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This resource guide was prepared to offer teachers and supervisors practical suggestions for the teaching of science to the pupils in the Career Guidance Program. The material presented parallels, as closely as possible, the regular science program for grade nine. However, many of the basic concepts and skills were drawn from the seventh year and eighth year regular science curricula. Material in this guide covers three science areas: chemistry, physics, and biology. Emphasis has been placed on providing the pupils with experiences in the manipulation and use of science materials rather than on classroom discussions of theory and teacher demonstrations. It is recommended that the three science areas included be taught in sequence as the concepts and skills developed in each area are designed to provide the pupils with the knowledges and skills required for the development of material in subsequent areas. Material in each area has been presented in the form of daily lesson plans. Each lesson is presented in the form of a problem, followed by a list of required materials and a suggested procedure. (BC)

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Career Guidance Series

RESOURCE MATERIAL FOR TEACHERS

Science

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CAREER
GUIDANCE
SERIES

Science

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- FOREWORD -

In an age of great scientific and technological advances it is paramount for us to prepare our young people for the demands and opportunities of our changing society. The task becomes truly challenging when we are dealing with the pupils in the Career Guidance Program.

This teaching guide capitalizes on the natural curiosity of young people to lead them to explore, search for, and discover scientific ideas. The material presented concentrates less on theory and more on experimentation with the hope that it will enkindle in these pupils an interest and a desire for further development and training in the area.

JOSEPH O. LORETAN
Deputy Superintendent of Schools

July, 1966

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THE CAREER GUIDANCE PROGRAM

The Career Guidance Program grew out of a deep concern on the part of the Junior High School Division for the many pupils who were over-age, frustrated, retarded in most school subjects, and indifferent to education. The typical pupil in this group has a poor self-image, few or no aspirations either academic or vocational, and is biding his time until he can drop out of school.

During the school year 1957-1958, Dr. Joseph O. Loretan, Deputy Superintendent of Instruction and Curriculum Division*, and Dr. Morris Krugman, Associate Superintendent of the Division of Child Welfare **, and five selected and interested principals worked on a plan and structure to create a program for these potential dropouts. In September 1958, six classes were organized in the 7th, 8th and 9th grades of five junior high schools. It was hoped that with specialized and intensive guidance and a curriculum centered around the world of work these pupils would remain in school and be infused with a desire to set higher educational goals for themselves.

In each of these schools a teacher was designated curriculum coordinator to work with the other teachers of these experimental classes to prepare special materials. Most of the schools used the core approach. A job area was chosen as the center of learning, e.g., Garment Trades, Food Handling, etc. All instruction in the various subject areas served to develop and to extend the learnings connected with the particular job area chosen. In September 1960, the Junior High School Division appointed a Job-Placement Supervisor to provide part-time employment for youngsters who wanted to earn money while in school.

This experiment was expanded to include a total of twenty-four junior high schools in September 1962 and thirty junior high schools in February 1963. The program now was organized in the 9th grade, since this was the terminal year of the junior high school and it was at this time that young people had to make a serious decision: Should they go on to high school or should they go to work? Therefore, a concentrated effort had to be made at this point to raise their educational and vocational aspirations if these pupils were to be motivated to seek higher learning. The program was introduced into the junior high schools that requested it. It comprised a unit of three classes, each with a maximum register of fifteen pupils. A full-time advisor was assigned in each school to meet with each class for group guidance twice a week and with every pupil individually at least once a week. An industrial arts teacher was also assigned full-time to instruct the pupils in pre-vocational and avocational skills.

* formerly Associate Supt. J.H.S. Div.
** now retired

Three years of experimentation and a study of similar programs throughout the nation showed that a new teaching approach was essential in every subject area, if these youngsters were to be rehabilitated and redirected. Adaptations or "watered-down" versions of the traditional curriculum without a modified approach presented learning situations which were only too familiar and were filled with the failures and frustrations of the past. It was also evident that once these pupils had spent some time in a Career Guidance class they began indicating that they no longer wanted to go to work; they now wanted to prepare themselves for high school.

Thus, in February 1963, a team of specialists in each of the curriculum areas began to work on specially-designed teaching guides in guidance and job placement, language arts, speech, social studies, science, mathematics and industrial arts. To prepare these guides the curriculum specialists visited each of the schools that had been in the Career Guidance Program from two to five years and studied the teacher-prepared materials in use, observed and conferred with the pupils in the classes, and interviewed the teachers and supervisors to become oriented with the pupils' backgrounds, aspirations, cultures, interests, and needs. Workshop committees composed of teachers, advisors, and assistant principals were organized to work with each curriculum specialist. As the teaching material was developed it was tried out experimentally in selected schools and evaluated.

By September 1963, teaching guides in seven subject areas were made available in mimeograph form to all the schools in the program. The subject matter developed departed largely from the job-centered themes and concentrated on the skills and subject matter necessary for further study in high school; less on theory and more on the functional and manipulative aspects of each subject area so as to present the pupils with true-to-life problems and situations. Beginning September 1963, the area of Office Practice was included to equip the pupils with immediate saleable skills for obtaining part-time jobs and to motivate them toward further vocational work in high school.

Through a continuous program of evaluation by teachers, supervisors, and curriculum consultants, the teaching guides were revised and extended and the present series evolved: Guidance and Job Placement, Language Arts, Mathematics, Social Studies I, Social Studies II, Social Studies III, Speech, Science, Industrial Arts, and Office Practice.

In September 1965, with the reorganization of the schools in New York City, the 8th grade became the terminal grade in some junior high schools. Thus, the Career Guidance Program was placed in the 8th grade of seventeen of these schools. At present there is a total of fifty-two schools in the Career Guidance Program.

C O N T E N T S

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ACKNOWLEDGEMENTS

This resource guide was prepared under the general direction of Max Rubinstein*, Assistant Superintendent, Junior High School Division, with the cooperation of Martha R. Finkler**, Acting Associate Superintendent, Junior High School Division. Irving Anker who was appointed Staff Superintendent, in February 1966, Office of Junior High Schools, has encouraged this project with his deep interest and cooperation.

Gida Cavicchia, Coordinator of the Career Guidance Program, served as project director with the cooperation of Willia Peace, Coordinator of Pupil Personnel of the Career Guidance Program.

Alice Pataky***, Junior High School Science Coordinator, planned, organized and was the principal writer of the original manual which was prepared during the school year 1962-1963, with the assistance of teachers of science in the Career Guidance Program: Edward Hom, J-136,X; Alfred Molini, J-136,K; and Martin Zung, J-55,X. Others who made contributions were: Paul Kahn, Julius Schwartz, Peter Greenleaf and Howard Sassone.

After three years of try-out and evaluation, the material was revised during the summer of 1966 by a committee of teachers and supervisors. The committee included Joyce Cherry, J-118,M; Stanley Leibowitz, J-265,K; and Jerome Levy, J-294,K. Alice Pataky acted as chairman and coordinated the work of the committee. Others who provided suggestions and advice were: Louis Weiss, Chairman of Chemistry and Biology, Brooklyn Technical High School, and Max Kohn, Chairman of the Industrial Processes Department, Brooklyn Technical High School.

Sam Schenberg, Director of Science; Sam Fried, Acting Assistant Director; and Alfred Beck, former Assistant Director of Science, served as consultants.

* now Dist. Supt., Dist. #29,Q.
** retired
*** now Asst. Principal, J-265,K.

Special thanks are extended to members of the Bureau of Curriculum Research: William Bristow, Assistant Superintendent, and Leonard Simon, Acting Assistant Director.

Elena Lucchini designed the cover.

Maurice Bassecher, Editor, had over-all responsibility for design and production.

The material was typed for photo offset by Mildred Bradt.

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Manhattan	- J-3, J-13, J-22, J-43, J-44, J-88, J-99, J-115, J-118, J-120, J-139, J-164
Bronx	- J-22, J-55, J-98, J-118, J-133, J-136, J-142
Brooklyn	- J-33, J-49, J-50, J-64, J-126, J-136, J-166, J-210, J-263
Queens	- J-16, J-142

INTRODUCTION

This resource guide was prepared to offer teachers and supervisors practical suggestions for the teaching of science to the pupils in the Career Guidance Program. The material presented parallels as closely as possible the regular 9th-Year Science curriculum. However, since many of the pupils in the Career Guidance Program do not have the necessary background in science to start the advanced work of the 9th-Year, many of the basic concepts and skills were drawn from the 7th-Year and 8th-Year regular science curricula.

The material in this guide covers only three science areas: Chemistry, Physics, and Biology. Earth Science, which is also included in the regular 9th-Year course of study was omitted because it would be impossible to cover four areas in the one year the pupils spend in a Career Guidance class. Emphasis has been placed on providing the pupils with many experiences in the manipulation and use of science materials rather than on classroom discussions of theory and teacher demonstrations. With this in mind, many of the lessons include a pupil worksheet designed to engage pupils in laboratory experiences.

The three science areas included in this guide should be taught in the sequence presented: Chemistry, Physics, and Biology for optimum results, as the concepts and skills developed in each area are designed to equip the pupils with the knowledges and skills required for the development of material in the subsequent areas. The material in each area has been presented in the form of daily lesson plans. Each lesson is presented in the form of a problem, followed by a list of required materials and a suggested procedure. The lessons of each of the areas should be taught consecutively, since the sequence of presentation is developmental.

It is recommended that the teacher acquaint himself with each lesson well in advance of presentation for the purpose of securing the materials suggested and becoming familiar and proficient with their use. It is also suggested that the out-of-license and inexperienced teachers consult with the regular science teachers and laboratory assistant of the school for assistance in special teaching techniques and handling of special equipment.

If pupil ability and interest warrant it, and time permits, the teacher may present further lessons as presented in the 9th-Year science course of study.

PROBLEM 1. HOW AM I LIKE A BURNING CANDLE?

OUTCOMES:

Gases from a candle and exhaled air contain carbon dioxide and water.
The gas that turns limewater milky is carbon dioxide.
A chemical change results in one or more new substances being formed.
Chemists use symbols and formulas for clarity and brevity.

MATERIALS:

test tubes
rubber tubing
tanks or other samples of gases
also see pupil worksheets

PROCEDURE:

1. Ask the class if they think there could be any similarity between them and burning candles.
2. Distribute pupil materials. Read instructions together. Be sure to set up proper procedure for distribution and collection of materials.
3. Demonstrate proper way to light a match - striking away from you and closing cover.
4. Circulate as the children are working and offer suggestions as needed.
5. When pupils have completed the activities and returned equipment demonstrate that limewater is a test for carbon dioxide by bubbling several gases through limewater in individual test tubes. You might use air, nitrogen, oxygen, etc. Point out the reaction only occurs when carbon dioxide is present.
6. Write on the chalkboard:
   $$\text{limewater} + \text{carbon dioxide} \xrightarrow{\text{makes}} \text{chalk} + \text{water}$$
7. Explain that a chemical change took place and that new substances were formed.
8. Introduce chemical symbols by asking children to write "carbon dioxide" as fast as possible. At the same time write CO_2 on the board.
9. Elicit the obvious advantage that this notation saves time. Explain also that the symbols are international and can be understood regardless of the language spoken.
10. Give the pupils symbols C for carbon, O for oxygen, H for hydrogen.
11. Write the formulas, $Ca(OH)_2$ for limewater, $CaCO_3$ for calcium carbonate or chalk, H_2O for water.
12. Explain that they will be using symbols occasionally and that they should know some of the common symbols and formulas.
13. Assist children in answering the questions on their worksheets.

PUPIL WORKSHEET

PROBLEM 1. How am I like a burning candle?

MATERIALS:

limewater	metal tray
test tube	candle
straw	matches
glass plate	

WHAT TO DO:

1. Fill a test tube $\frac{1}{4}$ full with limewater. Using the straw, blow gently into the limewater.
2. The limewater ______________________________
3. Exhale (breath out) onto the glass plate.
4. What happened?______________________________
5. Stand your candle in the tray following the teacher's directions on how to make it stick. Light the candle.
6. Quickly pass the glass plate over, but not touching, the flame.
7. What happened to the glass plate?______________________________
8. Place a bottle upside down over the burning candle until the flame goes out.
9. Quickly turn the bottle over and add some limewater. Gently shake the bottle to mix contents.
10. Write what happened. ______________________________

QUESTIONS TO ANSWER:

1. What happened when you exhaled into limewater? ____________________
2. What happened when gases from a burning candle were mixed with limewater?

   ____
3. What gas is known by its reaction with limewater? ____________________
4. Why can limewater be called a "test for carbon dioxide"? ______________
5. What other substance was given off by breathing and burning? __________
6. What is the easy way to write carbon dioxide? ____________________
7. What is the easy way to write water?____________________

PROBLEM 2. HOW CAN WE USE THE CHEMICAL, IODINE, TO TEST FOODS?

OUTCOMES:

Iodine changes to a blue-black substance when it comes in contact with starch.
This reaction is a chemical change.

MATERIALS:

See pupil worksheet. Prepare for class:

Lugol's solution	-	iodine solution
glucose or dextrose	-	simple sugar
corn or olive oil	-	fat
cornstarch or flour	-	starch
2% peptone or beef broth	-	protein

PROCEDURE:

1. Distribute pupil worksheets and materials.

2. Read directions with the pupils. Assist with proper techniques of pouring, mixing, etc.

3. Answer the questions on the worksheet with the class.

4. Explain that the substances they used are substances found in foods. Show a chart of the nutrients. Point out that there are several different vitamins and minerals.

5. Define nutrients as chemical substances found in foods that are necessary for good health.

6. Have children start a chart:

NUTRIENT	TEST	CHANGE SEEN
Starch		

PUPIL WORKSHEET

PROBLEM 2. How can we use the chemical, iodine, to test foods?

MATERIALS:

test tube rack	rice	fat or oil
7 test tubes	starch	water
iodine (poisonous!)	sugar	mineral (salt)
bread	protein	vitamin C tablet

WHAT TO DO:

1. Place a small amount of each of the nutrients named into a test tube, a different substance in each tube.

2. Add an equal amount of water to each tube. Put your thumb over each tube and shake it. Clean off your thumb each time so you do not make your mixture impure.

3. Add 4 drops of iodine solution to each test tube. Shake and add more iodine if necessary.

4. Tell what happened in each test tube:

SUBSTANCE	COLOR MADE
sugar	
starch	
protein	
water	
fat	
mineral	

5. What substance was present in the tube where there was a big color change? ____________

6. Now add a few drops of iodine solution to bread. What happened?
____

7. Add iodine to rice. What happened? ____________

8. What substance was present in both bread and rice? ____________

QUESTIONS TO ANSWER:

1. Iodine shows the presence of ____________
2. Iodine can be called a TEST FOR STARCH because ____________
3. The color change shows us a ____________ change took place.
4. A chemical change has taken place when ____________

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PROBLEM 3. HOW CAN WE FIND OUT IF A FOOD HAS SUGAR IN IT?

OUTCOMES:

Benedict's solution (blue) when heated with a simple sugar changes color. This color change shows that a chemical change took place. The degree of color change is an indication of the amount of sugar present: from green to yellow, to orange, to brick red.

MATERIALS:

7 test tubes in rack
alcohol lamp
matches
nutrients listed in previous lesson
see pupil worksheet
test tube holder

PROCEDURE:

1. Set up 7 test tubes, each containing a pure nutrient as listed yesterday.

2. Add about one-half inch of Benedict's solution to each tube. Demonstrate proper way to light an alcohol lamp. (Be sure lamp is on tray and that you don't hold the lamp as spilled alcohol will burn outside the lamp.)

3. Heat each test tube carefully, shaking gently, and being sure the mouth is pointed away from all people.

4. The contents in each tube will remain blue except for the one containing simple sugar which turns brick red. (Be sure you have not used sucrose or table sugar.)

5. Distribute materials and worksheets.

6. When the children have finished, review results with them.

NOTE: Lemon, although it contains much sugar, tastes sour because of its high acid content.)

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PUPIL WORKSHEET

PROBLEM 3. How can we find out if a food has sugar in it?

MATERIALS:

test tube rack with several test tubes
alcohol lamp
test tube holder
tray
foods to be tested, such as, lemon juice, onion, banana, egg white, carrot, etc.

WHAT TO DO:

1. Place a small amount of each food in separate test tube.

2. Add an equal amount of Benedict's solution to each tube.

3. When you are ready raise your hand so the teacher can help you to light the lamp and check that you heat the tube the right way. NEVER POINT A HEATED TEST TUBE AT ANYONE.

4. Heat contents of tube carefully so hot liquid does not spill out.

5. Fill out the chart:

FOOD	COLOR OF BENEDICT'S SOLUTION BEFORE HEATING	AFTER HEATING	IS SUGAR PRESENT?

QUESTIONS TO ANSWER:

1. What special food substance does Benedict's solution find?

____

2. Why is Benedict's solution when heated called a TEST FOR SUGAR?

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PROBLEM 4. WHAT ARE THE TESTS TO FIND PROTEINS AND FATS IN FOODS?

OUTCOMES:

Biuret solution turns purple or violet when protein is present.
A translucent or "greasy" spot on a brown paper bag is a positive test for fat.

MATERIALS:

brown paper bag
corn or olive oil
margarine
see pupil worksheet
a fatty food such as a doughnut
chart of nutrients

PROCEDURE:

1. Review the meaning of "food test."
2. Write the word "Biuret" * on the board. Tell the pupils how to pronounce it. Tell them that this substance is used to test for protein.
3. Distribute materials and worksheets. Assist pupils as they work.
4. When materials have been collected, turn to a wall chart of the nutrients and look for fats. Determine with the children that oil and margarine are mainly fats. Place some oil and some margarine on the brown paper. Hold the paper up to the light to see the characteristic translucent stain.
5. Test a food for its fat content. A fried food will show good results.
6. Explain that the stain does not "dry" up. Point out that in some parts of the world today and in years past "windows" were made this way to admit some light into dwellings.
7. Go over the questions on the pupil worksheets.
8. Review all the tests done so far. Remind the children to fill data on their charts started two lessons ago.

* To prepare Biuret solution: Mix 2.5 cc. of 3% copper sulfate solution with 100 cc. of a 10% sodium hydroxide. Prepare fresh as it deteriorates in about 24 hours.

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PUPIL WORKSHEET

PROBLEM 4. What are the tests to find proteins and fats in foods?

MATERIALS:

Biuret solution
test tubes
test tube rack
test tube with protein
test tube with egg white
another food brought in from home

WHAT TO DO:

1. Add 10 drops of Biuret solution to the protein.

2. What color is present? ________________

3. Place a piece of hard cooked egg white in a test tube. Add 10 drops of Biuret solution.

4. What color is in the tube? ________________

5. This showed that the egg white contained ________________.

6. Repeat the test on another food that you brought in. I tested ______________. It (did, did not) contain protein. I knew this because ________________.

7. Return your equipment and watch the teacher do the test for fat.

8. The fat made ________________________ that did not dry up. How long did the spot remain? ________________

QUESTIONS TO ANSWER:

1. What is present in foods that leave a grease spot on paper? __________

2. What are proteins, fats and other substances found in foods called? ________________________

3. What is the meaning of translucent?

4. How could you tell if rice contained protein?

PROBLEM 5. HOW CAN WE TEST FOR OTHER SUBSTANCES FOUND IN FOODS?

OUTCOMES:

The blue chemical, Indophenol, becomes clear when Vitamin C is added.

If a sample of food is burned as completely as possible, the ash remaining is the mineral content of the food. This test only shows that there are minerals in the food, but does not tell which minerals are present.

Heating a food causes the water in the food to evaporate. As the water is cooled again it forms droplets of water that we can see.

MATERIALS:

see pupil worksheets

PROCEDURE:

1. Explain that there are many different vitamins and minerals, and that a separate test is required to identify each.

2. Distribute pupil worksheets and trays of materials. Caution the class not to touch the materials until told.

3. Identify the materials in the tray. Read and explain the test for Vitamin C*. Then have the class do the procedures on the worksheet.

4. Repeat this method with the tests for minerals and water.

5. After the pupils have obtained a mineral ash from the peanut, explain that there are many chemicals called minerals. The ash they see is a mixture of several different chemicals.

6. Have children complete their charts.

*NOTE: If the pupils obtain a pink color when they test for Vitamin C, explain that this is only temporary and is of no importance. The turning of the indophenol from a blue color to colorless is the test. Sometimes the pink color will not appear.

PUPIL WORKSHEET

PROBLEM 5. How can we test for other substances found in foods?

MATERIALS:

- Vitamin C pill
- Indophenol
- peanut
- test tubes and rack
- test tube holder
- matches
- alcohol burner
- asbestos pad
- tongs
- dropper
- celery

WHAT TO DO:

Test for Vitamin C

1. Put a Vitamin C pill in a test tube. Dissolve it in water.
2. In another test tube put one inch of indophenol.
3. Add Vitamin C to the indophenol one drop at a time.
4. What happened to the contents of the tube? ______________________

Test for minerals

5. Put the alcohol burner on the asbestos pad. Light it.
6. Pick up a peanut with the tongs and hold it in the fire for 3 minutes.
7. Put the peanut and the tongs on the asbestos to cool.
8. What happened to the peanut?

Test for water

9. Put some water in a test tube.
10. Heat the bottom of the tube. What do you see toward the top of the test tube?____________________
11. Put some celery in a DRY test tube.
12. Repeat procedure in 10.
13. What did you observe? ______________________

QUESTIONS TO ANSWER:

1. The indophenol is a ____________________color.

2. I added Vitamin C to the indophenol. The color changed from a

   ________________ color to ____________________color.

3. A food is heated for a short time to see if it contains

   __________________________.

4. What are we trying to find when we heat a food for a long time?

   ____

PROBLEM 6. WHAT SUBSTANCES ARE FOUND IN FOODS?

OUTCOMES:

Foods contain certain necessary materials called nutrients.
The nutrients are: carbohydrates (starch and sugar), proteins, fats, minerals, vitamins and water.

MATERIALS:

food charts for pupil distribution

PROCEDURE:

1. Have pupils check charts and name the nutrients while you list them on the chalkboard.
2. Tell pupils to use their charts to answer the questions on their worksheets.
3. When pupils have finished, go over the questions with them.
4. Define the word NUTRIENT and review the list of nutrients.
5. Point out that each nutrient is needed for a specific reason and that each one is necessary.
6. Tell the children to bring in foods to test tomorrow.

PUPIL WORKSHEET

PROBLEM 6. What substances are found in foods?

MATERIALS:

Food chart

WHAT TO DO:

Use your food charts to answer the following questions:

1. Name three foods that have a lot of sugar.

2. Name three foods that have a lot of starch.

3. Which foods have a lot of protein?

4. Which foods have a lot of fat?

5. Which foods have no water?

6. Which foods have a lot of water?

7. Why is milk such a good food?

8. Which substances are found in milk?

9. Which substances are found in coffee?

10. Which foods are made of only one chemical substance?

PROBLEM 7. HOW CAN WE ANALYZE SOME OF THE FOODS THAT WE EAT?

OUTCOMES:

The nutrients we need are not found in every food.

Most foods contain more than one nutrient.

MATERIALS:

see pupil worksheet and materials in Problems 2 - 6

PROCEDURES:

1. Distribute worksheets and materials.
2. Remind pupils to follow procedures given in problems 2 - 6.
3. After pupils have tested their foods, have them report results for class comparison.
4. Compare the class results with nutrient charts.

PUPIL WORKSHEET

PROBLEM 7. How can we analyze some of the foods that we eat?

MATERIALS:

Benedict's solution
Iodine
Biuret solution
Indophenol
test tubes and rack
test tube holder
droppers
bread
worksheets for problems 2 - 6
brown bag paper
alcohol burner
matches
tongs
ring stand
test tube clamp
glass plate
foods brought from home

WHAT TO DO:

1. Follow the procedures given in problems 2 - 5 to test bread for each nutrient.

2. Write YES in the space on the chart if you find a food chemical. Write NO if you do not find it. An orange has been tested and results listed.

3. Test the foods you brought from home.

4. Write the name of the food on the chart. Put YES in the space if the food has the chemical, write NO if it does not.

FOOD	STARCH	PROTEIN	VITAMIN C	FAT	SUGAR	WATER	MINERALS
Orange	no	no	yes	no	yes	yes	yes
Bread							

QUESTIONS TO ANSWER:

1. What are the chemicals you found in foods called? ____________________

2. Did any food have all the chemicals you need? ________________________

PROBLEM 8. WHAT IS MATTER?

OUTCOMES:

Matter takes up space and has weight.
Air is matter although it can't be seen.
To see if something fits a definition, compare the characteristics stated with the characteristics of the object.

MATERIALS:

plastic bag	2 flasks	glass and rubber tubing
balanced stick	one-holed stoppers	string
see pupil worksheet		

PROCEDURE:

1. Explain that scientists say that anything that takes up space and has weight is called matter.

2. Write MATTER on the board.

3. Show the class various liquids and solids and say, "Is this matter?" "Why?"

4. Wave a plastic bag to collect some air in it. Hold opening closed and allow pupils to feel that there is something in the bag.

5. Ask, "How can you find out if air can be called matter?" Elicit that it must take up space and have weight to be called matter.

6. Demonstrate that air has weight by doing the following:

   Tie strings around the necks of two large flasks with single-holed stoppers and tubing. Suspend the flasks from each end of a yard stick or meter stick. Suspend the center of the stick from a support, and find the point at which the flasks just balance each other. Pump out air from one flask. Clamp tube closed and place it at the same spot on the stick. The class will observe that this flask is now lighter and the stick dips down on other side.

7. Elicit that the loss in weight was due to the air you removed and that air has weight.

8. Caution the class not to touch the materials. Distribute trays of materials and pupil worksheets.

9. Help the pupils identify materials and label the diagram.

10. Read and demonstrate each step.

    CAUTION: Show how to insert the funnel and glass tube into the rubber stopper and tubing. The glass and rubber must be moistened with water to reduce friction. A gentle twisting motion should be used and pressure should be applied as close as possible to the end of the funnel or tubing being inserted into the stopper.

PUPIL WORKSHEET

PROBLEM 8. Does air take up space?

MATERIALS:

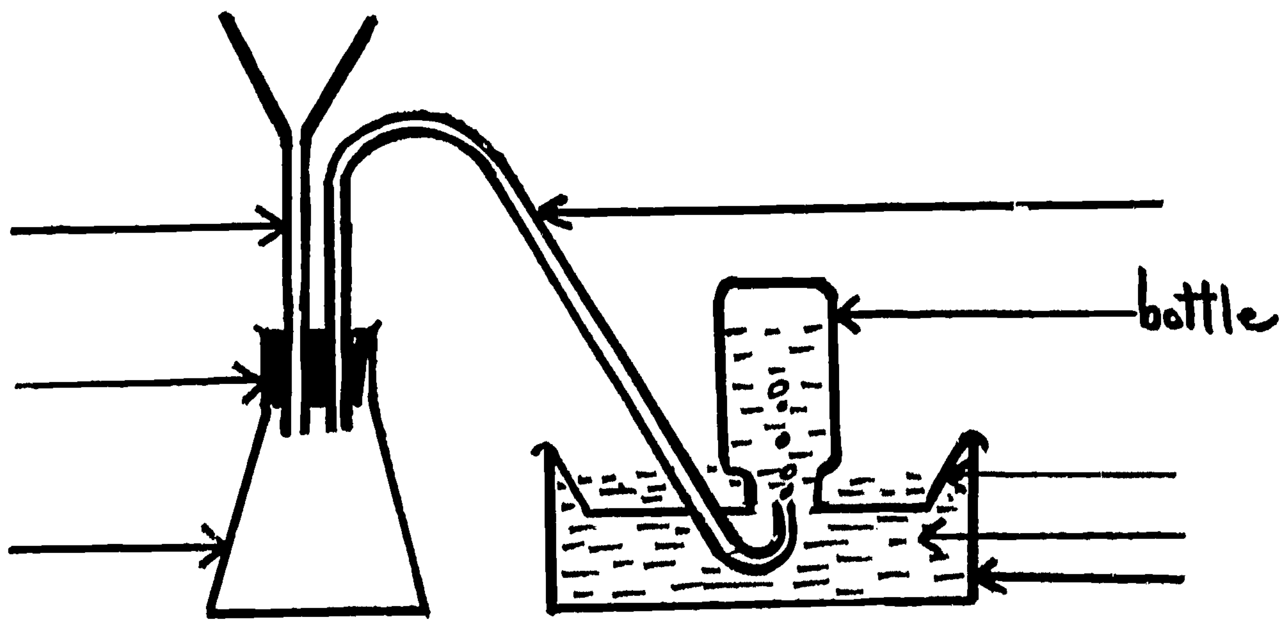
funnel	pinch clamp	flask
2-holed stopper	ring stand	clamp
rubber tubing	bottle	water
glass tube	tray	

WHAT TO DO:

Read the whole procedure before starting.

1. Look at your materials. Look at the drawing below.

2. Put the name of the part near the arrow that points to that part. One name has been written for you.



3. You will set up your experiment as in the drawing.

4. Make sure the pinch clamp is tight.

5. Fill the tray with water.

6. Fill the bottle to the top with water, hold the glass plate on top and turn bottle over.

7. Put the bottle in the tray mouth down.

8. Put the rubber tube into the bottle. DO NOT LIFT THE BOTTLE ABOVE THE WATER IN THE TRAY. The water in the bottle will come out.

9. Pour water into the funnel.

10. Open the pinch clamp and observe.

QUESTIONS TO ANSWER:

1. What did you see when water went into the funnel?

____

____

2. The pinch clamp did not let the _____________ in the flask go into the bottle.

3. The water in the bottle went down because the __________ in the flask went through the ____________________ and pushed the ________ out. This shows that air takes up _____________.

4. How do you know that air is matter?

____

HOMEWORK:

Put an (X) near things that are matter.

Example: wood ___X___

a. table ________

b. a very small piece of sugar ________

c. noise ________

d. water ________

e. a shadow ________

f. dust ________

g. iron nail ________

h. heat ________

i. air ________

j. steam ________

ERIC

PROBLEM 9. HOW SMALL CAN MATTER BE?

OUTCOMES:

Matter is composed of invisible particles.
These particles are in motion.

MATERIALS:

sugar	dropper
dilute ammonium hydroxide	1000 ml. graduated cylinder
copper sulfate	glass slide
microscope or microprojector	see pupil worksheet

PROCEDURE:

1. Have the class watch you dissolve some sugar in water.

2. Ask some students to examine the sugar solution and tell you if they can see the sugar.

3. Display a microscope or microprojector and elicit that this instrument makes objects larger.

4. Put a few drops of sugar solution on a slide and let the class observe them under the microscope.

5. Ask, "How do you know that the sugar is still there?" Elicit that they saw you add the sugar and that they would be able to taste it.

6. Elicit that the sugar breaks up into very small particles that can't be seen with the naked eye or a microscope.

7. Distribute trays of materials and pupil worksheets.

8. Explain that the graduated cylinder is similar to a measuring cup. They both tell how much space a material occupies.

9. When the pupils have finished, do the following demonstration:

   Display cylinder with 40 ml. of sugar and another with 40 ml. of marbles. Identify the marbles as representing water. Pour the sugar into the cylinder with the marbles, and have a student read the final volume. Elicit that the sugar particles filled the spaces between the water particles. Therefore, the volume of the sugar and water mixture is less than the sum total of each component.

10. Show how to smell a material correctly by waving the hand over the mouth of the test tube toward you. Caution the class never to put their noses into the test tube because the material might be poisonous and they could get a lethal dose. Smell a tube of cologne or ammonia or other substance with an odor. Particles move so you smell them.

11. Demonstrate that matter is composed of small particles that move in another way.

    Drop a small crystal of copper sulfate into a large graduated cylinder of water.
    Set on a high shelf to stand for about one month to observe diffusion.

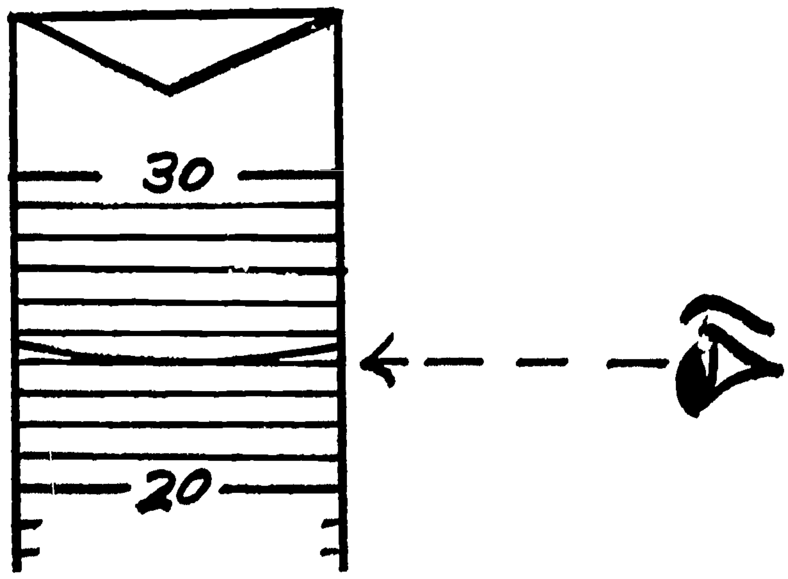
PUPIL WORKSHEET

PROBLEM 9. How small can matter be?

MATERIALS:
2 - 100 ml. graduated cylinders water
sugar

WHAT TO DO:
1. Pour a little water into a graduated cylinder.

2. Look at the drawing. When you read a cylinder keep your eyes level with the bottom of the curve in the water.



3. Look at the top of the cylinder. What two letters do you see? ____________ This is a short way of writing the name MILLILITER.

4. Look at the bottom line on the graduated cylinder. This line is one milliliter. The next line is two milliliters.

What does the top line say? ______________ ml.

5. To read a graduated cylinder count the number of lines from the bottom up to the bottom of the curve in the water. How much water does the cylinder in the drawing have in it? ______________________

6. Use the wet graduated cylinder. Put in 25 ml. of water.

7. Put 5 ml. of sugar into a DRY cylinder.

8. What do you think the reading would be if you combined the two? _________

9. Now add the sugar to the water. Carefully shake the cylinder to dissolve the sugar. How much of the solution is in the cylinder? ______________

QUESTIONS TO ANSWER:

1. Why did the sugar and water take up less space than you guessed? _________

2. Why does an odor spread? ______________________

PROBLEM 10. WHAT ARE COMPOUNDS?

OUTCOMES:

Matter that can be broken down rather easily into simpler substances is called a compound.

Water can be decomposed into oxygen and hydrogen.

Oxygen supports combustion. To test for oxygen use a glowing splint. It will make the splint burst into flame.

Hydrogen burns. To test for it use a burning splint. It will burn and a "pop" will be heard.

Formulas are used to write the names of compounds quickly.

MATERIALS:

see pupil worksheet

PROCEDURE:

1. Recall from the last lesson that the sugar and water were made up of very small particles. Have the class substantiate reasons for believing that these could, or could not be decomposed.

2. Caution the pupils not to touch the materials. Distribute trays of materials and pupil worksheets to the class.

3. Have the pupils do one procedure at a time, after they have read it and it has been discussed.

4. Demonstrate how to set up the equipment using the drawing on the worksheet as a guide.
   Wrap the bare end of two wires around the carbon rods to make electrodes. Fill the tray with water to which has been added a few drops of sulfuric acid. This solution should be very dilute. Then insert the carbon electrodes into the test tubes, and submerge the test tubes in the water to fill. Clamp the test tubes in place. Connect in series (+ to -).

5. Inspect the pupil's set-ups.

6. Help the pupils understand that an electric current is being passed through the water.

7. Direct the pupil' attention to the bubbles in the test tubes. Also, elicit that water is lower in one tube than in the other.

8. After the students test the one gas with a glowing splint and observe that the splint bursts into flame, identify the gas as oxygen. Write the word on the blackboard. Explain that oxygen helps things burn, but does not itself burn.

9. When the pupils test the other gas and observe that it explodes with a "pop", identify this gas as hydrogen. Write the word on the blackboard and explain that hydrogen burns rapidly.

10. Using a molecular model consisting of colored spheres, show how the water particles broke up into oxygen and hydrogen. Place the colored balls representing oxygen in one beaker, and the colored balls representing hydrogen in the other. Have a student count the balls in the oxygen beaker and compare it with the number of balls in the hydrogen beaker. Ask, "Which takes up more space - the oxygen or the hydrogen?" Elicit that the hydrogen takes up more space because there are more hydrogen atoms.

    Note: The water model should have two spheres of one color (hydrogen) joined with one sphere of a different color (oxygen).

11. Write on the board: water $\longrightarrow$ oxygen + hydrogen

12. Lead the class to an understanding that a chemical change occurred because a new material was produced. Explain that because water was broken up into new substances it is called a compound.

13. Challenge a student to race you in writing the chemical name for water on the board. Instead of writing the name, you use the formula H_2O. Elicit that this method is quicker and easier. Tell the class that you used a formula, and that there is a short way of writing the name of every compound.

PUPIL WORKSHEET

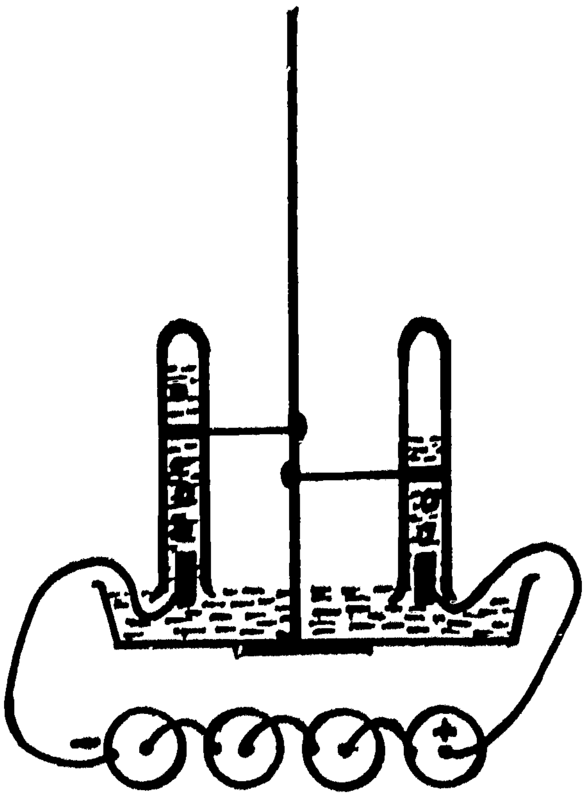
PROBLEM 10. Can water be broken up into new chemicals?

MATERIALS:

2 test tubes
tray
ring stand
2 carbon rods
wire with bare ends
2 test tube clamps
water containing a few drops of sulfuric acid
4 dry cells

WHAT TO DO:

1. Look at what your teacher does. Look at the drawing below. Then, set up your materials. DO NOT CONNECT THE WIRES TO THE BATTERIES.
2. Have your teacher look at the set-up. Wash your hands.
3. Connect the wires to the batteries. Look at the carbon rods and the water in the test tubes.
4. Wait until most of the water is out of the test tubes. Then pick up the test tube that has the most water. Let the water run out. Put a glowing splint in the test tube.
5. Pick up the other test tube. Let the water run out. Bring a burning splint to the mouth of the test tube.



QUESTIONS TO ANSWER:

Fill in the spaces. Use these words:

oxygen hydrogen compound electricity

1. ______________ was used to break up water.
2. The water broke up into ______________ and ______________.
3. ______________ made a glowing splint start to burn.
4. ______________ made a "pop" when it came near a burning splint.
5. ______________ will burn, but ______________ helps things burn.
6. The water broke up into more ______________ than ______________.
7. Because water can be broken up into new things it is called a ______________.
8. The formula for water is ______________.

PROBLEM 11. HOW ARE SMALL PIECES OF MATTER DIFFERENT?

OUTCOMES:

Matter in its simplest form is called an element.
Mercuric oxide can be decomposed into the elements mercury and oxygen.
Mercury, oxygen, hydrogen, carbon, etc. are examples of elements.
Symbols are used to write the names of elements quickly.
Compounds are composed of elements.

MATERIALS:

mercury	clamp
test tubes	matches
bunsen burner	beaker
ring stand	glass tubing

PROCEDURE:

1. Distribute trays of materials and pupil worksheets.

2. Elicit that during the last lesson, water was decomposed. It is called a compound because it can be broken up into new materials.

3. After the pupil activity do the following demonstration:

   METHOD A: Heat mercury in a commercial apparatus that consists of mercury and blue glass chips in a sealed tube.

   METHOD B: Pour about $\frac{1}{2}$" mercury in a 12" Pyrex test tube. To prevent spilling place a one-holed stopper into this test tube with a long piece of glass tubing to another large tube standing in a beaker of cold water, mouth up. Cover the beaker with a cardboard in which a hole has been punched out for the tube. The test tube in water will keep mercury vapor out of the classroom and this vapor will condense into liquid mercury.

4. Compare the mercuric oxide that broke up and the mercury which did not decompose. Explain that matter that cannot be broken up is called an element. State that scientists have tried to break mercury up by heating it or passing electricity through it, but it does not break up into new materials.

5. Recall that there is a short way of writing the names of elements. These are called symbols.

6. Display samples of various elements, and write their names and symbols on the blackboard. Tell the class that there are only 104 kinds of matter that are elements and that most of these are not common.

PUPIL WORKSHEET

PROBLEM 11. How are small pieces of matter different?

MATERIALS:

- mercuric oxide
- ring stand
- clamp
- test tube
- alcohol burner
- matches
- test tube
- splint

WHAT TO DO:

1. Fill the bottom of a dry test tube with mercuric oxide.
2. Clamp the test tube to the ring stand.
3. Put the alcohol burner under the test tube. DO NOT LIGHT THE ALCOHOL BURNER.
4. Have your teacher check the set-up.
5. Light the alcohol burner.
6. Watch the mercuric oxide. Let it get a little dark. Light a splint and blow out the fire. KEEP YOUR NOSE AWAY FROM THE TEST TUBE.
7. Put the glowing splint into the mouth of the test tube. What happened?
   This is a test to detect the presence of oxygen.
8. Heat the mercuric oxide five minutes or more.
9. What do you see at the sides of the test tube?

QUESTIONS TO ANSWER:

1. What was coming from the mouth of the test tube? ____________________
2. What was the shiny matter on the side of the test tube? ______________
3. This experiment shows that mercuric oxide breaks up into
   ________________________ and ________________________.
4. Mercuric oxide can be broken up into new things. It is called
   a ____________________. Water and __________________ are also called
   compounds.
5. Your teacher heated __________________in a test tube.
   It ______________(did or did not) break up into new matter.
6. ___________________ is called an ___________________ because it does
   not break up. _________________, ___________________, and ____________
   are also called elements.
7. How many different elements do we know? ________________

PROBLEM 12. CAN WE MAKE A COMPOUND BY JOINING ELEMENTS?

OUTCOMES:

Compounds can be made by joining elements.
Elements joining to form compounds are examples of chemical changes.
The same product can result from different chemical changes.

MATERIALS:

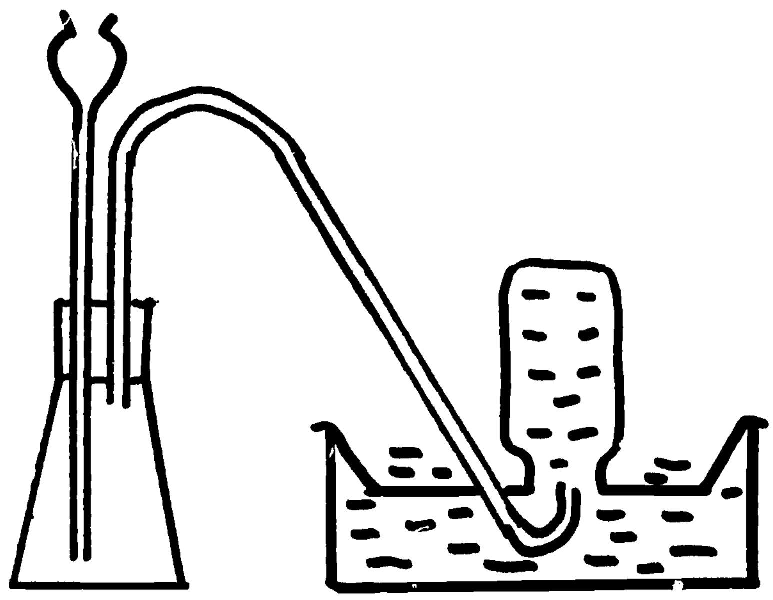
flask	rubber tubing	dilute sulfuric acid
thistle tube	collecting bottles	glass plates
2-hole stopper	bunsen burner	trough
glass tubing	mossy zinc	matches

PROCEDURE:

1. Review by eliciting that compounds can be decomposed into elements. Water breaks up into oxygen and hydrogen; mercuric oxide decomposes into mercury and oxygen.
2. Demonstrate the preparation of hydrogen.

   CAUTION: Because mixtures of hydrogen and air are explosive, caution must be exercised. No open flame should be brought near the generator. The generator should be washed with water immediately after use and the zinc should be saved.

   Set up the demonstration as shown in the diagram. Fill three bottles with water, and place them one at a time into the trough with the aid of glass plates. Place the free end of the delivery tube into each water-filled bottle in turn and allow the gas to fill the bottle completely by displacing the water. Discard the first bottle which contains an explosive mixture of hydrogen and air. Keep the other bottles face down on the glass plates to prevent the escape of the hydrogen.



3. Test one bottle of gas with a burning splint held at the mouth of the bottle. KEEP AWAY FROM THE GENERATOR. Have the class note that this is hydrogen by the fact that it burns.

4. State that the problem for this lesson is to find out if elements can combine to form compounds.

5. Promptly point to the cloudy appearance of the bottle after the hydrgen burns. Look for steam inside bottle.

6. Elicit that water (steam) was formed when the hydrogen burned.

7. Have a student write the symbol for hydrogen on the board. Then, elicit that oxygen was needed by writing the formula for water on the board.

8. Ask, "Where did the oxygen come from?"

9. Caution the class not to touch the materials. Distribute trays of materials and PUPIL WORKSHEETS.

10. Guide the pupils through the procedures. Demonstrate how to use a balance, and have the class follow you step by step.

11. After the pupil activity, explain that even though there are 104 elements, thousands of compounds can be made from these by combining the elements in different ways. This is similar to the thousands of words that can be made by various combinations of only twenty-six letters.

12. Answer the questions together.

PUPIL WORKSHEET

PROBLEM 12. Can we make a compound by joining elements?

MATERIALS:

balance	steel wool (fine #000)
crucible	pipe-stem triangle
alcohol burner	ring stand
matches	ring

WHAT TO DO:

1. Put a small piece of steel wool in a crucible.
2. Weigh the crucible on the balance. It weighed ________________.
3. Carefully take the crucible off the balance. Leave the weights in the same place on the balance.
4. Put the ring on the ring stand and the pipe-stem triangle on the ring.
5. Put the crucible in the pipe-stem triangle.
6. Heat the crucible for 10 minutes or more. Then, let the crucible cool.
7. Put the crucible back on the balance. What happens?________________

QUESTIONS TO ANSWER

1. Hydrogen cannot be broken up and is called an ________________.
2. A flame will make hydrogen ________________.
3. When the hydrogen burned we saw ________________ on the sides of the bottle.
4. To make water, we need ________________ and hydrogen.
5. The crucible was ________________ after we burned the iron.
6. The iron joined with the ________________ in the air.
7. When two elements join to make a compound it is called

   a ________________ change.
8. Write E next to the Elements. Write C next to the Compounds.

Sulfur E	Mercuric Oxide ________
Sugar ________	Carbon Dioxide ________
Oxygen ________	Iron ________
Hydrogen ________	Magnesium ________
Water ________	Mercury ________

PROBLEM 13. WHAT ARE PHYSICAL CHANGES?

OUTCOMES:

Matter may exist as solid, liquid or gas.
Solids have definite shape and volume; liquids have definite volume but take the shape of the container; gases have neither definite shape nor definite volume.
Changing from solid to liquid or gas and vice versa are physical changes.
Breaking, bending, tearing and cutting are other examples of physical change.
After a physical change, the same substance is still present.

MATERIALS:

ice cube	flask
iodine	rubber band
beakers of various sizes	bunsen burner
graduated cylinder	matches
balloon	see Nos. 10, 11

PROCEDURE:

1. Display a beaker of water, elicit its formula and write it on the blackboard. Now, show a piece of ice, write "ice" on the board and its formula, H_2O. Challenge the class to give the formula for water vapor.

2. Elicit that chemically, ice, water, and water vapor are the same. All of them could be decomposed into oxygen and hydrogen.

3. Place an ice cube in several different sized containers.

   Ask, "Has the shape of the ice cube changed?" "Does it take up the same amount of space?" Lead the pupils to understand that ice is called a solid because it has a definite shape and takes up a definite amount of space.

4. Pour a measured volume of water into one of the containers used in the ice demonstration. Pour it into another container, and measure the volume again. Elicit that the volume has stayed the same although the shape of the water has changed. Explain that water is called a liquid because its volume stays constant but its shape changes with the container.

5. With a rubber band, attach a small balloon to a flask containing a little water. Heat the flask. Have the class observe that the water vapor fills the balloon and takes the shape of the balloon and flask. Explain that if matter fills any space it can and takes the shape of the container it is a gas.

6. Display various solids and liquids, and have the pupils identify them as such. Elicit names of gases they have already learned.

7. Have the class identify iodine crystals as being solid. Carefully heat some iodine in a test tube, and direct the class to observe the solid change to a gas and back to a solid. Iodine will be deposited near the mouth of the test tube.

8. Have the class fill in the chart on the WORKSHEET.

9. Ask, "What type of change takes place when a solid becomes liquid or gas?" Elicit that this must be a physical change because you start and end with the same chemical substance.

10. Distribute trays of materials containing wood splint, chalk, magnesium ribbon, paper, scissors, mortar and pestle, copper wire.

11. Direct the pupils to break a piece of wood, cut a strip of magnesium ribbon, tear a piece of paper, crush a piece of chalk, bend a copper wire.

12. On the blackboard, develop a chart, such as, the following; and have the pupils work on a similar chart on their worksheets.

PHYSICAL CHANGES

Start with	What you did	End with
piece of wood	break it	many smaller pieces of wood
magnesium ribbon	cut it	several smaller pieces of magnesium
paper	tear it	smaller pieces of paper
chalk	crush it	small pieces of chalk
copper wire	bend it	bent copper wire

13. Elicit that these materials have been changed in size and shape but can still be recognized as being the same substance. Explain that these changes are called physical changes.

14. Contrast physical changes with chemical changes pupils have observed in the past. Develop a chart similar to the one for physical changes and have the pupils do likewise on their worksheets. Elicit that new materials were made.

CHEMICAL CHANGES

Start with	What was done	End with
limewater	blew carbon dioxide into it	chalk
mercuric oxide	heated it	mercury and oxygen
water	pass electricity through it	oxygen and hydrogen

15. Further show the difference between physical and chemical changes by lighting a piece of magnesium ribbon and having the class examine the residue. Explain that this new material is called magnesium oxide. Have the class explain the reaction that occurred.

PUPIL WORKSHEET

PROBLEM 13. What are physical changes?

PHYSICAL CHANGES

Start with	What you did	End with

CHEMICAL CHANGES

Start with	What was done	End with

QUESTIONS TO ANSWER:

1. In a ____________________ change you end with something new, but in a ______________________ change you end with the same substance.
2. Breaking, tearing, cutting, bending are all __________________changes.
3. Table salt can be broken up into sodium and chlorine. This is a ________________________ change.
4. The formula for water is _____________.
5. The formula for ice is _______________.
6. The formula for water vapor is ______________.
7. Water is a ________________; ice is a ________________; water vapor is a ____________________.
8. Ice changing to water is a ____________________ change.

PROBLEM 14. <u>WHAT IS THE DIFFERENCE BETWEEN A MIXTURE AND A COMPOUND?</u>

OUTCOMES:

The parts of a mixture are not chemically combined, retain their original properties, and can be separated easily.

The parts of a compound combine in definite, unvarying amounts.

In a mixture, the amounts of the components can vary greatly.

Compounds result from chemical changes.

MATERIALS:

See pupil worksheet.

PROCEDURE:

1. Distribute trays of materials and PUPIL WORKSHEETS.

2. Guide the class through the procedures elaborating where necessary.

3. When the pupils make the compound more heat may be needed than can be supplied by an alcohol burner. After they have begun to heat the test tube, call each group to the front and help them complete the reaction using the bunsen burner.

4. Answer questions on worksheet with class.

PUPIL WORKSHEET

PROBLEM 14. What is the difference between a mixture and a compound?

MATERIALS:

iron filings	matches	balance
iron powder	ring stand	test tube
sulfur	evaporating dish	test tube clamp
alcohol burner	paper towels	

WHAT TO DO:

Part A - Making a Mixture

1. Look at the iron filings. Test them with the magnet.
2. Look at the sulfur. Hold the magnet to the sulfur.
3. Put some iron and sulfur in the evaporating dish. Mix them together.
4. Separate the iron from the sulfur.

Part B - Making a Compound

1. Weigh out 6 grams of iron powder and 4 grams of sulfur.
2. Mix them together on a piece of paper.
3. Put the mixture in a DRY test tube.
4. Put the test tube in a clamp. Put the clamp on the ring stand.
5. Heat the test tube until you see it get red. Then heat it 5-10 minutes more.
6. Put the test tube in a beaker of cold water. This will break the test tube.
7. Look at the inside of the tube. Test it with a magnet.

QUESTIONS TO ANSWER:

1. What color are the iron filings?
2. Do the iron filings stick to the magnet?
3. What color is the sulfur? ____________ Does it stick to the magnet?
4. When we mix the iron and sulfur, the iron looks ______________ and the sulfur has a _______________ color. They stay the same.

5. Do you know how much iron is in the mixture?
6. Do you know how much sulfur is in the mixture?
7. Did you have to weigh the iron and sulfur to make a mixture?
8. Does the iron stick to the magnet after you mix the iron and sulfur?

9. Did you have to weigh the iron and sulfur to form a compound?
10. After you heat the mixture, do the iron and sulfur look as they did before?
11. After you heat the mixture, can you pull out the iron with a magnet?
12. A _______________ change made something new. The new substance we made is called a ______________________. It is made up of the elements _____________ and __________________. The formula for iron sulfide is _____________________.

PROBLEM 15. HOW CAN A MIXTURE BE SEPARATED?

OUTCOMES:

Some mixtures can be separated by filtration.
The parts of a mixture retain their original properties.
Filtration is one step in the purification of water.

MATERIALS:

see pupil worksheet

PROCEDURE:

1. Elicit that in the last lesson the class separated a mixture of iron and sulfur using a magnet.

2. Distribute trays of materials to every two or three pupils.

3. Direct the groups to make a mixture of salt and sand, and examine the mixture with a hand lens.

4. Elicit that because this is a mixture, the sand and salt still look the same and could be separated by sorting out the salt particles; the sand and salt were not weighed carefully and were not chemically combined.

5. Challenge the class to suggest ways in which the mixture could be separated. Lead them to suggest the use of water to dissolve the salt, and the use of a sieve to separate the salt water from the sand. Encourage them to plan a method of separating the salt and water.

6. Distribute PUPIL WORKSHEETS.

7. Have a student read each procedure and then, after the teacher demonstrates the required technique, have the class perform the operation.

8. After the pupil activity, elicit that large particles could be removed from our water supply by filtration.

9. Demonstrate the purification of water by filtration.

   Pour muddy water through a funnel that is filled with fine and coarse sand, and fine and coarse gravel.

PUPIL WORKSHEET

PROBLEM 15. How can a mixture be separated?

MATERIALS:

- mixture of sand and salt
- beaker
- alcohol burner
- funnel
- stirring rod
- filter paper
- tripod or ring stand and ring
- evaporating dish
- wire gauze
- tongs
- asbestos
- hand lens

WHAT TO DO:

1. Add water to the mixture of salt and sand.
2. Stir the mixture with the stirring rod.
3. Fold the filter paper.
4. Wet the funnel and put in the filter paper.
5. Put the funnel in the tripod or clamp.
6. Put a clean evaporating dish under the funnel.
7. Pour a little of the mixture into the funnel. Don't pour the mixture over the top of the filter paper.
8. Separate the salt from the sand.
9. Pour out most of the salt water.
10. Heat the salt water that is left in the evaporating dish.
11. Wait until the water is gone. Pick up the evaporating dish with the tongs and put it on the asbestos. THE EVAPORATING DISH IS VERY HOT.

QUESTIONS TO ANSWER:

1. What were the parts of the mixture in this experiment?
2. Why did you stir the mixture with water?
3. What happened when you heated the salt water?
4. Why did the sand stay in the funnel?

PROBLEM 16. HOW CAN WE GET DRINKING WATER FROM THE SEA?

OUTCOMES:

A method of converting sea water to fresh water is needed in dry countries that don't have sources of fresh water and by ships at sea.

Distillation is a method of removing salt from sea water.

Distillation involves salt water being heated and the steam that is produced being cooled and changed back to water.

The water-cycle is a natural process that is very similar to distillation. Salt flats are produced in such areas as the Salt Lakes and the Dead Sea.

MATERIALS:

flask
ring stands
clamps
ring
wire gauze
bunsen burner
matches
condenser
stoppers
rubber tubing
beaker

PROCEDURE:

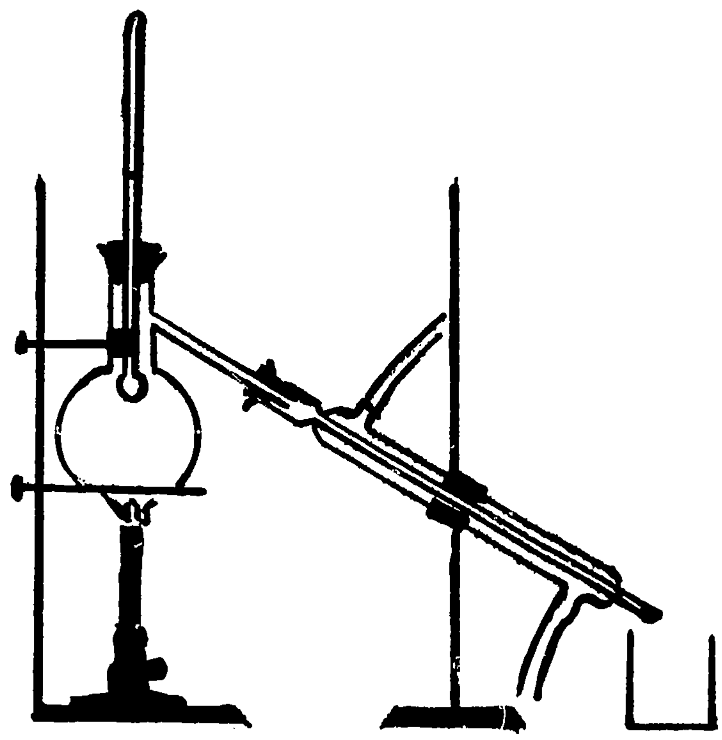
1. Ask, "Why can't we drink sea water?" Elicit that it is too salty and that it makes a person very ill.

2. Question the class about situations in which sea water must be converted into drinking water. Elicit such examples as ships at sea, arid countries, Guantanimo Bay military installation.

3. Have the class consider filtration as a means of separating the particles, but lead them to reject it because particles of salt will go through a filter.

4. Discuss the method used to separate the water from the salt in the last lesson. Have them recall the food test for water, and lead the pupils to suggest cooling steam as a means of recovering the water.

5. Construct a distillation apparatus as shown below. Pass a condenser around and have the pupils examine it; then direct them to draw the set-up in their notebooks and label the parts.



6. Tell the class that this process is called distillation. In the next lesson they will distill a mixture of water and table salt, but to demonstrate the process you will use a colored chemical in place of salt.

7. Distill a mixture of copper sulfate and water, explaining what happens in each part.

8. Discuss the water cycle and show how it is similar to the distillation process. Water is heated by the sun and is changed to a vapor. The vapor rises and is cooled, and eventually falls back to earth as rain.

9. Have the class explain how salt flats developed in the Salt Lakes and Dead Sea areas.

PROBLEM 17. HOW IS A MIXTURE DISTILLED?

OUTCOMES:

Distillation is the result of physical changes.

MATERIALS:

see pupil worksheet	test tube rack
silver nitrate solution	test tubes

salt solution - Make a salt solution of known composition by dissolving the salt in water and mixing thoroughly. Give the same volume to each group, and the groups will be able to compare their techniques and efficiency in separating the mixture.

PROCEDURE:

1. Explain that in this lesson the class will separate a salt water mixture. The groups will compete to see which one will collect the greatest amount of pure water.

2. Distribute trays of materials and PUPIL WORKSHEETS.

3. Show them again how the glass tube is inserted in the rubber stopper. As a safety precaution, cover the tube with a paper towel where you intend to grip it.

4. Demonstrate how to arrange the distillation apparatus.

5. After you check the groups, caution them to stop heating the mixture before it is dry.

6. Have each group report the amount of liquid collected.

7. Make a concentrated table salt solution and add silver nitrate solution. Direct the class to observe the deep white color that is obtained. Explain that if less salt were present, the color would not be as white.

8. Pour the same amount of sample from each group into labeled test tubes. Set the test tubes in a rack at the front of the room. Add silver nitrate solution to each of the samples. Have the class draw conclusions about the "purity" of the samples.

9. Have the class discuss the physical changes that occur during the distillation process.

10. Encourage the pupils to think of ways in which they could have improved the purity of the water. Lead them to conclude that a more efficient cooling system would help.

PUPIL WORKSHEET

PROBLEM 17.

MATERIALS:

salt and water mixture
rubber stopper and glass tube
ring stand and test tube clamp
eight-inch test tube
alcohol burner
six-inch test tube
small graduated cylinder
250 ml. beaker
paper towels
matches

WHAT TO DO?

1. Put the 8-inch test tube in the clamp.

2. Put 20 cc. of the salt and water mixture in the 8-inch test tube.

3. Put the rubber stopper in the mouth of the test tube.

4. At the end of the glass tube put a small test tube to catch the water.

5. HAVE YOUR TEACHER CHECK THE SET-UP.

6. Plan how you will cool the steam.

7. Light the alcohol burner and begin to distill. DO NOT BOIL THE SALT WATER UNTIL THE TEST TUBE IS DRY! Let a few drops of salt water stay in the big test tube.

8. Find out how much water you distilled. Use the graduated cylinder.

9. Give this "pure" water to your teacher.

QUESTIONS TO ANSWER:

1. How much water did you get? ______________ ML.

2. How did you cool the steam? ____

3. ______________________________ was used to see how much salt was left in the water. Was your sample pure?

4. What did the long glass tube take the place of in the experiment you saw in the last lesson?

5. What is distillation?

PROBLEM 18. HOW IS CHROMATOGRAPHY USED TO SEPARATE MIXTURES?

OUTCOMES:

Chromatography is a method used to separate small amounts of substances in mixtures.

Ink is a mixture of several chemicals.

MATERIALS:

see pupil worksheets
strips of filter paper (The paper should be long enough to reach from the
bottle top to the bottom of the glass jar.)
medicine droppers or solid glass rods
washable black or other ink
tape
paper towels
unknown mixture (Make a mixture of one or more substances the pupils have tested. Label the test tubes with numbers and record the components.)

PROCEDURE:

1. Elicit from the class that when a paper napkin is placed in a liquid, the liquid slowly rises and spreads.

2. Explain that scientists discovered that if different kinds of small particles are mixed in the liquid, they will travel along the paper at different speeds. Eventually the various substances will separate into bands.

3. Demonstrate and explain the technique of chromatography.

   Fasten a strip of filter paper to a pencil with tape. Place a drop of mixture to be separated at the bottom of the strip and allow it to dry. Fill the bottle with $\frac{1}{2}$" of water or alcohol solvent and place the pencil across the top of the bottle so that the lower end of the filter paper touches the solvent. Be sure that the spot of the mixture is close to, but not touching the solvent. Cover the bottle with paper toweling and allow the separation to proceed.

4. Distribute trays of materials and PUPIL WORKSHEETS.

PUPIL WORKSHEET

PROBLEM 18. How is chromatography used to separate mixtures?

MATERIALS:

- ink
- water
- 4 bottles
- dropper
- alcohol
- strips of filter paper
- mixture of food colors
- Wright's stain
- unknown mixture

WHAT TO DO:

1. Add a few drops of ink to a little water. Hold a strip of filter paper so the end reaches into the liquid. What happens?
2. Separate a mixture of food colors. How did the strip of paper look?
3. Place $\frac{1}{4}$ inch of alcohol and $\frac{1}{4}$ inch of water in a bottle. Add Wright's stain and test with paper strip. What did you see?
4. Find out what the unknown mixture contains. It can contain anything you have already tested.

QUESTIONS TO ANSWER:

1. What color or colors did you find in ink?

2. What colors did you find in the mixture of food colors?

3. What colors did you find in Wright's stain?

4. Your unknown mixture has the colors ________________________________

   ____________ ____________. What do you think it is? ______________

   ________________________________.

HOMEWORK:

Separate mixtures in your house using chromatography. In place of filter paper you can use white blotters or paper towels.

ERIC

PROBLEM 19. WHAT ARE ACIDS?

OUTCOMES:

Acids turn blue litmus red.

Many common substances are acidic.

Acids contain the element hydrogen.

Acids react with metals to liberate hydrogen

MATERIALS:

see pupil worksheets
To prepare dilute acids, add one part conc. acid to ten parts water.

PROCEDURE:

1. Tell the children they will be working with acids today - hydrochloric, sulfuric and acetic acids. Have the children look up and give the formulas for each: HCl, H_2SO_4, $HC_2H_3O_2$.

2. Have the children point out that each of these compounds contains hydrogen. This is characteristic of all acids.

3. Distribute materials and worksheets and assist pupils with exercise.

4. After materials have been collected, gather results of acid tests: lemon, vinegar, grapefruit, tomato are examples of acids. Ask the children to give a word to describe the taste. Acids taste sour.

5. Write characteristics of acids on the board as they are given by pupils.
    a. Acids are chemical compounds.
    b. They contain the element hydrogen.
    c. They tast sour.
    d. They turn blue litmus red.
    e. They react with metals and liberate hydrogen.

PUPIL WORKSHEET

PROBLEM 19. What are acids?

MATERIALS:

3 test tubes	red and blue litmus papers
dilute hydrochloric acid	splints
dilute sulfuric acid	mossy zinc
dilute acetic acid	matches
glass plate	substances from home to test for acidity
glass stirring rod	paper towel

WHAT TO DO:

1. Wet the glass plate. Lay 3 pieces of blue and 3 pieces of red litmus paper on it.

2. Dip the stirring rod into the hydrochloric acid. Touch the rod to a piece of red and to a piece of blue litmus. What happened?

3. Wash the rod with water. Then test the sulfuric acid in the same way. What happened?

4. Wash the rod again with water and test acetic acid. What happened?

5. Test lemon juice, aspirin, vinegar or other substances you brought from home with the red and the blue litmus papers. Make a list of the substances and tell next to each what happened and whether or not the substance is acidic.

6. Now place a small piece of mossy zinc into each of three test tubes.

7. Add hydrochloric acid to one test tube. Add sulfuric acid to the second and acetic acid to the third tube. What do you see?

8. Bring a burning splint to the mouth of each test tube. What happened?

QUESTIONS TO ANSWER:

1. What happened to red litmus paper when you put acid on it?

2. What happened to blue litmus paper when you put acid on it?

3. What happened when dilute acid was added to mossy zinc?

4. How do you know which gas was formed?

5. What other characteristics of acids do you know?

PROBLEM 20. WHAT ARE BASES?

OUTCOMES:

Bases turn red litmus blue.

Bases feel slippery.

Bases contain an OH or hydroxide group.

MATERIALS:

see pupil worksheet
test tubes
bunsen burner
5% solution of sodium hydroxide

PROCEDURE:

1. List the chemicals the children will test today - sodium hydroxide, potassium hydroxide and ammonium hydroxide. Have the children point out that each has hydroxide in its name. Now write the formulas for each -

   $NaOH$, KOH, NH_3OH

2. Identify these as belonging to a group of chemicals called bases.

3. Distribute materials and worksheets.

4. When materials have been collected, tell the children that the following substances are weak bases: human blood, baking soda, borax, milk of magnesia. Lye, lime water, washing soda and ammonia water are strong bases.

5. Demonstration: Bases dissolve wool but not cotton

   Boil a small sample of wool for three or four minutes in a 5% solution of sodium hydroxide. Have the class observe that the wool is completely dissolved.

   Repeat using cotton, and have the class observe that the cotton did not dissolve. Elicit that this could be a way of testing a fabric for its wool content.

6. Summarize by listing characteristics of bases.

7. Give children strips of litmus paper and have them test some toilet soaps at home.

PUPIL WORKSHEET

PROBLEM 20. What are bases?

MATERIALS:

- test tube
- sodium hydroxide
- potassium hydroxide
- ammonium hydroxide
- cottonseed oil
- glass plate
- stirring rod
- red and blue litmus paper

WHAT TO DO:

1. Wet the glass plate. Put three pieces of red and three strips of blue litmus paper on it.

2. Dip the stirring rod into the sodium hydroxide. Touch the rod to a piece of red and to a piece of blue litmus paper. What happened?

3. Wash the rod with water.

4. Dip the stirring rod into potassium hydroxide and test it with litmus paper. What happened?

5. Wash the rod and test the ammonium hydroxide with litmus paper. What happened?

6. Rub a drop of sodium hydroxide between two of your fingers. WASH YOUR HAND AT ONCE. KEEP YOUR HANDS AWAY FROM YOUR EYES. How did it feel?

7. Put one inch of water in a test tube.

8. Add a few drops of cottonseed oil to the test tube. Shake the test tube. Let the test tube stand for two minutes. What did you see?

9. Add a few drops of sodium hydroxide to the same test tube. Shake the test tube. Let the test tube stand for two minutes. What happened?

QUESTIONS TO ANSWER:

1. How do you use litmus paper to test for a base?

2. Why do you think the oil and water mixed after sodium hydroxide was added?

3. What are the formulas for sodium hydroxide ______, potassium hydroxide ______, and ammonium hydroxide ______?

4. What common substances do you know of that are bases?

PROBLEM 21. WHAT HAPPENS WHEN AN ACID AND A BASE ARE MIXED?

OUTCOMES:

Neutralization is a process where an acid and a base combine to form a salt and water.

Neutral solutions are neither acidic nor basic.

MATERIALS:

phenolphthalein
2 test tubes
dilute sodium hydroxide - add 20 grams of solid sodium hydroxide to a liter of water
dilute hydrochloric acid - add 1 part conc. HCl to 23 parts water
see pupil worksheet

PROCEDURE:

1. Elicit procedure for identifying an acid or a base.

2. Now show a bottle of phenolphthalein to the class and explain that it is an indicator. Add a few drops to test tube containing dilute HCl. Add an equal number of drops to dilute NaOH to note color reaction in base.

3. Distribute materials and worksheets. Caution pupils to wipe up spills and to rinse skin or clothes with water immediately.

4. Write the equation on the board:

$NaOH$	+	HCl	$\longrightarrow$	$NaCl$	+	H_2O
ammonium hydroxide		hydrochloric acid		sodium chloride (table salt)		water

5. Review questions on worksheet. Emphasize that neutralization is a chemical change in which an acid and a base combine to form a salt and water.

6. Display a variety of salts, such as, calcium chloride, ammonium dichromate, sodium carbonate, sodium bicarbonate, copper sulfate. Explain that these are salts and that salts are formed when acids and bases are mixed.

   NOTE: NaCl is a neutral salt; others may be acidic or basic. These salts react with water to form an acid or a base. The process is called hydrolysis and takes place when the salt of a strong acid and a weak base, or the salt of a weak acid and a strong base is added to water.

PUPIL WORKSHEET

PROBLEM 21. What happens when an acid and a base are mixed?

MATERIALS:

dilute sodium hydroxide
dilute hydrochloric acid
evaporating dish
alcohol burner
tripod
medicine droppers
hand lens
phenolphthalein
matches
stirring rod
graduated cylinder
tongs
asbestos

WHAT TO DO:

1. Put 10 ml. of sodium hydroxide in an evaporating dish.

2. Add a few drops of phenolphthalein.

3. Use a dropper and add hydrochloric acid drop by drop. Stir after you add each drop. Stop adding acid when one drop takes away the color. How many drops did you add?

4. Heat the evaporating dish until all the water is gone.

5. Pick up the dish with tongs. Let it cool on the asbestos.

6. Look at what is left in the dish with a hand lens. What does it look like?

QUESTIONS TO ANSWER:

1. To what group of chemicals does sodium hydroxide belong?

2. Why did the color of the phenolphthalein disappear when you added acid?

3. What kind of change took place?

4. Why do you think this process is called neutralization?

PROBLEM 22. WHAT ARE SOME PROPERTIES OF METALS?

OUTCOMES:

Elements can be classified as metals or non-metals.

We identify an element by its properties.

Among the properties of metals are:

a. silver-gray color (exceptions - gold, copper)
b. solid state (exception - mercury)
c. shine or lustre

MATERIALS:

Periodic Table of the Elements
see pupil worksheet

NOTE: stopper and seal mercury, phosphorus and iodine in separate test tubes. Caution pupils that they are poisonous and dangerous to handle. Rest of elements should be placed in box for easy distribution.

PROCEDURE:

1. Review the definition of element.

2. Distribute trays of materials and PUPIL WORKSHEETS. Caution the class not to open the sealed tubes.

3. Tell the pupils that elements can be divided into two main groups - metals and non-metals. Instruct the class to pick out the metals from the cigar box.

4. Correct errors in classification and question the pupils as to their reasons for calling an item a metal. Explain that features by which we recognize a substance are called its properties.

5. Have one student describe another student. Write the essential points of the description on the board. Explain that these could be considered his properties. The more we know about persons or things, the easier it is to identify them.

6. Display the Periodic Chart of the Elements. Have the pupils locate elements they know. Lead them to note that the metals are on the left side of the chart and that approximately 75% of the elements are classified as metals. They should also realize that all metals except mercury are solids; yet, non-metals are either gases or solids at ordinary temperatures, except bromine which is a liquid.

7. Direct the class to examine the sulfur, phosphorus, and iodine and note their dull appearances. Compare this with the shiny appearance of the metals.

8. Elicit the colors of various non-metals. Compare these with the silver-gray appearance of most metals.

9. Review the properties of metals discussed in this lesson.

10. Assign class to suggest other properties of metals.

PUPIL WORKSHEET

PROBLEM 22. What are some properties of metals?

MATERIALS:

copper
aluminum
iron
tin
lead
zinc
mercury
sulfur
iodine
carbon
phosphorus
sandpaper

WHAT TO DO:

1. Write the names of all the metals on the chart in Column 1.

2. Look at each metal. Is it a solid, liquid, or a gas? In Column 2 write SOLID or LIQUID or GAS next to each metal.

3. Sandpaper each metal. Does it shine, or is it dull? In Column 3 write SHINE or DULL next to each metal.

4. Look at the color of each metal. Write the color in Column 4 next to each metal.

1	2	3	4
METAL	SOLID, LIQUID, GAS	SHINY or DULL	COLOR

QUESTIONS TO ANSWER:

1. Which metal is a liquid at ordinary temperatures?

2. Why did you have to sandpaper the metals to see their lustre or shine?

3. What is the most usual color for a metal?

PROBLEM 23. WHAT ARE SOME OTHER PROPERTIES OF METALS?

OUTCOMES:

Metals are good conductors of heat.
Metals are good conductors of electricity.

MATERIALS:

2 test tubes	powdered sulfur	ring stand and clamps
2 thermometers	iron filings	bunsen burner
	see pupil worksheet	

PROCEDURE:

1. Fill one large test tube with iron filings and another tube with powdered sulfur. Insert thermometers into the top of contents of each tube. Take temperature readings before and after heating each tube at the bottom for an equal period of time. Compare the heat conductivities of the metal and non-metal.
2. Recall other examples: Spoon getting hot, hot pot handle, etc.
3. Distribute materials and worksheets. Go over questions.

PUPIL WORKSHEET

PROBLEM 23. What are some other properties of metals?

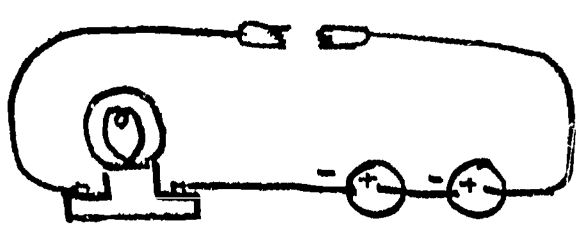
MATERIALS:

strips of copper, aluminum, iron, tin, lead, zinc, rubber, paper

wood splint	wires	2 1.5 volt batteries
glass rod	2 alligator clips	3 volt lamp in socket

WHAT TO DO:

1. Set up your equipment as in the diagram.



2. Test the electrical conductivity of each substance given to you by putting it between the two alligator clips.
3. Make a list of the materials you are testing. Next to the name, state if the light went on or not. In a third column, call it a conductor if it let electricity go through or a non-conductor if it did not let electricity go through it.

QUESTIONS TO ANSWER:

1. Why are metals used for making pots and pans?
2. Which metals are most commonly used for pots and pans?
3. Why are metals used for making electrical wires?
4. Why is copper the most commonly used metal for electrical wires?
5. Can you think of any properties of metals we have not discussed? Hint: Metals can be made into wires and sheets.

PROBLEM 24. WHAT ARE SOME CHEMICAL REACTIONS OF METALS?

OUTCOMES:

Metals combine with non-metals.

More active metals replace less active metals in a compound.

Metallic salts (compounds) may decompose into metals and non-metals.

Metals may change places in reactions between their compounds.

MATERIALS:

silver nitrate solution
sodium chloride (table salt) solution
see pupil worksheet

PROCEDURE:

1. Recall the pupil activities in which iron was burned and in which iron and sulfur were heated. Have the class identify the metal (iron) and non-metals (oxygen and sulfur) that took part in these chemical changes. Elicit that a metal combined with a non-metal.

2. Recall the pupil activity in which mercuric oxide was heated. Elicit that this compound decomposed into mercury (metal) and oxygen (non-metal).

3. Prepare clear solutions of sodium chloride and silver nitrate. Have the class identify these as compounds and write their formulas on the blackboard. Mix these chemicals and elicit that a chemical change has occurred as evidenced by the white precipitate. Complete the equation on the blackboard as follows:

$AgNO_3$	+	$NaCl \longrightarrow$	$NaNO_3$	+	$AgCl$
silver nitrate		sodium chloride	sodium nitrate		silver chloride

Have students identify the silver and sodium as being the metallic parts of the compounds, and elicit that in this chemical change the metallic elements changed places. (If allowed to stand in the light the precipitate gets darker as silver salts are sensitive to light. It breaks down into silver and chlorine).

4. Distribute trays of materials and PUPIL WORKSHEETS.

PUPIL WORKSHEET

PROBLEM 24. What are some chemical reactions of metals?

MATERIALS:

copper sulfate solution	iron nail
ferrous sulfate(iron sulfate) solution	copper strip
test tubes	sandpaper
test tube rack	silver nitrate

PROCEDURES:

1. Clean the iron nail and copper strip with sandpaper.

2. Dip the iron nail into the copper sulfate solution. What happened to the nail?

3. Dip the copper strip into the iron sulfate solution. What happened to the copper strip?

4. Put a strip of copper in the silver nitrate. Wait three or four minutes. Look at the copper strip and the silver nitrate. DO NOT GET SILVER NITRATE ON YOUR SKIN. IT BURNS.

5. What happened?

QUESTIONS TO ANSWER:

Using the following list of words, fill in the spaces.

silver	copper	iron
did	did not	blue
could	could not	silver

1. The iron nail had ____________________ on it.

   The iron took the place of the ____________ in the compound, copper sulfate.

2. The copper ______________ have iron on it. The copper _____________ take the place of the iron in the iron sulfate.

3. This shows that the __________________ is more active than the __________________.

4. The __________________ took the place of the silver in the silver nitrate and made the contents of the tube turn a ___________ color. This shows that _______________ is more active than ________________.

PROBLEM 25. HOW ARE METALS SEPARATED FROM THEIR ORES?

OUTCOMES:

Ores are naturally occurring minerals from which the pure metals are extracted.
Most metals are not found free in nature but are chemically combined with other elements.
Physical processes, such as, wet panning, flotation, magnetic separation are used to separate the ores from other earthy materials.
Chemical changes are needed to separate the pure metals from the non-metallic parts of the ores.

MATERIALS:

ore samples - see 1. below

PROCEDURE:

1. Show samples of ores. Write their names and chemical formulas on the board. For example:

cuprite - copper oxide	- Cu_2O
litharge - lead oxide	- PbO
hematite - iron oxide	- Fe_2O_3
bauxite - aluminum oxide	- Al_2O_3
galena - lead sulfide	- PbS
cinnabar - mercuric sulfide	- HgS
iron pyrites - iron sulfide (fool's gold)	- FeS_2
smithsonite - zinc carbonate	- $ZnCO_3$
magnesium carbonate	- $MgCO_3$
lead carbonate	- $PbCO_3$

2. Point out that the ores are chemical compounds containing metals and non-metals. Have children identify elements in the compounds named.

3. Explain that ores are found mixed with sand and other earthy materials and that by physical processes, the ores are separated from the other materials. Assign pupils to do research on:
   a. wet panning
   b. magnetic separation
   c. separation by flotation

4. Explain that when the ore has been extracted, it must now be treated chemically to remove the pure metal.

5. Look at the list on the board. Have the children point out, for example, that the oxygen must be removed from the first four ores, etc.

6. Distribute materials and pupil worksheets.

7. Go over questions with class.

8. Explain that other processes are used to separate metals from other compounds. Interested pupils may be assigned task of reporting on the blast furnace, roasting sulfides or carbonates, etc.

9. In preparation for the lext lesson do the following demonstration; Insert some clean steel wool in a cylinder. Clamp the cylinder to a ring stand, and lower it into a beaker of water so that its mouth is about ½" below the surface of the water. Set up another cylinder in the same manner except omit the steel wool. This cylinder will act as a control.
   NOTE: Clean the steel wool first by dipping it into dilute HNO_3, rinsing it with water, and dipping it into dilute acetic acid.

PUPIL WORKSHEET

PROBLEM 25. How can we separate a metal from its ore?

MATERIALS:

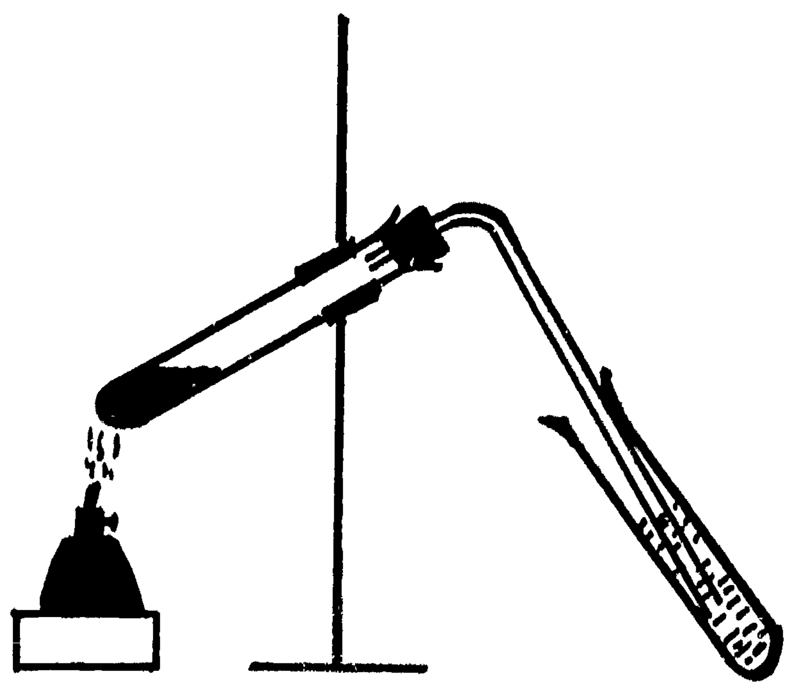
test tube	matches
ring stand	copper oxide (wire form)
test tube clamp	charcoal (powdered)
rubber stopper with right angle	balance
alcohol burner	beaker
limewater	glass tube

WHAT TO DO:

1. Weigh out 2 grams of copper oxide and 5 grams of charcoal.
2. Mix the copper oxide and charcoal on a paper.
3. Put the mixture in a test tube and clamp the test tube to the ring stand.
4. Put the rubber stopper and glass tube into the test tube.
5. Put limewater in another test tube.
6. Put the end of the glass tube into the limewater.
7. Heat the copper oxide and charcoal carefully for 10 minutes.
8. What happens to the limewater?
9. After 10 minutes take the burner away, and TAKE OUT THE STOPPER AND GLASS TUBE.
10. Let the test tube cool. Then empty the mixture into a beaker.
11. Rinse away the charcoal with water. What is left in the beaker?

QUESTIONS TO ANSWER:

1. What element is charcoal made of?
2. Why did the limewater change color?
3. Where did the carbon come from?
4. Where did the oxygen come from?
5. What kind of change took place?



PROBLEM 26. HOW CAN WE PROTECT METALS FROM CORROSION?

OUTCOMES:

Most metals react with gases in the atmosphere to form compounds.
They are coated with some material that protects them from the atmosphere.
Electricity can be used to coat one metal with another.
Electroplating involves a chemical change.

MATERIALS:

demonstration with steel wool set up in last lesson
examples of corroded metals
plated objects: nickel plated, chrome plated, etc.
see pupil worksheet

PROCEDURE:

1. Inspect the steel wool from the demonstration set up yesterday to see the rusting.

2. Show other examples of corrosion: tarnished silver, corroded aluminum, corroded copper. Note the differences in color and texture between pure and corroded metals.

3. Ask for other examples of corrosion they have noted and have them suggest ways of preventing it by:
   a. painting
   b. oiling or greasing
   c. plating as in galvanized steel

4. Pass around objects labeled "nickel plated", "chrome plated", etc. Elicit that plating is coating one metal with another.

5. Distribute materials and worksheets.

6. Go over questions. Point out that metals don't all corrode equally. Some, like iron, continue rusting throughout the materials. Others, like aluminum stop when the entire surface is corroded and forms a protective coating.

7. Elicit importance of electroplating with examples.

PUPIL WORKSHEET

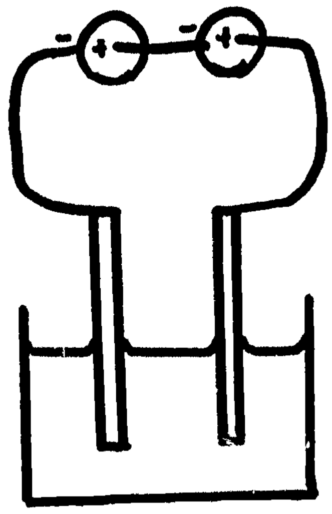
PROBLEM 26. How can we protect metals from corrosion?

MATERIALS:

2 carbon rods
5% solution of copper sulfate
2 dry-cells
teaspoon
wire
alligator clips
beaker

WHAT TO DO:

1. Set up the apparatus as in the diagram. Follow the diagram carefully. Do not let the carbon rods touch each other.



2. Raise your hand when you have finished setting up the equipment so your teacher can check it.
3. Let it run for 5 minutes. Then look at the two rods. What happened?
4. Take off the coated rod and connect the spoon instead. Place the spoon and the carbon rod into the copper sulfate solution.
5. Wait another 5 minutes. Then examine the spoon. What happened to it?
6. Take the equipment apart and return it.

QUESTIONS TO ANSWER:

1. Where did the copper that coated the spoon come from?

2. What is the chemical formula for copper sulfate?

3. How do you know copper sulfate is a compound?

4. What broke up the copper sulfate?

5. Why are some metals electroplated?

PROBLEM 27. <u>WHAT ARE SOME USES OF COMMON CHEMICAL COMPOUNDS FOUND IN THE HOME?</u>

OUTCOMES:

Many chemical compounds are known to us under different names.
Sodium hydroxide (lye) is important for the manufacture of some soaps.
Baking powder is a mixture of chemical compounds that produce carbon dioxide for leavening.

MATERIALS:

sodium hydroxide
20% solution of sodium hydroxide
commercial lye
rubbing alcohol
olive oil or coconut oil
evaporating dish
bunsen burner
beaker of saturated salt solution
stirring rod
ammonia water
see pupil worksheet

PROCEDURES:

1. Display solid sodium hydroxide and a 20% solution of sodium hydroxide. Tell the pupils that the common name for sodium hydroxide is lye. Write the chemical name, and formula, $NaOH$, on the board. Elicit that sodium hydroxide is a compound and, as the class learned previously, it is a very strong base.
2. Demonstrate the preparation of soap. Use <u>extreme</u> caution in heating. Keep pupils away from prep table.
Add 10 ml. of rubbing alcohol to two teaspoonfuls of olive oil or coconut oil in an evaporating dish. Add 5 ml. of the 20% $NaOH$, and heat gently while stirring. After the odor of the alcohol has disappeared, pour the mixture into a beaker containing a warm saturated solution of salt (dissolve as much salt in warm water as possible). Stir this mixture for one minute, and allow it to settle. The soap collects at the top and may be ladled off. Make suds by shaking a small amount of the soap with some water in a test tube.
3. Write on the board: Fat + Lye $\longrightarrow$ Soap + Glycerine
Tell the pupils that the salt water helped separate the soap from the glycerine.
4. Display a commercial drain-cleaner. Tell the pupils that it contains lye in solid form, and that it unclogs drains by acting on the grease as sodium hydroxide acted on the fat. Note the POISON label.
5. Display a bottle of commercial household ammonia. Elicit that this has the same smell as the base, ammonium hydroxide, and is in fact the same chemical. Have the class suggest reasons for its being used in the home (i.e. a base breaks up oil particles)
6. Distribute materials and worksheets.

PUPIL WORKSHEET

PROBLEM 27. How is baking powder made and used?

MATERIALS:

cream of tartar	test tubes	rubber tube
baking soda	lime water	teaspoon
cornstarch	flour	alcohol burner
beaker	one-hole rubber stopper with glass tube	matches
splint		

WHAT TO DO:

1. In a dry beaker mix one teaspoon of baking soda, one teaspoon of cream of tartar and one teaspoon of starch.

2. Put mixture in a dry test tube. Stopper with the one-holed stopper to which is attached a rubber tube.

3. Insert the free end of the rubber tube into a test tube containing lime water. What happened?

4. Now add a little water to the mixture and see if anything happens to the lime water.

5. What did you see?

6. In another dry beaker mix one teaspoon baking soda, two teaspoons cream of tartar and one teaspoon starch.

7. Add one teaspoon flour and some water to make a dry paste.

8. Put a small ball of this mixture (a dough) into a large spoon and warm gently over the alcohol lamp.

9. What happens to the dough?

QUESTIONS TO ANSWER:

1. What gas was made?

2. How do these bubbles of gas help make baked foods?

3. What are the chemical name and the formula for baking soda?

4. What is in baking powder?

5. Do you know any other common chemicals used at home?

PROBLEM 28. WHAT ARE SOME COMMON MAN-MADE MATERIALS:

OUTCOMES:

Many materials we use in our daily lives are the results of chemical research.

MATERIALS:

400 ml. beaker
analine hydrochloride
40% formaldehyde
glass rod
graduate cylinder
see pupil worksheet

PROCEDURE:

1. Point to different objects in the room and have the class identify the man-made materials found in them. For example, plastics, paper products, painted materials, alloys were creations of the laboratory.

2. Encourage them to think of personal materials and products they use daily, such as, shaving cream, deodorants, cold cream, hair preparations, etc. Point out that many of these were marketed only recently.

3. Tell the class to watch you carefully to try to discover what material you are making. Demonstrate the preparation of a plastic.

   Simultaneously pour 100 ml. of a saturated solution of analine hydrochloride and 100 ml. of 40% formaldehyde solution (formalin) into a 400 ml. beaker. Stir with a glass rod. Pour the thick dark brown substance into a mold.

4. Have the class identify the substance as a plastic. Tell them the names of the compounds you used and elicit that a chemical change had produced a new product.

5. Distribute materials and worksheets.

PUPIL WORKSHEET

PROBLEM 28. How can we prepare cold cream?

MATERIALS:

ammonium stearate
clear mineral oil
balance
beaker
stirring rod
perfume or cologne

WHAT TO DO:

1. Weigh 300 grams of ammonium stearate.
   Weigh 30 grams of mineral oil.

2. Mix the ammonium stearate and mineral oil.
   Add perfume.

3. Using a man's fragrance can make this a type of shaving cream.

QUESTIONS TO ANSWER:

1. How do you know that cold cream (or shaving cream) is a mixture and not a compound?

2. How many other kinds of things can you think of that are made through chemistry?

PROBLEM 29. HOW ARE PAINTS MADE?

OUTCOMES:

Paint is a mixture of colored pigment, oil and a dryer.
Pigments can be made by simple chemical reactions.
Dryers are chemicals that speed up the rate of drying.

MATERIALS: see pupil work sheet

PROCEDURE:

1. Explain that paint can be made by combining a colored chemical with oil, and that sometimes another chemical called a dryer is added.
2. Distribute materials and worksheets to each group of two or three pupils.
3. Go over questions. Emphasize the fact that paints are mixtures.

PUPIL WORKSHEET

PROBLEM 29. How are paints made?

MATERIALS:

carbon black	dryer	spatula
ammonium dichromate	matches	mortar and pestle
alcohol	asbestos	wood
turpentine	dropper	paint brush
linseed oil		

WHAT TO DO:

1. Make a small hill of ammonium dichromate on the asbestos. Put six drops of alcohol on top.
2. Carefully light the alcohol with a match.
3. Put the green compound you made into the mortar with a few drops of linseed oil.
4. Grind and mix the green pigment with the linseed oil. Add a little turpentine to make the paint thinner.
5. Paint the letter A on a piece of wood.
6. Add a little dryer to the paint. Paint the letter B on a new piece of wood.
7. Paint another piece of wood with plain linseed oil.
8. Put some carbon black in a clean mortar. Add linseed oil and grind it with the carbon black.
9. Add a little dryer and thin the paint with turpentine. Paint another piece of wood.
10. Set all the pieces aside. Check them at the end of the lesson.

QUESTIONS TO ANSWER:

1. What are the materials that go into making paint?
2. What reasons can you think of for painting things?
3. Next to a physical change write the letter P. Next to a chemical change write the letter C on the line.

	Kind of Change
a. Burn ammonium dichromate	________
b. Add linseed oil to pigment	________
c. Mix turpentine and paint	________
d. Grind the green pigment	________

PROBLEM 30. HOW DOES A FIRE EXTINGUISHER PUT OUT FIRES?

OUTCOMES:

Burning is the rapid combination of a substance with oxygen.
For a substance to burn it must have a sufficient supply of air and a high enough kindling temperature.

Carbon dioxide is a heavy gas that does not support combustion.

MATERIALS:

2 candles	flask	dilute sulfuric acid
large jar	one-holed stopper with tube	sodium bicarbonate
small jar	rubber tube	limewater
matches	wooden splint	tank of carbon dioxide
wood		2 test tubes

PROCEDURE:

1. Demonstrate that air is needed for a substance to burn.

   Light two candles and simultaneously place a large jar over one and a small jar over the other. When the candles go out, elicit that the candles needed air (oxygen) to burn and that they went out when the air supply was used up. The candle with the larger air supply was able to burn for a longer period of time.

2. Demonstrate that a material must be hot enough before it begins to burn.

   Bring a lighted match near a thick piece of wood. Elicit that the wood does not catch on fire because it is not hot enough. Explain that a substance must reach a certain temperature before it begins to burn, and that this temperature is called its kindling temperature.

3. Recall that in past lessons they burned hydrogen and iron. Elicit that in both cases the chemical change that occurred involved the combination of a substance with oxygen. Explain that this is the definition of burning used by scientists - the rapid chemical combination of a substance with oxygen.

4. Ask the class, "Now that you know what a fire needs to burn, how can you use this information to put out a fire?" Elicit that cutting off the air supply or cooling the fire will put the fire out. Point out that removing the fuel will also put out the fire.

5. Demonstrate that carbon dioxide can be made by adding dilute sulfuric acid to sodium bocarbonate (baking soda).

   Use a flask with a one-holed stopper and a glass tube. Connect a rubber tube and place it in lime water. Elicit that the lime water turns milky because the gas that is generated is carbon dioxide. SEE FIGURE. Explain that these are the two chemicals used in soda-acid fire extinguishers. Pour carbon dioxide gas over a burning candle. Place a burning splint in a second bottle of carbon dioxide. Elicit that the carbon dioxide does not burn. It is also a heavy gas, therefore it can be poured.

6. Distribute trays of materials and pupil worksheets.

7. Designate a safe place where the pupils can test their extinguishers.

PUPIL WORKSHEET

PROBLEM 30. How can we make a carbon dioxide fire extinguisher?

MATERIALS:

sodium bicarbonate
ketchup bottle
bottle cap with hole in center
vinegar
beaker
stirring rod
small test tube
string
wash basin

WHAT TO DO:

1. Mix three teaspoonfuls of sodium bicarbonate with some water in a beaker.

2. Fill one-half of the ketchup bottle with the mixture.

3. Fill the small test tube almost to the top with vinegar. The vinegar is taking the place of the sulfuric acid.

4. Carefully lower the small test tube into the bottle without spilling any vinegar. Screw the cap on the bottle tightly.

5. Start a small fire with paper in a wash basin after you check with your teacher.

6. Turn the bottle over and point it to the fire. What happened?

QUESTIONS TO ANSWER:

1. What was formed when sodium bicarbonate and vinegar were mixed?

2. What kind of change took place?

3. What two properties of carbon dioxide make it good for putting out fires?

4. What are the three things necessary for burning to take place?

5. What principle is used in putting out any fire?

PROBLEM 31. HOW IS A PHOTOGRAPH MADE?

OUTCOMES:

Silver salts which are sensitive to light are used to make photographs. A developer is used to bring about a rapid change of the silver salts. Hypo makes the contrasts in the photograph permanent by dissolving the silver salts.

MATERIALS:

4 trays	developer	sodium chloride
key	water	silver nitrate
pictures and negatives	hypo	2 test tubes

PROCEDURE:

1. Add a small amount of sodium chloride solution to a solution of silver nitrate. Pour the contents into 2 test tubes. Place one tube in the dark and expose the other one to a strong light.

2. Recall from an earlier lesson that silver chloride was formed and that it was changed by light. The dark material formed was silver. Elicit that the more light that strikes the salt, the more silver is formed and the darker the contents.

3. Examine the tube kept in the dark. Now expose it to light and add a little developer solution to see the immediate darkening.

4. Explain that photographic paper is made by coating paper with some of these light-sensitive silver salts. Film is made by coating a celluloid base with a gelatin emulsion of salts.

5. Have the pupils examine some pictures to see light and dark areas. Recall that dark areas were exposed to most light.

6. Examine some negatives. Point out that light and dark areas are reversed. (When film was exposed, white object reflected much light so film got dark. Black objects reflected less light, film is not exposed much.)

7. Use a slow printing paper, such as Velite, in a darkened classroom. Have the pupils place keys or other object on the paper and expose to light.

8. Demonstrate developing pictures and tell pupils they will do this in class next time. In each of four trays place respectively: developer, water, with a few drops of acetic acid, hypo fixer, water.
    a. Agitate print in developer until image appears.
    b. Dip into water in second tray (stop bath).
    c. Place in hypo or fixer and agitate occasionally for 10 minutes. (This dissolves rest of silver salts.)
    d. Place in fresh water for 15 minutes or more to wash off all chemicals. (Change water often.)

9. Review process of exposing and developing prints. (Films are extremely sensitive to light and can only be developed in a photographic dark room.)

10. Assign pupils to bring in negatives for next lesson.

(Tomorrow distribute materials and worksheets as soon as class enters classroom.)

PUPIL WORKSHEET

PROBLEM 31. How is a photograph made?

MATERIALS:

4 trays	developer	Velite paper
3 tongs	water	glass plate
negatives	hypo	light source

WHAT TO DO:

1. Set up 4 trays as your teacher did last lesson - developer, water with a few drops of acetic acid, hypo, plain water.

2. Take one piece of paper out of the envelope. Place a negative over the paper, then the glass plate.

3. Expose them to a bright light for a slow count of ten.

4. Drop the paper into the developer. Holding it with the tongs shake it until the image appears. Then drop it into the water.

5. Pick picture up immediately with second pair of tongs. Do this quickly as paper is still able to change color.

6. Drop picture into hypo or fixer. Use third pair of tongs to shake picture. Leave picture in hypo at least 10 minutes before you put it into the last tray.

7. Make another print. Change the length of time that you let the light shine on the paper and negative.

8. You may leave several pictures in the hypo at the same time. Do not let any of the hypo get into the developer or the developer won't work.

QUESTIONS TO ANSWER:

1. Why are silver salts used for photographs?

2. What does the developer do?

3. Why does a film become a "negative"?

4. How does the "negative" make a "positive" picture?

5. What is the purpose of the hypo?

PROBLEM 1. WHAT IS ELECTRICITY?

OUTCOMES:

Electricity is composed of very tiny particles which can move and produce heat.
Matter is electrical in nature.
a build-up or collection of electricity is known as static electricity.

MATERIALS:

Tesla coil
see pupil worksheet

PROCEDURE:

1. Motivate by asking, "Has anyone ever seen electricity?"

2. Demonstrate a Tesla coil by doing the following:

   a. Draw a small circle on a piece of paper and send a spark from the Tesla coil through the center of the circle. Pass the paper around and let the pupils observe the small holes.

   b. Concentrate the spark on a second piece of paper until it either scorches or catches fire.

3. Elicit explanations from the class. Point out that the Tesla coil produces high frequency alternating current and that particles are given off which produce heat when they move.

4. Distribute pupil worksheets. Read the list of materials with the class before distributing materials.

5. Distribute materials. Circulate while pupils are working, making suggestions and giving help.

6. Go over results of pupil activity and review answers to questions.

7. Summarize lesson by eliciting the outcomes.

PUPIL WORKSHEET

PROBLEM 1. What is electricity?

MATERIALS:

rubber rod
glass rod
plastic pen
silk cloth
fur strip

WHAT TO DO:

1. Touch a small piece of paper ($\frac{1}{2}$ inch square) with a glass rod, rubber rod, or plastic pen.
2. Rub each of the rods or the pen with the silk cloth. Then touch each one to the paper. Write on the chart below what happened.
3. Rub each thing with the fur strip. What happened?
4. Rub the glass and rubber rods together.

THINGS RUBBED AND TOUCHED TO PAPER	WHAT HAPPENED?
rubber rod and silk	
glass rod and silk	
plastic pen and silk	
rubber rod and fur	
glass rod and fur	
plastic pen and fur	
rubber rod and glass rod	

QUESTIONS TO ANSWER:

1. When did the glass rod, rubber rod, and pen attract the pieces of paper?
2. Which types of materials must be rubbed together to produce an attraction?
3. When have you noticed electricity attracting something or snapping?
4. Why do you think that rubbing the rod or pen made it attract the paper?
5. What does this tell us about how matter is made?

PROBLEM 2. WHAT IS MEANT BY AN ELECTRIC CURRENT?

OUTCOMES:

An electric current is a movement of electricity through a substance.

Current electricity continues to flow under the right conditions while a discharge due to a build up of static electricity occurs once.

MATERIALS:

see pupil worksheet

PROCEDURE:

1. Describe a person walking along a thick carpet. He touches a metal door knob and gets a shock. He places his hand on the knob again and nothing happens.

2. Elicit explanations from the class to bring out facts that a charge of static electricity had been built up and that there was a sudden discharge when the person touched the knob.

3. Distribute materials and worksheets.
   Be sure pupils wind wires in correct direction around screws.

4. When pupils have completed the exercise and have returned materials, go over answers to questions.

5. Recall the person walking on the carpet to point out that there was a single discharge. Have pupils point out that in today's lesson the electricity continues to flow as long as we keep the equipment connected.

PUPIL WORKSHEET

PROBLEM 2. What is meant by an electric current?

MATERIALS:

one dry cell
three one-foot strips of wire (bare at both ends)
minature lamp bulb and socket
salt solution in 100 ml. beaker

WHAT TO DO:

1. Look at your dry cell.
   What do you notice on top of the dry cell?

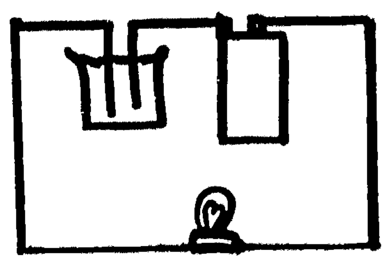
   One of these terminals is called the ________________ terminal and

   the other is the ________________ terminal.

2. Connect one wire strip to each terminal of the battery and then to the lamp socket. What happens?

3. Disconnect one wire. What happens?

4. Set up your equipment as shown in the diagram.



QUESTIONS TO ANSWER:

1. What happened when you set up the equipment in the diagram?

2. Why did the light go on?

3. How is the electricity in today's lesson different from the electricity we made yesterday?

PROBLEM 3. WHAT IS MEANT BY AN ELECTRIC CIRCUIT?

OUTCOMES:

In order to flow, electricity must follow a definite path.

The path must be complete or the current will not flow.

MATERIALS:

dry cell
one foot strip of insulated wire
see pupil worksheet

PROCEDURE:

1. Recall yesterday's lesson where pupils learned that a current was a continuous flow of electricity.

2. Elicit that an electric source and a path are needed. Introduce the word "circuit" and explain that this is the name given to the electrical path.

3. Distribute materials and worksheets.

   Pupils are to learn to follow the diagram. Be sure they hook up dry cells in series, i.e., plus to minus.

4. Show the students what is meant by a short circuit by placing a wire across the two terminals of a dry cell. A student can cautiously touch the wire to feel the heat generated.

   NOTE: Don't leave the dry cell short-circuited for more than 30 seconds.

5. Summarize by pointing out that the path must be complete or the current will not flow and that switches are devices used to close or complete a circuit.

PUPIL WORKSHEET

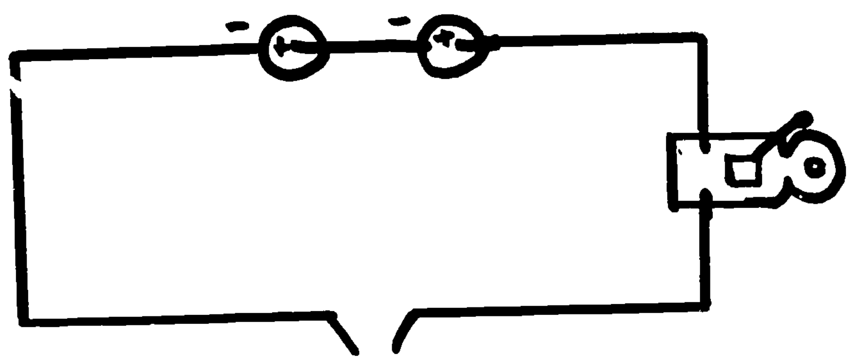
PROBLEM 3. What is meant by an electric circuit?

MATERIALS:

two dry cells	knife switch	screwdriver
bell	push button switch	wires

WHAT TO DO:

1. Set up the dry cells and bell as shown in the diagram.



Why doesn't the bell ring? ______________________________

2. Touch the ends of the wire together.

What happens? ______________________

3. Attach first the knife switch, and then the push button. Try each in the circuit.

QUESTIONS TO ANSWER:

1. What is the purpose of knife switches and push buttons?

2. What is the purpose of the dry cells?

3. What is a circuit? ______________________________

4. Why is a "short circuit" dangerous? ______________________

PROBLEM 4. HOW DO WE DRAW AN ELECTRIC CIRCUIT?

OUTCOMES:

To make things simple, electricians use symbols when drawing electrical circuits.

MATERIALS:

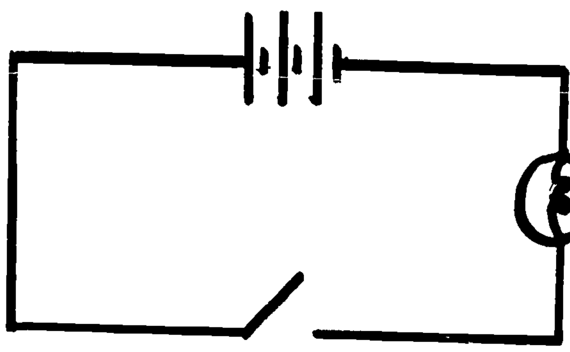
dry cells
miniature lamp and socket
knife switch
3 lengths of wire
wiring diagram from a radio or TV

PROCEDURES:

1. Set up three dry cells in series, connected to a knife-switch and a miniature lamp.

2. Have the pupils draw the set-up at their seats.

3. On the chalkboard draw the set-up using a schematic.



4. Have the students conclude that the schematic is the easier diagram to draw. Explain that this type of drawing is called a "schematic."

5. Explain the symbols by showing how they relate to the actual item.

   NOTE: An old dry cell which has been cut open will show the long and short terminals of the power source schematic.

6. Draw some other symbols, and show an actual wiring diagram from a radio or TV.

Bell 

 connected wires

push button 

 wires crossing but not connected

7. Give the children practice at "reading" schematics duplicated in advance or drawn on the board.

PROBLEM 5. WHAT ARE ELECTRICAL INSULATORS AND CONDUCTORS?

OUTCOMES:

Materials which carry an electric current are called conductors.

Materials which do not carry an electric current are called insulators.

Metals are good conductors of electricity.

MATERIALS:

see pupil worksheet
(Metal strips should all be same size, that of a glass slide.)

PROCEDURE:

1. Recall lesson from chemistry unit in which electrical conductivity of metals is established.

2. Distribute materials and worksheets.

3. Review questions.

4. Show various pieces of electrical equipment to note conductors and insulators; light bulb, plug, lamp socket, etc.

5. Together with the class, set up a set of safety rules:

    a. Never touch an electrical device that is in use when you are wet.

    b. Never let electrical appliances get wet.

    c. Be sure all electrical wiring is free of breaks.

    d. Any others that are suggested by pupils.

6. Be sure children are fully aware of fact that impure water (water is usually impure.) is a conductor of electricity and that the body's main protection is the skin. If the skin is wet, it offers little protection. Remind them, too, that ordinary house current can kill a person.

ERIC

PUPIL WORKSHEET

PROBLEM 5. What are electrical conductors and insulators?

MATERIALS:

- 2 dry cells
- wires
- galvanometer
- 2 alligator clips
- 3 volt lamp in socket
- glass slide
- electrician's tape (to test)
- strips of copper, aluminum, zinc, iron, rubber

WHAT TO DO:

1. Set up the equipment as you did in Chemistry, Problem 23, except that you will use a galvanometer in addition to a lamp in the circuit.

2. Test each strip of material by clipping it between the two clips. Break the circuit quickly so you don't run the dry cells down.

3. Fill in the chart below. Write down the best and the poorest metal conductors.

CONDUCTOR	NON-CONDUCTOR

QUESTIONS TO ANSWER:

1. What is another name for a non-conductor?

2. Why are bell buttons and wall switches made of plastic?

3. Do you think air is an insulator or a conductor?

4. How many other materials do you know of that are insulators?

5. What is the purpose of insulators?

6. In the human body a conductor or an insulator?

PROBLEM 6. HOW DOES ELECTRICITY PRODUCE HEAT?

OUTCOMES:

Heat is produced when electricity flows through a substance.

The amount of heat produced depends on the amount of current, the thickness of the wire and the material of which the conductor is made.

MATERIALS:

see pupil worksheet

PROCEDURE:

1. Review results of yesterday's lesson to recall that metals are not all equally good conductors.

2. Distribute materials and worksheets.

3. Show the heating elements in an iron, toaster, heater, etc. Explain the nichrome wire is generally used in these appliances.

4. Introduce the term "resistance" and explain that nichrome has more than 50 times the resistance of similar sized copper wires.

5. Explain or demonstrate that when wires made of the same materials are tested we find:

   a. The longer the wire, the more heat is made.

   b. The thinner the wire, the more heat is made.

6. Summarize:

   a. Heat is produced when electricity flows through a substance.

   b. The more electricity that flows through a wire, the more heat is produced.

   c. Some substances have higher resistance, that is, they don't let electricity go through easily, so they produce more heat.

PUPIL WORKSHEET

PROBLEM 6. How does electricity produce heat?

MATERIALS:

1 thermometer
12-inch piece of bare copper wire
12-inch piece of bare nichrome wire
insulated wire
3 dry cells
light bulb in socket

WHAT TO DO:

1. Make a circuit using one dry cell, insulated wire, light bulb in socket, and the piece of bare copper wire. Leave one wire loose.

2. Carefully wrap 3 turns of the bare wire around the bulb of the thermometer. Complete the circuit. Wait 10 Seconds. Read the temperature and disconnect the wire. What is the temperature?

3. Now place the bare nichrome wire in the circuit in place of the bare copper wire. What is the temperature?

4. Now place the bare copper wire back in the circuit. Add two more dry cells and again check the temperature in 10 seconds. What is the temperature?

QUESTIONS TO ANSWER:

1. Which wire made the most heat?

2. When did the copper wire get hotter, with one dry cell or with three?

3. What two things did you find that made a difference in the amount of heat made by electricity?

PROBLEM 7. WHY ARE FUSES PLACED IN A CIRCUIT?

OUTCOMES:

Fuses are safety devices placed in a circuit to prevent wires from overheating and creating a fire.

MATERIALS:

power pack
knife switch
miniature lamp and bulb
several lengths of wire
various types of fuses
fuse wires

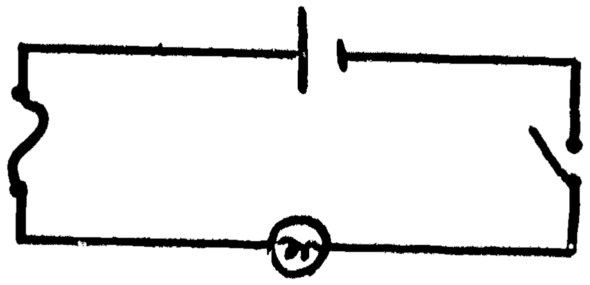
PROCEDURE:

1. Review the previous lesson by asking, "What happens when electricity passes through a wire?"
   Then ask, "What happens as we increase the amount of electricity passing through the wire?"

2. Have a student gradually increase the amount of current flowing through a piece of fuse wire inserted into a circuit with a lamp. Increase the current until the wire melts. Explain that we use the term "overloaded" to describe a circuit that has too much current flowing through it. Have children understand that fuse wire is especially made to melt when a certain temperature is reached.

3. Pass around fuses (plug and cartridge type) and have the pupils read the ampere numbers and describe the thickness of the metal in the fuse. Remind them that each allows a certain amount of electricity to flow through. When more than that flows through the wire, the temperature rises and the wire melts.

4. Place a 10-amp fuse in a circuit as shown in diagram.



   NOTE: The fuse can be placed in a lamp socket.
   Have a pupil complete the circuit. Open the circuit and replace the 10-amp fuse with a low-rated fuse or 0.1 or 0.5 amps. Have another pupil complete the circuit. (The wire should melt.) Explain that when the fuse wire melts we say the circuit has "blown".

5. Discuss, "Why are fuses made with different ratings?"

6. Demonstrate how a fuse is replaced.

7. Explain how circuit breakers are used in place of fuses.

8. As a summary ask, "Why is it dangerous to replace a 10-amp fuse with a 20-amp fuse?"

ERIC

PROBLEM 8. <u>HOW CAN WE CHECK AND REWIRE A PLUG?</u>

OUTCOMES:
To develop the skills needed to make simple electrical repairs.

MATERIALS:
Plug and frayed wire — see pupil worksheet
two lengths of double strand electric cord

PROCEDURE:
1. Show the class a plug and wire where the wire is frayed.
2. Have the students point out that this would be dangerous because:
   a. A person could touch the bare wires.
   b. A short-circuit is possible.
3. Distribute materials and pupil worksheets. Assist pupils and check work.

PUPIL WORKSHEET

PROBLEM 8. How can we check and rewire a plug?

MATERIALS:
plug
some electrical tape
screwdriver
3 lengths of double strand electral cord

WHAT TO DO:
1. Wire a plug by following the steps below:
   a. Divide one double strand electrical cord into two parts for a length of approximately two inches.
   b. Bare the ends of each strand of wire for about one-half inch.
   c. Wrap all the wire strands around the screws.
   d. The bare wires must not touch each other. WHY?
   e. The wires should be wrapped around the screw in the same direction as the screw is turned to tighten it.

2. Splice two lengths of cord together by the following steps:
   a. Divide each length of double strand electrical cord into two parts for a length of approximately two inches and remove the insulation from these ends.
   b. Leave one strand long and cut the other strand down to one inch. (See diagram).

   c. Twist the long strand of cord A together with the short strand of cord B. Twist the short strand of cord A together with the long strand of cord B.
   d. Wrap tape around each strand separately. WHY?
   e. Now wrap the two strands of insulted wire together.
   CAUTION: <u>NEVER</u> cut or work on any wire or plug which is connected to an electrical source.

PROBLEM 9. HOW IS ELECTRICITY MEASURED?

OUTCOMES:

Several devices can be used to measure electricity.

Voltmeters measure voltage or electrical pressure.

Ammeters measure amperes or amount of electricity flowing.

MATERIALS:

ammeter
voltmeter
picture of watt-hour meter
bathroom scale
quart container
see pupil worksheet

PROCEDURE:

1. Pour or collect water in a quart container so it takes 10 seconds to fill the container. Explain that since it took 10 seconds to fill the quart container, the rate or amount of flow is 1 quart per 10 seconds.

2. Show an ammeter and explain that this meter measures the rate of flow of electrons or the electric current in amperes.

3. Press against a scale to show that a force or push against an object can be measured. Explain that the amount of push against something is called pressure.

4. Show a voltmeter and explain that this meter measures the force or pressure driving the electrons around the circuit.

5. Distribute materials and worksheets.

6. Explain that the home watt-hour meters measure the amount of electricity we use during a certain period of time.

7. Summarize by reviewing the functions of each meter.

PUPIL WORKSHEET

PROBLEM 9. How is electricity measured?

MATERIALS:

voltmeter
2 dry cells
3 lengths of wire

WHAT TO DO:

1. Read the voltage written on the dry cell labels. Write the numbers on the chart below.

2. Listen to your teacher's direction on how to read the voltmeter.

3. Hook each dry cell, one at a time, to the voltmeter and write the number of volts of each on the chart. (Disconnect quickly.)

4. Add the volts on the labels and put the total at the bottom of the first column.

5. Now hook up both dry cells in series (plus to minus) and connect them to the voltmeter. How does this total compare with the total when each dry cell was tested separately?

	VOLTS ON LABEL	VOLTS ON VOLTMETER
DRY CELL # 1		
DRY CELL # 2		
TOTALS		

QUESTIONS TO ANSWER:

1. What is voltage?

2. What instrument measures voltage?

3. What is usual house voltage?

4. What is the unit of electric current?

5. How much is the usual house current?

PROBLEM 10.   HOW ARE WE CHARGED FOR THE ELECTRICITY WE USE?

OUTCOMES:

The work done by electricity is measured in units called <u>watts</u>.

We are charged for the number of watts we use each hour.

MATERIALS:

several different light bulbs

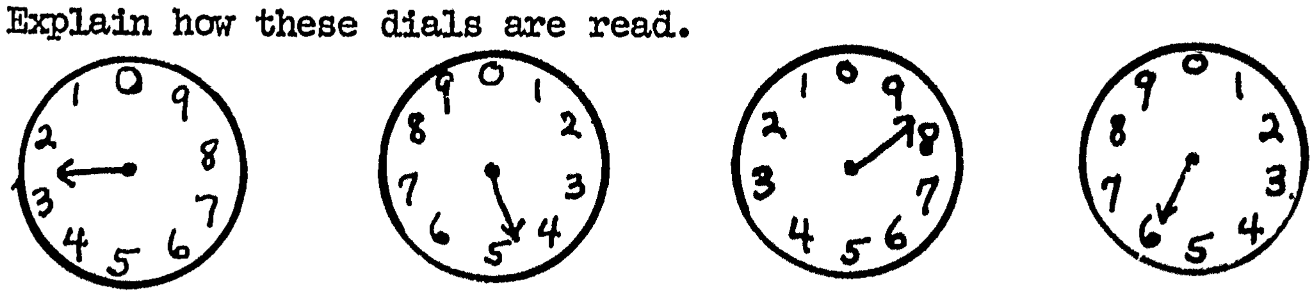
PROCEDURE:

1. Pass out several light bulbs of different wattage-rating.

2. Elicit from the students that the larger the wattage the more light the bulb produces. Explain that the bulb also uses more current.

3. Explain that in most basements there is an electric meter which keeps a count of the number of watts we use in an hour.

4. Draw the following meter dials.
   Explain how these dials are read.



5. Using some of the students' "light" bills calculate the cost of electricity over the period indicated on the bill.
   The average rate is 7.5 cents per kilowatt-hour or 7.5 cents for each 1,000 watts per hour. If two appliances rated at 1,000 watts each are being used, the cost per hour is 15 cents. The rate decreases with increased use.

6. Place several examples of meter readings on the board and have the students calculate the cost of the electricity.

7. Have the pupils check their parents' electric bill to look for the previous and present meter readings and to report on the number of kilowatts used for several two-month periods.

PROBLEM 11. HOW CAN WE MAKE ELECTRICITY?

OUTCOMES:

Electricity is produced chemically when we use two different metals and a solution that allows electricity to flow through it (an electrolyte).

MATERIALS:

galvanometer	lemon
strip of copper and zinc	2 lengths of wire
see pupil worksheet	(alligator clip at one end)

PROCEDURE:

1. Display the strips of metal and the lemon. Ask, "Can a lemon produce electricity?"

2. Attach the lengths of wire to the strips of metal and to the galvanometer. Dip the ends of the metal strips into the lemon. Elicit what happened. Point out that lemons contain acids and that acids in solution are electrolytes.

3. Distribute materials and pupil worksheets.

4. Explain that there are other combinations which produce electricity, such as, two different types of lead and sulfuric acid in an automobile battery.

5. Cut open an old dry cell. Have pupils identify the carbon rod, the metal container (zinc), and an electrolyte paste. Explain that the black paste contains the metal, manganese, and ammonium chloride which is slightly acid in solution.
   Write formulas on the board and have the children suggest acid may be HCl.

6. Be sure children understand that acid, base or salts added to water become electrolytes. Pure water does not conduct electricity.

PROBLEM 12. WHAT IS A MAGNET?

OUTCOMES:

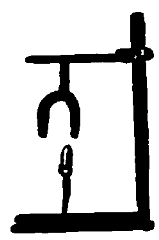
Magnets are objects that attract certain metals.
The ends of a magnet are called poles.
Poles that are alike repel each other. Poles that are the same attract each other.
A magnet produces an invisible field of force known as a magnetic field.

MATERIALS:

ring stand and clamp
fine thread or hair tied to a paper clip
see pupil worksheet

PROCEDURE:

1. Suspend a paper clip in "mid-air". (See diagram)



2. Elicit from the students that something from the magnet must be pulling on the clip.

3. Pass a piece of paper between the clip and the magnet.

4. To visibly demonstrate the magnetic field, use a section of a waxed milk carton. Place a magnet under the carton, sprinkle some iron filings on it, lift it carefully and heat it. After a few seconds the wax should melt. Remove the piece of carton and allow to cool. A fairly accurate picture of the magnetic field should be obtained.

5. Distribute materials and pupil worksheets.
Go over questions at end.

PUPIL WORKSHEET

PROBLEM 12. What is a magnet?

MATERIALS:

iron filings
2 magnets
sheet of plain white paper

various metallic and
non-metallic items

WHAT TO DO:

1. Try to pick up each one of the items on your tray with one of your magnets. On the chart below write the name of the item in the correct column.

PICKED UP (ATTRACTED)	DID NOT PICK UP

2. Using both magnets, place the end of one magnet next to the end of the other magnet. What happened?

3. Take one magnet and turn it around so that the other end comes next to the first magnet. What happened?

4. Lay the magnets end to end on the table with enough space between them so they don't move. Cover with a piece of paper. Sprinkle iron filings on the paper. Draw a picture of what you saw.

5. Return the iron filings to the shaker. Turn one magnet around and repeat what was done in 4.

QUESTIONS TO ANSWER:

1. What happens when two like poles come near each other?
2. What happens when two unlike poles come near each other?
3. How does the picture of the lines between two like poles look?
4. How does the picture of the lines between two unlike poles look?
5. What is meant by magnetic field?
6. Why did we use iron filings?
7. What kinds of things are attracted by magnets?

PROBLEM 13. HOW CAN WE USE ELECTRICITY TO MAKE A MAGNET?

OUTCOMES:

An electric current can produce a magnetic field.
The strength of an electromagnet can be increased by adding:
a. more current
b. more coils of wire

MATERIALS:

ring stand and clamps
2 dry cells
length of insulated wire
compass
iron nail
see pupil worksheet

PROCEDURE:

1. Demonstrate Oersted's theory by sending a current through an insulated wire. Place a compass near the wire and have the students observe the effect on the needle when the current is turned on and off. (Use two dry cells).
2. Elicit from the students that it seems as if the electric current is producing a magnetic field.
3. Demonstrate how to make an electromagnet by wrapping several turns of insulated wire around an iron nail.
4. Distribute materials and worksheets.
5. Go over questions at end of lesson.

PUPIL WORKSHEET

PROBLEM 13. How can we use electricity to make a magnet?

MATERIALS:

2 dry cells
1 two-foot length of insulated wire
1 iron nail
6 to 8 paper clips or tacks

WHAT TO DO:

1. Wrap 15 turns of wire around an iron nail, attach the ends to a dry cell and see how many paper clips or tacks you can pick up. Write your results below.
2. Connect another dry cell into the circuit and repeat the experiment. Write your results on the chart below.
3. Repeat the entire experiment, this time use 30 turns of wire. Write all results below.

Turns of Wire	Number of Tacks Picked Up with One Dry Cell	Number of Tacks Picked Up with Two Dry Cells
15		
30		

QUESTIONS TO ANSWER:

1. Why can a magnet be made using electricity?
2. How can you increase the strength of an electromagnet?
3. What makes an electromagnet so useful?

PROBLEM 14. HOW HAVE MAGNETS HELPED MAN?

OUTCOMES:

Some metals can be turned into magnets.
The earth acts as a giant magnet.
Directions are found on the earth by using a magnet called a compass.
Electromagnets are used to lift heavy amounts of metals, and to operate bells, telephones, telegraphs, etc.

MATERIALS:

lodestone	telegraph, telephone, bell, buzzer, etc.
compass	see pupil worksheet

PROCEDURE:

1. Show the class a natural magnet (lodestone) and demonstrate that it is a magnet.

2. Place a compass on the desk. Move the needle and allow it to come to rest. Move the compass again. Elicit from the students the fact that the earth must be attracting the needle in a particular direction. Ask them to point out how we can use this attraction.

3. Give each pupil a bar magnet, an iron nail and two paper clips.

4. Tell them to make the nails into magnets by stroking the nail in one direction only with one pole of the magnet. Have them test the nail by picking up the clips.

5. Elicit that they have made permanent magnets and that these nails are similar to the bar magnet and the compass needle.

6. Compare the permanent magnet with the electromagnet to point out that electromagnets are temporary magnets. They are magnets only while the electricity flows through the wires.

7. Point out that electromagnets are used in a greater variety of objects because it can be turned off and on and because its strength can be varied.

8. Show the objects or pictures and explain how the magnet is used:
   a. electromagnet crane - This moves large masses of iron and steel.
   b. telephone receiver - An electromagnet receives an electric current that varies. This makes the magnetism change in strength and pull on the diaphragm with changing force of attraction and vibrations are set up.
   c. bell or buzzer - Pressing the button closes the circuit and makes an electromagnet which attracts the clapper. When the clapper is pulled it hits the bell.

9. Elicit other ways in which magnets affect our lives. Explain that electric motors contain electromagnets and permanent magnets. Thus any device using an electric motor is an example of the usefulness of magnets.

PROBLEM 15. HOW CAN MAGNETS MAKE ELECTRICITY?

OUTCOMES:

When a coil of wire is moved through a magnetic field, electricity is produced.

Devices that produce electricity electricity by magnetism are known as generators.

MATERIALS:

large coil of wire
table top galvanometer
bar magnet
hand generator
see pupil worksheet

PROCEDURE:

1. Display a large coil of wire connected to a galvanometer. Explain that Michael Faraday set a similar experiment and then asked himself the following. "If electricity can produce magnetism, can magnetism produce electricity?" Move magnet near coil to see movement of needle.

2. Distribute materials and worksheets.

3. Go over questions.

4. Demonstrate a hand generator. Have pupils examine, to name parts, and operate, to show the greater the speed of operation, the more the electricity.

5. Refer back to lesson on magnetic lines of force to explain that coil cuts these lines of force and electricity flows.

6. Review that the following are needed to generate electricity:

    a. a coil of wire in a closed circuit.

    b. a magnetic field

    c. motion

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PUPIL WORKSHEET

PROBLEM 15. How can magnets make electricity?

MATERIALS:

galvanometer
coil of wire
magnet

WHAT TO DO:

1. Connect the bared ends of the coil to the terminals of the galvanometer. CAUTION: The galvanometer should be handled with great care.

2. Do the following experiments and record the results of each in the table below:

    a. Hold the coil of wire and move the north pole of the magnet in slowly.

    b. Repeat, moving the magnet rapidly.

    c. Repeat both experiments using the south pole.

    d. Place the magnet in the coil and don't move it.

    e. Move the coil of wire past the magnet.

TABLE OF RESULTS

	Galvanometer Reading	Direction
N-pole in slowly		
N-pole in rapidly		
N-pole out rapidly		
S-pole in slowly		
S-pole in rapidly		
Magnet not moving in coil		
Coil moving past magnet		

QUESTIONS TO ANSWER:

1. Besides the coil and the magnet, what else was needed to create an electric current?

2. Does current have a direction? How do you know?

3. How does the speed of a moving magnet affect the current?

PROBLEM 16. WHAT DO WE KNOW ABOUT LIGHT?

OUTCOMES:

We must have light in order to see.
Light is composed of colors.
Light travels in a straight line at the speed of 186,000 miles per second.
Light can be blocked, partially transmitted, or completely transmitted.
Opaque objects block light. Translucent objects allow some light to pass through. Transparent objects allow almost all the light to pass through them.

MATERIALS:

cigar box
short length of rubber tubing
prism
2 pieces of cardboard with small hole in each

PROCEDURE:

1. Unseen by the class, place an object in a cigar box which has a small hole punched in one end. Close the cover and ask a student to look into the box. Have another student look through the hole, but this time open the cover. Ask both students what they saw. Ask the class to explain.
2. Discuss what happens when some one walks into a dark movie theater. Explain what would happen in a light-proof room.
3. Have a student look into a short length of bent rubber tubing. Then have him straighten the tube and look through it. Ask, "What does this tell us about light?"
4. Have another pupil hold the two pieces of cardboard before his eyes about a foot apart. Let him look through one hole and move the other cardboard around to see that the holes must be on a line with the eye and the light source.
5. Elicit or state that light travels or leaves the object that makes the light. The speed at which it moves is 186,000 miles each second.
6. Pass sunlight coming through a hole in a large cardboard or the light from a projector through a glass prism to show that white light is composed of several colors.
7. Distribute the following materials:

   square of waxed paper
   square of glass
   candle
   square of wood

8. Instruct the class to light the candle and look at the flame through the wax paper, the glass and the wood. Then, they are to complete the chart.

OBJECT	AMOUNT OF LIGHT (ALL, SOME, NONE)	TYPE OF OBJECT
Clear glass		
Waxed paper		
Block of wood		

9. Summarize by eliciting outcomes.

PROBLEM 17. WHY DO WE SEE THINGS?

OUTCOMES:

Light must come from the object to the eye to be seen.

Some objects give off their own light.

Most objects are seen by reflected light.

Colored objects reflect those colors that we see and absorb the other colors.

MATERIALS:

cigar box with a hole at one end
several objects in box
see pupil worksheet

PROCEDURE:

1. Allow someone to look into the hole in the cigar box to identify any of the objects. Keep the lid closed.

2. Now open the lid while someone looks through the hole.

3. Elicit that light now shone on the objects and was then sent to the eye. Explain that this is called reflection and that most objects are seen by reflected light.

4. Recall that it is difficult to see clean, clear glass which transmits most of the light falling on it.

5. Elicit that white light is made up of several colors. Explain that white light that shines on something may be partially absorbed. For example, the green plants absorb most of the light except the green rays. These are reflected and we see a green plant.

6. Distribute materials and worksheets. Assist pupils in making accurate observations and drawings.

PUPIL WORKSHEET

PROBLEM 17. What is reflection?

MATERIALS:

paper
ruler
mirror
object
protractor

WHAT TO DO:

1. Place the paper flat on the desk. Stand the mirrow up at the edge of the paper.

2. Place an object on the paper near a corner away from the mirror.

3. Looking with one eye only, look at the reflection of the object.

4. Put one mark at the point on the mirror where you saw the image. Place another mark on the paper right under the place where your eye was.

5. Now draw one line from the eye to the point at the mirror. Draw another line from the mirror to the object.

6. Now construct a line at the point on the mirror at right angles to the mirror.

7. Measure the two angles. The line from the object and the right angle line form the <u>angle of incidence</u>. What does this angle measure?

8. The other line and the right angle line form the <u>angle of reflection</u>. What does this angle measure?

9. Repeat the above procedure using different points.

QUESTIONS TO ANSWER:

1. What is the law of reflection?

2. What must happen in order for us to see something?

3. What is the smallest size mirror a person can use to see his full image? (Use the law of reflection to figure it out.)

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PROBLEM 18. HOW DO LENSES HELP US TO SEE?

OUTCOMES:

Lenses refract (bend) light.
Convex lenses can be used to magnify objects.
Concave lenses spread the light out.

MATERIALS:

light source	round flask filled with fluorescein and (water
concave and convex lenses	optical disc apparatus
	see pupil worksheet

PROCEDURE:

1. Display several objects using lenses, such as, eye glasses, camera, microscope, magnifying glass, etc., to show the importance of lenses.

2. Tell the class that the shape of the lens determines what happens to the light that passes through it. Explain that when light passes from one substance into another, the light bends. Thus, when light goes from air into glass and back into air, it has been bent twice.

3. Distribute materials and worksheets.

4. When pupils have finished, go over the questions.

5. Using the optical disc apparatus, pass light through each lens and through the flask of water and fluorescein.

6. Have the pupils draw pictures of the light rays passing through some lenses.

7. Elicit the outcomes as a summary of the lesson.

PUPIL WORKSHEET

PROBLEM 18. How do lenses help us to see?

MATERIALS:

concave lens convex lens

WHAT TO DO:

1. Pick up one lens and run your fingers over both surfaces. How does it feel?

2. Now feel the other lens. How does this one feel?

3. Draw a picture of each lens as if you are looking at a cross section of the lens.

4. Label the one that bulges out in the middle a convex lens. Label the other one concave.

5. Look at some words on the worksheet through the convex lens. How do they look.

6. Do the same with the concave lens. What did you see?

QUESTIONS TO ANSWER:

1. What material are the lenses made of?

2. How would you describe this material in terms of what happens to light that shines on it?

3. Why does a lens make objects appear smaller or larger?

4. What are some uses of convex lenses?

5. What are some uses of concave lenses?

PROBLEM 19. HOW DOES THE EYE SEE?

OUTCOMES:

The eye is a light-proof organ which admits light images through a single opening.
It is a delicate and sensitive organ.
The brain receives and interprets light images, only then do we "see".

MATERIALS:
chart of the eye
model of the eye
eye of sheep, cattle or pig

PROCEDURE:

1. Display the chart and the model of the eye.

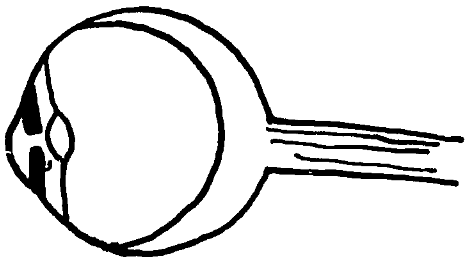
2. Point out the part and give the function of each of the parts:

a. eyeball	- light-proof organ
b. cornea	- protective covering in front of eye
c. crystalline lens	- convex lens which bends the light to form an image
d. iris	- colored part of eye that regulates size of opening(pupil)
e. retina	- sensitive "screen" on which image falls (image is inverted.)
f. optic nerve	- nerve which transmits image to brain. (Brain interprets image right side up.)

3. In addition, discuss the aqueous humor between the cornea and iris and the vitreous humor inside the eyeball. Both of these help to bend the rays of light and to maintain the shape of the eye.

4. Dissect an animal eye to show the eye as it actually looks.

5. Have pupils draw the diagram and label the parts.



6. Ask pupils to point to structures of eye on wall chart and give the job of each.

7. Pupils may be assigned projects of:
   a. determining correction lenses for various eye defects
   b. describing in words and drawings, nearsightedness, farsightedness, astigmatism
   c. studying diseases of eye, such as, glaucoma
   d. drawing up good habits for care of the eye

PROBLEM 20. HOW DOES THE MICROSCOPE WORK?

OUTCOMES:

Instruments with more than one lens are called compound instruments.
The microscope has several lenses.
The microscope has a mirror to catch and reflect light.

MATERIALS:

microscope
chart of microscope (see biology section)
see pupil worksheet

PROCEDURE:

1. Show the microscope to the class. Point out the mirror, the hole in the stage, the objective lenses and the eyepiece lens.

2. Show how the mirror moves. Allow a pupil to run his fingers over the mirror and describe it as having one plane or flat surface and one that is concave.

3. Draw on the board a broad beam of light being reflected from a flat surface.

4. Draw a narrow beam being made to diverge or spread by a concave mirror.

5. Explain that the flat mirror is used with sunlight and the concave mirror is used with artificial light.

6. Have pupils state the law of reflection and use that to explain the use of the mirror to direct light through the opening.

7. Allow one or two pupils to look at the objective lenses for the 10X and the 40X marks. Explain that this means the one makes things appear ten times as large and the other makes the image forty times as large as the object.

8. Now indicate the eyepiece lens and tell the class that this magnifies the image ten times. Guide the class to see that the final magnifications will be 100 and 400 times normal size.

9. Elicit that image is inverted as it passes through a lens.

10. Distribute pupil materials and worksheets.

PUPIL WORKSHEET

PROBLEM 20. How can we make a simple microscope?

MATERIALS:

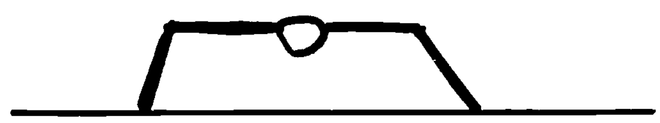
strip of metal (4"x1")
hammer
thin nail

WHAT TO DO:

1. With the hammer and the nail, punch a small hole through the center of the metal strip.

2. Make a one-inch bend on each end of the metal strip. Place the bent metal strip on your desk so that it stands without falling over.

3. Place a small drop of water on the hole. This instrument is called a water-drop microscope.



4. Observe the drop of water. Does it look like a convex or a concave lens?

5. Write a small letter "e" on a piece of paper. Place it under the microscope and look through the water drop. Press gently on the metal to get a clearer image. How does the size of "e" compare to the image through the water drop?

QUESTIONS TO ANSWER:

1. Why does the waterdrop make the "e" appear larger?

2. What is the purpose of the lenses in a microscope?

3. Why do we need a mirror on the microscope?

4. What kind of material do you need to be able to see it through the compound microscope?

ERIC

PROBLEM 21. HOW DO WE USE LIGHT TO TAKE PICTURES?

OUTCOMES:

Photography is a process which uses light to chemically produce a permanent picture.
Cameras gather light images and focus them on a film.

MATERIALS:

large test tube
5% silver nitrate solution
5% sodium chloride solution
test tube rack
light source
film strip projector
see pupil worksheet

PROCEDURE:

1. As a review, mix the silver nitrate and sodium chloride solutions together. Divide the suspension which is formed equally between both test tubes. Place one in front of the light source and the other in a dark area. Later in the lesson show the results.

2. Make several drawings on the board to show how the camera lenses form images.

3. Explain that cheaper cameras have a single fixed lens which will give a good image at most distances beyond six feet.

4. More expensive cameras are made so lenses can be moved to give clearest picture possible at various distances.

5. Distribute pupil materials and worksheets.

6. When pupils have completed, show the enlarging effect of a slide projector. Recall how contact prints were made in chemistry. Point out that negative may be put into an enlarger similar to the slide projector which can be moved to produce clear images of various sizes.

PUPIL WORKSHEET

PROBLEM 21. How can we make a pinhole camera?

MATERIALS:

shoe box (brought from home)
dull black water paint and large brush
sheet of thin white paper (tracing paper)
tape
pin

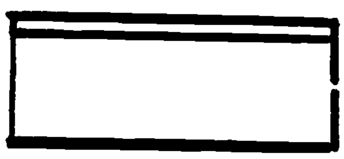
WHAT TO DO:

1. Paint the inside of the shoe box black.

2. Cut out one end of the shoebox and replace it with the white paper.

3. Make a small hole in the center of the opposite end of the shoe box.

4. Cover the box and point the pinhole end toward a bright object. If an image is not seen make the pinhole slightly larger.



QUESTIONS TO ANSWER:

1. Why did you paint the inside of the box black?

2. How did the pinhole act like a lens?

3. Is the image inverted?

4. If you wanted to take a picture where would the film be placed?

PROBLEM 22. WHAT FORMS OF LIGHT ARE USED IN THE HOME?

OUTCOMES:

Artificial light is produced by chemical changes and transformation of electrical energy.

Some common forms of lighting include:
a. incandescent lamp
b. fluorescent lamp
c. "neon" signs

MATERIALS:

magnesium strip	electric heater or a glowing wire set-up
tongs	fluorescent lamp demonstrator
asbestos pad	power pack
burner	assorted Geisler tubes
hand generator	

PROCEDURE:

1. Burn a strip of magnesium. Elicit that burning is a chemical change which produces heat and light.

2. Display the ash and recall that a new product results.

3. Describe Edison's search for a melt-resistant material, and the ultimate result. (carbonized sewing thread in a airless container)

4. Demonstrate an electric heater. Explain that the heater contains a very thick, heat-resistant metal. Recall that heat is produced as electricity flows. Point out there is also some light.

5. Demonstrate a light bulb lit by a hand generator. Examine the filament of a light bulb to note that it is long and thin. Recall that electricity flowing through very thin wires produces much heat. Point out that this filament becomes so hot it glows.

6. Demonstrate the fluorescent lamp apparatus and describe its method of light production.
Electricity strikes mercury vapor which sends electrically charged particles into the fluorescent chemical coating the lamp.

7. Demonstrate several Geisler tubes, and explain that "neon" signs are actually tubes containing many different kinds of glowing gases, not only neon gas. The gas determines the color.

8. Summarize as follows:

Main types of artificial lighting	Method of production
a. Incandescent lamp	Glowing metals
b. Fluorescent lamp	Glowing chemicals
c. "Neon" signs	Glowing gases

PROBLEM 23. WHAT IS SOUND?

OUTCOMES:

Sounds are caused by vibrating bodies.
Sounds travel at the speed of 1,100 feet per second.

MATERIALS:

bell, switch, and battery connected in series
see pupil worksheet

PROCEDURE:

1. Have all the pupils close their eyes and listen. Ask them to describe what happened.

2. As they tell some of the sounds they heard, explain that they are going to learn something about sound.

3. Distribute materials and worksheet. Have bell set up at demonstration table.

4. When exercises have been completed, go over questions.

5. Explain that the vibrations must fall between 20 and 20,000 vibrations per second to be heard.

6. Have children think of thunder storms to recall that the thunder clap always sounds after the lightning is seen.

7. Elicit that light travels at 186,000 miles per second. Tell the pupils that sound vibrations travel through the air at approximately 1100 feet per second. Explain how people often estimate how far away a storm is by the time interval between the flash and the sound.

8. Summarize by having pupils list what they have learned about sound.

PUPIL WORKSHEET

PROBLEM 23. WHAT IS SOUND?

MATERIALS:

pith ball and string
250 cc beaker of water
rubber band
tuning fork

WHAT TO DO:

1. Hold a pith ball by its string. Gently tap a tuning fork on a rubber heel and allow it to touch the pith ball. What happened?

2. Now tap the tuning fork firmly, and repeat what you did. What happened?

3. This time tap the tuning fork gently and dip the ends of the fork into a beaker of water. What happened?

4. Repeat but strike the fork firmly. Did anything change?

5. Stretch a rubber band. Have your partner pluck on the rubber band, first gently, then firmly. What did you hear?

6. On your teacher's desk you will find a bell circuit. Complete the circuit and hold your pith ball near the striker. What happens to the pith ball?

QUESTIONS TO ANSWER:

1. Was there any difference in the motion of the pith ball when the tuning fork was struck firmly and when it was struck gently?

2. Was there any difference in the sound made by the tuning fork?

3. When did the water splash more?

4. Did the rubber band sound differently when plucked hard rather than gently?

5. What did each of these experiments show you about what causes sound?

6. What did you learn about the loudness of sound?

7. What is the word that describes fast motion back and forth?

PROBLEM 24. HOW DOES SOUND TRAVEL?

OUTCOMES:

Sounds travel through matter in waves.
Sounds travel better through solid and liquid materials than through gases.
Sounds must travel through a substance. There are no sounds in a vacuum.

MATERIALS:

bell in vacuum jar
power pack
vacuum pump
2 small stones
Slinky toy or spring
1 empty fish tank
1 fish tank filled with water

PROCEDURE:

1. Stretch out a Slinky on the desk. Grasp both ends and with short jerking motions snap one end of the Slinky. Explain that sound travels through the air in the same fashion as the motion through the spring.

2. Give the following instructions to the class:

   a. Sit up straight in your chair, extend your arm onto the desk, and gently scratch the desk with your finger.
   b. Place your ear on the desk and scratch gently. (Make sure your arm is extended away from you.)

3. Ask, "Did you hear a difference in the sound?" "When was the sound louder?"

4. Have a pupil go up to the teacher's desk and place his ear next to the fish tank filled with water. Tap two stones together underwater. Then have him place his ear next to the tank without water. Tap the stones together inside the tank.

5. Have him tell in which tank the sounds were louder.

6. Ask for experiences at the beach or pool which also show that sounds travel better in liquids than in air.

7. Turn on the bell in the jar. Evacuate the air from the jar and elicit what happens. Have the students observe the striker still moving.

8. As a summary or homework assignment have the students come to the conclusion that sounds generally travel better through solids and liquids than through gases and that sounds must travel through a medium. There are no sounds in a vacuum because there is no substance to transmit the vibrations.

ERIC

PROBLEM 25. WHAT ARE SOME DIFFERENT FORMS OF ENERGY?

OUTCOMES:

There are two kinds of energy:

kinetic - the energy of doing something (motion)

potential - stored energy

Energy may be found in different forms:

mechanical	chemical
electrical	radiant (heat and light)

MATERIALS:

ruler	candles (2)	flashlight
beaker (100 ml.)	tesla coil	2 beakers (250 ml.)
eggbeater	hand generator	dry cell
match	hammer	

PROCEDURE:

1. Elicit from the students their concepts of the word energy.

2. Explain that simply stated, energy means to have the ability to move something.

3. Place a ruler on a cylindrical object. Place a penny on one end of the ruler and hold a book over the other end. Explain that the book has potential (stored) energy because it can do something. Drop the book onto the ruler. Elicit what happened.

4. Elicit and list on the board different forms of energy.

5. Hold up the objects listed above and have the pupils fill in a chart such as the one below.

ITEM	KIND OF ENERGY (potential or kinetic)	FORM OF ENERGY
EXAMPLE: Dry cell	Potential	Chemical
Eggbeater in use		
Unlit candle		
Burning candle		
Operating Tesla Coil		
Hand Generator		
Hammer in use		
Running Water		
A lit Flashlight		

NOTE: If a sink is unavailable for the running water experiment, pour the water back and forth between two beakers.

ERIC

PROBLEM 26. WHAT HAPPENS TO ENERGY WHEN IT IS USED?

OUTCOMES:

Energy is neither created or destroyed, but is transformed from one form to another.

MATERIALS:

wet cell (zinc strip, carbon rod, in a jar of saturated ammonium chloride)
miniature lamp and socket
hand generator
radiometer
see pupil worksheet

PROCEDURE:

1. Display a wet cell and elicit the type of energy involved.
2. Connect the wet cell to a miniature lamp socket and elicit the energy conversions which take place. (chemical to electrical to radiant)
3. Crank a hand generator. Elicit the energy conversions which take place.
4. Place a radiometer in light and elicit the energy conversion.
5. Distribute materials and worksheets.
6. Go over results.

PUPIL WORKSHEET

PROBLEM 26. What happens to energy when it is used?

MATERIALS:

match
hammer
asbestos pad
metal strip
wood splint
safety lighter

WHAT TO DO:

1. Look at the chart below and do what it says in the column headed "Experiment."

2. Next to each experiment write down the energy you start with and the energy you end up with.

EXPERIMENT	ENERGY AT THE BEGINNING	ENERGY AT THE END
Strike a match		
Rub hands together		
Hammer a metal strip (feel the strip)		
Burn a wood splint		
Strike a safety lighter		

QUESTIONS TO ANSWER:

1. How is running water used to generate electricity?

2. What kinds of energy changes take place in the body?

3. What is the law of the Conservation of Energy?

PROBLEM 27. WHAT ARE SIMPLE MACHINES?

OUTCOMES:

A simple machine is a device which enables us to do work more conveniently.
Some simple machines are:

levers	wheel and axle
pulleys	screws
inclined planes	wedge

MATERIALS:

cord	wedge	wood plank 8" long x 4" wide
18-inch ruler	paper	drill and bit or screwdriver and screw
pulleys	object to be weighed	
spring balance	pictures of various machines	

PROCEDURE:

1. Stack up 3 or 4 textbooks and have a student attempt to raise one end of the stack with one finger.
2. Place an 18-inch ruler about 3 inches under the books. Place a pencil under the ruler, near the books. Have the same student press on the ruler with his finger. Elicit which method required less effort. Explain that the ruler acted as a simple machine called a lever.
3. Elicit examples of levers: automobile bumper jack, crowbar, etc.
4. Weigh an object on a spring balance. Now weigh it using a system of pulleys. (Do not use a single fixed pulley as this only changes direction of force. Although this is useful, show a system which reduced the effort.)
5. Elicit examples of pulleys in use: block and tackle on ship for lifting cargo, pulleys on scaffolds, etc.
6. To demonstrate wheel and axle, open a door by turning the door knob. Remove the knob and try to turn the stem.
7. Elicit other examples, such as, water faucet, screw driver (handle is thicker), automobile steering wheel.
8. Briefly show examples of the inclined plane. Do not go into detail as pupils will do a laboratory lesson on the inclined plane tomorrow.
9. Show that the screw is a form of inclined plane by making a right triangle out of paper and wrapping it around a pencil. The cut edges make a spiral, the threads, of a screw. Elicit examples of screws, such as, sone car jacks.
10. Show a wedge and elicit that it is two inclined planes against each other. Elicit its use in splitting apart objects.
11. Summarize by listing the six simple machines on the board and some of their uses.

PROBLEM 28. HOW CAN WE TELL IF A SIMPLE MACHINE SAVES EFFORT?

OUTCOMES:

A simple machine is a device that enables us to do work better.
It usually enables us to use less force but requires us to move that force through a greater distance.
Work equals force times distance.
The work that comes out of a machine cannot be greater than the work that goes into it.

MATERIALS:

see pupil worksheet

PROCEDURE:

1. Distribute materials and worksheets.
2. Go over answers to questions.
3. Elicit outcomes.

PUPIL WORKSHEET

PROBLEM 28. How can we tell if a simple machine saves effort?

MATERIALS:

spring scale
thread or string
inclined plane board and cart
ruler
an object to be weighed (not to exceed 200 grams)

WHAT TO DO:

1. Your teacher will demonstrate how to use and read the spring scale.

2. For practice, weigh the object in your tray. (Use the thread to tie the object to the scale.) Write the weight find in the space below. Do not go on until your teacher checks it.

   Weight of object ________________

3. Weigh the cart by lifting it with the spring scale 4 inches off the desk. This is the force needed to lift the cart.

   Weight of cart ___________ Distance moved______________

4. Raise one end of the inclined plane 4 inches off the desk. Pull the cart up the inclined plane with the spring scale. As you are doing this carefully, check the scale, and record the reading below. (Do not take the reading as you begin to pull but as you are rolling.)

   Weight of cart on the inclined plane ______ Distance moved _______

5. Work is known as the product of a force x the distance it moves something.
   a. How much work did you do when you lifted the cart four inches?
   b. How much work did you do when you pulled the cart up the inclined plane?

QUESTIONS TO ANSWER:

1. Did the inclined plane increase the height to which the object was lifted?

2. Did the machine increase the amount of work you got out?

3. What good did the machine do?

4. Where have you seen inclined planes used to help do work?

PROBLEM 29. HOW DOES THE HUMAN BODY ACT AS A MACHINE?

OUTCOMES:

The body is mostly a combination of levers.
Some parts of the body act as inclined planes or screws.

MATERIALS:

chisel	screw, set halfway into a block of wood
screwdriver	human skeleton

PROCEDURE:

1. Have each student stretch out his arm and raise a textbook off the desk.
   NOTE: Be sure the arms are held stiff and the textbook is a large one.

2. Then instruct the students to bend their elbows and repeat the process. Ask, "Which method is easier?" Point out that the arm is itself a lever with a fulcrum at the elbow.

3. Draw or show the point of a chisel. "What simple machine does the chisel represent?" (inclined plane) Explain that the purpose of the chisel is to drive the point through or under something. Ask, "What objects in the mouth act as chisels?" (incisor teeth)

4. Point to the screw set into the wood and challenge a student to drive the screw into the wood without twisting his arm or using a hammer.
   NOTE: This can be accomplished by the student if he holds the screwdriver onto the screw and walks around in a circle.

5. Have a student perform the normal function with the screwdriver. Call attention to the motion of his arm. Elicit the simple machine this motion represents. (screw)

6. Study the human skeleton to move the bones as they would normally move to point out the hinged joints and movements, the ball and socket joints and movements.

7. Have pupils make a list in their books of the various examples given.

PROBLEM 30. WHAT IS WEIGHT?

OUTCOMES:

All matter has weight.
The weight of a body depends upon the gravitational force upon the body.
Units of weight include poinds, ounces and grams.

MATERIALS:

spring scale
several objects to be weighed
see pupil worksheet

PROCEDURE:

1. Drop several objects. Ask, "Why are they falling?" The students should understand that gravity is causing the objects to fall by pulling them toward the earth.

2. Ask, "Can we measure the pull of gravity on an object?" Elicit methods - heft, variety of scales.

3. Demonstrate by weighing several objects on a spring scale.

4. Explain that all matter has weight. Refer back to the chemistry unit and elicit that even air has weight. Recall that a balance scale was used.

5. Explain that scientists weight things in units called grams. Discuss weights in Europe.

6. Give out pupil materials and worksheets.

7. Elicit how many grams equal one ounce (30 g.)

8. Elicit the outcomes.

ERIC

PUPIL WORKSHEET

PROBLEM 30. What is weight?

MATERIALS:

spring scale with both ounces and grams on scale
known weights (10g, 20g, 100g)
unknown weights (washer, pen, metal block, mail, etc.)

WHAT TO DO:

1. Weigh the known weights one at a time on the spring scale. You may use two weights to get the different combinations found on the chart. Write the weight you found in ounces next to the weight in grams.

2. Weigh the unknown weights and write the weight of each in ounces and grams on the chart below.

	WEIGHT IN GRAMS	WEIGHT IN OUNCES
KNOWN WEIGTS		
UNKNOWN WEIGHTS		

QUESTIONS TO ANSWER:

1. How many kinds of scales do you know that are used for weighing things?

2. What is weight?

3. How does the spring balance work?

PROBLEM 31. WHAT IS MEANT BY PRESSURE?

OUTCOMES:

Pressure is produced by the weight of an object.
Pressure is the force on a surface.
Air pressure exerts a very powerful force.

MATERIALS:

bunsen burner	vacuum pump
tripod	Magdenberg hemisphere
gallon can	ruler
barometer	

PROCEDURE:

1. Have a pupil place his hand flat on his desk. Place your hand on his and apply pressure. Elicit from the student that he is feeling pressure on his hand. Ask, "What is causing the pressure?"

2. Demonstrate air pressure by heating a small amount of water in a gallon can. After steam has been coming out of the can for several seconds, turn off the flame and cap the can.
   NOTE: As the steam in the can cools and condenses, a partial vacuum is formed inside the can. The outside pressure being so much greater crushes the can.

3. Have a student evacuate the air from the Magdenberg hemispheres. Select two large boys and have them attempt to pull the hemispheres apart. Explain that air alone is holding the spheres together. Then call on a small boy, open the stopcock, and have the student separate the hemispheres.

4. Draw a long narrow column on the board. Explain that if this represented a column of air one inch square at the base, it would extend upward over two hundred miles. Have the class picture weighing that column and state that it would weigh almost fifteen pounds.

5. Explain that each square inch column would weight the same so we say air pressure is equal to approximately 15 lbs. per suqare inch.

6. Have the pupils figure the total force exerted downward on an object by air.

7. Show one or more barometers and explain that the air pressure is enough to hold up a column of mercury about 30 inches. Show the readings on an aneroid barometer. Explain the weather reports on air pressure.

8. Elicit the outcomes.

PROBLEM 32. WHAT HAPPENS TO THE PRESSURE OF AIR WHEN THE AIR MOVES?

OUTCOMES:

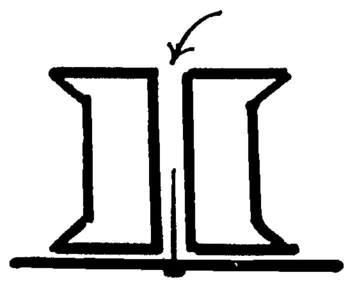
As air moves faster its pressure decreases.

MATERIALS:

thread spool	small disc of cardboard
pin	see pupil worksheet

PROCEDURE:

1. Set up the demonstration as shown in the diagram.



2. Blow into the spool. The cardboard should remain under the spool. Elicit explanations.

3. Distribute materials and worksheets.

4. Assist the children in answering the questions and drawing diagrams.

5. If an air compressor or other steady flowing air source is available perform the following: Connect a funnel to a length of rubber tubing. Attach the tubing to the compressor. Hold the funnel in an inverted position and turn the compressor on. Place a ping-pong ball into the funnel. The ball will stay in the funnel because the fast moving air rushing over the ball will reduce the downward pressure, and atmospheric pressure then forces the ball up into the funnel.

PUPIL WORKSHEET

PROBLEM 32. What happens to the pressure of air when the air moves?

MATERIALS:

3 x 5 yellow paper
2 - ping-pong balls with thread attached

WHAT TO DO:

1. Hold the paper on one edge between your thumb and forefinger.

2. Bring the paper up to your lips and blow across the top of the paper. What happened?

3. Was this what you had expected?

4. Repeat. Did the same thing happen.
Draw diagrams to show what happened.

5. Suspend the two ping-pong balls by holding the strings 2 or 3 inches apart. Blow between the two balls. What happened?

6. Draw diagrams to show what happened.

QUESTIONS TO ANSWER:

1. How do you explain the fact that the paper went up as you blew?

2. Why did the ping-pong balls movetoward each other?

3. Why does the shower curtain crowd in toward you when you are taking a shower?

4. What is Bernoulli's principle?

5. Using Bernoulli's principle, how could you explain how an atomizer

PROBLEM 33. <u>WHAT CAUSES AN AIRPLANE TO RISE?</u>

OUTCOMES:

The shape of an airplane wing causes air to move faster over the wing than under it.

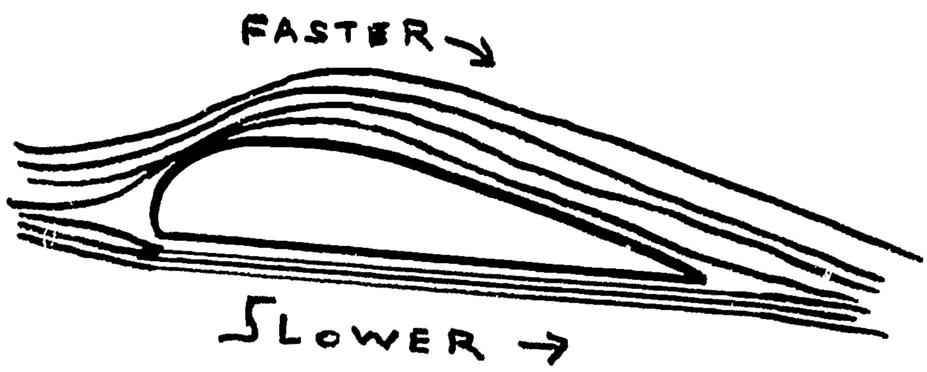
An airplane lifts off the ground because of the difference in air pressure above and below the wing.

MATERIALS:

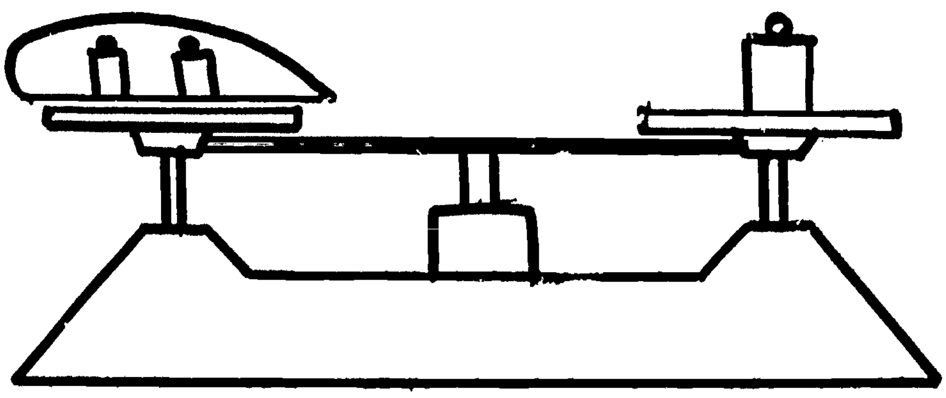
airfoil	assorted weights
Rexograph sheet on airfoil	manila folder
platform balance	airplane models

PROCEDURE:

1. Show an airplane pointing out the shape of a wing.
2. Draw and explain the airfoil.



3. A simple airfoil can be made from a manila folder which has one-half curved as shown in diagram. Blow air across the folder and the platform with the airfoil will rise.



4. Have the pupils draw cross sections of wings and identify leading edge and trailing edge. Help them draw lines representing air flow over and under the wings.
5. Develop idea that since the upper surface of the wing is greater than the lower surface, air moves faster across the top. Elicit that this reduces the air pressure across the top of the wing.
6. Examine models of airplanes to note shapes and sizes of wings, tails, body or fuselage.
7. Point out the tremendous speed at which the air moves across the surfaces and the large size of wings.
8. Elicit that: to rise, the force of lift must be greater than the downward pull of gravity; to remain in level flight, they must be equal; and to descent, gravity must be greater than lift.
9. Summarize by having pupils state Bernoulli's principle and the outcomes.

PROBLEM 34. WHAT IS DISPLACEMENT?

OUTCOMES:

An object submerged in a fluid displaces its own volume of the fluid.

MATERIALS:

graduated cylinder
metal cube
overflow can
water
see pupil worksheet

PROCEDURE:

1. Call two pupils to the front of the room. Tell one to stand on a spot. Tell the other pupil to stand on the same spot. Have pupils point out that the first one would have to move first. State that two objects cannot occupy the same space at the same time.

2. Tell the story told about Archimedes who sat in the tub and noticed that the water rose. As he sank deeper into the tub, the water rose higher. He saw that he was pushing water away or was taking its place. This is called displacement.

3. Explain that the class will study the displacement of water by objects lowered into it. Distribute materials and worksheets.

4. Assist the pupils with their exercise and go over questions.

5. Demonstrate by first lowering a cube into graduated cylinder and then into an overflow can that either method can be used to determine displacement or volume. Measure overflow water in a cylinder.

6. Elicit outcomes as a summary of lesson.

PUPIL WORKSHEET

PROBLEM 34. What is displacement?

MATERIALS

several metal cubes of various sizes
several irregular rocks or other objects that sink
ruler with centimeter scale
graduated cylinder large enough to fit cubes and rocks into
string
water

WHAT TO DO:

1. Use your ruler to measure each side of a cube. Write its size on the chart below.
2. Now figure the volume of the cube.
   (Volume equals length x width x height.)
   Enter the volume on the chart.
3. Measure each cube in the same way, entering the information on the chart.
4. Put enough water into graduated cylinder to half fill it. Write the height of the water on the chart.
5. Tie a string around a cube and carefully lower it into the cylinder until it is under water. Now what is the water level? Write that number on the chart.
6. How much water was displaced?
7. Repeat for each cube and each rock.
8. Complete the chart.

object	length of of side	measured volume	height of water in cylinder	height with object in water	water displaced
cube #1					
cube #2					
cube #3					
cube #4					
rock #1					
rock #2					
rock #3					

QUESTIONS TO ANSWER:

1. How did the volume of cube number 1 compare to the amount of water displaced?

2. Were the re-ults the same for each cube?

3. How much water is displaced where an object is lowered into water?

4. How can you measure the volume of an irregular solid?

5. How could you use this idea to measure one-half cup of butter easily?

ERIC

PROBLEM 35. WHAT HAPPENS TO OBJECTS WHEN THEY ARE PLACED IN WATER?

OUTCOMES:

Some objects placed in water sink, others float.

Objects placed in water lose weight.

The loss of weight in water is due to an upward push of the water, known as buoyancy.

An object that floats is pushed upward by a force equal to its weight.

MATERIALS:

see pupil worksheet

PROCEDURE:

1. Recall that the class discovered that water was displaced when any object was lowered into it.

2. Tell the class they will investigate further what happens when something is lowered into water.

3. Distribute materials and worksheets.

4. Review questions at end.

3

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PUPIL WORKSHEET

PROBLEM 35. What happens to objects when they are placed in water?

MATERIALS:

spring scale
blocks or cylinders of wood, cork.
several pieces of string
large beaker (500 ml)

WHAT TO DO:

1. On the chart below write the name of the items on your tray.

2. Weigh each item and record the weight of each below.

3. Half-fill your beakers with water. With the spring scale still attached, lower the objects one at a time into the water. Observe the weight of each and record it below. Also observe whether or not the object is floating or sinking. Record your observations on the chart.

4. Subtract the weight of the object in water from the weight of the object in air and this will give the buoyant force (upward push) of the water on the object.

ITEM	WEIGHT IN AIR	WEIGHT IN WATER	SINKS OR FLOATS	BUOYANCY (upward push of water)

QUESTIONS TO ANSWER:

1. What happened to the weight of each object when it was placed in water?

2. How much weight did a floating object lose?

3. Why is it easier to carry someone in the water than it is on land?

ERIC

PROBLEM 36. <u>WHY DO OBJECTS SINK OR FLOAT?</u>

OUTCOMES:

An object will float if it weighs the same as the weight of the water it displaces.

An object will sink if it weighs more than the weight of the water it displaces.

MATERIALS:

graduate cylinder	ruler
metal cube	balance scale
see pupil worksheet	

PROCEDURE:

1. Review:
    a. An object displaces water when it is lowered into it.

    b. All objects lose weight when they are placed in water.

    c. A floating object loses its entire weight in water.

2. Distribute materials and worksheets.

3. When pupil exercises are complete, measure a cube. Measure the water displaced. Children should recall that they are the same.

4. Now weigh the displaced water and weigh the object suspended in water to point out that the weight loss of the object is equal to the weight of the displaced water or the weight of a volume of water equal to the volume of the object. In other words, a body that sinks loses as much weight as the weight of its own volume of water.

5. Elicit that an object that floats displaces only its own weight of water. When it has gone down deep enough to displace enough water to equal its weight, it stays at that level.

6. Go over questions on pupil worksheet.

PUPIL WORKSHEET

PROBLEM 36. Why do objects sink or float?

MATERIALS:

overflow can	various objects of the same volume
catch bucket	pieces of thread
beaker	balance scale

WHAT TO DO?

1. Weigh each object on your tray and record the weights below.
2. Weigh the catch cup and record the weight below.
   NOTE: The weight of the catch bucket remains the same for each item.
3. Fill the overflow can with water until it overflows.
   NOTE: Catch the overflow in the beaker and discard. When the water stops flowing, drop in one of the objects and catch the displaced water in the catch bucket.
4. Weigh the catch bucket and the water and record your results on the chart below.
5. Repeat the experiment using one object at a time.
6. To find the weight of the displaced water, subtract the weight of the catch bucket from the weight of the catch bucket plus the water.

ITEM	WEIGHT OF OBJECT IN AIR	WEIGHT OF CATCH BUCKET	WEIGHT OF CATCH BUCKER AND WATER	WEIGHT OF DISPLACED WATER

QUESTIONS TO ANSWER:

1. Which items sank?
2. How did their weights compare to the weights of water displaced?
3. How did the weights of floating objects compare to the weights of the water they displaced?
4. Why do some objects sink while some objects float?
5. How can a heavy ship float?

PROBLEM 1. HOW CAN WE GROW LIVING THINGS FOR STUDY?

OUTCOMES: Living things require special conditions (optimum conditions) for growth.

MATERIALS:

specimens set up as samples
any specimens pupils did not bring in
materials for hay infusion: hay or dry leaves, jar or beaker, water from pond, from cut flowers, or tap water that has been standing 24 hours
also see pupil worksheet

PROCEDURE:

(Pupils should have brought in previously the wide mouth jars and specimens to be grown. Those specimens that pupils could not get should be ready for pupils to set up.)

1. Write the word BIOLOGY on the chalkboard.

2. Elicit simple definition that Biology is the study of living things.

3. Set up hay infusion for protozoa by placing a small amount of hay or dried grass or other leaves into the jar of water. Place in a dark place for 24 to 48 hours. Explain that protozoa (microscopic animals) will grow in the water and will be studied later.

4. Distribute equipment and pupil worksheets. Have samples ready to illustrate how they should assemble their materials. Provide tape for labeling individual work. It is not necessary for each pupil to set up all specimens but be sure to have at least one of each. It is wise to have duplicates of bread mold and beans.

5. Supervise work and assign a place for the jars to stand for future observation. Pupils should be reminded that they are to make periodic observations and that they are to add water when necessary.

6. Explain that pupils cannot complete problem immediately and the living things will be studied at various times during the unit, but have pupils point out that in each specimen set up, water was present.

NOTE: Earthworms may be found after a heavy rain under rocks or piles of leaves in the park. At other times, they may be found near the surface of the soil near wet drains and other wet places, or they may be purchased in some pet shops.

PUPIL WORKSHEET

PROBLEM 1. How can we grow living things for study?

WHAT TO DO:

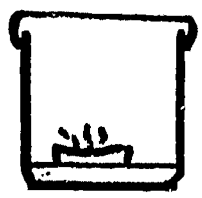
Choose the paragraphs that tell you how to grow your living things. Follow directions carefully. If you have a question raise your hand for help. Look at the samples on the front desk to see how your materials should look when you have finished.

You will have to keep a record of the changes your living things make on your log sheets. Keep a separate log for each specimen.

BREAD MOLD

Materials: wide mouth jar, cover for jar, paper towel or blotter, small piece of bread.

1. Wet the paper towel and place the paper in the bottom of the jar.
2. Put a little dust from the floor on the bread. Do not put much dust on the bread.
3. Place the bread on the paper towel in the jar.
4. Cover the jar.
5. Put the jar in a dark, warm place.
6. Check each day for one week.



GROWING A PLANT FROM SEED

Materials: lima beans, wide mouth jar, paper towel or blotter

1. Fit the paper towel or blotter around the sides of the jar. See the diagram below.
2. Place the lima beans between the paper and the jar.
3. Put a little water in the bottom of the jar. You must add water as the seeds use it.
4. Put the jar in a window. Do not cover.
5. Check every two days.

GROWING A PLANT FROM A LEAF CUTTING

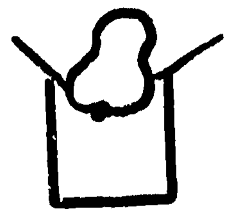
Materials: leaf from African violet, jar or dish, pot, soil, water.

1. Put the leaf in a small amount of water in a jar or dish.
2. When roots appear place the leaf in soil in a pot. The leaf should be on the surface of the soil.
3. Water every other day.
4. Keep in light but do not keep it in direct sunlight.

GROWING A POTATO

Materials: sweet potato or white potato, wide mouth jar, toothpicks, water

1. Put toothpicks in the side of the potato.
2. Balance the potato in the mouth of the jar.
3. Fill the jar with water so water is near an "eye" (bud) of the potato.
4. Place the jar in the window.



GROWING AN ONION

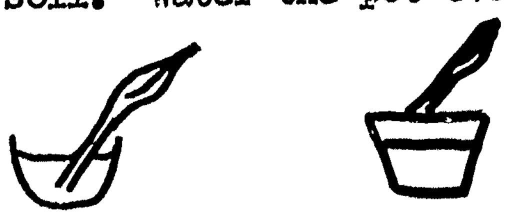
Materials: onion bulb, 3 toothpicks, jar

1. Put the toothpicks into the side of the onion.
2. Rest the toothpicks on the mouth of the jar so that the onion is balanced.
3. Fill the jar with water until the water just touches the bottom of the onion.
4. Place the jar in the window.
5. Add water whenever the onion roots cannot reach the water.

GROWING A PLANT FROM A STEM CUTTING

Materials: stem and leaf from a plant like coleus, jar, water, pot, soil

1. Put some water in the jar.
2. Put the stem in the jar in the water. Only a small part of the stem should be in the water.
3. Put jar in the window.
4. When the roots appear in a few days, carefully put the stem into the pot and cover the roots with soil. Water the pot every other day.



GROWING EARTHWORMS

Materials: a six inch or eight inch jar, leaves, dirt, grass, black paper, cover for jar with holes punched in the top

1. Fill the jar with leaves, dirt and grass.
2. Cover the sides of the jar with black paper.
3. Put the earth worms into the jar and put a cover on the jar.
4. Put the jar in a cool, dark place.
5. Coffee grounds, lettuce, or mashed potatoes may be mixed with the soil for food for the earthworms.

PROBLEM 2. HOW CAN THE MICROSCOPE HELP US STUDY LIVING THINGS?

OUTCOMES: The microscope is an instrument for letting us see small objects.

MATERIALS:

microscope lens paper
chart or projected chart of the microscope
see pupil worksheet

PROCEDURE:

1. Hold up a microscope and ask pupils to explain how it is used. Point out that it is an important tool in science.

2. Display a large chart or project a transparency. Quickly point out some of the parts.

3. Distribute pupil worksheets and microscopes.

4. Carefully point out each of the following while pupils identify parts and perform the action on their microscopes and label parts on their diagrams:
   a. The microscope has several lenses:
      eyepiece lens
      low power lens - short objective
      high power lens - long objective
      You may recall the work in Physics on the lens.
   b. Point out the body tube. Have students move tube up slowly with the large adjustment knob. Return to place.
   c. Move tube up with the small adjustment knob. Point out the difference in the movement and that the large one is used to find the material and the small one is to make what you see sharper and clearer. Use low power first and only use the small knob with high power.
   d. Point out mirror and show how to get light. Ask why mirror was turned toward the window?
   e. Point out stage, clamps and opening in stage, and condenser. Trace the path of light to the eye.

5. Check to see that all diagrams are completely labeled. Review parts briefly.

6. Read instructions from worksheet as students work and follow step-by-step.
   Check work where called for on the worksheet. When step six is completed, pass out slide for practice focus.

7. Summarize by:

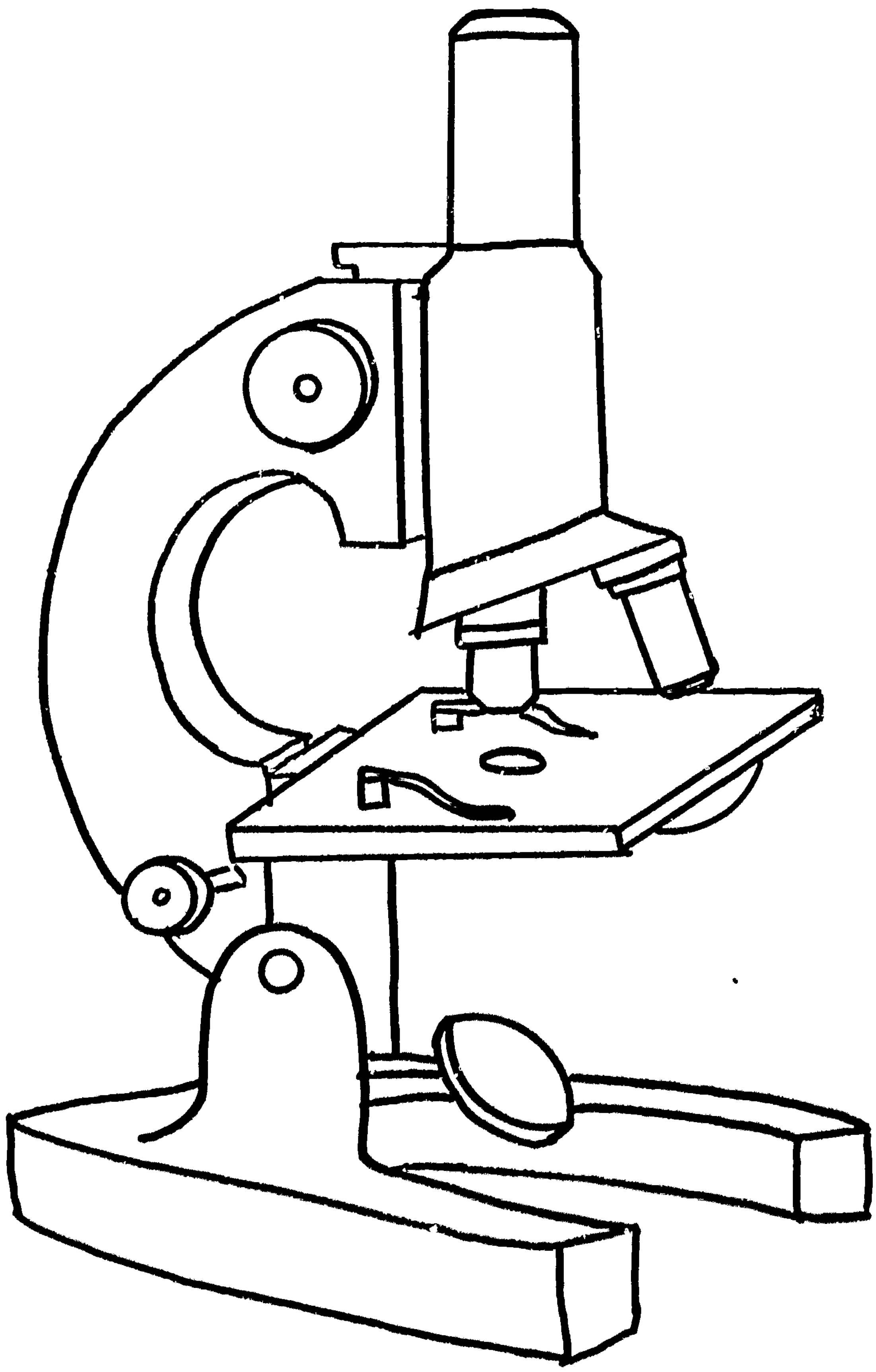
   eliciting names of parts on demonstration microscope in front.
   eliciting procedure for finding light and other steps learned.

PUPIL WORKSHEET

PROBLEM 2. How can the microscope help us study living things?

MATERIALS:

1. microscope
2. lens paper
3. slide of plant cell (You will get this later.)



YOU MUST KEEP THIS WORKSHEET FOR USE WHENEVER YOU USE THE MICROSCOPE.

ERIC

WHAT TO DO:

1. Clean lenses and mirror by wiping gently with lens paper.
2. Clean the lens in the opening in the stage.
3. Put the low power objective into place by turning it around until you feel it click.
4. Look through the eyepiece lens and at the same time turn the mirror toward the window until you see a full circle of bright light.
5. While you are looking at the light, turn the wheel of the condenser from number one to number five. What happens to the light in your field?
6. Raise your hand for checking.
7. Place your slide on the stage of the microscope and clamp.
8. While you are looking through the eyepiece, RAISE the tube slowly until you see your material, using the large adjustment knob.
9. If your picture is not clear, use the small adjustment knob to make the field clear.
10. Raise your hand for checking.
11. Turn the high power objective into place.
12. Use only the small adjustment knob to make the field clear.
13. Raise your hand for checking.
14. Draw what you see.
15. Get your microscope ready to be put away:
    a. Remove slide
    b. Turn the mirror level with the table
    c. Turn the lenses so that neither is in place (Neutral position)
    d. Put the tube all the way down

QUESTIONS TO ANSWER:

1. The condenser of the microscope changes the ______________________.

2. The large adjustment knob moves the ________________________. The small adjustment knob is used for ________________________________.

3. The job of the mirror is to ______________________.

4. The low power lens is found in the ___________________objective.

BRING THIS WORKSHEET TO CLASS NEXT TIME AND EACH TIME YOU ARE TO USE THE MICROSCOPE

LOG SHEET

1. What is the name of your animal or plant? ______________________
   (If you have two specimens you must keep two logs)

2. What things did you need for your project?

   a. ____________________ b. ____________________
   c. ____________________ d. ____________________
   e. ____________________ ____________________

3. How did you set it up? ______________________________________

   ____

4. What did you do for your plant or animal? List in order everything you did and gave it. ______________________________________

   ____

   ____

5. What changes did you see in your plant or animal during the past two weeks? List any change no matter how small the change may be.

DATE		CHANGES SEEN
Month	Day	

QUESTIONS TO ANSWER:

1. What do you think your plant or animal needs for growth? ______________________

   ____

2. How do you know that your plant or animal is alive? ______________________

   ____

   ____

PROBLEM 3. HOW DO WE KNOW SOMETHING IS ALIVE?

OUTCOMES: Living things carry on certain life processes that non-living things cannot perform.

MATERIALS:

For the pupils:

a small rock	a small growing plant (ivy)
a plastic flower or leaf	elodea in water with snail in test tube
a rubber insect	earthworm
	(You may substitute for a living thing a tree outside window, etc.)

For the teacher:

Set up on advance -	package of yeast
chart of yeast budding	two jars or flasks
microscope	sugar
slide and cover slip	warm water

PROCEDURE:

1. Distribute to students in the groups the pupil materials listed above. You may add any you feel will be helpful in solving the problem.

2. Have the pupils separate the materials into two groups - living things and non-living things.

3. Elicit and list on the board reasons for the groupings made. For example the following life functions may be cited:
   - digestion
   - ingestion
   - respiration
   - excretion
   - response to stimuli
   - locomotion
   - reproduction

4. Show the class the jars containing yeast which were set up in advance with one jar containing actively growing yeast in warm sugar water and the other in water without sugar. Elicit differences between the two jars of yeast. Ask which they think contains the live yeast.

5. Point out that the sugar is food for the yeast and the gas of the bubbles is the waste given off by the yeast.

6. Make two slides of the yeast cells and set up two microscopes. Cut down light to make the yeast more visible. Budding can be seen under high power.

7. Have students observe yeast under the microscope for budding. Show them budding on the chart so they will know what to look for. If you center some budding cells in the field, then you can point them out more easily.

8. Explain that this budding is reproduction of yeast.

9. Prepare two slides, each containing a drop of water from the hay infusion set up yesterday. Stages of microscopes should be parallel to table.

10. Allow children to come up to observe the protozoa moving.

11. If a plant, such as Mimosa (Sensitive plant), is available, touch the leaflets gently and observe them fold back.

12. Have pupils summarize by listing the functions they observed which indicate that something is alive.

13. Tell the children to bring in a list of ten living things, some of which cannot be seen, with the reasons they think they are alive. They are also to check their specimens set up previously to enter on their log sheets reasons they consider these things to be alive.

NOTE:

THIS MUST BE DONE AT THE END OF THIS LESSON FOR USE ABOUT THREE DAYS LATER.

Get four sterile covered Petri dishes with nutrient agar in them. On one place a hair from a student, on another dirt from under the fingernail. Expose one to air for several minutes. Do not put anything on the fourth plate and do not open it.

Incubate the dishes until needed in the lesson "How do one celled plants and animals reproduce asexually?"

PROBLEM 4. WHY ARE CELLS CALLED THE BUILDING BLOCKS OF LIVING THINGS?

OUTCOMES: All living things are made of one or more small units called cells.

Cells are small units of living material.

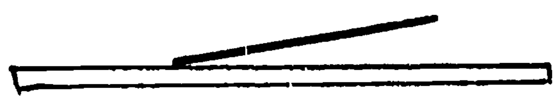
MATERIALS:

bioscope
chart showing a typical plant cell
and a typical animal cell
see pupil worksheet

hay infusion
slide and coverslip

PROCEDURE:

1. Distribute equipment and worksheets. Guide the pupils through procedure.
Show how to put cover slip on properly.



2. Elicit that the appearance of the cells is like bricks.
Have them make comparisons among the different preparations.

3. When their work is completed project a slide of protozoa from the hay infusion. Have the pupils compare these cells with the other cells. Elicit differences.
Explain that some living things are made of only one cell, while other living things are made of many cells put together.
(Movement of protozoa can be slowed down by placing a few strands of cotton on slide.)

4. Summarize by eliciting answers to questions on worksheet.

NOTE:

If your time is limited and you know the group will not finish, only have them prepare the slide of elodea, look at the prepared slide of epithelium and the slide of protozoa. You may even omit the prepared slide if you must.

PUPIL WORKSHEET

PROBLEM 4. Why are cells called the building blocks of living things?

MATERIALS:

- onion
- elodea
- slide
- Iodine solution called Lugol's
- worksheet
- worksheet on the microscope
- coverslip
- microscope
- dropper
- forceps
- slide of epithelium
- water
- lens paper
- paper towel

WHAT TO DO:

1. Clean your slide and cover slip using the water and paper towel. Be careful not to break the cover slip.

2. Place a small leaf of elodea on the slide using forceps.

3. Place a drop of water over the leaf on the slide.

4. Put a cover slip over the leaf the way your teacher shows you.

5. Set your slide aside where it will not be disturbed.

6. Get your microscope ready for work. Use your worksheet for help in getting it ready.

7. Look at the leaf under the microscope.
   Draw what you see.

8. Clean your slide again.

9. Place a thin section of onion skin on your slide.

10. Put a drop of the Lugol's solution on the onion skin.

11. Put a coverslip over the onion.

12. Look at the onion skin under the microscope

13. Draw what you see.

14. a. How is the onion skin like the elodea?
    b. How are they different?

15. Look at the slide of epithelium under the microscope.

16. Draw what you see.

17. a. How are these cells different from the cells you have seen?
    b. How are these cells like the cells you have seen?

18. Clean up your work area.

19. Look at the cells your teacher is showing.

20. a. Draw the cells you see.

    b. How are these cells like the cells you have seen?
    c. How are these cells different from the other cells you have seen?

QUESTIONS TO ANSWER:

1. The blocks that you saw are called ______________________.
2. All the living things we saw were made of ________________.
3. The animals the teacher showed were made up of ____________.
   (how many)
4. What differences did you find between the plant cells and the animal cells?

5. Make a diagram of each kind of cell (plant and animal) to show these differences.

PROBLEM 5. WHAT DIFFERENT TYPES OF CELLS MAKE UP OUR BODIES?

OUTCOMES: All living things are made of cells.
Our bodies are made of cells.
There are many kinds of cells to do many different jobs.

MATERIALS: slides of different types of cells to project or drawings of these cells. (a filmstrip would be helpful if available)
See pupil worksheet

PROCEDURE:

1. Ask the children what they think the human body is made of.

2. Elicit that since we are living things we must be composed of cells.

3. Ask if students think that skin would have the same type of cell as the muscle under the skin. Ask for a reason for any answer. They should conclude that since skin does a different job from muscle that their cells may be different.

4. Distribute worksheet. Do each step and have the students repeat as soon as you have shown them. Check work where required on the worksheet.

5. When completed, collect equipment quickly.

6. Project slides, or show pictures, of different types of cells. Elicit the differences shown among the different types of cells. Explain something of the job of the cells.

7. Summarize by having children name four kinds of cells that make up the body.

8. Ask children to prepare a chart of five kinds of cells at home:

TYPE OF CELL	JOB DONE

NOTE: Add approximately 1.48 gm. methylene blue dye to 100 ml. of 95% isopropyl alcohol. To use this stock solution, mix 10ml. solution with 90 ml. distilled water.

PUPIL WORKSHEET

PROBLEM 5. What different types of cells make up our bodies?

MATERIALS:

glass slide
cover slip
paper towel
toothpick with flat edge
dropper bottle of Lugol's solution
lens paper
microscope
bottle of water
worksheet of microscope

WHAT TO DO:

1. Clean your slide and cover slip using the water and paper towel. Be careful not to break the cover slip.
2. Scrape the inside of your check gently with the flat edge of the toothpick. You will not see much on the toothpick, but the material is there.
3. Gently rub the flat edge of the toothpick on th center of the slide so you get the material on the slide. All you will see is a small bit of whitish liquid on the slide.
4. Put two drops of Lugol's solution on the material.
5. Place the cover slip on the slide.
    a. Hold the cover slip by the edge.
    b. Put one edge at the edge of the liquid on the slide.
    c. Then drop the cover slip. DO NOT PRESS THE COVER SLIP DOWN.
6. Set your slide aside where it will not be disturbed.
7. Get your microscope ready for work. Get light. Use your old worksheet for help in getting the microscope ready.
8. Raise your hand for your teacher to check the light.
9. Now put the slide on the stage and clamp.
10. Focus on the material on the slide.
11. Raise your hand for checking.
12. Turn to high power carefully. Raise your hand for help if you need it. BE VERY CAREFUL. DO NOT BREAK THE SLIDE. DO NOT LET THE LENS TOUCH THE SLIDE.
13. Raise your hand for checking.
14. Draw what you see.
15. Clean up your work area.
    a. Remove slide.
    b. Put the microscope away.
    c. Put all equipment in the proper place.

QUESTIONS TO ANSWER:

1. We made a slide showing ______________________________.
2. The material on the slide came from ______________________________
3. The inside of the jaw is made of ______________________________

PROBLEM 6. HOW DO ONE CELLED PLANTS AND ANIMALS REPRODUCE ASEXUALLY?

OUTCOMES: Asexual reproduction is reproduction of a new living thing from one parent.
Fission is one method of asexual reproduction in which a living thing divides into two equal parts. Bacteria and protozoa reproduce by fission.
Budding is another method of asexual reproduction in which the organism divides into unequal parts. Yeast reproduce by budding.

MATERIALS:

Petri dishes with bacterial colonies
chart of protozoa showing fission
chart of bacteria showing fission
chart of yeast showing budding
see pupil worksheet

PROCEDURE:

1. Show pupils the Petri dishes on which colonies of bacteria are growing. Recall that these were started by placing hair on one, placing dirt from under the fingernail on another, and exposing the third one to air.

2. Ask where the large numbers of bacteria came from to note that reproduction has taken place. Explain that bacteria are microscopic plants but many bacteria together form visible colonies.

3. Have pupils examine the fourth dish. Point out that this one is sterile, that it is known as a CONTROL and is like each of the other dishes in each respect except the one and that it provides a comparison.

4. Distribute equipment and worksheets. Guide pupils in their slide study.

5. Explain that a paramecium is a protozoa. Point out other protozoa on wall chart.

6. Go over questions on the pupil worksheet with the class.

PUPIL WORKSHEET

PROBLEM 6: How do one celled plants and animals reproduce asexually?

MATERIALS:
- microscope
- lens paper
- slide of paramecium

WHAT TO DO:

1. Set up the microscope following the directions given previously.
2. Wipe slide gently with lens paper to remove any finger prints. Handle the slide by the edge only.
3. Place slide on the stage and clamp. Look at the slide.
4. Draw what you see.

5. Paramecium is one kind of animal called ________________. They reproduce by ________________. This method is ________________ reproduction because there is ____________ parent for a new paramecium to be formed.
6. Clean up your work area.

QUESTIONS TO ANSWER:

1. Asexual reproduction means ________________________________.
2. Paramecium reproduces by ________________________________.
3. Bacteria reproduce by ________________________________.
4. Yeast reproduce by ________________________________.
5. The methods of reproduction mentioned are ________________ because only one parent is needed to make a new plant or animal like the parent.

PROBLEM 7. HOW DO SOME MULTICELLULAR PLANTS AND ANIMALS REPRODUCE ASEXUALLY?

OUTCOMES: Bread mold reproduces by sporulation.
Some higher plants reproduce and regenerate parts by vegetative propagation.
Hydra reproduces by budding.
Some higher animals can regenerate parts. They cannot reproduce a whole new organism asexually.

MATERIALS:

Growth experiments: bread mold, African violet, coleus stem, earthworm, onion
Live Hydra, if available Chart of Hydra showing budding
Chart of bread mold showing parts
See pupil worksheet

PROCEDURE:

1. Display samples of bread mold grown by the students and plants grown from parts of plants - African violet, coleus stem, onion bulb, potato.
   Point out the plants that are beginning to grow from a small part.

2. Elicit the number of parents needed. Explain that this kind of asexual reproduction is called vegetative propagation.

3. Show a live Hydra or a preserved specimen. Use a chart to show budding.

4. Distribute worksheets and materials.

5. Display chart of bread mold with parts labeled. Guide the pupils through the worksheet activity. Explain that the spores can stay alive without growing for a long time until they reach optimum conditions. Elicit what these conditions are. Elicit that some of these spores must have been in the dust they put on the bread.

6. Give other examples of vegetative propagation, for example, strawberry plant or spider plant growing from runners (long stems), new bulbs from a single bulb, potatoes from tubers, banana from stem cuttings, and ferns from rhizomes (underground stems.)

7. Briefly explain regeneration and distinguish between regeneration of a part and reproduction of a new organism.
   a. Lobster can regenerate a lost claw.
   b. Some lizards can lose their tails and regenerate new ones.

8. Have pupils list various ways of vegitative reproduction with examples of each.

PUPIL WORKSHEET

PROBLEM 7: How do some multicellular plants and animals reproduce asexually?

MATERIALS:

- bread mold growing
- hand lens
- hand microscope
- lens paper
- slide and cover slip
- forceps
- dropper
- jar or beaker

WHAT TO DO:

1. Look at the bread mold through the hand lens.

2. Draw what you see. Use the chart in the front of the room to find out the names of what you saw.

3. With forceps, carefully take some bread mold from the jar and put it on the slide. Do not take much.
4. Add a drop of water to the bread mold.
5. Put on a cover slip. Be sure not to press the cover slip down.
6. Set the microscope for light.
7. Look at the slide under the microscope.
8. Draw what you see. Have your teacher check to see that your mold is not too thick. Use the chart in the front of the room to find out the names of the parts you see.

QUESTIONS TO ANSWER:

1. The small round objects which are inside the ball-like part of the bread mold are ______________________.
2. Bread mold reproduces by the ________________ falling on the right material to grow.
3. Make a list of the other many celled plants and animals that you heard about today. Tell how they reproduce asexually.

PLANT OR ANIMAL	HOW THEY REPRODUCE ASEXUALLY

4. Regeneration means ____.

PROBLEM 8. HOW DO FLOWERS ALLOW FOR SEXUAL REPRODUCTION OF PLANTS?

OUTCOMES: Flowers contain the male and female parts of the plant. These are the parts necessary for reproduction.

MATERIALS:

chart of the flower
model of the perfect flower
samples of flowers: pussywillow, tulip, corn, buttercup, etc.
see pupil worksheet

PROCEDURE:

1. Display a model, a chart or a projection of a complete flower.

2. Identify the flower as the part of the plant containing the male and/or female parts of the plant needed for reproduction.

3. Show the samples of flowers. Identify the ones with both male an female parts, such as lily, tulip, rose and bettercup. Show others, such as, corn, pussywillow, flowers of willow, trees or birch trees which are either staminate (male) or pistillate (female) flowers.

4. Draw on the board:

5. Have the children identify the parts on the flower model, include sepals, petals and functions of each.

6. Explain that the anther produces the pollen grains with the male gamete or sex cell and that the ovary contains ovules or female sex cell.

Distribute worksheets and materials.

a. Have pupils identify the parts on their flowers.

b. Have them proceed with the dissection carefully.

c. Caution them to save the parts for mounting on cardboard with plastic wrap covering.

PUPIL WORKSHEET

PROBLEM 8. How do flowers allow for sexual reproduction in plants?

MATERIALS:

large flower, such as, gladiolus or tulip
razor blade (single edge) or scalpel
forceps
hand lens
chart

WHAT TO DO:

1. Find all the parts you named earlier.
2. Remove sepals. Why does a flower have sepals? ________________
3. Remove petals carefully. Why do some flowers have petals? __________
4. Find the stamens (male) and pistil (femal).
5. Find the anther and filament parts of the stamen.
6. Find the stigma, style, and ovary parts of the pistil.

7. Draw a stamen and label the anther and filament

8. Draw the pistil and label the stigma, style and ovary

9. Touch an anther to the stigma. What happens? Use the hand lens to look at the stigma before and after it is touched with the anther.

10. Shake an anther over paper. The material which fell on the paper is called ________________.

11. Make a crosswise cut through the ovary. Inside the ovary there are many ________________. They are attached to the ovary wall. Use the hand lens to look inside the ovary closely.

12. Mount your flower parts on a cardboard and label them at home.

QUESTIONS TO ANSWER:

1. The male part of the flower is the ______________ which has two parts ______________ and ______________.

2. The pollen grains are found on the ________________. Pollen grains are ______________ (male, female).

3. The female part of the flower is the ______________ which has three parts ______________, ______________ and ______________.

4. The ovules are found in the ________________. They are ______________ (male, female).

5. We know the stigma of the flower is __________ because the __________ stuck to the stigma.

PROBLEM 9: HOW DOES FERTILIZATION TAKE PLACE IN THE FLOWER?

OUTCOMES: Flowers must be pollinated for reproduction to take place.

Pollination is the transfer of pollen to the stigma of the same or different flower.

Fertilization in the flower is the union of the sperm nucleus of the pollen grain and the ovule.

MATERIALS:

chart showing pollination and fertilization

flower model

PROCEDURE:

1. Display the chart and the flower model.

2. Define pollination. Elicit three ways that pollination could be accomplished. Some pupils will know insects (bees) and wind transfer pollen. Explain that pollen can be transferred from the anther to the stigma of the same flower by the natural movement of the flower (self-pollination).

3. Explain the importance of pollination using corn as an example. Corn is wind pollinated (cross-pollinated). If a stalk should be isolated (behind a barn or other building) so that the wind cannot get any pollen to it, no ears or corn (no kernels) will be produced. Save reason to be elicited later from the students.

4. Distribute worksheets showing stages from pollination to fertilization. Elicit: the parts already known, such as, the pistil, stigma, ovary. Use model or chart to refresh memory on parts.

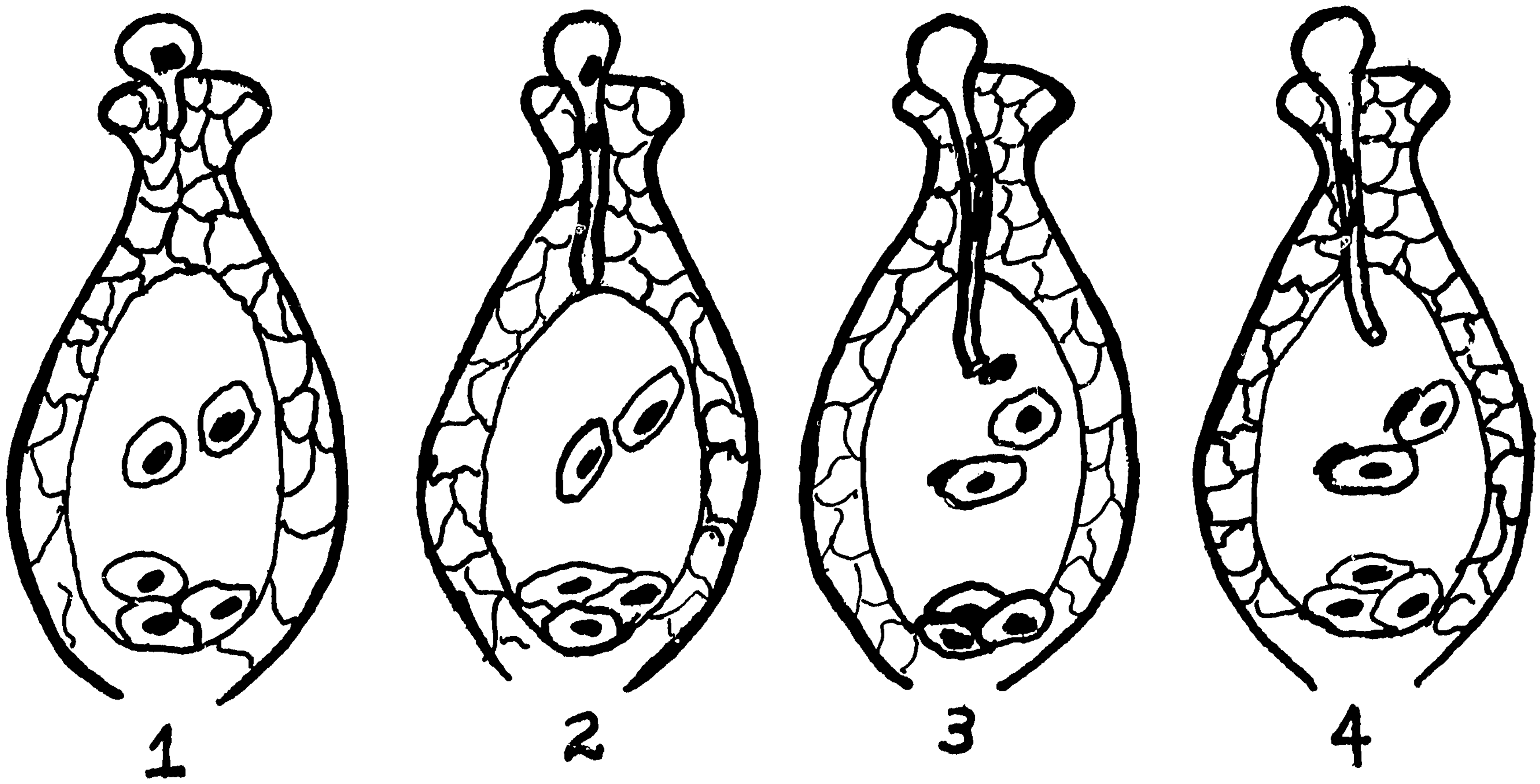
5. Recall that the stigma contains a sticky material to catch the pollen and provide for the growth of the pollen tube.

6. Trace the development of pollen tube, nuclei traveling down the tube, and union with the ovule. Define fertilization. Point out parts on each diagram on the chart so that they can note the changes that take place.

7. Summarize by answering the questions on the worksheet with the pupils.

PUPIL WORKSHEET

PROBLEM 9: How does fertilization take place in the flower?



WHAT TO DO:

1. Label these parts in each diagram.

pollen grain	pistil	ovary
pollen tube	stigma	ovules
sperm nucleus		

2. What is the difference between picture 1 and picture 2 above?

3. What has changed in picture 3?

4. What has changed in picture 4?

QUESTIONS TO ANSWER:

1. Pollination is ______________________________ .

2. The male sex cell is the ______________________ .

3. The female sex cell is the ____________________ .

4. Fertilization is completed in picture ______ because ____________ .

5. Fertilization means ____________________________________ .

PROBLEM 10. WHAT ARE FRUITS AND SEEDS?

OUTCOMES: The fertilized egg (zygote) develops into a seed.

The ovary around the seed develops into the fruit.

Any plant structure containing seeds is a fruit.

MATERIALS:

chart on fruits and seeds
museum jar of bean
germinating seed grown in class by students
see pupil worksheet
samples of various fruits and seeds (try to include some fruits we do not eat: e.g., rose - maple tree)

PORCEDURE:

1. Review briefly the process that produced the fruit. Use pictures where possible to show pollination by insect.

2. Explain that after fertilization most of the original parts of the flower die and fall away but the fertilized egg cell divides many times and develops into what we call a seed. The ovary which contains the fertilized egg grows and stores food and is called a fruit.

3. Show samples of fruits and seed.

4. Work step-by-step with the class as outlined on the worksheet.

5. Do review exercises on worksheet identifying fruits and seeds with pupils.

6. Have children list "fruits" and "vegetables". Now explain that all plants are vegetables (botanically) and any plant structure containing seeds is a fruit. Thus peppers, squash, etc. are fruits.

7. Suggested Homework:

   Give the class a list of plant parts and have pupils identify the fruits and the seeds on the list.

ear of corn	lima bean
corn kernels	pickle
cucumber	squash
tomato	lettuce
string bean	watermelon

PUPIL WORKSHEET

PROBLEM 10. What are fruits and seeds?

MATERIALS:

pea pod (fruit)
hand lens
dissecting needle
razor blade or scalpel
paper for drawing diagrams

WHAT TO DO:

1. Look at the fruit (pea pod) you have on your table. Look for any parts of the flower that may still be present.
    a. Find the blossom end of the fruit where the flower was before the fruit developed.
    b. Find the stem end where the fruit is attached to the plant.
    c. Look for some sepals that may be at the stem end.
    d. You may see the old stigma and stamens at the blossom end.
2. Draw a large diagram of your fruit (pea pod). Label the blossom end, stem end, and other parts if present.
3. Carefully split your pea pod in half along the seams. Be careful not to loosen the seeds (peas) inside.
4. Find where the peas are attached to the wall of the fruit.
5. Draw a picture of the peas (seeds) in the pod attached to the pod(fruit). Label the diagram.
6. Remove one of the seeds (peas). Using the lens, look at the scar at the place where the pea was attached. There is a very small opening near the scar called the micropyle. This is where the pollen tube entered.
7. Remove the outer layer (seed coat) of material around the seed. Be carefull not to destroy anything underneath. When the seed coat is removed, you will see a small tail-like part called the hypocotyl.
8. Draw a diagram of the seed showing the hypocotyl.
9. Carefully split the seed (pea) in half. It is easy to do this along the split or line you see around the seed. Look at the small part attached to the hypocotyl. This is the embryo or young plant. The two halves are the seed leaves. They contain food for the young plant to grow on until it has roots.
10. Draw a diagram of the split pea showing one seed leaf and the embryo. Look at the jar your teacher has to see the parts clearly.

QUESTIONS TO ANSWER:

1. The pea is really a ________________. The pod is a ________________.

2. The old ovary is now the ____________. The old ovules are now _______.

3. What must happen to the flower before a fruit and seeds can be made? ______

____

4. Write the meanings of these words in your notebooks:

micropyle   hypocotyl   embryo

PROBLEM 11. HOW DO SOME ANIMALS REPRODUCE SEXUALLY?

OUTCOMES: Frogs and most fish reproduce by external fertilization and external development of the eggs.

The frog reproduces by external fertilization and development.

The frog develops from egg to adult through many stages called "metamorphosis".

MATERIALS:

fish containing roe (eggs) - perch is a good specimen.
transparency for overhead projector of the internal structure of fish showing the reproductive system.
transparency or chart of reproductive organs of frog showing external differences between male and female.
chart and/or museum jar showing stages of metamorphosis of frog.
see pupil worksheet

PROCEDURE:

1. Show dissection of female fish. To dissect the fish: Make a ventral cut from the vent to the region between the pectoral fins and from there to the base of each pectoral fin. Remove a flap of body wall from each side of the medial cut to expose the body cavity.

2. Show transparency to identify the reproductive parts of the fish.
   a. In the female there will usually be a large mass of eggs or roe covered by a thin membrane. The oviduct can be traced to the cloaca.
   b. In the male, two long, thin, white structures running almost the entire length of the body cavity are testes. A sperm duct leads to the cloaca.

3. Recall the term fertilization - the union of egg and sperm. Point out that fertilization is external in most fish. The female deposits her eggs in a chosen place. The male follows and deposits sperm over the eggs. Fertilization can then take place.

4. If time permits, you may tell of some peculiar reproductive habits of fish like salmon, stickleback and grunion.

5. Using the chart of frog, locate reproductive parts of the male and female frog.

6. Using a chart of museum jar showing metamorphosis, point out the stages of development of the frog from fertilization to adult.

PREPARATION FOR CHICK EMBRYO DEMONSTRATION

(Set up 3 or 4 days before teaching Problem 13)

Get at least two dozen fertilized eggs. These are best obtained from farms or hatcheries.* The eggs in the grocery store are usually not fertilized.

Incubate the eggs at a temperature of 103° F. Most incubators have a thermostate. If your incubator is home made change the wattage of light bulb or the insulation to adjust the temperature. Be sure the thermometer is at the level of the eggs. The temperature may vary within the incubator. Put a pan of water in the incubator so that the atmosphere will be moist.

Put a pencil mark on each egg. The eggs must be turned around twice daily so that the membranes will not adhere to the shell. The pencil mark will let you know when eggs have been turned 180 degrees.

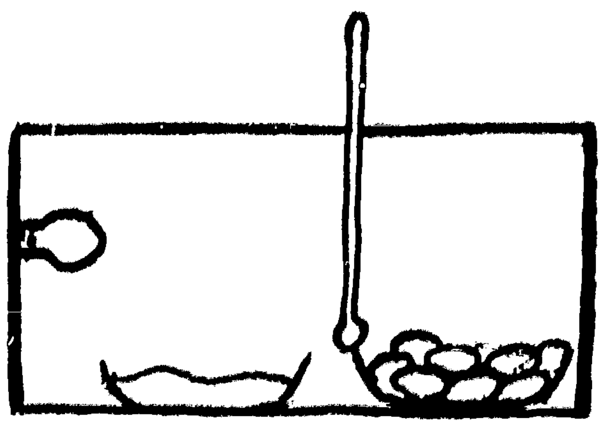
Eggs can be removed daily for observation. When an egg is removed, be sure the egg is held in the same position as it was in the incubator so the embryo will remain on top.

Embryos can be removed from the yolk and mounted on glass plates in ten percent formalin for display.

Some eggs can be left to hatch. If they do, let the chick remain in the incubator to dry off. Remove chicks to warm place (light bulb can provide heat). Give chick feed and water. Wood shavings should be put on the bottom of box to absorb droppings.

Instructions for opening the eggs to demonstrate are included in the problem on the egg.

* You may get fertilized eggs from the State University Agricultural and Technical College at Farmingdale in Farmingdale, Long Island.



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PROBLEM 12. HOW DOES A FERTILIZED EGG DEVELOP?

OUTCOMES: The fertilized egg divides many times.

The cells divide through a process called mitosis.

The group of new cells change shape.

MATERIALS:

chart of developing egg of starfish
prepared slides of starfish egg
chart of mitosis
individual pupil charts of mitosis and of developing egg

PROCEDURE:

1. Show chart of stages of developing starfish egg. The unfertilized egg shows the nucleus. The fertilized egg is surrounded by a fertilization membrane so no nucleus is seen.

2. Explain that the egg cells divide into a round cluster of cells called a morula. The division continues until there is a hollow ball of cells filled with liquid called a blastula. Division continues and one side of the blastula becomes pushed in and structure two cell layers thick is formed - a gastrula.

3. Study slides of the developing egg. Point out same stages seen on the chart.

4. Give out worksheets of mitosis. Label parts with class so they will readily see the changes from stage to stage. Explain that all cells divide this way.
(This is true except for sex cells during gametogenesis. Gametes must undergo reduction division (meiosis) to adjust the chromosome number. If the class is sufficiently interested and able, you may go into this.)

5. As a review, have pupils label the three stages of the developing egg on their charts. Explain that very little if any growth takes place in the early stages of cell division so cells get smaller as numbers increase.

PUPIL WORKSHEET

PROBLEM 12. How does a fertilized egg develop?

MATERIALS:

blank chart of mitosis - cell division
blank chart of developing egg

WHAT TO DO:

1. Label each "phase" of mitosis. Use the teacher's chart as a guide. What does "phase" mean?

2. On the diagram of the resting stage, label the following parts:
   nucleus
   cell membrane
   sytoplasm

3. Look at the second diagram. What differences do you see between this diagram and the first diagram?

   Do you see any new parts? Where did these parts come from?

4. Look at each diagram. Find the differences in each diagram. The long rod-like parts are chromosomes.

5. Label on each diagram:
   chromosomes
   cell membrane
   cytoplasm

6. What has happened to the nucleus?

QUESTIONS TO ANSWER:

1. The part of the cell that changes the most when a cell divides is the ____________________.

2. When the nucleus begins to divide, the material in the nucleus arranges itself into ____________________.

3. Can you tell how a new cell is made? Tell what changes take place in the cell step-by-step to make a new cell.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

4. Label the stages on the diagram of the egg.

PROBLEM 13. WHAT CHANGES TAKE PLACE INSIDE THE EGG BEFORE THE EGG HATCHES?

OUTCOMES: Much of the egg material provides food for the developing embryo.

The fertilized egg goes through many changes in order to develop into a chick.

It takes twenty-one days for the egg to develop under the proper conditions of temperature and moisture.

The embryo of the chicken develops very much as mammals do, including humans.

MATERIALS:

a three or four day chick embryo
saline solution - 9 gm. iodine free salt(NaCl) in 1000 cc water at 103° F.
finger bowl
charts of developing chick embryo

PROCEDURE:

1. Review and elicit, if possible, that much cell division has taken place inside the egg from the time it was fertilized until now. Explain that the egg has developed beyond the gastrula stage.

2. To demonstrate the four-day chick embryo, by doing the following:
   a. Assemble the equipment - finger bowl half-full of the saline solution which is 103° F. You may use a probe as a pointer.
   b. Remove the egg from the incubator only when you are ready to open and show it to the group.

c. Be sure to hold the egg in the same position as it was in the incubator so that the embryo will be on top. Crack the egg gently on the edge of the finger bowl.
d. In the three-day or four-day embryo the heart is beating and will continue to beat for a half hour if the saline is at 103° F.

3. Show these parts to the pupils. Project diagram if possible.

Other eggs should be removed and opened at later stages close to 8, 10, 14, 16, 18, 21 days. Open in the same manner as the four-day egg. In 21 days some may hatch.

4. After several observations of the embryos have been made, ask, "What conditions are necessary for the egg to hatch?"

5. Start filling in the chart below. Follow procedure above until all data have been entered.

What changes take place inside the eggs before it hatches?

4 days ______________________________

8 days ______________________________

10 days ______________________________

14 days ______________________________

16 days ______________________________

18 days ______________________________

21 days ______________________________

6. Explain that these changes in the egg are very similar to the development of human embryos but the human takes much longer to develop.

Note: The questions may be used as a worksheet of observations for the pupils. Duplicate the questions of the summary with ample space for the pupils to write in their observations. Be sure to give them things to look for when you show them, e.g., heart, body, head, limbs, eyes, size, shape.
Identify organs. Look for groups of organs that form systems.

PROBLEM 14. HOW DOES THE BODY WORK?

OUTCOMES: The body has many parts or systems that work together to make it function.

Organs that work together to do a specific job form a system.

MATERIALS:

manikin

wall charts of each system - digestive, respiratory, circulatory, nervous, excretory, muscular, skeletal

unlabeled diagrams of systems

PROCEDURE:

1. Ask the class to name some of the functions or activties of the body, such as, breathing, eating, moving, etc.
2. Ask them to consider each of these activities to determine if the activity is performed by the entire body or if specific parts are involved in order to develop idea of systems.
3. Display the manikin and have pupils help "dissect" it and identify organs.
4. Point out a group of organs that form a system, i.e., they work together to perform a specific job.
5. Hang the charts of the systems in front of the class.
6. Distribute worksheets and blank charts of the systems.
7. Have the pupils label the blank charts using the manikin and large charts for reference. Have them complete the worksheets. Circulate, giving assistance.
8. Summarize by compiling in chart form information elicited from pupils:

system	job	organs that make up the system

9. Point out that one system depends on the work of other systems. Explain that the body must have all systems functioning properly.
10. Have the children:
    Complete at home the charts begun in class.

PUPIL WORKSHEET

PROBLEM 14. How does the body work?

MATERIALS:

blank diagrams of systems
pictures of organs you brought in

WHAT TO DO:

1. Look at the manikin in the front of the room. Make a list of organs you see.

2. Tell what the job of each organ is. Write the job next to the name.

3. Look at the large charts in the front of the room. Find a blank chart that is like the large charts.

   a. Write the title of the system on each chart.

   b. Label the organs.

4. Arrange the pictures of organs you brought in in groups that go together.

QUESTIONS TO ANSWER:

1. Each group of organs working together to do a special job is called

   ____

2. How is it possible to fit all the groups of organs into the body?

   ____

3. Fill in the summary chart:

SYSTEM	ORGANS IN THAT SYSTEM	JOB OF SYSTEM

PROBLEM 15: HOW DOES THE DIGESTIVE SYSTEM DO ITS JOB?

OUTCOMES: Each organ of the digestive system helps to change food into a soluble form.
Soluble (digested) food enters the blood from the small intestine where digestion has been completed.
Food must be made water soluble to be used by the body.
Food is used or needed in the cells of the body.

MATERIALS:

chart of digestive system
model or picture of villus
pupil diagrams of digestive system
manikin
picture of stomach wall

PROCEDURE:

1. Show the chart of the digestive system.
Trace the path of the food through the system, eliciting names of organs as you trace. Explain that the liver, gall bladder and pancreas are accessory organs and that food does not pass through them. Have children check their charts of systems as you work with wall chart.
2. Describe the function of each organ. Show picture of stomach lining to elicit reason stomach is suited for its job of churning and mixing.
3. Explain that digestion is started in the mouth and is completed in the small intestines. (Process takes about 15 hours.) From here digested food materials enter the blood to go to the cells of the body. Other materials which cannot be digested pass through large intestines and rectum to leave body.
4. Explain that food has not become a part of the body until it has left the digestive system or alimentary canal. The food materials which we cannot digest, for example, plant cellulose, are never "in the body", they pass through the "tube within a tube."
5. Show a model of a villus. On the cross section, show that food must pass through vessel walls and cell membranes to enter blood.
6. Have pupils summarize the lesson by tracing the path of food using the manikin. Allow them to dissect the model to describe an organ and its function.

PROBLEM 16. WHAT CHEMICAL CHANGES TAKE PLACE IN THE MOUTH AND STOMACH?

OUTCOMES: Starch is changed to sugar by saliva in the mouth.
Some proteins are digested in the stomach.

MATERIALS:

two beakers of water
two 10" pieces of cellulose tubing
see pupil worksheets
starch suspension - 1 gm. starch in 1000 cc hot water
starch suspension + saliva

PROCEDURE:

1. Have children recall the tests for starch and sugar.
2. Distribute materials and assist pupils in their observations.
3. When they have completed, ask, "Why is digestion necessary?" and set up the demonstration in the diagram. The cellulose tubing represents intestines. Tie tight knots and rinse thoroughly before placing in beakers. Be sure there is enough water in beakers for pupil tests tomorrow.

PUPIL WORKSHEET

PROBLEM 16. What chemical changes take place in the mouth and stomach?

MATERIALS:

7 test tubes in a rack
test tube holder
Lugol's solution
Benedict's solution
starch suspension
droppers
matches
label
cotton
1% solution hydrochloric acid
1% solution pepsin
cooked egg white
alcohol burner

WHAT TO DO:

1. Set up 6 test tubes with the following things:
   a. starch suspension
   b. starch suspension
   c. starch suspension and saliva (shake to mix)
   d. starch suspension and saliva (shake to mix)
   e. saliva
   f. saliva
2. Allow the tubes to stand while you continue.
3. Into a clean test tube, place some cooked egg white.
4. Add equal amounts of pepsin and hydrochloric acid. This mixture is like the juices of the stomach.
5. Stopper the tube with cotton, label it with your name, and give it to your teacher for storage in a a warm place until tomorrow.
6. Now test the tubes above
   a. for starch: test tubes a, c, e
   b. for sugar: test tubes b, d, f
7. There was a positive starch test in the tube containing ____________
8. There was a positive sugar test in the tube containing ____________

QUESTIONS TO ANSWER:

1. Did the saliva contain sugar or starch?
2. Did the starch suspension contain sugar?
3. How can you explain that starch plus saliva contained sugar?
4. What happens to bread in the mouth?
5. (Answer tomorrow) What happened to the egg white?

PROBLEM 17. WHY IS DIGESTION NECESSARY?

OUTCOMES: The same as the outcomes listed in the previous lesson.

MATERIALS:
- chart of the digestive system
- manikin
- the two beakers set up during previous lesson
- see pupil worksheet

PROCEDURE:

1. Distribute worksheets and the equipment for the lesson.

2. Display the osmosis set-ups and review what the parts of the set-up represent.

3. Help pupils answer the questions in the procedure. Recall that Lugol's solution is used to show when starch is present and Benedict's solution is used to show when sugar is present. Do this before the pupils make the tests.

4. Check them carefully as they make the tests for starch and sugar. Be sure they know how to heat properly in the test for sugar.

5. When they have completed the tests and questions, develop with them the reason starch must be changed to sugar. Explain that for any material to enter the cells, it must be able to go through the wall of the small intestine and the wall of the blood tube and to enter the cell through the cell membrane.

6. Explain that nutrients must be changed into a form able to enter the cells. These materials are changed chemically. This is digestion. Point out that the organs of the digestive system act to change the food chemically so it is dissolved and can enter the cell where it is used.

7. Develop the chart on the worksheet with the pupils.

8. Summarize by:

   a. Eliciting the path of food in the body
   b. Eliciting what happens to food in each place or organ of the system
   c. Eliciting a definition of digestion
   d. Answering, "Why must food be digested?"

PUPIL WORKSHEET

PROBLEM 17: Why is digestion ncesssary?

MATERIALS:

water from the two beakers set up in the previous lesson
test tubes — Lugol's iodine solution
burner — Benedict's solution

WHAT TO DO:

1. Look at the beakers on the table in the front of the room.
   a. In one beaker there is ______________ in the tubing.

   b. In the other beaker there is ______________ in the tubing.

   c. The tubing represents ______________ and the water represents ______________.

2. Get some water from the beaker containing tube of starch and water and pour into a test tube.
3. Put a few drops of Lugol's iodine solution into the test tube.
   Why did you put iodine solution in the water? What does this show?
   a. The starch (did, did not) go through the membrane.
   b. I can tell because ______________________.
4. Pour some water from the beaker where the starch and saliva were in in a test tube.
5. Add some Lugol's iodine solution to the water. What happens?
6. Test water from each beaker with Benedict's solution. Heat gently.
   What does this show?
   Some material did go through one membrane. I know this because

   ____.
7. In the tubing with starch and saliva ______________ was made.
8. In the body starch must be changed to ______________________.
   This change begins in the ______________.

QUESTIONS TO ANSWER:

1. The organs of the digestive system are:

2. When starch is digested, the starch is changed to ______________.

3. The other food materials must be changed or ______________________.

4. Most digestion happens in the ______________.

5. We must digest food because ______________________________.

PROBLEM 18. HOW DOES THE BODY USE THE FOOD WE EAT?

OUTCOMES: Foods are needed:

a. to produce heat
b. to produce energy
c. for growth and repair
d. to regulate body functions

The chief energy foods are those foods containing carbohydrates and/or fats and oils.

MATERIALS:

spray can cover	thermometer
butter or margerine	calorie charts
wick	food charts
water	matches

PROCEDURE:

1. Take the cover of a spray can such as that used for hair sprays or spray starch. Add water to the outer ring and place a small amount of melted butter containing a string wick in the center section. Take the temperature of the water. Then ignite the wick and when the butter has burned, take the temperature of the water again to show that heat was produced when the butter burned.

2. Hold a piece of lump sugar with tongs. Dip the sugar into cigarette ashes. Then ignite it to show sugar is a fuel and will burn to produce beat and energy.

3. Refer back to chemistry unit and have children describe burning as an oxidation process, i.e. something combining with oxygen.

4. Hold a peanut by tongs or on a dissecting needle and ignite it.

5. Have calorie charts available for pupils to look up calorie values for butter, peanut and sugar. Explain that a calorie is a unit of heat and therefore high calorie foods are our energy foods.

6. Have children summarize that foods do a variety of jobs: that particular substances in foods do special jobs; that our chief energy foods are those containing carbohydrates and/or fats or oils. (Proteins can be used to provide energy when necessary.)

PROBLEM 19. WHAT MATERIALS ARE NEEDED FOR GROWTH AND REPAIR?

OUTCOMES: Proteins are needed for growth and repair.
Minerals are needed in small amounts to replace lost minerals and also for general body maintenance.

MATERIALS:

bacteria that have been incubated for one or two days in tubes containing nutrients (below)
bone that has had calcium removed by being soaked in dilute hydrochloric acid
hemoglobin (iron) charts

NOTE: Pure specimens of non-pathogenic bacteria can probably be obtained from a neighborhood college

PROCEDURE:

1. Display bacteria that have been incubated in
   a. 2% solution of glucose
   b. peptone solution
   c. fat suspension
   d. water
   e. peptone and glucose

2. Examine the tubes for greatest degree of growth and reproduction (most cloudiness). The peptone and sugar should be first, peptone alone, second.

3. Elicit that proteins are needed for growth and the formation of new material.

4. Display a bone which has been in dilute hydrochloric acid for a few days to remove the calcium. Have children examine it to see it is flexible. Have them point out the need for calcium in making bones and teeth hard.

5. Show a color chart of blood with varying amounts of the mineral, iron.

6. Summarize by having pupils:
   a. Give uses of protein and name some tissues of body needing protein.
   b. Name some important minerals and the tissues that need them.

Tomorrow's lesson will be a pupil research lesson. For this reason, only a worksheet will be given.

PUPIL WORKSHEET

PROBLEM 20: Why are vitamins necessary for good health?

MATERIALS:

charts on vitamins - food sources, uses in body, and deficiency diseases
stories of vitamin deficiency research
textbooks

WHAT TO DO:

1. Use the books to find stories of the studies of vitamins and the deficiency diseases. You are to keep a record of several. You will also get a chance to report in class.

2. List below some people involved with the studies, the diseases they studied and the vitamin involved.

NAME	DISEASE	VITAMIN

3. What were the results of studies made where animals were fed pure nutrients lacking vitamins?

4. Using a chart of the vitamins, make a list of the ones known to be important, what they are needed for and some foods that supply the vitamins.

5. Which vitamin cannot be stored in the body and therefore must be replenished daily?

6. Which other nutrients, besides vitamins, are regulators of body functions?

7. What can you say about the amount of each vitamin needed?

8. Why is vitamin D called the "sunshine vitamin"?

9. Why is bread labeled "enriched"?

10. Is it necessary to take vitamin pills? Why?

Raise your hand when you have completed so your teacher will know you can be called on to report your findings.

PROBLEM 21: WHY IS THE HEART SO IMPORTANT?

OUTCOMES: The blood travels in a one way closed system of tubes. The heart pumps or pushes the blood through the body.

MATERIALS:

model of villi
chart of circulatory system
goldfish
microscope
see pupil worksheet
slide
cotton or gauze
chart of heart
Petri dish

PROCEDURE:

1. Show chart of circulatory system. Elicit if possible the organs in the system - heart, arteries, veins, capillaries. Point out arteries and veins (use color code - usually red for artery and blue for vein). Point out how blood is carried to all cells of the body through capillaries.

2. Show circulation in tail of goldfish:
   a. Place goldfish on slide. Wrap the fish and slide together with wet gauze or cover with large wad of wet cotton. Leave tail exposed.
   b. Place in Petri dish and place on stage of microscope.
   c. Keep tail wet by using dropper.
   d. Focus sharply. It is necessary to check the focus between viewings by the pupils because the fish may move.

3. Point out that the brick-like structures are the cartilage blocks that make the skeleton of the goldfish tail (like the fingers in our hands). The moving particles are cells of the blood traveling through capillaries. Explain that blood moves through the body in a similar manner.

4. Explain that arteries take blood away from the heart and veins, take blood to the heart. Capillaries join arteries to veins and allow for materials to leave and enter the blood. Elicit what type of vessel was seen in the model of the villi. Look at model of the villi to recall food absorption.

5. Explain that at the same time blood is traveling to all other parts of the body through the other blood vessels. Show aorta and the many branches of it.

6. Trace the path of blood through the heart. Explain that the heart has two parts. One side, the right, pumps only to the lungs and the left side pumps to the body. Elicit the importance of this arrangement.

7. Summarize by having pupils trace path of blood from one place in the body to another. Emphasize the heart. Caution them that blood can never by-pass the heart once it has entered a vein from a capillary network.

PUPIL WORKSHEET

PROBLEM 21: Why is the heart so important?

MATERIALS:
stethoscope

WHAT TO DO:

1. Listen to the heartbeat of your neighbor.

2. Count the number of beats for a half minute. Multiply by two to get number beats per minute. There were __________ beats per minute.

3. Check the number of beats by repeating.

4. Place two fingers on the wrist of your neighbor next to the thumb (do not use your thumb). Count the number of beats per minute. There were ______ beats per minute. Check the number.

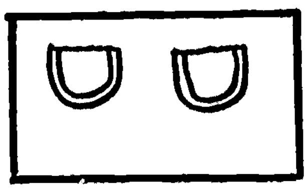
5. Count the number of beats per minute at the following points:
   temples - side of forehead ___________.
   side of neck ___________.

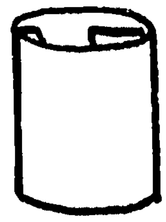
6. Are the numbers the same? __________

7. You are feeling the pulse at the wrist, temples and neck. These beats are really the _______________ going through _______________________.

8. Hold your arm down at your side. Pump the fist open and closed to make your veins stand out. N ow make a tight fist. Put a finger on a prominent vein near the elbow and while pressing, move your finger toward the wrist and hold it at the wrist. You will see a small bulge along the vein. This happens at a valve in the vein.
   Did you feel a beat in the vein? _________________

9. To get an idea of how a valve looks and works, make the following at home:
   Cut a small flat square and two pockets like the diagram. Glue the pockets on the square as shown.





10. Roll the square to make a tube with the pockets on the inside. Glue into a tube.

11. Imagine that blood were going through this tube and tried to go backwards, what would happen? ____
    ____

QUESTIONS TO ANSWER:

1. The heart pushes or pumps the blood through _________________________.
2. The blood goes back to the heart through ___________________________.
3. The blood cannot go backwards because _____________________________.

PROBLEM 22: HOW DOES OXYGEN GET INTO THE BLOOD?

OUTCOMES: We breathe in air and extract the oxygen in the lungs. The respiratory system prepares the oxygen for entering the blood.

MATERIALS:

pluck or hazlet ordered from a local butcher shop in advance
chart of respiratory system

PROCEDURE:

1. Examine the wall chart of the respiratory system. Point out the structures and elicit names.

2. Have pupils check their charts to fill in omissions. As they check their charts, trace the path of the air telling what happens to it as it enters each structure.

3. Gather the pupils around the hazlet.
   a. Point out the cartilage rings of the trachea, the branching, the color and consistency of the lungs. Insert a tube into a bronchiole and blow carefully. Cut into the lung to see the spongy appearance.
   b. Examine the heart to see the size and shape, the location, the large blood vessels.
   c. Cut open the heart along the sides to see the insides of the four chambers and the valves.
   d. Trace the blood through the heart emphasizing that blood enters the heart with a low oxygen content. As it goes through the right atrium and then the right ventrical it goes to the lungs. In the lungs it picks up oxygen and goes back to the left side of the heart. Then it is pumped to all parts of the body.
   e. Point out how closely the heart and lungs are associated.
   f. Look for parts of the diaphragm. Point out that this is the muscle that controls air going in or out of the lungs.
   g. Refer back to the chart of the respiratory system to study the alveoli to note blood vessels where oxygen enters the blood stream and carbon dioxide leaves it to enter the lungs and be exhaled.

   h. Assign the special project of making a breathing apparatus demonstration.

PUPIL WORKSHEET

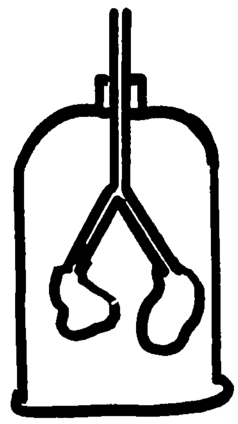
PROBLEM 22: How does oxygen get into the blood?

MATERIALS:

labeled diagram of respiratory system
2 balloons
bell jar
Y tube
rubber sheeting
one-holed rubber stopper
rubber bands

WHAT TO DO:

1. Assemble the materials as in the diagram.



2. Explain the diagram:
   a. What do the balloons represent?
   b. What does the Y tube represent?
   c. What does the rubber sheet represent?
   d. What does the jar represent?

3. Grasp the center of the sheet and pull down gently. What happens?

4. Push the sheet up. What happens?

QUESTIONS TO ANSWER:

1. What is the movement of the diaphragm that causes air to enter the lungs?

2. How does this movement of the diaphragm allow the air to enter? Explain carefully.

3. What two things happen to the air in the nose?

4. What happens to the air in the lungs?

PROBLEM 23: WHAT JOBS MUST BLOOD DO?

OUTCOMES: Liquid part of the blood carries stored foods and some liquid wastes.
Red cells carry oxygen to the cells and carbon dioxide away from the cells.
Some white cells fight bacteria.
Blood clots to prevent blood loss.
Antibodies in the blood help to fight foreign materials in the body.
The liquid part carries chemicals made by glands to other organs of the body.
Blood is made of red corpuscles, white cells, platelets and a colorless liquid called plasma.

MATERIALS:
chart of blood cells
centrifuge
outdated blood from hospital
photo micrograph or diagram of blood smear that shows red and white cells
see pupil worksheet

PROCEDURE:

1. Elicit and review the jobs of the blood covered so far - carrying food to the cells, carrying oxygen to cells.

2. Run blood in centrifuge to show that the blood is about half cells and half liquid. The cellular material will go to the bottom of the centrifuge tube. Call attention to the red mass at the bottom.

3. Demonstrate how a blood smear is made.

4. Guide pupils through the worksheet exercises.

5. Elicit the composition of the blood after the children complete their work.

6. Tell them the functions of the various parts to be written on their summary charts. (See Outcomes.)

7. Demonstrate the clotting mechanism using the outdated blood. Allow 50 cc. to clot in a flask. (A pinch of calcium chloride may hasten the process.)

8. Summarize by helping children complete the charts on the worksheets.

PUPIL WORKSHEET

PROBLEM 23: What jobs must blood do?

MATERIALS:

microscope	2 slides
lens paper	coverslip
blood	prepared slide of blood

WHAT TO DO:

1. Get your microscope ready for work.

2. Watch how your teacher prepares a blood smear.

3. Now you make a blood smear.

4. Look at the slide under the microscope.
   a. Why is the blood not very red?

   b. What do you see on the slide?

5. Look carefully between the many red corpuscles. You may see a few cells which are large and granular. These are white cells. Look at the picture of a blood smear. Your teacher has to check your observation.

6. Now look at your prepared slide under the microscope. The blood has been stained so you can see the cells better.

7. Draw a diagram of several red corpuscles and any white cells you see.

QUESTIONS TO ANSWER:

1. Blood is made of a liquid called ________ with ________ cells and ___________ cells floating in the liquid.

2. The part of the blood which is red is ________________.

3. The liquid part of the blood is ________________ in color.

Your teacher will help you complete your chart but first put in the things you know.

PARTS OF BLOOD	JOB OF THIS PART OF BLOOD

PROBLEM 24: HOW ARE WASTES REMOVED FROM THE BODY?

OUTCOMES: The excretory system removes most liquid wastes.
Urine is made of urea, water and salts.
The kidneys rid the body of urea.
Sweat glands of the skin remove urea, salt and water from the body.

MATERIALS:

kidney - fresh chart of kidney showing tubules and Bowman's capsule
model of kidney chart of sweat gland
see pupil worksheet

PROCEDURE:

1. Review parts of the excretory system.
2. Display fresh kidney. Cut kidney open lengthwise to show cortex and medullary regions and pelvic region.
Point out that the kidney is made of many tubules beginning with the capsule. Show how liquid wastes can leave capillaries and enter the cup of the capsule. Liquid from the blood similiar to the plasma leaves the blood and as this liquid passes through the length of the tubules most of the useful material re-enters the blood stream through other capillaries. The liquid remaining in the kidney tubules is urine. This flows into the bladder in the pelvic area through the ureter. It is stored in the bladder until eliminated from the body.
3. Trace the path of the urine.
4. What is the compostion of urine? * Distribute worksheets. Be sure to do each test with pupils. Do not let them proceed until all are ready to go on.
5. Give the correct composition of normal urine as:

95% water	
2.3% urea	1.0 % chlorides (salts)
.05% glucose	1.65% other materials

Mention that urea is the harmful waste product. In large amounts in the body urea is a poison. It is made by the chemical changing of proteins.
6. Show a chart or diagram of sweat gland. Point out that the body sweats or perspires. Elicit that the perspiration tastes salty. Tell them it contains water, salt and urea - waste products of the cells.

* Artificial urine is prepared by:
Adding 10 grams of glucose or dextrose
5 grams of sodium chloride
10 grams of urea (on S-1 list)
5 grams of albumin (white of egg may be used)
to 1000 ml. of water.
Be sure mixture is slightly acid, if not, add a few drops of HCl. Use tea to color the urine.
Make some samples with different amounts of salt, sugar and albumin for unknowns.

NOTE: Urine does not normally contain sugar or albumin but any urinalysis will include a routine test for these. It is included in the urine sample for practice for the pupils.

PUPIL WORKSHEET

PROBLEM 24: What is the composition of urine?

MATERIALS:

a bottle of artificial urine	burner
red and blue litmus	medicine dropper
test tube rack with 4 test tubes	graduated cylinder
test tube holder	urease tablet

dropper bottles containing Benedict's solution, silver nitrate, 36% acetic acid, phenolphthalein

WHAT TO DO:

1. Look at the sample.
   The color is ________ Urine is __________ (clear, cloudy)
2. Test with litmus paper.
   Urine is _____________ (acid, base, neutral)
3. Test for sugar:
   a. Put 5 ml. of urine in a test tube.
   b. Put 5 ml. of Benedict's solution in test tube.
   c. Heat gently.
   d. This urine sample______(does, does not) contain sugar.
4. Test for salt:
   a. Put 5 ml. of urine in a test tube.
   b. Add a few drops of silver nitrate.
   c. If you see a white material, there is salt in the urine.
   d. This sample of urine ________ contains salt.
5. Test for urea:
   a. Put 5 ml. of urine in test tubes.
   b. Add 1 urease tablet and a few drops of phenolphthalein.
   c. If you see a red color then urea is in the urine.
6. Test for albumin:
   a. Fill a test tube three-fourths full of urine.
   b. Heat the upper portion until it boils. Be careful not to have it boil out of the tube.
   c. Add three drops of acetic acid and boil again.
   d. If you see a white material the protein, albumin, is in the urine.

QUESTIONS TO ANSWER:

1. The sample of urine we tested contained ____________________________.
2. What materials are found in normal urine?
3. Sugar and albumin are not usually found in urine. What does it mean if you do find them?
4. If a large amount of salt is found in urine what does it tell you about the person's diet?

PROBLEM 25: HOW DOES THE BODY KNOW WHAT IS GOING ON AROUND IT?

OUTCOMES: Our nervous system is adapted for carrying messages.
Our senses, with their nerve endings, receive stimuli and send messages to spinal cord and brain.
There are special relays for the reaction response to answer the stimulus-reflexes.
There are special areas of the brain that receive and answer messages from particular parts of the body.

MATERIALS:
charts: nervous system, brain, eye, ear, cross-section fo skin
models: ear and eye

PROCEDURE:

1. Review the structure and function of the eye. Emphasize the nerve endings in the retina, the optic nerve and the need for the message to reach the brain.

2. Quickly review the production of vibrations and their interpretation by the ear as sound. Display chart or model of the ear. Point out parts necessary for hearing. (Semicircular canals play a role in balance, not hearing). Point out the auditory nerve leading to the brain. This must be functioning properly if the vibrations are to be "heard".

3. Show chart of cross-section of skin. Review some of the functions of skin, such as, the protection it offers against germ invasion, excretory function by production of perspiration, temperature regulation and irritability (sensitivity to stimuli of various kinds). Point out nerve endings in skin. Elicit some of "feelings" it senses: heat, pain, touch.

4. Show chart of nervous system. Point out central nervous system consisting of spinal cord and brain.

5. Distribute pupil charts or have children draw diagrams of central nervous system. Have them label the parts of the brain, the spinal cord and one or two sensory and motor nerves.

6. When children have completed their diagrams, review the functions of nervous system, particularly that of sensing what is going on around or to the body. Point out that any feeling that is understood or recognized has been received by the brain.

PROBLEM 26: WHAT ARE REFLEX ACTIONS?

OUTCOMES: Reflexes are rapid, involuntary and usually protective reactions to stimuli.

MATERIALS:

chart of nervous system
diagram of stimulus and reflex action
chart of skin cross section

PROCEDURE:

1. Distribute materials and have children complete exercise.
2. Have children report on results.
3. Elicit that they had reacted to a stimulus before they were aware of what had happened.
4. Elicit other times this happens.
   a. putting hand on hot object
   b. stepping barefoot on a sharp rock
5. Remind them that the hand came up before they actually felt the pain, in other words, before the message reached the brain.
6. Have pupils name the simple reflexes they know.
   a. iris reflex (contraction or dilation as a result of light stimulus)
   b. sneeze reflex
   c. blinking reflex
   d. patellar reflex (knee jerk)
   e. some responses to dangerous conditions (touching hot object)
7. Summarize that reflexes are rapid, involuntary and usually protective.

PUPIL WORKSHEET

PROBLEM 26: What are reflex actions?

MATERIALS: paper and pencil

WHAT TO DO:

1. Working in pairs, one member is to cover his eyes for one minute until the partner says to uncover eyes.
2. Stare directly at each other.
3. What happened to the eyes of the person who had had them covered?
4. Repeat.
5. Now change roles. The other person covers his eyes.
6. One member is to cross one knee over the other with a relaxed leg.
7. Now strike his knee just below the knee cap quickly and carefully with the back of your hand.
8. Raise your hand if you need the teacher's help.
9. What happened?
10. Change places and repeat.
11. Snap your fingers in front of your partner's face without touching him. What happens.

QUESTIONS TO ANSWER:

1. What three reflex actions did you observe?
2. What is a reflex action?
3. Name some other reflex actions.
4. What are conditioned reflexes? (The mouth watering at the sight of food is an example.)

PROBLEM 27: HOW DOES REPETITION AFFECT OUR ACTIONS?

OUTCOMES: Habits are formed by constant repetition.
Concentration and training can change a habit.

MATERIALS: stop watch

PROCEDURE:

1. Tell the pupils to write their names ten times as fast as they can, then raise their hands when finished. Write time range on board.

2. Now instruct them to write their names with the other hand. Stop them at the end of the longest time needed in first part.

3. Elicit that the first group of signatures was neater, that they wrote automatically the first time but had to think of each letter and how to make each letter the second time.

4. Now instruct the pupils to write the passage you dictate but instruct them not to cross the "t's" nor dot the "i's". Dictate as quickly as pupils can follow:
   "Hitch your wagon to a star. A stitch in time saves nine. Don't cross your bridges till you come to them. Time and tide wait for no man. Don't count your chickens before they hatch."

5. Have each pupil count the number of times he failed to omit crossing the "t" and dotting the "i" to emphasize how hard it is for most of us to ignore a habit.

6. Find out how many pupils play musical instruments or type. Elicit that each of these activities is a voluntary activity, that is, the person is aware of, and directs or controls, the activity. Point out that constant practice and repetition increase the speed and accuracy in most skill activities.

7. Have the pupils hold hands in a circle formation. Designate a lead man. He is to squeeze the hand of the person to the right until the action gets back to the lead man who calls out when his hand is squeezed. Use a stop watch to time ten successive trials. Put time needed for each trial on the board. There should be rapid improvements at first, but plateaus may be reached. There may even by some regression. This is characteristic of learning. (Repeat tomorrow.)

8. Tell children to practice writing their names with the "wrong" hand for one week to check progress.

9. Summarize:

   Habits are formed by constant repetition. We are usually not aware of an action which is a habit.

   Concentration and training can change a habit.

   Repetition can increase speed at which we perform voluntary actions.

PROBLEMS 28 and 29: <u>HOW DO ORGANS AND SYSTEMS REALLY LOOK IN AN ORGANISM?</u>

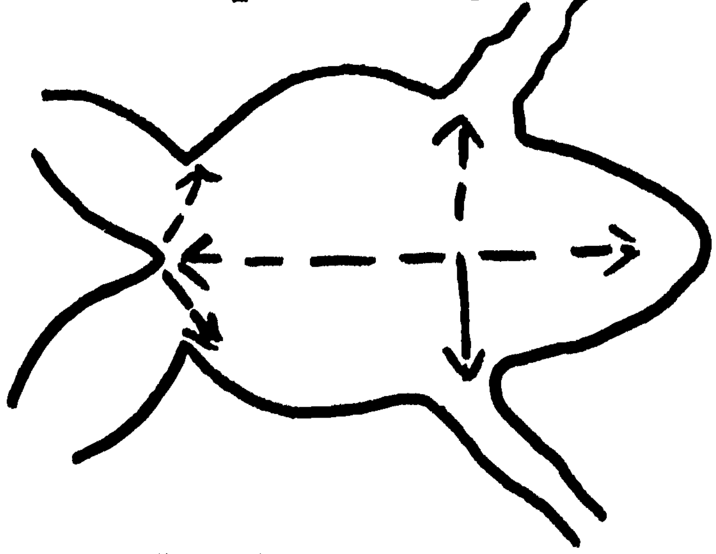
OUTCOMES: The organs and systems look somewhat different from the charts. These organs of the frog are similar to those in our body.

MATERIALS:

freshly killed and pithed frog	forceps
dissection pan	scissors
pins	probe
dissecting needles	wall charts of systems of frog

PROCEDURE:

1. Explain carefully reason for dissection. Dissections are done to see the organs as they are naturally and are done with an attitude of scientific investigation.
2. Have students observe closely as you dissect the frog. Pin the frog to the tray by putting pins through the feet.
3. Picking up the skin with forceps cut the frog as shown in the diagram.
4. Cut through the muscle layer underneath the skin in the same way. Be careful not to cut deep or the organs will be destroyed.



5. Lay the flaps back and anchor.
6. This is just a demonstration of techniques of dissection.
7. Review method of dissection.
   Review the body systems and organs the pupils are to see the following day. Heart will beat for approximately a half hour after pithing.

PROCEDURE: (second day).

1. Distribute the worksheets and equipment. Distribute the frogs only when the class is ready for work.
2. Guide them carefully through the procedure on the worksheet.
3. Assist pupils who are having difficulty.
4. Summarize by eliciting their observations and the outcomes.

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PUPIL WORKSHEET

PROBLEM 29: How do the organs and systems really look in an organism?

MATERIALS:

frog
dissecting pan
pins
dissecting needles
forceps
scissors
probe

WHAT TO DO:

1. Look at your frog. How do skin markings help you tell male from female?
2. Pin the frog down the way your teacher did.
3. Begin to cut the skin only the way the teacher showed you.
4. Pin the flaps of skin back.
5. Under the skin you see ____________.
6. Now cut the next layer under the skin as you saw your teacher do. Be careful not to damage any organs underneath.
7. Pin the flaps back.
8. Observe all the organs you see. If any egg mass is present remove it. List all the organs you see.
9. Push the probe gently through the mouth, down the throat. You should see the end of the probe in the stomach.
10. Remove the intestines and measure their length. ____________ Compare with the length of the body cavity. How did such a long intestine fit into such a small space? ____________
11. Identify the parts of the reproductive system. ____________
12. Push all the organs over to the side so you can see the nerves near the spine. Trace a nerve to the leg.
13. Remove some skin from the leg. Find the continuation of the nerve in the leg.
14. Pinch the nerve. What happens to the leg?
15. Find the heart and the veins and arteries near the heart.
16. Note how the tonque is attached. Why is it attached this way? ____________ ____________.
17. Notice how all the tubes lead to one cloaca.

QUESTIONS TO ANSWER:

1. Which systems did you see?

2. Which organs did you see? Organize them by systems.

3. Which organs looked different from the way you expected them to look?

PROBLEM 30: HOW CAN WE HELP MAINTAIN GOOD HEALTH BY PROPER MEAL PLANNING?

OUTCOMES: We must plan meals that will include the proper amounts of each nutrient.
We must balance our meals. To do this we use the Basic Four food chart which has been organized to include all required nutrients.

MATERIALS:
chart of nutrients
chart of vitamins
Basic Four food chart

PROCEDURE:

1. Display charts of food nutrients and the vitamins.
2. Ask one or two pupils to plan a menu for one day using these charts. Elicit that this is very difficult.
3. Point out that we must have enough of all the nutrients to be healthy.
4. Ask the children to name some foods they eat. Write them on the board grouping them into the four food groups.
5. Ask the children to suggest headings for each group.
6. Display a chart of the "basic four" and explain its use.
7. Have the children plan meals for one day.
8. Then have them take out their logs of meals they ate for one week and analyze each day's meals for balance.

PROBLEM 31: HOW DOES EXERCISE HELP TO KEEP THE BODY HEALTHY?

OUTCOMES: Exercise maintains muscle tone.
Exercise stimulates the circulation and respiration.

MATERIALS:

chart of muscles

PROCEDURE:

1. Have pupils perform the activities on the worksheet. Help them answer the questions on the worksheet.

2. Elicit what happens when a muscle which has been inactive is used a great deal in a short time.

   a. riding a bicycle for first time in spring
   b. playing baseball the first day out
   c. swimming the first time in a long time

3. Explain that the more often a muscle is used the stronger and more reliable it is when called on for use. Muscles which are seldom used are easily strained and pulled.

4. Point out some of the large muscles of the body on the chart.

5. Explain that while exercising, all body functions are given a boost and so general body tone is boosted.

   a. weight is more easily controlled
   b. appetite is stimulated
   c. circulation is improved

6. Explain the importance of exercise by telling how people who are in bed for long periods in hospitals are given exercise by nurses.

7. Summarize by eliciting the reactions of the body to exercise. Elicit the long range effects.

PUPIL WORKSHEET

PROBLEM 31. How does exercise help to keep the body healthy?

MATERIALS: stethoscope

WHAT TO DO:

1. Count the number of heart beats per minute of your neighbor.
   The number of beats per minute is ____________.

2. Now have your neighbor do 10 push ups or sit ups, or jump 20 times.

3. Now count the number of heart beats per minute again.
   The number of beats per minute is ____________.
   Why is there a difference?

4. Repeat the steps but this time you do the exercise and let your neighbor count the number of your heartbeats per minute.
   Before I did the exercise my number of beats per minute was ______.
   After I did the exercise the number of beats per minute was ______.

5. Do you notice any difference in the way you are breathing after exercise? Explain.

QUESTIONS TO ANSWER:

1. Exercise ________________ (increased, decreased) my circulation.

   I know because ________________________________.

2. Exercise ____________________ my respiration.

   I know because ________________________________.

3. A lot of exercise can cause other changes in the body.

   Can you make a list of other changes made by exercise.

PROBLEM 32: WHAT HAPPENS WHEN SOME ORGANISMS INVADE OUR BODY?

OUTCOMES: Bacteria growing at a rapid rate cause local infections when they enter the body where the skin is broken.
Bacteria produce toxins which interrupt normal body functions.
Parasites can cause damage to tissues.
Protozoa can interrupt normal functions.

MATERIALS:

3 or 4 Petri dishes with nutrient agar
bacteria in broth
water containing decaying meat
filmstrip and/or charts: life cycle of some parasites like hookworm, tapeworm; protozoa, such as amoeba, malarial flagellate
picture of white blood cell leaving capillary and ingesting bacterium

PROCEDURE:

1. *Set up demonstration to show the prevalence of bacteria. Incubate until tomorrow.
    a. Take dirt from the fingernail of pupil and place on Petri dish.
    b. Have a student breathe on agar.
    c. Expose Petri dish to air for several minutes.
    d. Keep a control plate.

   *Incubate the water containing decaying meat. (food poisoning)

2. From their previous work with bacteria elicit why body has good conditions for bacterial growth - food, moisture, darkness, warmth.

3. Recall and/or explain body protection - skin, moist sticky linings to catch bacteria, cough and sneezes to expel foreign material, antibodies in the blood and the action of phagocytes (white blood cells).

4. Explain how rapid growth of bacteria can cause an accumulation of mucus in nose and throat in body's attempt to get rid of bacteria. In lungs, fluid may collect in extreme cases. Why is this dangerous?

5. Elicit what happens when skin is broken and bacteria enter and an infection begins. Tell that pus is the accumulation of white blood cells that were unsuccessful in killing the bacteria. Display a picture of this process.

6. Show life cycle of certain parasites. Explain damage they can do -
    a. Worms bore through tissues and cause permanent damage.
    b. Worms live on the food of the body.
    c. Malarial protozoa live in the blood producing toxins.

7. Point out that many diseases are caused by viruses, exceedingly tiny organisms.

8. Summarize by assisting pupils in filling in a chart of organisms and conditions they can cause.
   Conclude that specific diseases are caused by specific germs.

PROBLEM 33: HOW CAN WE PREVENT HARMFUL ORGANISMS FROM ENTERING BODY?

OUTCOMES: Cleanliness of body and of materials we use can prevent many bacterial infections.
Proper care of breaks in the skin can prevent infection.
Proper preparation and storage of foods can prevent infections (food poisoning).
Drinking water that is properly treated prevents protozoan and bacterial infections.
We can eliminate the conditions for worm infestation to occur.

MATERIALS: Petri dishes and other materials from incubator

PROCEDURE:

1. Point out from the colonies in the Petri dishes that bacteria are found everywhere. Elicit the source of the ones grown.

2. Using the information from the previous lesson on life cycles, etc., help pupils think of ways of preventing the invasion of organisms.
   a. Keep dirt from under fingernails. Wash hands.
   b. Don't put hands in mouth.
   c. Use clean private utensils.
   d. Use antiseptics on cuts and scratches.
   e. Use disinfectants to clean areas at home where germs may breed. (Explain that antiseptics usually prevent germs from multiplying. Disinfectants, which are stronger, kill them.)

PUPIL WORKSHEET

PROBLEM 33: How can we prevent harmful organisms from invading the body?

WHAT TO DO:

Next to the list below, give ways you think we can prevent the conditions that some harmful organisms cause in our body. How can we keep these organisms out of the body?

ORGANISMS OR CONDITION	
BACTERIAL infection	
cuts	
colds	
trichina	
hookworm	
malaria	
tapeworm	
food poisoning	

PROBLEM 34: HOW ARE CHEMICALS USED TO HELP THE BODY FIGHT INFECTION?

OUTCOMES: Antibiotics prevent germ growth.
Antitoxins and vaccines help give the body immunities to germs.
Many drugs used correctly can correct temporary poor health conditions of the body.

MATERIALS:

disc containing antibiotics — forceps

2 bacterial cultures on Petri dishes

PROCEDURE:

1. Place a disc containing antibiotics on the agar near a bacterial colony. Cover. Incubate this dish and the control dish. Check both dishes tomorrow and following days to see if bacterial growth is halted near antibiotic. Some bacteria are affected, some are not.

2. Ask children to describe the smallpox vaccination. Explain that vaccines contain dead or weakened germs. When these germs enter the body, the body makes its own antibodies and antitoxins. Point out that it takes time for the immunity to develop, but that it is long lasting.

3. Explain that there are times when immediate immunities are needed. If a person has been exposed to a serious disease, he may be given serums containing antibodies or antitoxins already made by an animal or other person. When these are injected into a person, he starts fighting the infection immediately; however, the effects don't usually last very long.

4. Elicit diseases from which the pupils or their siblings have been protected: polio, smallpox, diphtheria, measles, typhoid, whooping cough, tetanus, tuberculosis.

5. Define:
   a. toxins - poisons made by germs
   b. antitoxins - chemicals made by the body to counteract the toxins
   c. foreign body - any substance not normally found in the body
   d. antibodies - cells or substances made by the body to destroy the germs that enter
   e. antibiotics - chemicals that are special medicines given to fight some infections already started

6. Caution that medicines should only be used when prescribed by the doctor for that particular person, because:
   a. People are sometimes allergic to a drug.
   b. If overused, some drugs lose their effectiveness. Body may build up a tolerance or even antibodies to combat the effects.

7. Elicit that medicines are given as temporary and drastic actions by physicians to cure diseases and are not to be taken unless prescribed.

PROBLEM 35: WHAT CHANGES DOES ALCOHOL MAKE IN OUR BODY?

OUTCOMES: Alcohol is a depressant and slows down body functions.

Continued use of alcohol causes a severe damage of liver tissue called cirrhosis.

Alcohol affects the nervous system, causing slower reflexes, changes in behavior, poor motor control.

MATERIALS:

picture of a normal live and liver with cirrhosis evident

PROCEDURE:

1. Elicit effect too much alcohol has on a person. Keep responses of pupil from straying. They should realize that:

    a. sense of balance is upset
    b. vision may seem impaired
    c. response to stimuli is slow - reflexes almost lost

2. Explain reason for conditions elicited:

    a. Alcohol is quickly absorbed by the blood and quickly travels through the body
    b. Alcohol affects the nervous system and the brain. Many times people are injured because of poor nervous function. Since the nervous system is slowed down all body functions are slowed down.

3. Explain that frequent use of alcohol can cause permanent liver damage. Display pictures to show cirrhosis.

4. Elicit some of controls on use of, and advertising of, alcohol beverages.

    a. "Hard liquors" are not advertised on T.V.
    b. Liquor may not be sold to minors.
    c. Some states forbid its sale completely, others forbid its sale in bars and taverns, but not in bottles, etc.

5. Summarize by reviewing the outcomes.

PROBLEM 36: HOW DOES TOBACCO AFFECT THE BODY?

OUTCOMES: Tobacco contains nicotine and tars which can cause poor health when accumulated in the body.

Many scientists and doctors believe that smoking can cause cancer.

MATERIALS:

cigarette
watch glass
filmstrip and booklets on smoking and cancer
(available from the American Cancer Institute)

PROCEDURE:

1. Burn a cigarette completely in a watchglass. Show the tars' residue on the watchglass.

2. Explain that not all these tars enter the lungs, but some do. The tars accumulate in the lungs with continued smoking.

3. Show from filmstrip or in booklets how scientists have taken cigarette tars and produced cancers on plants and in laboratory animals. The amount of tars required to produce the cancer is great and would take many years to accumulate that amount in the lungs.

4. Point out that some people seem to be more susceptible to cancer than others.

5. Other than cancer, smoking can:

   a. impair respiration (Athletes usually do not smoke, especially swimmers and runners because it produces difficulty in breathing.)
   b. irritate the throat (Coughing often develops and persists. Infections are then easily started in the throat.)
   c. constrict the blood vessels (This reduces blood flow to various parts of the body.)
   d. increase rate and strength of heart beat
   e. depress the appetite

6. Point out that smoking often becomes a habit which is very hard to break and that the younger a person is when he starts, the more likely he is to become addicted to smoking.

PROBLEM 37: HOW DO NARCOTICS AFFECT THE BODY?

OUTCOMES: The body often develops a dependence on narcotics so the person becomes addicted.
Some narcotics are used to kill pain or induce sleep but only under doctor's care.
Narcotics are so dangerous that their use and sale by individuals is forbidden by law except when prescribed by a physician.

MATERIALS:
booklets and other materials on narcotics

PROCEDURE:

1. Elicit, if possible, the symptoms of narcotics addiction. such as:
    a. need for increasingly larger doses
    b. weakened, thin body
    c. tremendous craving
    d. loss of appetite
    e. gradual decline of health often resulting in early death.

2. Explain that narcotics are habit forming. Even when given by doctors, the doctors are careful to watch for signs of addiction. In addition, overdoses are usually fatal.

3. Discuss legitimate uses of narcotics.
    a. Morphine is used to induce sleep particularly when a person is in pain.
    b. Opiates, cocaine and barbiturates are used to relieve pain and/or induce sleep.

4. Explain that marijuana has no use in medicine because of its variable effect. Its danger lies in fact that it usually leads to more dangerous drugs.

5. Caution that hercin is completely outlawed in the United States because it cannot be controlled. A single dose usually leads to addiction. Because it is illegal, it is expensive and a person may do anything to get the money. He feels he cannot live without the drug.

6. Elicit that the terrible tragedies are the facts that human lives are destroyed, addicts exhibit antisocial behavior, victims become unemployable.

7. Arrange for a speaker from Department of Health or Police Department.