DOCUMENT RESUME

ED 131 294 CE 008 907

TITLE	Vocational-Technical Physics Project. Instructor's Manual. Field Test Edition.
INSTITUTION	Forsyth Technical Inst., Winston-Salem, N.C.
SPONS AGENCY	North Carolina State Dept. of Public Instruction, Raleigh. Occupational Research Unit.
REPORT NO	VT-103-239
NOTE	48p.; For related documents see, CE 008 904-906 and CE 008 966
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	Individualized Curriculum; Laboratory Manuals; *Learning Activities; *Mechanical Equipment; *Physics Curriculum; *Physics Instruction; Secondary Education; Teaching Guides; Technical Education; Vocational Education
IDENTIFIERS	Alternators (Electric Generators); Jacks (Lifts); Thermometers

ABSTRACT

This instructor's manual in vocational physics consists of five modules: Jacks, Thermometers, The Alternator, The Pool Table, and The Radiator. It is an individualized approach, designed for use with accompanying student manuals on each of the individual modules. Each module in the instructor's manual consists of a general description plus an outline of student objectives, prerequisites laboratory exercises, equipment and supplies, audiovisual materials, tests, instructional strategies, and estimated completion time. Appended to the manual is more specific information about equipment and supplies, including sources of supplies and costs. Tests and keys for each of the modules are appended. (NJ)

FIELD TEST EDITION

INSTRUCTOR'S MANUAL

Vocational Technical Physics Project

Sponsored By

the

Occupational Research Unit

State Department of Education

Raleigh, North Carolina

MODULE I.

JACKS

I. DESCRIPTION

A discussion of some theoretical and practical aspects of simple machines. Certain mechanical concepts and their applications are explained with emphasis on conservation of energy, inherent inefficiency of machines, and stresses in materials under load.

II. OBJECTIVES

A. After completing this module, the student will be able to recognize the definitions and applications of the following terms. Testing will be by multiple choice questions.

1. Weight
2. Simple Machine
3. Lever
4. Inclined Plane
5. Hydraulic Press
6. Actual Mechanical Advantage
7. Theoretical Mechanical Advantage
8. Work
9. Pressure
10. Energy
11. Friction
12. Efficiency
13. Torque
14. Stress
15. Tensile Stress
16. Compressive Stress
17. Shear Stress
18. Ultimate Strength
19. Elasticity
20. Safety Factor

B. The student will also be able to solve numerical problems involving the following quantities.

1. Actual Mechanical Advantage
2. Theoretical Mechanical Advantage
3. Work
4. Pressure
5. Efficiency
6. Torque
7. Stress

III. PRE-REQUISITES

Before beginning this module, the student should be able to work the following types of mathematical problems.

1. Given several numbers, calculate the average of their values.
2. Given the diameter of a circle, calculate its area and circumference.
3. Given the diameter and height of a cylinder, calculate its lateral surface area.
4. Make conversions between the following units:

   (a) inches - feet
   (b) ounces - pounds
   (c) grams - kilograms

The student should also be able to read the scale of an English/metric rule and the scale of a spring balance.

IV. LABORATORY EXERCISES

1. Mechanical Advantage of the Ratchet Bumper Jack.
2. Mechanical Advantage of the Hydraulic Jack
3. Efficiency of a Jack
4. Load Limitations on Jacks

V. EQUIPMENT AND SUPPLIES (by experiment)

1. Mechanical Advantage of the Ratchet Bumper Jack
   a. ratchet bumper jack
   b. loads of 25, 50 and 75 pounds (see appendix I)
   c. spring scale, 0-72 oz. or 0-2000 g.
   d. two jack handles, one 6 in. long and one 12 in. long
   e. bathroom scale

2. Mechanical Advantage of the Hydraulic Jack
   a. two hydraulic jacks, different sizes, with platforms (see appendix I)
   b. loads of 25, 50 and 75 pounds (see appendix I)
   c. spring scale, 0-72 oz. or 0-2000 g.
   d. jack handle, 12 in. long
   e. rule, English or metric
   f. bathroom scale

3. Efficiency of a Jack
   a. ratchet bumper jack
   b. two hydraulic jacks, different sizes, with platforms (see appendix I)
   c. loads of 50 and 100 pounds (see appendix I)

d. spring scale, 0-72 oz. or 0-2000 g.
e. jack handle, 12 in. long
f. rule, English
g. bathroom scale

4. Mechanical Advantage and Efficiency of the Screw Jack
   a. screw jack, with platforms (see appendix I)
   b. loads of 50, 75 and 100 pounds (see appendix I)
   c. spring scale, 0-72 oz. or 0-2000 g.
   d. three jack handles, 6 in., 12 in., and 18 in. long
   e. rule, English or metric
   f. lubricating oil, a light machine oil
   g. a solvent such as kerosene or carbon tetrachloride

5. Load Limitations on Jacks
   a. ratchet bumper jack
   b. two hydraulic jacks, different sizes
   c. screw jack
   d. rule, English or metric

VI. AUDIO-VISUAL MATERIALS

A. Required

1. Sound/slide "Simple Machines and the Concept of Work" (51 slides, 1 tape-15 min.)

2. Sound/slide "Using Jacks" (55 slides, 1 tape - 15 min.)

3. Sound/slide "Load Limitations" (31 slides, 1 tape- 15 min.)

B. Optional

1. Film, 16 mm "Simple Machines: Work and Mechanical Advantage", color, 14 min. Coronet Instructional Media, 369 W. Erie Street, Chicago, Illinois 60610

2. Film, 16 mm "Behavior of Structural Materials" color, 22 min. McGraw-Hill Textfilms, 330 W. 42nd Street, New York, New York 10036
   (Shows how structural materials behave under various kinds of stress)

3. Filmstrip "Simple Machines Make Work Easier" No. 554 from set A-10 Mechanics, Popular Science Audio-Visuals, Inc., 335 Lexington Avenue, New York, New York 10017

4. Filmstrip "Experiments with Simple Machines" No. A449-5, Society for Visual Education, Inc. 1345 Diversy Parkway Chicago, Illinois 60614.

VII. TESTS

One pre-test (35 items-multiple choice), one post-test (35 items-multiple choice), and one scoring key. (see appendix II)

VIII. INSTRUCTIONAL STRATEGIES

A. Suggested Procedure for Students

1. See that student can meet pre-requisites.
2. Give the pre-test.
3. Instruct students to begin reading module and performing the laboratory experiments.
4. Take up laboratory data sheets as the student completes them.
5. Instruct students to use the available audio-visual materials after completing each unit.
6. Student should answer review questions and discuss them with the instructor.
7. After student completes module, give the post-test.

B. General

1. Orient students to modular materials and the "application approach" to learning physics.
2. Assign students to work through module in groups of two or three.
3. Additional groups can be started on this module at 3-4 hour intervals.
4. Caution students about danger of loads falling off jacks.
5. If experimental determination of mechanical advantage is inconsistant, try increasing this amount of weight being lifted.
6. It may be necessary to use a vernier calipher to accurately measure the diameters of cylinders in Experiments no. 2 and 5.
7. Caution students about the particular solvent they use in Experiment no. 4.
8. In most cases it will be desirable to have students hand in complete booklet for laboratory grading instead of tearing data sheets out.
9. Use the review questions to keep track of student progress.
10. Use student performance sheet for tracking (see appendix III).

IX. ESTIMATED COMPLETION TIME FOR MODULE

15 Contact Hours

6

MODULE II
THERMOMETERS

I. DESCRIPTION

An examination of the operation of several types of thermometers is used as a means to study the effect of heat. Kinetic molecular theory is used to explain the concept of heat and temperature. Expansion thermometers are used to study the effects of heat on solids, liquids and gases. Thermocouples and thermistors are discussed because of their technological importance.

II. OBJECTIVES

After completing this module the student will be able to do the following.

A. Use molecular theory to describe the differences between

1. heat and temperature, and
2. solids, liquids, and gases.

Testing will be by multiple choice questions.

B. Describe the construction and operation of

1. a bimetallic thermometer
2. a liquid-in-glass thermometer,
3. a constant volume gas thermometer,
4. a constant pressure gas thermometer,
5. a thermocouple thermometer, and
6. a thermistor thermometer.

Testing will be by discussion questions.

III. PRE-REQUISITES

The students should be able to read the scales of the following instruments.

1. metric rule
2. mercury-in-glass thermometer
3. Bourdon pressure gauge
4. millivolt meter
5. ohmmeter
6. milliammeter

IV. LABORATORY EXERCISES

1. An Observation of Linear Expansion
2. Making a Bimetallic Thermometer
3. Making a Liquid-in-Glass Thermometer
4. Making Two Gas Thermometers
5. Making and Testing Some Thermocouples
6. Making and Using a Real Thermocouple
7. A Comparison of Thermistors with Ordinary Materials
8. Calibrating a Thermistor

V. EQUIPMENT AND SUPPLIES (by experiment)

1. An Observation of Linear Expansion
    a. two support bases with rods
    b. aluminum wire, #18 - #22 gauge
    c. small weight with hook
    d. metric rule
    e. matches
    f. bunsen burner or propane torch

2. Making a Bimetallic Thermometer
    a. bimetallic coil from a thermostat or automatic choke
    b. wooden block, about 2"x2"x1/2"
    c. wood screws
    d. ice
    e. beaker, 800 ml or larger
    f. hot plate
    g. mercury thermometer

3. Making a Liquid-in-Glass Thermometer
    a. thistle tube funnel
    b. rubber stopper (size to fit funnel)
    c. ethyl alcohol
    d. dye or food coloring
    e. ice
    f. beaker
    g. hot plate
    h. mercury thermometer
    i. metric rule

4. Making Two Gas Thermometers
    a. support base with rod
    b. buret clamps
    c. two boiling flasks, 250 ml
    d. beaker, 800 ml or larger
    e. two hole stopper, no. 4
    f. one hole stopper, no. 4
    g. glass tubing
    h. rubber tubing
    i. rubber rubing clamp
    j. pressure gauge, 0-30 psi (or less)
    k. ice
    l. hot plate
    m. mercury thermometer

5. Making and Testing Some Thermocouples
   a. aluminum wire, #22 gauge
   b. copper wire, enameled, #22 gauge
   c. iron wire, #22 gauge
   d. millivolt meter, 0-10 MV (a less sensitive scale may work)
   e. bunsen burner or propane torch

6. Making and Using a Real Thermocouple
   a. iron-constantan thermocouple wire, #24 gauge
   b. millivolt meter, 0-50 MV or 0-100 MV
   c. candle

7. A Comparison of Thermistor with Ordinary Materials
   a. iron wire, #22 gauge
   b. thermocouple wire, type J (see Appendix I)
   c. bunsen burner or propane torch
   d. thermistor, disc type (see Appendix I)
   e. ohmmeter

8. Calibrating a Thermistor
   a. electric water temperature gauge (automotive) such as TRW no. 610563, includes thermistor and ammeter (ammeter not used)
   b. milliammeter, 0-100 ma
   c. resistor, 100 ohms
   d. 12 volt battery, or D. C. power supply
   e. beaker, 800 ml
   f. hot plate
   g. mercury thermometer
   h. connecting wires

VI. AUDIO-VISUAL MATERIALS

A. Required

1. Sound/slide "Temperature and Heat" (36 slides, 1 tape - 15 min.)
2. Sound/slide "Expansion Thermometers" (46 slides, 1 tape - 15 min.)
3. Sound/slide "Electrical Thermometers" (42 slides, 1 tape - 15 min.)

B. Optional

1. Film, 16 mm "The State of Matter" color, 18 min. CRM Educational Films, Del Mar, Calif. 92014.
2. Film, 16 mm "Molecular Theory of Matter", color, 12 min. Encyclopedia Britannia Educational Corp., 425 Michigan Ave., Chicago, Ill. 60611.
3. Filmstrip "Kinetic Molecular Theory" Chemistry Series Set 1, No. 619001, McGraw-Hill Book Co.
4. Film loop, 8 mm "Heat Expands Metals" No. 13035, Doubleday Multimedia
5. Film loop, 8 mm "Heat Expands Liquids" No. 13045, Doubleday Multimedia
6. Film loop, 8 mm "Heat Expands Gases" No. 13055, Doubleday Multimedia.

VII. TESTS

One pre-test (9 items multiple choice and 6 items discussion) one post-test (9 items multiple choice and 6 items discussion), and one scoring key (see appendix II).

VIII. INSTRUCTIONAL STRATEGIES

A. Suggested Procedure for Students

1. See that student can meet pre-requisites.
2. Give the pre-test.
3. Instruct students to begin reading module and performing the laboratory experiments.
4. Take up laboratory data sheets as the student complete them.
5. Instruct students to use the available audio-visual materials after completing each unit.
6. Student should answer review questions and discuss them with the instructor.
7. After student completes module, give the post-test.

B. General

1. Orient students to the use of modules materials and the "application approach" to learning physics.
2. Instruct students in the use of the audio-visual equipment.
3. Assign students towork through the module in groups of one to three. Additional groups can be started on the module any time if enough supplies, hot plates and mercury thermometers are available.

4. Caution students to wear safety glasses when noted in the module.
5. Use student performance sheet for tracking (see Appendix III).

IX. ESTIMATED COMPLETION TIME FOR MODULE

15 Contact Hours

MODULE III

THE ALTERNATOR

I. DESCRIPTION

A discussion of the basic electrical quantities, their relationship, and their measurement. Emphasis is on electro-magnetic interactions and energy conversion.

II. OBJECTIVES

A. After completing the module, the student will be able to recognize the definitions and applications of the following terms. Testing will be by multiple choice questions.

1. electric potential
2. electric current
3. resistance
4. volt
5. ampere
6. ohm
7. voltmeter
8. ammeter
9. ohmmeter
10. magnet
11. generator
12. alternator
13. diode
14. alternating current
15. direct current
16. oscilloscope
17. energy
18. power
19. joule
20. watt
21. series circuit
22. parallel circuit
23. torque
24. efficiency

B. The student will be able to name the factors that

1. determine the resistance of a material,
2. determine the strength of an electromagnet, and
3. determine the size of an induced voltage.

Testing will be fill-in-the blank questions.

C. The student will also be able to solve numerical problems involving the following quantities.

1. electric current
2. voltage
3. resistance
4. energy
5. power

III. PRE-REQUISITES

Before beginning the module, the student should be able to work the following types of mathematical problems.

1. Given two whole numbers, calculate their product.
2. Given two whole numbers, one a dividend and one a divisor, calculate the quotient.
3. Given two decimal fractions, calculate their sum.
4. Given two decimal fractions, calculate their differences.

The student should also be able to read a mercury-in-glass thermometer.

IV. LABORATORY EXERCISES

1. Measuring Electric Potential Difference
2. Measuring Electric Current
3. Measuring Resistance
4. Ohm's Law
5. The Magnetic Field Around A Permanent Magnet
6. The Magnetic Field Around A Current-Carrying Wire
7. Induced Voltage
8. Alternating Current
9. Controlling Alternator Voltage
10. Resistive Heating
11. Series and Parallel Circuits
12. Converting Manpower into Watts
13. Energy Loss in the Alternator

V. EQUIPMENT AND SUPPLIES (by experiment)

1. Measuring Electric Potential Difference

   a. multimeter (such as Simpson Model 260 SP)
   b. several different d.c. voltmeters
   c. several different batteries

2. Measuring Electric Current

   a. multimeter
   b. several different d.c. ammeters
   c. 12 or 6 volt battery or d.c. power supply
   d. several power resistors, 10 to 100 ohms
   e. connecting wires

3. Measuring Resistance

   a. multimeter
   b. several resistors with color code
   c. resistance coils of different lengths, gauges and materials
   d. iron wire, #22 gauge
   e. bunsen burner

4. Ohm's Law

   a. 12 or 6 volt battery or d.c. power supply
   b. d.c. ammeter, 0-1 A
   c. d.c. voltmeter, 0-10 V
   d. resistor, about 25 ohms - 5 watt
   e. resistance coils of different lengths, gauges and materials
   f. alternator field coil
   g. connecting wires

5. The Magnetic Field Around a Permanent Magnet

   a. bar magnet
   b. piece of cardboard
   c. iron filings
   d. horseshoe-shaped magnet
   e. magnetic compass
   f. meter stick

6. The Magnetic Field Around A Current-Carrying Wire

   a. 12 or 6 volt battery
   b. d.c. ammeter, 0-10 A
   c. piece of cardboard
   d. iron filings
   e. variable resistor, about 0-10 ohms - 10 amps
   f. magnetic compass
   g. alternator field coil
   h. meter stick

7. Induced Voltage

   a. galvanometer
   b. bar magnet, 4 inches long with hole through center of flat side, with base (see Appendix I)
   c. horseshoe magnet
   d. coil of wire, about 200 turns or more and large enough to slide bar magnet into its center
   e. alternator armature

8. Alternating Current

   a. oscilloscope, d.c., such as Telequipment Model 551B
   b. ~~several different batteries~~
   c. 120 to 6 (or 12) volt transformer
   d. coil of wire
   e. alternator armature
   f. bar magnet, 4 inches long mounted on base (see Appendix I)

g. diode from alternator
h. resistor, 100 ohm
i. connecting wire
j. ohmmeter

9. Controlling Alternator Voltage

a. alternator-motor assembly (see Appendix I)
b. battery, 6 or 12 volt
c. d.c. ammeter, 0-1 amp
d. d.c. voltmeter, 0-12 volts
e. variable resistor, about 0-10 ohms -1 amp
f. connecting wires

10. Resistive Heating

a. alternator-motor assembly (see Appendix I)
b. battery, 12 volt
c. 30 watt, 5 ohms resistor and water container, or an electrical calorimeter
d. d.c. ammeters, 0-5 amp
e. d.c. voltmeter, 0-12 volt
f. watch, with second hand, or stop watch
g. mercury thermometer
h. connecting wires

11. Series and Parallel Circuits

a. alternator-motor assembly (see Appendix I)
b. battery, 12 volt
c. d.c. ammeter, 0-15 amps
d. d.c. voltmeter, 0-12 volt
e. three headlights, 12 volt, type 6014, with sockets (see Appendix I)
f. connecting wires

12. Converting Manpower into Watts

a. alternator-motor assembly (see Appendix I)
b. battery, 12 volt
c. hand crank (see Appendix I)
d. d.c. ammeter, 0-10 amp

13. Energy Loss in the Alernator

a. alternator-motor assembly (see Appendix I)
b. battery, 6 or 12 volt
c. variable resistor, about 0-10 ohm- 1 amp
d. four headlights, 12 volt, type 6014, with sockets (see Appendix I)

e. d.c. voltmeter, 0-12 volt
f. d.c. ammeter, 0-20 amp
g. connecting wires

VI. AUDIO-VISUAL MATERIALS

A. Required

1. Sound/slide "Current Electricity" (55 slides, 1 tape-15 min.)
2. Sound/slide "Magnets from Electricity" (37 slides, 1 tape - 15 min.)
3. Sound/slide "Electricity from Magnets" (38 slides, 1 tape - 15 min.)
4. Sound/slide "Energy Conversion" (60 slides, 1 tape 15 min.)

B. Optional

1. Film, 16 mm "Electricity in Motion" (25 min. B&W) Encylopedia Britannica Film Inc.

2. Film, 16 mm "Magnetism and Electricity" (14 min. color) McGraw-Hill Book Co.

3. Film, 16 mm "Electromagnetic Induction" (14 min. B&W) Coronet Instructional Films

VII. TESTS

One pre-test (29 items-multiple choice, 3 items- fill-in-the-blank), one post-test (29 items- multiple choice, 3 items - fill-in-the-blank), and one scoring key. (see appendix II)

VIII. INSTRUCTIONAL STRATEGIES

A. Suggested Procedure for Students

1. See that student can meet pre-requisites.
2. Give the pre-test.
3. Instruct students to begin reading module and performing the laboratory experiments.
4. Take up laboratory data sheets as the student completes them.
5. Instruct students to use the available audio-visual materials after completing each unit.
6. Student should answer review questions and discuss them with the instructor.
7. After student completes module, give the post-test.

B. General

1. Orient students to the use of modular materials and the "application approach" to learning physics.

2. Instruct student in the use of the audio-visual equipment.

3. Assign students to work through module in groups of two or three.

4. Caution students about the danger of the belt and pulley used on the alternator-motor assembly.

5. Use student performance sheet for tracking.

IX. ESTIMATED COMPLETION TIME FOR MODULE

20 Contact Hours

MODULE IV

THE POOL TABLE

I. DESCRIPTION

A discussion of the basic concepts of mechanics-velocity, acceleration, mass, force, momentum and kinetic energy. The conservation of momentum and energy are also examined.

II. OBJECTIVES

A. When the student completes this module he will be able to recognize the definition and applications of the following quantities and the factors that determine their magnitude. Testing will be by multiple choice questions.

1. velocity
2. acceleration
3. force
4. mass
5. momentum
6. kinetic energy

B. The student will also be able to explain the results of certain collisions in terms of the concepts of:

1. conservation of momentum, and
2. conservation of energy.

Testing will be by discussion questions.

III. PRE-REQUISITES

Before beginning this module, the student should be able to work the following types of mathematical problems.

1. Given two decimal numbers, calculate their sum, their difference or their product.

2. Given a measurement in millimeters, convert it to meters.

The student should also be able to read the scale of a metric rule.

IV. LABORATORY EXERCISES

1. Measuring Velocity
2. Measuring Acceleration
3. Frictional Force
4. Transfer of Momentum
5. Energy Transfer and Conversion

V. EQUIPMENT AND SUPPLIES (by experiment)

1. Measuring Velocity

   a. Pool table (see appendix I)
   b. billiard ball
   c. Polaroid camera
   d. type 107 film
   e. tripod
   f. motorized strobe (see appendix I)
   g. photoflood lamp
   h. metric rule (see appendix I)

2. Measuring Acceleration

   (uses data from Experiment No. 1)

3. Frictional Force

   a. metric balance
   (uses data from Experiment No. 1)

4. Transfer of Momentum

   (same as for Experiment No. 1 with the addition of one billiard ball)

5. Energy Transfer and Conversion

   (same as for Experiment No. 1)

VI. AUDIO-VISUAL MATERIALS

A. Required

   1. Sound/slide "Velocity and Acceleration" (27 slides, 1 tape-15 minutes)
   2. Sound/slide "Force and Mass" (24 slides, 1 tape-15 minutes)
   3. Sound/slide "Momentum and Energy" (31 slides, 1 tape-15 minutes)

B. Optional

   1. Film, 16 mm "Velocity and Acceleration", B&W., 14 minutes, Coronet Instructional Film
   2. Film, 16 mm "Forces", B&W, 20 minutes, Modern Learning Aids

VII. TESTS

One pre-test (12 items multiple choice and 3 items discussion), one post-test (12 items multiple choice and 3 items discussion), and one scoring key (see appendix II).

VIII. INSTRUCTIONAL STRATEGIES

A. Suggested Procedure for Students

1. See that student can meet pre-requisites.
2. Give the pre-test.
3. Instruct students to begin reading module and performing the laboratory experiments.
4. Take up laboratory data sheets as the student completes them.
5. Instruct students to use the available audio-visual materials after completing each unit.
6. Student should answer review questions and discuss them with the instructor.
7. After student completes module, give the post-test.

B. General

1. Orient to the use of modular materials and the "application approach" to learning physics.
2. Instruct the students in the use of the audio-visual equipment.
3. Assign students to work through the module in groups of two or three.
4. Use student performance sheet for tracking (see appendix III).

IX. ESTIMATED COMPLETION TIME FOR MODULE

10 contact hours

MODULE V.

THE RADIATOR

I. DESCRIPTION

A discussion of the three methods of heat transfer as found in the radiator. Emphasis is on the factors that affect heat transfer by conduction, radiation and convection.

II. OBJECTIVES

A. After completing the module the student will be able to recognize the definitions and applications of the following terms. Testing will be by multiple choice questions.

1. radiator
2. heat exchanger
3. thermal energy (heat)
4. temperature
5. conduction
6. radiation
7. thermal conductivity
8. convection
9. specific heat

B. The student will also be able to name the factors that affect heat transfer by

1. conduction
2. radiation
3. convection

Testing will be by fill-in-the-blank questions.

III. PRE-REQUISITES

Before beginning the module the student should be able to read the Celsius scale of a mercury-in-glass thermometer.

IV. LABORATORY EXERCISES

1. Heat Transfer by Conduction
2. Heat Transfer by Radiation
3. Heat Transfer by Convection
4. Heat Transfer by an Automobile Radiator

V. EQUIPMENT AND SUPPLIES (by experiment)

1. Heat Transfer by Conduction
   - a. three identical glass or metal clyndrical containers (such as 140 ml overflow cans)
   - b. several sheets of notebook paper
   - c. fiberglass insulating material or some heavy fabric
   - d. hotplate (or Bunsen burner and ringstand)
   - e. large beaker, 500 - 1,000 ml
   - f. mercury-in-glass thermometer, Celsius

2. Heat Transfer by Radiation
   a. two metal containers (such as 500 ml overflow cans) identical except one white or metallic and one black
   b. hotplate (or Bunsen burner and ringstand)
   c. large beaker, 500 - 1,000 ml
   d. mercury-in-glass thermometer, Celsius

3. Heat Transfer by Convection
   a. copper coil, made by winding 10 - 12 feet of 1/4-inch flexible copper tubing around a 2 1/2-inch diameter cylinder
   b. a container large enough to contain the copper coil, such as an 800 ml beaker
   c. 2-250 ml beakers
   d. funnel
   e. rubber tubing
   f. support base and clamp for funnel
   g. ringstand
   h. alcohol, methyl or ethyl
   i. hotplate (or Bunsen burner and ringstand)
   j. ice
   k. one or more mercury-in-glass thermometers, Celsius

4. Heat Transfer by an Automobile Radiator
   a. automobile radiator (from Chevrolet Vega 1971-72, without air conditioning), Sears catalog number F28AR9330NV
   b. electric fan, two speed
   c. one-hole corks or rubber stoppers to fit radiator
   d. glass tubing
   e. rubber tubing
   f. mercury-in-glass thermometer, Celsius
   g. hot water supply

VI. AUDIO-VISUAL MATERIALS

A. Required

1. Sound/slide "Conduction and Radiation" (42 slides, 1 tape-15 min.)

2. Sound/slide "Conduction and Convection" (34 slides, 1 tape-15 min.)

B. Optional

NONE IDENTIFIED

VII. TESTS

One pre-test (10 items multiple choice, 3 items fill-in-the-blank), one post-test (10 items multiple choice, 3 items fill-in-the-blank), and one scoring key. (See appendix II)

VIII. INSTURCTIONAL STRATEGIES

A. Suggested Procedure for Students

1. See that student can meet pre-requisites.
2. Give pre-test.
3. Instruct students to begin reading module and performing the laboratory experiments.
4. Instruct students to use available audio-visual materials after completing unit.
5. Student should answer all questions in module.
6. After student completes module, give the post-test.

B. General

1. Orient students to use of modular materials and the "application approach" to learning physics.
2. Instruct students in the use of the audio-visual equipment.
3. Assign students to work through module in groups of two or three.

IX. ESTIMATED COMPLETION TIME FOR MODULE

10 Contact Hours

APPENDIX I.

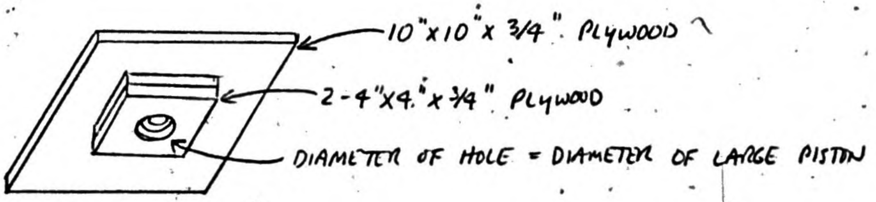
EQUIPMENT AND SUPPLIES

Module I - Jacks

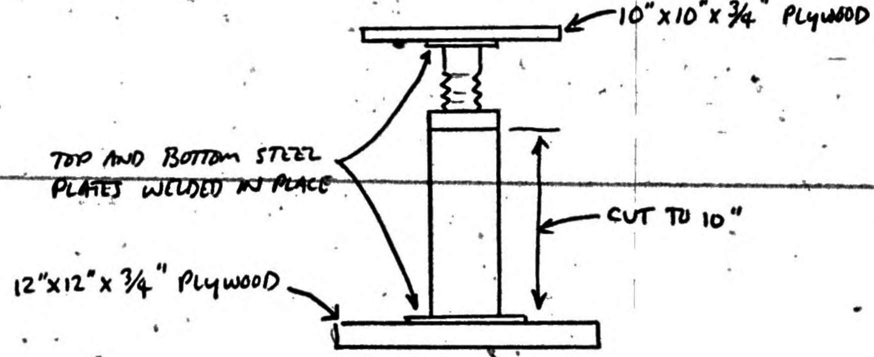
Loads For Jacks - Almost anything can be used here, such as stacks of 5 kg laboratory weights, bags or boxes of sand, or even students. The bathroom scale is used to determine the amount of load used.

Jack Handles - When using the hydraulic jack, the handle that comes with the jack is fairly heavy and will affect the calculation of A.M.A. The input force due to the weight of the handle can be determined or some pieces of 3/4 inch thinwall aluminum conduct (EMT) can be used for jack handles.

Platforms for Jacks



PLATFORM FOR HYDRAULIC JACKS (2 NEEDED)



SCREW JACK (JACK POST)

Module II. - Thermometers

Thermocouple Wire - The only requirement here is that it be an iron-constantan thermocouple. A commercial wire that works well is available from LEEDS AND NORTHRUP, 1250 National Drive, Winston-Salem, N.C. for about 10 per foot. The catalog number is 24-50-24, Type J.

Thermistor - A wide variety of thermistors would work here, such as a type LB21J1 DISC sold by FENWAL ELECTRONICS, 63 Fountain Street, Framingham, Massachusetts. This company sells a selection of twelve thermistors in their EXPERIMENTAL THERMISTOR KIT No. G200 for about $20.00.

Module III. - Alternator

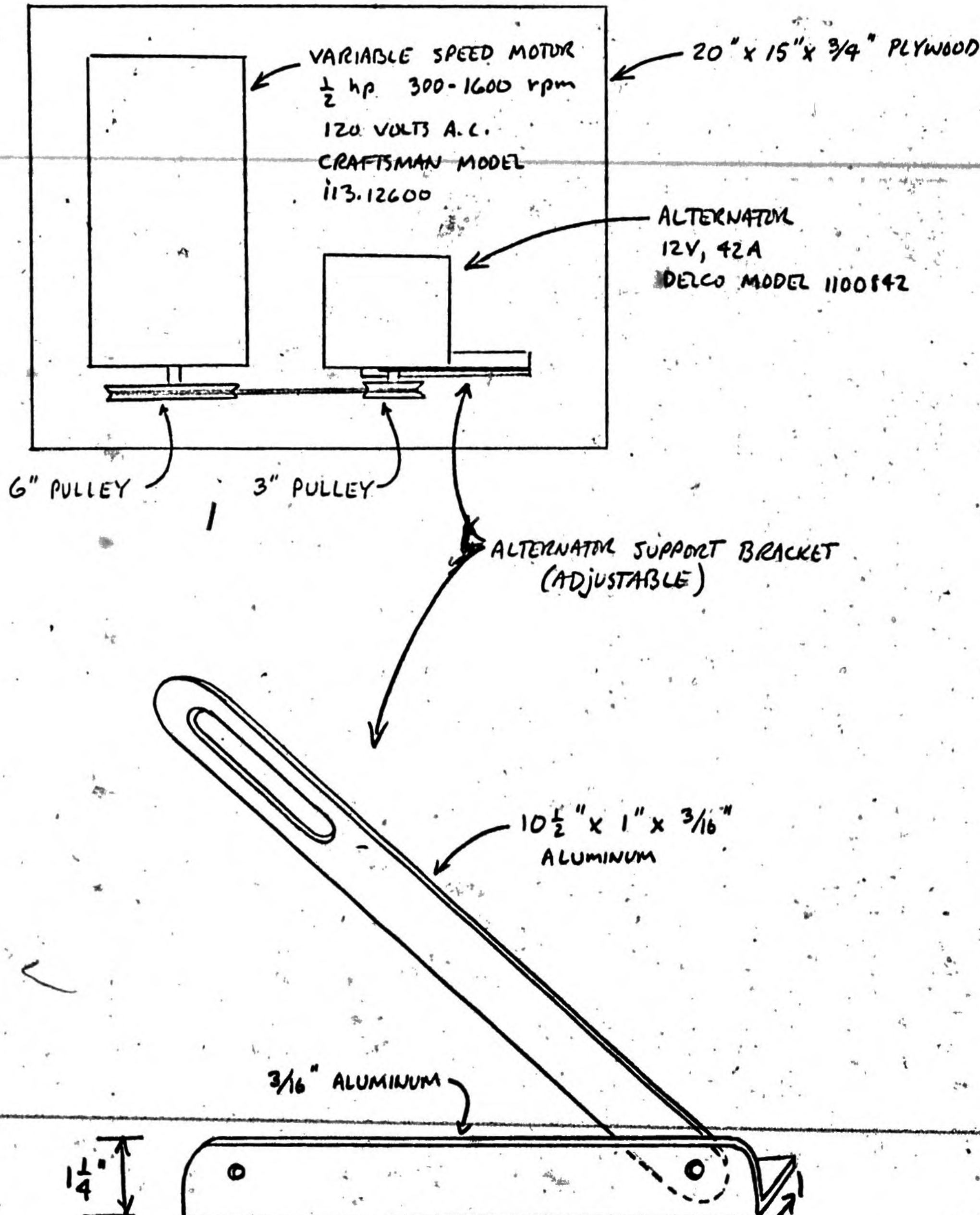
Bar Magnet - This magnet should be 4 inches long with a 3/16" hole through the middle of the flat side. The base is used to support the magnet so it can be rotated. The base should be a piece of wood, 8" x 8", with a three inch bolt through the center that will pass through the hole in the magnet. The hole in the magnet was made with an electric discharge machine in the machine shop.

Alternator-Motor Assembly- (See next page)

Hand Crank - This is a crank with a 5" arm, made to fit the end of the drive shaft of the motor.

Headlights - These are 12 volt, type 6014 automobile head lights used as electrical loads. The red and white leads are used and the black lead is taped and not used. The lights can be supported by leaving them in their original boxes, pointed up, or by mounting on a wooden board.

ALTERNATOR - MOTOR
ASSEMBLY



Module IV. - Pool Table

Pool Table - The ideal device here is a 7' x $3\frac{1}{2}$' (or smaller) pool table. The prime requirement, however is for a level, high friction surface. A fabric-covered lab table would probably work well. The fabric should be dark to provide high contrast in the photographs.

Motorized Strobe - This is a device made especially for use with the Polaroid camera. It can be obtained from SCIENCE KIT, INC., Cat. No. 65711, for $17.00. The disc with two slots should be used to get a time interval of 0.1 second. A xenon strobe light also works well, but requires that the room be darkened.

Metric Rule - A regular metric rule can be used here since it can be read to 0.5 mm. However, a device that works better is the comparator magnifier (cat. no. 30,325) and reticle (cat. no. 30,323) from EDMUND SCIENTIFIC CO. The cost is about $27.00. This enables the student to measure distances accurate to 0.1 mm.

	ITEM	SOURCE	COST
Module I Jacks	1 Ratchet Bumper Jack, 1½ ton capacity	Sears	5.00
	1 Hydraulic Jack, 1½ ton capacity	Sears	12.00
	1 Hydraulic Jack, 5 ton capacity	Sears	23.00
	1 Jack Post, Short	Sears	7.00
Module II Thermometers	1 Millivolt Meter, 0 - 100 mv, accurate to ± 2 mv, such as Fluke model 8,000 a multimeter	BSC Associates, Inc. 1039 Wendover Avenue Greensboro, NC 27405	300.00
	200 feet thermocouple wire, iron-constantan (type J) #24 Gauge	Leeds and Northrup 1250 National Drive Winston-Salem, NC (Cat. no. 24-50-24)	20.00
	1 Thermistor Kit	Fenwall Electronics 63 Fountain Street Framingham, Mass. (Cat. no. 6200)	20.00
Module III The Alternator	1 Variable speed motor, 120 v.a.c., ½ hp, 300 - 1600 r.p.m.	Sears (Craftsman Model 113.12600)	175.00
	2 Alternators, 12V, one with pulley	Any Auto parts supplier (Delco Model 1100842)	136.00
	1 Pulley, 4-inch outside Diameter, 5/8-inch Bore	Sears (Cat. no. 9 GT 28042)	2.00
Module IV	1 Pool table, any size, with balls	Brady Distributing Co. 1900 W. Morehead St. Charlotte, NC (7' x 3½' Table)	370.00
	1 Polaroid Camera, Model 420	Science Kit, Inc. (Cat. no. 65950)	68.00
	1 Motorized Strobe for Polaroid Camera	Science Kit, Inc. (Cat. no. 65711)	17.00
	1 Tripod	Science Kit, Inc. (Cat. no. 65888)	24.00
Module V The Radiator	1 Radiator, small (Such as 1971-72 Vega)	Sears (Cat. no. F2BAR9330NV)	65.00
	20 feet copper tubing, flexible, ¼-inch	Any Hardware Store	5.00
	1 Electric Fan, 2 speed	Any Appliance Store	25.00

APPENDIX II

TESTS AND KEYS

TEST - JACKS

Name ____________________ Date ______________ Score ___________

Curriculum ____________________ Time Spent on Module __________ hours

School ______________________ Time Spent on Test __________ Minutes

A. Select the letter corresponding to the term that best fits the blank. Put that letter in the space at the left of the question.

____ 1. The force that gravity exerts on bodies is called ____________.
(a) pressure (b) stress (c) weight (d) mass

____ 2. A simple machine is generally used to increase ______________.
(a) weight (b) force (c) energy (d) work

____ 3. The efficiency of a machine is less than 100% due to __________.
(a) friction (b) heat (c) stress (d) energy

____ 4. The ratio of work output to work input is called ____________.
(a) safety factor (b) efficiency (c) actual mechanical advantage (d) theoretical mechanical advantage

____ 5. A rigid bar that is free to pivot about a point is a __________.
(a) hydraulic press (b) inclined plane (c) lever (d) wedge

____ 6. The measure of the turning effort of a force is called __________.
(a) lever (b) work (c) gravity (d) torque

____ 7. A screw is an example of the ______________.
(a) wedge (b) lever (c) hydraulic press (d) inclined plane

____ 8. Applying a force to a piece of metal creates ________________.
(a) work (b) stress (c) friction (d) torque

____ 9. A simple machine using pistons and cylinders is the __________.
(a) block and tackle (b) lever (c) cam (d) hydraulic press

____10. The ratio of output force to input force is ________________.
(a) actual mechanical advantage (b) theoretical mechanical advantage (c) efficiency (d) safety factor

____11. Pulling something apart causes a ______________________.
(a) shear stress (b) compressive stress (c) tensile stress (d) torque

____12. The ratio of input distance to output distance is ____________.
(a) actual mechanical advantage (b) theoretical mechanical advantage (c) efficiency (d) safety factor

_____13. Exerting a force over a distance is an example of ____________.
(a) stress (b) pressure (c) weight (d) work

_____14. Pushing something together causes a ________________.
(a) torque (b) tensile stress (c) shear stress (d) compressive stress

_____15. Applying a force to a fluid creates ________________.
(a) pressure (b) torque (c) work (d) friction

_____16. The ability of a metal to return to its original shape after being stretched is ________________.
(a) efficiency (b) energy (c) safety factor (d) elasticity

_____17. Cutting a metal causes ______________. (a) torque
(b) tensile stress (c) shear stress (d) compressive stress

_____18. The ability to do work is called ______________. (a) energy
(b) friction (c) pressure (d) efficiency

_____19. The stress required to break a metal is called ______________.
(a) elastic limit (b) ultimate strength (c) safety factor
(d) tensile stress

_____20. The ratio of breaking load to allowable load is ____________.
(a) actual mechanical advantage (b) theoretical mechanical advantage (c) safety factor (d) efficiency

_____21. A simple machine cannot increase ______________. (a) force
(b) work (c) distance (d) torque

_____22. Actual mechanical advantage does not equal theoretical mechanical advantage due to ________________. (a) weight (b) work
(c) stress (d) friction

_____23. A wrench is used to apply ________________. (a) pressure
(b) stress (c) torque (d) distance

_____24. Friction in a machine causes input work to be changed to ________________. (a) heat (b) force (c) output work
(d) potential energy

_____25. Punching a hole in a piece of metal causes ________________.
(a) tensile stress (b) shear stress (c) compressive stress
(d) elasticity

B. Select the letter corresponding to the answer that matches yours or is very close.

_____26. A 10,000 pound weight is lifted a distance of 1/8 inch by an effort of 25 pounds applied to an 18-inch handle on a screw jack for one revolution. Find the actual mechanical advantage.
(a) 400 (b) 144 (c) 905 (d) 452

_____27. Find the work done by the jack in problem #26. (a) 1,250 foot-lbs. (b) 236 foot-lbs. (c) 37.5 foot-lbs. (d) 104 foot-lbs.

_____28. Find the torque exerted on the jack handle in problem #26. (a) 1,250 foot-lbs. (b) 37.5 foot-lbs. (c) 236 foot-lbs. (d) 104 foot-lbs.

_____29. The small piston in a hydraulic has a diameter of ½ inch and moves 2 inches when an effort of 20 pounds is applied. This causes the large piston, with a diameter of 2 inches to move 1/8 inch lifting a load of 300 pounds. What is the theoretical mechanical advantage? (a) 16 (b) 15 (c) 102 (d) 95.5

_____30. Find the pressure created in the large cylinder in problem #29. (a) 40 psi (b) 15 psi (c) 102 psi (d) 95.5 psi

_____31. Find the efficiency of the hydraulic jack in problem #29. (a) 107% (b) 94% (c) 90% (d) 95.5%

_____32. If a ¼inch diameter cable is made of a steel with an ultimate tensile strength of 75,000 psi, how much weight will it support before breaking? (a) 1,527,887 lbs. (b) 3,682 lbs. (c) 14,726 lbs. (d) 4,688 lbs.

_____33. If 5,000 pounds is required to punch a 1 inch diameter hole in a 1/10 inch thick sheet of aluminum, find the ultimate shear strength of the aluminum. (a) 5,000 psi (b) 6,366 psi (c) 50,000 psi (d) 15,915

_____34. A ratchet bumper jack with an actual mechanical advantage of 30 is used to lift the end of a car. As an effort of 50 pounds is moved through a distance of 20 feet the car is raised 6 inches. Find the weight of the load lifted. (a) 1,500 lbs. (b) 1,200 lbs. (c) 600 lbs. (d) 2,000 lbs.

_____35. Find the theoretical mechanical advantage of the jack in problem #34. (a) 120 (b) 30 (c) 40 (d) 75

TEST - THERMOMETERS

Name ______________________________ Date ____________ Score ________

Curriculum ______________________________ Time Spent on Module ________ Hours

School ______________________________ Time Spent on Test ________ Minutes

A. Select the letter corresponding to the term that best fits the blank. Put that letter in the space at the left of the question.

_____ 1. Thermometers measure the ______________ of a body.
(a) heat (b) temperature (c) molecules (d) energy

_____ 2. The total of the energy of all the molecules of a body is called ____________. (a) heat (b) temperature (c) degrees (d) expansion

_____ 3. The average of the energy of the molecules of a body is called ____________. (a) heat (b) temperature (c) degrees (d) expansion

_____ 4. Adding a cup of cold water to a bucket of warm water will cause the temperature of the water to ______________. (a) increase (b) decrease (c) remain the same

_____ 5. Adding a cup of cold water to a bucket of warm water will cause the thermal energy of the water to ______________. (a) increase (b) decrease (c) remain the same

_____ 6. Adding heat to a body causes the molecules to ____________.
(a) speed up (b) slow down (c) multiply (d) remain the same

_____ 7. Degrees are used to measure ____________. (a) energy (b) heat (c) expansion (d) temperature

_____ 8. Molecules have the most freedom to move in a ______________.
(a) solid (b) liquid (c) gas

_____ 9. Molecules have the least freedom to move in a ______________.
(a) solid (b) liquid (c) gas

B. The following are discussion questions. Use the space below the question to write your answer. Use a small sketch if it helps. If more space is needed use the back of the test.

1. Describe a bimetallic thermometer and explain how it works. Include an explanation of why two different metals must be used.

2. Describe a liquid-in-glass thermometer and explain how it works. Include an explanation of how the liquid used limits the temperature range of the thermometer.

3. Describe a constant-volume gas thermometer and explain how it works.

4. Describe a constant-pressure gas thermometer and explain how it works.

5. Describe a thermocouple thermometer and explain how it works.

6. Describe a thermistor thermometer and explain how it works.

TEST - THE ALTERNATOR

Name ______________________ Date: ______________ Score __________

Curriculum ______________ Time Spent on Module: ____________ Hours

School ______________ Time Spent on Test: ____________ Minutes

A. Select the letter corresponding to the term that best fits the blank. Put that letter in the space at the left of the question.

_____ 1. The work that an electron can do, divided by the amount of charge, is called ________________.
(a) efficiency (b) electric potential (c) power (d) resistance

_____ 2. The movement of electrons is called ____________________.
(a) energy (b) power (c) electric current (d) volts

_____ 3. A device used to study a rapidly changing voltage is an __________
(a) oscilloscope (b) ohmmeter (c) ammeter (d) alternator

_____ 4. The rate at which energy is converted from one form to another is called ________________. (a) efficiency (b) torque (c) joules (d) power

_____ 5. Relative motion between a conductor and a ______________ will induce a voltage. (a) diode (b) magnet (c) generator (d) watt

_____ 6. Opposition to an electric current is called ________________.
(a) voltage (b) power (c) torque (d) resistance

_____ 7. Electric potential is measured with a(n) ________________.
(a) voltmeter (b) ohmmeter (c) ammeter (d) diode

_____ 8. The current is the same in all parts of a ____________ circuit.
(a) direct (b) series (c) alternating (d) parallel

_____ 9. Mechanical energy is converted to electrical energy by a __________.
(a) voltmeter (b) magnet (c) generator (d) diode

_____10. Electric current is measured with an ________________.
(a) ammeter (b) ohmmeter (c) alternator (d) oscilloscope

_____11. Power is measured in ____________. (a) joules (b) volts (c) ohms (d) watts

_____12. The measure of the turning effort of a force is called __________.
(a) torque (b) energy (c) power (d) efficiency

_____13. Electric current that changes direction at regular time intervals is called ______________. (a) electric potential (b) direct current (c) alternating current (d) energy

_____14. A resistor is an example of an ____________ conversion device.
(a) ampere (b) power (c) torque (d) energy

_____15. Electric potential is measured in ______________. (a) amperes (b) volts (c) ohms (d) watts

_____16. Electric current is measured in ______________. (a) amperes (b) volts (c) ohms (d) watts

_____17. Resistance is measured in ______________. (a) amperes (b) volts (c) ohms (d) watts

_____18. A battery puts out ______________ when connected to a load. (a) ohms (b) direct current (c) alternating current (d) efficiency

_____19. Alternating current is changed to direct current by a ______________. (a) generator (b) alternator (c) series circuit (d) diode

_____20. Resistance is measured with an ______________. (a) ohmmeter (b) ammeter (c) oscilloscope (d) alternaor

_____21. Energy is measured in ______________. (a) watts (b) joules (c) volts (d) amps

_____22. The voltage is the same across each device in a ______________ circuit. (a) direct (b) series (c) alternating (d) parallel

_____23. A measure of how well a device converts the energy put into it into the kind of energy you want is called ______________. (a) torque (b) efficiency (c) resistance (d) power

_____24. A device that supplies the electrical energy for an automobile is called an ______________. (a) ammeter (b) ohmmeter (c) alternator (d) oscilloscope

B. Fill in the blanks in the following statements.

1. The resistance of a material is determined by

   (a) ______________, (b) ______________,
   (c) ______________, and (d) ______________.

2. The strength of an electromagnet is determined by

   (a) ______________, (b) ______________, and
   (c) ______________.

3. The size of an induced voltage is determined by

   (a) ______________, (b) ______________, and
   (c) ______________.

C. Work the following problems and select the answer that matches yours or is very close.

_______ 1. Calculate the current that will be in a 5 ohm resistor when a voltage of 120 volts is across it.
(a) 240 (b) 2.4 (c) 24 (d) 0.042 amps

_______ 2. Calculate the voltage across a 30 ohm resistor that has 3 amps in it.
(a) 90 (b) 0.1 (c) 10 (d) 900 volts

_______ 3. Calculate the internal resistance of an alternator which has an internal voltage drop of 8 volts when the load current is 40 amps.
(a) 2 (b) 0.2 (c) 5 (d) 0.5 ohms

_______ 4. Calculate the power rating of a light bulb that carries 0.5 amps at 120 volts.
(a) 75 (b) 6 (c) 60 (d) 240 watts

_______ 5. Calculate the energy converted when a 40-watt light bulb is used for 30 minutes.
(a) 72,000 (b) 1,200 (c) 20 (d) 1.3 joules

TEST - THE POOL TABLE

Name ______________________________ Date ______________ Score ____________

Curriculum ______________________ Time Spent on Module ______________ Hours

School _________________________ Time Spent on Test ______________ Minutes

A. Select the letter corresponding to the term that best fits the blank. Put that letter in the space at the left.

_____ 1. The distance that a body travels, divided by the time required is its _______________. (a) acceleration (b) velocity (c) momentum (d) kinetic energy

_____ 2. When a body is accelerated, its _______________ changes. (a) mass (b) velocity (c) force

_____ 3. A body cannot be accelerated without the use of _______________. (a) momentum (b) kinetic energy (c) mass (d) force

_____ 4. The difficulty in accelerating a body is measured by its _______________. (a) velocity (b) force (c) mass (d) momentum

_____ 5. The mass of a body, multiplied by its velocity, is its _______________. (a) acceleration (b) force (c) momentum (d) kinetic energy

_____ 6. A body that has momentum also has _______________. (a) kinetic energy (b) force (c) acceleration

_____ 7. If the unbalanced force on a body is zero, then the body must have zero _______________. (a) velocity (b) acceleration (c) momentum (d) kinetic energy

_____ 8. When finding the _______________ of a body, its velocity is more important than its mass. (a) kinetic energy (b) momentum (c) acceleration (d) force

_____ 9. When the velocity of a body is doubled, its _______________ is also doubled. (a) acceleration (b) momentum (c) kinetic energy (d) mass

_____ 10. As a billiard ball rolls across a table, the unbalanced force acting on it is _______________. (a) in the direction of motion (b) opposite the direction of motion (c) zero

_____ 11. As the mass of a body increases, the force necessary to cause a certain amoung of acceleration _______________. (a) increases (b) decreases (c) stays the same

_____ 12. If an object is moving, it must have _______________. (a) momentum (b) kinetic energy (c) velocity (d) all of these (e) none of these

B. The following are discussion questions. Use the space below the question to write your answer. Use a small sketch if it helps. If more space is needed, use the back of the sheet.

13. If a Cadillac and a Volkswagon moving at the same speed collide head on and stick together, they will move in the direction that the Cadillac was going. Explain this in terms of conservation of momentum.

14. When a billiard ball strikes a rail and bounces off, it loses some of its speed. Explain this in terms of conservation of energy.

15. When a pitched baseball is caught by the catcher, it loses both momentum and energy. How do you know?

TEST - THE RADIATOR

Name ______________________________ Date ____________ Score __________

Curriculum ____________________ Time Spent on Module ______________ Hours

School ________________________ Time Spent on Test ______________ Minutes

A. Select the letter correspinding to the term that best fits the blank. Put that letter in the space at the left.

_____ 1. A device made to transfer heat from one fluid to another is a ________. (a) thermometer (b) radiator (c) water jacket (d) molecule

_____ 2. The transfer of heat due to collisions between very small particles is called ______________. (a) radiation (b) convection (c) thermal energy (d) conduction

_____ 3. The addition of thermal energy to a material results in an increase in its ______________. (a) thermal conductivity (b) temperature (c) convection (d) specific heat

_____ 4. The transfer of heat by a moving fluid is called ________________. (a) convection (b) conduction (c) radiation (d) thermal conductivity

_____ 5. A device used to move heat from one place to another is called a ________________. (a) insulater (b) heat exchanger (c) thermomete (d) molecule

_____ 6. Heat in the form of an electromagnetic wave is called ______________. (a) specific heat (b) thermal energy (c) temperature (d) radiatio

_____ 7. The quality of insulation material depends upon its ________________. (a) thermal conductivity (b) specific heat (c) thermal energy (d) temperature

_____ 8. The temperature of a material decreases when __________________ is taken out. (a) specific heat (b) convection (c) heat (d) thermal conductivity

_____ 9. The ability of a material to adsorb heat is measured by its __________. (a) thermal energy (b) radiation (c) temperature (d) specific heat

_____ 10. The main method by which the automobile engine is cooled is __________. (a) conduction (b) convection (c) radiation

B. Fill in the blanks in the following statements.

1. The factors that affect heat transfer by conduction are ____________, ________________, and __________________.

2. The factors that affect heat transfer by radiation are ____________, ________________, and __________________.

3. The factors that affect heat transfer by convection are ____________, ________________, and __________________.

TEST KEY

JACKS

PART A

1. C	13. D
2. B	14. D
3. A	15. A
4. B	16. D
5. C	17. C
6. D	18. A
7. D	19. B
8. B	20. C
9. D	21. B
10. A	22. D
11. C	23. C
12. B	24. A
	25. B

3 POINTS EACH

PART B

26. A
27. D
28. B
29. A
30. D
31. B
32. B
33. D
34. A
35. C

2 1/2 POINTS EACH

TEST KEY

THERMOMETERS

PART A

1. B
2. A
3. B
4. B
5. A
6/ A
7. D
8. C
9. A

PART B

Each answer must be evaluated by instructor.

(6 points each)

TEST KEY

THE ALTERNATOR

PART A

1.	B	13.	C
2.	C	14.	D
3.	A	15.	B
4.	D	16.	A
5.	B	17.	C
6.	D	18.	B
7.	A	19.	D
8.	B	20.	A
9.	C	21.	B
10.	A	22.	D
11.	D	23.	B
12.	A	24.	C

PART B

1. Cross-sectional area
   Length
   Temperature
   Type of Material
   or
   Size
   Temperature
   Type of Material

2. Turns of wire
   Current
   Core Material

3. Length of Wire
   Strength of Field
   Relative Speed

PART C

1. C
2. A
3. B
4. C
5. A

(3 points each)

TEST KEY

THE POOL TABLE

PART A

1. B
2. B
3. D
4. C
5. C
6. A
7. B
8. A
9. B
10. B
11. A
12. D

PART B

Each answer must be evaluated by instructor.

THE RADIATOR

TEST KEY

PART A

1. B
2. D
3. B
4. A
5. B
6. D
7. A
8. C
9. D
10. B

PART B

1. Surface Area } Size
   Thickness } Size
   Temperature Difference
   Thermal Conductivity

2. Color
   Temperature
   Surface Area

3. Fluid Used
   Rate of Flow
   Temperature Difference

APPENDIX III

STUDENT PERFORMANCE SHEET

Student ______________________ Curriculum ____________ School __________

Instructions: This is a record of the students' progress on each module. Indicate the students' primary activity during <u>each</u> <u>hour</u> of class in the space provided. For classes of more than one hour, repeat the date.

PR = taking pre-test
PO = taking post-test
I, II, ... = number of unit student is working on
X = absent

MODULE: ____________

DATE																																	
ACTIVITY																																	

MODULE: ____________

DATE																																	
ACTIVITY																																	

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MODULE: ____________

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ACTIVITY																																	

INSTRUCTOR CHECKLIST FOR INDIVIDUAL MODULES

Instructor's Name________________________________ Module_________________________

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1.	The module objectives are adequately stated.	5	4	3	2	1
2.	The written materials are sufficient for students to meet the objectives.	5	4	3	2	1
3.	The learning activities are appropriate to facilitate learning.	5	4	3	2	1
4.	The audio-visual materials are appropriate to facilitate learning.	5	4	3	2	1
5.	The test questions are appropriate measures of the objectives.	5	4	3	2	1
6.	The format of the module made it easy to use.	5	4	3	2	1
7.	The level of reading difficulty and mathematics required are appropriate for the students involved.	5	4	3	2	1
8.	Overall, this module is very good for use in teaching vocational physics.	5	4	3	2	1

9. My suggestions for improving this module and the audio-visual materials are:

____

____

____

____

____

____

____

STUDENT CHECKLIST MODULE ____________________

Select the response that matches the way you feel the question should be answered. Do not put your name on this paper.

	Yes	Mostly Yes	Mostly No	No
1. Did you understand the objectives of the module?				
2. Do you think the objectives are worthwhile?				
3. Was the module easy to read?				
4. Was the reading interesting?				
5. Were the lab exercises worthwhile?				
6. Was the lab equipment appropriate?				
7. Did the equipment work well?				
8. Were you able to do the calculations involved?				
9. Were you able to use this module without a lot of help from your teacher?				
10. Did the audio-visual materials help you to understand the concepts?				
11. Did the test fit the objectives?				
12. Will the knowledge that you gained from this module help you in your vocation?				

Can you suggest any way in which the module can be changed to make it better? Comment on the reading material, lab exercises, lab equipment, A-V materials, and test. (Use back of sheet if more space is needed.) ____________________

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