chairperson and six to assume each of the *destructive group roles* depicted in the handout. The role assigned to each student is kept secret. Ask the class to pay close attention as the role play is being conducted. **Discussion** When the role play session is finished, ask the class to identify the particular role that each individual has played. Have them identify the negative aspects of each role. Record the class observations on the board or an overhead transparency. Discuss whether the students' observations are correct or incorrect.
Allow 10 minutes for role play.	**Role Play** Assign one student to serve as chairperson and eleven to assume each of the *group task roles* and the *group building and maintenance roles* as depicted in the handout. The role play assigned to each student is kept secret. Ask the class to pay close attention as the role play is being conducted.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Discussion Have the remainder of the class identify the particular role each individual is playing. Ask them to identify the group task roles played by the students. Record the class observations on the board or an overhead transparency. Discuss whether the students' observations are correct or incorrect. **Final Discussion** After completing these role-playing sessions, discuss the following questions with the students: 1. How did the two role-playing sessions differ? 2. Which do you prefer to be a part of and why? 3. What are some things you can do to be a good participant in group discussions and meetings? **Summary** At the conclusion of this lesson, encourage the students to list the things they have learned about the following items: 1. Types of communication 2. Verbal and nonverbal skills 3. Listening skills 4. Group discussions and meetings

• Effect-Cause •
Problem-Solving Technique

Define the problem

Why does Brian continue to make mistakes when keeping his records?

Possible Causes	Related Facts	Accept/ Reject Cause
1. Brian does not know how to keep accurate records.	• Brian's teacher, Mr. King, has given clear instructions.	Reject
2. Brian does not have the time required to keep good records.	• Brian devotes much time to his record books - mostly to their appearance.	Reject
3. Brian does not listen to constructive criticism.	• Brian does not hear Mr. King's constructive criticism. • Brian focuses only on the appearance and presentation of his record books.	Accept

Decision/Recommendation

Recommend to Brian that he listen to and accept the constructive criticism Mr. King is offering him. Offer encouragement to Brian and tell him that it is OK to admit you need help. Emphasize that accurate figures in his record book are just as or more important than its presentation.

• **Effect-Cause** •

Problem-Solving Technique

Define the problem		
Possible Causes	**Related Facts**	**Accept/ Reject Cause**
Decision/Recommendation		

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills by using actual situations involving group and individual interaction to reinforce verbal and nonverbal communication and listening skills. Integrate the applied academic competencies to reinforce the learning outcomes for each group activity and role play.

Evaluating Student Learning

Evaluate students through written tests, oral group discussions and demonstration of communication skills with a rating level of good or excellent.

This activity was adapted by Shawn Oliver, Agricultural Education Department, Ohio State University, 208 Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, Ohio 43210. Portions of the material were taken from the *Communicator's Handbook*.

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Directions - While student (storyteller) tells story, student listeners (listeners 1 and 2) respond verbally and nonverbally according to role play handouts.

Listening Role Play

(Storyteller)

Directions – Tell listeners how you helped an individual in the community clean up the area around his/her residence.

(cut along dotted line)

Listening Role Play

(Listener 1)

Directions - While storyteller is speaking, stare into space; look at your watch or the clock in the classroom; ask someone for the time; move around in your seat; cross your arms; frown; shake your head; and/or hum.

(cut along dotted line)

Listening Role Play

(Listener 2)

Directions - While storyteller is speaking, smile; move your head in agreement; sit on the edge of your seat; give verbal responses like "yes," "O.K.," or "that's good."

Barriers to Good Listening

Directions
For each of the following situations, list what you think is a barrier to listening. Indicate how you think the barrier might be removed.

SITUATION 1
Warren has just been introduced to his high school homecoming queen. Although he has met only one beauty queen in his life, he thinks they are all the same – snobs. What type of listening barrier do you think he has created?

Barrier: *This barrier could be removed by:*

SITUATION 2
Mary Ann is standing in front of her school with a group of friends. Her boyfriend - Frank - drives by on his motorcycle. Although her friends are speaking to her, she does not hear them because she is distracted by Frank. What type of listening barrier do you think she has created?

Barrier: *This barrier could be removed by:*

SITUATION 3
Brian is in a meeting with his teacher - Mr. King. They are reviewing his record books. Brian completed his books neatly and is very proud of this fact. Mr. King is trying to explain to Brian that he has made some mistakes in his record keeping, but Brian doesn't hear him because he is so focused on the way his books look. What type of listening barrier do you think he has created?

Barrier: *This barrier could be removed by:*

SITUATION 4
During class Will's teacher hands him a note asking him to report to the principal's office. He has never been to the principal's office before; he is very worried about what will happen there. Consequently, when he is in the office waiting room, he does not hear the principal's secretary telling him the principal will see him now. What type of listening barrier do you think he has created?

Barrier: *This barrier could be removed by:*

SITUATION 5
Sara is introducing her friends, Jackie and Amy, to each other. Unfortunately, they have met before and are not happy to see each other again. What type of listening barrier do you think they have created?

Barrier: *This barrier could be removed by:*

Key to Barriers to Good Listening

Directions
For each of the following situations, list what you think is a barrier to listening. Indicate how you think the barrier might be removed.

SITUATION 1

Warren has just been introduced to his high school homecoming queen. Although he has met only one beauty queen in his life, he thinks they are all the same – snobs. What type of listening barrier do you think he has created?

Barrier: preconceived idea

This barrier could be removed by:
Reserve judgment until you to get to know a person. Remember that no two people are alike.

SITUATION 2

Mary Ann is standing in front of her school with a group of friends. Her boyfriend - Frank - drives by on his motorcycle. Although her friends are speaking to her, she does not hear them because she is watching Frank. What type of listening barrier do you think she has created?

Barrier: feelings that distract

This barrier could be removed by:
Keep your feelings in check, concentrate on the people you are with and on what they are saying. They deserve your full attention.

SITUATION 3

Brian is in a meeting with his teacher - Mr. King. They are reviewing his record books. Brian completed his books neatly and is very proud of this fact. Mr. King is trying to explain to Brian that he has made some mistakes in his record keeping, but Brian doesn't hear him because he is so focused on the way his books look. What type of listening barrier do you think he has created?

Barrier: desire to appear clever or to impress someone

This barrier could be removed by:
Just be yourself and don't try to impress everybody.

SITUATION 4

During class Will's teacher hands him a note asking him to report to the principal's office. He has never been to the principal's office before; he is very worried about what will happen there. Consequently, when he is in the office's waiting room, he does not hear the principal's secretary telling him the principal will see him now. What type of listening barrier do you think he has created?

Barrier: new, unfamiliar experience

This barrier could be removed by:
Concentrate on what is happening, not on what might happen. Remember that new experiences can also be positive.

SITUATION 5

Sara is introducing her friends, Jackie and Amy, to each other. Unfortunately, they have met before and are not happy to see each other again. What type of listening barrier do you think they have created?

Barrier: former experience

This barrier could be removed by:
Talk to the two individuals and try to work things out.

Group Task Roles

1. The *starter* suggests or proposes new ideas or new ways of regarding group problems or goals.
2. The *information seeker* may ask someone to explain suggestions, information, or facts.
3. The *opinion seeker* asks primarily for the opinions of other group members or asks them to explain opinions that have already been stated.
4. The *information giver* offers facts or other items of interest which help the group. Personal experiences may be included in this information.
5. The *opinion giver* states a personal belief or opinion.
6. The *go-getter* prods the group to action or decision. This person tries to make the group develop greater or higher quality activities.
7. The *explainer* tries to figure out what would happen if a particular idea or suggestion is adopted.

Group Building and Maintenance Roles

1. The *encourager* praises, agrees with, and accepts ideas and suggestions of others.
2. The *peace maker* works to settle differences.
3. The *gatekeeper* tries to keep communication channels open by encouraging participation of others.
4. The *standard setter* expresses standards for the group to try to achieve.

Destructive Group Roles

1. The *clown* may work in many ways – laughing at others, making fun of the acts or feelings of others, attacking the group or its problems, making unkind jokes, and showing envy toward someone's contribution to the group by trying to take credit for it or belittling it.

2. The *blocker* tends to have negative reactions and is very stubborn. He or she disagrees with and opposes everything. After the group is finished dealing with an issue, the blocker will try to return to it.

3. The *bragger* wants personal attention and works in various ways to get it. He or she will boast, act in unusual ways, or go to extremes to avoid being placed in what he or she perceives as an inferior position.

4. The *cry-baby* uses the group as a sounding board for his or her personal problems and other matters which are of no interest to the group.

5. The *horseplayer* makes a display of his or her lack of involvement. Not knowing when to quit, this person continually disrupts group activities and makes sure that nothing gets done.

6. The *dominator* tries to show how superior he or she is to the rest of the group. This individual continually interrupts the activities of the group by trying to control everything that takes place.

Program AGRISCIENCE

Unit 8 - Personal Development

Preparing and Delivering Oral Presentations

Competency/Terminal Performance Objective

8.0.6 Given a choice of topics and a time limit, prepare and deliver an oral presentation. All criteria must be achieved at the good or excellent level.

Competency Builders/Pupil Performance Objectives

8.0.6.1 Given a group situation, evaluate audience and demographic variables with no more than two errors.

8.0.6.2 Identify factors that affect the timeliness and focus of a presentation using a scenario. List at least three factors that must be considered.

8.0.6.3 When given a role play, identify the sources for gathering information. List at least five sources.

8.0.6.4 Use criteria and standards to compose a presentation outline when given a choice of topics. The outline will meet the guidelines specified in class.

8.0.6.5 When presented with a blank copy of an outline, compose an outline and a speech. All criteria must be achieved at the good or excellent level.

8.0.6.6 When given a list of different ways to present information, prepare presentation materials for a given speech with 80 percent correct responses.

8.0.6.7 Given a simple topic, practice presenting a two- or three-minute speech that meets the criteria specified in class.

Applied Academics Competencies

Communications

3.0.7 Evaluate spoken communications.

3.0.11 Evaluate nonverbal messages.

4.0.2 Use nonverbal messages.

4.0.3 Participate in discussions.

4.0.5 Participate in dramatic presentations (e.g., role playing).

4.0.6 Organize presentation.

4.0.11 Demonstrate techniques of speech delivery.

4.0.13 Use visual media.

Mathematics

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector and blank transparencies
3. Index cards (3" by 5")
4. Resource person - speaker scheduled to speak five minutes
5. Overheads –
   Banquet Scenario
   Delivering Your Speech
   Steps and Key points in Preparing and Delivering a Speech
6. Handouts –
   Jim and Ms. Smith Dialogue
   Outline for Composing a Speech
   Checklist for a Written Speech
   Blank copies of *Outline for Composing a Speech*
   Activity for Presenting Visuals in an Oral Presentation - Fact Sheet
   Delivering Your Speech

Situation

This activity is to be conducted with Level 1 Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach	**Introduction**
Arrange for a guest to speak to the class for about five minutes.	Ask the guest speaker to address the class for about five minutes. An example of an appropriate speaker would be a former FFA chapter president and current sophomore from a nearby college majoring in Agricultural Education and Communication. He or she could present a speech given to a local FFA Chapter when he or she retired as president. Instruct students to pay attention to the presentation because a discussion will follow.
	Discussion
	Discuss the following questions with the class: 1. How many of you are ready to present a speech like the one you just heard and win a contest? 2. Do you feel the speech was effective? 3. What did you like or dislike about how the speaker presented the topic? 4. What changes would you have made? Why? 5. Do you think you could present a similar speech? Why or why not?
Write the problem statement on the board.	*HOW DO WE PROPERLY PREPARE AN ORAL PRESENTATION?*
Draw a bullseye on the board to illustrate the analysis of an audience.	Inform the class that targeting a presentation to the needs of the audience results in a more effective speech and public speaker. Explain the following characteristics which a speaker must know in order to analyze his or her audience. Draw a bullseye on the board to illustrate your explanation. 1. People (first circle - outside) 2. Age (second circle - inside) 3. Commonality or interests (third circle - inside) 4. The issue(s) which are most important to them (center circle)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	After finishing the bullseye, relate this to **demographics** – the characteristics of human populations. Ask the class how the bullseye example can help them understand what to look for when analyzing an audience.
	Activity
Allow 10 minutes for group interaction.	Divide the class into pairs and ask them to list the three items they feel are most important when analyzing an audience. Have a volunteer from each pair write his or her pair's list on the board. After all the lists are on the board, erase any duplicates and add any important characteristics not listed.
	Discussion
	After finishing the activity, discuss with the class those characteristics which are essential for evaluating the audience and demographic variables (see list below). 1. Purpose of speech 2. Knowledge of topic 3. Location of speech 4. Age and gender of audience 5. Organizational memberships 6. Credibility of speaker
	Explain to the students that a successful speaker always has a timely topic. A speaker whose topic is not timely or focused will not be as effective.
	Draw a circle on the board. Divide it into 12 pie segments. Label each segment with a month of the year. Ask the students to look at the circle and answer the following questions: 1. Which month would be the most favorable month to plant corn in order to harvest in January? 2. Why are we concerned with certain times of the year for corn planting? 3. What would happen if a crop was harvested at the wrong time?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	4. Would timing the planting of your crop affect the harvest? 5. How can timing the planting be compared to preparing for an oral presentation?
	Lecture
Show overhead transparency – *Banquet Scenario* (see page 8.0.6 - 14).	Pose the following situation to the students: "You are asked to speak to a group of FFA members at the end-of-year banquet. They want you to talk about how they should be involved in contests that year. Instead you should have highlighted some of their accomplishments for that year and encourage them to participate next year." Explain that this is part of **timing** and **focusing** a presentation. Ask the students this – now that you have analyzed your audience and have determined the timeliness of your topic, are you ready to prepare and deliver an oral presentation? What else must you do? – **Gather information.**
	Role Play
Give copies of the dialogue – *Jim and Ms. Smith* to the students reading the parts (see page 8.0.6 - 15).	Ask for two volunteers to read the dialogue – *Jim and Ms. Smith.*
	Discussion
	After the students finish the role play, discuss the key points made. Ask the class if there was a lack of information. What sources of information were identified? What other sources could be used? Use the following example to demonstrate how a lack of information or inaccurate information can cause problems: "Sarah asked her grandmother how she makes her famous spaghetti sauce. Her grandmother told her some of the ingredients, but mostly shared how it tasted. Sarah decided to make the sauce by using the information her grandmother gave her. She began by using the ingredients she remembered from her grandmother's conversation, and then she added other ingredients she thought would produce the desired taste. When she finished, the sauce tasted nothing like her grandmother's sauce."

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Ask the class to explain why Sarah's preparation did not produce the desired results. Include the following items in the discussion: 1. Sarah needs a recipe or an outline to follow. 2. Sarah must know the specific ingredients to put into the sauce. 3. Like Sarah, you cannot produce the desired results in a **speech** without a recipe or **outline** to help organize your thoughts. 4. Do you feel an outline would help you as a speaker? How?
	Lecture
Distribute handout – *Outline for Composing a Speech* (see page 8.0.6 – 16).	Distribute copies of the handout – *Outline for Composing a Speech.* Give the class time to study the handout and ask questions.
	Activity
	Divide the students into groups of four or five. Ask each group to prepare a speech outline. Suggest the following subjects for the speeches: 1. "How to Mow Your Lawn" 2. "How to Put Gasoline in a Car"
Review the key points of a speech outline by using the group examples. Make certain no key points have been omitted from the outlines.	After the groups have finished their outlines, have one person from each group share his or her group's outline with the class. The students should identify any key points missing from each group's outline. Now ask the groups to cooperatively develop lists of those items that should be included in a speech outline. Ask the students if they think composing an outline aids in writing the speech.
	Supervised Study
Distribute the form – *Checklist for a Written Speech* (see page 8.0.6 – 17).	Have the students remain in their groups; distribute the form – *Checklist for a Written Speech* to each group. Ask the groups to complete this form and develop a checklist guide. Remind them to refer to the items for a speech outline which they identified earlier in this lesson. Each student should make a list of key points to remember when writing a speech from an outline.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Homework Assignment Distribute blank copies of *Outline for Composing a Speech* (see 8.0.6 – 18).	**Independent Study** Ask the groups to prepare an outline and a written speech on a simple topic that is of interest to them. Have them follow the examples discussed in class. **Discussion** Discuss with the students the importance of knowing how to present the speech. Not only is it important to choose an appropriate topic, but the presentation of the speech must also be considered. For example, should a speaker just present a talk, or should he/she also have something to show the audience? Ask the students to "brainstorm" the different types of visuals that can be used to present information. Each group should identify the different visuals they could use. Have them describe the type, color, and size of each visual. Ask for a volunteer to write the list on the board. (Each student is to create a **master** list for all types, colors, and sizes of visuals mentioned in class.) *TYPES OF VISUALS* Discuss the **types** of visuals most appropriate for presentations – see the following examples: line, bar, or combination graph; pie chart; posters; handouts; props - actual item; chalkboard; slides; and/or overheads *COLORS OF VISUALS* Discuss the **colors** of visuals most appropriate for presentations – see the following examples: orange, red, green, blue, black, purple, or shades of these colors. *SIZES OF VISUALS* Discuss the **sizes** of various visuals. Ask someone to describe the appropriate size for each visual used in the speech. Remind them that people sitting at the back of the room must be able to see the visuals clearly. Ask the students to describe their impressions of different speakers they have heard. Which speakers were most impressive? Did these speakers use visuals? What types? Which visuals worked and which did not?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Distribute handout – *Activity for Presenting Visuals in an Oral Presentation - Fact Sheet* (see page 8.0.6 – 19). Allow fifteen minutes for this activity.	**Activity** Divide the class into groups of three. Distribute the handout – *Activity for Presenting Visuals in an Oral Presentation*. Ask each group to decide how to present the information below (from the handout) as a visual. They should use the master lists they created during the discussion on visuals. ***Fact Sheet*** *Information* 1. Market price for cattle 1980 $0.34/lb. 1990 $0.37/lb. 1985 $0.39/lb. 1995 $0.34/lb. 2. Amount of time it takes to prepare a speech (percentages) 25% Analyze audience/select topic 35% Gather information/Prepare outline 20% Compose speech 10% Prepare materials - visuals and similar items 10% Practice speech 3. Total Grade Point Average (G.P.A.) Sally 2.8 Terry 2.2 Marcus 0.0 Naomi 3.8 **Discussion** Now that the class knows how to prepare visuals, it is time to prepare to speak. Begin a discussion on the characteristics of effective speakers. Ask the students to identify some local and non-local people who are effective speakers. What characteristics or qualities do these people demonstrate that enable them to be effective speakers? (Ask a volunteer to list these characteristics on the board.) Which of the characteristics or qualities listed are the most important? Rank them in order of importance. Two of the most important characteristics are **confidence** and **naturalness**. These characteristics can be attained by **practicing** a speech. If a speaker does not exhibit these qualities, his or her good ideas or thoughts may not be communicated to the audience.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Discuss the following checklist with the class: *Checklist for Practicing Speeches* 1. Your speech does not have to be read word for word. A speaker demonstrating **naturalness** does not read his/her speech (e.g., political speaker). 2. Practice your speech in front of a mirror. This is helpful when checking your **non-verbal** communication (e.g., hand gestures, facial expressions). 3. Use family and friends as **test audiences**. Deliver your speech to them and ask for suggestions on how you might improve. 4 Pay attention to the **tone** of your voice. If your voice is a monotone, try changing the pitch or inflection (e.g., singers do this when emphasizing a lyric). 5. **Rule of thumb** – Practice your speech at least three to six times before delivering it.
Distribute the handout – *Delivering Your Speech* (see page 8.0.6 – 20). Show this as an overhead transparency also. Reinforce information given with your own personal examples.	*HELPFUL HINTS – Delivering Your Speech* 1. Begin your speech by looking **directly** at the audience and **smiling**. This helps you begin and also prepares the audience. 2. **Talk to the audience** – not to the floor or your paper. 3. **Make eye contact** with various members of the audience. 4. **Stand up straight**; don't lean on the podium. 5. Prepare your listeners for **shifts in the subject matter**; lead them from point to point as you go along. 6. If you make an error, **recover gracefully** and **go on**. Do not call attention to your mistake. 7. Keep your voice **strong** and **clear** throughout the entire speech. Now that the students know what is involved in effectively delivering an oral presentation, it's time to put all this information to work.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Activity Allow five minutes for the students to fill out their index cards.	**Activity** *Part 1* Distribute index cards to the students and ask each of them to list activities they would like to participate in this year and why.
Allow five to ten minutes for the students to prepare their speeches.	*Part 2* Now ask each student to prepare a one- to two-minute speech about these activities. When preparing these speeches they should refer to the information covered previously in this lesson. *Part 3* Have each student deliver his or her speech to the entire class. The class should critique each speaker on paper. Ask them to base their critiques on criteria covered in the checklists and discussions presented earlier in this lesson.
Steps-Key Points Problem-Solving Technique Use the information on pages 8.0.6-11 and -12 (student copy). Show the overhead transparency – *Steps and Key Points in Preparing and Presenting a Speech* (see page 8.0.6 – 21).	**Final Discussion** To summarize this lesson, discuss the following **key points** of speech preparation and presentation: 1. Analyze your audience and determine demographic variables. 2. Make sure your topic is timely and focused. 3. Look at all possible sources when gathering your information. 4. Prepare an outline. 5. Write your speech. 6. Prepare graphs, charts, overheads, and similar items appropriate for presenting your information. 7. **Practice**, **practice**, **practice** your delivery.

• Steps/Key Points •
Problem-Solving Technique

Define the problem

What are the steps to follow when preparing and presenting a speech?

What to Do (Steps)	How to Do It (Key Points)
1. Analyze your audience and determine the demographic variables.	• Identify the ages, occupations, and genders of your audience. • Identify the level of knowledge that the audience has concerning your topic.
2. Be certain your topic is timely and focused.	• Determine if your topic is timely and interesting by introducing it to a person who could be a member of your audience. • Determine if your topic can be discussed in the allotted time.
3. Look at all possible sources when gathering your information.	• Check the library for current sources of information. • Request interviews from experts or their help in identifying additional sources of information.
4. Prepare an outline.	• Organize your thoughts before you write. • Prepare an outline according to the suggestions presented earlier in this lesson.
5. Write your speech.	• Using your outline, turn the ideas into sentences and paragraphs.
6. Prepare graphs, charts, overheads, and similar items appropriate for presenting your information.	• Determine the size of the room in which you will present your speech and what types of visual aids will be available. • Select the most effective visual aids to support your speech.
7. Practice, practice, practice your delivery.	• Be certain you have plenty of time to practice before you present your speech. • Practice in front of a mirror. • Practice with an audience and ask for feedback.

• **Steps/Key Points** •

Problem-Solving Technique

Define the problem	
What to Do (Steps)	**How to Do It (Key Points)**

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills by using role playing, practice time, and choice of topics. Integration of the applied academic competencies will occur during role playing and practice time.

Evaluating Student Learning

Evaluate students by using criteria and guidelines set forth during class discussion and lecture. All criteria demonstrated, role played, and practiced must receive a good or excellent rating.

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Banquet Scenario

You are asked to address a group of FFA members at the end-of-year banquet; you talk about how they should be involved in contests that year.

Instead, you should have highlighted some of their accomplishments for that year and encourage them to participate next year.

Gathering Information

Jim and Ms. Smith Dialogue

Jim – Help! I have to give a speech and I don't know where to get my information.

Ms. Smith – It's O.K., Jim. It's good that you started gathering your information early. Good sources will be valuable to your speech.

Jim – All I have ever been taught is to go to the library and start searching books and magazines. I'm sure I can find some information.

Ms. Smith – That may be true Jim, but don't limit yourself to only the library. That's a good place to start after you identify your topic, but there are many computer database systems available now that can make your library search a little easier. Some of those are AGRICOLA and ERIC.

Jim – Computers? Great, I am just learning how to use one. This will give me some good practice. What else should I do?

Ms. Smith – When you are looking for the most current information, select journal or magazine articles instead of books. Also, some people ignore one of the most valuable sources of information.

Jim – What's that?

Ms. Smith – People – set up interviews with experts or others who may be knowledgeable about your topic. People are an excellent, timely source of information. Using their quotes, stories, or examples will help your speech be more personable.

Jim – Do you have any other tips for me?

Ms. Smith – Yes, if you use people you must always give them credit for saying what you repeat from them.

Jim – Are there other sources besides people, books, or magazines?

Ms. Smith – Television and radio can also be useful.

Jim – Great! Thanks for all your help.

Ms. Smith – You're welcome! I'm glad I could help.

Outline for Composing a Speech

I. **Specific Purpose:** First, determine what you want the audience to do as a result of your speech.

II. **Introduction:** Use something *unique* and *attention-getting*; for example – a startling statement, a question, unusual facts, or an appropriate joke or story.

III. **Statement of Intent:** This is your *purpose statement.* Be clear and explain why you are there; for example – "In this speech, I will share with you the importance of being an agriculture student heading into the 21st century. You must be involved, committed to learning, working, and encouraging others to do the same."

IV. **Body:** This part of the speech can have two, three, or four *main points*. However, more than four points are difficult to cover in a four- to five-minute speech. Support each point with valid statements that give complete information and explain each point clearly. Stories and examples may also be used in the body of the speech.

V. **Conclusion:** This is a *transitional* sentence that lets your audience know that you are ready to restate your points; for example – "Now let's look back at what I have shared today." A simple pause may also be just as effective.

VI. **Summary of Main Points:** This part of the speech *restates* the main points in your speech.

VII. **Concluding Sentence:** This is a *final, memorable* statement. If possible, connect this to the attention-getting statement made in the introduction; be creative. A challenge may also be appropriate at this point. Memorize your concluding sentence.

Checklist for a Written Speech

1. Is the topic narrow and specific?

2. Is the title "catchy" enough to spark interest?

3. Does the introduction state the purpose of the speech, relate the importance of the speech to the audience, and preview the main points you wish to cover?

4. Are all the statements related to the topic and to each other?

5. Do the introduction, body, and summary blend smoothly together?

6. Is the body well developed; that is – does it tell your story?

7. Is the speech mostly in your own words? If not, have you given credit for quotes and other information you are using?

8. Do you have a good summary that briefly reviews all your major points and leaves the audience with a feeling of completeness or satisfaction?

9. Are the grammar, spelling, and sentence structure correct?

10. Is the speech the correct length?

Outline for Composing a Speech

SPECIFIC PURPOSE

INTRODUCTION

I.

A.

B.

C.

II.

BODY

III.

A.

B.

1.

2.

IV.

A.

B.

C.

V.

A.

1.

2.

B.

CONCLUSION

VI.

A.

B.

C.

VII.

Activity for Presenting Visuals in an Oral Presentation

FACT SHEET

Information

1. Market price for cattle

1980	$0.34/lb.	1990	$0.37/lb.
1985	$0.39/lb.	1995	$0.34/lb.

2. Amount of time it takes to prepare a speech (percentages)

25%	Analyze audience/select topic
35%	Gather information/prepare outline
20%	Compose speech
10%	Prepare materials - visuals and similar items
10%	Practice speech

3. Total Grade Point Average (G.P.A.)

Sally	2.8	Terry	2.2
Marcus	4.0	Naomi	3.8

Delivering Your Speech

1. Begin your speech by looking **directly** at the audience and **smiling**. This helps you begin and also prepares the audience.

2. **Talk to the audience** – not to the floor or your paper.

3. **Make eye contact** with various members of the audience.

4. **Stand up straight**; don't lean on the podium.

5. **Prepare** your listeners for **shifts in the subject matter**; lead them from point to point as you go along.

6. If you make an error, **recover gracefully** and **go on**. Do not call attention to your mistake.

7. Keep your voice **strong** and **clear** throughout the entire speech.

Steps and Key Points in Preparing and Presenting a Speech

1. Analyze your audience and determine demographic variables.

2. Make sure your topic is timely and focused.

3. Look at all possible sources when gathering your information.

4. Prepare an outline.

5. Write your speech.

6. Prepare graphs, charts, overheads, and similar visual aids appropriate for presenting your information.

7. Practice, practice, practice your delivery.

Program	**AGRISCIENCE**
Unit	**8 – Personal Development**

Developing Professionalism

Competency/Terminal Performance Objective

8.0.7 In a written test, identify at least five factors to consider in developing professionalism.

Competency Builders/Pupil Performance Objectives

8.0.7.1 Given a list of sources for research information, correctly identify the sources for a particular research topic.

8.0.7.2 Given a list of technical manuals, journals, and periodicals, write a weekly article summary that meets the specifications outlined in class.

8.0.7.3 Provided with a discussion of the importance of attending formal and informal educational training opportunities, identify at least three benefits of attending.

8.0.7.4 Presented with a list of possible committees, serve on one committee and complete a committee report form according to the specifications outlined in class.

8.0.7.5 Given the time and location of a meeting, attend the meeting and identify at least five characteristics of a professional.

8.0.7.6 Given a list of professional organizations, select an organization and identify at least three reasons why participation is important.

Applied Academics Competencies

Communications

1.0.1 Evaluate and respond critically to forms and techniques of printed media.

1.0.5 Identify details such as who, what, why, where, when, or how.

1.0.13 Determine author's purpose.

1.0.15 Summarize material.

1.0.20 Identify main idea and supporting details.

2.0.1 Use word processing, graphics, and/or desktop publishing as aids for writing.

2.0.4 Prepare written report(s).

2.0.10 Organize facts, details, and examples in logical order.

4.0.3 Participate in discussions.

Mathematics

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector
3. Overhead transparencies –
   Job Interview Scenario
   Sources of Information
   Benefits of Effective Committees
4. Handouts –
   Committee Worksheet Example
   Committee Responsibilities
   Committee Worksheet Blank
   An Efficient Committee Chairperson
   Checklist for a Good Committee Member

Situation

This activity is to be conducted with Level I Agriscience students.

<table>
<tr><th>Directions for the Teacher</th><th>Teaching Procedures:
Interest Approach/Teaching Methods</th></tr>
<tr><td>Interest Approach
Show overhead transparency – Scenario - Job Interview (see page 8.0.7-12).</td><td>Show the overhead transparency – Scenario - Job Interview.
Discussion
After reading the overhead transparency, discuss the following questions with the class:
1. In your own words, what happened here?
2. Do you feel the interviewer was fair in his observations?
3. How do you think the student felt?
4. What could the student have done differently to avoid this?
5. What plans do you have for being well versed in your professional area?
6. What is the actual question being addressed?</td></tr>
<tr><td>Write the problem statement on the board.</td><td>HOW DO WE DEVELOP PROFESSIONALISM?
Let's first define professionalism...
"...the status, methods, character, or standards of a specific activity which is a source of livelihood."
Explain to the students that now is a good time to start work on their professionalism skills. This is an important step in their preparation and search for a job. Begin with a look at how to research information about the profession of agriculture.</td></tr>
<tr><td>Ask a student to write the class responses on the board.</td><td>Discussion
Discuss the following items with the class:
1. Why would you want to research information about agriculture?
2. Where are some places to go to do that research?
• Local library
• National Agricultural Library
• AGRICOLA Agriculture Database
• County Extension Office
• State Department of Agriculture
• Agriculture Committee Reports - state legislature
• Farm Bill
• Agriculture census data</td></tr>
</table>

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	3. When asked to do a report on agriculture or looking for information about an area in the field, how do you determine what to look for? (Choose a topic that interests you, something you're curious about.)
Show the overhead transparency – *Sources of Information* (see page 8.0.7-13).	4. What would be the best sources of information? (Books, if recent, may provide some useful information; however, the best choices for information are shown in the overhead transparency - *Sources of Information*.) 5. What types of magazines or journals related to agriculture does your family subscribe to? 6. What other sources of information can you add to this list? **Homework Assignment** Ask the students to select a different technical manual, journal, or periodical to read each week. They should pick one article to summarize from this publication. The summary must be one page and have the proper source citation. Stress to the students that not only is reading materials in your professional area important, so is attending formal and informal education or training opportunities.
Forked-Road Problem-Solving Technique Allow 10 minutes for the group problem-solving. Use the information on pages 8.0.7-9 and -10 (student copy). Allow 10 minutes for all group reports. After group decisions are presented, offer your personal experiences of attending a training session.	**Supervised Activity** Divide the class into four groups. Have the students imagine they are agricultural education teachers and are given the opportunity to attend an educational training seminar. Ask them to use the forked-road problem-solving technique to determine if they should attend the meeting. *For example* – 1. What are some things you might learn from this meeting? 2. What are possible benefits and drawbacks of spending time with other agriculture teachers? After the groups have finished their discussions, ask them to report their decisions to the class.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Ask a student to write the class responses on an overhead transparency or the board.	Since the students have discussed opportunities for education outside the school setting, ask them to now imagine they have been asked to serve on a banquet committee. Discuss the following questions with them: 1. How do you feel about serving on a banquet committee? 2. What value do you place on this responsibility? 3. Are you eager to serve, or do you feel it will take up too much time? 4. As a member of an organization, how should you respond to committee responsibilities? 5. Can you give examples of organizations that use committees? 6. Why do committees exist? What is their purpose? 7. What are some benefits of effective committees?
Show overhead transparency – *Benefits of Effective Committees* (see page 8.0.7-14).	Discuss with the class the following important goals of a committee: 1. Involves more members in the organization's activities. 2. Provides an opportunity for members to develop leadership ability. 3. Enables the chapter to complete more activities. Using the FFA as an example, discuss the key role that committees play. For example – an FFA chapter has a committee to develop a Program of Activities each year which identifies the activities the chapter plans to participate in throughout the year. The FFA has 11 standing committees. Five of them include the following: 1. Leadership 2. Recreation 3. Community Service 4. Earnings, Savings, and Investments 5. Conduct of Meetings

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Distribute handouts – *Committee Worksheet - Example*, *Committee Responsibilities*, and *Committee Worksheet - Blank* (see pages 8.0.7-15 - 17). Allow 15 minutes for this activity.	**Supervised Activity** Divide the class into five groups - one for each of the standing committees listed previously. Each group must select a chairperson. Ask each committee to review the handouts – *Committee Worksheet Example* and *Committee Responsibilities* and note their particular committee's responsibilities. Each committee should discuss the committee's goal, the ways and means of accomplishing that goal, members who will be responsible, and possible costs. After the committees are finished with their discussions, they should complete the handout – *Committee Worksheet - Blank* and present it to the class.
	Discussion After the committees have completed their worksheets and finished their discussions, ask them the following questions: 1. What did you learn from working on your committee? 2. Did your committee find it easy or difficult to work together? Why? 3. What, if anything, could have helped your committee run more smoothly? 4. In what ways, if any, did working on the committee change your attitudes about committees? 5. Do you feel your committee worked well for the time allotted? 6. How could you have been better prepared for the activity? 7. How helpful was your committee chairperson?
Distribute the handouts – *An Efficient Committee Chairperson* and *Checklist for a Good Committee Member* (see pages 8.0.7-18 and 19).	8. What are characteristics of an efficient committee chairperson? (Refer to the handout – *An Efficient Committee Chairperson*.) 9. What are the characteristics of a good committee member? (Refer to the handout – *Checklist for a Good Committee Member*.)

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Lecture Explain to the students that there is certainly more to learn about committees than discussed so far. The best way to learn about committees is to serve on one. At this point this lesson has covered researching information, reading journals, attending training opportunities, and participating on committees. What else could possibly be left in developing professionalism? **Discussion** Ask the students the following questions: 1. Can you learn more by attending a meeting or skipping it? Why? 2. Will workshops do you any good if you don't attend? Why? 3. Seminars, conferences and demonstrations can help present you with new, useful knowledge in your profession. Can you receive the benefits if you don't go? The key to these activities is **attendance**. Encourage the students to attend meetings of the organizations in which they are members. They should go to every seminar or workshop they can to gain new knowledge and stay current in their professions. **Homework Assignment** Ask the students to attend the next meeting of an organization in which they are members. Have them write a paragraph on what they learned at the meeting and what they would have missed had they not attended.
If needed, offer the following answers to question 3: you learn more about the profession, meet other people in the profession, network - get to know other people who may help you get a job, and stay current on issues in your profession.	**Discussion** Discuss with the class the importance of participation in their professional organizations. Include the following questions: 1. Why do you think participation in professional organizations is important? 2. In which professional organizations are your parents or friends members? 3. What are some benefits of participation in professional organizations?

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Summary Summarize this lesson plan by reviewing the following basic guidelines: 1. Research information. 2. Read related manuals, journals, and periodicals. 3. Attend formal and informal education or training opportunities. 4. Participate on committees. 5. Attend meetings, workshops, and seminars. 6. Participate in professional organizations.

• Forked Road •

Problem-Solving Technique

Define the problem

As an agriculture teacher, do you attend the upcoming educational training seminar?

Factors to Consider	Choice one	Choice two
	Do not attend seminar	*Attend seminar*
1. Where is the seminar?	Nearby	Nearby
2. Are you willing to make the time commitment?	I'm not willing to give up a free Saturday once a year.	I am willing to give up a free Saturday once a year.
3. What are the benefits of attending the seminar?	None seen	Fellowship, sharing ideas with other ag ed teachers
4. What is the magnitude of the loss if you do not attend the seminar?	Somewhat of a loss	Great loss
5. What is the cost of the seminar?	Affordable	Affordable
6. How much time away from school is required?	None	None

Decision/Recommendation

I should attend the training seminar which is offered once a year on a Saturday.
I will not miss school and the cost of the seminar is affordable.

• Forked Road •

Problem-Solving Technique

Define the problem

Factors to Consider	Choice one	Choice two

Decision/Recommendation

794

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills through attending a professional meeting, committee reporting, and identifying sources for research on professionalism. Using applied academics competencies, students will be able to apply the concept of professionalism with their chosen areas of interest and make educated decisions related to participation in professional organizations.

Evaluating Student Learning

Evaluate students through written tests, weekly writing assignments, and class discussions.

This activity was developed by Shawn Oliver, Agricultural Education Department, Ohio State University, 208 Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, Ohio 43210.

Ohio Agricultural Education Curriculum Materials Service

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Scenario
Job Interview

Imagine yourself in a job interview. You think your resume is quite impressive; you made straight A's in high school and college; you were a member of quite a few clubs and organizations. The interviewer for a major agriculture company asks you about your major. He asks about the latest research in the area, major innovations, and conventions in your profession. You are unable to answer because you spent all your time reading school books. Consequently, you failed to gain an understanding of your profession or to interact with others in your field.

The interviewer says, "Thanks for coming in. I just don't think you're what we are looking for. We need someone more versed in the field."

Sources of Information

(a brief list)

1. TECHNICAL MANUALS

2. JOURNALS

   Agricultural Education journals

   Journal of Applied Communication

   Horticulture journals

3. PERIODICALS

   Weekly Farm Report magazines

   State Agriculture magazines

   Time Magazine

   Newspapers

   Kiplinger Report

Benefits of Effective Committees

1. Committees can do most of the work in an organization if they are well selected and the responsibilities are explained. They can relieve busy officers of the minor details involved in chapter activities.

2. Committees accommodate differences in individuals. Each member can contribute ideas and do the kind of work for which he or she is especially suited.

3. Committees can provide opportunities for inexperienced members to increase their leadership abilities.

4. Committees consider ideas from members other than the officers.

5. Committees get more of the members involved. The organization is more active and more goals are accomplished.

6. All the committee members together have more contacts than the officers alone. These contacts can give the organization advice and assistance. Committee members are also aware of more available community resources to accomplish the organization's goals and activities.

Committee Worksheet

Name of Committee	Purpose/Goals of Committee	Committee Activities	Chapter Activities	Members Who Are Responsible	Costs
Membership	To increase chapter membership	Obtain list of possible members. Write letters explaining benefits of membership.	Membership drive	Sam, Dave, John and Chris	Stationary and Postage - $50.00
	To recognize outstanding members	Order plaques, one for each month of the year to recognize outstanding member.	Outstanding member recognized at monthly meeting	Beth, Larry, Tom and Roger	Plaques - $125.00
		Committee submits names to executive committee for final selection.			
		Work with chapter reporter in taking a picture and writing a news article.			Pictures - $18

Report submitted by
Committee Members:

Dave
Sara
Tim
Anna

Committee Responsibilities

1. **LEADERSHIP**

   FFA leadership programs need participation and "learning by doing" experience. This committee organizes activities that help all FFA chapter members to develop leadership skills by practice.

2. **RECREATION**

   FFA members work hard, but also recognize the importance of having fun. This committee plans recreation activities that are fun for all members.

3. **COMMUNITY SERVICE**

   The FFA is known for the services it provides the community. This committee plans chapter activities that will benefit the local community by making it safer, more attractive, etc.

4. **EARNINGS, SAVINGS, AND INVESTMENTS**

   Organizations need money to operate. The FFA is no exception. This committee develops activities that help the chapter earn and manage funds to the best interest of the members.

5. **CONDUCT OF MEETINGS**

   Meeting together as a chapter is important in communication and active member participation. This committee selects programs of interest to members and ensures the conduct of regular meetings and special programs.

Committee Worksheet

Blank

Name of Committee	Purpose/Goals of Committee	Committee Activities	Chapter Activities	Members Who Are Responsible	Costs

An Efficient Committee Chairperson:

1. Knows all the committee members.
2. Looks at committee duties and decides which duties should be completed and when.
3. Prepares the agenda for committee meetings.
4. Collects information on committee topics or projects.
5. Selects a secretary.
6. Encourages each member to enter committee discussions.
7. Leads the discussion and summarizes the decision of the group; presents compromise positions.
8. Refrains from expressing personal opinions too frequently.
9. Schedules meetings at convenient times and locations.
10. Keeps members on the appropriate subject.
11. Obtains materials needed for each meeting.
12. Reviews minutes and committee reports prior to their approval.

Checklist for a Good Committee Member

1. Attends all meetings of the committee.
2. Is businesslike and attentive.
3. Enters into the discussion during the meeting.
4. Offers ideas and makes suggestions.
5. Does not dominate the discussion.
6. Accepts others' ideas for consideration.
7. Accepts responsibility and tackles jobs that need to be done.
8. Completes all jobs and responsibilities given him/her.
9. Makes decisions only after all ideas are presented.
10. Works well with other members.

Program	AGRISCIENCE
Unit	8 - Personal Development

Applying Citizenship Skills

Competency/Terminal Performance Objective

8.0.8 Given a list of opportunities to participate in a community activity, select and participate in at least one activity, applying the concepts mentioned in class.

Competency Builders/Pupil Performance Objectives

8.0.8.1 Given an actual situation, identify factors that show the importance of leadership to citizenship. List at least three factors.

8.0.8.2 Recognize importance of volunteerism and community service to citizenship when evaluating a role play about volunteering in the community. Identify at least three factors of importance.

8.0.8.3 Assess the value of volunteerism and community service when involved in a game, according to the discussions offered in class.

8.0.8.4 When given a definition of leader, identify at least 10 leadership qualities.

8.0.8.5 Using past experience and information discussed in class, identify at least five qualities of a responsible volunteer.

8.0.8.6 Given a choice of service opportunities, participate in at least one leadership, volunteer, or community service opportunity.

Applied Academics Competencies

Communications

2.0.3 Record observations.

2.0.4 Prepare written report(s).

2.0.10 Organize facts, details, and examples in logical order.

2.0.13 Use correct grammar.

2.0.14 Use correct spelling.

2.0.15 Write complete sentences.

2.0.18 Use written language to express oneself clearly.

3.0.1 Demonstrate effective listening skills.

3.0.5 Identify main idea(s).

3.0.7 Evaluate spoken communications.

3.0.8 Draw inferences and/or conclusions.

3.0.11 Evaluate nonverbal messages.

4.0.2 Use nonverbal messages.

4.0.5 Participate in dramatic presentations (e.g., role playing).

4.0.13 Use visual media.

Applied Academics Competencies *(continued)*

Mathematics

3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

1. 2 flip charts
2. 2 magic markers
3. 12 index cards (3" x 5")
4. Chalkboard and overhead projector
5. Stopwatch
6. Handout - *Your Responsibilities in Your Community*
7. *Dialogue on Citizenship Responsibilities* (2 copies)
8. Overhead transparency- *Definition of Citizenship*

Situation

This activity is to be conducted with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach Have the students write responses on the board and an overhead transparency. (Allow 10 minutes for speech by community leader.)	**Activity** Ask the students to identify people they consider to be leaders in the community. They should also list the characteristics exhibited by these leaders. Ask a leader in the community to talk to the class about his/her role in the community. This person should also offer suggestions on how the students can become leaders and develop citizenship skills. Offer students an opportunity to ask questions. **Discussion** After the guest speaker is finished, discuss the following questions with the students: 1. How do you define leadership? 2. What are some qualities of a leader? 3. How does leadership relate to citizenship? 4. What is citizenship?
Write the problem statement on the board.	***HOW DO WE APPLY CITIZENSHIP SKILLS?***
Show the overhead on page 8.0.8-10 – *Definition of Citizenship.* Distribute handout on page 8.0.8-11 – *Your Responsibilities in Your Community.* (Allow 10 minutes for the students to complete the handout.)	**Activity** Show the overhead - *Definition of Citizenship*. Read and discuss with students. Ask students to complete the handout - *Your Responsibilities in Your Community.* **Discussion** After the students have completed the handout, discuss the following questions: 1. After completing this activity, what responsibilities do you feel you have toward your community? 2. Have you experienced a situation like this or one similar to this? 3. What is a **leader**? 4. Does leadership relate to any of the situations? If so, how? 5. Why do you feel we need citizens who are good leaders?
Possibilities-Factors Problem-Solving Technique Use the information on pages 8.0.8-7 and -8 (student copy).	After discussing the situations presented in the handout, lead the class through the problem-solving technique regarding situation #2. Then ask the students to select the situation they prefer to examine more closely by using the same technique.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	WHAT IS A LEADER?
	Discussion
Divide the class into three groups.	Have each group list the qualities of a leader. Ask a representative from each group to read his/her group's list. Write each list on the board; cross out any repeats to compile one complete list. After discussing the contents of the final list, ask the following questions: 1. Does a leader participate in only those activities he/she likes? 2. Is the leader the only person who can decide what the group should do? 3. Does a leader encourage individuals in a group to volunteer to help with projects and meet the needs of a community?
	VOLUNTEERISM
	Discussion
Divide the class into two groups. You will need a flip chart and magic marker for each group.	Ask the students to define **volunteerism**. Write the definition on the board. **Activity**
Assign one student to serve as officiator and score-keeper. The officiator holds the card pile. One opportunity for volunteerism should be written on each index card. *Sample opportunities* – hospital, school, nursing home, class trips, organizing local parade, church, delivering food to elderly, tutoring, mowing lawns, home help, raking leaves, recycling, cleaning up trash	Conduct the following game: 1. Divide the class into two teams – each with a designated "artist." 2. Designate a student as officiator and timekeeper. 3. Position the teams on opposite sides of the room. Set up two flip charts so each one faces its respective team and cannot be seen by the other team. 4. Ask one of the "artists" to choose a card from the stack. (Each card lists an opportunity for volunteers to serve.) 5. Have each "artist" draw on his/her team's flip chart a picture conveying the volunteerism opportunity listed on the card. The students have one minute to complete their drawings.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	6. Both teams must guess what is being drawn without looking at the opposing team's drawing. If a team guesses correctly in the time allotted, they are awarded one point. If no one guesses correctly, no points are awarded and the game resumes with new artists, a new officiator, and a new card. 7. After 20 minutes the team with the most points is declared the winner.
	Discussion
Offer the following list if needed: honest, eager to serve, punctual, expecting nothing in return, dependable, wanting to help, friendly.	After finishing the activity, discuss the following items: 1. What are some of the ways people can volunteer? 2. Identify some qualities of a responsible volunteer.
	ROLE PLAY
Have two students read *Dialogue on Citizenship Responsibilities* on page 8.0.8 - 12.	Ask two students to role play using the *Dialogue on Citizenship Responsibilities.*
	Discussion
	After completing the role play, discuss the following questions: 1. Were the people having the discussion interested in their roles as citizens? 2. As a young person, how do you define your role as a citizen? 3. How can your class or organization show good citizenship in the community? 4. In what types of leadership, volunteer, and community service opportunities could the class participate?
	Supervised Study
Set a day and time for the chosen community service. Supervise the activity.	Ask the students to discuss community service opportunities and choose one or two in which to participate. Each student should participate in at least one community service project as part of the class participation and course grade.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Independent Study Ask students to write reports on what they did in the community, what they learned, and how they feel about their roles in the community. (Emphasize that they must use correct grammar and spelling.) **Final Discussion** To summarize this activity, discuss the following items with the students: 1. How do you define **citizenship**? 2. In what ways can you plan to volunteer at school or in the community? 3. Name two qualities of a leader. 4. Name two qualities of a volunteer. 5. Citizenship and volunteering are opportunities for you to serve – true or false? 6. What else might citizenship and volunteering be considered? *Example*: a responsibility

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

How would you respond to the elderly lady who needs help carrying her groceries?

Factors to Consider	Possibilities (Possible Solutions)			
	Just ignore the situation.	**Stop and help.**	**Call on a friend to help you.**	**Make fun of her.**
1. Are you able to help the lady?	Yes	Yes	Yes	Yes
2. Do you have the time to help the lady?	Yes	Yes	Yes	Yes
3. What might happen to the lady if she carries the groceries all by herself?	She might get hurt.	She will be OK.	She needs immediate help.	She might get hurt.
4. Is the lady a stranger to you?	Yes	Yes	Yes	Yes
5. What is your attitude toward the elderly?	Bad	Good	Good	Bad

Decision/Recommendation

I should help the lady carry her groceries. If my friend is with me, I should ask him or her to help also.

• Possibilities - Factors •

Problem-Solving Technique

Define the problem

Factors to Consider	Possibilities (Possible Solutions)			

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills through community involvement activities and a game simulating volunteerism and community service. Skills will be demonstrated through role play with communication and mathematics academics competencies applied throughout lesson.

Evaluating Student Learning

Evaluate students through participation in game activity and written assignments; identification of the factors important to leadership and citizenship; and recognition of the importance of volunteerism and community service.

This activity was developed by Shawn Oliver, Agricultural Education Department, Ohio State University, 208 Agricultural Administration Bldg., 2120 Fyffe Road, Columbus, Ohio 43210.

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Definition of Citizenship

Citizenship is the allegiance an individual owes to a country in return for the privilege of enjoying its rights and freedoms. The people who enjoy these rights and freedoms are called ***citizens***, and the allegiance they owe is referred to as the ***responsibilities of citizenship***.

Citizenship Skills

Your Responsibilities in Your Community

Describe how you would respond in the following situations:

1. You are walking home from school and you notice that a fire has broken out in a nearby warehouse. What would you do?

2. You are riding your bike and notice an elderly lady in your community is having trouble carrying her groceries. What would you do?

3. You heard on the radio that your hometown is designating Saturday as a clean-up day and are asking for volunteers to help. You had planned on playing basketball at the park that day with your friends. What would you do?

4. Your community does not have a mandatory recycling program. However, you have learned about recycling and are very familiar with the procedures. Your family doesn't presently recycle. What would you do?

Dialogue on Citizenship Responsibilities

Joe – Andrew, I read in the paper that they are having a community clean-up on Saturday.

Andrew – Yes, I read that, too. I'm planning to go. Are you?

Joe – No way! Saturday is my only day off. Why would I want to spend it working? They won't miss me anyway.

Andrew – Are you sure about that Joe? There's a lot of cleaning up to do. We sure could use your help. You live in this community. Your kids go to school here. Isn't its cleanliness important to you?

Joe – I don't think it's my job. Let those who have nothing better to do clean. Me – I'd rather watch a football game.

Andrew – Aren't you proud of this community, Joe? Why don't you show that by helping out? There will be plenty more football games to watch. Why not help out this once? It could even be fun!

Joe – This seems really important to you. OK, I'll help!

Program: AGRISCIENCE

Unit: 8 – Personal Development

Forming Interpersonal Relationships

Competency/Terminal Performance Objective

8.0.9 Given a simulated situation, identify the characteristics of healthy and unhealthy relationships, as well as key tools to develop effective interpersonal communication. All criteria must be achieved at the good or excellent level.

Competency Builders/Pupil Performance Objectives

8.0.9.1 Presented with real-life scenarios, identify the consequences of healthy and unhealthy relationships with 80 percent accuracy.

8.0.9.2 Identify how personal actions and decisions affect others when presented with real-life scenarios. List at least five factors.

8.0.9.3 On a written assignment, provide examples of situations when expressing feelings and ideas to others is important. All criteria must be achieved at the good or excellent level.

8.0.9.4 When evaluating personal experiences involving interpersonal communication, identify strategies to deal with current issues. List at least three strategies.

Applied Academics Competencies

Communications

2.0.8 Develop main idea(s) supported by details and examples.

3.0.8 Draw inferences and/or conclusions.

4.0.3 Participate in discussions.

4.0.5 Participate in dramatic presentations (e.g., role playing).

Mathematics

3.2.6 Use problem-solving techniques.

Equipment, Supplies, References, and Other Resources

1. Chalkboard
2. Overhead projector
3. Overhead transparencies –
   Possible Feelings or Expressions Resulting from Unhealthy Relationships
   Scenario of Girl
   Scenario - Father/Son Relationship
   Results of Healthy Relationships
   Why It May Be Difficult to Express Feelings and Ideas
   Possible Results of Being Able to Express Feelings and Ideas

Equipment, Supplies, References, and Other Resources *(continued)*
4. Handouts – *Interpersonal Relationships – Skit #1 - Unhealthy Relationships* (need 3 copies, one for each skit participant) *Interpersonal Relationships – Skit #2 - Healthy Relationships* (need 3 copies, one for each skit participant)
Situation This activity is to be conducted with Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Interest Approach Ask for six volunteers: one male and two females for skit #1 and three males for skit #2. Distribute the handouts to the volunteers – *Interpersonal Relationships - Skit #1 - Unhealthy Relationships* and *Interpersonal Relationships - Skit #2 - Healthy Relationships* (see pages 8.0.9 -12 and -13). Give them five minutes to discuss the skits among themselves.	***HEALTHY AND UNHEALTHY RELATIONSHIPS*** **Role Play #1** Explain to students that it is very important they pay close attention to what is said today. Some of them will be acting out skits and offering discussion on some very tough and sensitive topics. They should not relate the people in the skits to the roles they are playing. Ask them to instead determine the meaning of what is being said. Ask for six volunteers: one male and two females for skit #1, and three males for skit #2. Begin with skit #1 about unhealthy relationships – ask the three students to act out the skit for the class. **Discussion** After the students have finished skit #1, discuss the following questions: 1. What did you think of skit #1 with Adam, Pam and Elizabeth? 2. Is this an example of a healthy or an unhealthy relationship? Why? 3. How would you feel if you were Pam? Elizabeth? Adam? 4. What could Adam have done differently and why? 5. What did you learn about relationships from this skit? 6. What are the various types of relationships? 7. Do you feel the skills and knowledge necessary to form one-on-one relationships are different from those necessary for group relationships? in what way?
Write the problem statement on the board.	***HOW DO WE FORM INTERPERSONAL RELATIONSHIPS?*** **Role Play #2** Interpersonal relationships involve interaction between two or three people. Ask the second group of volunteers to perform skit #2 about healthy relationships.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	Discussion After the students have finished acting out skit #2, discuss the following questions: 1. What is your reaction to this skit? 2. How was it different from skit #1? 3. How do you feel about the way Dan and Jim treated Bob? 4. How do you think Bob felt on his way to the cafeteria? 5. Do you think Bob feels blessed to have such good friends?
Allow 10 minutes for this activity. Provide this example if necessary: "selfishness" could be characteristic of an unhealthy relationship, and "generosity" could be its opposite.	**Supervised Activity** Demonstrate to students how healthy relationships can be a valuable resource in our lives. Ask the class to pair off and list the characteristics of an unhealthy relationship on the left side of a sheet of paper. Then write the opposite of each characteristic on the right side of the paper. When the students are finished writing, ask five of the pairs to share their lists with the rest of the class. Ask a volunteer to write a master list on the board. **Discussion** After the master list has been compiled, discuss the following questions with the class: 1. What were some of the characteristics mentioned most often? 2. Why do you feel some of the unhealthy characteristics are unhealthy? 3. What other characteristics would you add to the list? Discuss with students the concept that there are consequences to almost everything we do, good or bad. A **consequence** is something that results from an action.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Show the overhead transparency – *Scenario - Father/Son Relationship* (see page 8.0.9-14).	*PERSONAL ACTIONS AND THEIR CONSEQUENCES* **Activity**
Situation-to-be-Improved Problem-Solving Technique Use the information on pages 8.0.9-9 and -10 (student copy).	Show the overhead transparency to the class and ask their reactions to the father/son scenario. After reviewing the father/son scenario with the class, define the problem and the situation to be improved. Then discuss the following question: • What are some possible consequences of this unhealthy relationship?
Show the overhead transparency – *Possible Feelings or Expressions Resulting from Unhealthy Relationships* (see page 8.0.9-15).	With the above situation in mind, discuss the overhead transparency – *Possible Feelings or Expressions Resulting from Unhealthy Relationships* and the following questions: 1. What is the son possibly feeling? 2. What would be the ideal situation? Now that the students have discussed some consequences of unhealthy relationships, it's time to look at a healthy relationship.
Show the overhead transparency – *Scenario of Girl* (see page 8.0.9-16).	Discuss the overhead transparency – *Scenario of Girl.* Explain to the students that Sue seems to feel very good about her relationship with her parents; the relationship appears to be a healthy one. **Discussion** After viewing the overhead transparency discuss the following items with the class: 1. Do you agree that this is a healthy relationship? Why or why not? 2. Give specific reasons why you think this relationship is healthy.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Now show the overhead transparency – *Results of Healthy Relationships* (see page 8.0.9-17).	3. In what other way(s) could the parents have responded to her grades? 4. Why do you think they responded the way they did? 5. What are some possible consequences of that healthy relationship? What are some things Sue may feel? 6. Do you see how the personal actions of people in the skits and scenarios affected people? **Supervised Study**
Encourage the students not to use real names or situations that could offend someone. Allow 15 minutes for this activity.	Divide the class into four groups. Ask two of these groups to identify a situation in which personal actions and decisions **positively** affect a person(s). Ask the other two groups to identify a situation in which personal actions and decisions **negatively** affect a person(s). Each group should include the following information when describing their respective situations: 1. Evaluate why the actions/decisions negatively or positively affected the person(s). 2 Identify what the people involved could have done differently. Have each group present to the class a brief (three-minute) description of their situation along with their observations. Explain to the class that our actions and decisions affect the people around us; therefore, we must take responsibility for our actions and decisions. Another important aspect of interpersonal relationships is expressing our ideas and feelings to others. Some people find this easy to do – others find this difficult.
Show and discuss the overhead transparency – *Why It May Be Difficult to Express Feelings and Ideas* (see page 8.0.9-18). Ask a student to write the class responses on an overhead transparency.	***IMPORTANCE OF EXPRESSING FEELINGS AND IDEAS*** **Discussion** Discuss the following items with the class: 1. Give some examples of times when you feel it is easy to express what you think and feel. Describe the types of people and types of situations.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Show and discuss the overhead transparency – *Possible Results of Being Able to Express Feelings and Ideas* (see page 8.0.9-19). Allow 5 to 10 minutes for this activity.	2. Give some examples of times when you feel it is not easy to express what you think and feel. 3. Why might it be hard for you to express what you think and feel? Do you feel these reasons make it OK for you to continue suppressing your feelings and ideas? 4. What is healthy about being able to express feelings and ideas? 5. What could be the results? 6. How could you encourage people to express their ideas and feelings to others?
Allow 5 to 10 minutes for this activity.	**Supervised Study** Have the class pair up for an exercise in expressing ideas and feelings on the interpersonal level. Ask the students to take turns sharing with their partners how they feel about being a member of a particular organization or group. They should also include what they hope to accomplish as a member. Now it is time to discuss the final topic of this lesson plan: how to deal with current issues that may be causing problems.
	SOURCES OF ADDITIONAL HELP
Allow five minutes for this activity. Emphasize that this information is for their eyes only and will be kept completely **confidential**.	**Supervised Study** Ask the students to make a list of current issues they are facing in their lives that could be related to interpersonal communication skills discussed in this lesson. They should identify those issues related to healthy or unhealthy relationships, their inability to express feelings or ideas, and their inability to feel comfortable with others. Also ask them to include the things they learned in this lesson that could help them in these areas. Explain to the class that some of them may have identified issues they are presently working through, or situations they have already faced. Whatever the case may be, they may someday find themselves needing additional help to solve a problem. The following are some people who could assist them:

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
	1. Parents 2. School counselor 3. Teacher 4. Friend 5. Doctor 6. Pastor **Homework Assignment** Ask the students to identify two areas of their interpersonal behavior that they currently want to improve. They should describe the situations and identify strategies for improvement. Ask them to list the people they will talk with and those personal actions or reactions they want to change. **Summary** Review the topics covered in this lesson. 1. Healthy and unhealthy relationships 2. Personal actions and their consequences 3. Importance of expressing feelings and ideas 4. Sources of additional help

• **Situation-To-Be-Improved** •

Problem-Solving Technique

Define the problem

How can the son learn to communicate again with friends and family?

Characteristics to Be Considered	Current Situation	Ideal Situation	Difference Between Ideal and Current Situations	Recommendations
1. The son's home environment is not pleasant. 2. The father's attitude toward his son is not good. 3. The son denies that a problem exists. 4. The son has stopped expressing his feelings. 5. What help is available to the son?	The son lives at home with both parents. The father works many hours each week. When the father is home, he frequently yells at his son. The father rarely attends any school events in which his son is involved. The son doesn't talk to his friends or family anymore. When asked, he says nothing is wrong.	The son would open up and communicate his real feelings with his friends and family. He would recognize his worth apart from others' opinions of him.	Communication link between the son and his parents is missing.	Refer the son to a school or church counselor with whom he feels free to express his true feelings and better understand his home situation. Suggest the parents become more involved in their son's life.

Decision/Recommendation

Refer the son to a school or church counselor or someone with whom he can freely express his feelings. Suggest the son's parents seek professional help in order to better communicate with him.

• Situation-To-Be-Improved •

Problem-Solving Technique

Define the problem

Characteristics to Be Considered	Current Situation	Ideal Situation	Difference Between Ideal and Current Situations	Recommen-dations

Decision/Recommendation

Helping Students Apply Concepts/Principles/Skills

Apply Concepts/Principles/Skills through the identification of healthy and unhealthy interpersonal relationships, evaluation of personal experiences, and role playing interpersonal relationships. By using applied academics competencies and competency builders, students will be able to apply the characteristics that form during interpersonal relationships.

Evaluating Student Learning

Evaluate students through a written test, simulated situations, and real-life scenarios. List strategies for interacting in current situations. Also list factors identifying how personal actions and decisions affect others. All written work, lists, and strategies must receive a good or excellent rating.

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INTERPERSONAL RELATIONSHIPS

Skit #1 - Unhealthy Relationships

WEDNESDAY

Adam – Hi Pam, how are you?

Pam – Pretty good today. Thanks.

Adam – I'm glad we've been dating for a few months now. I have some great tickets to the theater downtown. I wanted to know if you would like to go. It's this Saturday.

Pam – Super! Yeah, I'd love to go. Since this is Wednesday, I have a few days to get something to wear. *(Walk away, pause, then come back)*

THURSDAY

Pam – Got to tell you – my mom and I went shopping. I got the perfect dress. Two days until the theater – I can't wait!

Adam – Great! *(Pam walks away)*

FRIDAY

(Elizabeth joins Adam)

Elizabeth – Hi Adam! You sure are cute. I've been admiring you for awhile. I didn't know if you noticed. Maybe we can get together sometime soon.

Adam – *(Says to himself aloud)* - Wow! Elizabeth wants to go out with me. She is the most beautiful girl in school. I'll take her to the theater. Pam won't mind just this once.

Adam – Hey! I have two tickets to the theater Saturday night. Would you like to go?

Elizabeth – Sure Adam. That's fine. *(Elizabeth walks away)*

(Pam joins Adam)

Adam – Hi Pam! Listen, I have some cousins coming in from out of town this weekend. I can't take you to the theater. Maybe some other time.

Pam – Oh Adam, I just bought a new dress. But that's OK. Family comes first; I understand.

INTERPERSONAL RELATIONSHIPS

Skit #2 - Healthy Relationships

Jim – Hi Bob. Are you trying out for the chorus today?

Bob – Yes, I thought I would. I made it last year. It's just a fun time. Plus, I really do like to sing.

LATER THAT MORNING

(Dan enters)

Dan – Hi Bob! I heard you tried out for the chorus today. Did you make it?

Bob – No, Dan, I didn't. I'm so embarrassed. I don't know what happened. I won't be sitting with you guys at lunch today. You're probably too embarrassed to be seen with me.

Dan – Hey Jim, come over here. Bob didn't make the chorus. Now he thinks we don't want to associate with him. I told him we don't care if he's in the chorus. He's still our friend.

Jim – Good. You're absolutely right. Dan – we don't like you because of the things you do or don't do. We like you because of who you are. You're our friend, Bob – **know that**. Come on, let's have lunch. The line is probably getting long by now.

Bob – Thanks guys.

(The three walk away together)

Scenario – Father/Son Relationship

You have a friend who lives at home with both parents. His father works many hours each week. When the father is home, he usually yells at your friend. His father rarely attends any school events in which your friend is involved. Your friend suddenly stops talking to his family and friends.

Possible Feelings or Expressions Resulting from Unhealthy Relationships

1. Hurt feelings
2. Anger
3. Misplaced anger
4. Low grades
5. Non-caring attitude
6. Perfectionism
7. Denial
8. Concealment of true feelings (e.g., jokes instead)
9. No talking – shy
10. No expression of feelings

Scenario of Girl

Sue is an above-average student. She works hard and studies. She took home her midterm grade card with three B's and one C. She shows the card to her parents. Her mother says, "Sue, that's pretty good. I'm really proud of you. If there is anything I can do to help you improve your C in math, let me know."

Her father looks at the grades and asks, "Did you do your best?" Sue says, "Yes." He says, "Great, I am so proud of you. I know I have never offered to help you with school work, but maybe next Saturday after we go horseback riding, we can work through a few math problems." "OK Dad," Sue says.

Results of Healthy Relationships

1. Love
2. Support
3. Encouragement
4. Acceptance
5. Affirmation
6. Freedom to express true feelings/thoughts
7. Freedom to be oneself

Why It May Be Difficult To Express Feelings and Ideas

1. You react according to past hurts and failures.

2. You are not encouraged to do so by parents.

3. You want to be everyone's friend and are afraid of offending someone.

4. You think your ideas are not good enough.

5. You think you have no right to express your ideas.

6. You have a fear of rejection.

7. You are not sure what you feel; you have always been a thinker, not a feeler.

8. You have suppressed emotions.

9. You are afraid of what you might feel.

Possible Results of Being Able to Express Feelings and Ideas

1. Important ideas are shared.

2. Issues are not hidden; therefore, they can be dealt with.

3. No built-up anger exists to cause tension.

4. You have the freedom to be who you are.

5. Everyone is valued.

6. You feel more a part of the group or project.

Program AGRISCIENCE

Unit 8 - Personal Development

Perform Computer Functions

Competency/Terminal Performance Objective

8.0.10: Given a list of performance objectives, perform computer functions, based on the criteria specified in an assessment instrument.

Competency Builders/Pupil Performance Objectives

8.0.10.1	Given a list of terms, use computer terminology, based on definitions provided in assessment instrument.
8.0.10.2	Provided with a computer, apply basic computer skills to achieve program use as specified in assessment instrument.
8.0.10.3	Provided with a computer, operate equipment to achieve computer use, as specified in assessment instrument.
8.0.10.4	Using a computer, save, store, and retrieve information without loss of data.
8.0.10.5	Provided with a computer, create files to achieve program use, as specified in assessment instrument.
8.0.10.6	Provided with a computer, input data to achieve program use, as specified in assessment instrument.
8.0.10.7	Provided with a computer, process data to achieve program use, as specified in assessment instrument.
8.0.10.8	Provided with a computer, produce output to achieve program use, as specified in assessment instrument.
8.0.10.9	Provided with a computer, print documents to achieve program use, as specified in assessment instrument.
8.0.10.10	Provided with a computer, use manufacturers' manuals, documentation, and other reference materials to achieve program use, as specified in assessment instrument.

Applied Academics Competencies

Communications

1.0.2	Select and use appropriate reference sources and illustrative materials
1.0.4	Determine solutions to problems
1.0.6	Make predictions about information
1.0.8	Define words used in context
2.0.3	Record observations
2.0.4	Prepare written report(s)
2.0.9	Write legibly
2.0.13	Use correct grammar
2.0.14	Use correct spelling
2.0.15	Write complete sentences
3.0.1	Demonstrate effective listening skills
3.0.4	Identify sources of information
3.0.6	Follow directions
4.0.3	Participate in discussions
4.0.12	Use appropriate language

Applied Academics Competencies

Mathematics

1.2.1 Round and/or truncate numbers to designated place value
1.2.2 Computer and solve problems involving integers, fractions, decimals, and percentages using order of operations
1.2.3 Compare, order, and determine equivalence of real numbers (e.g., fractions, decimals, percentages)
1.2.4 Estimate, apply, and solve problems involving fractions, decimals, percentages, and real numbers
1.2.5 Set up, solve, and apply ratios and proportions
1.2.6 Solve problems and make application involving integers, fractions, decimals, percentages, ratios, and proportions
1.2.7 Translate written and/or verbal statements into mathematical expressions
1.2.8 Estimate answers
3.2.6 Use problem-solving techniques

Equipment, Supplies, References, and Other Resources

Equipment

1. computer terminal and printer
2. word processing, spreadsheet, and database software program
3. data disk
4. reference books, documentation
5. laboratory packets - agriculture related

References

Camp, William G., Moore, Gary E., Foster, Richard M., Moore, Barbara A., *Microcomputer Applications for Students in Agriculture*, The Interstate Printers & Publishers, Inc. Danville, IL

Situation

This activity is to be conducted with a class of Level I Agriscience students.

Directions for the Teacher	Teaching Procedures: Interest Approach/Teaching Methods
Use information on pages 8.0.10-4 through -6 and -7 (student copy). Use handouts on pages 8.0.10-8 through -17 included in this lesson plan.	**Procedure** 1. Define computer terminology. Using the vocabulary list on pages 8.0.10-13 through -15, define computer terminology. Add or delete appropriate terminology that would be applicable to your computer terminal and its software. 2. Start computer. Locate the power source, on/off switch for the monitor, CPU, and surge protector. 3. Save, store, and retrieve computer files. 4. Input information. 5. Process data. 6. Process data on screen. 7. Print. 8. How do you use documentation as a resource?

• **Four Question** •
Problem-Solving Technique

Question 1: How important is using a computer?

- The majority of all occupations use computers in some aspect.
-
-
-
-
-

Question 2: What problems have we had with using a computer?

- Don't understand computer terminology.
- Can't startup computer.
- Can't save, store, or retrieve files.
- Can't input information into computer.
- If I do get information into the computer I can't process the data.
- Can't produce desired output to screen.
- Can't print data.
- Don't understand how to use documentation or manuals.

Question 3: What do we need to know or be able to do in order to use a computer?

- Define computer terminology.
- Startup computer.
- Save, store, and retrieve computer files
- Input information into the computer.
- Process data.
- Process data on screen.
- Print.
- How to use documentation as a resource.

Question 4: What is the specific related information we need to know to use a computer?

Word Processing

- How do I create a new document?
- How do I type in text?
- How do I insert text?
- How do I select and delete text?
- How do I undo a mistake
- How do I save my work?
- How do I ask for help?
- How do I open a document?
- How do I scroll through a document?
- How do I move text with cut and paste?
- How do I copy text?
- How do I replace text?
- How do I search for text?
- How do I find text?
- How do I save my revisions?
- How do I make characters bold?
- How do I make characters larger?
- How do I center text?
- How do I print my work?
- How do I quit the program?

Spreadsheet

- How do I create a new worksheet?
- How do I open an existing worksheet?
- How do I select cells and move around a worksheet?
- How do I enter worksheet data?
- How do I edit worksheet data?
- How do I enter a formula?
- How do I use worksheet functions to simplify formulas?
- How do I save a worksheet?
- How do I close a worksheet window?
- How do I delete a worksheet?
- How do I move and copy data and formats?
- How do I insert cells, rows, and columns?
- How do I clear and delete cells, rows, and columns?
- How do I find and replace cells and data?
- How do I sort data?
- How do I format worksheet data?
- How do I align worksheet data?
- How do I change column width and row height?
- How do I print my worksheet?

Question 4: What is the specific related information we need to know to use a computer? *(continued)*

Database

- How do I create a new file?
- How do I open and close existing files?
- How do I save files?
- How do I quit the application?
- How do I name a field?
- How do I specify the type of information the field will hold?
- How do I create a formula to calculate and summarize fields?
- How do I arrange and format fields?
- How do I print records?
- How do I add information to my database?
- How do I edit information?
- How do I type or paste data into different fields?
- How do I find and sort information?
- How do I delete records and files?

• Four Question • Problem-Solving Technique
Question 1: How important is using a computer?
Question 2: What problems have we had with using a computer?
Question 3: What do we need to know or be able to do in order to use a computer?
Question 4: What is the specific related information we need to know to use a computer?

Crop Rotation Handout

Herbicides for four-year crop rotation on Case Study Farm

Field Number	Year	Crop	Acres	Weed Problem	Chemical Used	Rate Acre	Cost Unit	Unit Used	Gallons Needed	Cost Acre	Cost Field
1	1992	Soybeans	50	Foxtail	Prowl	2	$28.53	pints	6.25	$3.57	$178.31
	1993	Corn	50	Foxtail	Lariat	3	$18.01	quarts	37.50	$3.38	$168.84
	1994	Soybeans	50	Foxtail	Prowl	2	$28.53	pints	6.25	$3.57	$178.31
	1995	Corn	50	Foxtail	Lariat	3	$18.01	quarts	37.50	$3.38	$168.84
2	1992	Wheat	75	Canada Thistle					0.00	$0.00	$0.00
	1993	Hay	75	Canada Thistle					0.00	$0.00	$0.00
	1994	Hay	75	Canada Thistle					0.00	$0.00	$0.00
	1995	Hay	75	Canada Thistle					0.00	$0.00	$0.00
3	1992	Corn	55	Quackgrass	Roundup	1.5	$36.39	quarts	20.63	$13.65	$750.54
No-Till	1993	Soybeans	55	Quackgrass	Roundup	1.5	$36.39	quarts	20.63	$13.65	$750.54
No-Till	1994	Corn	55	Quackgrass	Roundup	1.5	$36.39	quarts	20.63	$13.65	$750.54
No-Till	1995	Soybeans	55	Quackgrass	Roundup	1.5	$36.39	quarts	20.63	$13.65	$750.54
4	1992	Corn	40	None Identified	Lariat	2.5	$18.01	quarts	25.00	$2.81	$112.56
	1993	Soybeans	40	None Identified	Prowl	1	$28.53	pints	2.50	$1.78	$71.33
			40		Preview	6	$31.16	ounces	1.88	$1.46	$58.43
	1994	Corn	40	None Identified	Lariat	2.5	$18.01	quarts	25.00	$2.81	$112.56
	1995	Soybeans	40	None Identified	Prowl	1	$28.53	pints	2.50	$1.78	$71.33
					Preview	6	$31.16	ounces	0.00	$1.46	$0.00
5	1992	Corn	75	Velvetleaf	Lariat	3	$18.01	quarts	56.25	$3.38	$253.27
	1993	Corn	75	Velvetleaf	Lariat	3	$18.01	quarts	56.25	$3.38	$253.27
	1994	Soybeans	75	Velvetleaf	Prowl	1.5	$28.53	pints	7.03	$2.67	$200.60
			75		Scepter 70DG	2.8	$92.64	ounces	1.64	$2.03	$151.99
	1995	Corn	75	Velvetleaf	Lariat	3	$18.01	quarts	56.25	$3.38	$253.27

Crop Budget Handout (part 1)

Field Number 5 - 75 Acres												
		Corn			Corn			Soybeans			Corn	
	Number	**Price**	**Total**	**Number**	**Price**	**Total**	**Number**	**Price**	**Total**	**Number**	**Price**	**Total**
	Amount	**Unit**	**Value/Cost**	**Amount**	**Unit**	**Value/Cost**	**Amount**	**Unit**	**Value/Cost**	**Amount**	**Unit**	**Value/Cost**
Estimated Returns	150	$2.63	$29,587.50	150	$2.63	$29,587.50	60	$5.99	$26,955.00	150	$2.63	$29,587.50
Total Returns												
Estimated Costs												
Land Rent	75	$90.00	$6,750.00	75	$90.00	$6,750.00	75	$90.00	$6,750.00	75	$90.00	$6,750.00
Seed	75	$22.50	$1,687.50	75	$22.50	$1,687.50	75	$8.75	$656.25	75	$22.50	$1,687.50
Herbicide	75	$3.38	$253.50	75	$3.38	$253.50	75	$4.70	$352.50	75	$3.38	$253.50
Fertilizer	75	$49.70	$3,727.50	75	$50.80	$3,810.00	75	$21.06	$1,579.50	75	$49.70	$3,727.50
Lime	75	$6.83	$512.25	75	$6.83	$512.25	75	$6.83	$512.25	75	$6.83	$512.25
Machinery Costs, Fuel, Trucking , Etc.	75	$75.00	$5,625.00	75	$75.00	$5,625.00	75	$69.00	$5,175.00	75	$75.00	$5,625.00
Drying	75	$0.20	$2,250.00	75	$0.20	$2,250.00	75	$0.00	$0.00	75	$0.20	$2,250.00
Interest 8.5%			$589.50			$591.83			$425.72			$589.50
Total Costs			$20,805.75			$20,888.25			$15,025.50			$20,805.75
Return to Labor and Management			$8,781.75			$8,699.25			$11,929.50			$8,781.75

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Crop Budget Handout (part 2)

Field Number 3 - 55 Acres		Corn			Soybeans			Corn			Soybeans	
	Number	Price	Total	Number	Price	Total	Number	Price	Total	Number	Price	Total
	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost
Estimated Returns	8250	2.63	$21,697.50	3300	$5.99	$19,767.00	8250	2.63	$21,697.50	3300	$5.99	$19,767.00
Total Returns												
Estimated Costs												
Land Rent	55	$90.00	$4,950.00	55	$90.00	$4,950.00	55	$90.00	$4,950.00	55	$90.00	$4,950.00
Seed	55	$22.50	$1,237.50	55	$8.75	$481.25	55	$22.50	$1,237.50	55	$8.75	$481.25
Herbicide	55	$13.65	$750.75	55	$13.65	$750.75	55	$13.65	$750.75	55	$13.65	$750.75
Fertilizer	55	$49.70	$2,733.50	55	$21.06	$1,158.30	55	$49.70	$2,733.50	55	$21.06	$1,158.30
Lime	55	$6.83	$375.65	55	$6.83	$375.65	55	$6.83	$375.65	55	$6.83	$375.65
Machinery Costs, Fuel, Trucking , Etc.	55	$75.00	$4,125.00	55	$69.00	$3,795.00	55	$75.00	$4,125.00	55	$69.00	$3,795.00
Drying	55	$0.20	$1,650.00	55	$0.00	$0.00	55	$0.20	$1,650.00	55	$0.00	$0.00
Interest 8.5%			$448.30			$326.14			$448.30			$326.14
Total Costs			$15,822.40			$11,510.95			$15,822.40			$11,510.95
Return to Labor and Management			$5,875.10			$8,256.05			$5,875.10			$8,256.05
Field Number 4 - 40 Acres		Corn			Soybeans			Corn			Soybeans	
	Number	Price	Total	Number	Price	Total	Number	Price	Total	Number	Price	Total
	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost
Estimated Returns	6000	$2.63	$15,780.00	2400	$5.99	$14,376.00	6000	$2.63	$15,780.00	2400	$5.99	$14,376.00
Total Returns												
Estimated Costs												
Land Rent	40	$90.00	$3,600.00	40	$90.00	$3,600.00	40	$90.00	$3,600.00	40	$90.00	$3,600.00
Seed	40	$22.50	$900.00	40	$8.75	$350.00	40	$22.50	$900.00	40	$8.75	$350.00
Herbicide	40	$2.81	$112.40	40	$3.24	$129.60	40	$2.81	$112.40	40	$3.24	$129.60
Fertilizer	40	$49.70	$1,988.00	40	$21.06	$842.40	40	$49.70	$1,988.00	40	$21.06	$842.40
Lime	40	$6.83	$273.20	40	$6.83	$273.20	40	$6.83	$273.20	40	$6.83	$273.20
Machinery Costs, Fuel, Trucking , Etc.	40	$75.00	$3,000.00	40	$69.00	$2,760.00	40	$75.00	$3,000.00	40	$69.00	$2,760.00
Drying	40	$0.20	$1,200.00	40	$0.00	$0.00	40	$0.20	$1,200.00	40	$0.00	$0.00
Interest 8.5%			$313.75			$225.40			$313.75			$225.40
Total Costs			$11,073.60			$7,955.20			$11,073.60			$7,955.20
Return to Labor and Management			$4,706.40			$6,420.80			$4,706.40			$6,420.80

Crop Budget Handout (part 3)

Field Number 1 - 50 Acres	Soybeans				Corn		Soybeans				Corn	
	Number	Price	Total	Number	Price	Total	Number	Price	Total	Number	Price	Total
	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost
Estimated Returns	2000	$5.99	$11,980.00	6000	$2.63	$15,780.00	2000	$5.99	$11,980.00	6000	$2.63	$15,780.00
Total Returns												
Estimated Costs												
Land Rent	50	$70.00	$3,500.00	50	$70.00	$3,500.00	50	$70.00	$3,500.00	50	$70.00	$3,500.00
Seed	50	$8.75	$437.50	50	$22.50	$1,125.00	50	$8.75	$437.50	50	$22.50	$1,125.00
Herbicide	50	$3.57	$178.50	50	$3.38	$169.00	50	$3.57	$178.50	50	$3.38	$169.00
Fertilizer	50	$29.30	$1,465.00	50	$14.03	$701.50	50	$29.30	$1,465.00	50	$14.03	$701.50
Lime	50	$15.28	$764.00	50	$15.28	$764.00	50	$15.28	$764.00	50	$15.28	$764.00
Machinery Costs, Fuel, Trucking , Etc.	50	$69.00	$3,450.00	50	$75.00	$3,750.00	50	$69.00	$3,450.00	50	$75.00	$3,750.00
Drying	50	$0.00	$0.00	50	$0.20	$1,200.00	50	$0.00	$0.00	50	$0.20	$1,200.00
Interest 8.5%			$277.53			$317.60			$277.53	50		$317.60
Total Costs			$9,795.00			$11,209.50			$9,795.00			$11,209.50
Return to Labor and Management			$2,185.00			$4,570.50			$2,185.00			$4,570.50
Field Number 2 - 75 Acres		Wheat			Hay			Hay			Hay	
	Number	Price	Total	Number	Price	Total	Number	Price	Total	Number	Price	Total
	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost	Amount	Unit	Value/Cost
Estimated Returns	3375	$3.75	$12,656.25	262.5	$80.00	$21,000.00	262.5	$80.00	$21,000.00	262.5	$80.00	$21,000.00
	1500	$1.00	$1,500.00									
Total Returns												
Estimated Costs												
Land Rent	75	$70.00	$5,250.00	75	$70.00	$5,250.00	75	$70.00	$5,250.00	75	$70.00	$5,250.00
Seed	75	$10.25	$768.75	75	$15.00	$1,125.00	75	$15.00	$1,125.00	75	$15.00	$1,125.00
Herbicide	75	$0.00	$0.00	75		$0.00	75		$0.00	75		$0.00
Fertilizer	75	$32.59	$2,444.25	75	$42.80	$3,210.00	75	$42.80	$3,210.00	75	$42.80	$3,210.00
Lime	75	$17.88	$1,341.00	75	$17.88	$1,341.00	75	$17.88	$1,341.00	75	$17.88	$1,341.00
Machinery Costs, Fuel, Trucking , Etc.	75	$50.00	$3,750.00	3.5	$30.00	$7,875.00	3.5	$30.00	$7,875.00	3.5	$30.00	$7,875.00
Interest 8.5%			$384.03			$532.70			$532.70			$532.70
Total Costs			$13,554.00			$18,801.00			$18,801.00			$18,801.00
Return to Labor and Management			$602.25			$2,199.00			$2,199.00			$2,199.00

Cattle Budget Handout

		Cattle	
	Number	Price	Total
	Amount	Unit	Value/Cost
Estimated Returns	100	$74.25	$89,100.00
Total Returns			
Estimated Costs			
Cattle	100	$101.00	$45,450.00
Feed	100	$322.83	$32,283.00
Buildings	100	$20.00	$2,000.00
Misc.	100	$5.00	$500.00
	100	$0.00	$0.00
	100	$0.00	$0.00
	100	$0.00	$0.00
Interest 8.5%			$2,557.43
Total Costs			$80,233.00
Return to Labor and Management			$8,867.00

COMPUTER SCIENCE VOCABULARY

ASCII. (AS-key) American Standard Code for information Interchange. A standard system for representing symbols, letters, and numbers in terms of eight bit bytes of 0's and 1's.

Back up. To make a second copy of programs or data to prevent loss.

Boot. To load the disk operating system (DOS), or computer application into the computer's RAM.

Bug. An error in a program.

Byte. A string of eight bits, used to represent a symbol, an operation, or a value.

CPU. Central processing unit.

Cursor. The blinking light on the screen that shows where the computer is focusing its attention.

Data base software. A program written to record, manipulate, reorder, and retrieve repeated sets of the same information on multiple individuals. An example is a mailing list program.

Directory. The list of programs or files on a diskette or drive.

Disk, diskette. A flat circle of plastic, coated wit n oxide, used to record and store magnetized spots.

Disk drive. A mechanical device used to allow a microcomputer to read from and write to a diskette.

Documentation. The printed instructions for using a software package or program. Also, explanatory lines written into a program, to assist other programmers in following the program's logic.

DOS. (doss) Disk operating system. The set of programs which provide the directions to the microcomputer to fully use the disk drive.

Dot matrix printer. A printer which has a print head containing a rectangular pattern of steel pins. Selected pins are driven forward, striking the ink ribbon, producing a pattern of dots to form a printed letter or other symbol.

Edit. To make changes in a file.

File. A set of data or program code having a specific meaning.

Graphics. The ability of a microcomputer to generate pictures, graphs, etc.

Hard copy. Printed output.

Hard disk. A metal disk used to store large quantities of information.

COMPUTER SCIENCE VOCABULARY

(continued)

Hard disk drive. A mechanical device used to allow a microcomputer to read from or write to a hard disk.

Hardware. The mechanical components of a microcomputer system.

Initialize. To prepare a diskette for use by a particular microcomputer and DOS. The disk drive first demagnetizes, then sets up tracks and sectors. Initialization may include the transfer of DOS onto the diskette.

Input. 1. *Verb*. To enter information into the computer's RAM. 2. *Noun*. The information entered.

Integrated software. Software having more than one major function and allowing the exchange and sharing of information between functions. An example is a program that uses a data management system and a word processing system to produce personalized letters to multiple addresses.

K, kilobyte. A unit for counting large numbers of bytes. One K = 1024 bytes but is usually taken to mean 1000 bytes, for ease of interpretation.

Keyboard. A mechanical device, like a typewriter, used to allow a microcomputer user to input letters, numbers, and other symbols directly into the RAM.

Laser printer. A printer which produces a very high-quality print, but which is still too expensive for most microcomputer users.

Letter-quality printer. A printer that operates like a typewriter. Produces high-quality print.

Load. To retrieve a file from the diskette, or other auxiliary storage, and place a copy into the RAM. The file remains on the storage device and only an exact copy is "loaded."

M, megabyte. Actually 1,048,576 bytes, generally considered 1 million bytes for ease of interpretation.

Memory. That part of the microcomputer's circuitry that can store either permanent or temporary instructions. RAM or ROM.

Menu. Within a program, a selection of options presented on the screen.

Menu-driven program. A program which mostly, or totally, uses a sequence of menus to lead the user through its various functions.

Microcomputer. A small computer having smaller memory and slower operating speed than the larger minicomputers and mainframe computers.

COMPUTER SCIENCE VOCABULARY

(continued)

Modem. MOdulator/DEModulator. A device used to allow a microcomputer to send or receive information along a telephone line. May be external or internal. May operate by producing sounds into a telephone receiver (acoustic) or electrical impulses into the telephone line (direct-connect).

Monitor. The device used to visually display computer output. Also **CRT** or **display**.

Mouse. A small, hand-held device for providing input to the microcomputer through movement along some surface, such as a tabletop.

Network. More than one computer connected together and communicating/sharing information.

Output. Information produced by the computer and transferred to some external device or medium for display or storage.

Password. A code word or other code that must be supplied by the user to the microcomputer, before he or she will be allowed to activate some function or have access to certain information.

Food Item Template

Group	Reference	Name	Grams	Tcal	Prot	%	Carb	%	Fat	%
1	11	Coke/Pepsi	370	151	0.1	0.3%	38.5	102.0%	0.00	0.0%
1	12	Diet Coke/Pepsi	355	2	0.1	20.0%	0.3	60.0%	0.00	0.0%
1	20	Brewed Coffee	240	2	0.1	20.0%	0.5	100.0%	0.01	4.5%
1	30	Brewed Tea	240	2	0.0	0.0%	0.5	100.0%	0.00	0.0%
2	35	Brie	28	95	5.9	24.8%	0.1	0.4%	7.85	74.4%
2	37	Cheddar Cheese	28	114	7.1	24.9%	0.4	1.4%	9.40	74.2%
2	45	Cottage Cheese Nonfat	145	123	25.0	81.3%	2.7	8.8%	0.61	4.5%
2	46	Cream Cheese	28	99	2.1	8.5%	0.8	3.2%	9.89	89.9%
2	55	Mozzarella	28	80	7.6	38.0%	0.9	4.5%	4.68	52.7%
2	59	Parmesan	28	129	11.8	36.6%	1.1	3.4%	8.51	59.4%
2	62	Ricotta	246	340	28.0	32.9%	12.6	14.8%	19.50	51.6%
2	65	American	28	106	6.3	23.8%	0.5	1.9%	8.86	75.2%
2	66	Swiss	28	95	7.0	29.5%	0.6	2.5%	6.98	66.1%
2	80	Sour Cream	14	30	0.4	5.3%	0.6	8.0%	2.93	87.9%
2	98	Skim Milk	245	86	8.3	38.6%	11.9	55.3%	0.44	4.6%
2	106	Instant Dry Milk - Mix	68	244	23.9	39.2%	35.5	58.2%	0.51	1.9%
2	114	Chocolate Milk Powder	21.6	75	0.7	3.7%	19.5	104.0%	0.70	8.4%
2	119	Malted Milk Powder	21	87	2.3	10.6%	15.9	73.1%	1.70	17.6%
2	124	Ice Cream - 1 cup	133	269	4.8	7.1%	31.7	47.1%	14.30	47.8%
2	148	Yogurt Nonfat	227	127	13.0	40.9%	17.4	54.8%	0.41	2.9%
3	150	Egg	50	79	6.1	30.9%	0.6	3.0%	5.60	63.8%
4	166	Margarine 1 Tbl	14.2	50	0.1	0.8%	0.1	0.8%	5.50	99.0%
4	180	Olive Oil 1 Tbl	14	125	0.0	0.0%	0.0	0.0%	14.00	100.8%
5	206	Apple	212	125	0.4	1.3%	32.0	102.4%	0.80	5.8%
5	209	Apple Juice 1 Cup	248	116	0.1	0.3%	29.0	100.0%	0.30	2.3%
5	211	Applesauce Unsweetened	244	106	0.4	1.5%	27.5	103.8%	0.10	0.8%
5	212	Applesauce Sweetened	255	195	0.5	1.0%	51.0	104.6%	0.50	2.3%
5	223	Banana	114	105	1.2	4.6%	26.7	101.7%	0.50	4.3%
5	239	Grapefruit	246	74	1.4	7.6%	18.8	101.6%	0.20	2.4%
5	252	Kiwi	76	46	0.8	7.0%	11.3	98.3%	0.30	5.9%
5	267	Orange	131	60	1.2	8.0%	15.4	102.7%	0.20	3.0%
5	271	Orange Juice	249	110	2.0	7.3%	25.0	90.9%	0.70	5.7%
5	277	Peach	87	37	0.6	6.5%	9.6	103.8%	0.00	0.0%
5	289	Pear D'Anjou	200	120	0.8	2.7%	30.0	100.0%	0.70	5.3%
5	313	Raisins	14	41	0.5	4.9%	11.1	108.3%	0.00	0.0%
5	318	Strawberries	149	45	0.9	8.0%	11.1	98.7%	0.60	12.0%
6	326	Bagel	68	200	7.5	15.0%	38.2	76.4%	1.75	7.9%
6	408	Fig Bars - 4	56	210	2.0	3.8%	42.3	80.6%	3.80	16.3%
6	419	Graham Crackres	14	60	1.0	6.7%	10.8	72.0%	1.50	22.5%
6	422	Saltine - 4	12	50	1.0	8.0%	9.0	72.0%	1.10	19.8%
6	424	Wheat Thin - 4	8	35	1.0	11.4%	5.0	57.1%	1.40	36.0%
6	434	English Muffin	50	140	4.5	12.9%	26.2	74.9%	1.10	7.1%
6	442	Pancake 1	27	60	2.0	13.3%	9.0	60.0%	2.00	30.0%
6	470	Pretzel	16	65	1.5	9.2%	12.8	78.8%	0.60	8.3%
7	491	Oatmeal 1 Cup	234	145	6.0	16.6%	25.2	69.5%	2.40	14.9%
7	505	Grape Nuts	57	202	6.6	13.1%	26.4	52.3%	0.20	0.9%

Food Item Template

Group	Reference	Name	Grams	Tcal	Prot	%	Carb	%	Fat	%
7	512	Raisin Bran	56	174	5.3	12.2%	42.9	98.6%	1.10	5.7%
7	539	Popcorn Air Popped	8	30	1.0	13.3%	6.0	80.0%	0.40	12.0%
7	545	Rice	165	180	3.6	8.0%	39.9	88.7%	0.20	1.0%
7	551	Pasta	130	190	6.5	13.7%	39.1	82.3%	0.65	3.1%
7	559	Flour White	125	455	13.1	11.5%	95.1	83.6%	1.20	2.4%
7	562	Whole Wheat Flour	120	400	16.0	16.0%	85.2	85.2%	2.40	5.4%
8	563	Clams	85	65	11.0	67.7%	0.2	1.2%	1.00	13.8%
8	583	Salmon Broiled	85	120	17.0	56.7%	0.0	0.0%	5.00	37.5%
8	587	Shrimp Boiled	100	109	23.8	87.3%	0.0	0.0%	1.50	12.4%
8	592	Tuna Water Packed	85	135	30.0	88.9%	0.0	0.0%	1.00	6.7%
9	597	Ground Beef	85	325	22.0	27.1%	0.0	0.0%	26.00	72.0%
9	623	Pork Loin	67	166	23.0	55.4%	0.0	0.0%	7.50	40.7%
10	646	Chicken Breast	86	142	26.7	75.2%	0.0	0.0%	3.00	19.0%
10	649	Chicken Stewed	140	248	38.2	61.6%	0.0	0.0%	9.40	34.1%
10	653	Turkey Light Meat	85	133	25.4	76.4%	0.0	0.0%	2.70	18.3%
13	720	Almonds	28	167	5.7	13.7%	5.8	13.9%	14.80	79.8%
13	726	Cashews	28	163	4.6	11.3%	8.1	19.9%	13.70	75.6%
13	728	European Chestnuts	143	350	4.5	5.1%	75.7	86.5%	3.10	8.0%
13	737	Mixed Nuts	28	166	4.8	11.6%	7.1	17.1%	14.40	78.1%
13	740	Peanuts	28	165	7.6	18.4%	5.2	12.6%	14.00	76.4%
13	743	Peanut Butter 1 Tbl	16	95	4.6	19.4%	2.5	10.5%	8.20	77.7%
13	747	Pistachio	28	164	5.9	14.4%	7.0	17.1%	13.70	75.2%
14	759	Chocolate	28	145	2.0	5.5%	16.0	44.1%	9.00	55.9%
14	773	Honey 1 Tbl	21	65	0.0	0.0%	17.4	107.1%	0.00	0.0%
14	776	Jelly	18	49	0.0	0.0%	12.7	103.7%	0.00	0.0%
14	779	Brown Sugar	28	98	0.0	0.0%	26.9	109.8%	0.00	0.0%
14	781	White Sugar	12	45	0.0	0.0%	12.0	106.7%	0.00	0.0%
15	802	Green Beans	136	26	1.6	24.6%	6.1	93.8%	0.10	3.5%
15	820	Broccoli Cooked	156	46	4.6	40.0%	8.7	75.7%	0.40	7.8%
15	832	Carrot	72	31	0.7	9.0%	7.3	94.2%	0.10	2.9%
15	838	Cauliflower Raw	50	12	1.0	33.3%	2.5	83.3%	0.00	0.0%
15	849	Corn	82	67	2.5	14.9%	16.8	100.3%	0.00	0.0%
15	853	Eggplant	160	45	1.3	11.6%	10.6	94.2%	0.40	8.0%
15	854	Garbanzo Beans	163	270	15.0	22.2%	45.0	66.7%	4.00	13.3%
15	868	Lettuce	56	10	0.5	20.0%	2.0	80.0%	0.10	9.0%
15	879	Onions Chopped	160	54	1.9	14.1%	11.7	86.7%	0.40	6.7%
15	891	Peas	80	63	4.1	26.0%	11.4	72.4%	0.20	2.9%
15	899	Baked Potatoes	202	220	4.7	8.5%	51.0	92.7%	0.20	0.8%
15	906	Boiled Potatoes	135	116	2.3	7.9%	27.0	93.1%	0.10	0.8%
15	907	Baked French Fries	50	110	1.7	6.2%	21.0	76.4%	2.00	16.4%
15	908	Fried French Fries	50	158	2.0	5.1%	19.8	50.1%	8.30	47.3%
15	911	Mashed Potatoes	210	222	4.0	7.2%	35.1	63.2%	8.90	36.1%
15	946	Tomatoes	123	24	1.1	18.3%	5.3	88.3%	0.30	11.3%

Helping Students Apply Concepts/Principles/Skills

Evaluating Student Learning

After completing this activity, have students record their observations on pages 8.0.10-19 and-20.

This activity was submitted by Steven Gratz, Supervisor, Applied/Correlated Academics and Intervention, Division of Vocational and Career Education, Ohio Departments Buildings, 65 S. Front Street, Columbus, OH 43266-0308

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Data Record and Observation Sheet

Title ____

Name ______________________________ Date __________ Period ________

Objective(s) ______________________________________

____

PLAN	ACTUAL
Experimental Design	**Procedure**

PLAN	ACTUAL
Hypothesis	Results

NOTES

Conclusions

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