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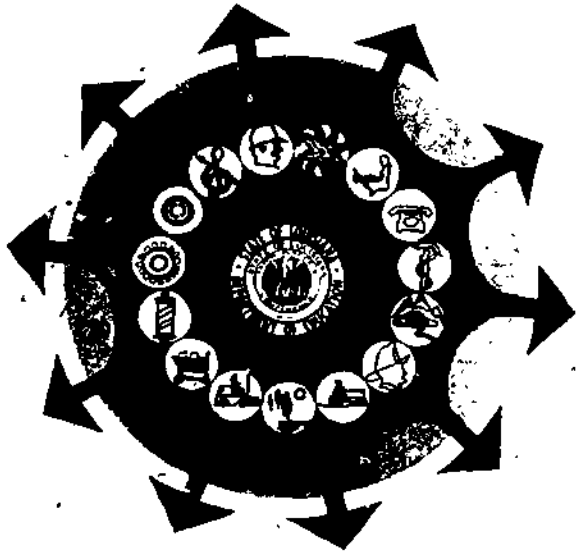
ABSTRACT

The tentative guide in power and energy for senior high school use is part of a series of industrial arts curriculum materials developed by the State of Louisiana. The course is designed to provide "hands-on" experience with tools and materials along with a study of the industrial processes in power and energy. In addition, the student is also offered the opportunity to make tenative career decisions, analyze employment trends, and experience guidance in the various careers related to the power and energy job family. The student has the opportunity to design, plan, and complete appropriate articles and learn of the careers related to those articles. The major units of the course are: safety; introduction to power and energy; power sources: work, energy, power; basic tools used in power and energy laboratory; mechanical systems; fluid systems; electrical power systems; combined systems of power; and internal combustion engine. The outline format includes performance objectives with suggested learning activities for the major unit topics and subtopics. Suggested resources refer the user to the State Department of Education's adopted textbook list and to the resource list appended to the document. (Author/NJ)



INDUSTRIAL ARTS CURRICULUM GUIDE

CURRICULUM GUIDE 1335

GRADES 9-12

POWER AND ENERGY

Issued by
LOUISIANA STATE DEPARTMENT OF EDUCATION

LOUIS J. MICHOT
STATE SUPERINTENDENT

1974

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POWER AND ENERGY

Overview

In this course the student, through "hands on" experiences with tools and materials and study of the industrial processes in power and energy, will have had an opportunity to make tentative career decisions, analyze employment trends, and experience guidance in the various careers related to the power and energy job family.

Special attention is given to helping students discover their technical abilities and to interesting them in obtaining career information. Students have an opportunity to design, plan and complete appropriate articles and learn of the careers related to those articles. Both individual and group educational experiences are encouraged. Students will use practical application of language arts, mathematics and science in solving meaningful problems. They will also use safe work habits and will participate actively in the operation and management of the power and energy laboratory.

POWER AND ENERGY

Safety

Introduction to Power and Energy

Power Sources

Work, Energy, Power

Basic Tools used in Power and Energy Laboratory

Mechanical Systems

Fluid Systems

Electrical Power Systems

Combined Systems of Power

External Combustion Engine

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
Lessons that appear in the following numbered sequence are the activities for that particular day.			SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THE GUIDE.
I. Safety (2)	I. The student will practice using correct safety techniques demonstrated in class. Safety should not be taught in a unit but incorporated through this curriculum where hazards might occur.	I. Instructor will lecture and demonstrate proper safety techniques in the use of hand tools, power equipment, flammables, etc.	
II. Introduction to Power and Energy (4) Time allotted (4) hrs.	II. Upon completion of this unit the student will be able to identify the content of power technology. (1) Skills basic to power and energy. (2) Occupations and professions in the field of power and energy. (3) Practical applications of language arts, science, mathematics, and methods of research in power and energy.	II. Explanation and demonstration.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
III. Power sources (10) Time allotted (10) hrs.	III. The student will be able to identify the sources of power as the first step in the development of man's use of power.	III. Explanation and demonstration	See State Department of Education's adopted textbook list for resource materials. Also see list at end of the guide.
A. Natural sources	The student will be able to identify the following sources of power: (1) Muscle (2) Water (3) Wind (4) Sun	Explanation and demonstration	
B. Electrical sources	The student will be able describe electric sources of power as follows. (1) Mechanical (2) Chemical	Explanation and demonstration of electrical sources of power	
C. Thermal sources	The student will be able to state the applications of thermal sources of power including the following: (1) Solids (2) Gases (3) Liquids (4) Atomic	Explanation and demonstration of thermal sources of power. Students could use the following examples of thermal sources: (1) Solid rocket fuel as a solid source of power (2) Compressed gas, such as CO_2 cartridge for a gas source (3) Burning of gasoline in a small engine as a liquid source	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(2) Pliers (a) Combination slip joint (b) Pump-type pliers (c) Vise grip pliers (d) Standard and universal wrenches (3) Wrenches (a) Open-end wrench (b) Box-end wrench (c) Socket wrench (d) Standard and universal wrenches (4) Chisels (a) Cape chisel (b) Cold chisel (c) Diamond point chisel (d) Half round chisel (e) Round nose chisel (5) Files (a) Classification of files (b) Shapes of files (c) Care of files (d) Methods of filing (6) Punches (a) Pin punch (b) Pricle punch (c) Center punch (d) Drift punch		SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THE GUIDE.

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(7) Hammering tools (a) Ballpeen hammer (b) Rawhide mallet (c) Plastic mallet (d) Rubber mallet (e) Brass mallet (8) Drilling tools (a) Hand drill (b) Electric drill (c) Drill press (d) Twist drills (e) Reamers (9) Tap and die set (a) For U.S.S. threads (b) For S.A.E. threads (c) Screw extractor set (d) Thread chaser (10) Soldering tools (a) Soldering gun (b) Soldering copper (11) Measuring tools (a) Steel rules (b) Calipers (c) Thickness gauge (d) Spark plug gauge (12) Specialized tools and equipment (a) Valve spring compressor	Demonstrate and explain the safety practices to follow in the uses and care of tools, equipment, and supplies in	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THE GUIDE.

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	(b) Piston ring compressor (c) Main gear wheel puller	power mechanics.	
VI. Mechanical systems (10) Time allotted (10) hrs.	Upon conclusion of this unit the student will be able to describe the operation of mechanical power systems.		
A. Power input	The student will be able to recognize the power input that produces motion in the mechanical power systems. (1) Reciprocating, rotary, and linear motion (2) Inertia, momentum, and acceleration	Explanation and demonstration through the operation of a gasoline engine. Students could see examples of power input through the following: (1) The piston of the engine is an example of reciprocating motion; the crankshaft is an example of linear motion. (2) The student could push and stop a model car to illustrate the principles of inertia, momentum, and acceleration.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THIS GUIDE.
B. Control and control devices	The student will be able to name devices used to control power in a mechanical system.	Explanation, demonstration and use of basic machines (levers, inclined planes, gears, pulleys and clutches and control devices). The student could be given examples of these basic machines and experience how he	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		can control the mechanical movement of objects using the basic machines. Safety in working with mechanical systems should be discussed.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THIS GUIDE.
C. Transmission	The student will be able to describe simple power transmission devices in a mechanical system.	Explanation and demonstration of friction and transmission devices such as solid shafts, cables, and belts. The student should be allowed to set up mechanical systems using solid shafts, cables, and belts along with the basic machines earlier studied in the mechanical system control and control devices.	
D. Power output	The student will be able to identify the output of power in a mechanical system.	Explanation of output Examples: Moving an automobile, cutting the lawn, or operation of machinery. The student could be required to research examples of mechanical output such as mentioned above.	
VII. Fluid Systems	Upon conclusion of this unit the student will be able to describe the operation of a fluid system.		

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
A. Principles and theory	The student will be able to explain the principles and theory of a fluid power system as it applies to simple systems he daily encounters.	Explanation and demonstration Students should be actively involved in the teacher's demonstration using a fluid reservoir (air or water), applying pressure at one point to illustrate the pressure transferred to another point.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(1) Measurement of pressure	The student will be able to measure pressure.	Explanation, demonstration. Reading of various types of pressure gauges should be experienced by the students.	
(2) Control and transmission principles	The student will be able to identify and control the transmission in a fluid system.	Explanation and demonstration Safety in working with fluid systems should be discussed.	
B. Characteristics	The student will be able to relate principles of hydraulic and pneumatic systems in the use of fluid power, including advantages and disadvantages of each.	Explanation, demonstration and operation of hydraulic systems using liquid and pneumatic systems using air as the pressure transferring fluid.	
C. Phases of operation			
(1) Power input	The student will be able to recognize the power input that produces motion	The student should be allowed to set up and operate hydraulic and pneumatic fluid	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	in the fluid power systems.	power systems using the following: Hydraulic reservoirs, fluid and filter, hydraulic pumps and air compressors. Students could bring an example such as a shock absorber.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(2) Control and control devices	The student will be able to name control devices of fluid systems.	The student should be allowed to set up and use transmission lines in the system, transmitting fluid power to raise and lower an object.	
(3) Transmission	The student will be able to describe the simple transmission used in fluid systems.	The student should be allowed to set up and use transmission fluid power to raise and lower an object.	
(4) Power output	The student will be able to identify the output of power in fluid systems.	Explanation of output through cylinders, motors, and pressures in fluid power systems. (1) Fluid power cylinder as used in a hydraulic landing gear system on air craft (2) Power brakes and power steering on an automobile (3) Movement of bulldozer blade using hydraulic lines	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		(4) Car lift in a garage Students could be taken on a field trip to see hydraulic and pneumatic systems in operation or examples could be simulated in the classroom using applications of an air pump or compressed air.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
VIII. Electrical power systems	Upon conclusion of this unit the student will be able to describe the basic operation of an electrical power system.		
A. Principles and theory	The student will be able to express the basic principles and theory of electrical power.	Explanation and demonstration. Perform experiments in static electricity if weather conditions permit.	
(1) Magnetism	The student will be able to explain the theory of magnetism and how it applies to electrical power.	Explanation and demonstration. Each student should use various magnets and iron filings and then construct and use an electromagnet to see the various force patterns.	
(2) Generation of electrical power	The student will be able to produce electrical power by mechanical and chemical means.	Explanation and demonstration of low voltage electricity produced mechanically and chemically (6-12 Volts). The student could be allowed	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		to mechanically produce electricity by constructing and using a generator. He could also chemically produce electricity by constructing a simple wet cell. Electrical safety should be demonstrated and discussed.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(3) Electrical measurement	The student will be able to perform basic measurement of electrical power.	Explanation and demonstration showing various electrical measuring devices used at low voltages of 6-12 volts. Students should be allowed to connect and read the various measuring devices used, such as an ohm meter, volt meter, and amp meter. Electrical safety should be discussed concerning the proper use of these measuring devices.	
(4) Circuits	The student will be able to identify an electrical circuit.	Explanation and demonstration identifying the circuit and the characteristics of the circuit. Students should be allowed to set up simple circuits using a power source, load, switching device, and connectors. Examples: (1) Simulate the magnetic system such as that of	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		a small engine. (2) A starter-battery system such as that of the automobile	
(5) Alternating and direct current	The student will be able to define the difference between alternating and direct current.	Explanation of an alternating and direct current. Students can set up simple AC and DC circuit. Safety should be discussed with low voltages used.	
B. Phases of operation	The student will be able to describe the operation of an electrical system.	Explanation and demonstration. Safety demonstration discussion, review, and testing should be covered both individually and collectively	
(1) Power input	The student will be able to recognize the power input that produces motion in the electrical system.	Students should be allowed to set up and operate electrical circuits utilizing various types of power input systems. Example: Design a 6 volt circuit for head lights, parking lights, brake lights and turn signals.	
(2) Control and transmission	The student will be able to describe the control transmission systems used in electrical system.	Students should be allowed to set up and operate electrical circuits utilizing different types of controls and methods of transmission.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		Examples: (1) Control of a circuit using resistors, relays and switches (2) Methods of transmission through experiments with various conducting and non-conducting materials and examining various types of wiring and cables	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(3) Power output	The student will be able to identify forms of power output in electrical systems.	Students will be allowed to set up and operate electrical circuits to produce motion, heat, light, or sound. Examples: (1) Construction of a simple electric motor (2) Construction of an electromagnet (3) Use of electrical heating elements (4) Lighting systems controlled by switches or thermostats as used in automobiles (5) Electric buzzer or horn Students may also take a field trip to see forms of power output in electrical systems.	

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TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
c. Joining a trade union	The student will be able to define trade and list several trades that have union affiliation.	Instructor will have labor representative give short talk to students.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
IX. Combined systems of power	Upon conclusion of this unit the student will be able to describe how the mechanical, fluid, and electrical systems together form a combined system of power and career opportunities.	Series of shop activities where the student experiments with various types of engines. Learning activity packages, individual experiments, filmstrips and transparencies can be utilized.	
A. Internal combustion engines:	The student will be able to describe the operation of internal combustion engines before proceeding to the study and experimentation of engine components and subsystems.	Transparent engines can be used to show the 2 & 4 strokes of an engine.	
1. Operating principles:			
a. Reciprocating Type:			
(1) 4-cycle	The student will be able to understand and explain the operating principles and	The relationship of piston motion, valve operation and ignition firing can be	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	features of 4-cycle engines.	illustrated physically, by using transparent, live firing engines.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(2) 2-cycle	The student will be able to understand and explain the operating principles and features of 4-cycle engines.	A basic description can be offered and cut-away models can be used to highlight the major features.	
b. Rotary type- (Wankels) turbines	The student will be able to: a. Expose each part of the 4-stroke cycle in a rotary engine. b. Relate the rotor and crankshaft rotations. c. Compare the 4-strokes of the rotary with the 4-strokes of the Otto engine. d. Sketch the Wankel Rotor and housing. e. Describe the operation of a turbine.	A transparent Wankel can be used to display the working components such as the rotor and the crankshaft. Cut-away model of a turbine can be used to display the rotor and housing arrangement.	
c. Diesel, compression ignition	The student is introduced to compression ignition principles. He will be able to: a. Define diesels or compression ignition engines. b. Recognize diesel engines.	A detailed description can be offered on the operating principles of 4-cycle diesels. Schematic diagrams can be used for each stroke to aid the student in visualizing the strokes. The intake, compression power and exhaust strokes can be described. In each case,	

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	c. Explain the principles of 4-cycle diesel engine operation. d. Introduce the function of the principle parts of a 4-cycle diesel engine.	the physical process involved should be explained for better understanding of the related elements as they occur in actual operation.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
d. Spark ignition system	The student will be able to: a. Describe the function of the points, condensor, coil and spark plugs b. Define the ignition timing c. Conduct tests and relate crankshaft rotation to degree readings.	A live firing, transparent engine can be used to describe and show the function of the points, condensor, coil and spark plugs. The student can examine each part and obtain a first-hand experience with those components. A physical interpretation of ignition timing can be offered through the use of the same transparent engine. The relationship of crankshaft rotation, piston position and degree readings can be shown. Definitions of Top Dead Center (TDC), advanced or delayed timing (BTDC and ATDC) can be given with the student observing this relationship through the transparent cylinder of the engine.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
2. Mechanics of Engines	The student will be able to understand and name the basic components and their functions and recognize the subsystems of engines. He will actively participate in adjusting engine controls and operate these engines under various conditions. He will develop a sound knowledge on engine operation before disassembly.	Shop activities where the students conduct hands-on activities with various engines. Operation of different engines and measurement of engine power output. Students should be encouraged to use tools and dynamometers to develop a knowledge of instrumentation.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THIS GUIDE.
a. Reciprocating 2- & 4-cycle engines			
(1) Power control and carburetion PART I	The student will be able to experience and understand: a. The components which control the fuel/air mixture ratio b. The basic principles involved in venturi-type carburetors c. How the fuel/air mixture can affect the power output.	The basic elements of a simple carburetor can be shown and explained by disassembling and examining a simple carburetor.	

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(2) Power control & carburetion PART II	The student will be able to experience and understand: a. How the fuel is controlled. b. What components are involved in fuel control.	The basic elements of the fuel metering and float system of a small engine carburetor can be presented by the use of charts and drawings. The venturi type of carburetors from small engines may be introduced for the purpose of exhibiting how better carburetor performance is achieved. The mechanism involved in achieving a constant level of fuel in the tank can be shown and explained.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(3) Power control and carburetion PART III	The student will understand and experiment with the mechanisms involved in: a. Choke of a carburetor b. Throttle of a carburetor	The choke may be described with the aid of diagrams. The use of the choke in a cold start can be explained. The function of the choke for increasing the fuel/air ratio should be described.	
(4) A typical small engine carburetor	The student will be able to: a. Work with and recognize an up-draft carburetor. b. Remove and install this type carburetor on a Briggs & Stratton engine.	The student may remove and install a Briggs and Stratton up-draft carburetor. The student should experiment with a simple up-draft carburetor of widespread use. The student must disassemble an up-draft carburetor which incorporates adjustments on	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
		idle speed, idle mixture and high speed mixture. He will be able to develop experience in disassembling and assembling a Briggs & Stratton engine carburetor.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THE GUIDE.
(5) Disassembly and operation of an up-draft carburetor	The student will be able to: a. Recognize an up-draft carburetor. b. Identify the parts of the carburetor. c. Name the fuel sub-systems of the carburetor. d. Locate the three adjustments on the carburetor and state what they do.	A Briggs and Stratton engine may be used for the students to disassemble a typical up-draft carburetor and study the mechanism.	
(6) Function of a cylinder head	The student will be able to: a. Learn the procedure of disassembling a transparent engine cylinder head. b. Develop skills in the utilization of hand tools during the disassembly of a cylinder head. c. Study in greater detail the components of a cylinder. d. Reassemble the cylinder head and properly torque it.	The primary function of a cylinder head can be described. A detailed procedure should be offered to disassemble the cylinder head of transparent live firing engine.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(7) Compression	The student will be able to: a. Relate his experience with transparent cylinder engine to other engines. b. Develop a basic understanding, and learn the functions of a piston, cylinder and ring set, by observing the piston operation through a transparent engine. c. Apply his basic knowledge and experience to other similar conventional engines.	How compression is achieved may be shown through the use of a transparent cylinder engine. The student can observe directly how the piston and rings cause compression.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE THE LIST AT THE END OF THIS GUIDE.
(8) Torque	The student will be able to: a. Familiarize himself with a crankshaft and a connecting rod. b. Identify and explain the functions of these parts. c. Have a knowledge of how the force of a piston is transmitted to a crankshaft.	The fact that torque in engines is one of the most important performance parameters must be emphasized and defined in terms of physical components which cause the torque. The connecting rod and crankshaft which are internal parts causing torque can be shown.	
(9) Camshaft operation	The student will be able to: a. Have a sound knowledge of camshaft operation.	Describe the operating principle of a camshaft. Let the student observe how the lobes of the camshaft push against	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	b. Examine the cam lobes. c. Observe how the lifters and valves are activated. d. Handle similar camshaft assembly and disassembly.	the lifters.	
(10) Lifter, rocker arm and valve operation	The student will be able to: a. Understand the basic mechanisms which operate the valves. b. Examine the lifters and push rods for wear. c. Study the function of each component by observing the system in action. d. Apply his experience and knowledge to other designs found in different engines.	The lifters and rocker arms may be described. Help the student conduct simple experiments to obtain a physical feel for these components and observe their functions.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS, ALSO SEE LIST AT THE END OF THIS GUIDE.
(11) How engines are air cooled	The student will have: a. A basic understanding why cooling is required. b. A knowledge of how an air cooling system operates. c. An insight as to why the cooling system should be free from obstacles.	Describe the air cooling system of small engines. Most 2- & 4-cycle small engines are air cooled. The student should experiment to demonstrate the basic mechanics of air cooling.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(12) Disassembly of a 2-cycle Tecumseh engine	The objectives of this activity are: a. To expose the student to the use of hand tools. b. To have the student obtain a hands-on experience. c. To have the student study the inner components of a 2-cycle, small gasoline engine.	Obtain the disassembly procedure of a small Tecumseh engine and offer it to the student. The disassembly procedure must be detailed so that the student can follow the procedure with relative ease. Photographs must be used at every major step to help the student in disassembling the unit.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE THE LIST AT THE END OF THIS GUIDE.
(13) Reassembly of a Tecumseh engine	The purpose of this activity is to: a. Lead the student into assembling a Tecumseh engine. b. Offer him the use of tools. c. Give him hands-on experience on minor trouble shooting.	Offer the assembly procedure of Tecumseh, 2-cycle engine. With the aid of photographs the student should be able to reassemble the Tecumseh engine. He learns the basic components inside of an engine and after minor adjustments, the student puts the engine into working order.	
(14) Disassembly of a 4-cycle Briggs & Stratton engine	The student will be able to: a. Use hand tools properly. b. Develop basic skills with hands-on experience. c. Observe and recognize the inner components of a 4-cycle, small gasoline engine.	Obtain the disassembly procedure of a small Briggs & Stratton engine. Disassembly must be detailed so that the student can follow the procedure with relative ease. Photographs must be included at every major step to help the student in disassembling the unit.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(15) Assembly of a small 4-cycle Briggs & Stratton engine	The student will be able to: a. Assemble a Briggs and Stratton engine. b. Properly use tools. c. Gain experience on minor trouble shooting.	The assembly procedure of a 4-cycle Briggs & Stratton engine is offered. With the aid of photographs in the manual and step-by-step procedure, the student reassembles the Briggs & Stratton engine. He learns the basic components inside of an engine and after minor adjustments, the student puts the engine into working order.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(16) Engine performance characteristics	The student will be able to: a. Relate definitions to actual engine processes. b. Conduct experiments meaningfully. c. Understand why engines perform differently when engine parameters are varied. d. Understand that these parameters are adjusted during a tune-up.	Define those parameters which control the performance and efficiency of an engine. Explain the ignition timing, compression ratio, manifold pressure, fuel/air mixture ratio, torque and horsepower and relate their effect on engine performance. A transparent engine can be used to exemplify the definition.	
(17) Operating procedures of an electric dynamometer/generator	The student will have: a. A basic knowledge of the operating features of an electric dynamometer. b. A knowledge of the techniques used to measure the torque and engine speed.	Explain to the student that it is essential that measurement of engine power output variations be taken with reasonable care and accuracy. Describe measurement techniques and proper use of dynamometers.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	c. An understanding of the use of an electric dynamometer.		
(18) Coupling horizontal and vertical shaft engines to dynamometers	The student will be in a position to: a. Properly couple engines to dynamometers. b. Understand the loss of power whenever a transmission is used to change the angle of rotation. c. Properly select couplers.	In order to measure the performance of small gasoline engines, it is necessary to properly couple these engines to dynamometers so as to avoid excessive vibrations and inaccurate readings.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO LIST AT THE END OF THIS GUIDE.
(19) Measuring the horsepower of a 4-cycle Briggs & Stratton engine	The student will experience: a. Horsepower ratings of engines. b. Where the peak horsepower occurs. c. Testing the power output of an engine.	Since the most commonly used small gasoline engine is the Briggs & Stratton, give the student the opportunity to measure the performance of it or the power output.	
(20) Measuring the horsepower of a 2-cycle Tecumseh engine	The student will have: a. A better understanding of the operating features of a 2-cycle engine. b. Data to compare with 4-cycle engines.	Have the student develop some experience in measuring the performance of a 2-cycle, Tecumseh engine and later compare it with a 4-cycle engine. Any small, 3 horsepower engine with a dynamometer can be used.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(21) Comparison of 2- & 4-cycle engine characteristics	The student will: a. Have a sound knowledge of the basic difference in the horsepower and torque curves between 2- & 4-cycle engines. b. Differentiate these two types of engines by recognizing the physical feature of each type. c. Understand where each type of engine fits best.	Highlight the differences in performance of 2-& 4-cycle small gasoline engines. Comparisons must be made on idling, power density and exhaust.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE THE LIST AT THE END OF THIS GUIDE
(22) Operation of engines on various fuels	The student will gain: a. A broader view of the 4-cycle engine operation demonstrating the alternate use of fuel. b. A better understanding of combustion and power generation. c. Experience in the use of different fuels showing the level of power they can produce.	The operating characteristics and power performance of engines depend heavily on the type of fuel. Experiments should be offered whereby the student can operate an engine on either liquid or gaseous fuel. In performing these tests, he will broaden his knowledge in the use of various energy sources.	
(23) Effect of manifold pressure on torque and horsepower	a. Basic knowledge of how manifold pressure affects horsepower output.	One of the most important parameters in internal combustion engines is the manifold pressure. A detailed explanation of the relationship of manifold pressure to engine	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	b. An understanding of the relationship between manifold pressure and cylinder pressure. c. Experience in measuring how manifold pressure changes.	power output should be given. Also, experiments should be offered for the student showing causes and effects with hands-on experience.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(24) Effect of timing on engine performance	The student will be able to: a. Define ignition timing and its effect on power output. b. Observe the physical process involved in igniting the fuel at a certain position of the piston.	Explain the fact that ignition timing of an internal combustion engine is one of the most important elements which governs the power output and emissions of an engine. This can be achieved by the use of a live firing, transparent engine.	
(25) Effect of gaseous fuels on engine power	The student will be able to: a. Use gaseous fuels in internal combustion engines. b. Measure the power output with gaseous fuels and then compare it with gasoline or alcohol fuels.	Discuss and explain the use of gaseous fuels with 4-cycle internal combustion engines. Also, offer an experiment for the student to experience the differences between liquid & gaseous fuels. This can be achieved by the use of a transparent engine.	
(26) Measurement techniques of fuel and air	The student will be able to: a. Measure fuel and air. b. Properly connect flowmeters. c. Read flowmeters.	Make sure the student obtains experience and develops skills in the quantitative measurement of liquid or gas flow into an engine. Use a small gasoline engine.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(27) Efficiency of engines	The student will have: a. A basic understanding of the factors which affect the efficiency of an engine. b. A knowledge of how efficiency tests are performed. c. An opportunity to learn the definitions of energy units both mechanical and chemical.	This subject must be discussed in detail because of its sophistication. Experimental procedures should be shown providing the student with hands-on experience measuring the efficiency of an engine. The effect of fuel/air mixture ratio, ignition timing, compression ratio and type of fuel on efficiency must be indicated. Such experiments may be carried out by the use of a flowmeter.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE THE LIST AT THE END OF THIS GUIDE
(28) Effect of compression ratio on performance	The student will understand: a. The definition of compression ratio. b. Effect of compression on horsepower. c. Effect of compression on cylinder pressure.	Explain the fact that the compression ratio of an internal combustion engine is one of the most important parameters effecting the efficiency, power output and emissions of an engine. Those engines which incorporate variable compression mechanisms may be utilized.	
(29) Energy conversion--heat to electricity	The student will understand: a. What energy is. b. What units are used in measuring energy. c. Conversion of energy from one form to another.	Explain the relationship of energy units and offer an experiment for the student to observe and measure the energy conversion process. For example, the conversion of fuel (stored energy) to heat and pressure (combustion) to mechanical	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	d. Inefficiencies of energy conversion devices.	energy may be shown.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
b. Rotary type (Wankel) engines	The student will be able to understand the basic operation of Rotary piston engines, their components and subsystems. The student will be able to identify the advantages and disadvantages of rotary engines, their efficiency and operating features and characteristics.	Series of shop activities are suggested where the student systematically studies the components and their functions by the use of a transparent functional Wankel engine and/or transparencies.	
(1) The Wankel engine and the four cycles	The student will be able: a. To display how the Wankel engine develops the same 4 strokes as a small 4-cycle gasoline engine. b. To compare the 4 strokes of the Rotary engine with the 4 strokes of the Otto engine. c. Sketch the geometry of the Wankel rotor and housing.	Make a presentation of the Wankel intake, compression, power and exhaust strokes. Describe each stroke with the aid of diagrams and sketches. The Wankel 4 cycles may be compared with the conventional reciprocating 4-cycle engine.	
(2) The 4-stroke cycle of the rotary engine	The student will be able: a. To expose each part of the 4-stroke cycle in a rotary engine.	A Wankel engine may be used to show the intake, compression, power and exhaust strokes of the rotary piston.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	b. To relate the rotor and crankshaft rotations.		
(3) Visi-Wankel operating instructions	The student will be able to: a. Operate the Wankel properly. b. Observe the operation of the rotary piston.	A Wankel engine which is a modified rotary engine may be utilized for hands-on activity. With the use of an electric motor, the rotor can be operated for observation of rotors, seals, crankshaft and other parts.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(4) Description of the Wankel carburetor	The student will be able to: a. Explain why a carburetor is needed. b. State differences between air flow in a Wankel and reciprocating engine. c. Explain the functions of the venturi, float, valve and metering jets. d. Understand the need for main and idling fuel systems. e. Understand the differences between float, diaphram and overflow carburetors.	Explain how controlling of fuel/air mixture is achieved in the Wankel carburetor. The basic components of a carburetor such as the choke, throttle and the float system should be described. Diagrams, transparencies and a sample carburetor may be utilized.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(5) Operation and disassembly of the Wankel carburetor	The student will be able to explain and have experience in: a. The components which control the fuel/air mixture ratio. b. The basic principles involved in venture-type carburetors.	Describe the Wankel engine carburetor and offer a procedure to disassemble the carburetor. The student should obtain an insight to the parts of a carburetor and their function. The fuel/air mixture control method must be described as the student studies each part of the carburetor. Manuals and small typical carburetors are available for this purpose.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(6) Disassembly of the KM-48 Wankel engine	The student will be able to: a. Disassemble a Wankel engine. b. Give the proper name to the components of the Wankel engine. c. Show wear in a characteristic manner.	A disassembly procedure is offered to the student, in order for him to take apart the engine and study its components. The student, after disassembling the engine, examines each part for its characteristic wear. He obtains a hands-on experience with the use of metric tools in addition to developing skills in disassembly and reassembly of rotary engines.	
(7) Wankel engine rotor seals	The objective of this section is: a. To study the seals of the Wankel engine. b. To compare the seals (rings) of a reciprocating	The main purpose of this section is to have the student examine the seals and study how they cause sealing of gases. Their unique design is compared with the conventional rings.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	engine with the seals of the Wankel.		
(8) Assembly of the Wankel engine	The student will be able to: a. Learn to use proper tools for assembly. b. Assemble the components in their proper locations. c. Recognize all the parts by their proper names and functions.	Use metric tools and have the student experience the assembly of a Rotary engine. He will be exposed to the use of various tools, their names and sizes (in metric) and follow the procedures to properly assemble the unit. Utilize presently available manuals which offer step-by-step procedures.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THE GUIDE.
(9) Powered operation of the Wankel engine	The student will be able to: a. Acquaint himself with the engine. b. Operate it. c. Learn its features.	After the student has learned the components of the Rotary engine, he is ready to study its operating procedure and performance features. Have him follow the operator's manual to run the engine.	
(10) Cooling and lubrication in the Wankel engine	The student will: a. Have a knowledge of the cooling system for the Wankel engine. b. Properly prepare the fuel-oil mixture. c. Learn how the Wankel is lubricated.	Explain to the student that the Wankel engine operates at a higher temperature due to its power stroke at every face or side of the rotary piston; that is, the power stroke takes place at each stroke of the piston.	

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(11) Ignition system of the Wankel engine	The student will be able to: a. Disassemble the engine and examine the ignition system. b. Describe a magneto ignition system. c. Understand basic operation of a magneto.	Describe the magneto ignition system of the Wankel engine with the aid of schematic diagrams. Offer disassembly procedure to take the engine apart and physically examine the components of the Wankel magneto system.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(12) Operation of the Wankel with an electric dynamometer/ generator	The objectives of this section are to: a. Introduce the concept of a dynamometer. b. Provide the experience in connecting one mechanical system to another. c. Familiarize the student with the use of an electric dynamometer/generator.	Orient the student to engine loading and use of a dynamometer. Explain the features of an electric dynamometer/ generator. Show how the Wankel may be coupled to the dynamometer and measure the torque and speed. Have the student conduct tests and take measurements using the Wankel engine.	
(13) Installation of flowmeters	The student will be able to: a. Properly fit a flowmeter to the Wankel engine. b. Read flowmeters accurately.	Explain to the students that, in order to calculate the fuel/air mixture ratio, it is required that both quantities be measured accurately.	
(14) Wankel power output measurements	The student will be able to: a. Recognize what is meant by torque and power.	Describe the variation of torque and horsepower output at different engine speeds. Present the method of calculating horsepower. A step-by-step	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	b. Understand that engine power and torque depend on engine speed. c. Have first-hand experience with the process of power output measurement.	procedure should be shown to conduct performance tests with the use of an electric dynamometer/generator.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(15) Performance comparison between rotary and reciprocating engines	The student will be able to compare: a. Engine revolutions per power stroke. b. Engine torque output at different speeds. c. Efficiency d. Horsepower output.	Have a comparative study made between a rotary engine (Wankel) and a Briggs & Stratton engine.	
(16) Effect of fuel/air ratio on horsepower and efficiency	The student will be able: a. To demonstrate the influence of the fuel/air ratio on Rotary engine performance. b. To provide quantitative measurement of the horsepower and efficiency of the Wankel engine.	Explain that the fuel/air ratio has an important effect on the performance of the engine, the engine efficiency and the make-up of the exhaust.	
(17) Effect of fuel change on Wankel engine	The student will be able: a. To display the characteristic response of the Wankel engine to changing its fuel.	Reveal the fact that the Wankel engine can operate with ethyl alcohol or methyl alcohol mixed with castor oil as lubricant.	

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	b. Use a different fuel, other than gasoline, in the Wankel engine.		SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
c. Compression ignition (Diesel) engines	He will develop a basic knowledge of Diesels, the names of the components and their functions, disassembly and reassembly of diesels, operation and power output measurements, emission characteristics and efficiencies.	Use a small Diesel engine, electric dynamometers, flowmeters and tools to help the student conduct hands-on activities with Diesel engine.	
(1) 2-cycle Diesel operation	The student will be able: a. To explain the difference between 2-cycle and 4-cycle Diesel engine operation. b. To provide a detailed description of the steps in a 2-stroke Diesel engine cycle.	Discuss, with the aid of schematic diagrams, the operating principles of 2-cycle Diesel engine.	
(2) Fuel injection system on Diesel engines	The student will be able to identify the two most common types of fuel injectors as described: a. The common rail type injector. b. The jerk pump injector.	Discuss, with the aid of schematic diagrams, the common rail type injector and the jerk pump injector. The student should gain a sound background on this subject before disassembling injectors and pumps.	
(3) Diesel fuels	The student will be able to:	Describe the differences between gasoline and Diesel fuels. Explain octane ratings and	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	a. Differentiate between gasoline and Diesel fuels. b. Rate octane numbers.	emphasize their importance, especially with high compression engines. The method of rating fuels must be explained and how its numbering is related to "gas-knock" caused in engines.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(4) Combustion process in the Diesel engine	The student will learn and be able: a. To explain the difference between flame propagation in a fuel/air mixture and a diffusion flame near a fuel droplet. b. To explain how combustion in a spark ignition engine and a Diesel engine differ by using these two processes.	Point out that the combustion of fuels in Diesel engines is of a considerably different nature. Combustion process should be described in diffusion type of flames and pre-mixed flames as it occurs when a mixture of fuel and air is ignited.	
(5) Compression tests	The student will learn: a. The definition of compression ratio. b. How the conditions in the cylinder depend on compression ratio. c. How air gets hot when compressed.	Explain that compression ratio is the basic parameter that differentiates diesel and spark ignition gasoline engines.	
(6) Fuel injector	The student will be able to: a. Locate a typical diesel	A procedure should be shown to disassemble a fuel injector for observation and study purposes.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	engine fuel injector. b. Remove the fuel injector from the Diesel engine.	Problems associated with air getting into fuel lines should be discussed and explained.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THE GUIDE.
(7) Fuel injection controls	The student will be able to: a. Describe three ways of varying fuel amounts.	Provide the student with an introduction to three possible ways of varying the injected fuel volume for throttle control on Diesel engines.	
(8) Operation of a typical Diesel engine	The student will be able to: a. Start a Diesel engine. b. Control its power levels.	Offer the student an opportunity to operate a typical, single cylinder Diesel engine. This experience makes him aware of the basic differences in the operating mode of a Diesel engine vs. a small gasoline engine (spark ignition type).	
(9) Comparison of Diesel engines with spark ignition gasoline engines	The student will be able to define and describe: a. Power control b. Knocking and method of ignition. c. Compression ratio. d. Engine speed. e. Costs of operation and initial investment.	Discuss the basic operating principles and differences between a Diesel and a gasoline engine.	
(10) Power control and fuel air ratio	The student will be able to: a. Vary the fuel/air ratio of a diesel engine.	Discuss the effect of fuel/air ratio on the horsepower output of a Diesel engine. With the use of an electric dynamometer,	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
	b. Take power output measurements. c. Operate a Diesel under various loads. d. Measure the fuel and air into the engine.	measurements may be taken of torque and speed from which horsepower is calculated. Flowmeters are connected to measure the fuel and air flow rates.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THIS GUIDE.
(11) Coupling Diesel to dynamometer and flowmeters	The student will be able to: a. Assemble the Diesel engine to a flowmeter system.	Introduce the student to the use of a dynamometer and flowmeter for measuring the power output and the flow of fuel and air to the engine.	
(12) Operating a typical Diesel engine	The student will be able to: a. Operate an air cooled Diesel engine. b. Prime a Diesel engine for "cold or hot" starts.	Show the student the operating procedure for running a single cylinder, air cooled Diesel engine. The student should familiarize himself with the starting procedure and operation of the engine.	
(13) Measuring fuel and air flow in a Diesel engine	The student will be able to: a. Take fuel and air measurements. b. Calculate the fuel/air ratio. c. Indicate why Diesel engines operate at a lower fuel/air ratio.	Present the students with the use of flowmeters in measuring fuel and air.	
(14) Efficiency of	The student will be able to:	Indicate to the student that one of the basic advantages of a high	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
A Diesel engine	a. Measure the efficiency of the Diesel engine. b. Develop performance figures for the efficiency of a small Diesel engine.	compression ignition engine is its higher efficiency compared to gasoline engines. Present the definition and method of calculating the efficiency of an engine. The ideal efficiency vs. actual should be explained.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THIS GUIDE.
(15) Fuel injector disassembly	The student will be able to: a. Explain a typical Diesel engine fuel injector. b. Explain the operation of a fuel injector.	Explain to the student that the operation of an injector is an important aspect of a Diesel engine. The teacher should provide a detailed procedure for the disassembly of the injector.	
(16) Disassembly of a Diesel	The student will be able to: a. Disassemble a Diesel engine. b. Study the combustion chamber design used in the Diesel engine.	In order to study the piston and cylinder of a Diesel engine have the student disassemble the unit. This helps him to obtain some experience in the use of tools and procedures.	
(17) Disassembly of an injection pump	The student will be able to: a. Remove, disassemble and reassemble injection pump used on a Diesel engine.	Provide the student with the directions of disassembly and reassembly of the injection pump of a typical Diesel engine. Direct the student to disassemble a single cylinder Diesel pump and its unique parts.	
(18) Injector timing on engine performance	The student will be able to: a. Change the injection timing of a Diesel engine.	Explain to the student that just as the performance of a spark ignition engine can be changed drastically by changing the	

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	b. Take quantitative measurements of engine performance with different injector timing settings.	ignition timing, the peformance of a Diesel engine can be changed by changing the injector timing.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT END OF THIS GUIDE.
B. EXTERNAL COMBUSTION ENGINE			
(1) Operating principles of a 2-stroke steam engine	The student will be able to: a. Understand the basic operating principles of 2-stroke steam engine. b. Examine the basic components of a transparent, live firing steam engine. c. Develop a basic perspective and recognition of steam engines.	A pictorial representation should be used on the operation of a 2-stroke steam engine. An open-cycle transparent steam engine may be used to physically demonstrate each stroke.	
(2) Operating principles of open & closed cycle steam engines	The student will be able to: a. Differentiate between an open-cycle and a closed-cycle engine. b. Understand the concept of recycling the exhaust of a steam engine through a condensor. c. Apply his knowledge in industry.	Have the basic theory of open and closed, reciprocating steam engines described with the aid of diagrams. Utilize a transparent, open-cycle steam engine to exemplify the principles of open-cycle engines.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(3) Operation of the steam engine	a. Operate an open-cycle steam engine. b. Recognize the functions of each major component.	Have students observe the operation of the open-cycle and name two major components.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(4) Sub-systems of an open-cycle steam engine	The student will be able to: a. Define all major sub-systems. b. Physically examine the parts. c. Describe the function of each subsystem. d. Have the student appreciate the variances between an external and an internal combustion engine.	Direct the student into studying each major subsystem of the steam engine. He should learn the functions of the superheater, boiler, valve arrangment, crank-shaft, cams and gears.	
(5) Coupling an open-cycle steam engine	The student will be able to: a. Use an electric dynamometer.	Utilize an electric dynamometer/generator to measure the horse-power of the steam engine.	
(6) Horsepower measure-ment of an open-cycle steam engine	The student will be able to: a. Calculate the horsepower output of the steam engine. b. Properly measure the torque and speed of the steam en-gine.	Offer the experimental procedure in measuring the torque and speed of the steam engine. A method of calculating the horsepower from the obtained data is described. Ample use of photographs should help the student to operate the engine properly.	

TOPIC OUTLINE	PERFORMANCE OBJECTIVES	SUGGESTED ACTIVITIES	RESOURCES
(7) Effect of steam rates on engine power	The student will be able to: a. Make proper adjustments of steam flow into the engine. b. Measure the horsepower change at different steam flow rates.	Explain that the power output of a steam engine is dependent upon the amount of steam admitted during the intake stroke. Have the students operate an engine.	SEE STATE DEPARTMENT OF EDUCATION'S ADOPTED TEXTBOOK LIST FOR RESOURCE MATERIALS. ALSO SEE LIST AT THE END OF THIS GUIDE.
(8) Superheat in steam engines	Students will be able to: a. Differentiate between superheated steam and wet steam by its properties. b. Understand why it affects the engine performance.	Explain the effect of superheat on engine efficiency and power output. Introduce the concept of wet and dry steam and its importance on engine operation.	
(9) Efficiency of a steam engine	The student will be able to: a. Establish why steam engines are inefficient. b. Learn how to calculate the efficiency of a steam engine. c. Estimate, from the obtained data, the efficiency of the open-cycle steam engine.	Explain that the steam engines are basically inefficient. Offer a method of calculating the efficiency of a steam engine.	
(10) Operating principles of turbines	The student will be able to: a. Group the basic differences of reciprocating vs. rotary external engines. b. Describe how a turbine operates.	Transparencies and cut-away models may be utilized to relate the principles with actual models.	

POWER TECHNOLOGY

Resource Materials

The following list of resource materials is by no means complete nor exhaustive. It merely represents a compilation of the best and most available materials known and used by the members of the committee.

1. A Guide for Equipping Industrial Arts Facilities. Washington, D.C.: The American Industrial Arts Association, 1967.

2. Althouse, Andrew, D., William A. Bowditch, and Carl H. Turnquist. Modern Welding. South Holland, Illinois: Goodheart-Wilcox Co., 1970.

3. Artic Enterprises, P. O. Box 643, Theif River Falls, Minnesota, 56701.

4. Attberry, Pat H. Power Mechanics. Homewood, Ill.: Goodheart-Wilcox Company, Inc., 1961.

5. Begman, Myron L. Manufacturing Processes. 4th ed., New York: John Wiley and Sons, Inc., 1960.

6. Boan & MacDonald. Power Mechanics of Energy Control. Bloomington, Illinois: McKnight & McKnight Publishing Company.

7. Bohn, Ralph C. and Angus J. MacDonald. Power Mechanics of Energy Control. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1970.

8. Bohn, Ralph C. and Angus J. MacDonald. Power Mechanics. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1972.

9. Briggs and Stratton Manufacturing Company.

10. DCA Educational Products, Inc., DCA's Power Technology Series Transparencies Set: 4865 Stenton Avenue, Philadelphia, Pa., 19144.

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12. "Free" Sams Educational Materials Catalog. 4300 W. 62nd St., Indianapolis, Indiana, Howard W. Sams Company.

13. General Power Technology for Industrial Arts. 2nd ed. Georgia Department of Education, 1969.

14. Glenn, Harold T. Exploring Power Mechanics. 3rd ed. Peoria, Illinois: Charles A. Bennett Company, Inc., 1972.

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16. Groneman, Chris H. and John L. Feirer. General Shop. New York: McGraw-Hill, Inc., 1963.

17. Independent Garage Owners Association.

18. Industrial Arts Education for Louisiana Schools, Bulletin No. 1197.

19. Johnson, Harold V. General-Industrial Machine Shop. Peoria, Illinois: Charles A. Bennett Company, 1963.

20. MacDonald, K. L. Small Gasoline Engines. Indianapolis, Indiana: Howard W. Sams Company, Inc., 1972.

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22. Mechanics Handbook. Grafton, Wisconsin: Tecumseh Products Company, 1971.

23. Outboard Marine Corporation, Lincoln, Nebraska: 68501.

24. Pipe, Ted. Small Gasoline Engines Training Manual. 2nd ed. Kansas City: Howard W. Sams and Company, Inc., 1972.

25. Prakken, Lawrence W., ed. School Shop. Ann Arbor, Michigan: Prakken Publications, Inc.

26. Purvis, Jud. All About Small Gas Engines. Goodheart-Wilcox Company, Inc.

27. Safety in Industrial Arts Education for Louisiana Schools. Bulletin No. 1203. State Department of Public Education, 1971.

28. Small Engines - Car, Operation, Maintenance, and Repair, Vol. II. Doraville, Ga.: Foote and Davies.

29. Stephenson, George E. Power Technology. Albany, New York: Delmar Publishers, 1973.

30. Stephenson, George E. Small Gasoline Engines. Albany, New York: Delmar Publishers, 1964.

31. Stewart, Harry L. and John M. Storer. Fluid Power. Indianapolis, Indiana: Howard W. Sams and Company, Inc., 1970.

32. Sullivan, J. A. Developing Instructional Systems for the Power Laboratory. Department of Occupational Education, School of Engineering and Technology, Southern Illinois University, Carbondale.

33. Tune-Up Services & Trouble Shooting. Indianapolis, Indiana: Howard W. Sams and Company, Inc., 1972.

34. Units and Student Experiments. Southwest Texas State College Industrial Arts Department, San Marcos, Texas, 1970.

35. Wetzel, Guy F. Automotive Diagnosis and Tune-Up. 5th ed. Bloomington, Illinois: McKnight Publishing Company, 1970.

36. Wisconsin Manufacturing Company.

37. Lux, Donald G., Willis E. Ray, and H. Dean Hauenstein. World of Construction. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1971.