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ABSTRACT

This model instructional unit was developed to aid trade and industrial education teachers in Louisiana in preparing students for careers in the field of power mechanics. Students are provided experiences related to the design, theory, construction, and appropriate uses of the power systems, as well as the maintenance and repair of the more common industrial power systems. The guide provides model performance objectives, current technology content, sources, and lists of supplemental materials. Following a course description and rationale, the guide contains 11 instructional units covering the following topics: introduction; safety; tools and equipment; mechanical power systems; external combustion engines; internal combustion engines; fluid power systems; electrical power systems; automated systems and robotics; careers; and special projects. Each unit consists of introduction; competencies; general performance objectives/goals; specific performance objectives and mastery criteria; methodology; suggested interest approaches; unit outline; subject-matter content related to specific performance objectives and learning activities; activity sheets; transparency masters; test with answer key; evaluation and testing methods; and equipment and supply list. (KC)

POWER MECHANICS

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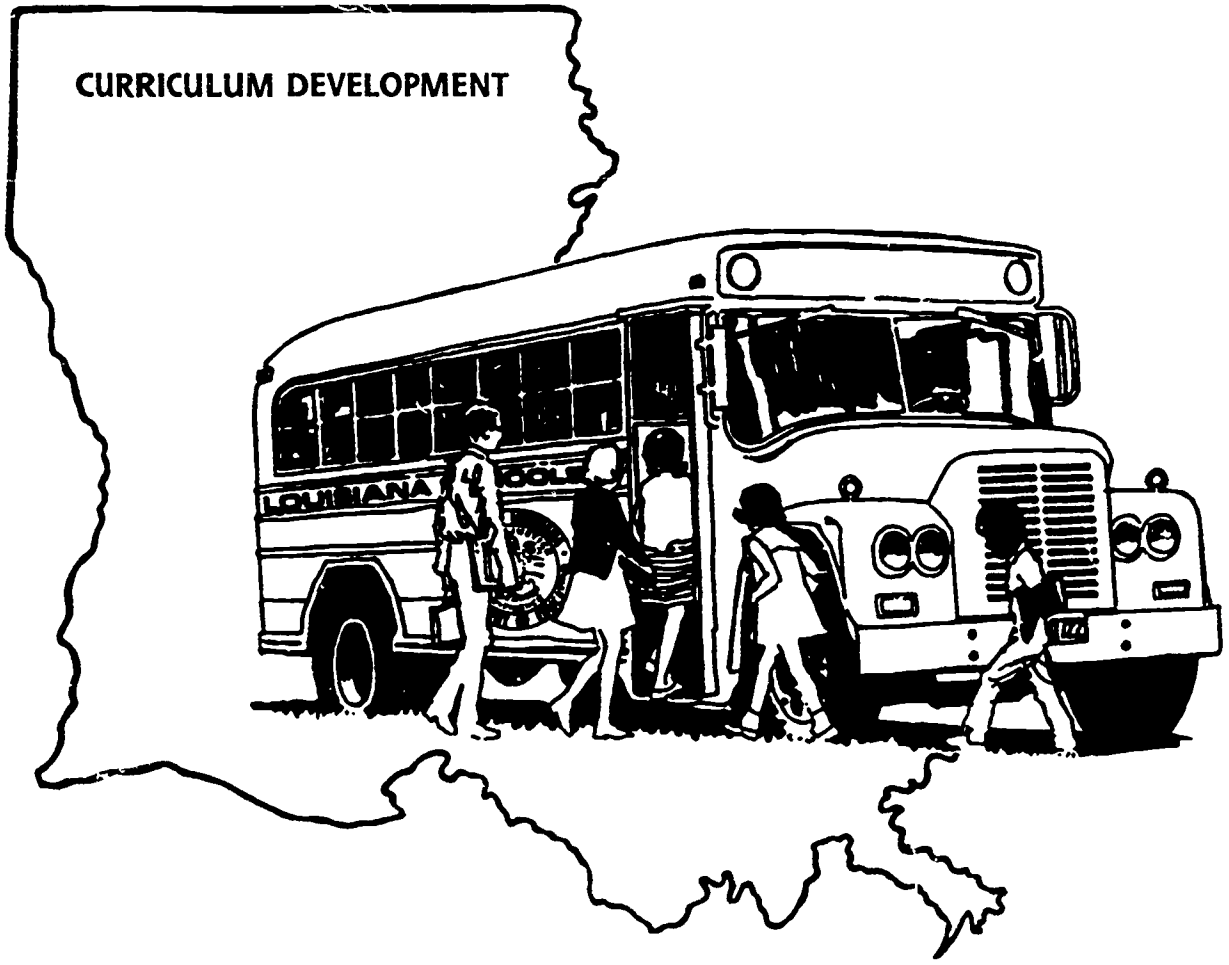

LOUISIANA DEPARTMENT OF EDUCATION

THOMAS G. CLAUSEN, Ph.D.
State Superintendent

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POWER MECHANICS CURRICULUM GUIDE

PROJECT DIRECTORS

MR. PETER A. TERRITO, JR.
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Funded by
The State of Louisiana
Department of Education
Office of Vocational Education

Louisiana State University

June 30, 1987

FOREWORD

This Curriculum Guide, Power Mechanics, was produced as a project funded by the Louisiana State Department of Education to Louisiana State University. This Model Unit represents the concerted efforts of six Industrial Arts/ Technology Education teachers throughout the State of Louisiana.

The Model Instructional Unit was developed for the express purpose of aiding experienced as well as beginning Industrial Arts/Technology Education teachers. It provides model performance objectives, current instructional content, sources, and supplemental materials.

I believe that the Unit will make a major contribution to the improvement of instruction in Industrial Arts/ Technology Education in Louisiana.

Thomas G. Clausen

Thomas G. Clausen, Ph.D.
State Superintendent of Education

ACKNOWLEDGEMENTS

This publication represents the cooperative efforts of Louisiana State University, Department of Industrial and Technical Education, and the Industrial Arts Section of the Office of Vocational Education, Louisiana State Department of Education.

Special recognition goes to the Project Directors, Mr. Peter A. Territo, Jr. and Dr. James G. McMurry. A special commendation also goes to the members of the curriculum writing team whose diligent efforts culminated in the development of this curriculum guide. The team members were Bill Bischoff, John M. deBen, III, Barry M. Quirk, and Charles E. Whitman.

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COURSE DESCRIPTION

This course is designed to provide senior high school students with the opportunity for in-depth exploration in the field of Power Mechanics. Of primary concern are the various power conversion and generation systems, and the productive utilization of those systems. Specifically, students are provided experiences related to the design, theory, construction, and appropriate uses of the power systems, as well as the maintenance and repair of the more common industrial power systems.

Target Grade Level:

This Power Mechanics Course is designed for Senior High School students in grades 10, 11, and 12.

Prerequisite:

None.

Time Period:

55 minutes per day for 36 weeks, or 180 days. Consideration must be given to the opening and closing of school, and other individual school related activities which will ultimately affect the actual time frame.

Units of Credit:

One unit of credit will be allotted to students successfully completing this Power Mechanics Course, as per Bulletin 741, the Louisiana Handbook for School Administrators.

RATIONALE

In recent years, great technological advances have been made in the design, manufacture and efficiency of man's power-producing and power-transmission components. These advances have been prompted by governmental fuel economy and emission standards, stringent state and federal safety requirements, and by American industry's demand for more dependable, powerful, and efficient power producing and transmitting components.

Industrial Arts Education in Louisiana must rise to the occasion and accept the challenge these technological changes have brought forth. No longer is it possible for a simple course in small gasoline engines to provide our children with the concepts, awareness, or the basic competencies for productive careers in an increasingly technological society. Toward this goal, this Power Mechanics Curriculum Guide has been developed.

Upon inspection of this Guide, the teacher will find the more traditional sections which concern themselves with safety, tools and equipment, and internal combustion engines. In the past, these component parts represented the totality of a senior high school industrial arts course. However, as previously mentioned, today's circumstances dictate that we further expand our offerings to provide students with a curriculum that reflects modern technologies.

Therefore, units are included on mechanical power, external combustion engines, fluid power systems, and basic electrical power systems. Because many power systems today are being combined to create automated systems and robotics, a unit bearing that title has also been added.

Students may develop a deep personal interest in the field of Power Mechanics after they become involved in the various activities. A unit on careers has been incorporated to assist the teachers in providing guidance to their students.

Lastly, a special projects unit has been provided so that teachers may enhance and expand their program with a degree of uniqueness. Within this unit are sections on energy conservation and research and safety posters, just to name a few.

In closing, we believe that teachers will find Power Mechanics an immensely interesting field where limits are set only by the extent of the individual's imagination. Students who enroll in this course can expect many new and exciting learning experiences in areas of technology that many did not know existed. The field of Power Mechanics will continue to expand at a rapid rate. Through the utilization of this curriculum guide, both teachers and students will be better prepared to meet the challenges of tomorrow.

CONTENT OUTLINE

This time schedule is designed to be flexible. Depending on the specialized equipment and materials available, time can be shifted between units.

(1 Wk)	Unit I	Introduction
(1 Wk)	Unit II	Safety
(2 Wks)	Unit III	Tools and Equipment
(4 Wks)	Unit IV	Mechanical Power Systems
(2 Wks)	Unit V	External Combustion Engines
(12 Wks)	Unit VI	Internal Combustion Engines
(4 Wks)	Unit VII	Fluid Power Systems
(4 Wks)	Unit VIII	Electrical Power Systems
(3 Wks)	Unit IX	Automated Systems and Robotics
(1 Wk)	Unit X	Careers
(2 Wks)	Unit XI	Special Projects
36 Wks	TOTAL	

UNIT I

INTRODUCTION TO POWER MECHANICS

INTRODUCTION

The study of Power Mechanics engages students in practical experiences and experiments as part of the course content. Varied areas may be taught as the facilities and economics of the school permit. Activity units are coordinated with theoretical units to give opportunity for student skill development and exploration related to the major power systems used today.

This course is technically oriented. Therefore, the student activities reflect the skills, work procedures, and reasoning necessary to work with today's mechanical systems.

COMPETENCIES

1. Develop interest and introduce students to the field of Power Mechanics.

2. Acquire knowledge of historical and future perspectives of Power Mechanics.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Explain class management procedures.

2. Develop an understanding of the historical development of Power Mechanics.

3. Analyze the employment opportunities available within the field of Power Mechanics.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. Given the proper reference materials, discussions, handouts, and lectures. the student will be able to state the rules and policies for laboratory management with an accuracy of 75%.

2. The student will explain historical and future perspectives in Power Mechanics with 75% accuracy.

3. The student will develop and exhibit the proper attitude necessary to succeed in the field of power mechanics.

4. The student will explain the opportunities available in the field of Power Mechanics.

METHODOLOGY

This unit will introduce students to the field of Power Mechanics. Emphasis will be placed on the historical development of Power Mechanics. Methods of teaching to be employed include lecture, audiovisual, library research, field trips, text, discussion, and testing.

SUGGESTED INTEREST APPROACHES

1. Students will research the historical development of Power Mechanics and make a class presentation.

2. Obtain a guest speaker in the Power Mechanics field to discuss historical and future perspectives.

3. Audiovisuals, where available, will be used to present the introduction to the Power Mechanics field.

UNIT OUTLINE

INTRODUCTION

I. Class Organization and Management

A. Shop rules
B. Grading policy
C. Duty schedule

II. History of Power Mechanics

A. Origins of power
B. Steam
C. Age of electricity
D. Internal combustion engine
E. Nuclear age
F. Space age

III. Career Opportunities

A. Job interests
B. Career qualifications

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

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1. Given the proper reference materials, discussions, handouts, and lectures, the student will be able to state the rules and policies for shop organization and management with an accuracy of at least 75%.

Subject Matter Content	Learning Activities
Shop Management	1. List the rules and policies for laboratory management.
	2. Discuss the organization of the tools, equipment and work-areas within the lab.
	3. Discuss the importance of following rules in

Power Mechanics laboratories.

4. Construct a poster displaying shop rules.

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2. The student will explain historical and future perspectives in Power Mechanics with a 75% accuracy.

Subject Matter Content	Learning Activities
History and Future of Power Mechanics	1. Research and present a report on the history of Power Mechanics. 2. Present film, magazine articles, and illustrations on the future of Power Mechanics.

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3. The student will develop and exhibit the proper attitude necessary to succeed in the field of Power Mechanics.

Subject Matter Content	Learning Activities
Work Attitude	1. Make a list of proper attitudes in the work place. 2 Make a list of negative attitudes to avoid in the work place. 3. View audiovisual aids concerning work habits.

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4. The student will explain career opportunities available in the field of Power Mechanics.

Subject Matter Content	Learning Activities
Career Opportunities	1. List career options in Power Mechanics.

2. View film on Power Mechanics careers.

3. Discuss career goals of high school students.

UNIT TEST

INTRODUCTION

I. SHORT ANSWER

A. List five rules to be observed in the Power Mechanics laboratory.

B. How has the use of power affected the evolution of our civilization?

C. List the three ways in which one's daily life is affected by the various forms of power.

D. How is atomic energy being put to constructive use to benefit mankind?

E. Summarize the process of making a career decision.

UNIT TEST

ANSWER KEY

INTRODUCTION

1. a. Keep your work area clean.
   b. Put all tools away when you finish using them.
   c. Use compressed air with caution.
   d. Know where electrical circuit breakers are located for an emergency shutoff.
   e. Wear proper eye protection where indicated.

2. There is hardly any human activity that does not depend upon the use of power. The vast supply of power serves all of us, making possible the products of industry such as our automobiles, homes, food, clothing, and even our entertainment. Man's ability to produce and utilize power has helped to shape our modern civilization.

3. a. Electrical power is used extensively in the home for cooling, heating, and illumination.
   b. Mechanical power from internal combustion engines is used to power our automobiles and transportation systems.
   c. Nuclear power is being used throughout our country to fuel generators producing electrical energy.

4. Power electrical generators: Power ships and submarines; breeder reactors.

5. Learn as much as you can about careers you're interested in (work conditions, entry requirements, and major duties). Match career characteristics with your own abilities, interests, and values. Identify the requirements that do not match your personal characteristics. Eliminate career areas and narrow your choices until only a few careers remain. Accept suggestions and information from others, but make your own decision on a career.

EVALUATION AND TESTING

Ways to Evaluate Pupil Growth

- Unit test
- Class assignments
- Participation in class discussions
- Projects

EQUIPMENT AND SUPPLIES

Student

Textbook
Notebook
Handouts
Pen/pencil

Teacher

Textbook and teacher manual
Overhead projector
Curriculum guide
Chalkboard, chalk and eraser
Audiovisual aids
Models

BULLETIN BOARD IDEAS

- Display manufacturers illustrations of engines/power transmissions.
- Post laboratory organization and management policies.
- Display pictures of both historical and futuristic uses of power.

SUPPLEMENTARY MATERIAL

Textbooks

Bohn, Ralph C. and MacDonald, Angus, J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Glenn, Harold J. Exploring Power Mechanics. Peoria, IL: Bennett, 1973.

Worthington, General Power Mechanics. New York: McGraw-Hill Publishers, 1968.

Instructor's Guide

Bohn, Ralph C. and MacDonald, Angus, J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing col, 1983.

Resources

U.S. Dept. of Energy
Dept. of Marketing and Education
Washington, D.C. 20545

American Vocational Association
1410 King Street
Alexandria, VA 22314

Industrial Education
262 Mason St.
Greenwich, CT 06830

UNIT II

SAFETY

INTRODUCTION

To work effectively, today's Industrial Arts student needs to be able to operate modern shop tools and equipment safely. This unit will present safety as it applies to the students, teachers, and administration.

COMPETENCIES

1. Master the basic safety skills.

2. Explain and demonstrate safety rules as they apply to working in an Industrial Arts shop.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. On a written exam, students will state the rules of safety in a Power Mechanics lab with an accuracy of 100%.

2. On a written exam, students will list all school personnel involved in the responsibility for safety in a Power Mechanics lab, with 75% accuracy.

3. Students will be able to develop a written safety inspection program for the Power Mechanics lab, with 75% accuracy.

4. Given a hypothetical situation, students will list two problems that might arise if safety instructions are not followed in the Industrial Arts shop with 75% accuracy.

METHODOLOGY

This unit has been designed to teach and reinforce the principles of safety. Emphasis is placed on laboratory

demonstrations of safe operation of tools and machines. Text and lab reports will be used to illustrate the principles of safety.

SUGGESTED INTEREST APPROACHES

1. Demonstrate safe operation of shop tools and equipment.
2. Construct safety posters and bulletin boards.
3. Identify and correct safety hazards on school grounds.
4. Have students view films or filmstrips that will explain safety procedures.
5. Invite guest speakers to discuss topics on safety.
6. Review current state and/or local publications relating to industrial safety.

UNIT OUTLINE

I. Introduction to Safety

II. Responsibilities for Safety

- A. Principal
- B. Teacher
- C. Students

III. Developing a Safety Program

- A. Statement of philosophy
- B. Safety instruction and exams
  1. Causes of accidents in an Industrial Arts lab
  2. General safety instructions
  3. Safety instruction for personal protection
  4. Shop housekeeping practices
  5. Safety instruction for use of equipment and tools
  6. Safety instruction for flammable and combustible liquids
  7. Electrical safety instructions
- C. Safety Inspection program

D. Preventive maintenance program
E. Student organizations for safety control
F. Emergency action plan
G. Promoting safety awareness
H. Written and performance exams

IV. Safety Instruction: A Teacher's Responsibility

A. How to plan for teaching safety
B. Providing safety instruction
C. Enforcement of safety rules
D. Evaluating safety instruction

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

I. On a written exam, students will state the rules of safety instruction in a Power Mechanics lab with an accuracy of 100%.

Subject Matter Content	Learning Activities
Need for Safety Instruction	1. Lecture and discussion on the need for industrial safety.
	2. View transparences that will enhance one's understanding of the need for safety.
	3. Read a teacher-prepared handout that explains safety instructions.

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2. On a written exam, students will list all school personnel responsible for safety in a Power Mechanics lab, with 75% accuracy.

Subject Matter Content	Learning Activities
Responsibility for Safety	1. View transparencies on the heirarchy of responsibility.

2. Prepare and present group reports that will explain the responsibility of safety.

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3. Student will develop a written safety inspection program for the Power Mechanics lab, with 75% accuracy.

Subject Matter Content	Learning Activities
Developing a Safety Inspection Program	1. List advantages of developing a safety program. 2. Compare the safety programs demonstrated by the students. 3. Select and implement a safety program.

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4. Given a hypothetical situation, students will list two problems that might arise if safety instructions are not followed in the Industrial Arts shop, with 75% accuracy.

Subject Matter Content	Learning Activities
General Shop Safety Instruction	1. Develop a shop safety checklist. 2. Summarize the important factors in shop safety. 3. Make a list of job categories for general safety instruction.

UNIT TEST

SAFETY

Each teacher is to develop and administer a safety exam specifically for this Power Mechanics course. Because of the extreme variance in the lab organization and layout, the tools and equipment therein, and the actual course content, only that specific teacher can develop a valid safety exam.

The teachers should develop questions for the exam from their lectures. School system rules and regulations, and the material found in Bulletin 1674, General Safety Manual for Vocational Technical Education and Industrial Arts Programs, issued by the Office of Vocational Education, Louisiana State Department of Education, are also of great use in developing both lessons and exams.

Exams should be as thorough and comprehensive as are the lectures. Students must be required to perform satisfactorily on the teacher-generated safety exam before they are permitted to work in the lab.

EVALUATION AND TESTING

Ways to Evaluate Pupil Growth

- Unit test
- Participation grade
- Class assignments
- Safety performance
- Safety poster

EQUIPMENT AND SUPPLIES

Student

Notebook
Textbook
Special instruction sheets
Bulletin board supplies
Safety glasses
Pen/pencil

Teacher

Textbook and manual
Chalkboard, chalk and eraser
Overhead projector
Transparencies
First aid kit
Fire extinguisher
Film/filmstrip projectors
Safety glasses

BULLETIN BOARD IDEAS

- Post safety rules
- Post accident report form
- Post safety inspection check-list
- Display commercial safety posters
- Display student safety posters

SUPPLEMENTARY MATERIAL

Strasser, Marland K., Bohn, Ralph E.
Fundamentals of Safety Education
New York: Macmillan Co. 1973.

General Safety Manual for Vocational Technical Education and Industrial Arts Programs
Bulletin No. 1674
Issued by the Louisiana State Department of Education

NOTE:

The following pages were copied from Bulletin 1674 to serve as a guide for the development of safety instruction. Each teacher should obtain a copy of Bulletin 1674 from the Office of Vocational Education, Louisiana State Department of Education. Information found therein should be incorporated into the daily lessons. Safety rules and regulations are provided for the use of tools and equipment, as well as aspects of a general safety program.

The safety regulations that follow offer specific, tangible suggestions for avoiding common pitfalls and reducing the chance of accident and/or injury.

It is suggested that these safety instructions be used as examples in writing instruction sheets for each school situation, or that these safety instruction sheets be copied directly and used in the instructional program.

General Safety Instructions

1. No horse-playing or practical joking in any shop area.

2. Never take chances.

3. Observe all posted safety notices and posters.

4. Know where fire extinguishers are located and how to use them.

5. Insure that the ventilation system is operating for your work station or area.

6. Secure approval of your instructor on all work you plan to do. This applies to all projects and assignments in which you use shop equipment and tools.

7. Report immediately to your instructor upon incurring any injury, even though slight.

8. Caution any person you see violating a safety rule.

9. Report to the instructor any equipment that does not seem to work properly.

10. Keep tools and materials from projecting over the edge of benches, whenever possible, so someone will not walk into them and get injured.

11. Follow prescribed safety instructions in handling large, heavy, and long pieces of material. In general, never carry material over six feet in length or over 50 pounds in weight without assistance.

12. Practice designated procedures to use in case of earthquake, fire, or other emergency.

13. Walk, do not run, in all shop areas.

14. Be considerate of the safety of others.

15. Adhere to safety rules pertinent to a specific shop.

16. Report unsafe conditions to the instructor.

17. Never throw any object in the shop; an accident or an injury may result.

18. Never use compressed air for other than specific purposes.

19. Make certain hands and tools are free of oil and grease.

20. Clean work stations and place tools in the proper areas at the end of each class period.

21. Study fire regulations pertinent to the shop so that you can assist in closing windows, making proper exits, etc.

22. If you feel ill, do not operate a machine. Report to your instructor.

23. Use proper lifting techniques when moving heavy objects.

24. Never treat or remove particles from the eye. See your instructor or school health personnel for immediate attention.

Safety Instructions for Personal Protection

1. Wear proper eye protection while participating in activities that may endanger your eyes.

2. Be sure clothes are safe and suitable for shop work. Remove or fasten any loose clothing. Roll loose sleeves above your elbows. Keep hair away from equipment in operation. Students with long hair must confine their hair in nets or caps when around tools and equipment.

3. Rings, bracelets, watches, and other jewelry must be removed when working in labs/shops.

4. Wear gloves when materials such as rough boards, metal subject to burrs or sharp edges, glass, or other such materials are handled.

5. Wear protective clothing and equipment for the use intended for its wear. Avoid wearing gloves or anything else that may be pulled into a machine.

6. Wear a respirator when harmful dust or fumes exists.

7. Use face shields during hazardous operations in cutting metal, wood, or similar material.

8. Never use flammable liquids for cleaning purposes.

9. Wear rubberized protective equipment when working with electricity.

10. Wear ear protection when excessive noise is encountered.

11. Wear helmet and hand shields when performing operations that produce intense radiant energy like arc welding and heavy gas cutting.

12. Wear canvas or heavy cotton work gloves for operations when the main hazards are blisters caused by friction. When heat is involved, like foundry work, a more protective type of glove or mitten should be worn.

13. Wear safety shoes with steel toes when lifting heavy objects or working around them.

14. Shop coats, aprons, or coveralls should be worn for general body protection against dirt and grease.

15. Remove ties when working around machine tools or rotating equipment.

16. Use soap and water frequently as a method of preventing skin disease.

Safety Instructions for Use of Equipment and Tools

1. Use the right tool for the job.

2. Never leave a machine while it is running.

3. Observe rules governing operator's zones around tools and machines.

4. Use a brush or piece of wood to clear away dry chips from your machine or bench. (The machine must be turned off and have come to a complete stop.)

5. Secure permission from your instructor for using machines and have special set-ups approved.

6. Do not use tools or equipment until instruction relative to safe handling has been given.

7. Persons not operating power tools or assisting in the operation thereof, should keep clear of the machine and operator.

8. Do not stop or start a machine for another person except in an emergency.

9. Machines must be operated by only one person at a time.

10. Do not use machines for trivial operations, or when hand tools would best accomplish the task.

11. Do not tamper with adjustments or play with machinery at any time. Serious accidents may result.

12. Do not lean on machines. You may press a switch or throw a control which, upon starting, could endanger the safety of the operator or damage the machine.

13. Stop all power machinery to oil, adjust, or clean.

14. Allow revolving machinery to stop on its own. Resist the desire to grab chucks, spindles, or other rotating parts with the hand.

15. Use power tools only when your instructor is present in the room.

16. Set up shields to stop flying chips, sparks or particles.

17. Replace grinding wheels showing cracks, those out of balance, or those worn too small to allow proper clearance (not more than 1/8") between the tool rest and stone.

18. Keep cutting tools sharp.

19. Never mount a grinding wheel unless the speed of the motor and the speed of the wheel are known and the two are appropriate.

20. When starting a machine, allow it to reach its operating rpm before using it.

21. When finished with a tool, clean and return it to its proper location.

22. Ensure that vise handles hang free when not in use.

23. Know and follow the specific requirements of the kind and type of machine you are operating.

24. Enclose all gears, moving belts, and other power transmission devices, or erect barricades to prevent contact.

25. Operate equipment only after passing a test for safe operation for that machine.

26. Do not use defective tools, machines, or other equipment.

27. Do not remove guards and safety devices.

28. Observe specific safety zones designated by the instructor and become familiar with color codes.

29. Do not talk with other students while operating machines.

30. Observe safety rules posted at or near potentially hazardous machines.

31. Do not operate any machine until you have received proper instruction, and fully understand how to operate it.

32. Have your instructor check special machine setups.

33. Check machines and make all adjustments before turning on the power.

34. Make sure other persons are clear before turning on the power.

35. Be sure the guards are in place and function properly.

36. Start and stop your own machine, and remain with it until it has come to a complete stop.

37. Never leave a running machine unattended.

38. Allow a safe distance between your hands and blades, cutters, or moving parts. Keep your fingers in such a position that there is no danger of their slipping into the cutter or moving parts.

39. Keep machines clear of tools, stock, and other items.

40. Keep the floor around the tools clear of liquids, scraps, tools, and other material.

41. Give the machine your undivided attention when using it. Never look away for any reason.

42. Notify your instructor of any breakage or malfunction.

43. Allow all machines to come to a complete stop before removing work or making a new setup.

44. Use the proper size and type of hand tool for the specific task.

45. Make sure that all cutting tools are sharp and in good condition before using them.

46. Handle edged or pointed tools by the handles, with sharp points or edges pointed away from you and others.

47. When using sharp-edged tools, be sure to direct their action away from yourself and your classmates.

48. Clamp small work on a bench, or secure it in a vise, when using a gouge or wood chisel or driving screws.

49. Control chisels, gouges, and carving tools with one hand while the other supplies the power.

50. When chipping or cutting with a cold chisel, arrange your work so that classmates are protected from flying chips.

51. Pass tools to other persons with handles forward.

52. Carefully read instruction sheets before operating machines.

53. Avoid using wrenches that do not properly fit the nuts, bolts, or other objects which they are being used to turn.

54. Develop a respect for machine tools and understand their purpose.

55. Recognize the distinctive sound of a properly adjusted and smooth-running machine tool.

SAFETY INSTRUCTIONS FOR OPERATING THE GRINDER

1. Obtain permission from the instructor before operating the grinder.
2. Wear proper clothing.
3. Wear a face shield, safety glasses, or goggles and use a glass safety guard on the grinder.
4. See that the guard is in place.
5. Set tool rest 1/16" to 1/8" from the wheel.
6. Dress the wheel when necessary.
7. Make sure that no one except you is inside the operator's zone.
8. Adjust the grinder for your job before turning the power on.
9. Stand to one side of the wheel when turning the power on. The wheel may be cracked, causing it to break up.
10. Turn on the power after permission is given.
11. Keep your hands away from the wheel while it is in motion.
12. Hold the work with your hands. Ask permission to grind small pieces.
13. Use the face of the wheel only.
14. Press materials against the wheel with the correct amount of pressure.
15. Keep work in motion across the face of the wheel.
16. Do not grind on the side of the grinding wheels.
17. Stand to one side when starting the machine.
18. Discard or report grinding wheels that are excessively small or cracked.
19. Hold all small work pieces with "vise grip" type of pliers.
20. Do not leave the machine until the grinding wheels have come to a full stop.

SAFETY TEST FOR GRINDER

Name: _____ Class: _____ Date: _____

Multiple Choice: For each item below select the one best answer. Then write the letter that represents your choice on the line to the left of each item. Fill in the blank for questions 6 and 7.

_____ 1. You must wear a face shield or safety glasses when using a grinder because they:

A. Are becoming to you
B. Magnify the work, thus making it easier for you to see
C. Protect your eyes from bright light
D. Protect your eyes from flying particles

_____ 2. Adjust the grinder tool rest:

A. Immediately after the grinder is turned on
B. Before turning the power on
C. When the wheel is not in motion
D. After the power is turned off and the wheel is coasting

_____ 3. You should set the grinder tool rest:

A. 1/4" away from the wheel
B. So the wheel rubs lightly against the tool rest
C. 1/2" away from the wheel
D. No more than 1/8" from the wheel

_____ 4. To grind small pieces of stock, you should:

A. Hold them in your bare hands
B. Hold them with a rag
C. Use a coarse wheel
D. Receive special instruction and permission from the instructor

_____ 5. You should stand to one side of the grinding wheel while it is gathering speed because:

A. It may have a defect, and the wheel will fly to pieces
B. The air currents from the wheel are unhealthy
C. It will tempt you to use the wheel too soon and cause it to stop
D. You can see if the wheel is running true

6. When using the grinder, you should keep your hands away from the _____.

7. To grind small pieces of stock, you should ask permission from the _____.

GENERAL SAFETY INSTRUCTIONS - ELECTRICITY/ELECTRONICS

1. After the power supply is turned off, work on the electrical circuits as if the power is on. Remember that "unloaded guns kill."

2. When a fuse burns out, check the circuit for the reason(s) before replacing the fuse.

3. Remember that safety devices are designed to protect you. However, they sometimes do not function-BEWARE!

4. Always replace a fuse with one of the proper rating for the circuit.

5. Adhere to the National Electrical Code and local regulations for safe and approved wiring.

6. Determine the type of current prior to repairing or replacing any wires.

7. Do not use any equipment which produces a slight shock when operated.

8. Never wear metal rings, bracelets, or chains while working in the electrical/electronics trades.

9. Never guess. Always know exactly what you are about to do.

10. Remember that standing in water or on a damp floor is hazardous, even when turning an electrical switch on or off.

11. Do not take a chance and touch one wire while thinking it is the ground wire.

12. Do not touch or move "downed" wires lying on the ground. Report them to the police department.

13. Always have another person with you while you work on high voltage.

14. On all occasions, study the hazards of electricity and acquire skill in preventing accidents.

15. Do not connect or operate loose wires and unknown switches without knowledge of their purposes.

16. Always wear rubber-soled shoes; stand on a rubber mat or a dry board without nails; and work as if the wires are "hot," when repairing or installing electical equipment in a damp area.

17. Always work one side of the circuit at a time. This minimizes the danger of closing a circuit with your body.

18. Consider carefully all action around electricity. Physical movement should be unhurried.

SAFETY TEST FOR ELECTRICITY/ELECTRONICS

Name: _____ Class: _____ Date: _____

Multiple Choice: For each item below select the one best answer. Then write the letter that represents your choice on the line to the left of each item.

_____ 1. Downed wires lying on the ground should be reported to the:

A. Police department
B. School principal or director
C. Mayor's office
D. Closest electrician

_____ 2. When a fuse burns out, you should first:

A. Replace the fuse with one of the same capacity
B. Place a piece of heavy wire in the fuse holder
C. Replace the fuse with one of larger capacity
D. Check the circuit for cause of the burned-out fuse

_____ 3. Which of the following should be removed when working in the electrical/electronics trades?

A. Metal rings
B. Bracelets
C. Neck chains
D. All of the above

_____ 4. Hot soldering irons or guns should be placed:

A. In the middle of the work bench
B. On a wooden shelf
C. Where unsuspecting persons will not be burned
D. On the floor

_____ 5. If you do not know the purpose of a switch or loose wire, you should:

A. Connect the wires together or operate the switch to see what happens
B. Obtain information about their purpose

C. Put tape over them
D. Cut the wires off so they will neither show nor hide the switch

SAFETY INSTRUCTIONS FOR OPERATING THE DRILL PRESS

1. Wear proper eye protection.

2. Hold material securely with a vise or clamps.

3. Select a properly sharpened bit. For metal, center punch when a hold is to be drilled.

4. Adjust the table or the depth stop to avoid drilling into the table.

5. Select the correct speed, normally slower for metal - faster for wood. The larger the bit, the slower the speed.

6. Be certain that the table and head of the drill press are secure.

7. Select the correct size and the kind of drill for the work. Be sure it is sharp.

8. Select the designated coolant for the drill press and apply it to the drill point as needed. (No coolant is used when drilling wood.)

9. See that the belt guard is in place.

10. Remove the chuck key immediately after using it.

11. Keep hands away from the revolving spindle, chuck, drill and chips.

12. Operate the feed handle so that the drill cuts evenly into the work.

13. Ease up on the feed pressure when the drill begins to break through the material.

14. Back the drill out as soon as the hole is drilled.

15. Allow the drill press to stop before attempting to remove the work, chips, or cuttings. Do not stop the revolving chuck with your hands.

16. Use a brush to remove the chips or the shavings.

17. Keep the floor clean around the drill press.

18. Step away immediately if the work comes loose and is caught in the drill. Shut off the power, if possible, without endangering yourself.

SAFETY TEST FOR OPERATING THE DRILL PRESS

Name: _____ Class: _____ Date: _____

Multiple Choice: For each item below select the one best answer. Then write the letter that represents your choice on the line to the left of each item. Fill in the blanks for questions 7 and 8.

____ 1. When drilling, the work should be held:

A. By hand
B. By someone else
C. In a vise or clamps
D. On the floor

____ 2. For drilling metal, you must:

A. Center punch where the hole is to be drilled
B. Mark the outer edges of the hole
C. Use a dull drill bit
D. Drill at the fastest speed possible

____ 3. When drilling is completed, stop the revolving drill chuck by:

A. Hand
B. Jamming the drill bit into scrap stock
C. Throwing the drill into reverse
D. Allowing the drill to come to a stop by itself

____ 4. Remove chips with:

A. A brush
B. A rag
C. An air nozzle
D. Your hand

____ 5. When the floor becomes cluttered with chips:

A. Kick them over to one side
B. Sweep them up and put them in the trash can
C. Put a rubber mat over them

____ 6. If the work is caught and spins around with the drill bit:

A. Grab the work and stop it
B. Leave the area and go out the nearest exit
C. Step away and turn off the power to the drill
D. Run to tell the school maintenance personnel

7. When drilling, you must protect your eyes by wearing _____.

8. To avoid drilling into the drill press table, you should _____ the _____ stop.

GENERAL SAFETY INSTRUCTIONS FOR SMALL ENGINES

1. Pull the spark plug wire off of the spark plug before attempting any repairs.
2. Do not work around the fan blade while the engine is running.
3. Never check the motor oil with the engine running.
4. Operate an engine only where there is adequate ventilation.
5. Never drain gasoline around a hot engine or in a closed area.
6. Always wear safety glasses when operating on an engine or working with any solvents.
7. Never let the starter cord snap back.
8. Be sure the engine is properly mounted before attempting to operate it.
9. Never remove a spark plug wire while the engine is still running.
10. Never start a lawn mower in stones or dirt while people are near.
11. Never examine or turn the mower blade without securing the spark plug wire away from the spark plug.
12. Exercise caution when disassembling spring-loaded parts.
13. Consider the engine - and especially the exhaust muffler - hot until checked and found to be otherwise.
14. Do not run an engine without the blower housing as well as all other items in place.
15. Do not lift heavy objects alone. Seek sufficient help.
16. Do not use your mouth to start the siphon hose.
17. Use compressed air with caution. Do not blow toward others.
18. If oil or grease is spilled on the floor, clean it up immediately.

19. Keep your work area clean.

20. Put all tools away when you finish using them.

SAFETY

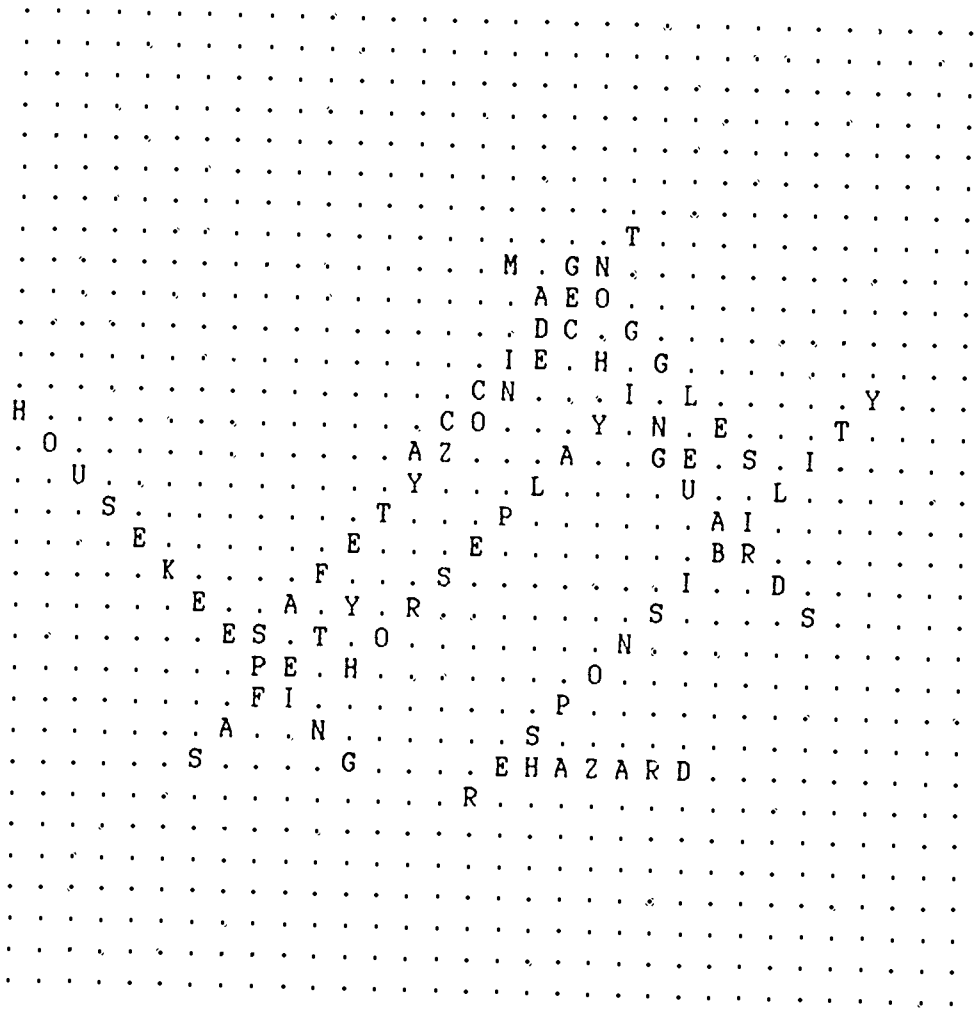
J G S R G P X Q R I E Z W C G M T M Z Q E U B Z B L C G J J K I
K A G R K Z N N U X S X W G W J K Q F L N E V I L J I W J L K M
U T O C E G R X B K H A N S A J B M S L E A I U G M F A F Y K K
B J M O D P I C T N M G H T M O G X R Z A S Q N T L M W F S L N
G A C P X T Z C Z K W Y K N Q C T N T J J G Z Y K L E V J J Z B
F E D D Z I A Y D W Y Y G X R V P O G X O F A V I K C H A P T M
S Y A G V U W X D Q B O J N O K S H L P Y J G W S F O K X D Q I
L P V W E S I G N A D T M S Y Z H V R T T S T Q Q K W X T R S U
W R B X K H H I G F Z Q C V M O M B G N Q D G N U T P K Q A I T
H X Q R K D F L X P B X E R L H H A E O N P A Y Q H F K U Z B T
T L C J Y O K L M P N S M X V G Z D C M G Y H X G T J Y R P L A
I I I S B X Q O S L Y M P W H L I E O H Z G R C A Y Q U O H H Z
S W V S R V P I Z Y Z S Y W G C N H B W I K L K D P R J Y D F U
H Z B B D U O S F E B P O F C O F R P Y A N Z E L I T T N M V P
M O G U M S O S O D O P K A Z C C H A F P G E U S L I E O V U E
Y X U S N I L V S Q M B V Y G Q M L L V D M U Q C L S A M Y S U
A Q H S Q J N S C D I F T Y B I P V A S I Q F A I O U Y C Z D W
X I N H E D S N H B Z E C C T E K R U N R H U B R I Q J D C S N
Z U U A R K S O C E F O N U S Y X K K C K J I T S D I L Z N Q U
Q Z G X H D E W J A E Y T R N V S Q S F G S E B I Q S L U E T Y
N F S T T M J E S Y T L O E M W X N W W N E P E N T F C P V T S
V A S G B O C C P E G H E R P S O R T O I I Z D Z F W B E K Y N
F G S L F E X Y F I A W H K F A O K P X Q B T L K X P I I B N D
S Q D X P D B A Z C N Z S M Y U L S P Q Y G Y O I H Z R M H E E
H R O C G H S Z N R S G V S Y D E H A Z A R D B D X N Y N C H B
T N N C T P T A D L K J R X F R U N B L F U E H D L Q U T Y R Z
E K W Y U U O E H B D B H H X R Q G T W L C X A N W D H X C D T
H N I V Q J S R Y V A X M F M E U W N Z W P Z Q M L U O R H Q E
O C I Z V L X U H G F F N R G E X C Y B L G L V V Z P F E F H T
V C Y D R A P B J D Z H H T U O Q C O V T B N A Z R U Q J U B F
W I Z K X D E D Y M U C Z T T Z H V V K E U H A Z R Q H P P S O
L Q D S F S E F M K E I W B V V G M Q V D W W Q I Z F U P U B V

THERE ARE 10 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

ACCIDENT
GUARDS
HORSEPLAY
MACHINE
SAFETY
GOGGLES
HAZARD
HOUSEKEEPING
RESPONSIBILITY
SAFETYZONE

SAFETY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UNIT III

TOOLS AND EQUIPMENT

INTRODUCTION

Due to the specialization and sophistication of Power Mechanics devices and components, there are a multitude of tools and equipment currently in use. Students must be familiar with these tools and equipment if they are to develop basic competencies in the repair and maintenance of basic Power Mechanics systems.

The purpose of this unit is to present to the student the tools and equipment common to the field, along with instruction in their care, use, and maintenance.

COMPETENCIES

1. Develop basic competencies in the selection, use, and care of tools and equipment.
2. Develop basic competencies in the selection, use, and care of measuring instruments.
3. Develop basic competencies in the use of electrical test instruments and to analyze the resulting test readings.
4. Discuss the selection and installation of fasteners in particular applications.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Demonstrate comprehension of workshop and tool safety rules and procedures.
2. Identify examples of common mechanics' hand and power tools and state their proper usage.
3. Demonstrate the proper use of hand and power tools.
4. Demonstrate an acceptable degree of skill in using mechanical and electrical measuring tools and instruments.

5. Identify the types of mechanical fasteners and state their correct applications.

6. Comprehend thread terminology and demonstrate the ability to recognize and cut internal and external threads using a tap and die set.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. Given the written tests on general shop safety, personal protection, equipment, and tool safety, students will choose the correct responses with 100% accuracy.

2. Given an assortment of mechanics' hand tools on a written or oral test, students will name each tool by sight and explain its usage with 75% accuracy.

3. Given a set of specific mechanical tasks to perform with mechanics' hand tools, students will demonstrate proper operation techniques and perform the tasks with 75% accuracy.

4. Given a list of specific tasks to perform with mechanics' shop power tools, students will demonstrate proper operation techniques to perform the tasks with 75% accuracy.

5. Given the mechanics' shop measurement instruments and specific machined parts from small gas engines on a lab test, students will identify each tool, measure the parts, and record their readings with 75% accuracy.

6. Given the Power Mechanics shop electrical test instruments and a series of tests to perform on small engine electrical components, students will identify each instrument, state its purpose, demonstrate their ability to test components and record their readings with 75% accuracy.

7. Given a wide assortment of mechanical fasteners on a written test, students will name each fastener and state its correct application with 75% accuracy.

8. Given an assortment of machine bolts and nuts, a thread pitch gauge, and a bolt diameter gauge, students will measure the diameter, length and thread, pitch, determine the class of fit, and tensile strength, and list their findings with 75% accuracy.

9. Given an assortment of rusted machine bolts and nuts and a tap and die set on a lab test, students will renew the threads with 75% accuracy.

METHODOLOGY

This unit has been designed to provide a review of the basic tools, instruments, fasteners, knowledge of application, techniques, and procedures necessary to work on small gasoline engines. Some methods that can be used to teach this unit are large group presentations and demonstrations, small group lab projects and independent study. In addition, texts, manuals, group projects, community resources. and various audio visual aids would enhance the study of this unit.

SUGGESTED INTEREST APPROACHES

1. Show students a film on the care and use of mechanics' hand tools.
2. Distribute to the students copies of the Sears, Snap-on, and other tools catalogs.
3. Invite a small engine, motorcycle, or outboard engine mechanic to speak on the importance of good hand tool purchasing, use, and care.

UNIT OUTLINE

TOOLS, EQUIPMENT, AND FASTENERS

I. Basic Hand Tools

II. Power Tools

III. Measuring Tools and Instruments

IV. Electrical Test Instruments

V. Fasteners

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

1. Given the written tests on general shop safety, personal protection, equipment, and tool safety, students will choose the correct responses with 100% accuracy.

Subject Matter Content	Learning Activities
Safety	1. Prepare and present a "safety in the mechanics shop" lecture. 2. Prepare a poster listing safety rules. 3. Distribute to each student a dated Acknowledgement of Safety Instruction and Pledge sheet and have each student sign it.

2. Given an assortment of mechanics' hand tools on a written or oral test, students will name each tool by sight and explain its usage with 75% accuracy.

Subject Matter Content	Learning Activities
Hand Tools	1. Exhibit examples of all the basic mechanics' hand tools, individually name each tool, and have the class name each tool. 2. Prepare handouts with illustrations of basic mechanics' hand tools and have students write the

name of each tool next to its illustration.

3. Give lab demonstrations explaining the usage of each mechanics' hand tool.

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3. Given a set of specific mechanical tasks to perform with mechanics' hand tools, students will demonstrate proper operating techniques and perform the tasks with 75% accuracy.

Subject Matter Content	Learning Activities
Hand Tool Techniques	1. Show movies or film strips on hand tool techniques.
	2. Give lab demonstrations explaining and showing the proper operation techniques using the mechanics' hand tools to perform specific tasks.
	3. Divide students into work groups to practice using the mechanics' hand tools on specific tasks.

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4. Given a list of specific tasks to perform with mechanics' shop power tools, students will demonstrate proper operation techniques to perform the tasks with 75% accuracy.

Subject Matter Content	Learning Activities
Power Tool Techniques	1. Prepare handouts that illustrate each power tool and have each

student write the tool's name, parts, and safety rules.

2. Present lab demonstrations explaining the usage and techniques for each power tool.

3. Observe students performing specific power tool tasks. Coach and correct the student when necessary.

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5. Given the mechanics' shop measurement instruments and specific machined parts from small gas engines on a lab test, students will identify each tool, measure the parts, and record their readings with 75% accuracy.

Subject Matter Content	Learning Activities
Measuring Instruments	1. Prepare handouts that illustrate each measuring instrument and have each student write in the tool's name and parts.
	2. Present lab demonstrations explaining the proper technique for using each of the measuring instruments.
	3. Prepare a poster illustrating a steel rule with two scales, one with English fractional and one with metric divisions.

4. Divide into groups and have students measure assorted machine parts with a rule that has both English and metric divisions.

5. Divide into groups and have students practice measuring various parts.

---

6. Given the Power Mechanics shop electrical test instruments and a series of tests to perform on small engine electrical components, students will identify each instrument, state its purpose, demonstrate their ability to test components, and record their readings with 75% accuracy.

Subject Matter Content	Learning Activities
Electrical Test Instruments	1. Exhibit electrical test instruments. Explain the name, function, and use of each instrument.
	2. Prepare handouts with illustrations of each electrical instrument. Students will write the name, function, and use of each tool.
	3. Divide into groups and have students run tests and experiments using test instruments and record their readings.

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7. Given a wide assortment of mechanical fasteners on a written test, students will name each fastener and state its correct application with 75% accuracy.

Subject Matter Content	Learning Activities
Fasteners	1. Prepare an assortment of fasteners on a demonstration board. Name each fastener and have the class repeat the names. 2. Prepare a handout with illustrations of the common fasteners used in mechanic shop applications. Have students write the name and application of each. 3. Divide into groups and give each group a list of "scavenger hunt" fasteners to find over the weekend.

---

8. Given an assortment of machine bolts and nuts, a thread pitch gauge, and a bolt diameter gauge, students will measure the diameter, length and thread pitch, determine the class of fit, and tensile strength, and list their findings with 75% accuracy.

Subject Matter Content	Learning Activities
Threaded Fasteners	1. Prepare handouts illustrating both English and metric thread specifications. 2. Discuss threaded fasteners' identification and applications.

	3. Divide into groups and have students practice identifying threaded fasteners and recording their findings.

9. Given an assortment of rusted mechanical bolts and nuts and a tap and die set on a lab test, students will renew the threads with 75% accuracy.

Subject Matter Content	Learning Activities
Thread Restoration	1. Prepare and demonstrate renewing threads on damaged, rusted, or dirty bolts and nuts.
	2. Divide into groups and have students practice renewing threads on rusted or dirty bolts and nuts.

UNIT TEST

1. Name the two most common screwdriver types. _____ and _____.

2. Chisels are used chiefly for _____ metal.

3. When using or grinding a chisel always wear _____ or _____.

4. To cut threads on a shaft a mechanic uses a _____

   A. Drill bit
   B. Die
   C. Spanner
   D. Tap

5. To cut threads in a hole a mechanic uses a _____

   A. Tap
   B. Die
   C. Wrench
   D. Drill bit

6. The most common mechanic shop hammer is the _____

   A. Claw hammer
   B. Plastic tip hammer
   C. Sledge hammer
   D. Ball-pein hammer

7. A ratchet wrench needs a set of _____

   A. Hammers
   B. Spinners
   C. Wrenches
   D. Sockets

8. This wrench has a different size opening on each end and it grasps the nuts on only two flats.

   A. Box end
   B. Combination
   C. Open end
   D. Adjustable

A. Adjustable
B. Box-end
C. Open-end
D. Combination

10. This wrench is used to tighten nuts and bolts to a manufacturer's specifications.

A. Torque
B. Rachet
C. Torx
D. Adjustable

11. Name five types of pliers.

12. Name four types of punches.

13. What are the three most popular portable electric drill chuck sizes?

14. What are the four systems used to classify twist drill sizes?

15. This electrical test instrument can perform many different tests on batteries, charging systems, circuits, and electrical components.

A. Test light
B. Timing light
C. Ammeter
D. Volt-Ohm multimeter

16. This measuring tool can precisely measure a round shaft's diameter.

A. Outside micrometer
B. Inside micrometer
C. Feeler Gauge
D. Depth micrometer

17. Measuring tools graduated in fractions are classified as using the _____ system of measurement.

UNIT TEST

ANSWER KEY

TOOLS AND EQUIPMENT

1. Standard, Phillips
2. Cutting
3. Goggles, safety glasses
4. B
5. A
6. D
7. D
8. C
9. D
10. A
11. Needle nose, adjustable locking, slip joint, combination, diagonal cutter.
12. center, starting, pin, aligning.
13. 1/4", 3/8", 1/2"
14. Fractional, numerical, letter range (A to Z), metric.
15. D
16. A
17. English

EVALUATION AND TESTING

Ways to Evaluate the Pupil Growth

- o Unit test
- o Class participation grade
- o Homework grade
- o Project garde

EQUIPMENT AND SUPPLIES

Student

Textbook
Notebook
Pen/pencil
Folder with pockets
Safety glasses

Teacher

Textbook and manual
Power mechanics curriculum guide
Chalkboard, chalk and eraser
Bulletin board supplies
Filmstrip projector
Overhead projector
Parts washer
Hand and power tools
Measurement and electrical test instruments
First aid kit
Safety glasses

BULLETIN BOARD IDEAS

- o Display tool identification posters.
- o Post general safety rules for tools and equipment.
- o Display safety posters on the safe use of tools and equipment.

SUPPLEMENTARY MATERIALS

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UNIT IV

MECHANICAL POWER SYSTEMS

INTRODUCTION

Mechanical power systems may be defined as those systems that exclusively use the principles of the six simple machines to transmit and control energy to do work. In most cases, we must change and move "raw" mechanical power before we can put it to work. Gears, belts, clutches, couplings, and other mechanical devices provide the means by which we can control and transmit power.

The purpose of this unit is to introduce to the students the many, varied mechanical devices used by man. Students will be provided the opportunity to perform experiments with the more common power control and transmission devices.

COMPETENCIES

1. Define and discuss the various mechanical power systems.
2. Perform experiments utilizing gears, belts, clutches, coupling, and other mechanical devices.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Describe the various mechanical power systems.
2. Analyze and compare different mechanical power systems.
3. Perform experiments utilizing mechanical devices.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. The student will describe what is meant by "mechanical advantage" and explain how it is calculated with 75% accuracy.
2. The student will identify the six simple machines with 75% accuracy.

3. The student will explain how mechanical devices are able to switch power on and off, change the direction of power, and change force and speed with 75% accuracy.

4. The student will perform experiments with gears, pulleys and belts, sprockets and chains, clutches and couplings with 75% accuracy.

5. The student will identify the difference between spur gears, helical gears, bevel and miter gears, ring and pinion gears, and worm gear sets with 75% accuracy.

6. The student will explain the function of a universal joint with at least 75% accuracy.

7. On a written test, students will describe the difference between friction and anti-friction bearings with 75% accuracy.

8. The student will define bore, stroke, displacement, and compression ratio with 75% accuracy.

9. The student will be able to calculate work, power, horsepower, and torque with an accuracy of 75%.

METHODOLOGY

This unit will consist of definitions and experiments designed to familiarize students with the principles of mechanical power systems. Emphasis will be placed on experiments pertaining to gears, belts, clutches, couplings, and other mechanical devices.

SUGGESTED INTEREST APPROACHES

1. Students will perform experiments dealing with mechanical power systems.

2. Students will identify and explain the uses of mechanical power systems while touring the school plant

3. Arrange for a field trip to local industry to observe their use of mechanical power systems.

UNIT OUTLINE

MECHANICAL POWER

I. Definition

II. Input - Source of Power for the Mechanical System

- A. Reciprocating
- B. Rotary
- C. Linear
- D. Inertia
- E. Momentum
- F. Acceleration
- G. Control, the need to change or regulate motion

III. Mechanical Advantage

- A. The Lever
  - 1. First class
  - 2. Second class
  - 3. Third class
- B. Inclined plane
  - 1. Wedge
  - 2. Screw

IV. Control Devices

- A. Gears
  - 1. Spur gears
  - 2. Helical gears
  - 3. Bevel and miter gears
  - 4. Worm gears
  - 5. Gear users
- B. Pulleys and Belts
  - 1. Positive drive units
  - 2. Non-positive drive units
- C. Clutches
  - 1. Friction clutch
  - 2. Positive clutch
  - 3. Centrifugal clutch
  - 4. Overrunning or freewheeling clutches
- D. Couplings

V. Transmission

- A. Friction
- B. Bearings

1. Sleeve bearings
2. Anti-friction bearings

VI. Exploration of Mechanical Principles

A. Sliding friction
B. Sliding and rolling bearings
C. Fixed and movable pulleys
D. Design problem
E. Spur gears
F. Stop pulleys and belts
G. Chain and sprockets
H. Powered windlass
I. Cam and cam followers
J. Design problem

VII. Bore, stroke, displacement, compression ratio

A. Terms defined
B. Calculations

VIII. Work

A. Defined
B. Calculation

IX. Power

A. Defined
B. Calculation

X. Horsepower

A. Defined
B. Calculation

XI. Energy

A. Defined
B. Potential Energy
C. Kinetic Energy

XII. Torque

A. Defined
B. Calculation

XIII. Thrust

A. Defined
B. Calculation

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

1. The student will describe what is meant by "mechanical advantage" and explain how it is calculated with 75% accuracy.

Subject Matter Content	Learning Activities
Mechanical Advantage	1. Demonstrate mechanical advantage with lab experiments. 2. Students will perform experiments which utilize mechanical advantage. 3. Students will solve problems using work equation

$$\frac{\text{Force X Distance}}{\text{Input work}} = \frac{\text{Force X Distance}}{\text{Output work}}$$

2. The student will identify the six simple machines with 75% accuracy.

Subject Matter Content	Learning Activities
Simple Machines	1. Students will list the six simple machines and provide an example of each. 2. On a walking tour of the school, use of simple machines will be observed. 3. Students will divide into groups and construct simple machines in the lab.

3. The student will explain how mechanical devices are able to switch power on and off, change the direction of power, and change force and speed with 75% accuracy.

Subject Matter Content	Learning Activities
Changes is Mechanical Power	1. List the types of changes in mechanical power. 2. Divide the students into groups and perform experiments that involve changes in mechanical power. 3. Demonstrate devices that change the form of motion.

---

4. The student will be able to perform experiments with gears, pulleys and belts, sprockets and chains, and clutches and couplings with 75% accuracy.

Subject Matter Content	Learning Activities
Control Devices	1. List the control devices and explain their use. 2. Divide students into groups and perform experiments with the use of control devices. 3. On a field trip to local industry, observe the use of control devices.

---

5. The student will be able to identify the differences between spur gears, helical gears, level gears, miter gears, ring and pinion gears, and worm gear sets with at least 75% accuracy.

Subject Matter Content	Learning Activities
Gears	1. List the various types of gears. 2. Identify the differences between gears. 3. Divide students into groups and perform experiments with the use of gears. 4. View a film illustrating the types of gears and their uses.

---

6. The student will be able to explain the function of a universal joint with 75% accuracy.

Subject Matter Content	Learning Activities
Couplings and Universal Joints	1. Define couplings. 2. List the types of couplings. 3. Explain how a universal joint works. 4. Students will report on the uses of universal joints in our industrial society.

---

7. On a written test, students will describe the difference between friction and anti-friction bearings with 75% accuracy.

Subject Matter Content	Learning Activities
Bearings	1. List types of anti-friction bearings. 2. Observe a cutaway model of a friction bearing and an anti-friction bearing. 3. Divide students into groups and have them perform experiments noting differences in friction and anti-friction bearings.

8. The student will define bore, stroke, displacement, and compression ratio with an accuracy of 75%.

Subject Matter Content	Learning Activities
Engine Measuring Terms	1. List engine measuring terms. 2. Explain how to calculate the displacement of a piston engine. 3. View film dealing with stroke, displacement, and compression ratio. 4. Group discussion of film with emphasis on measuring terms.

9. The student will calculate work, power, horsepower, and torque with an accuracy of 75%.

Subject Matter Content	Learning Activities
Calculating Work, Power, Horsepower, and Torque	1. List the formulas necessary to complete calculations. 2. Complete problems involving work, power, horsepower, and torque.

UNIT TEST

MECHANICAL POWER SYSTEMS

I. Short Answer

1. List the three basic ways mechanical power systems can change input power.

2. Name the five most common mechanical control devices.

3. What is a spur gear?

4. What are the two major advantages of using helical gears instead of spur gears?

5. What is the main use of a worm gear set?

6. What is the function of a universal joint?

7. What is the advantage of oil-impregnated bearings?

8. What are the three most common types of anti-friction bearings?

II. Solve the following problems.

1. An automotive engine produces a torque of 120 pound-feet. This torque is transferred into the transmission, which is shifted into low gear. The gear provides a mechanical advantage in force of 3:1. What is the torque of the transmission output shaft?

2. If the rear end assembly of an automobile has a fixed speed reduction of 4:1, and the input speed is 600 rpm, what is the output speed?

3. How much work does a 120 pound boy do in climbing to the top of the Washington Monument, a climb of 550 feet?

4. A mechanic uses an 18 inch pipe wrench to loosen a 1.2 inch pipe fitting. What torque is applied to the fitting if a force of 50 pounds is needed?

UNIT TEST

ANSWER KEY

MECHANICAL POWER SYSTEMS

I. 1. a) Switch power on and off
b) Change the power's direction
c) Change the power's force and speed

2. Gears, pulleys and belts, sprockets and chains, clutches, and couplings.

3. A gear with teeth cut parallel to the L-shaft that runs through the gear.

4. a) The increased gear tooth contact allows more torque to be transferred.

b) The increased contact helps prevent excessive wear and breakage.

5. To provide increased torque with reduced speed.

6. It permits shafts connected to it to be out of alignment and still move.

7. These bearings require no additional lubrication.

8. Ball, roller, and tapered roller bearings.

I. . Input torque = 120 lb.-ft.
Output torque = 3 X 120 lb.-ft = 360 lb.-ft.

2. Input speed = 600 RPM
Output speed = $\frac{600 \text{ RPM}}{4}$ = 150 RPM

3. Work = Weight X Distance = 120 lbs X 550 ft. = 66,000 ft. lbs.

4. Torque = Force X Radius = 50 lbs X 18 in. = 75 lbs-ft.

EVALUATION AND TESTING

Ways to Evaluate Pupil Growth

- Unit test
- Class assignments
- Class participation
- Projects
- Problem solving
- Laboratory experiments
- Work habits

EQUIPMENT AND SUPPLIES

Student

Textbook
Notebook
Instruction sheets
Lab manual
Safety glasses
Pen/pencil

Teacher

Textbook
Bulletin board supplies
Chalkboard, chalk, eraser
Curriculum guide
Audio visual equipment and materials
Mechanical power experimenter
Safety glasses

BULLETIN BOARD IDEAS

- Post safety rules for mechanical systems.
- Display pictures of the six simple machines.
- Display pictures/illustration of various power transmission system.
- Display student posters on mechanical system.

SUPPLEMENTARY MATERIALS

Power Experimenter

Multi-Power Lab-Mechanical
Vega Enterprises Inc.
Technical Training and Testing Center
Rural Route 3, Box 193B, Decatur, IL 62526

Textbooks

Bohn, Ralph C. and MacDonald, Angus J., Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Glenn, Harold J., Exploring Power Mechanics. Peoria, IL: Bennett, 1973.

Instructor's Guides

Bohn, Ralph C. and MacDonald, Angus J., Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Resources

U.S. Department of Energy
Dept. of Marketing and Education
Washington, D.C. 20545

American Vocational Association
1410 King Street
Alexendria VA 22314

Industrial Education
262 Mason St.
Greenwich, CT 06830

Equipment Suppliers

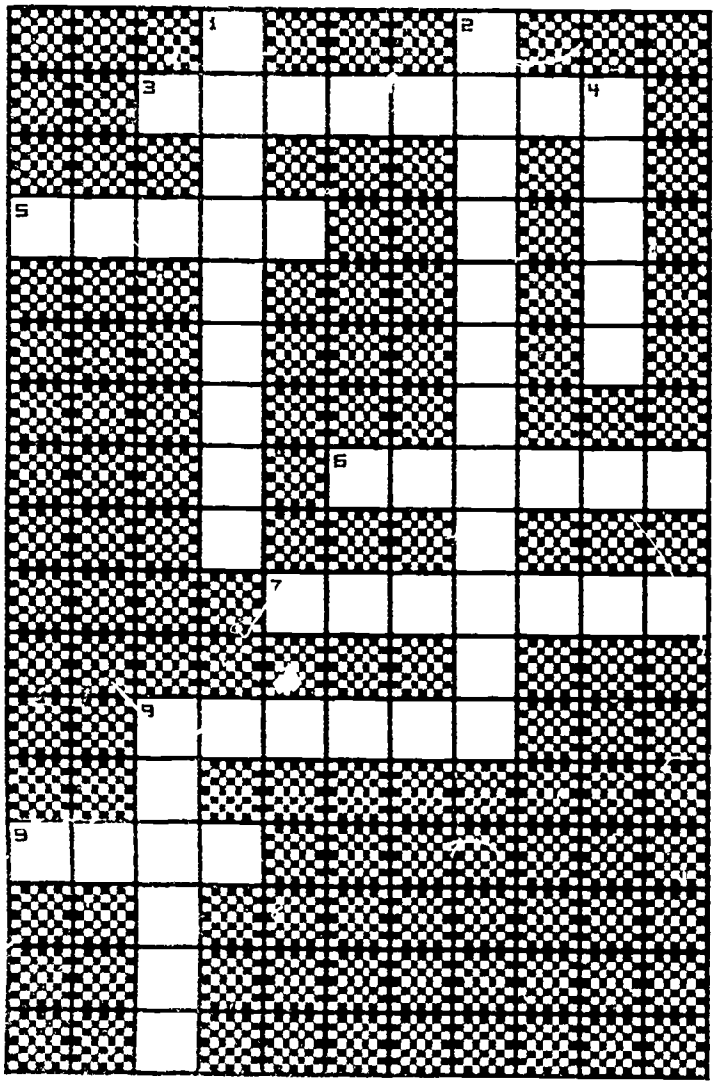
Energy Concepts Inc.
3254 North Kilbourn Ave.
Chicago, IL 60614

Ken Cook Education Systems
12855 W. Silver Springs Dr.
P.O. Box 207
Butler, WI 53007

Lab Volt
P.O. Box 686
Farmingdale, NJ 07727

Mega-Technologies
Educational Division of Megatech Corp.
29 Cook St.
Billeaica, MA 01866

MECHANICAL POWER



ACROSS CLUES

3. CONNECTION
5. RATIO OF DOING WORK
6. ABILITY TO DO WORK
7. ENERGY OF MOTION
8. FORWARD OR UPWARD PUSH
9. FORCE X DISTANCE

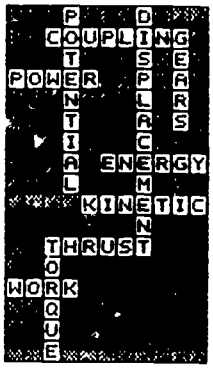
DOWN CLUES

1. STORED ENERGY
2. AREA OF BORE X LENGTH OF STROKE
4. PROVIDE DIRECTIONAL CHANGE
8. TWISTING FORCE

WORD LIST: MECHANICAL POWER

COUPLING	KINETIC	THRUST
DISPLACEMENT	POWER	TORQUE
ENERGY	POTENTIAL	WORK
GEARS		

ANSWERS: MECHANICAL POWER



UNIT V

EXTERNAL COMBUSTION ENGINES

INTRODUCTION

Versatility, simplicity, and high efficiency are reasons why external combustion engines have played an important role in industrial development for more than three hundred years. In this unit we will discuss the construction, operation, and applications of common external combustion engines.

COMPETENCIES

1. Define what is meant by the term external combustion engine.
2. Identify the difference in characteristics between the external and internal combustion engines.
3. Identify the major types of external combustion engines.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Identify the major types of external combustion engines.
2. Describe the operation of the common external combustion engines.
3. Compare the different characteristics between external and internal combustion engines.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. On a written report, the students will trace the historical development of the steam engine from its conception to the present date with 75% accuracy.
2. On a written test, students will list the different types of steam engines and their components, and explain their operating principles with 75% accuracy.
3. On a written test, students will name and define the three types of motion possible with heat engines with 75% accuracy.

4. On a written test, students will explair the operations of the Stirling engine noting its advantages and disadvantages with 75% accuracy.

5. On a written test, students will identify the three basic types of steam turbines and describe their operating principles and their advantages with 75% accuracy.

METHODOLOGY

This unit has been designed to inform and reinforce the basic operating principles of external combustion engines. Emphasis is placed on class discussion, report writing, and written tests. The lectures, and research reports will be used to illustrate these basic principles.

SUGGESTED INTEREST APPROACHES

1. View films and/or filmstrips that will explain external combustion engines.

2. Have students prepare posters and bulletin board displays and positions illustrating external combustion engines.

3. Students will prepare and present oral or written reports on external combustion engines.

UNIT OUTLINE

EXTERNAL COMBUSTION ENGINES

I. Introduction to External Combustion Engines

   A. Historical development
   B. The industrial revolution

II. Reciprocating steam engine

   A. Types of steam engines
   B. Engine components
   C. Operating principles

III. Steam Turbines

A. Types of steam turbines
   1. Impulse turbine
   2. Reaction turbine
   3. Compound turbine
B. Applications of steam turbines

IV. The Stirling engine

A. Operating principles
B. Components of the Stirling engine
C. Advantages and disadvantges of the Stirling engines

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

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1. On a written report, students, will trace the historical development of the steam engine from its conception to the present date with 75% accuracy.

Subject Matter Content	Learning Activities
Historical Development of the Steam Engine	1. View films or filmstrips that explain the historical development of the steam engine. 2. Prepare a bulletin board display of the historical development of the steam engine. 3. Prepare a written report tracing the historical development of the steam engine.

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2. On a written test, students will list the different types of steam engines and their components, and explain their operating principles with 75% accuracy.

Subject Matter Content	Learning Activities
Steam Engines	1. View a film or filmstrip that explains steam engine operation. 2. Discuss and list the types of steam engines and their applications. 3. Have the students prepare a report and present a speech on the types of steam engines, their operating principles, components, and applications.

---

3. On a written test, students will be able to identify the three basic types of steam turbines and describe their operation with 75% accuracy.

Subject Matter Content	Learning Activities
Steam Turbines	1. Discuss the three basic types of steam turbines. 2. List the applications of steam turbines. 3. Have students prepare a report and present a speech on various types or aspects of the steam turbine.

---

4. On a written test, students, will explain the operation of the Stirling engine noting its advantages and disadvantages with 75% accuracy.

Subject Matter Content	Learning Activities
The Stirling Engine	1. View a film and/or filmstrip explaining Stirling engine construction and operation. 2. Discuss the Stirling engine's operating principles. 3. Discuss the possible uses of the Stirling engine. 4. Summarize the important factors of the Stirling engine.

5. On a written test, students will write the names of the three types of steam turbines and describe their operating principles and their advantages with 75% accuracy.

Subject Matter Content	Learning Activities
Steam Turbines	1. Show a film on steam turbine. 2. Present a lecture and discuss the types of operating principles, and uses of steam turbines. 3. Have students prepare posters on steam turbines.

UNIT TEST

EXTERNAL COMBUSTION ENGINES

1. What are heat engines?
2. Name two types of external combustion engines.
3. Name the two classes of steam engines.
4. Briefly describe the operation of the steam engine.
5. Identify the two operating principles of steam turbines.
6. Name at least two important uses of steam turbines.
7. Name two gases used in Stirling engines.
8. Why are reciprocating steam engines seldom used today?

UNIT TEST

ANSWER KEY

EXTERNAL COMBUSTION ENGINES

1. Heat engines are devices that convert heat energy into mechanical energy.

2. Steam engine and Stirling Cycle engines.

3. Reciprocating steam engines and steam turbines.

4. Heat boils water, changing it into steam. Steam drives the engine. Mechanical energy is produced.

5. Reaction, Impulse.

6. Powering ocean-going ships, and powering generators to produce electricity.

7. Helium and Hydrogen.

8. Steam turbine and internal combustion engines are more efficient.

EVALUATION AND TESTING

Ways to Evaluate Pupil Growth

- Unit test
- Class assignments
- Class participation
- Projects
- Reports

EQUIPMENT AND SUPPLIES

Student

Notebook
Textbook
Bulletin board supplies
Supplementary reading materials
Safety glasses
Pen/pencil

Teacher

Research notes
Textbook and manual
Chalkboard, chalks, eraser
Curriculum guide
Film/filmstrip
Film/filmstrip projects
Transparencies
Safety glasses

BULLETIN BOARD IDEAS

- Display cutaway illustrations of external combustion engines.
- Display student posters depicting external combustion engines.
- Display pictures depicting the historical development of external combustion engines.

SUPPLEMENTARY MATERIALS

Textbooks

Bohn, Ralph C.; Fales, Dr. James; Kuetemeyer, Dr. Vincent F.; MacDonald, Angus J. Energy, Power Transportation Technology. Bloomington, IL: Bennet & McKnight Publishing Co., 1986.

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Stephenson, George E. Power Mechanics: New York, Delmar Publishers, 1968.

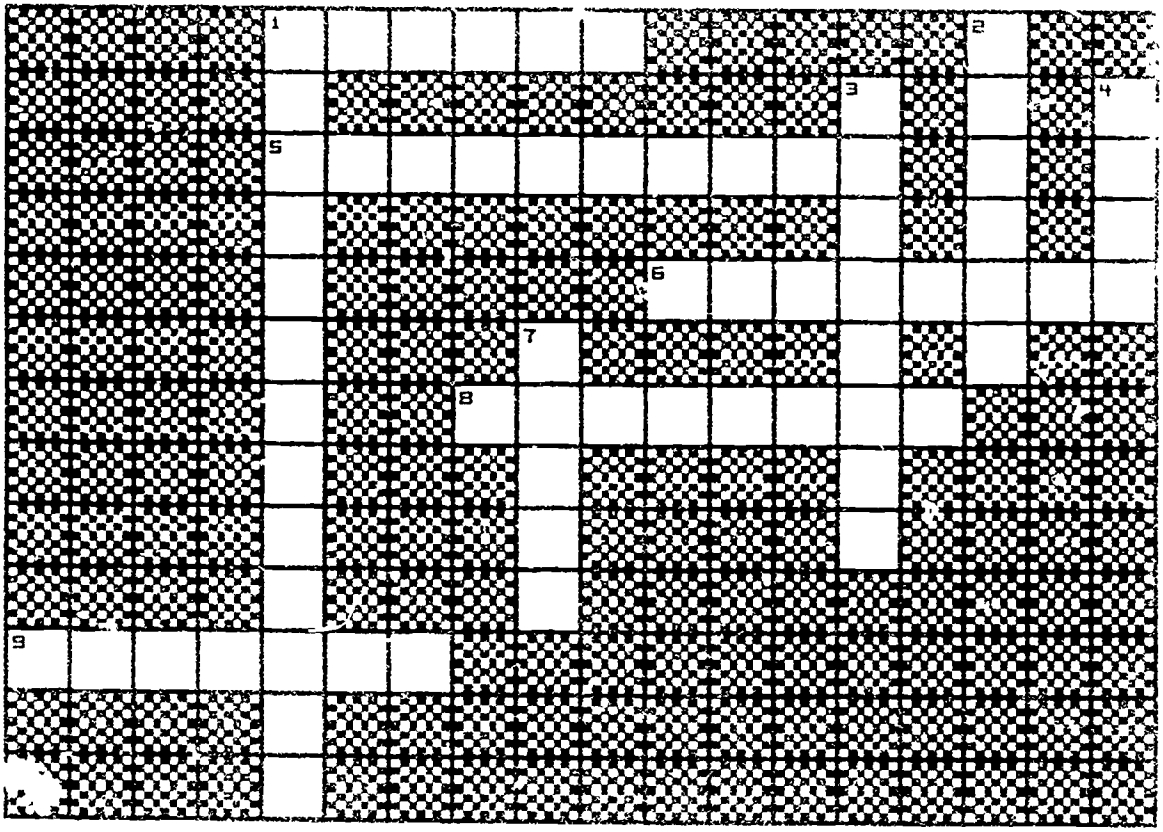
Supplementary Material

Catalogs of energy films are availabe from:

U.S. Dept. of Energy Film Library
P.O. Box 62
Oak Ridge, TN 37830

American Public Power Assoc.
2000 Virginia Ave, N.W.
Washington, D.C. 20037

EXTERNAL COMBUSTION



ACROSS CLUES

1. CIRCULAR MOTION
5. BURNING
6. OUTSIDE
8. STEAMLESS
9. TURNED BY FORCE OF STEAM

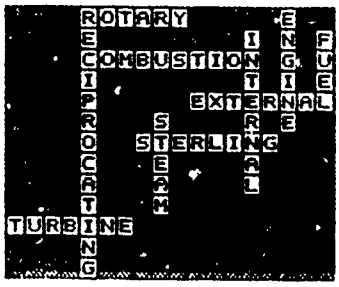
DOWN CLUES

1. BACK AND FORTH
2. CONVERTS ENERGY
3. INSIDE
4. COMBUSTIBLE
7. WATER VAPOR

WORD LIST: EXTERNAL COMBUSTION

COMBUSTION	INTERNAL	STERLING
ENGINE	RECIPROCATING	STEAM
EXTERNAL	ROTARY	TURBINE
FUEL		

ANSWERS: EXTERNAL COMBUSTION



EXTERNAL COMBUSTION

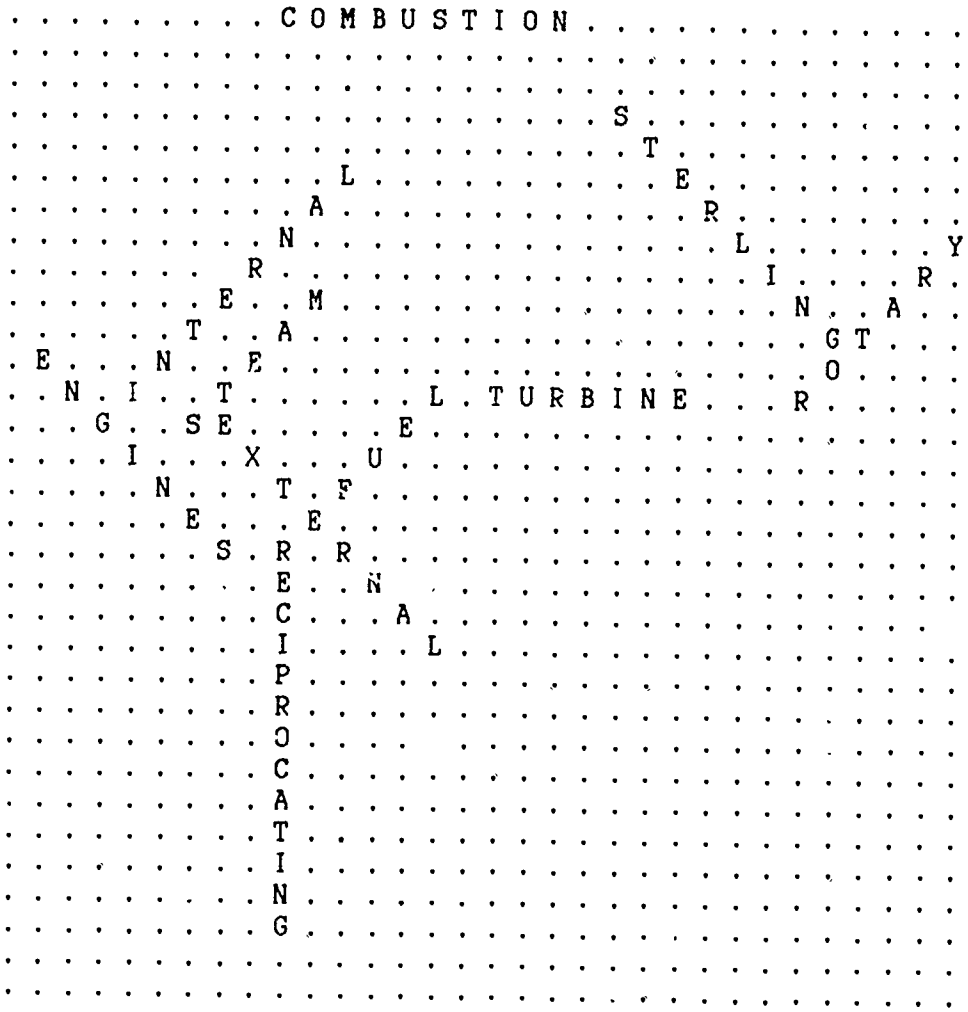
I Y F R W D W X Z C O M B U S T I O N L S N L A H Z Y D A T O S
T G D V V N P S X Y S T B I G N Z W T S N I P E V K L S H N I T
Y W O O N V P R K V L A W Q J C K B A E W I L O J X M O W C E N
O B N X A Z X J J O J X P H W C S W D J S L Y N D K Y I J U D Q
Y P B P D P Y D V X Z Y J S E P S L U N C T I F K G G E Q I U T
P D O O S K F J W Y Q L F K X B H M N U F P E U D M P A Q R Q J
A L K A A R P H F R A A I P Q A K Q A O E T I R E Q P X B Y C B
C R H I O Y G V K N I F Q B V S I C T S W K D U L W O J E K V Y
E J F K D U J H P P V D K W M X Q R C F D H D L X I X U G Z R T
U T B S G E D E I P M G I Q Y M U D L G T E L S L O N F I A O G
S W G B E C T D S A M L E K W T T N J Q W N J H R N N G T E R J
N E Q R I N E V E T W F B Y Q D B P C B D A Z K V N W O Q I G D
B T N G I Y O T R U V V H D L T T U R B I N E F B X R K V U I B
J X U G E D S E O S V O S E U X K Z D L Z K W J O L Z I Y M C V
C D T O I K M N X H I P U Q V F Q B D O F Q A W Y B Y G V Q D I
J G H Q B N E H C T A F G S H L N X O U L Y T D Y Y Z L R G H B
Z F Z Q R E E P M L E T Q T L Z M Z G K W D J T O V N U E H W Z
O L D I R I A S P R Z R F I N H O P I O V T L J H J W I H G T Z
M B Y F F B X I S E R V N H R C H L F A A V F X T Z I T C B I J
J N I L U P O P F C B X D A F V W P M H N A R S T X I J N V J U
G Z Z X W P N N R I I I G R L Q S D X V V O G B J E Z I P J Z E
S U H C X Z R G R P N E C C M A L V X W R F V X H B M A K M H Z
Z V S A X H B O N R I C O K W F G M Q Q G G V D O V I A W B G E
F A D O O J F R X O C I K T S O D C X E U L X G T D K I T H E T
T D J R Y J F G B C F G P T [illegible] J M R F Y T P I F Q Z S Z J Y H J
I H M J O C M I C A X U G Q W I V B N U U D K P H U X C T I U W
Z G N K A Y F B X T A Q Z H I D N Z I T X I Y G P N D N J D H D
G L B I Z K H N Z I T V K R F X P W N L N O E T Z B O L J Q Z P
G X J B C T T L M N W G Y E P O E C T D F N H S W Z D K Q I V T
T H R J R F K U G G B X V P G B Y E J U H A R Z B I Q N C U W T
Y D A E H K Q S S B U K B B V S Z B C M N Y D H X U W X J R Z O
P J N Q I O T P A Y X Q C F Q T R E N Z T F V Q D C P T V L W I

THERE ARE 10 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

COMBUSTION	ENGINES
EXTERNAL	FUEL
INTERNAL	RECIPROCATING
ROTARY	STEAM
STERLING	TURBINE

EXTERNAL COMBUSTION



UNIT VI

INTERNAL COMBUSTION ENGINES

INTRODUCTION

During its relatively short history, the internal combustion engine has played a significant role in the economic development of many nations. Various forms of these engines are used to supply power for the transportation, mining, manufacturing, and construction industries. It is important for students to become familiar with the types, operation, maintenance, and applications of internal combustion engines.

COMPETENCIES

1. Students will discuss and compare various internal combustion engines including diesel two and four-stroke cycle gasoline engines, rotary combustion engines, jet engines, and rocket engines.

2. Students will understand the basic sub-systems of internal combustion engines.

3. Students will trouble diagnose, disassemble, inspect, recondition, reassemble, start, and tune a small gasoline engine.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Describe the operations of the various kinds of internal combustion engines.

2. Evaluate and compare the advantages and disadvantages of the various types of internal combustion engines.

3. Recognize and identify internal combustion engine systems and their component parts.

4. Perform repair and maintenance operations on small gasoline two and four-stoke cycle engines.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. Given specific examples of internal combustion engines, students will identify designs and explain the significance of these designs with 75% accuracy.

2. Given a cutaway drawing of a single cylinder gasoline engine, the students will identify basic components with an accuracy of 75%.

3. The students will describe the operation of the two - stroke cycle gasoline engine with an accuracy of 75%.

4. The students will identify three advantages and disadvantages of the two-stroke cycle gasoline engine as compared to the four-stroke cycle gasoline engine, with an accuracy of 75%.

5. On a written test, the students will list the types of two-stroke cycle gasoline engines, the types of two-stroke cycle valves, and explain the lubrication systems of two-stroke cycle gasoline engines with an accuracy of 75%.

6. On a written test, students will explain the operation of a four-stroke cycle gasoline engine with 75% accuracy.

7. Given diagrams of engine designs and construction, students will list the name of each type on a written test with 75% accuracy.

8. Given an assortment of internal small engine components, students will identify each part and explain its function with 75% accuracy.

9. Given a cutaway model or illustration of a four-stroke cycle gasoline engine on a written test, students will write the names of the operational systems and state their function with 75% accuracy.

10. On a written test, students will list the purposes, additives, weights, and classifications of lubricating oils and explain the components of the engines' lubrication system with 75% accuracy.

11. On a written test, students will compare air and liquid cooling systems and identify the parts of each with 75% accuracy.

12. On a written test, students will name the components of typical gasoline engine fuel systems, the principles of carburetion, and the types of carburetors, governor and throttle controls and air cleaners with 75% accuracy.

13. Given a small gasoline engine, students will identify and describe the functions of the ignition system components with an accuracy of 75%.

14. Students will trace the flow of electricity through both magneto and battery coil ignition systems with 75% accuracy.

15. Students will cite the advantages of using the solid state ignition system with an accuracy of 75%.

16. Given a small four-stroke cycle gasoline engine, students will demonstrate ability to perform maintenanc procedures with 75% accuracy.

17. Given a small four-stroke cycle gasoline engine, students will demonstrate ability to troubleshoot small engine systems with 75% accuracy.

18. Given a small four-stroke cycle gasoline engine, students will demonstrate ability to disassemble, inspect, recondition, reassemble, and start the engine with 75% accuracy.

19. On a written test, the students will discuss the major differences between gasoline and diesel engines with 75% accuracy.

20. The students will describe the function and operation of the diesel fuel injection system with an accuracy of 75%.

21. On a written report, students will trace the historical development of the rotary combustion engine with 75% accuracy.

22. On a written test, students will describe the operation of the rotary combustion engine with 75% accuracy.

23. On a written test, students will list the applications of the rotary combustion engine with 75% accuracy.

24. On a written test, students will list the advantages and disadvantages of the rotary combustion engine with 75% accuracy.

25. On a written report, students will compare and contrast the components and operation of the ramjet engine and the pulsejet engine with 75% accuracy.

26. On a written test, students will list the three classifications of turbojet engines with 75% accuracy.

27. On a written test, students will describe the operation of the gas turbine with 75% accuracy.

28. On a written report, the students will compare and contrast the types of rocket systems with 75% accuracy.

METHODOLOGY

This unit will consist of the description and comparison of the various internal combustion engines. Emphasis will be placed on design, uses, maintenance, and repair of the various engines. Instruction on two and four-stroke cycle internal combustion gasoline engine units will rely heavily on practical demonstrations and hands-on activities for the students.

SUGGESTED INTEREST APPROACHES

1. Arrange a field trip to local industry to observe the various kinds of engines in operation.

2. Invite an auto/diesel/heavy equipment mechanic to talk to the class concerning the requirements of their job.

3. Demonstrate the proper engine maintenance procedures to the class.

4. Have students disassemble, inspect, repair and reassemble small gasoline engines.

5. Have students construct model rockets from commercial kits and launch them according to the model rocket safety code.

UNIT OUTLINE

INTERNAL COMBUSTION ENGINES

I. Reciprocating Gasoline Engines

A. Historical development
B. Basic components
C. Types of reciprocating gasoline engines

1. Two-stroke cycle engines
   a. The two-stroke cycle operating principles
      (1) Principles of operation
      (2) Advantages and disadvantages
   b. Types of two-stroke cycle engines
      (1) Loop scavenged
      (2) Cross scavenged
   c. Two cycle valves
      (1) Rotary-disc valves
      (2) Reed valves
      (3) Piston valves
   d. Lubrication
      (1) Fuel-oil mixture
      (2) Oil injection
   e. Applications
      (1) Marine engines
      (2) Farm
      (3) Home
      (4) Industrial
      (5) Light aircraft
      (6) Motorcycles
2. Four-stroke cycle engines
   a. The four-stroke (OTTO) cycle
      (1) Principles of operation
      (2) Advantages and disadvantages
   b. Classification and designs
   c. Cylinder block and internal components
      (1) Valves and valve trains
      (2) Pistons and piston rings
      (3) Crankshafts and connecting rods
      (4) Engine bearings
   d. Operational systems
      (1) Lubrication
         (a) Friction
         (b) Purposes of lubricating oils
         (c) Additives
         (d) Weights and classifications of oils
         (e) Lubrication systems

(2) Cooling Systems
(a) Air cooling
(b) Liquid cooling

3. Fuel systems
   a. Types of carburetors
   b. Principles of carburetion
   c. Components
   d. Governor throttle controls
   e. Air cleaners
4. Ingition systems
   a. Basic theory of operation
   b. Ignition system components
      (1) Spark plugs
      (2) Breaker points
      (3) Condenser
      (4) Magneto
      (5) Ignition advance systems
   c. Types of ignition systems
      (1) Breaker point ignition system
         (a) Magneto
         (b) Battery
      (2) Solid state ignition systems
         (a) Capacitive-discharge ignition (CDI)
         (b) Transistor-controlled ignition (TCI).
   d. Engine electrical maintenance procedures
   f. Engine electrical troubleshooting procedures
   g. Engine electrical and repair procedures
      (1) Disassembly and inspection of electrical system
      (2) Reconditioning and/or replacement of parts
      (3) Reassembly

II. Diesel Engines

A. Historical development
B. Basic components
C. Types of diesel engines
   1. Two-stroke cycle
   2. Four-stroke cycle

D. Engine design
   1. Cylinder arrangement
   2. Cylinder block construction
   3. Piston crown design

E. Fuel systems
    1. Injection systems
        a. In-line cam-operated, fuel-injection pump
        b. Rotary fuel-injection pump
        c. Detroit Diesel pump/injectors
    2. Injection system operation
        a. Plunger
        b. Relief passage
        c. Needle valve
F. Glow plugs
G. Superchargers
    1. Rootes blower
    2. Turbocharger
H. Applications
    1. Farm
    2. Industrial
    3. Marine
    4. Automotive

III. Rotary Combustion Engines

A. Historical development
B. Basic components and operation
C. Applications
D. Advantages and disadvantages

IV. Jet Engines

A. Ramjet engines
    1. Description
    2. Major components
    3. Types
        a. Subsonic
        b. Low supersonic
        c. High supersonic
B. Pulsejet engines
    1. Description of operation
    2. Major components
C. Turbojet engines
    1. Description of operation
    2. Classifications of turbojet engines
        a. Centrifugal-flow turbojet
        b. Axial-flow turbojet
        c. Turbofan engine
D. Gas turbines
    1. Description of operation
    2. Major components
    3. Applications
        a. Mining

b. Construction
c. Ships
d. Experimental automotive

V. Rocket Engines

A. Operating principles
B. Liquid-type rocket system
   1. Components
   2. Monopropellant system
   3. Bipropellant system
C. Solid-type rocket system
   1. Components
   2. Propellants

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

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1. Given specific examples of internal combustion engines, students will identify designs and explain the significance of the designs with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Design	1. Show a film on the historical development of the internal combustion engine. 2. Using diagrams on internal combustion engines, discuss the significance of engine design changes which have occurred.

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2. Given a cutaway drawing of a single cylinder gasoline engine, the students will identify basic components with an accuracy of 75%.

Subject Matter Content	Learning Activities
Gasoline Engine Components	1. Show transparency of engine cutaway. 2. Identify parts on a cutaway model of a small engine.

3. The students will describe the operation of the two-stoke cycle gasoline engine with an accuracy of 75%.

Subject Matter Content	Learning Activities
Two-Stroke Cycle Gasoline Engine Operation	1. Observe a model of a two-stroke cycle gasoline engine. 2. Discuss two-stroke cycle gasoline engine operation. 3. Disassemble, inspect, and reassemble major components of a two-stroke cycle gasoline engine. 4. Discuss the applications of two-stroke cycle gasoline engines.

4. The students will identify advantages and disadvantages of the two-stroke cycle gasoline engine as compared to the four-stroke cycle gasoline engine with an accuracy of 75%.

Subject Matter Content	Learning Activities
Comparison of Two-Stroke Cycle Engines to Four-Stroke Cycle Engine	1. List the advantages and disadvantages of two-stroke cycle gasoline engines. 2. List advantages and disadvantages of four-stroke cycle gasoline engines. 3. Compare and contrast 1 and 2 above.

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5. On a written test, students will list the types of two-stroke cycle engines, types of two-stroke cycle valves and explain the lubrication systems of two-stroke cycle gasoline engines with an accuracy of 75%.

Subject Matter Content	Learning Activities
Two-stroke Cycle Engine Valves and Lubrication Systems	1. Observe types of two-stroke cycle engines on display in the shop. 2. Disassemble engines noting types of valves used in two-stroke cycle engines. 3. Discuss lubrication systems used in two-stroke cycle engines. 4. Show students samples of oil injection pumps.

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6. On a written test, students will explain the operation of a four-stroke cycle gasoline engine with 75% accuracy.

Subject Matter Content	Learning Activities
Four-Stroke Cycle Engines	1. Discuss the operating principles of a four-stroke cycle engine using visual aids and models. 2. Prepare a handout with illustrations of the strokes of a four-stroke cycle engine. Students will write the name, function, and parts in action on each stroke.

7. Given diagrams of engine designs and construction, students will name each type on a written test with 75% accuracy.

Subject Matter Content	Learning Activities
Four-Stroke Cycle Engine Design	1. Prepare a poster, illustrating the types of four-stroke cycle engine designs and construction. 2. Have the students discuss advantages and disadvantages of the various designs.

8. Given an assortment of internal small engine components, students will identify each part and explain its function in engine operation with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Components	1. Disassemble a small gas engine in a lab demonstration.

Exhibit the component and have the students name it and explain its function.

---

9. Given a cutaway model or illustration of a four-stroke cycle gasoline engine on a written test, students will write the name of the systems and state their functions with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Systems	1. Using a cutaway model or audiovisual materials, present a lesson on the various engine systems.
	2. Distribute illustrations of a four-stroke cycle engine and have students write the name and function of each of the engine's systems.

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10. On a written test, students will list the purposes, additives weights, and classifications of lubricating oils and explain the components of the lubricating system with 75% accuracy.

Subject Matter Content	Learning Activities
Lubricating Systems	1. Prepare and present a lecture on lubricating oils, purposes, weights, additives and classifications. Use audio-visual aids and oil cans from various companies.

2. Exhibit examples of engine lubricatic systems parts. Cal. out the names of th systems and components and hav the students discus their operation.

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11. On a written test, students will compare air and liqu cooling systems and identify the parts of each with 7: accuracy.

Subject Matter Content	Learning Activities
Engine Cooling Systems	1. Distribute cutaway illustrations of a.. and liquid engine cooling systems. Have the students write the names of the cooling system parts and their functions.

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12. On a written test, students will name the components of typical gasoline engine fuel systems, the principles of carburetion, and the types of carburetors, governor and throttle contols and air cleaners with 75% accuracy.

Subject Matter Content	Learning Activities
Fuel Systems	1. Show examples of lawnmower, outboard, and motorcycle fuel systems.
	2. Prepare and present a lecture, using carburetor models an. audiovisual aids, describing the principles of carburetion, the types of small engi carburetors, and governor throttle controls.

3. Simulate operation of battery and magneto ignition systems using student/teacher generated models.

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15. Students will cite the advantages of using solid state ignition systems with 75% accuracy.

Subject Matter Content	Learning Activities
Cite Advantages of Using Solid State Ignition	1. Show students the physical differences between breaker points and solid state ignitions. 2. List the advantages of solid state ignitions systems.

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16. Given a small four-stroke cycle gasoline engine, students will demonstrate ability to perform maintenance procedures with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Maintenance	1. Demonstrate these maintenance procedures: oil check and change, fuel check and addition, clean air filter or replace, ignition tune-up, and carburetor adjustment. 2. Distribute handouts listing step-by-step engine maintenance procedures.

3. Simulate operation of battery and magneto ignition systems using student/teacher generated models.

---

15. Students will cite the advantages of using solid state ignition systems with 75% accuracy.

Subject Matter Content	Learning Activities
Cite Advantages of Using Solid State Ignition	1. Show students the physical differences between breaker points and solid state ignitions. 2. List the advantages of solid state ignitions systems.

---

16. Given a small four-stroke cycle gasoline engine, students will demonstrate ability to perform maintenance procedures with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Maintenance	1. Demonstrate these maintenance procedures: oil check and change, fuel check and addition, clean air filter or replace, ignition tune-up, and carburetor adjustment. 2. Distribute handouts listing step-by-step engine maintenance procedures.

3. Divide into groups and have student practice specific maintenance operations on small gas engines.

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17. Given a small four-stroke cycle gasoline engine, students will demonstrate ability to troubleshoot engine systems with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Troubleshooting	1. Prepare and present a lecture on troubleshooting: problems and causes.
	2. Distribute engine manufacturer's service manuals and have students study the troubleshooting charts.
	3. Discuss trouble-shooting the following: starting systems, engine noises, cooling systems, ignition systems, governor controls, fuel systems, and compression problems.
	4. Divide the students into groups and have them practice specific trouble-shooting procedures on small gasoline engines.

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18. Given a small four-stroke cycle gasoline engine, students will demonstrate their ability to disassemble, inspect, recondition, reassemble, and start the engine with 75% accuracy.

Subject Matter Content	Learning Activities
Engine Overhaul	1. Demonstrate disassembly and parts inspection procedures on a small, 3 to 4 horsepower, four-stroke cycle engine. 2. Divide the students into groups and have them practice disassembly and inspection procedures of a 3 to 4 horsepower four-stoke cycle gasoline engine. 3. Demonstrate reconditioning and/or replacement procedures for valves, cylinders, pistons, rings, connecting rods, crankshafts, bearings, gaskets, and seals. 4. Divide students into groups and have them practice specific engine reconditioning and/or replacement procedures. 5. Demonstrate reassembly and starting procedures of a four-stroke cycle gasoline engine. 6. Have each team reassemble and start their engines.

19. On a written test, the students will identify the major differences between gasoline and diesel engines with 75% accuracy.

Subject Matter Content	Learning Activities
Diesel Engines	1. Discuss the differences between gasoline and diesel engines. 2. View film describing the operation of a diesel engine. 3. Arrange field trip to observe applications of diesel engines.

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20. The students will describe the function and operation of the diesel fuel injection system with an accuracy of 75%.

Subject Matter Content	Learning Activities
Diesel Fuel Injection Systems	1. List the parts of the injection systems. 2. Discuss the different types of injection systems. 3. Draw a diagram of an in-line, cam-operated, fuel-injection system. 4. Observe audiovisual aids concerning diesel fuel injection systems.

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21. On a written report, students will trace the historical development of the rotary combustion engine with 75% accuracy.

Subject Matter Content	Learning Activities
Historical Development of the Rotary Combustion Engine	1. View a filmstrip that explains the historical development of the rotary combustion engine. 2. Prepare a bulletin board display of the historical development of the rotary combustion engine. 3. Assemble a model kit of a rotary combustion engine.

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22. On a written test, students will describe the operation of the rotary combustion engine with 75% accuracy.

Subject Matter Content	Learning Activities
Operation of the Rotary Combustion Engine	1. Use a model to explain the operation of the rotary combustion engine.

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23. On a written test, students will list the applications of the rotary combustion engine with 75% accuracy.

Subject Matter Content	Learning Activities
Applications of Rotary Combustion Engines	1. Discuss the applications of the rotary combustion engine. 2. Prepare a bulletin board display that will illustrate the applications of the rotary combustion engine.

24. On a written test, students will list the advantages and disadvantages of the rotary combustion engine with 75% accuracy.

Subject Matter Content	Learning Activities
Advantages and Disadvantages or the Rotary Combustion Engine	1. Discuss and record the advantages and disadvantages of the rotary combustion engine.

25. On a written report, students will compare and contrast the components and operation of the ramjet engine and the pulsejet engine with 75% accuracy.

Subject Matter Content	Learning Activities
Ramjet and Pulsejet Engines	1. View a film presenting the ramjet and pulsejet engines. 2. Prepare and present a written report explaining the components and operation of the ramjet and pulsejet engines.

26. On a written test, students will list the three classifications of turbojet engines with 75% accuracy.

Subject Matter Content	Learning Activities
Classification of Turbojet Engines	1. View a film explaining turbojet engines. 2. Discuss the operation of the turbojet engine. 3. Assemble a model kit of a turbojet engine.

4. Field trip to an airport to observe turbojet engines.

27. On a written test, students will describe the operation of the gas turbine with 75% accuracy.

Subject Matter Content	Learning Activities
Gas Turbines	1. Discuss the operating principles of the gas turbine. 2. Discuss the advantages of gas turbines. 3. Present uses of gas turbines in mining, manufacturing, shipping, and experimental automobile engines.

28. On a written report, students will compare and contrast the types of rocket engine systems with 75% accuracy.

Subject Matter Content	Learning Activities
Rocket Engines	1. View a film explaining the types of rocket engine systems. 2. Discuss the rocket engine systems. 3. Have the students prepare and present written reports explaining the types, uses, and advantages of rocket propulsion. 4. Construct model rockets from scratch or use pre-packaged

kits. Have the students fire their rockets and calculate trajectory and maximum height.

UNIT TEST

INTERNAL COMBUSTION ENGINES

I. Multiple Choice

1. List the four strokes of a four-stroke cycle gasoline engine in sequential order.

2. How many revolutions of the crankshaft are necessary to complete the four-stroke cycle.
   a. One
   b. Two
   c. Three
   d. Four

3. This engine part converts rotary motion into reciprocating motion.
   a. Piston
   b. Connecting rod
   c. Crankshaft
   d. Cramshaft

4. The pressure produced by the weight of air molecules above the earth is called _____.
   a. Hydraulic pressure
   b. Atomospheric pressure
   c. Vacuum
   d. Gauge pressure

5. Small four-stroke gas engines generally use this type of lubrication system.
   a. Splash system
   b. Fuel-oil mixture
   c. Positive displacement pump
   d. Full pressure pump

6. Which of the following parts is not part of an air cooled engine's cooling system.
   a. Cooling fins
   b. Muffler
   c. Flywheel
   d. Air shroud

7. The rotating combustion engine was invented by:
   a. Henry Ford
   b. Felix Wankel
   c. Rudolph Diesel
   d. Ferdinand Porsche

8. How many phases does the rotor go through in one revolution of the rotary combustion engine?
   a. Four
   b. Three
   c. Two
   d. None

9. A rotary combustion engine's rotor rotates in a _____ chamber.
   a. Oval
   b. Cylinder
   c. Triangular
   d. Epitrochoidal

10. Which of the following characteristics is <u>not</u> an advantage of the rotary combustion engine over a piston engine?
   a. Lighter weight
   b. More moving parts
   c. Less vibration
   d. Quicker acceleration

11. When the eccentric shaft revolves three times, the rotor revolves _____ in a rotary combustion engine.
   a. Three times
   b. Two times
   c. Once
   d. 120 degrees

II. Short Answer:

1. Name the two basic types of gasoline piston engines.

2. Name the advantages two-stroke cycle gasoline engines have over four-stroke cycle gasoline engines.

3. Describe the operation of the two-stroke cycle gasoline engine.

4. What is the main difference in operation between diesel and gasoline engines?

5. Describe how fuel is ignited in a diesel engine.

6. What is the greatest advantage of the diesel engine over the gasoline engine?

7. Which type of jet engine is commonly used on commercial airliners?

8. Name the jet engine that has no moving parts.

9. What is the main difference between a jet engine and a rocket engine?

10. Define thrust.

11. Explain how a rocket engine operates.

UNIT TEST

ANSWER KEY

INTERNAL COMBUSTION ENGINES

I. Multiple Choice

1. Intake, compression, power, exhaust
2. B
3. C
4. B
5. A
6. B
7. B
8. D
9. D
10. B
11. C

II. Short Answer

1. Four-stroke cycle engine and two-stroke cycle engine.

2. Fewer moving parts, simpler, easier to build, lighter in weight.

3. A. Compression stroke: As the piston moves up, it blocks off the intake and exhaust ports, thus sealing in the air fuel mixture. The piston compresses the mixtures and at the same time the upward piston movement creates a partial vacuum in the crankcase. This allows a new air-fuel mixture to enter the crankcase through the reed valve.

   B. Power stroke: The spark plug ignites the compressed air fuel mixture. The hot expanding gases push the piston down. The piston passes the exhaust port, which allows the burned gases to begin to leave the engine. Then the piston passes the intake port. Because of the pressure exerted by the downward piston movement, the new air-fuel mixture pushes up into the combustion chamber and the new mixture helps to push out the burned gases.

4. A diesel engine uses high compression of the air-fuel mixture for ignition while the gasoline engine uses an ignition spark to ignite the air-fuel mixture.

5. The high compression raises the temperature of the air inside the cylinder to approximately 1000 F. This high temperature ignites the fuel as it enters the cylinder.

6. Fuel economy.

7. Commercial airlines commonly use the turbofan engine.

8. The jet engine that has no moving parts is the ramjet.

9. The main difference between a rocket engine and a jet engine is that rocket engines carry their own oxygen supply. Jet engines use oxygen from the atmosphere.

10. Thrust means the forward push produced by a linear engine.

11. A rocket engine operates by the combustion of solid or liquid fuel and its on-board oxidizer, and the resulting high velocity ejection of hot gases.

EVALUATION AND TESTING

Ways To Evaluate Pupil Growth

- Unit Test
- Class participation grade
- Homework grade
- Project grade

EQUIPMENT AND SUPPLIES

Student

Notebook
Textbook
Supplementary reading
Safety glasses
Work clothes
Pen/pencil

Teacher

Bulletin board supplies
Research notes
Chalkboard, chalk and eraser
Textbook and manual
Curriculum guide
Films/filmstrips
Film/filmstrip projectors
Transparencies
Overhead projector
Hand and power tools
Assortment of small engines and/or models
Safety glasses

BULLETIN BOARD IDEAS

- Display crossectional illustrations and spec charts from various manufacturers.
- Display posters on rocketry.
- Post safety rules for working with engines.
- Have the students generate safety posters and display them.
- Prepare a display depicting the historical development of the engine, from the earliest steam engines to the space shuttle.

SUPPLEMENTARY MATERIALS

Books

[illegible], [illegible]. Power Mechanics. South Holland, IL: Goodheart-Wilcox Company, Inc., 1986.

[illegible], Ralph C. and MacDonald, Angus J. Power Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

[illegible], William H.; Margulies, Morton; and Worthington, Robert [illegible]. General Power Mechanics. New York: McGraw-Hill Book Company, 1968.

[illegible], George R. The Repair and Maintenance of Small Gasoline Engines. Reston, VA: Reston Publishing Co., Inc. 1976.

[illegible], Harold T. Exploring Power Mechanics. Peoria, IL: Chas. A. Bennett Co., Inc. 1973.

[illegible], Bill. American Warplanes. New York: Crescent Books, 1986.

[illegible], John R. Exploring Power Technology. South Holland, IL: Goodheart-Wilcox Co., Inc. 1981.

[illegible], [illegible]. Small Engines Operation and Service. [illegible], IL: American Technical Publishers, 1981.

PUBLIC AND PRIVATE AGENCIES

American Vocational Association
1410 King Street
Alexandria, VA 22314

American Petroleum Institute
2101 L Street, N.W.
Washington, D.C. 20037

International Technology Education Association
(Formerly The American Industrial Arts Association)
1914 Association Drive
Reston, VA 22091

FEDERAL GOVERNMENT

U.S. Dept. of Energy
Dept. of Marketing and Education
Washington, D.C. 20545

U.S. Dept. of Energy Film Library
P.O. Box 62
Oak Ridge, TN 37830

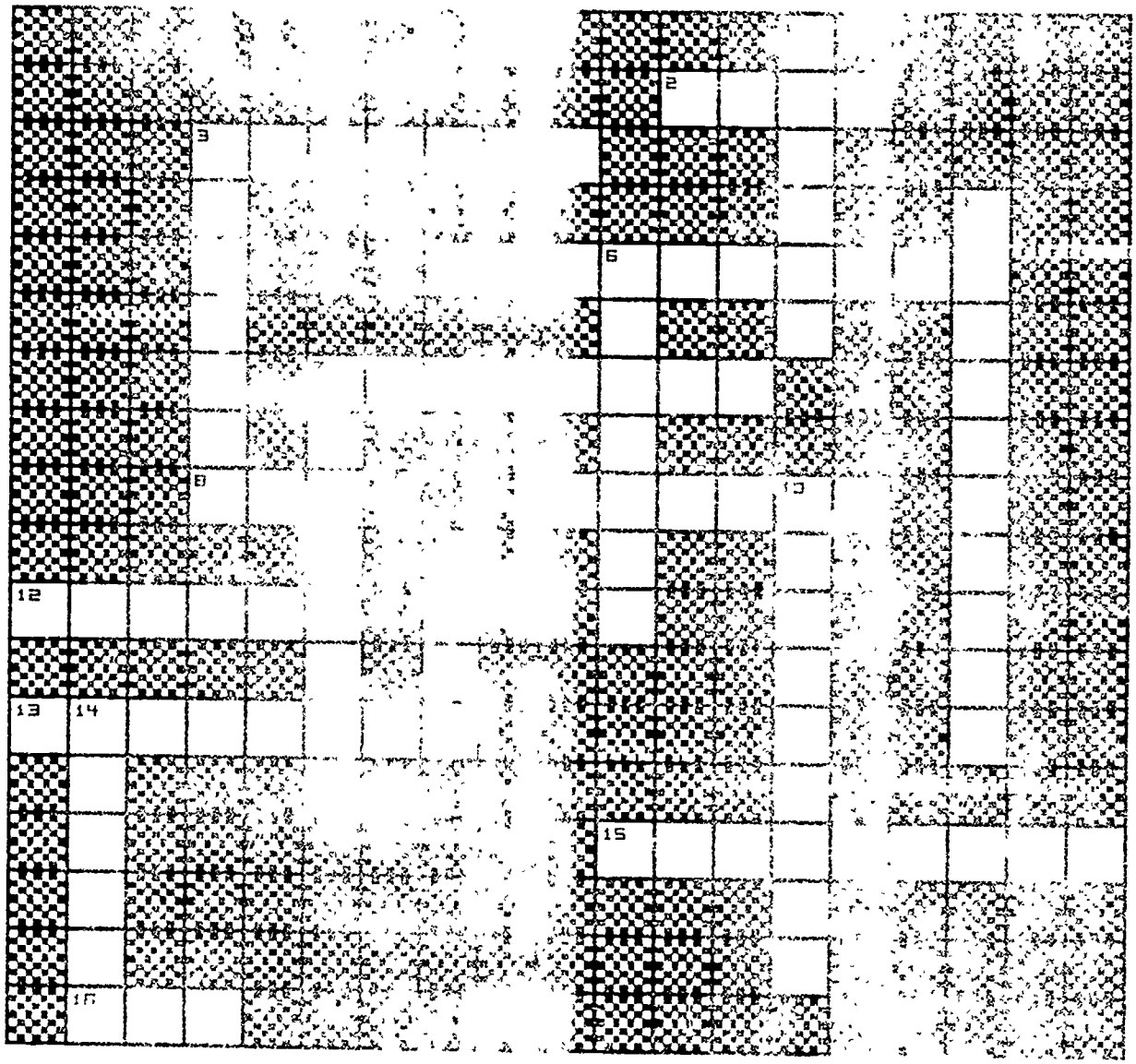
JOURNALS

Discovery
Time-Life Bldg.
Chicago, Ill. 60611

Industrial Education
262 Mason St.
Greenwhich, CT. 06830

School Shop
Box 8623
Ann Arbor, MI 48107

SMALL ENG



ACROSS CLUES

2. TOP OF COMBUSTION CHAMBER
3. REDUCES EXHAUST NOISE
5. MIXES GASOLINE AND AIR
7. CONTROLS VALVES
8. LUBRICANT
9. DISTRIBUTES OIL
12. UPWARD MOTION RESULTS IN COMPRESSION
13. STORES ENERGY
15. IGNITES AIR-FUEL MIXTURE
16. CONNECTION BETWEEN PISTON AND CRANKSHAFT

DOWN CLUES

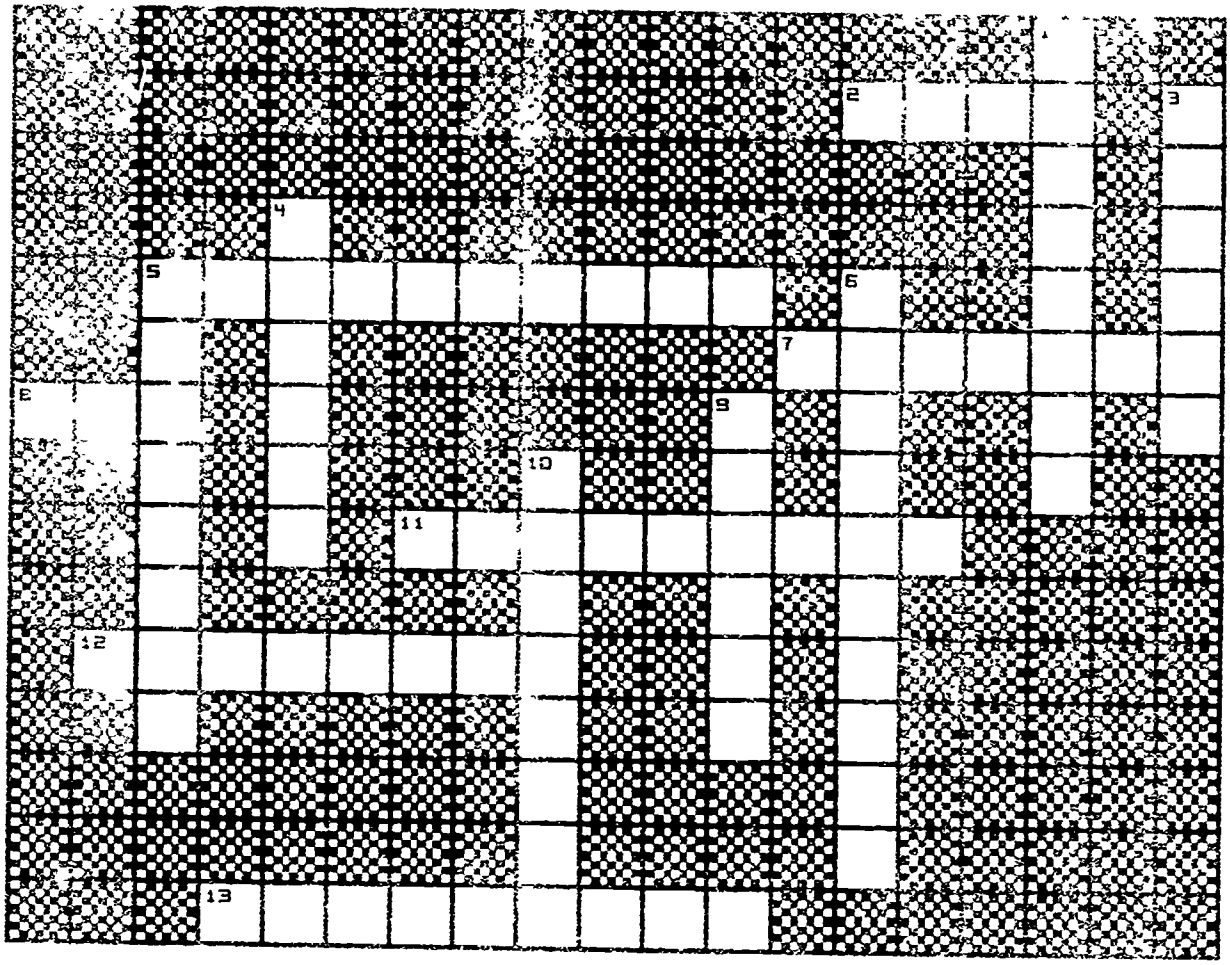
1. CONTROL INTAKE AND EXHAUST
3. PRODUCES [illegible] CURRENT
4. RECIPROC[illegible]OTION
6. REDUCE FR[illegible]
7. COMBUSTI[illegible]
10. CAM LOBE
11. GASKET
14. BETWEEN [illegible]

WORD LIST: SMALL ENGINE PARTS

BEARING
CARBURETOR
CAMSHAFT
CRANKSHAFT
CYLINDER
DIPPER
ECCENTRIC
FLYWHEEL
HEAD
LIFTER
MAGNETO
MUFFLER
OIL
PISTON
ROD
SEAL
SPARKPLUG
VALVES

ANSWERS: SMALL ENGINE PARTS

SMALL G[illegible] IGINE



ACROSS CLUES

2. GASKET
5. RECIPROCATING TO ROTARY
7. PRODUCES ELECTRICAL CURRENT
8. LUBRICATING MATERIAL
11. IGNITES AIR FUEL MIXTURE
12. REDUCES FRICTION
13. CAM LOBE

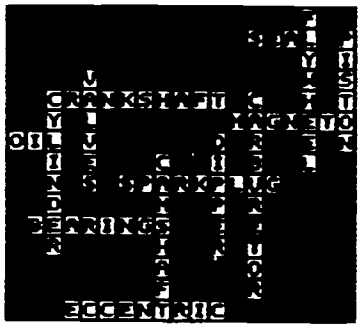
DOWN CLUES

1. ENERGY STORAGE UNIT
3. UPWARD MOVEMENT REDUCES IN COMPRESSION
4. CONTROL INTAKE AND EXHAUST
5. COMBUSTION CHAMBER
6. PRODUCES AIR FUEL MIXTURE
9. DISTRIBUTES OIL
10. CONTROLS VALVES

WORD LIST: SMALL GAS ENGINE

BEARINGS	DIPPER	PISTON
CARBURETOR	ECCENTRIC	SEAL
CAMSHAFT	FLYWHEEL	SPARKPLUG
CRANKSHAFT	MAGNETO	VALVES
CYLINDER	OIL	

ANSWERS: SMALL GAS ENGINE



SMALL ENGINE PARTS

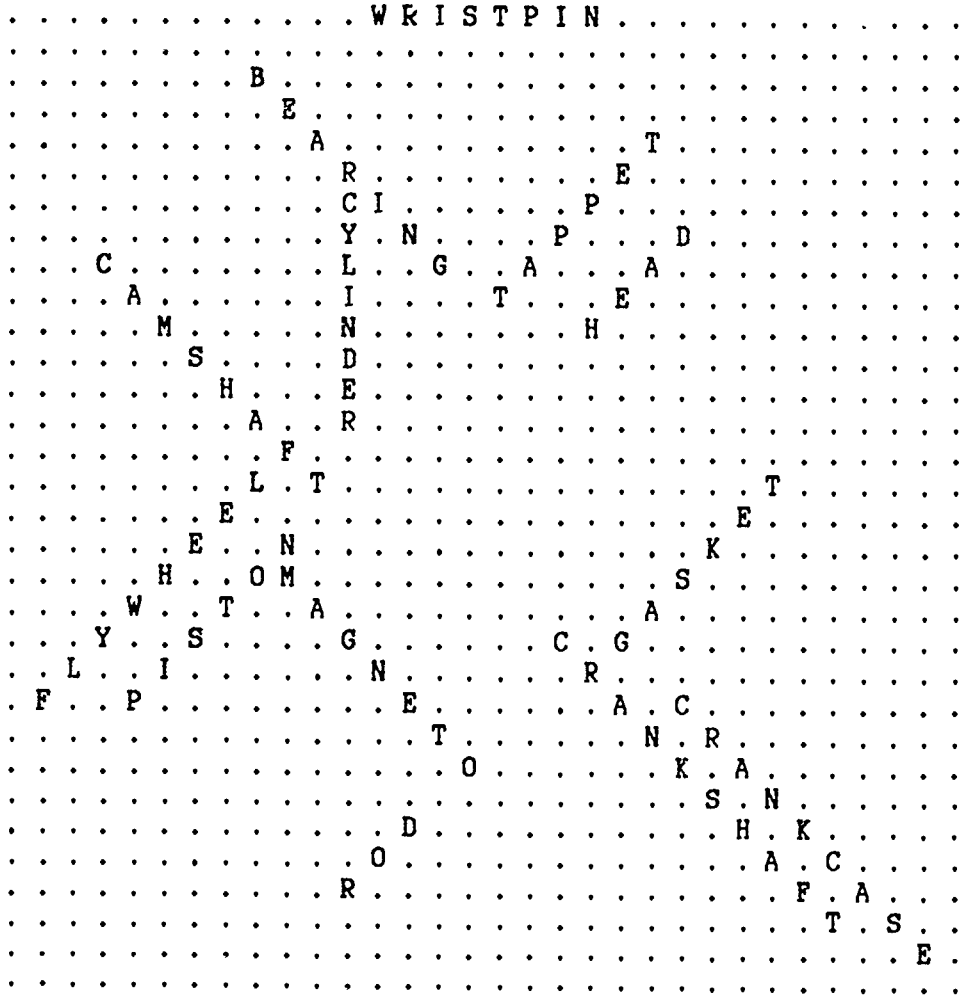
J J Q M J K U K V K A O W R I S T P I N Q U O Q J W B A S D O W
K M P P I A D J B V K C O G Q G J F Q Z U J E C S U C Q M C M K
D E F Q T T Y H B N A W Z X K X B L W E V N N R Q H T O N B O J
J Z W F R O V R J E D M P V M V Z K E F W B Y H B F F D S F B H
Z E A B Z Q H Q L S A H C E K D I M H L P T N H C F I G K M W X
D L H Z W J Z M N T E R O I X U Y P C O E Y K V W X S B C P U X
V T E O Z B L H U U N C I X F H N U P P H Z Z B L D P S X G E D
D A O E Y X F G F Q V Y E N U M H S P R J P D P N I U V J I R Q
L S G C W J U F O E C L F U G Q B A M Z G A T X V T E D U C E D
D L H E A G G E H V J I I A O U T C S Z E W L M Y C G Z Q Q R P
O E Q N Q M D L D I G N Q S Y G F T W H B B F J W Y M I C E S Q
O E A D E A S K I Z E D D Q S E F Y J F C S Y X E D F G Y J Z C
Z C C S W M H H J G P E O F L W J C N H B V C U Y U M B C Q L M
G F I Q J N V Y A S Q R X S Q T I N W U P Z F B N N C K P X Z K
C N X M J N E K Q F U C L V R R P A D S C B B O T M T Q S E U K
S F N Z M L S G L Q T U Q T Y M T Z O T A X Q D F T H D I A J Q
C I A B V S K E D K Y Q F Z M L B R V U J C L K E T U J I S V Q
F X D G S B E T M N J Z I V J P V S D D O D P K I F Y D K V R B
O F B W Q H K V O M C J Z X G A D Y Q K U A S H U M B K W J W T
E Z S D W C O T H Q A K P K Z G Z G L P J A C H F Z K R B C P E
O D G Y E E S C I Y Q G D Q Q S R G C V G A X H O H H L R X U Q
Y M L B S I K M P C Q T N V V F A W C R L E A X Z W Y G J U C B
D F R D P P B O I T A F A E P Z Z S T C A W C C J C S N Z M X H
H J Y U I F L Q R A P H A A T C R S A N F N E R S J T V D E M C
W L T F O H D E C E V M U X I O S Q E B R C K J A W U J E L U J
E R N C H X Q X K K M I K V O P G F G U O N A S K N W X I N H K
G L R R T E O M W L K C T D D V L C A D F L J P H D K M U E G A
T V V J H D Q B P Z S D O S Q S X S P M U B Y J P A B C O Y J P
F W M D N S C V B N U R H A H N P R F K X L N Q V T F J A T H G
M C D J W X H A D D A I Z Z B Z F S X Y N W H F N M U T I S R V
E C J K N H T O G Y O M D U R M B B M N D D O T C N W F O Y E O
U B O N M J I R O N X T L C X P C Z O I F D G X F M W I Z N J G

THERE ARE 13 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

BEARING
CAMSHAFT
CRANKCASE
CRANKSHAFT
CYLINDER
FLYWHEEL
GASKET
HEAD
MAGNETO
PISTON
ROD
TAPPET
WRISTPIN

SMALL ENGINE PARTS



UNIT VII

FLUID POWER SYSTEMS

INTRODUCTION

Fluid power has often been called the "muscles of industry." There are two types of fluid power systems: pneumatic and hydraulic. Hydraulic systems use a liquid such as oil to transmit and control power. Pneumatic systems use a gas such as air to transmit and control power. Both systems have advantages over other power systems. These advantages include a simplified power transmission, multiplication of force or speed. accurate control, and trouble-free operation.

The usage of fluid power systems in industry is greatly increasing. Robotics and automated manufacturing systems rely heavily on both hydraulics and pneumatics. The purpose of this unit is to provide students with the foundation necessary for their future jobs in industry.

COMPETENCIES

1. Identify pneumatic and hydraulic system components.
2. Understand the basic laws of science on which fluid power systems function.
3. Perform hydraulic and pneumatic experiments.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Explain the fundamentals of pneumatic and hydraulic systems.
2. Solve mathematical problems involving pressure, temperature and volume.
3. Complete lab experiments demonstrating the principles of hydraulics and pneumatics.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. The student will be able to define the term fluid power.
2. The student will describe how fluid is able to transfer force as well as change the relationship between force and distance or speed with 75% accuracy.
3. The student will explain the operation of a Bourdon tube pressure gauge.
4. The student will complete experiments involving the fundamentals of fluid power with 75% accuracy.
5. The student will solve mathematical problems involving changes in pressure, temperature, and volume in fluid power systems with 75% accuracy.
6. The student will identify and describe the operation of the various kinds of pumps with 75% accuracy.
7. The student will explain the operation of a continuous flow air compressor with 75% accuracy.
8. The student will explain the operation and use of globe valves, gate valves, pressure relief valves and pressure control valves with 75% accuracy.

METHODOLOGY

This unit has been designed to present and reinforce the principles of Fluid Power. Emphasis is placed on laboratory experiments dealing with pneumatic and hydraulic systems. Manuals, texts, and lab reports will be used to facilitate instructions in the principles of Fluid Power.

SUGGESTED INTEREST APPROACHES

1. Demonstrate experiments dealing with hydraulics and pneumatics.

Allow students to perform laboratory experiments.

3. Have students research and prepare an oral and written report.

4. Arrange for a field trip to a local industry emphasizing hydraulic and pneumatic uses.

UNIT OUTLINE

FLUID POWER SYSTEMS

I. Introduction to Fluid Power

- A. Fluid power defined
- B. Fundamentals of fluid power
- C. Basic components of a fluid power system

II. Principles of Fluid Power

- A. Pascal's Law
- B. Boyle's Law
- C. Charles' Law
- D. Bernouli's Principle

III. Advantages of Fluid Power

- A. Control
- B. Mechanical advantage
- C. Light weight and simplicity
- D. Safety
- E. Cost

IV. Types of Fluid Systems

- A. Hydraulic systems
- B. Pneumatic systems

V. Transmission Lines

- A. Resistance
- B. Pressure drop
- C. Turbulence
- D. Reynolds number

VI. Conductors

A. Rigid
    1. Steel
    2. Stainless steel
    3. Copper
    4. Plastic
B. Semi-rigid
    1. Seamless tubing
    2. Electrically welded tubing
C. Flexible - Hose

VII. Connectors

A. Threaded
B. Tube
C. Flared
D. Flareless
E. Welded
F. Quick-disconnect couplings

VIII. Fluid Power Symbols

IX. Hydraulic Fluids

A. Reservoirs design and construction
B. Filtration
    1. Hydraulic filters
    2. Pneumatic filters
C. Types of hydraulic fluids
D. Hydraulic oil additives

X. Pumps

A. Rotary
    1. Gear
        a. Internal gear
        b. External gear
    2. Vane
    3. Screw
    4. Rootes lobed rotor
B. Piston
    1. Radial
    2. Axial
    3. Reciprocating

XI. Compressors

A. Continuous-flow compressors
B. Positive-displacement compressors

XII. Control Valve

A. Pressure control valves
B. Directional control valves
    1. Two-way valve
    2. Three-way valve
    3. Four-way valve
C. Flow Control Valve
D. Valve Construction
    1. Globe valves
    2. Plug valves
    3. Gate valves
    4. Needle valves
    5. Spool valves

XII. Actuators

A. Cylinders
    1. Single-acting cylinders
    2. Differential double-acting cylinders
    3. Non-differential double-acting cylinders
B. Motors
C. Diaphram actuators

XIII. Accumulators

SPECIFIC PERFORMANCE OBJECTIVES

---

1. The student will be able to define the term fluid power.

Subject Matter Content	Learning Activities
Fluid Power	1. Discuss the fundamental principles of fluid power. 2. Discuss hydraulics and give examples of industrial applications. 3. Discuss pneumatics and give examples of industrial applications.

4. Present a filmstrip on the fundamental principles and application of fluid power.

5. Schedule a field trip to observe hydraulic and pneumatic systems in industrial settings.

---

2. The student will describe how fluid is able to transfer force, as well as change the relationship between force and distance or speed, with 75% accuracy.

Subject Matter Content	Learning Activities
Controlling Liquids	1. Complete experiment involving relationship of cylinder speed to varying air pressure.
	2. Demonstrate how force is increased by using cylinders with larger pistons.

---

3. The student will explain the operation of a Bourdon tube pressure gauge.

Subject Matter Content	Learning Activities
Bourdon Tube Pressure Gauge	1. Observe the operation of a pressure gauge.
	2. Explain the operating principle of the Bourdon tube gauge.

---

4. The student will complete experiments on the fundamentals of fluid power with 75% accuracy.

Subject Matter Content	Learning Activities
Fluid Power Experiments (Experiments vary depending on the equipment available.)	1. Demonstrate to the students the use of the fluid power trainers/ experimenters. 2. Divide the students into groups and have them perform basic work-ups so that they may learn to operate the equipment. 3. Demonstrate the principle that the force a cylinder is able to produce, or the load it can support. is a product of the area times pressure (F=PA). 4. Through experimentation, the student will learn of the applications of air receivers used in compressed air systems and will learn why air receivers are used in compressed air systems. 5. The student will experiment with applications in which single-action cylinders are suitable.

5. The student will solve mathematical problems involving changes in pressure, temperature, and volume in fluid power systems with 75% accuracy.

Subject Matter Content	Learning Activities
Fluid Power Laws	1. Discuss fluid power laws. Include Boyles, Charles, Pascals, Gay Lusac, and Bernouli's principle. 2. Using formulas relating to pressure, temperature and volume, solve problems as assigned.

---

6. The student will identify and describe the operation of the various kinds of pumps with 75% accuracy.

Subject Matter Content	Learning Activities
Pumps	1. Identify the different types of pumps. 2. Describe the operation of the various pumps. 3. Demonstration of pump operation. 4. Experiments utilizing pumps.

---

7. The student will explain the operation of a continuous-flow air compressor with 75% accuracy.

Subject Matter Content	Learning Activities
Continuous-Flow Compressors	1. Identify continuous-flow compressors. 2. Describe the operation of the continuous-flow compressors.

3. State applications of continuous-flow compressors.

---

8. The student will explain the operation and use of globe valves, gate valves, pressure relief valves, and pressure control valves with 75% accuracy.

Subject Matter Content	Learning Activities
Control Valves	1. Identify the different types of control valves.
	2. Explain the operation of control valves.
	3. Perform experiments with different kinds of control valves.

UNIT TEST

FLUID POWER SYSTEMS

I. Short Answer

1. What is fluid power?

2. What design feature of the Bourdon tube makes it straighten as pressure increases?

3. Describe the relationship between the pressure and the temperature of a gas when the volume remains constant.

4. Show the mathematical relationship between temperature change and combined change in volume and pressure.

5. Describe in your own words how a fluid transfers force.

6. In a pneumatic power system, what two contaminants does the filter remove from the air?

7. Name three basic types of hydraulic pumps.

8. What advantage does the gate valve have over the globe valve?

9. What are the functions of a directional control valve?

10. Name two common fluid power activators.

II. Solve the following problems

1. If 12 cubic feet of gas has a pressure increase from 10 psig to 45 psig without a temperature change, what is the new volume?

2. A gas having a volume of 4 cubic feet is heated from 90° F to 640° F. If the pressure remains constant, what is the new volume?

UNIT TEST

ANSWER KEY

FLUID POWER SYSTEMS

1. Fluid power is the use of pressurized liquids and gases to control and transmit power.

2. The outer surface of the tube has a greater area than the inner surface.

3. The pressure increases or decreases in proportion to the temperature change.

4. $\frac{P_1}{T_1} = \frac{P_2V_2}{T_2}$

5. Force applied to a fluid produces a pressure on the fluid. The fluid exerts this pressure equally in all directions. The force resulting from the pressure produces motion in the fluid system.

6. Dirt and moisture.

7. Piston pump, gear pump, and vane pump.

8. Fluids do not change direction as they pass through the gate valve. This makes gate valves more efficient than globe valves.

9. To control the fluid flow from different sources or to redirect fluid flow to different parts of the system.

10. Cylinders and motors.

1. In absolute pressure, 10 psig = 25; 45psig = 60.
$P_1V_1 = P_2V_2$

25 psig X 12 cu.ft. = 60 psig X V2
V2 = 5 cu. ft.

2. In absolute Fahrenheit temperature, 90° F = 550; 640° F = 1100

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \qquad \frac{4 \text{ cu.ft.}}{550 \text{ Fa}} = \frac{V2}{1100 \text{ Fa}}$$

V2 = 8 cu.ft.

EVALUATION AND TESTING

Ways To Evaluate Pupil Growth

- Unit test
- Class assignments
- Class participation
- Projects
- Problem solving
- Laboratory experiments
- Work habits

EQUIPMENT AND SUPPLIES

Student

Textbook
Notebook
Instruction sheets
Lab manual
Safety glasses
Pen/pencil

Teacher

Textbook and manual
Bulletin board supplies
Curriculum guide
Fluid power experimenter
Audiovisual equipment and materials
Chalkboard, chalk, and eraser
Safety glasses
Fluid power sectioned components, models, samples, etc.

BULLETIN BOARD IDEAS

- Post safety rules for fluid power
- Post fluid power symbols
- Display manufacturers charts depicting fluid power circuits.
- Display student posters.
- Display sectioned views of fluid power components.

SUPPLEMENTARY MATERIALS

Textbooks

Bohn, Ralph C. and MacDonald, Angus J.
Power: Mechanics of Energy Control.
Bloomington, IL: McKnight Publishing Co., 1983.

Glenn, Harold J. Exploring Power Mechanics.
Peoria, IL: Bennett, 1973.

Instructor's Guides

Bohn, Ralph C. and MacDonald, Angus J.
Power Mechanics of Energy Control.
Bloomington, IL: McKnight Publishing Co., 1983.

Resources

U.S. Department of Energy
Department of Marketing and Education
Washington, D.C. 20545

American Vocational Association
1410 King Street
Alexandria, VA 22314

Industrial Education
262 Mason st.
Greenwich, CT. 06830

Equipment & Supplies

Energy Concepts, Inc.
3254 North Kilbourn Ave.
Chicago, IL. 60641

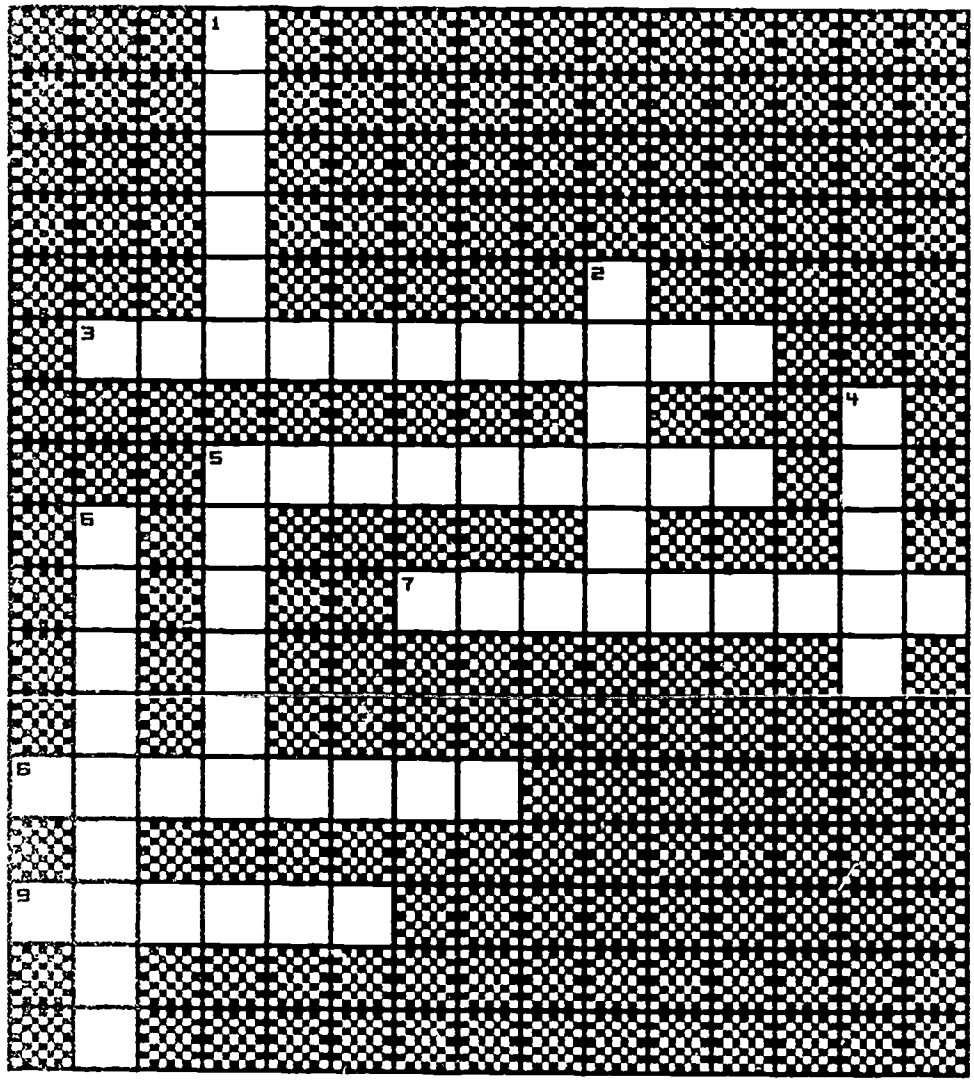
Vega Enterprises, Inc.
Power Experimenter Multi-Power Lab - Fluid
Technical Training and Testing Center
Rural Route 3, Box 300B
Decatur, Illinois 62526

Ken Cook Education Systems
12855 W. Silver Springs Dr.
P.O. Box 207
Butler, WI 53007

Lab Volt
P.O. Box 686
Farmingdale, NJ 07727

Mega-Technolcgies
Education Division of Mega-tech Corp.
29 Cook St.
Billerica, MA 01866

FLUID POWER



ACROSS CLUES

3. FORCING TOGETHER
5. AIR UNDER PRESSURE
7. LIQUID UNDER PRESSURE
8. FORCE PER UNIT AREA
9. AMOUNT OF SPACE FLUID TAKES UP

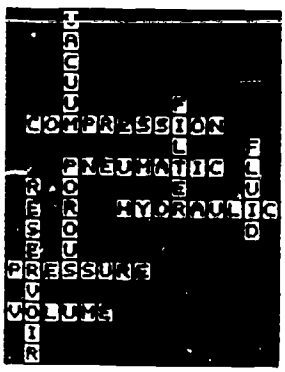
DOWN CLUES

1. BELOW ATMOSPHERIC PRESSURE
2. CLEANS FLUID
4. ANY LIQUID OR GAS
5. HAVING MANY SMALL HOLES
6. TANK HOLDING FLUID

WORD LIST: FLUID POWER

COMPRESSION
FILTER
FLUID
HYDRAULIC
PNEUMATIC
POROUS
PRESSURE
RESERVOIR
VACUUM
VOLUME

ANSWERS: FLUID POWER



FLUID POWER

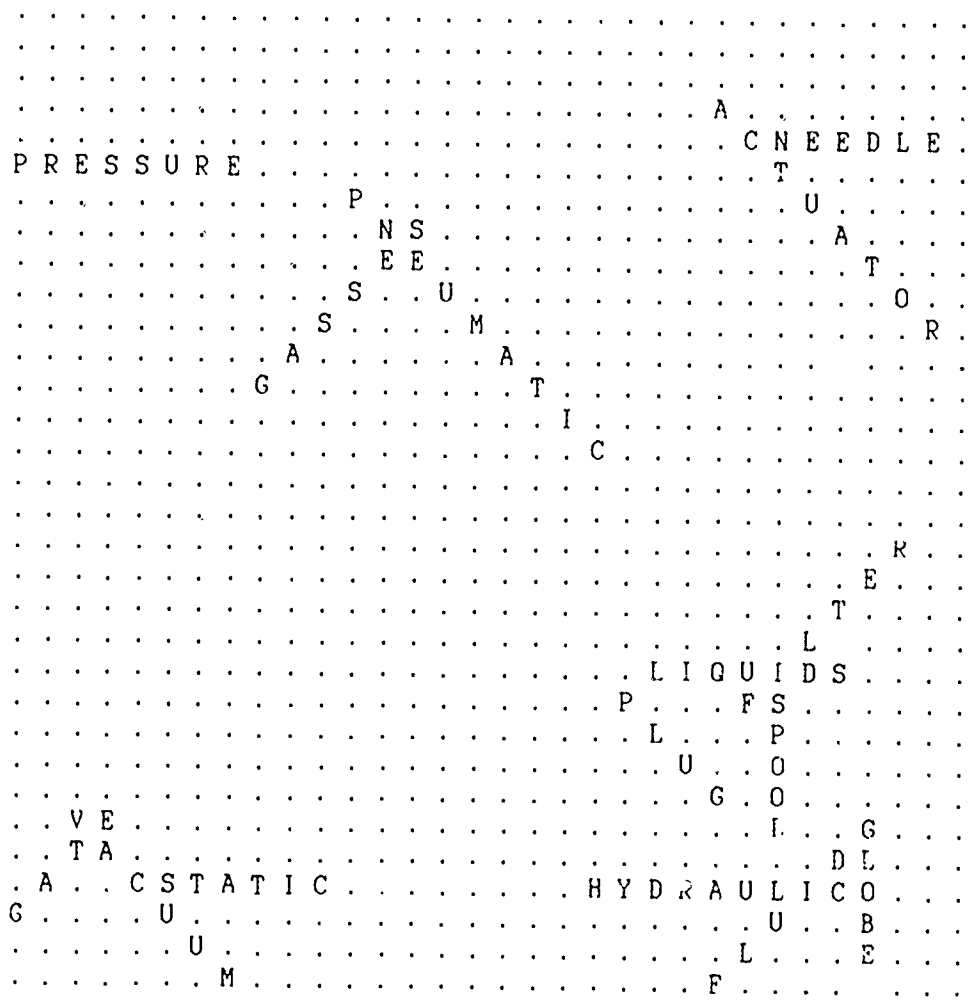
L Q T O Z U E V U E X V P D I R H Q Y N T R G G H L G P L L S U
N K C X J R O F U O N O N T U G V J H Z L U I G E Z Y S S U G L
U C L Q P H C K M T C B H V Q O D J U J O T F E C T Q J I X X D
O Z P E O I Y P V T G X Z I K I Q L H W Y J K A M U S G W R E T
I T W A R U A E I I C C B A B K U J K W H C V N C N E E D L E U
P R E S S U R E S C C O A U Y Y Q W P H L O K G S T K I O Y C O
K B I L J X V Y H K C P Z Q N F V M I D E Y G F K R U E W A B V
W K W I Q P V V D G A Q N S D G E H J H E R Q L A G A A Q S V O
A M R O A X U B B G B D E E X L J P S O M G S C O R Z C T P O P
P T H X H D S Q E B H S S V U I C V R M I E U K A T F G R O E U
P I J R J C C R D E S V A R W M T W B G V V G A W G J Q Y S R N
U J O Z Q K W G O A Y T T Y J A A E X W K M Q R N A D B R R V B
K F J V H X F V G E C E C R P B L T Y A X T X Z L V A Z U G S H
H X S G Z G E G T K Y W X U H L F O I Y P C X P F C Q Y K V R T
Q M R B Q X L V A L N H Y M O F D L Y C X J G J L X M L A E W W
G B H K G Y D L K B S U R M S I L G P I Y H O U O F O W V I D K
Y S D Z Z H F W N J F M I X P D U S T A R C O T I K X A Y T Y Y
F R P J I T Y Q Z O I T L G N X R A J O D I P X V T J L J R O W
N L W H B V G X T K D P F C A H Y V V U Y J H K H H W S E A D C
T X I N B F H X D H X H V K C O E B W L C Z J I S H O T I O R U
S B W P M J J F O E Z I P N M V E U D C I K Q Y F O L U L O R C
B X J D M Z Y Z M I X U E E E H H I S M Z L I Q U I D S T W V J
U H B M N T C L P W P Z E J M W J J H W P Q S O F S S C F G W Y
S M O D K G R G U Y W O J X F V F E W A V L M B N P K M E F M L
X M S K I W P P K K O A I O R F H H K Y S P U I K O B T Y K N X
G P Z Q V T O U T O E R D H A K E O M R A M M G R O J J K C S L
A N V E N E P N A Z F L G O A R U B E H I J Q L N L V W G I E F
V U T A J P Y M I M P J F B B K H R T D O I G M Y O K D L N O S
N A D S C S T A T I C Y A P E M B R Q H Y D R A U L I C O E W L
G P Z O O U K R N W Z E P V B Y N J I E P X W D V U Q A B O P L
R Y V L C Y U B G H L W K T V B H C Y D K Z I I L X C L E A X G
J X H Q G A K M Z T E V G O O H N U E F T D K F Q V Q L B K Y Y

THERE ARE 15 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

ACTUATOR
FLUID
GATE
HYDRAULIC
NEEDLE
PNEUMATIC
SPOOL
VACUUM
FILTER
GASSES
GLOBE
LIQUIDS
PLUG
PRESSURE
STATIC

FLUID POWER



UNIT VIII

ELECTRICAL POWER SYSTEMS

INTRODUCTION

Knowledge of basic electronics principles is needed to understand the operation of electrical components, controls, and devices that are used in different types of power systems. Also, in many instances mechanical or fluid systems will be used in conjunction with electrical controls, motors, and other devices. This unit will present fundamental information to the students so that they may be aware of the uses of electricity as it applies to the field of Power Mechanics

COMPETENCIES

Describe the structure, operation, and testing of electrical devices using illustration, identification, and application of electronic principles.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Illustrate the structure of an atom and discuss the role it plays in conducting electricity.
2. Explain the theory of electron flow.
3. Define descriptive terms which relate to electricity/electronics.
4. Describe how electromotive force is developed in various devices. Assemble, test, and compare devices in circuits that use magnetism to do work.
5. Show the relationships of voltage, amperage, and resistance.
6. Calculate and/or measure voltage, amperage, and resistance.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. On a written test, students will draw an atom and identify its parts with 75% accuracy.
2. On a written test, students will explain the law of charges and how it relates to electron flow with 75% accuracy.

3. On a written test, students will define terms relating to electricity and electronics with 75% accuracy.

4. Given a specific device, students will describe how it can be used to develop voltage with 75% accuracy.

5. Given Ohm's Law, students will state the different relationships of voltage, amperage, and resistance; calculate respective values, and assign the proper unit of measure with 75% accuracy.

6. Given a simple circuit and a VOM, students will measure voltage, amperage, and resistance of the circuit with 75% accuracy.

7. Given disassembled electromechanical devices, students will be able to assemble, test and summarize their methods of using magnetism to do work with an accuracy of 75%.

METHODOLOGY

This unit has been designed to incorporate instruction lectures, demonstrations, and guidance of students engaged independent study of the operation and testing of power-producing electrical devices.

SUGGESTED INTEREST APPROACHES

1. Plan a field trip to an electrical power plant.

2. Show films and videotapes of various industrial electrical components in operation.

3. Perform experiments with electro-mechanical devices.

4. Have the students section motors, generators, solenoids batteries, and transformers in preparation of the class lectures.

UNIT OUTLINE

ELECTRICAL POWER SYSTEMS

I. Electron Theory

- A. Atomic particles and charges
- B. Law of Charges
- C. Flow of electricity

II. Important Electrical Terms

- A. Conductor
- B. Insulator
- C. Circuit
  1. Source
  2. Load
  3. Conductor
  4. Switch
  5. Types of Circuits
     - a. Series
     - b. Parrallel
- D. Ground
- E. Continuity

III. Characteristics of Electricity

- A. Amperage
  1. Definition
  2. Unit of measure
  3. Symbol
  4. Types
     - a. AC
     - b. DC
  5. Measurement
- B. Voltage (Electromotive Force)
  1. Definition
  2. Unit of measure
  3. Symbol
  4. Method of measurement
- C. Resistance
  1. Definition
  2. Unit of measure
  3. Symbol
  4. Method of measurement

IV. Ohm's Law

- A. Definition
- B. Three different forms

C. Application
D. Problems and solutions

V. Electrical Controls

A. Regulators
B. Relays (solenoids)
C. Transformers

VI. Cells and Batteries

VII. Generators/Alternators

VIII. Motors

A. Basic construction
B. Operation
C. Types
1. Advantages
2. Disadvantages
D. Specifications

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

---

1. On a written test, students will draw an atom and identify its parts with 75% accuracy.

Subject Matter Content	Learning Activities
Atomic Particles and Charges	1. Illustrate the structure of an atom using drawings and models. 2. Discuss the importance of the atom and the atomic particles in conducting electricity.

---

2. On a written test students will explain the law of charges and how it relates to electron flow with 75% accuracy.

Subject Matter Content	Learning Activities
Law of Charges - Electron Flow	1. View film on electron theory. 2. Demonstrate methods of producing static electricity and show the relation- ships between charged particles. 3. Perform simple experiments which relate charge to attraction and repulsion. 4. Demonstrate the flow of free electrons using drawings.

3. On a written test, students will define certain terms relating to electricity and electronics with 75% accuracy.

Subject Matter Content	Learning Activities
Definition of Terms	1. Discuss and demonstrate the difference between conductors and insulators. 2. Explain what is needed for a complete curcuit. 3. Discuss the meaning of grounding. 4. Layout simple circuits and show the importance of each part.

4. Given a specific device, students will describe how it can be used to develop voltage with 75% accuracy.

Subject Matter Content	Learning Activities
Development of Voltage	1. Demonstrate different ways of producing electricity. 2. Explain how the various devices produce electricity

5. Given Ohm's Law, students will state the different relationships of voltage, current, and resistance, calculate respective values, and assign the proper units of measure with 75% accuracy.

Subject Matter Content	Learning Activities
Ohm's Law - Voltage, Amperage and Resistance.	1. View film which differentiates between voltage, amperage and resistance. 2. Have the students work Ohm's Law problems. 3. Perform experiments which enable students to see the effects of charges in voltage and resistance.

6. Given a simple circuit and a VOM, students will measure total voltage, amperage, and resistance of the circuit with 75% accuracy.

Subject Matter Content	Learning Activities
Measure Voltage and Current Flow	1. Demonstrate the proper method of measuring voltage, amperage, and resistance using a VOM.

2. Layout simple circuits and make amperage, voltage, and resistance measurement using a VOM.

---

7. Given disassembled electromechanical devices, students will assemble, test, and summarize their methods of using magnetism to do work with an accuracy of 75%.

Subject Matter Content	Learning Activities
Electromechanical Devices	1. Lab exercise involving the identification of parts of various electromechanical devices.
	2. Write a short paper summarizing the operation of a particular electromechanical device and list its industrial applications.
	3. Test individual components and assemble a particular device (e.g. solenoids, drill motors, starter motors).
	4. Test devices under working conditions.

UNIT TEST

EL CTRICAL POWER SYSTEMS

1. List the sub-atomic particles an atom and their corresponding charges.

2. Which sub-atomic particle has the ability to move from one atom to another?

3. State the law of charges.

4. Define negative charge.

5. Define positive charge.

6. Define conductor and list examples.

7. Define electromotive force.

8. Define electricity.

9. List six sources of voltage and specific devices utilized to generate electricity.

10. What is the unit of measure of electromotive force?

11. Power in a circuit must be turned off when measuring the total _____ of a circuit.

12. The unit of measure of current flow is the _____.

13. To properly measure circuit voltage, the voltmeter must be placed in _____ with the load.

14. State Ohm's Law.

15. Write Ohm's Law in formula form.

16. Set up the formula needed to determine the total resistance of a circuit if voltage and current values are known.

17. List two types of electrical devices which convert magnetic energy to mechanical energy.

18. List two types of motion which can be produced using an electrical device.

19. What are four major components of a motor?

20. List 3 major specifications which should be considered when choosing a motor for a particular application.

UNIT TEST

ANSWER KEY

ELECTRICAL POWER SYSTEMS

1. Neutron (neutral), proton (positive), and electron (negative).

2. Electron.

3. Like charges repel and unlike charges attract.

4. Excess of electrons.

5. A deficiency of electrons.

6. Allows free electrons to move easily (copper, silver, alluminum).

7. Electrical pressure resulting in difference in potential.

8. Flow of electrons through a conductor.

9. Chemical - cell/battery
   Friction - Van Der Graff generator
   Pressure - phonograph needle
   Heat - thermocouple
   Magnetic - generator
   Light - photovoltaic cell.

10. Volt.

11. Resistance.

12. Ampere.

13. Parallel.

14. Voltage = Amperage X Resistance.

15. E = I X R.

16. R = E/I.

17. Solenoid, motor.

18. Linear, rotary.

19. Stator, armature, slip rings/bushes and comutator.

20. Phase, horsepower, duty rating.

EVALUATION OF TESTING

Ways To Evaluate Pupil Growth

- Unit test
- Class assignments
- Class participation
- Projects
- Problem solving
- Laboratory experiments
- Work habits

EQUIPMENT AND SUPPLIES

Student

Textbook
Notebook
Instruction sheets
Safety glasses
Pen/pencil

Teacher

Textbook and manual
Bulletin board
Chalkboard, chalk and eraser
Audiovisual aids
Curriculum guide
Experimental modules and supplies
Electrical test equipment
Safety glasses
Various electrical components

BULLETIN BOARD IDEAS

- Post electrical safety rules
- Display illustrations of various electrical components
- Display student safety posters
- Display illustrations depicting the use of electricity in the field of power.

SUPPLEMENTARY MATERIALS

Textbooks

Schivaller, Anthony C. Energy Technology - Sources of Power. Worcester. Massachusetts, 1980.

Bohn. Ralph and MacDonald. Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Roth. Alfred C. Small Gas Engines. South, Holland, IL: Goodheart - Wilcox Publishing Co., 1985.

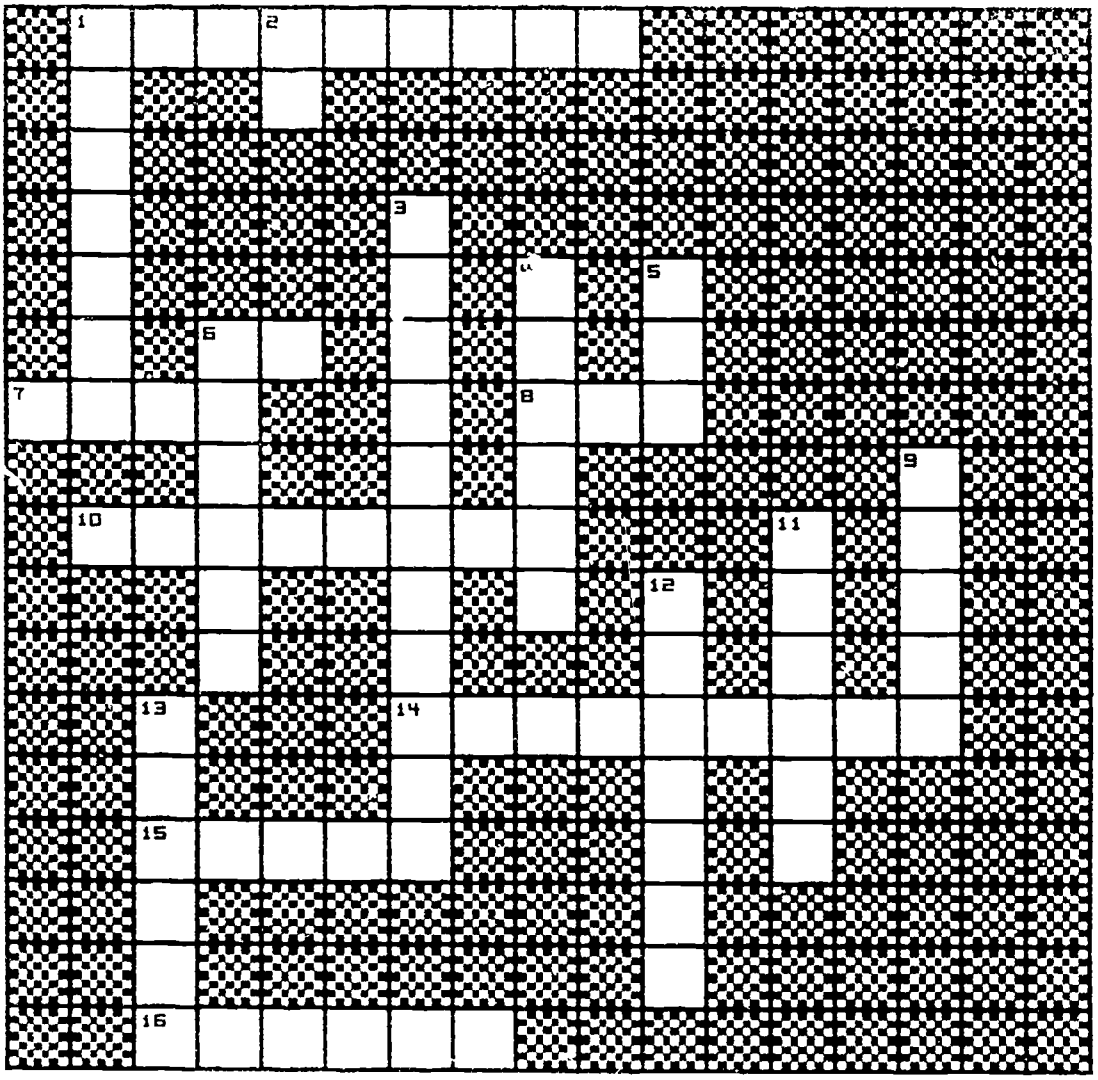
Walker, John R. Exploring Power Technology, Basic Fundamentals. South Hollad. IL: Goodheart - Wilcox Co., Inc. 1981.

Resources

Principles of Electricity
General Electric Co.,
Educational Relations Dept. M.H.W.
Schenectady, N.Y.

Magnetic Effects of Electricity
Encyclopedia Britannica Film, Inc.
1150 Wirmette Avenue
Wilmette. Illinois

ELECTRICITY



ACROSS CLUES

1. ALLOWS MOVEMENT OF ELECTRONS
6. ALTERNATING CURRENT
7. BASIC UNIT OF MATTER
8. UNIT OF RESISTANCE
10. NEGATIVE PARTICLE
14. DOES NOT CONDUCT
15. ELECTROMAGNETIC SWITCH
16. OPENS/CLOSES A CIRCUIT

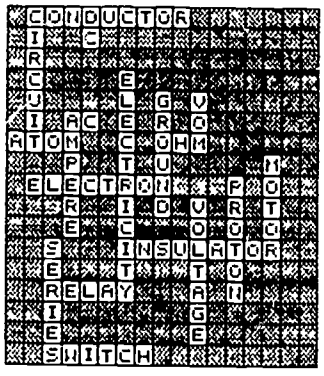
DOWN CLUES

1. SOURCE TO LOAD PATH
2. DIRECT CURRENT
3. THE FLOW OF ELECTRONS
4. TO EARTH
5. MEASURING INSTRUMENT
6. CURRENT
9. PRODUCES ROTARY MOTION
11. POSITIVE PARTICLE
12. EMF
13. IN LINE

WORD LIST: ELECTRICITY

AC
AMPERE
ATOM
CIRCUIT
CONDUCTOR
DC
ELECTRON
ELECTRICITY
GROUND
INSULATOR
MOTOR
OHM
PROTON
RELAY
SERIES
SWITCH
VOM
VOLTAGE

ANSWERS: ELECTRICITY



ELECTRICITY

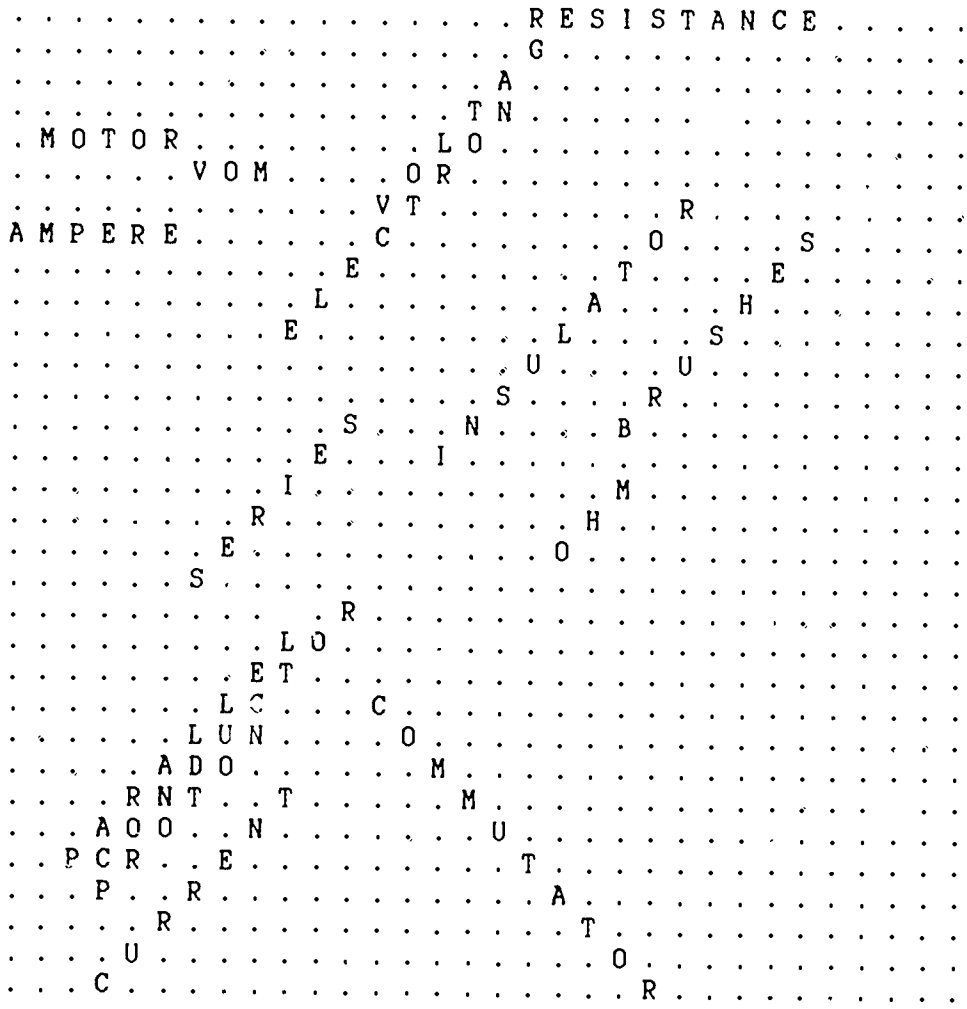
R N P T L F T J K J G D Q Y M M T R E S I S T A N C E R E U E Q
J V C N U M X R X Q X I O X F U F G L H J Z Q M G Y V G S N F R
U K H V C X F X N Q K A L I A P A G O F M F S E B W R K Z R T X
U L J G E M Q U Y P O I P B K T N S N P W J U I B G M M F V V D
X M O T O R C Y U Y K O G K L O G D U M G X E M M J S I H U T B
E F O E A J V O M S L X K O R Q U T O F Y F T L J H H T M C F U
Y H R I C N B E I F H A V T P A C S T Z G X R R P I P U L F P P
A M P E R E Q Z Z S A K C T K G I G F U I O T H W I S H T A Q I
M S Y P Q C E R K B S E R W T U U O L D T R C U I E H E Z I I A
Y V M D U Q P V C T L D F Q Z R G I K A Q Q B M H D Y I U S O Z
T W W S J Y Q Z H E W M Q B O Y V B L A W C C S Y T N K T I T E
J T Y F V U F Y Y Z D Z I H Y I M U M W U P I F F S C O O J A K
V A R Q R P I E F N U S X T Q B S H E B V R B F M G B F J X V I
K X U S Q J W S V D O S W E V N M G P A B A U A B X Q G W C A A
G V H S V W P G K X E B K M I S D D F D W D N V M R G Z X X S B
L J C J P D D N X I X V X I J D D T W E M L T F M E D J X H U T
L F O W O F B F R V E K M K D T P G J H B L C W C J I K K I L E
B H W G W P N E X G K U M J E G I G O N V F N Z E W K B T X X C
L M D E H U S H A N W N E F P X R W L W G P M I W T W S L G H Z
K P R X Y X T R J H G R Y K X P O T R E M P H J V M K H B Q B T
S U A Y B Y P A Z L O N W T C H G D M E N H J C J W Z G Z O Q F
T I A L F C V H E T N T C I N B S H Z I Q O F Z C Y Y H L O V R
E O R T U F I L C W B F C L Q K D F V V K A J O R Z B S A A A A
E B A L B R L U N G I Y S O P K A H V S T O H I G M V Z F H U Z
W Z T P S A D O H M U V B G M S R A R S N A E F X L I T Q B S L
M Z X S R N T K X T T C G Q V M A S I Y Y D Q S A N W O D H A U
K K M A O O G X N Y S C O L L N U M Q D Z N Z S C M P Z B M L V
L X P C R D O E L H S R Y I Z B Q T A T Y V M T R O A E N D T Q
L Y S P D B R W T X W U G E I W M Q A L B J J Y M M G F J A V P
B W U Z A R S I A W E B U N Y M F V J T S O N V L S T P W Y I O
L H L N U I X U N H H Z J N S M A P M M O G P K K T Y R H P C V
T F V C J M O S U J W T J M S M K F L B P R E L O W V S I J W X

THERE ARE 15 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

AMPERE
COMMUTATOR
CURRENT
INSULATOR
OHM
PROTON
SERIES
VOM
BRUSHES
CONDUCTOR
ELECTRON
MOTOR
PARALLEL
RESISTANCE
VOLTAGE

ELECTRICITY



UNIT IX

AUTOMATED SYSTEMS AND ROBOTICS

INTRODUCTION

Modern industry utilizes power systems to perform work. In some instances, two or more of these power systems are combined to do work which would be impossible through one source alone. Nowhere is this more in evidence than in automated systems. Automation and robotics have brought forth a new age of industrial productivity. They frequently combine mechanical, electrical, and fluid power systems to achieve the highest level of output.

Students who are to be employed in their modern setting must be prepared to meet the challenge. This unit will introduce the students to the information and experience necessary to prepare them for life in a modern, industrialized society.

COMPETENCIES

1. Define automated system.
2. Identify the sub-system within the larger automated system.
3. Discuss the advantages and disadvantages of automated systems and robotics.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Discuss custom-built automated machinery and cite examples of manufacturing applications.
2. Describe how different types of power systems are used to drive custom-built automated machinery.
3. Discuss robots and explain how they are utilized in industry.
4. Name the major parts of a robot.
5. Evaluate the different systems used to power and control robots.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. The student will define custom-built automated machines and cite examples of manufacturing applications with 75% accuracy.

2. The student will describe how different types of power systems are used to drive custom-built automated machinery with an accuracy of 75%.

3. The student will be able to explain how robots are utilized in industry with 75% accuracy.

4. The student will name and discuss the major parts of a robot with an accuracy of 75%.

5. The student will evaluate and compare the different systems used to supply power to and control robots with 75% accuracy.

METHODOLOGY

Throughout this course, students have been studying and experimenting with the various power systems. In this unit, students will study how these individual power systems are combined and integrated into automated systems and robotics.

SUGGESTED INTEREST APPROACHES

1. Plan a field trip to an industry which uses an automated production process.

2. Show films and videotapes of robotics and automation systems operation and construction.

3. Depending on resources, construct an automated system using mechanical, fluid and electrical trainers.

UNIT OUTLINE

AUTOMATION SYSTEMS AND ROBOTICS

I. Custom-built automated machinery

- A. Definition
- B. Applications
  - 1. Delivery
  - 2. Production
- C. Power system utilization

II. Robot

- A. Definition
- B. Manufacturing applications
  - 1. Operational advantages
    - a. Handling heavy materials
    - b. Handling high temperature materials
    - c. Working in toxic environments
    - d. Highly repetitive operations
      - (1) Sorting
      - (2) Pick and place
- C. Major Parts
  - 1. Manipulator
    - a. Definition - system of mechanisms used to do work
    - b. Axes
    - c. Components
      - (1) Base
      - (2) Arm
      - (3) Wrist
      - (4) Gripper
  - 2. Activators - drive mechanisms that position manipulators.
    - a. Hydraulic
      - (1) Components
      - (2) Advantages
      - (3) Disadvantages
    - b. Pneumatic
      - (1) Components
      - (2) Advantages
      - (3) Disadvantages
    - c. Electric
      - (1) Components
      - (2) Advantages
      - (3) Disadvantages
  - 3. Power supply - provides energy for the robot's activators

a. Hydraulic (Pumps)
   (1) Servo controlled
   (2) Non-Servo controlled
b. Pneumatic (air compressor)
   (1) Servo controlled
   (2) Non-Servo
c. Electrical (Motors)
   (1) Servo controlled
   (2) Stepping motor

4. Controller - brains of the robotics system which regulates power distribution
   a. Mechanical - limited sequence
      (1) Drum controller
      (2) Air logic
   b. Programmable
      (1) Teach pendent
      (2) Computer terminal
      (3) Lead through

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

---

1. The student will define custom-built automated machinery and cite examples of manufacturing applications with 75% accuracy.

Subject Matter Content	Learning Activities
Automated Machinery	1. View films which show custom-built automated machinery operating.
	2. Write a short report on a specific custom-built automated machine.
	3. Discuss ways of applying custom-built automated machinery to local industry.

---

2. The student will describe how different types of power systems are used to drive custom-built automated machinery with an accuracy of 75%.

Subject Matter Content	Learning Activities
Drive Systems	1. Discuss the difference between power systems that drive machinery used for delivery and those used for production. 2. Design a custom-built automated delivery system given a specific number of operations and floor space.

3. The student will be able to explain how robots are utilized in industry with 75% accuracy.

Subject Matter Content	Learning Activities
Robotics Applications	1. Discuss past and present definitions of robots. 2. View films of robots performing various manufacturing operations.

4. The student will name and discuss the major parts of a robot with an accuracy of 75%.

Subject Matter Content	Learning Activities
Robot Components	1. View film or videotape on robotics nomenclature. 2. Discuss the different parts and how they effect the total operation of a robot.

5. The student will evaluate and compare the different systems used to supply power to and control robots with an accuracy of 75%.

Subject Matter Content	Learning Activities
Robotics Power and Control Systems	1. Discuss the operation of mechanisms used to drive robot manipulators. 2. Discuss the various methods of programming robots. 3. Have the students write a short paper comparing and contrasting advantages of using specific power systems and controls. 4. View a film which demonstrates different methods of programming.

UNIT TEST

AUTOMATED SYSTEMS AND ROBOTICS

1. List two examples of custom-built automated machines.

2. List two hazardous production operations which a robot could perform that would improve worker safety.

3. Define activators.

4. What are four components of a manipulator?

5. What are the three types of activator systems?

6. What is one advantage of using hydraulically powered robots rather than pneumatically powered robots?

7. A _____ powered robot would be used to perform spray painting operations because this system produces no _____.

8. What are two advantages of using a pneumatically powered robot?

9. List three methods of programming the robot controller.

UNIT TEST

ANSWER KEY

AUTOMATED SYSTEMS AND ROBOTICS

1. Conveyor systems, CNC machinery.

2. Loading forge machinery and spray painting.

3. Drive mechanisms used to position manipulators.

4. Base, arm, wrist, and gripper.

5. Hydraulic, pneumatic and electric.

6. Hydraulically powered robots can lift heavier loads and have smoother movement.

7. Hydraulically, sparks.

8. The system is relatively inexpensive and operates at a higher speed than electric or hydraulic systems.

9. Teach pendant, computer terminal, and lead through.

EVALUATION OF TESTING

Ways of Evaluating Pupil Growth

Unit test
Class assignments
Class participation
Projects
Work habits

EQUIPMENT AND SUPPLIES

Student

Textbooks
Notebook
Pen/pencil
Instruction sheets
Handouts
Safety glasses

Teacher

Textbook and manual
Bulletin board
Chalkboard, chalk, and eraser
Audiovisual aids
Curriculum guide
Experimental modules and supplies
Handouts
Safety glasses

BULLETIN BOARD IDEAS

- Post robotics safety rules
- Display student posters
- Display automated systems/robotics illustrations from various manufactures.

SUPPLEMENTARY MATERIALS

Textbooks

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

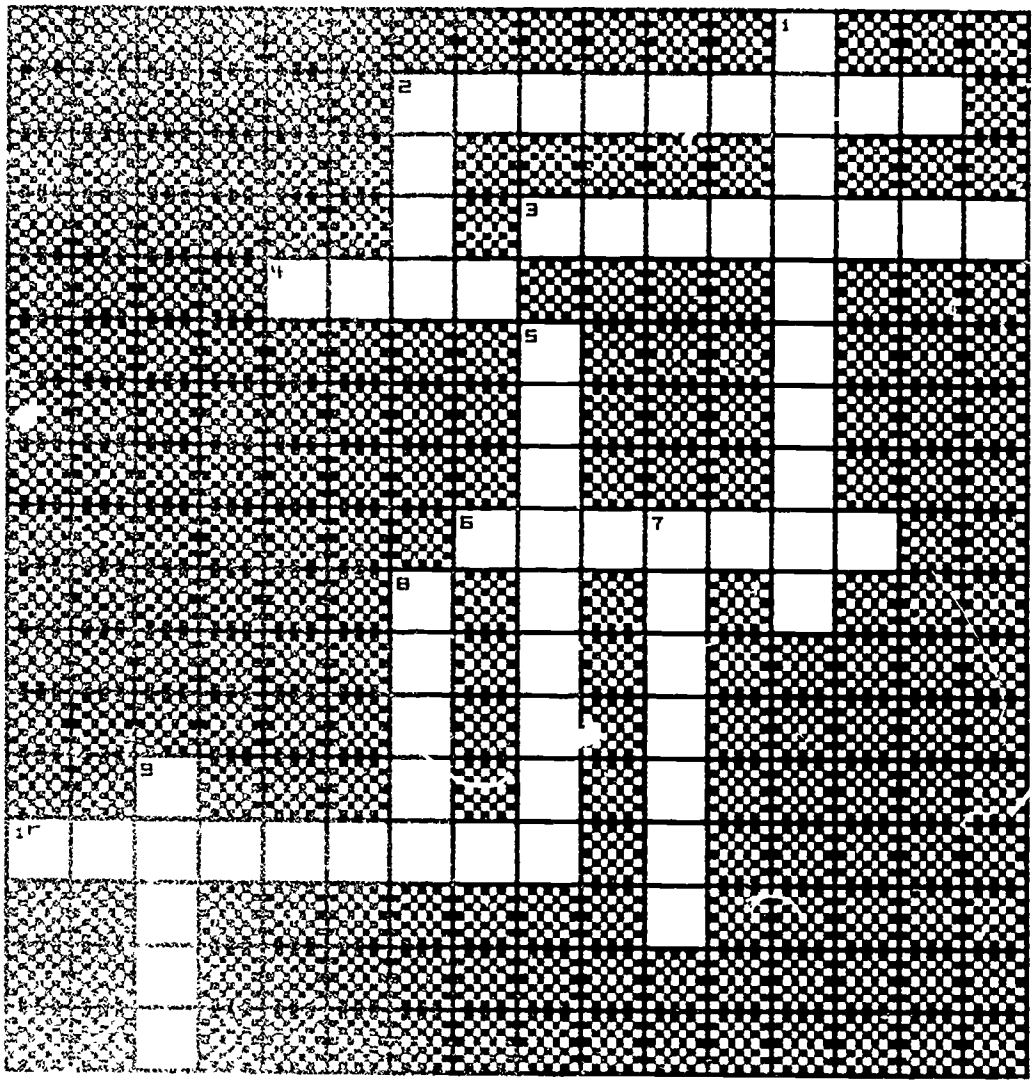
Hoekstra, Robert L. Robotics and Automated Systems Cincinnati, OH: South-Western Publish Co., 1986.

Resources

Robot Applications
Heathkit/Zenith
St. Joseph, MI 49085

Films and Videotapes
Society of Manufacturing Engineers
One SME Drive/P.O. Box 930
Dearborn, Michigan 48121

ROBOTICS



ACROSS CLUES

2. DRIVE MECHANISM
3. MOST ACCURATE
4. ROTATES ARM
6. HANDLES WORK LOAD
10. FASTEST ROBOT

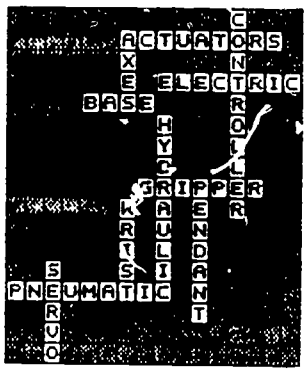
DOWN CLUES

1. BRAINS
2. DEGREES OF FREEDOM
5. MOST POWERFUL
7. HAND HELD CONTROLS
8. ROTATES GRIPPER
9. AUTOMATIC CONTROL MECHANISM

WORD LIST: ROBOTICS

ACTUATORS	ELECTRIC	PNEUMATIC
AXES	GRIPPER	SERVO
BASE	HYDRAULIC	WRIST
CONTROLLER	PENDANT	

ANSWERS: ROBOTICS



ROBOTICS

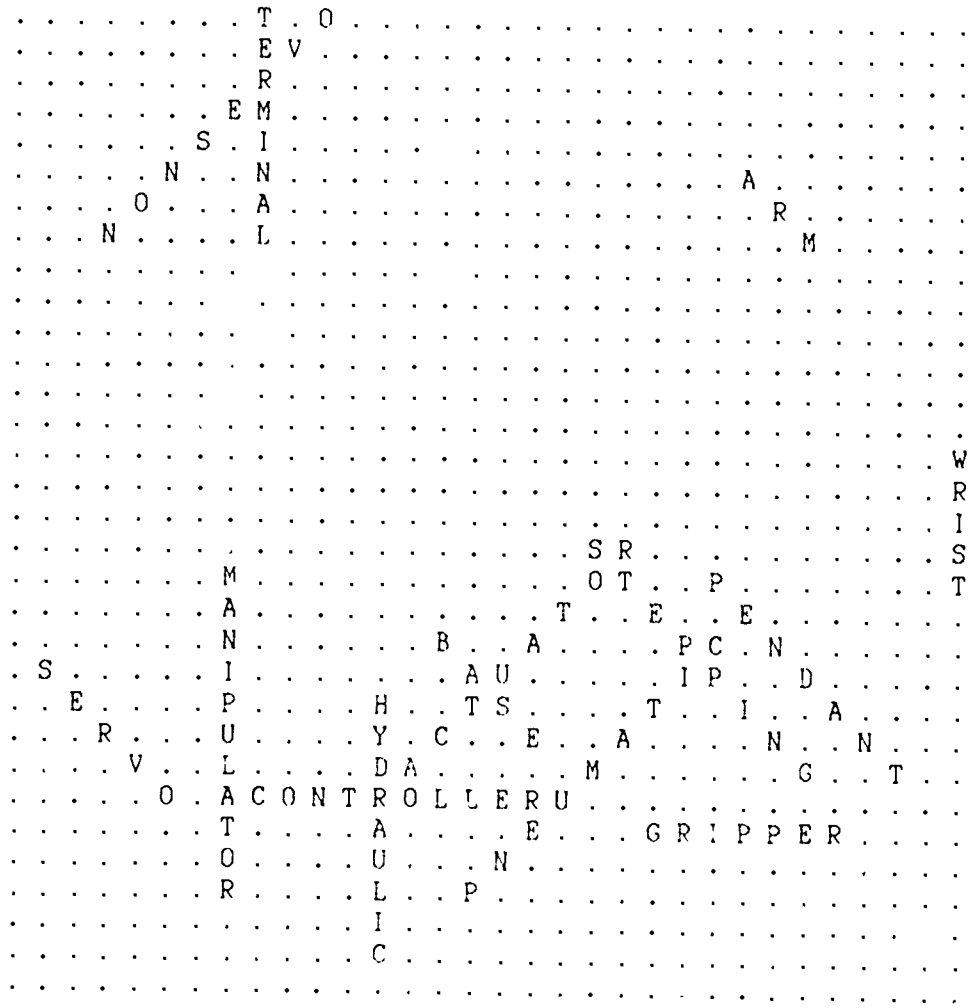
K L S H N I T Y T W O O O N V P R K V L A W Q J C K B A E W I L
O J X M O W C E E V N O B N X A Z X J J O J X P H W C S W D J L
Y N D K Y I J U R D Q Y P B P D P Y D V X Z Y J S E P S L U N C
I F K G G E Q E M I U T P D O O S K F J W Y Q F K X B H M N U F
P U D M P A S Q I R Q J A L K A A R P H F R A I P Q A K Q A O E
T I E Q P N X B N Y C B C R H I O Y G V K I F Q A B V S I C T S
W K J U O W O J A E K V E J F K D U J H P V D K W R M X Q R C F
D H D N L X X U L G Z T U T B S G E D I P G I Q Y M M U D L G T
F L S L O F I O G S W G B E C D S M L E K W T T N J Q W N J H R
N N E R J N Q R I E V T W F B Y Q D B P O B D A Z K V N W Q I G
D B T G Y O R U V V H D T F B X K V U I B J X U E D O S V O S U
X K Z D L Z K W J O L Z I Y M C V C D T O K M N H I P Q V F Q B
D O F Q A W Y B Y G V Q D I J G H Q B E H C A G S H L N X O U L
Y T D Y Y Z L R G H B Z F Z Q R E P M L T Q T L Z M Z C K W D J
T O V N U E H W Z O L D I R I A P Z F I N H O P I O V T L J H W
J W I H G T Z M B Y F F B X I C R V H R C H L F A A V F X T Z R
I T C B I J J N I L U P O P F B X D F V W P M H N A R S T X I I
J N V J U G Z Z X W P N N P I I G R Q S R S D X V V O G B J E S
Z I P J Z E S M U H C X Z R G R N E C O T C M P A L V X W R F T
V X H B M A K A M H Z Z V S A X H B T O N E I C E O K W F G M Q
Q G G V D O V N I A W B G E B F A A D O O J P C F N R X C I K T
S S O D C X E I U L X G T D K A U I T H E T I P T D D J R Y J F
G B E F G P T P D J M R H F Y T S T P I F T Q Z I S Z A J Y H J
I H M R I O C U M I C X Y U C G Q E W I A V B N U N U D N K P H
U X C T V I U L W Z G N D A K A Y F B M X A Q Z H I G D N T Z I
T X I Y G O P A C O N T R O L L E R U N D N J D H D G L B I Z K
H N Z T V K R T F X P W A N L N O E E T Z G R I P P E R B O L J
Q Z P G X J B O C T T L U M W G N Y E P O E C T D F N H S W Z D
K Q I V T T H R R J R F L K U P G B X V P G B Y E J U H A R Z B
I Q N C U W T Y D A E H I K Q S S B U K B B V S Z B C M N Y D H
X U W X J R Z O P J N Q C I O T P A Y X Q O F Q T R E N Z T F V
Q D C P T V L W I Y O X V V S X Y P N J E N E A N K J G J J V B

THERE ARE 14 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

ACTUATOR	ARM
BASE	CONTROLLER
GRIPPER	HYDRAULIC
MANIPULATOR	NONSERVO
PENDANT	PNEUMATIC
SERVO	STEPPING
TERMINAL	WRIST

ROBOTICS


TERMINAL
EVOLUTION
SENSOR
MANIPULATOR
CONTROL
HYDRAULIC
BASE
SHOULDER
ELBOW
ARM
WRIST
PITCH
ROTATE
GRIPPER

UNIT X

CAREERS

INTRODUCTION

Producing and controlling energy to provide power requires the efforts of many people. These people earn a living in one of the many careers in the areas of energy sources, transportation, power transmission, control, and the use of power. Careers in Power Mechanics cover a wide range of interests and abilities.

COMPETENCIES

1. Identify career opportunities in Power Mechanics.
2. Describe job positions in Power Mechanics.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Identify career path options in Power Mechanics.
2. Describe career possibilities in Power Mechanics.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. Students will list and describe at least three jobs available in the field of Power Mechanics.
2. The student will explain why knowledge about oneself should be matched with knowledge about careers with 75% accuracy.
3. Given an applicant's qualifications, students will identify on a written test at least five entry-level Power Mechanics skills the applicant possesses with a 75% accuracy.

4. On a written test the student will describe the five common career types used in Power Mechanics with a 75% accuracy level.

5. The student will be able to develop a plan to meet the entry-level requirements for a chosen career.

METHODOLOGY

This unit will enable the student to explore the career opportunities in the field of Power Mechanics. Methods of teaching to be employed include: lecture, audiovisual, individual library research, field trips, text, discussion and testing.

SUGGESTED INTEREST APPROACHES

1. Survey students to determine job interests and qualifications.

2. Arrange for guest speakers from Power Mechanics related jobs to discuss their jobs and entry level skills needed.

3. Schedule a field trip to local industries to observe workers in the Power Mechanics field.

4. Assign articles and reports on jobs in Power Mechanics that can be presented to the class.

UNIT OUTLINE

CAREERS

I. Choosing a Career

A. Knowing yourself
1. Abilities
2. Interests
3. Values
B. Finding out about careers
1. Start at school
2. Learn at work
3. Do research
4. Field trips
5. Talk with workers

II. Careers in Power Technology

A. Generation of electricity
B. Transportation
C. Automation
D. Conservation and the environment
E. Business and management

III. Career Types

A. Production worker
B. Mechanic
C. Technician
D. Technologist
E. Engineer

IV. Preparing for Your Career

A. Job application
B. Resume

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

---

1. Students will list and describe at least three jobs available in the field of Power Mechanics.

Subject Matter Content | Learning Activities

Career Paths	1. Discuss various jobs made available in the field of Power Mechanics. 2. View film or filmstrip on career opportunities in Power Mechanics.

---

2. The student will explain why knowledge about oneself should be matched with knowledge about careers with 75% accuracy.

Subject Matter Content	Learning Activities
Knowing Oneself	1. Compare personal characteristics and needs with the requirements of the career. 2. Have a personnel director from local industry discuss the qualities he looks for in a prospective employee. 3. List student personal characteristics that would make one a good Power Mechanics employee.

---

3. Given an applicant's qualifications, students will identify, on a written test, at least five entry level Power Mechanics skills the applicant possesses with 75% accuracy.

Subject Matter Content	Learning Activities
Skills Needed for Entry-Level Power Mechanics	1. Discuss the importance of entry level skills in Power Mechanics 2. Prepare a resume for a job applicant in Power Mechanics.

3. View film on job interviews or possible entry level skills needed for Power Mechanics.

---

4. On a written test the student will describe five common career types used in Power Mechanics with a 75% accuracy level.

Subject Matter Content	Learning Activities
Career Types	1. Indicate levels of education needed for various career types.
	2. Research career types and make presentation to class.
	2. Field trips to observe career types at work.

---

5. The student will develop a plan to meet the entry-level requirements for a chosen career.

Subject Matter Content	Learning Activities
Entry-Level Job Requirements	1. Discuss the duties and working conditions of the various job classifications in Power Mechanics.
	2. Choose a job and report to the class the reasons for your choice and the qualifications you will have to meet.

UNIT TEST

CAREERS

I. Short Answer

1. Why should you determine your abilities before selecting a career?

2. What two things must you compare to make a wise career choice?

3. Name four sources of career information.

4. Summarize the process of making a career decision.

5. What is the difference between a mechanic and a technician?

6. What is considered the "key" to career opportunities?

7. Identify five common career types.

UNIT TEST

ANSWER KEY

CAREERS

I. Short Answer

1. One will see what things are done well and what things are done poorly. The students will develop an understanding of strengths and weaknesses.

2. 1) Personal characteristics and needs.
2) The requirements of the career.

3. Any four of the following: school, summer and part-time jobs, the library (research), school counselors, field trips, talking with workers.

4. Learn as much as possible about careers of interest. Match career characteristics with one's own abilities, interests, and values. Identify the requirements that do not match one's personal characteristics. Think about the good and bad points of possible careers. Eliminate career areas and narrow the choices until only a few careers remain. Accept suggestions and information from others, then make an independent decision on a career.

5. Mechanics usually work on transportation equipment. Technicians work with other types of power system equipment.

6. Education

7. 1) Production worker 2) Mechanic 3) Technician
4) Technologist 5) Engineer

EVALUATION AND TESTING

Ways To Evaluate Pupil Growth

- Unit tests
- Class assignments
- Class participation
- Special projects
- Work habits

EQUIPMENT AND SUPPLIES

Student

Textbook
Notebook
Pen/pencil

Teacher

Textbook and manual
Bulletin board supplies
Chalkboard, chalk and eraser
Curriculum guide
Audiovisual equipment
Audiovisual aids

BULLETIN BOARD IDEAS

- Display pictures of persons employed in various areas of Power Mechanics.
- Post flyers from colleges and trade schools offering additional training.
- Post the names of the schools' guidance counselors.

SUPPLEMENTARY MATERIALS

Textbooks

Glenn, Harold J. Exploring Power Mechanics. Peoria, IL: Bennett, 1973.

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Duffy, Joseph W. Power - Prime Mover of Technology. Bloomington, IL: McNight Publishing Co., 1972.

Instructors Guide

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McNight Publishing Co., 1983.

Resources

U.S. Department of Energy
Dept. of Marketing and Education

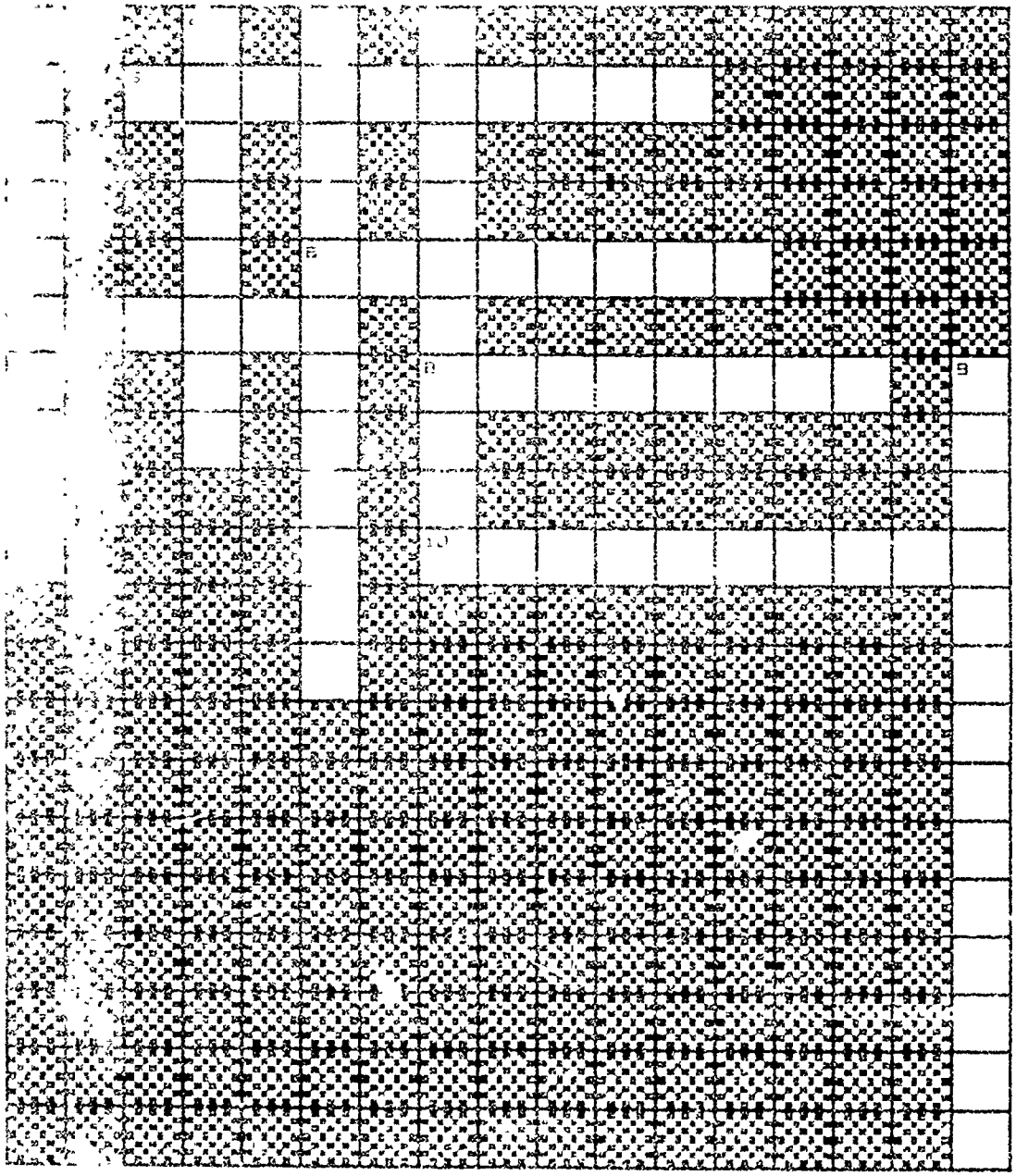
U.S. Department of Energy Film Library
P O. Box 62
Oak Ridge, TN 37830

American Vocational Association
1410 King Street
Alexandria, VA 22314

Discovery
Time-Life Building
Chicago, IL. 60611

Industrial Education
262 Mason St.
Greenwich, CT. 06830

School Shop
Box 8623
Ann. Arbor, MI 48107



ACROSS CL

5. ELE[illegible]ONTROLS
6. ENGINEERING PROFESSION
7. OCCU[illegible]ATION IN [illegible]FF
8. SKILLED WITH MACHINES
10. SPEC[illegible]ALIZED IN MECHANICAL PPC[illegible]SSES

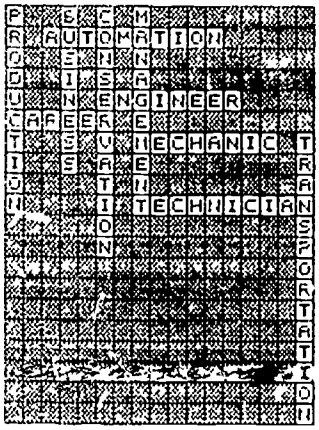
[illegible] CLUES

1. PLANT OF EFFORT
2. WORK ACTIVITY
3. PRESERVATION OF NATURAL RESOURCES
4. [illegible], CONTROL AND OPERATE
9. FIXED TO PLACE

WORD LIST: CAREERS

AUTOMATION
BUSINESS
CAREER
CONSERVATION
ENGINEER
MANAGEMENT
MECHANIC
PRODUCTION
TECHNICIAN
TRANSPORTATION

ANSWERS: CAREERS



CAREERS

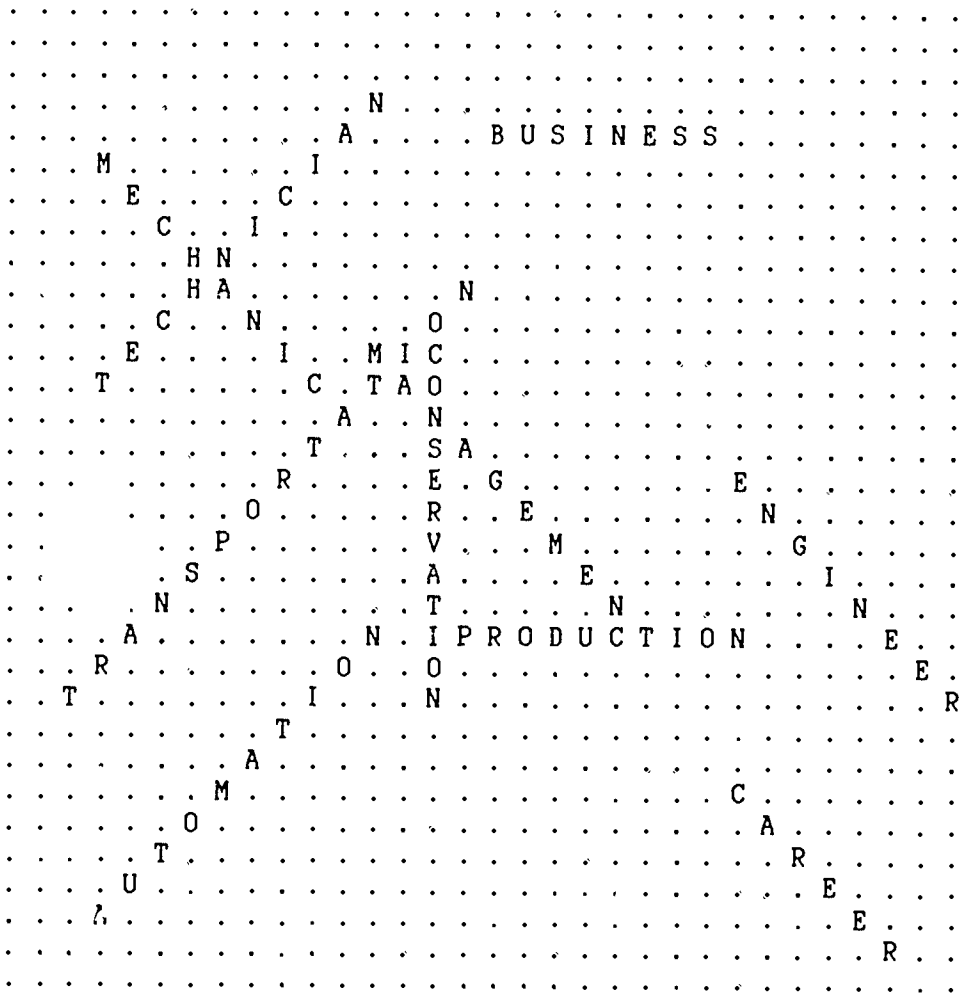
R L Z H H L E X O T Y R Z I H U T A L Y S R T W X O S T S L Q T
O Z U E V U E X V P D I R H Q Y N T R G G H L G P L L S U N K C
X J R O F U O N O N T U G V J H Z L U I G E Z Y S S U G L U C L
Q P H C K M T C B H V Q N O D J U J O T F E C T Q J I X X D O Z
P E O I Y P V T G X Z A I K I Q B U S I N E S S L H W Y J K M U
S G W M R E T I T W I A R U A E I I C C B A B K U J K W H C V N
U S C C E O A U Y C Y Q W P H L O K G S K I O Y C O K B I L J X
V Y H K C C Z Q I N F V M I D E Y G F K R E W A B V W K W I Q P
V V D G A Q H N D G E H J H E R Q L A G A Q S V O A M R O A X U
B B G B D X H A L J P S O M G N S C O R Z C P O P P T H X H D S
Q E B H S C V I N C V R M I O E U K A T F G R E U P I S R J C C
R D E V E A R W T I W B M I C G V V G A W G J Q Y S N U J O Z Q
K W G T O Y T T Y J C A T A O E X W K M Q R N A D B R R V B K F
J V H X F V E C E C R A P B N L Y A X T X Z L V A Z U G S H H X
S G Z S E G T K Y W T X U H S A L F O Y P C X P F C Q Y K Y R T
Q M R B Q X L V A R L N H Y E M G O F D L Y X J E G J L X M L A
P W W G B H K G O Y D L K B R S U E R M S I L G P N I Y H O U O
F O W V I D K P Y S D Z Z H V F W N M J F M I X P D G U S T A R
C O T I K X S A Y T Y Y E N U P J I T E Y Q Z O I T L I G N X R
A J O D I N P X V T J L J O T W N L W H N B V G X T K D N P F C
A H Y V A V U Y J H K H N H I P R O D U C T I O N W S A D E C T
X I N R B F H X D H X O H V O K C O E B W L C Z J I S H O I E O
R U T S B W P M J J I F O E N Z I P N M V E U D C I K Q Y F O R
U L O R C B X J D T M Z Y Z M I X U E E E H H I S M Z T W V J U
H B M N T C L P A W P Z E J M W J J H W Q S G S C F G W Y S M O
D X G R G U Y M W O J X F V F E W A V M B N K M C E F M L X M S
K I W P P K O K O A I O R F H H K Y S P I K B T Y A K N X G P Z
Q V T O U T T O E R D H A K E O M R A M M R J J K C R S L A N N
E P N A U Z F L G O A R U B E H I J Q L N V W I E F V E U J P Y
M I M A P J . B B K H R T D O I G M Y O K N O S N D S Y E A P E
M B R Q E W L P Z O O K R N W Z E P V B Y N J I E P X W D R V Q
A O P L R Y V L C Y B G H L W K T V B H D Y D K Z I I X C L A X

THERE ARE 10 WORDS HERE - CAN
YOU FIND THEM?

HERE ARE THE WORDS TO LOOK FOR:

AUTOMATION
CAREER
ENGINEER
MECHANIC
TECHNICIAN
BUSINESS
CONSERVATION
MANAGEMENT
PRODUCTION
TRANSPORTATION

CAREERS


BUSINESS
MANAGEMENT
CONSERVATION
PRODUCTION
MECHANICAL
TECHNICIAN
TRANSPORTATION

UNIT XI

SPECIAL PROJECTS

INTRODUCTION

This unit will enable the student to take an active part in research and presentation of selected areas of Power Mechanics. Depending on the length of time spent on this unit, two or more of the following areas can be explored. Special projects will encourage students to pursue independent study. Rather than teaching this unit at one time during the year, the instructor may elect to pull various units at different times as appropriate. For example, the safety posters would fit in well within the framework of the safety unit!

COMPETENCIES

1. Define and analyze special project units.
2. Develop and present projects dealing with conservation, research, safety, process display, and technical speaking.

GENERAL PERFORMANCE OBJECTIVES/GOALS

1. Identify special project units.
2. Select and use various reference materials effectively.

SPECIFIC PERFORMANCE OBJECTIVES AND MASTERY CRITERIA

1. The student will investigate a local energy problem and suggest possible solutions to the problem.
2. The student will give a three to five minute speech fifteen minutes after having drawn a card on which a topic for their speech is written with 75% accuracy.

3. The student will deliver a memorized speech of three to five minutes in length on a topic related to industrial or technology fields with 75% accuracy.

4. The student will select and research an Industrial Arts/Technology Education related topic and present a written report with 75% accuracy.

5. The student will produce a safety poster on a given size sheet using artistic expressions with 75% accuracy.

6. The student will read and analyze technical articles and write a comprehensive report summarizing the key elements of the articles with 75% accuracy.

7. The student will construct and display an industrial or technological process within a defined area with 75% accuracy.

METHODOLOGY

This unit has been designed to allow the student to become proficient in research and presentation. Emphasis has been placed on both speaking and writing ability as this unit conforms to both AIASA and LIASA guidelines. The instructor may want to enter his/her student(s) in state and national competition. For additional information, the instructor should contact the Industrial Arts Section Chief, Office of Vocational Education, Louisiana State Department of Education.

SUGGESTED INTEREST APPROACHES

1. Inform the students of the great importance of expressing oneself clearly in both speaking and writing.

2. Have the industrial arts club president at your school explain the special projects competitive events held at state and national industrial arts student conferences.

UNIT OUTLINE

SPECIAL PROJECTS

I. Energy Conservation

II. Extemporaneous Speech

III. Prepared Speech

IV. Research Paper

V. Safety Poster

VI. Technical Report Writing

VII. Technology Process Display

SPECIFIC PERFORMANCE OBJECTIVES AND LEARNING ACTIVITIES

1. The student will investigate a local energy problem and suggest possible solutions to the problem.

Subject Matter Content	Learning Activities
Local Energy Problem	1. Interview an executive of a local industry. 2. On site visit of an industrial plant. 3. Record findings of visit and summarize important factors. 4. Prepare and present a written report on the solutions to the local energy problem.

2. The student will give a three to five minute speech fifteen minutes after having drawn a card on which a topic for the speech is written.

Subject Matter Content	Learning Activities
Impromptu Speech	1. Demonstrate the ability to communicate verbally to an audience.

---

3. The student will deliver a memorized speech of three to five minutes in length on a topic related to industrial or technology fields with 75% accuracy.

Subject Matter Content	Learning Activities
Memorized Speech	1. Research speech topic and record in outline form. 2. Demonstrate the ability to communicate verbally to an audience.

---

4. The student will select and research an Industrial Arts/Techology Education related topic and present a written report with 75% accuracy.

Subject Matter Content	Learning Activities
Research Paper	1. Demonstrate the ability to select and research a topic. 2. Create written communication following an accepted format.

---

5. The student will produce a safety poster on a given size sheet using artistic expression with 75% accuracy.

Subject Matter Content	Learning Activities
Safety Poster	1. Demonstrate the ability to recognize safety needs.

2. Communicate a safety message in visual form.

---

6. The student will read and analyze technical articles and write a comprehensive report summarizing the key elements of the articles with 75% accuracy.

Subject Matter Content	Learning Activities
Technical Report Writing	1. Demonstrate the procedure for conducting library research.
	2. Provide students the opportunity to do self-directed research.
	3. Demonstrate the ability to consolidate various information sources into a complete and comprehensive report.

---

7. The student will construct a display on industrial or technological process within a defined area with 75% accuracy.

Subject Matter Content	Learning Activities
Display	1. Demonstrate the knowledge of a process by fabricating a display of the researched process.

UNIT TEST

SPECIAL PROJECTS

This unit on Special Projects will not require a unit test because of the variety of formats covered. The student evaluation will come from the individual grades on each area covered. The unit grade would be an average of the grades acquired.

EVALUATION AND TESTING

- Give students class participation grades.
- Conservation projects will be evaluated.
- Speeches will be graded for content and presentations.
- Research papers will be graded.
- Displays will be evaluated for content, originality, and overall visual appeal.

EQUIPMENT AND SUPPLIES

Students

Textbook
Notebook
Professional magazines
Pen/pencil

Teacher

Textbook and manual
Curriculum guide
Chalkboard, chalk and eraser
Audiovisual aids
Professional magazines
Professional journals
Access to library materials

BULLETIN BOARD IDEAS

- Post directions for the various special projects.
- Post student work as it is submitted.
- Post AIASA/LIASA bulletins, posters, and other materials.

SUPPLEMENTARY MATERIAL

Textbooks

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Crouse, William H. Margules, Morton; and Worthington. General Power Mechanics. New York: McGraw-Hill Publishers, 1968.

Glenn, Harold J. Exploring Power Mechanics. Peoria, IL: Bennett, 1973.

Instructors Guide

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. Bloomington, IL: McKnight Publishing Co., 1983.

Resources

U.S. Department of Energy
Dept. of Marketing and Education
Washington, D.C. 20545

American Vocational Association
1410 King Street
Alexandria, VA 22314

Industrial Education
262 Mason St.
Greenwhich, CT. 06830

School Shop
Box 8623
Ann Arbor, MI. 48107

PROJECT GUIDELINES

The following material was compiled from the American Industrial Arts Student Association Guidelines for Competitive Events. This material can be used in conjunction with the unit material presented. These competitive events are held each year in regions throughout the State.

ENERGY CONSERVATION

OVERVIEW: AIASA chapters entering Energy Conservation are required to investigate a local energy problem and present a solution(s) to the problem. Entry involves the presentation of a two- or three-dimensional model and an interview with a chapter representative.

I. CONTEST PURPOSE

The purpose of the Energy Conservation contest is to provide a means for AIASA chapters to demonstrate their knowledge of energy production methods and to create within the members a knowledge of energy alternatives.

II. ELIGIBILITY FOR ENTRY

Entries are limited to one (1) per chapter, and the student chosen to represent the chapter may enter only one (1) interview-type event.

III. LEVELS OF COMPETITION

A. The Energy Conservation Contest application form must be typed and sent with two (2) additional copies to the Competitive Events Coordinator. These three (3) copies of the application form must be postmarked no later than the established deadline date set prior to the National Conference. (Approximately two (2) months before the conference.)

B. Finalists will be notified by mail at least thirty (30) days before the conference.

C. The length of each finalist's interview shall not exceed twenty (20) minutes.

D. Finalists who fail to report on time for any phase of the judging will be disqualified.

IV. SPECIFIC REGULATIONS

A. Each AIASA chapter desiring to compete for this award must complete the application provided by National AIASA. The application:

1. Will be signed by the chapter president, chapter advisor, and the school principal.

2. Will be approved for consideration and be recommended by the school principal.

3. Will specifically designate the chapter respresentative for the interview on the conference registration form. This representative must be an active member in good standing of the entered chapter.

4. Cover the current AIASA year only.

5. May include 6 but not more than 12 photographs on your chapter's one major community development project (either color or black and white photographs). Captions describing each photograph are limited to 50 words; no other supplemental materials will be considered.

B. The chapter representative will be responsible for discussing AIASA Energy Conservation related activities and/or material which the judges deem necessary and appropriate. However, this discussion and the questions asked by the judges will be standard for all interviews.

C. The following is a list of topics which a chapter must address in the presentation of documentation within the application.

1. How did the chapter determine the energy conservation need(s) of our society which led the chapter to select the activity?

2. How does this activity fit into a long-range energy conservation plan?

3. Objectives (explain what the chapter planned to accomplish).

4. Description (relate briefly what was involved in planning and carrying out the activity).

5. Number of chapter members involved. Explain how they were involved.

6. Number of other community citizens who participated. List the organizations, agencies, or special interest groups involved and explain briefly how they were involved.

7. List types of information provided to the community on the project (radio, TV, posters, civic club meetings, school assemblies, newspaper articles, and others).

V. PROCEDURE

A. The Competitive Events Coordinator and two (2) other judges will select the finalists in each level from the premailed resumes.

EXTEMPORANEOUS SPEECH

OVERVIEW: AIASA contestants in Extemporaneous Speech are required to give a three- to five-minute speech fifteen minutes after having drawn a card on which a topic for their speech is written.

I. CONTEST PURPOSE

The purpose of Extemporaneous Speech is to provide a means for AIASA members to demonstrate their knowledge of and ability to communicate about technology subjects.

II. ELIGIBILITY FOR ENTRY

Entries are limited to two (2) per chapter.

III. LEVELS OF COMPETITION

Level I and Level II as described in General Rules.

IV. TIME LIMITATIONS

Each speech shall not be less than three (3) minutes or more than five (5) minutes. The Contest Coordinator shall introduce the contestant by number only and the contestant may introduce his/her speech by title only. The timekeeper shall visually notify the speaker of the time remaining by using six separate cards. Each of the six cards shall have a number (4, 3, 2, 1, 1/2, 0) shown in descending order to the contestant by the timekeeper during the speech. Contestants are to be penalized on each judge's score sheet one point per ten (10) seconds for speaking over five (5) minutes or under three (3) minutes. Time commences when the speaker begins talking.

V. SPECIFIC REGULATIONS

Each speech shall be the result of the contestant's own effort, using any reference material which the contestant may bring to the preparation room. No other assistance may be provided. Students will be responsible for bringing their own 3x5 notecards to the contest. Any notes for speaking must be made during the fifteen-minute preparation period. While contestants will be permitted to use notes when speaking, it should be noted that deductions in scoring may be made for this practice if it detracts from the effectiveness of the presentation.

VI. PROCEDURE

A. Registration - Contest participants must register for the event in accordance with procedures established for each conference.

B. Participation Sequence - Students will gather at one location, as identified at registration, to draw for places on the program.

C. Topic Selection - Shall be held fifteen (15) minutes before each student enters the preparation room. Each student will draw three cards containing one topic per card from a box and select one topic to speak on, and then return the two unused cards to the box.

D. Preparation

1. After selection of topic, the first student will enter a preparation room, separate from the speech delivery room, and will be given fifteen (15) minutes to prepare his/her speech.

2. Seven (7) minutes after the first student enters the preparation room, the second student will enter the room, go to a different section, and begin his/her speech preparation. Fifteen (15) minutes will be allowed to prepare the speech.

3. All remaining participants will be allowed to enter the preparation room in seven-minute intervals, thus enabling a constant flow of students to speak before the judges in seven-minute intervals. (Allows for one minute to enter room and announce entry number, five minutes for speech presentation, and one minute to exit room.)

E. Introductions - The Contest Coordinator shall introduce each contestant by assigned number in order of the drawing.

F. Audience - Observers will not be allowed in the audience or the performance room during contest heats. Observers will be allowed to sit in the audience of the performance room during the finals only. No talking or gesturing will be permitted. Observers will NOT be allowed to enter or leave during a speech. APPLAUSE SHALL BE WITHHELD UNTIL ALL CONTESTANTS HAVE SPOKEN.

G. After speaking, the student must return his/her topic card to the judges.

PREPARED SPEECH

OVERVIEW: AIASA contestant in Prepared Speech are required to deliver a memorized speech of three (3) to five (5) minutes in length on a topic related to industrial or technology fields.

I. CONTEST PURPOSE

The purpose of the Prepared Speech contest is to provide a mean for AIASA members to demonstrate their ability to communicate verbally to an audience.

II. ELIGIBILITY FOR ENTRY

Entries are limited to two (2) per chapter.

III. LEVELS OF COMPETITION

Level I and Level II as described in General Rules.

IV. TIME LIMITATIONS

Each speech shall not be less than three (3) minutes or more than five (5) minutes. The Contest Coordinator shall introduce the contestant by number only and the contestant may introduce his/her speech by title only. The timekeeper shall visually notify the speaker of the time remaining by using six separate cards. Each of the six cards shall have a number (4, 3, 2, 1, 1/2, 0) shown in descending order to the contestant by the

timekeeper during the speech. Contestants will be penalized on each judge's score sheet one point per each ten-second interval of speaking over or under the allotted time. Time commences when the speaker begins talking.

V. SPECIFIC REGULATIONS

A. Each speech shall be the result of the contestant's own efforts, utilizing any reference materials which the contestant wishes to use.

B. Topic selection - Contestants may choose the subject for their speech; however, the subject must pertain to AIASA and/or relate to Industrial Arts/Technology Education.

C. A bibliography MUST be submitted to the judges before presenting the speech. Ten (10) points shall be deducted for contestants who fail to submit a bibliography.

D. Contestants may use two 3x5 cards for notes. However, deductions in scoring may be made for this practice if it detracts from the effectiveness of the presentation.

E. Contestants will not be allowed to hear other contestants' presentations.

VI. PROCEDURE

A. Registration - Contest participants must register for the event in accordance with procedures established for each conference.

B. Participation Sequence - Students will gather at one location as identified at registration to draw/sign-up for speaking times.

C. Introduction - The Contest Coordinator shall introduce each contestant by number and in order of the drawing.

D. Audience - Observers other than contestants will be allowed to sit in the audience of the performance room. No talking or gesturing

will be permitted. Observers will NOT be allowed to enter or leave during a speech. APPLAUSE SHALL BE WITHHELD UNTIL ALL CONTESTANTS HAVE SPOKEN.

VII. REQUIRED CONTEST PERSONNEL AND EQUIPMENT

A. Contest Coordinator

B. Judges - three (3) per heat

C. Two (2) timekeepers per level shall be designated who will record the time used by each contestant in delivering his/her speech. The timekeepers will note to the judges any undertime or overtime for which deductions should be made and inform the contestant of the amount of time remaining in minutes by using 5x7 cards with the numbers 4, 3, 2, 1, 1/2, and 0 placed on them and shown to the contestant throughout the speech. Time shall be indicated to the contestant throughout the speech, in descending order.

D. Materials and equipment supplied by the committee:

1. Speaker's stand
2. Stopwatches for timekeepers
3. Table and chairs for 3 judges
4. Rating sheets for judges furnished by Competitive Events Coordinator
5. Chairs for audience
6. One set of six 5x7 cards with one of the following numbers on each card: 4, 3, 2, 1, 1/2, and 0.

RESEARCH PAPER

OVERVIEW: AIASA members entering the Research Paper contest are required to research an Industrial Arts/Technology Education related topic which they select and present a written paper on the topic.

I. CONTEST PURPOSE

The purpose of the Research Paper contest is to provide a means for AIASA members to demonstrate their ability to select a topic, research the topic, and create written communication following an accepted format.

II. ELIGIBILITY FOR ENTRY

Entries are limited to two (2) per chapter.

III. LEVELS OF COMPETITION

Level I and Level II as described in General Rules.

IV. TIME LIMITATIONS

While this is not a "timed" event, all schedules must be adhered to as presented in Sections V and VI.

V. SPECIFIC REGULATIONS

A. The research paper is an individual project. No recognition will be given to a group effort.

B. The introduction, review of related literature, and conclusion shall be limited to ten (10) pages.

C. Charts, tables, drawings, diagrams, and short reprints of reference material are to be placed in the appendix. The appendix will not count as part of the ten (10) pages of the research paper.

D. A bibliography of ALL references used is to be included. This also will not count as part of the ten (10) pages of the research paper.

E. The basic outline shall include:

Title Page (which must be removable for judging)
Table of Contents
Introduction (include title above the Introduction section)
Review of Literature
Conclusion
Endnotes/Footnotes, if applicable

F. The research paper shall be typewritten, double spaced, on one side of good-quality 8 1/2" x 11" plain white paper.

G. The topic of the research paper may be related to any aspect of Industrial Arts/Technology Education.

H. The title page is to be included at the beginning of the paper, using the following format: (NOTE: The title of the research paper must also be listed at the top of the first page of the research paper.)

TITLE OF PAPER

being

A Paper Entered in the

RESEARCH PAPER CONTEST

by

Put Your Name Here
Home Address

Chapter Name _____ Level _____

School Name _____ Grade _____

School Address _____ Entry Number _____
(assigned by Coordinator)

_____

Date _____ Approved _____
AIASA Local Advisor

I. The title page will not count as one of the ten (10) pages of the research paper.

J. Contestants may not have entered this research paper at any previous National Conference.

K. Three (3) copies of the research paper shall be mailed to the Competitive Events Coordinator by the present deadline date. NOTE: NO ENTRIES WILL BE ACCEPTED THAT ARE POSTMARKED BEYOND THE DEADLINE DATE. (It is advisable to keep an additional copy of the research paper.)

SAFETY POSTER

OVERVIEW: Safety Poster is designed to direct member attention to the area of laboratory safety. Contestants are required to produce a safety poster or a given size sheet using artistic expression.

I. CONTEST PURPOSE

The purpose of the Safety Poster contest is to provide a means for AIASA members of demonstrate their ability to recognize safety needs and to communicate safety messages in visual form.

II. ELIGIBILITY FOR ENTRY

Entries are limited to two (2) per chapter.

III. LEVELS OF COMPETITION

Level I and Level II as described in General Rules.

IV. TIME LIMITATIONS

While this is not a "timed" event, all schedules must be adhered to as presented in "Specific Regulations" and "Procedure" sections.

V. SPECIFIC REGULATIONS

A. Posters can depict any safety procedure/concept as long as it relates to some phase of Industrial Arts. All posters are to be a hanging type of cardboard or poster board.

B. Maximum size is limited to 24 inches by 36 inches. Total cost of materials in the production of the poster shall not exceed $5, and a list of costs must be neatly printed on the reverse side.

C. Contestants must not leave posters until entry numbers have been affixed by an official on the back of their posters. The entry number will be assigned during contest registration. Contestant's name, school, etc. must not be on the poster during judging.

D. Entries must have been started after the past National Conference competition.

VI. PROCEDURE

A. Registration - Contest participants must register for the event in accordance with procedures established for each conference.

B. Posters must be entered during the assigned contest entry time. Late entries will not be accepted.

C. Posters may be picked up only at the assigned time.

D. All winning safety posters become the property of AIASA, Inc. for a period of one year, to be utilized as deemed appropriate by the corporate board members.

VII. REQUIRED CONTEST PERSONNEL AND EQUIPMENT

A. Contest Coordinator to collect posters and position posters for judging per level.

B. Two (2) persons to register entries and place entries on the easel.

C. Three (3) judges per level.

D. Display easel for each level to be placed 10-15 feet from the judges.

VIII. CRITERIA AND JUDGING

A. Contestants shall be ranked in numerical order on the basis of final score to be determined by each judge without consultation with each other. The winner will be that contestant whose total score is the highest. Other placings shall be determined in the same manner.

B. Ratings will be based upon the following:

1.	Eye Appeal	20 points
2.	Safety Content Validity A measurement of the entrant's ability to present a valid safety theme for an Industrial Arts classroom . .	20 points
3.	Originality	20 points
4.	Organization	20 points
5.	Interest	10 points
6.	Neatness	10 points
	TOTAL	100 points

SCHOOL SHOP MAGAZINE TECHNICAL REPORT WRITING

OVERVIEW: AIASA contestants in School Shop Magazine Technical Report Writing are required to read and analyze technical articles and write a comprehensive report summarizing the key elements of the articles.

I. CONTEST PURPOSE

The purpose of the School Shop Magazine Technical Report Writing contest is to provide a means for AIASA members to demonstrate their ability to consolidate various information sources into a complete and comprehensive report.

II. ELIGIBILITY FOR ENTRY

No more than two (2) entries per chapter.

III. LEVELS OF COMPETITION

Level I and Level II as described in General Rules.

IV. TIME LIMITATIONS

The allotted time for preparation of the paper shall be one (1) hour. All contestants in this event must arrive and be "in place" at the specified time and place, since only one time frame will be designated for this event.

V. SPECIFIC REGULATIONS

A. Only a dictionary and thesaurus may be carried into the contest area and be used in preparing the paper.

B. ALL contestants will begin after the instructions have been given and upon the signal of the Contest Coordinator. Late contestants will be disqualified.

C. Only contestants will be allowed in the contest area. No contestants will be allowed to leave the area until time has expired and papers are collected by the Contest Coordinator. Should a contestant finish before the allotted time, the contestant will keep his/her paper, remain seated, and not talk to or disturb any other contestant. Violators will be disqualified at the discretion of the Contest Coordinator.

D. A ballpoint pen and paper will be supplied by the Contest Coordinator and must be turned in the at conclusion of the contest.

E. Contestant's name, chapter, state, or other identifying information will disquality that contestant's paper. Each paper will have the "Contestant Entry Number" placed in the upper right-hand corner of the first page, just above the title of the paper.

F. Length of the paper will be limited to ten (10) pages.

VI. PROCEDURE

A. Registration - Contest participants must register for the event in accordance with procedures established for each conference.

B. All contestants will gather at the identified location and time specified in the Conference Program. Those contestants arriving after the designated time will be disqualified and not be allowed to enter the contest area.

C. Given pen, paper, and three (3) technical articles on one topic, the contestant will prepare a technical report on that topic complete with bibliography.

D. All winning technical papers become the property of AIASA, Inc. for a period of one (1) year, to be utilized as deemed appropriate by the corporate board members.

VII. REQUIRED CONTEST PERSONNEL AND EQUIPMENT

A. Contest Coordinator

B. Judges - a minimum of three (3) per level

C. A timekeeper for each level (unless held in same room and at same time)

D. Materials and equipment supplied for judges or contestants

1. Tables and chairs for judges.
2. Tables and chairs, or tables armchairs for contestants.
3. Clock for timekeeper.
4. Securable room for each level (preferable) during time of contest. Levels may be staggered to accommodate contestants to be served in a smaller area. However, if this is done, each contestant must be notified of his/her participation time.
5. Judges' rating sheets.
6. Ten to twenty sheets of paper per contestant.
7. One ballpoint pen per contestant.

VIII. CRITERIA FOR JUDGING

A. Each contestant's paper will be reviewed and scored by each judge for that level, without consultation with each other.

TECHNOLOGY PROCESS DISPLAY

OVERVIEW: AIASA chapters entering the Technology Process Display contest are required to construct and display an industrial or technological process within a defined area.

I. CONTEST PURPOSE

The purpose of the Technology Process Display contest is to provide a means for AIASA chapters to demonstrate their knowledge of a process which they have researched by fabricating a display of the researched process.

II. ELIGIBILITY FOR ENTRY

A. Only AIASA chapters in good standing are eligible for entry.

B. Each chapter that is eligible may enter one display or exhibit for competition at the national contest level during the annual convention.

C. One entry per level.

III. LEVELS OF COMPETITION

Level I and Level II as described in General Rules.

IV. TIME LIMITATIONS

While this is not a "timed" event, all schedules must be adhered to as presented in Section V and VI.

V. SPECIFIC REGULATIONS

A violation of regulations A or B will disqualify entry.

A. The exhibit size may not exceed 4'x4'x8' high.

B. The exhibit must depict some industry, industrial process, operation, or application of methods or processes used in industry. (Applications of new technology to solve technical problems are encouraged.)

VI. PROCEDURE

A. Registration - Contest participants must register for the event in accordance with procedures established for each conference.

B. Exhibit must be entered during the assigned contest entry time.

C. Contest Coordinator must attach an entry number in the lower right corner of the exhibit. The contest number will be assigned during contest registration.

VII. SUPPLY LIST

A. Personnel

1. Contest Coordinator
2. Judges, three (3) per level
3. Helpers, two (2) per level

B. Equipment

1. Contest guidelines (3 per level)
2. Judges' rating sheets
3. Marking pens for judges, 12
4. Display tables for technology process display (a minimum of 12 4' x 8' tables per level)
5. Table and chair for judges (3-person workstation per level)
6. List of entries

VIII. CRITERIA FOR JUDGING

A. The exhibit must be a chapter project.

B. Each exhibit shall have a description of the industry or industrial process it depicts. The number of chapter members participating in the total exhibits shall also be noted.

C. No student or advisor will be allowed to stand by exhibits during judging.

D. Rating will be based on the following:

Organization	20 points
Originality	20 points
Subject Coverage	30 points
Interest and Appeal	15 points
Workmanship	15 points