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ABSTRACT

This module is the first in a series of three wiring publications; it serves as the foundation for students enrolled in a wiring program. It is a prerequisite to either "Residential Wiring" or "Commercial and Industrial Wiring." The module contains 16 instructional units that cover the following topics: occupational introduction; general safety; electrical safety; hand tools; specialty tools and equipment; using trade information; basic equipment; basic theory; DC circuits; AC circuits; wiring methods; conductors; low voltage wiring; overcurrent protection; load centers and safety switches; and existing structures. Each instructional unit follows a standard format that includes some or all of these eight basic components: performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to tests and assignment sheets. All of the unit components focus on measurable and observable learning outcomes and are designed for use for more than one lesson or class period. Instructional task analyses; a glossary; a list of tools, equipment, and materials; and 34 references are provided. (KC)


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South Dakota
Nebraska
Iowa
Colorado
Kansas
Missouri
Oklahoma
Arkansas
Texas
Louisiana

BASIC WIRING

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BASIC WIRING

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FOREWORD

Basic Wiring is the first in a series of three wiring publications and serves as the foundation for students enrolled in a wiring program. It is a prerequisite to either *Residential Wiring* or *Commercial and Industrial Wiring.* This series of publications should provide the flexibility that instructors need to meet the individual needs of their students and the community.

Residential Wiring is a revision of MAVCC's 1983 wiring publication of the same name. This manual picks up where the basic manual ends and prepares the student for entry-level employment in the residential wiring trade.

Commercial and Industrial Wiring includes the additional technical knowledge and applications required for job entry in the commercial and industrial wiring trade.

These publications were developed with the assistance of many individuals who have expertise in various areas of the wiring trade. Some of these individuals represent professional associations and industry. Their assistance and devotion to this project is greatly appreciated. It should be emphasized that the student needs to be aware of professional trade associations and take an active part in them as much as possible. The professional trade associations, as well as vocational education, are an excellent avenue for continuing education within the electrical trade.

Every effort has been made to make these publications basic, readable, and by all means, usable. Three vital parts of instruction have been intentionally omitted from these publications: motivation, personalization, and localization. Those areas are left to the individual instructors and the instructors should capitalize on them. As these publications are used, it is hoped that students performance will improve and that students will be better able to assume a role in electrical wiring.

Harley Schlichting, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

Greg Pierce
Executive Director
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USE OF THIS PUBLICATION

Instructional Units

Basic Wiring contains sixteen units of instruction. Each instructional unit includes some or all of the basic components of a unit of instruction; performance objectives, suggested activities for teachers and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the tests. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated

    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations

C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities for the Instructor

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of instructors will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives in the unit. The teacher will find that the information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledge which is a necessary prerequisite to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

BASIC WIRING

INSTRUCTIONAL TASK ANALYSIS

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)

UNIT I: OCCUPATIONAL INTRODUCTION

1. Terms and definitions
2. Importance of the NEC
3. Job responsibilities of electrical workers
4. Desirable physical abilities of electrical workers
5. Employment opportunities in the electrical field
6. Occupational hazards related to electrical work
7. Interview an electrical worker
8. Compare employment opportunities in the electrical field

UNIT II: GENERAL SAFETY

1. Terms and definitions
2. Personal safety rules
3. General safety rules
4. Shop conditions that should be reported
5. Things OSHA expects of an employer
6. Things OSHA expects of an employee
7. Colors of the safety color code
8. Color coding of the safety tags or signs
9. Components of the fire triangle

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	10. Types of fires
	11. Types of fire extinguishers
	12. Factors contributing to back injuries
	13. Steps in lifting safely
	14. Safety practices for step ladders and extension ladders
	15. Safety practices for scaffolds
	16. Safety practices for power lifts
	17. Hazardous cleaners and lubricants
	18. Storage of hazardous materials
	19. Hazardous materials that may be found at the job site
	20. General guidelines for first aid emergencies
	21. First aid for eye injuries
22. Complete a student safety pledge form	
23. Identify and correct safety violations	
24. Draw a layout of your school shop and apply safety color code	

UNIT III: ELECTRICAL SAFETY

	1. Terms and definitions
	2. Major causes of electrical accidents
	3. Basic electrical safety practices
	4. Electrical fire prevention practices
	5. Safety practices around live circuits
	6. Proper grounding

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	7. Importance of the third wire
	8. Ground fault interrupters
	9. Uses for lockout devices
	10. Facts about electrical shock
	11. Treating a victim of electrical shock
12. Complete an electrical safety checklist	
13. Solve problems concerning electrical safety practices	

UNIT IV: HAND TOOLS

	1. Terms and definitions
	2. Common hand tools
	3. Electricity-specific hand tools
	4. Uses of common hand tools
	5. Uses of electricity-specific hand tools
	6. Factors to consider when purchasing hand tools
	7. Rules for care of various hand tools
8. Clean and lubricate an adjustable hand tool	
9. Use a cutting-crimping tool	
10. Adjust wire strippers	
11. Set up and use a hack saw	
12. Cut rigid conduit with a pipe cutter	
13. Ream rigid conduit	
14. Bend EMT conduit	
15. Use a knockout punch	
16. Use a hole saw	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT V: SPECIALTY TOOLS AND EQUIPMENT	
	1. Terms and definitions
	2. Typical power equipment
	3. General safety rules for using power equipment
	4. Parts of a hydraulic knockout set
	5. Specific safety rules for using hydraulic knockout sets
	6. Parts of a hydraulic pipe bender
	7. Safety rules for using hydraulic pipe benders
	8. Parts of an electrical polyvinyl chloride (PVC) heater
	9. Specific safety rules for using electric polyvinyl chloride (PVC) heaters
	10. Parts of a power drill
	11. Specific safety rules for using power drills
	12. Parts of a power threader
	13. Specific safety rules for using power threaders
	14. Typical rules and scales
	15. Typical test equipment
16. Measure objects using a rule	
17. Determine lengths of lines using an architect's scale	
18. Use a hydraulic knockout punch	
19. Bend a 90-degree stub using a hydraulic pipe bender	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
20. Make offset and 90-degree bends using an electric PVC heater	
21. Cut, ream, and thread rigid conduit with a power threader	
22. Measure resistance using a VOM	
23. Measure DC voltages using a VOM	
24. Measure AC voltages using a VOM	
25. Measure amperage using a clamp-on ammeter	
26. Determine the current of a multiple-loop clamp-on ammeter	
27. Check conductor insulation with a megger	

UNIT VI: USING TRADE INFORMATION

	1. Terms and definitions
	2. Purpose of the National Electrical Code
	3. Factors that are not covered by the NEC
	4. Intent of the NEC regarding mandatory enforcement
	5. NEC chapter numbers and their areas of application
	6. Sequence of organizational components of NEC information
	7. Steps for finding information in the NEC
8. Use the National Electrical Code (NEC) index	
9. Use the National Electrical Code (NEC) introduction and first chapter	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
10. Answer questions related to residential wiring practices using the NEC as a reference	
11. Locate allowable ampacities for various conductors using the NEC as a reference	
12. Interpret conduit fill tables using the NEC as a reference	
13. Find information in the NEC	

UNIT VII: BASIC EQUIPMENT

	1. Terms and definitions
	2. Classes of outlet boxes
	3. Information needed to calculate boxfill
	4. Types of enclosures
	5. Purposes of controller enclosures
	6. Types of devices
	7. Types of covers and plates
	8. Supports and anchors commonly used in electrical wiring
	9. Screws, bolts, and nuts commonly used in electrical wiring
	10. Classes of box mounting devices for steel structures
11. Determine the correct number of conductors for boxfill	
12. Install outlet boxes on wood studs on a framed wall	
13. Install outlet boxes on steel structures and rods using caddy clips	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
14. Install outlet boxes on steel studs using caddy metal stud clips for switch boxes	
15. Install masonry boxes in a block wall	

UNIT VIII: BASIC THEORY

1. Terms and definitions
2. Principles of electron flow
3. Basic sources of generation
4. Distribution of electricity
5. Electrical schematic symbols
6. Diagrams and schematics
7. Letters and their terms
8. Ohm's law
9. Ohm's law in wheel expression
10. Uses of Ohm's law
11. Formulas from Ohm's law
12. Ohm's law for power
13. Ohm's law for power in wheel expression
14. Uses of Ohm's law for power
15. Formulas from Ohm's law for power

16. Draw a diagram of the power distribution supplying your school shop
17. Solve problems for an unknown voltage
18. Solve problems for an unknown amperage
19. Solve problems for unknown resistance and wattages

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT IX: DC CIRCUITS	
	1. Terms and definitions
	2. Applications of DC circuits
	3. Application of Ohm's law to DC
	4. Characteristics of series circuits
	5. Basic formulas for Watt's law
	6. Kirchoff's voltage law
	7. Characteristics of parallel circuits
	8. Kirchoff's current law
	9. Characteristics of series-parallel circuits
	10. Facts about magnetism
11. Solve problems for an unknown current	
12. Solve problems for an unknown resistance	
13. Solve problems for an unknown voltage	
14. Determine the total resistance in a series circuit	
15. Determine unknown resistor values in a series circuit	
16. Solve problems for unknown current in a series circuit	
17. Solve problems for unknown resistance in a series circuit	
18. Solve problems for unknown voltage in a series circuit	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
19. Apply Kirchoff's voltage law to series circuits	
20. Solve problems for unknown resistance in a parallel circuit	
21. Solve problems for unknown current in a parallel circuit	
22. Apply Kirchoff's current law to parallel circuits	
23. Solve problems for unknown resistance in a series-parallel circuit	
24. Solve problems for unknown voltage in a series-parallel circuit	
25. Solve problems for unknown current in a series-parallel circuit	
26. Compute power using Ohm's power law	

UNIT X: AC CIRCUITS

1. Terms and definitions
2. Principles of AC theory
3. Principles of induction
4. Characteristics of inductance
5. Factors affecting inductors
6. Power characteristics in an inductive circuit
7. Characteristics of a transformer
8. Classes of transformers
9. Transformer connections on a three-phase delta system
10. Transformer connections found in electrical trades

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	11. Power in three-phase circuits
	12. Testing for polarity
	13. Characteristics of capacitance
	14. Types, ratings, and common defects of capacitors
	15. Characteristics of impedance in RC circuits
	16. Characteristics of impedance in RL circuits
	17. Characteristics of power in an AC circuit
	18. Basic switching circuits used in electricity
19. Solve power factor problems	
20. Solve RC and RL circuit problems	
21. Draw a diagram of a single pole switch on a light	
22. Draw a diagram of two three-way switches on a light	
23. Draw a diagram of two three-way switches and a four-way switch on a light	
24. Wire a single pole switch controlling a single lighting outlet with the supply line entering the switch box	
25. Wire a single pole switch controlling a single lighting outlet with the supply line entering the lighting outlet box	
26. Wire a three-way switching situation with the supply entering a single lighting outlet	
27. Wire a four-way switching situation with the supply entering the lighting outlet box	

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT XI: WIRING METHODS	
	1. Terms and definitions
	2. Wiring methods found in electrical trades
	3. Wiring methods and their common applications
4. Reference the National Electrical Code to identify uses of wiring methods	
5. Install a set screw conduit fitting	
6. Install a compression type conduit fitting	
7. Braid the ground conductor of a service entrance cable	
8. Install an ENT coupling and connector on ENT conduit	
UNIT XII: CONDUCTORS	
	1. Terms and definitions
	2. Factors that determine type and size of conductors
	3. Characteristics of good connections
	4. Types of connectors, terminals, and lugs
	5. Types of insulation
	6. Conductors commonly found in electrical wiring
	7. Types of cable found in the electrical field
	8. Cords and their conductors
	9. Cables and their conductors

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
10. Select conductors for various ampacities and temperatures	
11. Calculate ampacity of conductors, given number of conductors in raceway	
12. Calculate ampacity and conductor sizes	
13. Select cords for various applications	
14. Select proper types of insulation	
15. Install cord on utilization equipment	
16. Use a fish tape to install wire in conduit	
17. Prepare an aluminum conductor for termination	

UNIT XIII: LOW VOLTAGE WIRING

1. Terms and definitions
2. Parts of a low voltage wiring system
3. Low voltage lighting circuit off/on cycle
4. Energizing of a chime circuit
5. Manual fan switching circuit
6. Thermostat system switch in cool position, fan switch on auto
7. System switch in heat position
8. Anticipator circuits on low voltage thermostats
9. Communication circuits and their characteristics
10. Smoke and fire alarm systems
11. Operation of a garage door opener

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
12. Draw a wiring diagram indicating the proper connection for bell circuit equipment	
13. Wire a two switch low voltage lighting circuit	
14. Wire a two button chime circuit	
15. Determine heat anticipator current draw	
16. Install a wall thermostat	

UNIT XIV: OVERCURRENT PROTECTION

1. Terms and definitions
2. Types of overcurrent protective devices
3. Operation of a single element fuse
4. Operation of a dual element time delay fuse
5. Types of circuit breakers
6. Requirements for fuses of less than 600 volts
7. Requirements for circuit breakers of less than 600 volts
8. Installations that require GFCI protection

9. Calculate fuse sizes
10. Test cartridge fuses

UNIT XV: LOAD CENTERS AND SAFETY SWITCHES

1. Terms and definitions
2. Types of safety switch enclosures
3. Safety switch system configurations
4. Types of load centers and enclosures

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
	5. Common load center accessories
	6. Parts of a fusible load center
	7. Parts of a breaker load center
	8. Common panel bus configurations
	9. Safety rules for working around load centers and safety switches
10. Using the NEC, answer questions related to load centers	
11. Install a safety switch	
12. Wire a load center or breaker panel	
13. Wire a receptacle circuit to a load center	

UNIT XVI: EXISTING STRUCTURES

1. Terms and definitions
2. Construction members common in existing structures
3. Common routes for new cable installations in existing structures
4. Possible methods for getting cable through or around construction members
5. Wall or ceiling composition
6. Optional calculation for additional loads to existing installations
7. Exceptions to the NEC requirements for support of flexible metal conduit
8. Steps for determining the number of conductors allowed in a conduit, based on cross sectional area

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
9. Determine the number of conductors allowed to be added to an existing conduit	
10. Install a box with dry wall grips in a plasterboard wall	
11. Secure a box with dry wall supports (box tins)	
12. Install a box in a lath and plaster wall	
13. Install a box in a paneled wall	
14. Install a box in a concrete block wall	

Bonding jumpers — Pieces of wire or other conductors that connect different metal parts

Bonding jumper circuit — Connections between portions of a conductor in a circuit to maintain required ampacity of the circuit

Bonding jumper equipment — Connections between two or more portions of the equipment grounding conductors

Boxfill — Number of conductors of a certain size permitted in a box; number is based on cubic inches of box

Brick bat — Piece of a brick

Building code — Standards developed to provide for safe building construction practices

C

Cabinet — Enclosure designed either for surface or flush mounting; provided with a frame, mat, or trim in which a swinging door or doors may be hung

Cable — A factory assembly of two or more insulated and uninsulated conductors having an outer sheath of moisture-resistant, flame-retardant, non-metallic material

Cable-tie — Plastic straps with pull-through fasteners for binding together conductors or cables

Calibration — Technique of testing and adjusting an instrument by referencing it to another instrument or device of known accuracy and precision

Cardiopulmonary resuscitation (CPR) — Emergency procedure performed by trained individuals to aid a heart attack victim

Channel — Groove formed in materials

Chuck — Device for holding a component of a tool rigid

Circuit — A complete path for current to flow from the source through the load and back to the source

Circuit box — Box where electrical connections are made, usually through circuit breakers

Circuit breaker — Automatic overcurrent device that trips on overloads or shorts and is resettable

Circular mils — The diameter of a conductor in thousandths of inches multiplied times itself

Coaxial cable — Conductor used for carrying communication signals

Color coding — Assigning colors to conductors based on their uses

Combustibles — Materials or liquids that catch fire easily

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Combustibles — Materials or liquids that catch fire easily

Concentric knockout — Several removable metal rings that allow for entrance of various standard sizes of connectors into a cabinet

Conductor — Material through which electrons flow easily; used to connect components

Conduit — Pipe or tube which holds and protects wires or cables

Connections — Termination points where conductors are joined together

Copper-clad aluminum — Aluminum conductor with an outer coating of copper metallurgically bonded to the aluminum core

Copper wire — Conductor made of copper

Cord — Two or more stranded conductors grouped together in a flexible covering

Coupling — Mechanical device for connecting conduit and cabling

Covered — Conductor encased within material of composition and thickness not recognized by the *National Electrical Code* as electrical insulation

Cross handle — Handle set across a power tool to prevent the tool from turning

Cross sectional area — Area in square inches allowed in a conduit or tubing; area required for conductors in a conduit or tubing

Cube tap — A device that plugs into a receptacle and provides space for connection of two or more attachment plugs

Current-limiting overcurrent protective device — Device that, when interrupting current in its current-limiting range, reduces the short-circuit current flowing in the faulted circuit to substantially less than would otherwise flow into the fault

Cutter — Hardened steel device used to cut holes in metal boxes

D

DC — Abbreviation for direct current

Dead front — Removable cover used to prevent exposure of live parts to persons on the operating side of the equipment

Device — Electrical equipment that carries or transfers current but does not use it

Die — Component that backs up cutter on opposite side of metal box

Dielectric materials — Insulating materials capable of accumulating an electrical charge

Disconnecting means — Device or group of devices, or other means by which circuit conductors can be disconnected from their source of supply

Domains — Molecules that act as small magnets when arranged end to end

Drop cloth — Cloth used to catch falling debris from cutting or chipping work

Drop chain — Short length of small chain used to pull cable or flexible conduit through an enclosed space or wall cavity

Dual-element fuse — Fuse that has a thermal cutout element with a time delay that permits momentary harmless inrush currents to flow without having the fuse

Dustproof — So constructed or protected that dust will not interfere with successful operation

Dusttight — So constructed that dust will not enter the enclosing case

E

Eccentric knockout — Knockout that is removed in sections to form larger holes

Edison base plug fuse — Fuse with a base that fits the same sockets as a regular based incandescent bulb

Electricity — Invisible energy

Electromagnet — A magnet made by winding a conductor around a metal core with voltage applied

Electron flow — When electrons are transferred from one atom to another

Equipment — A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation

Error — How far the measurement is from the actual value

Explosionproof — Capable of containing hot explosive flames within the enclosure to prevent explosions in the surrounding atmosphere

Exposed (as applied to wiring methods) — On or attached to the surface or behind panels designed to allow access

F

Fault current — Current that flows from one conductor to ground or another conductor because of an abnormal connection or arc between the two

Ferrule type cartridge fuse — Fuse with metal caps on a cylindrical case

Fire extinguisher — That which quickly puts out fires or at least smothers flames

First aid — Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

Fish — Establishing a connection between two points so a cable can be installed

Fish tape — Long tape of steel, nylon, or other material used to push or pull a conductor into a raceway

Fish wire — Length of wire with a hook formed in one end to catch materials being installed in a space

Fitting — An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function

Flux lines — Power around a magnet

Formula — A mathematical expression used to find unknowns

Fuse — Safety device placed in a circuit; in cases of excessive current, it melts, thus opening the circuit

G

Ground — Electrical point or any good conductor that is connected to a common chassis with zero relative voltage; usually conductors are connected to the earth

Grounded — Connected to earth or to some conducting body that serves in place of the earth

Grounded conductor — Intentionally grounded system or circuit conductor (neutral)

Grounding conductor — Conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes

Grounding electrode conductor — Conductor used to connect the grounding electrode to the equipment grounding conductor or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system

Ground fault — Accidental connection between an electrical circuit or equipment and the earth or some conducting body that serves in place of the earth

Ground fault circuit interrupter — Breaker or device designed to protect individuals and equipment by deenergizing or tripping a circuit when current to ground reaches 0.005 amperes

H

Hazard — A potential source of danger

Heat detectors — A fire warning device commonly used in a residence; available in two types; fixed or rate-of-rise temperature detectors

Heat shrink — Nonconductive material placed around a conductor for insulation; shrinks when heated

Henry — Amount of inductance into a conductor when the current changes at the rate of one ampere per second

Hertz — One complete positive to negative cycle in an alternating current circuit

Hydraulic — A system where the main operation of equipment is operated by fluids

Hydraulic oil — Specially formulated oil for hydraulic pumps

I

Insulated — Conductor encased within material of composition and thickness recognized by the *National Electrical Code* as electrical insulation

Insulation — Nonconductive material that prevents leakage of electricity from a conductor and protects against accidental contact

Interrupting rating — Maximum available short-circuit current that an overcurrent device can safely interrupt without danger to itself

J

Joint Industry Conference (JIC) boxes — Boxes or enclosures made to Joint Industry Conference Standards for such uses as junction boxes and housing terminal blocks

Junction boxes — Enclosures designed for conduit or cable entrances to enclose the conductor splices and taps

Jurisdiction — Power, right, or authority to interpret the law (code)

K

Knockout (KO) — Partially cut out piece of metal or plastic that can be forced out when a hole is needed

Knockout punch — Device used to make openings for conduit in metal enclosers

L

Lath and plaster — Old method for covering interior walls; small strips of wood spaced evenly over studs to support and hold plaster

Live circuit — Circuit with voltage applied

M

Magnetism — Property possessed by certain materials which exerts a mechanical force on other magnetic materials, and which can cause induced voltage in conductors when relative movement is present

Mandatory enforcement — Governmental authority to demand compliance with the National Electrical Code requirements for electrical installations

Mil — One thousandth of an inch

Momentary contact switch — A switch that is closed or opened only while the operator touches it

Multimeter — Instrument capable of measuring a "mulitiple" of values

Multi-outlet assembly — A type of surface of flush raceway designed to hold conductors and receptacles

N

National Electrical Code (NEC) — A publication developed by the National Fire Protection Association to help safeguard persons and property from hazards arising from the use of electricity

National Electrical Manufacturers Association (NEMA) — Develops electrical equipment standards

National Fire Protection Association (NFPA) — Develops and publishes fire and industrial safety standards

NEMA Type 1 — General purpose enclosure for use indoors under usual service conditions

NEMA Type 2 — Driptight enclosure used indoors to exclude falling moisture and dirt

NEMA Type 3 — Weather resistant (weatherproof) and suitable for indoor and outdoor use; will exclude falling dirt, light liquid splashing, rain, snow, sleet, and windblown dust

NEMA Type 4 — Watertight and dustproof enclosures suitable for areas where a great amount of splashing occurs, such as hose down area

NEMA Type 5 — Dust-tight enclosure not suitable for use around water

NEMA Type 12 — Industrial use enclosure designed to exclude oil, coolant, flying dust and lint, and falling dirt

NEMA enclosures — Electrical enclosures specifically designed to standards for use in specific locations and various conditions such as indoor, outdoor, dusty, corrosive, wet, and explosive conditions

O

Occupation — The vocation or activity at which a person works

Occupational Safety and Health Administration (OSHA) — Federal legislation designed to insure safe and sanitary working conditions for employees

Ohm — Unit of measure for the opposition to electron flow in a circuit

Oil circuit breaker — Load interrupter in which the interrupting contacts operate submerged in transformer oil

Opposition — A resistance to current flow

Outlet boxes — Electrical boxes designed for the mounting of receptacles, switches, light fixtures, or other devices

Overcurrent protection — Weak link in the circuit that limits the amperage to a specified amount

Overload — Larger than normal current flowing within the normal current path

P

Parallax correction — Viewing analog VOM from directly above the needle to avoid the possibility of wrong readings due to depth perception

Parallel circuit — A circuit which provides more than one path for current to flow

Pinch point — Any opening that may close and bind a finger or hand

Pipe chase — Usually a vertical space between two floors, dedicated for the running of pipes and conduits between floors

Plasterboard — Thin board formed of layers of plaster and paper; Sheetrock

Pneumatics — A system where the main operation of equipment is operated by air

Polarity — When magnetism leaves a body north and enters south

Polyvinyl chloride (PVC) — Plastic pipe

Power — Rate of consumption of energy

Precision — Instrument consistency

Premises wiring (system) — That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, and wiring devices, both permanently and temporarily installed which extends from the load end of the service drop, or load end of the service lateral conductors to the outlet(s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment

Primary — Where voltage enters a transformer

Print — Industrial blueprint; industrial wiring diagram

Pull-push solenoid — Solenoid with two electromagnetic circuits that will pull or push a plunger depending on which magnet has current applied to it

R

Rainproof — So constructed, protected, or treated as to prevent rain from interfering with successful operation

Raintight — So constructed or protected that exposure to a beating rain will not result in the entrance of water

Ram — Device used to transfer hydraulic pressure to a mechanical device

Relay — Electromagnetic device for remote or automatic control

Resistance — Opposition to electrical current flow; measured in units of ohms; must be measured from one point to another

Resolution — How well an instrument will indicate a small change in the measured value

S

Safety — State or condition of being safe; freedom from danger, risk, or injury

Secondary — Where voltage leaves a transformer

Selective coordination — The use of interrupting devices sized and installed so that the one nearest a fault or overload will open before any of the larger upstream devices open

Series circuit — A circuit where the same current passes through each component

Series-parallel circuit — A circuit that contains some components in series and some in parallel

Shock — The sudden stimulation of the nerves and muscles caused by the discharge of electricity through the body; shock can occur if the body contacts an electrical circuit and can cause serious burns and muscle damage

Short circuit — Larger than normal current flowing outside the normal current path

Single element fuse — Fuse that contains only one element and is not designed to carry an overload

Single phase — One power source

Smoke detector — A fire warning device commonly used in a residence that is available in two types: photoelectric or ionization

Snap ring — Metal ring which fastens around or in a shaft to keep other parts stationary

Solenoid — Electromagnetic cylinder that will move an iron plunger when current is applied

Spaghetti — Nonconductive material placed around a conductor for insulation; does not shrink

Stud finder — Compass type tool which uses a magnet to locate nails and thus indicate stud locations

T

Telephone system — A personal communication system installed in the home to provide outside conversation with the world

Thermostat — A device that senses temperature variations from a set point and, in turn, acts to control a circuit

Time current curve — Plotted curve showing how long a fuse or breaker will carry an overload before opening the circuit

Transformer — An electrical device used to step up or step down a primary voltage to a desired secondary voltage

True power — The power that a device is actually using

Type letter — Identification accepted by the trade in referring to the particular types of insulations

Type "S" plug fuse — Fuse with special size limiting characteristics for each amperage range

U

Underfloor crawl space — Working space underneath the house

Underwriters Laboratories (UL) — Test equipment and list items for use in specified situation

V

Volt — Unit of measure of electromotive force or potential difference

Voltage — Electromotive force (emf); force that drives electricity through conductors; must be measured across, between, or be referenced to a second point

Voltage drop — Reduction in circuit potential difference due to resistance

Voltage rating — Maximum voltage at which a device is designed to operate

W

Watt — Unit of measure for the power of an electric circuit

Waveform — The shape of a wave as a function of time, distance, and amplitude

Windings — Conductors coiled around a metal core in a transformer or motor

Wire lug — Metal connector crimped or soldered to a conductor; allows conductor to be fastened with a screw or bolt

BASIC WIRING

TOOLS, EQUIPMENT, AND MATERIALS LIST

A

Adjustable wire strippers
Adjustable wrench
Ammeter
Anchors
Antioxidant
Arbor

B

Bar hanger
Battery
Bolts
Box clips
Breaker index sheet
Breakers
Brick wall

C

Cable clamp, 3/8"
Carriage lever accessory
Clamp-on ammeter
Cleaning cloth
Compression type fitting, 1/2"
Concrete chisel
Conduit bender
Connectors
Copper wire
Cord connector
Couplings
Cutting/crimping tool
Cutting oil

D

Device box
Die head accessory
Door bell buttons
Drill
Drill bit
Drill motor
Drop chain
Drop cloth
Drop light and cord
Duplex receptacle
Dust mask

E

Electrician's knife
EMT bender, 1/2"
Extension cord

F

Fish tape, steel
Fixed appliance, small
Fuses

H

Hacksaw
Hacksaw blade
Hammer
Hanger bar
Header board
Heating unit
Hole saw
Hook knife
Hydraulic pipe bender

I

Incandescent bulb, 120V

K

Keyhole saw
Knockout punch

L

Ladder
Level
Lighting relay
Light socket
Live disconnect

M

Masking tape
Megger
Mortar
Multimeter

N

Nails
Needlenose pliers
NM cable

O

Octagon box
Oil
Oiler
Outlet boxes

P

Pail
Paneled wall
Pencil
16 penny nails
Phasing tape
Pipe or conduit
Pipe cutter
Pipe reamer
Pipe vise
Plasterboard
Plasterboard nails
Plaster rings
Pliers
Pouch tools
Power threader, stand
Protective gloves
PVC conduit
PVC glue
PVC heater

R

Reamer
Resistor
Rigid conduit
Romex staples

S

Safety glasses
Safety switch
SE cable
Set screw fitting, 1/2"
Shop towel
Single pole switch
Solid insulated conductor
Solvent
Solvent tray
Sponge
Square boxes
Staples
Steel pipe
Stepladder
Stud clips
Stud wall
Switch, 3-way
Switch, 4-way

T

Test leads
Thermostat
Thermostat subbase
Tool carriage accessory

V

Vise
Volt-ohmmeter

W

Whisk broom
Wire, #10 THHN
Wire brush
Wire connectors
Wire lug
Wire nuts
Work board

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OCCUPATIONAL INTRODUCTION
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss the occupational outlook of the electrical field as well as the hazards involved and the working conditions. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define NEC and occupation.
2. State the importance of the NEC.
3. List job responsibilities of electrical workers.
4. Select from a list desirable physical abilities of electrical workers.
5. List eight employment opportunities in the electrical field.
6. List four occupational hazards related to electrical work.
7. Interview an electrical worker. (Assignment Sheet #1)
8. Compare employment opportunities in the electrical field. (Assignment Sheet #2)

OCCUPATIONAL INTRODUCTION
UNIT I

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Provide students with objective sheet.

C. Discuss unit and specific objectives.

D. Provide students with information and assignment sheets.

E. Discuss information and assignment sheets.

F. Integrate the following activities throughout the teaching of this unit:

1. Invite local contractors, electricians, and inspectors to class to discuss employment opportunities and their respective job responsibilities.

2. Visit local electrical construction sites.

3. Visit a local manufacturer that employs electrical maintenance workers.

4. Upon completion of Assignment Sheet #1, have students share the information they obtained during their interviews with electrical workers.

5. Upon completion of Assignment Sheet #2, have students compare employment opportunities and compile a list of local employment opportunities.

6. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

G. Give test.

H. Evaluate test.

I. Reteach if necessary.

REFERENCES USED IN WRITING THIS UNIT

A. *Electricity Occupations Curriculum Guide.* Springfield, IL: Illinois Office of Education-Division of Vocational and Technical Education, 1975.

B. Taylor, Mark. *Residential Wiring.* Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1983.

OCCUPATIONAL INTRODUCTION
UNIT I

INFORMATION SHEET

I. **Terms and definitions**

A. National Electrical Code (NEC) — A publication developed by the National Fire Protection Association to help safeguard persons and property from hazards arising from the use of electricity

(NOTE: The National Electrical Code is updated every three years.)

B. Occupation — The vocation or activity at which a person works

II. **Importance of the NEC**

A. The NEC sets the minimum standards for electrical work in general and specific instances.

B. Any person employed in the electrical field should obtain a copy of the NEC and know how to use it.

(NOTE: This is commonly referred to as the electrician's bible.)

III. **Job responsibilities of electrical workers**

(NOTE: The student entering the electrical field should be aware of the need for continued study. As industry changes, new methods and techniques will become industry standards. If you allow yourself to fall behind the emerging technology, your job may become obsolete. Electrical workers are expected to use and interpret the National Electrical Code as well as perform complex mathematical calculations.)

A. Install all types of electrical equipment.

B. Hang electrical fixtures.

C. Install switching and power outlets.

D. Install appliances.

E. Design electrical systems.

F. Troubleshoot and repair defective systems.

G. Practice good work ethic. Be dependable and honest.

H. Be courteous to customers and co-workers.

I. Communicate effectively with people.

J. Practice good personal hygiene.

K. Participate in trade organizations.

EXAMPLES: IBEW, AIECA, AGC, NECA

INFORMATION SHEET

IV. Desirable physical abilities of electrical workers

A. Ability to distinguish colors

(NOTE: Many components and conductors commonly used in the electrical field are color coded. It is imperative that workers are able to distinguish colors readily.)

B. Ability to lift heavy objects

C. Ability to work in confined areas such as crawl spaces and attics

D. Ability to work on ladders and scaffolds

E. Ability to work with hands in a skillful manner

V. Employment opportunities in the electrical field

A. Electrician's helper — One who assists an electrician

B. Installer — Installs electrical equipment under the supervision of a journeyman

C. Apprentice — A helper with two years of experience

D. Journeyman — Electrician working under the supervision of a contractor

E. Master electrician or contractor — Licensed to enter contractual agreements involving electrical work

F. Maintenance electrician — Maintains and repairs electrical equipment and processes

G. Electrical parts/equipment salesperson — Works for electrical wholesale parts outlet

H. Inspector — Represents authority having jurisdiction over electrical installations

VI. Occupational hazards related to electrical work

(NOTE: The electrical worker is a highly respected trade worker. The jobs that are performed are generally in the areas or surroundings more desirable than other trades. However, conditions do occur that are more demanding or are in areas that are more difficult to work in such as crawl spaces and high places. Inclement weather is also a factor.)

A. Death — Careless and unsafe work habits can result in fatal accidents

B. Burns — Accidental shorts or faults occasionally blow slag or molten metal which can burn

C. Broken bones or bruises — Working on ladders or in other hazardous construction situations can result in falls

D. Sprains or muscle tear — Many pieces of electrical equipment are heavy and bulky, and help must be summoned often to avoid injury to one person.

OCCUPATIONAL INTRODUCTION
UNIT I

ASSIGNMENT SHEET #1 — INTERVIEW AN ELECTRICAL WORKER

NAME _____ SCORE _____

Directions: Locate and interview an electrical worker in your area. Answer the following questions based on your interview. Be prepared to discuss the interview in class.

1. What is the occupation of the worker being interviewed and what are the job responsibilities?

2. What type of training is needed? _____

3. What kind of salary can be expected? _____

4. What is the future outlook for this occupation? _____

OCCUPATIONAL INTRODUCTION
UNIT I

TEST

NAME _____ SCORE _____

1. Define NEC and occupation.

   a. NEC — _____

   _____

   _____

   _____

   _____

   _____

   b. Occupation — _____

   _____

   _____

   _____

2. State the importance of the NEC.

   _____

   _____

   _____

3. List six job responsibilities of electrical workers.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

OCCUPATIONAL INTRODUCTION
UNIT I

TEST

NAME _____ SCORE _____

1. Define NEC and occupation.

   a. NEC — _____

   _____

   _____

   _____

   _____

   _____

   b. Occupation — _____

   _____

   _____

   _____

2. State the importance of the NEC.

   _____

   _____

   _____

3. List six job responsibilities of electrical workers.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

TEST

4. Select from the following list desirable physical abilities of electrical workers by placing an "X" in the blanks preceding the correct statements.

   _____a. Ability to lift at least 250 lbs.

   _____b. Ability to work with hands in a skillful manner

   _____c. Ability to see perfectly

   _____d. Ability to distinguish colors

   _____e. Ability to work in confined areas such as crawl spaces and attics

   _____f. Ability to work on ladders and scaffolds

5. List eight employment opportunities in the electrical field.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

   g. _____

   h. _____

6. List four occupational hazards related to electrical work.

   a. _____

   b. _____

   c. _____

   d. _____

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

7. Interview an electrical worker. (Assignment Sheet #1)

8. Compare employment opportunities in the electrical field. (Assignment Sheet #2)

OCCUPATIONAL INTRODUCTION
UNIT I

ANSWERS TO TEST

1. a. NEC — National Electrical Code; a publication developed by the National Fire Protection Association to help safeguard persons and property from hazards arising from the use of electricity
   b. Occupation — The vocation or activity at which a person works

2. The NEC sets the minimum standards for electrical work in general and specific instances; any person employed in the electrical field should know how to use it.

3. Any six of the following:

   a. Install all types of electrical equipment.
   b. Hang electrical fixtures.
   c. Install switching and power outlets.
   d. Install appliances.
   e. Design electrical systems.
   f. Troubleshoot and repair defective systems.
   g. Practice good work ethic. Be dependable and honest.
   h. Be courteous to customers and co-workers.
   i. Communicate effectively with people.
   j. Practice good personal hygiene.
   k. Participate in trade organizations.

4. b, d, e, f

5. The following answers may be listed in any order:

   a. Electrician's helper
   b. Installer
   c. Apprentice
   d. Journeyman
   e. Master electrician or contractor
   f. Maintenance electrician
   g. Electrical parts/equipment salesperson
   h. Inspector

6. The following answers may be listed in any order:

   a. Death
   b. Burns
   c. Broken bones or bruises
   d. Sprains or muscle tear

7.-8. Evaluated to the satisfaction of the instructor

GENERAL SAFETY
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify hazardous conditions on the job and practice good safety. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 100 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to general safety with their correct definitions.
2. Complete statements concerning personal safety rules.
3. Select true statements concerning general safety rules.
4. List three shop conditions that should be reported.
5. Select true statements concerning things OSHA expects of an employer.
6. Select from a list things OSHA expects of an employee.
7. Match colors of the safety color code with their correct uses.
8. Match safety tags or signs with their correct color coding.
9. List the three components of the fire triangle.
10. Match types of fires with their classifications.
11. Match types of fire extinguishers with their uses.
12. Match factors contributing to back injuries with their causes.

OBJECTIVE SHEET

13. Arrange in order the steps in lifting safely.

14. Select true statements concerning safety practices for step ladders and extension ladders.

15. Select true statements concerning safety practices for scaffolds.

16. Select true statements concerning safety practices for power lifts.

17. Select true statements concerning hazardous cleaners and lubricants.

18. Complete statements concerning storage of hazardous materials.

19. Distinguish between hazardous materials that may be found at the job site.

20. Complete statements concerning general guidelines for first aid emergencies.

21. Select true statements concerning first aid for eye injuries.

22. Complete a student safety pledge form. (Assignment Sheet #1)

23. Identify and correct safety violations. (Assignment Sheet #2)

24. Draw a layout of your school shop and apply safety color code. (Assignment Sheet #3)

GENERAL SAFETY
UNIT II

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

(NOTE: Make copies of Handout #1 to distribute to students prior to discussing Objective V.)

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

1. Have a Red Cross representative give class demonstration on first aid and CPR.
2. Have local fire marshall or fire extinguisher company representative demonstrate the proper use of fire extinguishers.
3. Discuss the fire evacuation plan for the classroom and shop, including evacuation routes and fire exits, as well as after-emergency evacuation routes and procedures for tornado alerts.
4. Have local OSHA inspector give talk.
5. Invite a safety representative from local industry to talk to class about safety practices and procedures.
6. Obtain safety slides or films and show to class.
7. Show students examples of safety tags and signs.
8. Discuss the Good Samaritan Act and your state's policy on using lifesafing techniques in emergency situations.
9. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas of improvement.

H. Give test.

I. Evaluate test.

J. Reteach if necessary.

REFERENCES USED IN WRITING THIS UNIT

A. *ABC's of Fire Protection*. Belleville, NJ: Walter Kidde & Co., Inc., 1978.

B. *Safety in Electrical Maintenance*. Rockville, MD: NUS Training Corporation, a Halliburton Company, 1980.

C. Taylor, Mark. *Residential Wiring*. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1983.

SUGGESTED SUPPLEMENTAL MATERIAL

Publications

A. *American Red Cross: Adult CPR*. American National Red Cross, 1987.

(NOTE: Contact your local Red Cross chapter to order this publication.)

B. *The American Red Cross, Standard First Aid and Personal Safety*. Garden City, NY: Doubleday and Co., Inc., 1978.

C. *OSHA Safety and Health Standards*. Washington, D.C. 20402: U.S. Department of Labor, Occupational Safety, and Health Administration.

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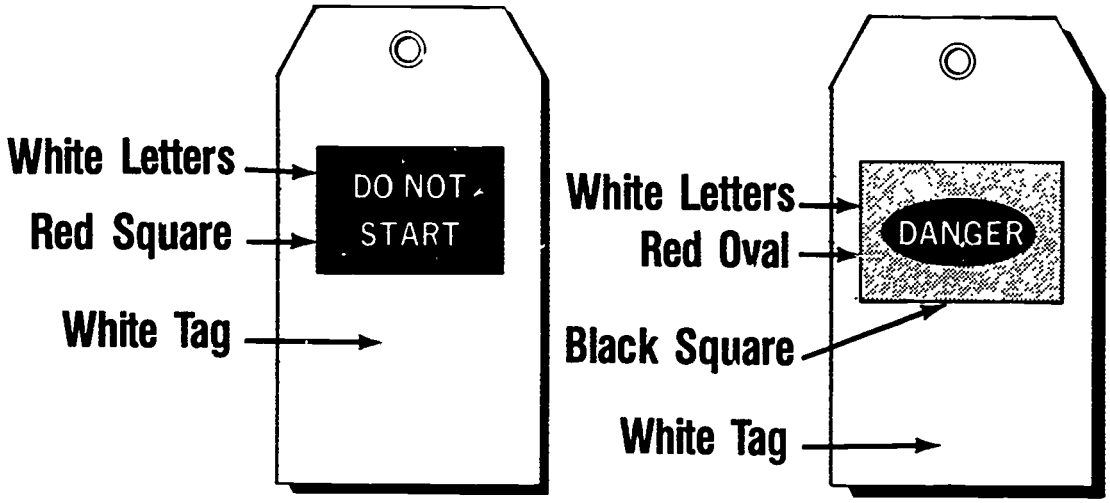
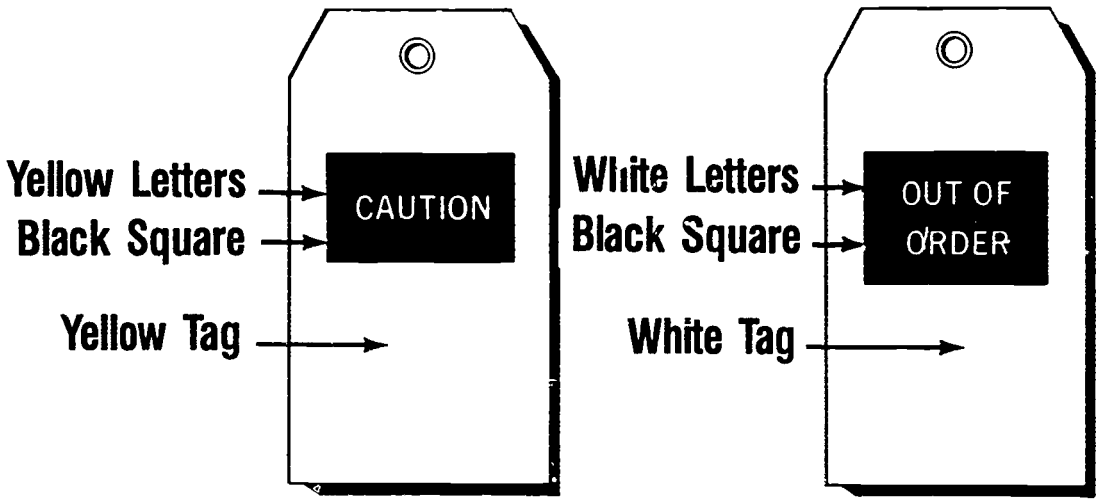
Maintain Tools

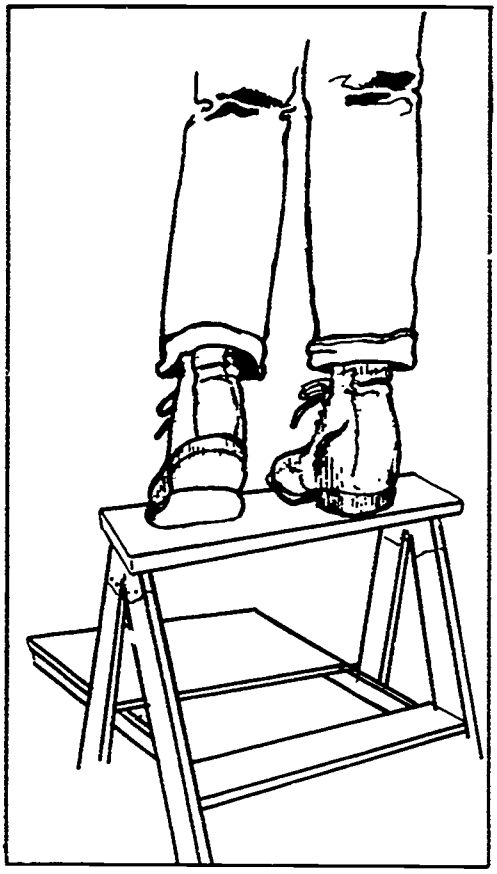
Faulty Equipment Can Result in Injury

Safety Tag Color Codes

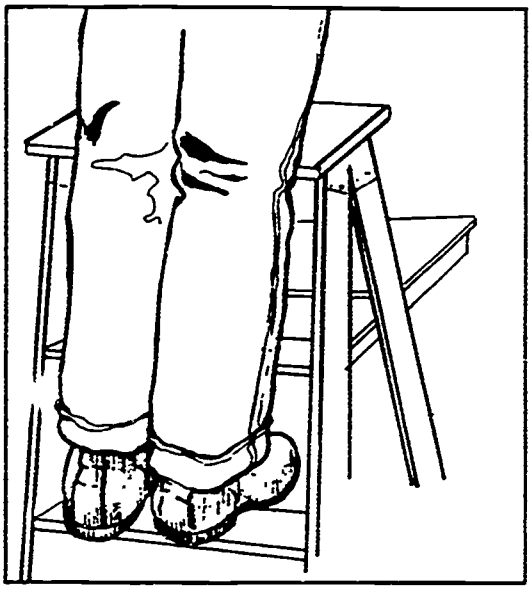




Safety Practices for Step Ladders

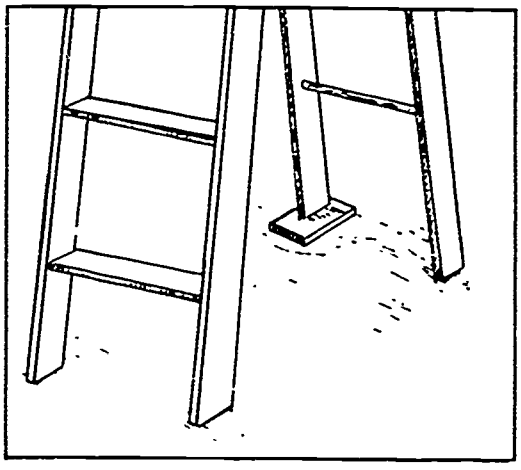


Incorrect

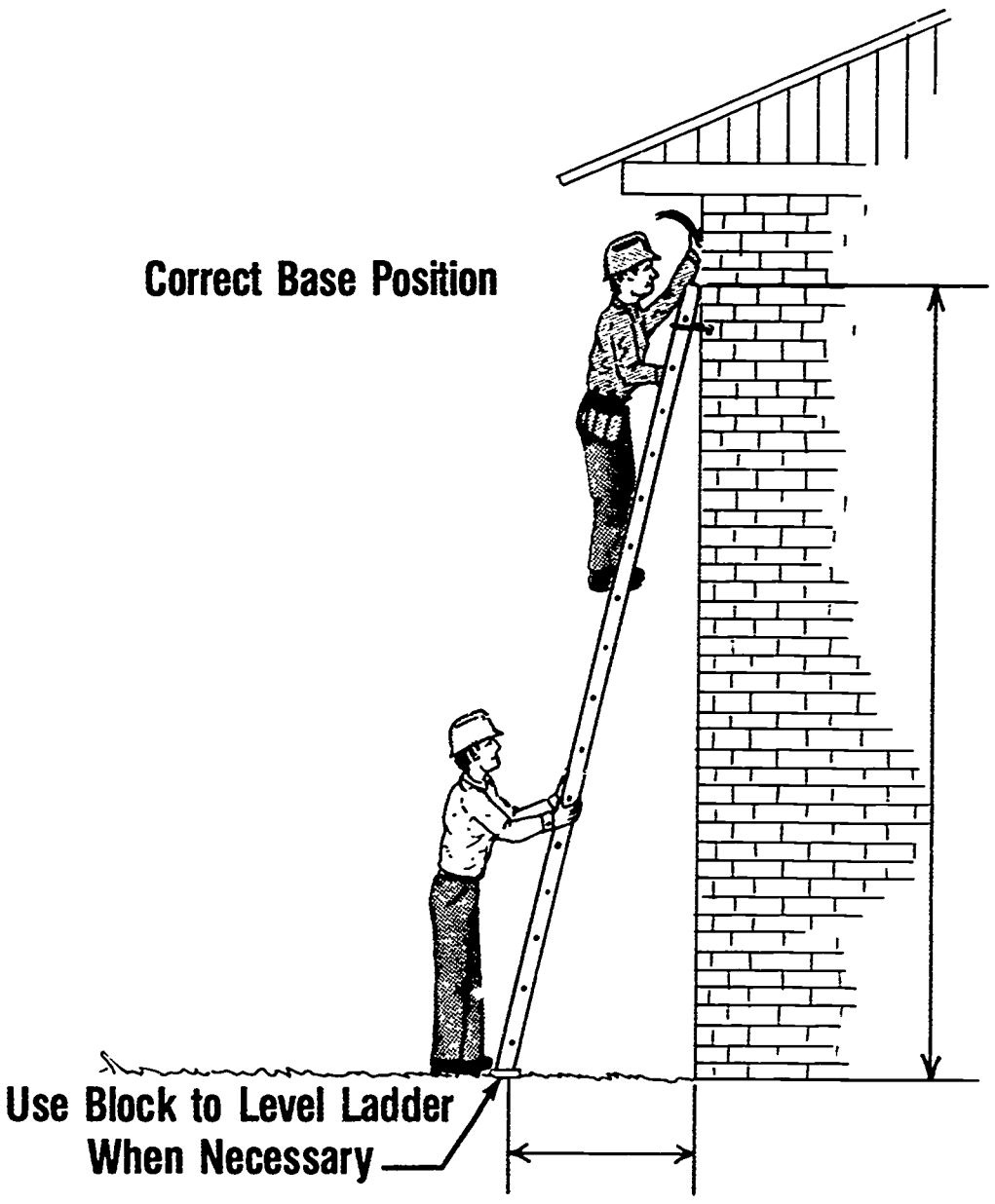


Correct

Use Block to Level Ladder When Necessary

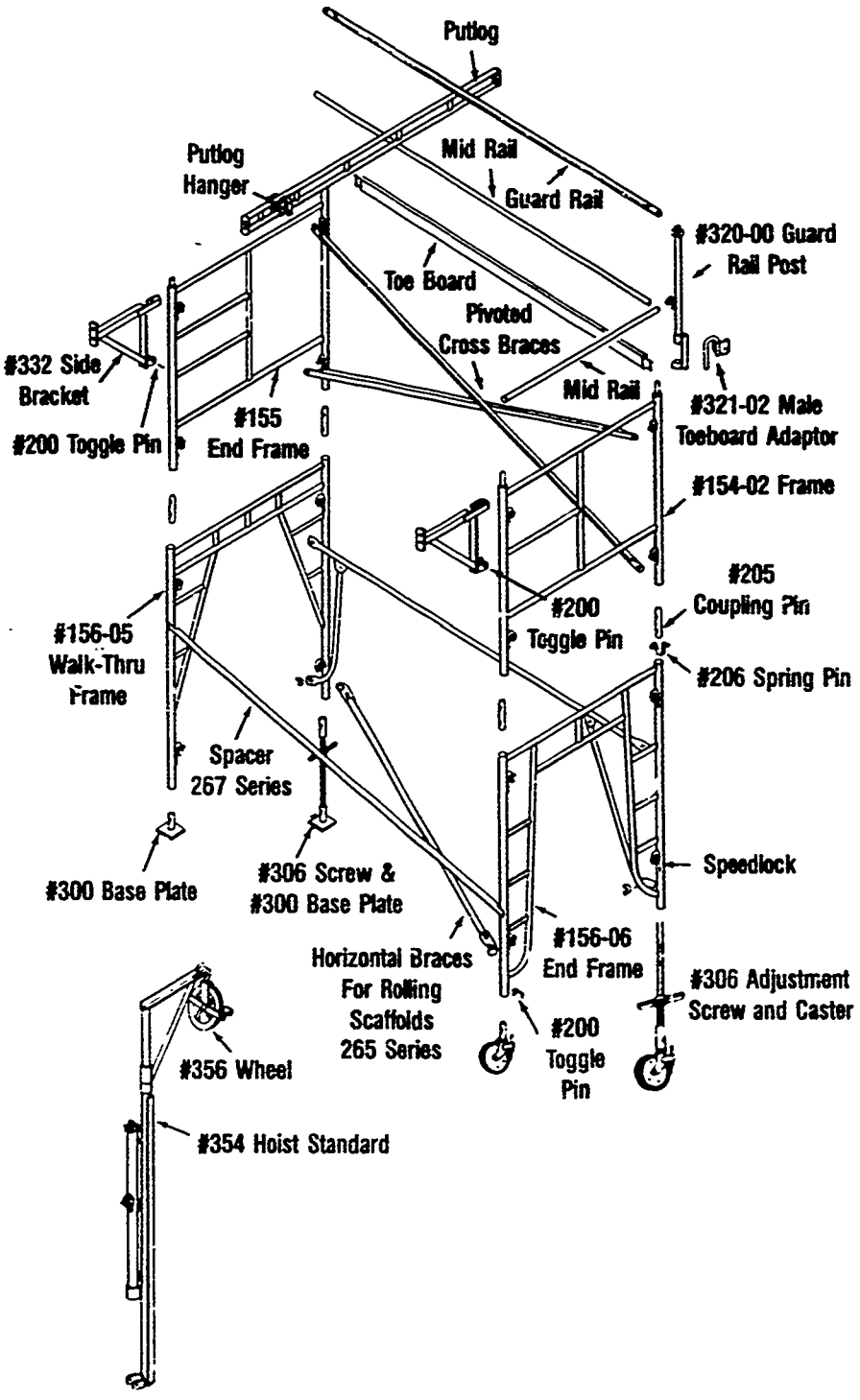


Safe Ladder Angle



Correct Base Position is 1/4 the Vertical Height

Construction of Scaffold



GENERAL SAFETY
UNIT II

HANDOUT #1 — OSHA POSTER #2203

job safety and health protection

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers through the promotion of safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers: **Each employer shall furnish to each of his employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to his employees, and shall comply with occupational safety and health standards issued under the Act.**

Employees: **Each employee shall comply with all occupational safety and health standards, rules, regulations and order issued under the Act that apply to his own actions and conduct on the job.**

The Occupational Safety and Health Administration (OSHA) of the Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards and its Compliance Safety and Health Officers conduct jobsite inspections to ensure compliance with the Act.

Inspection: The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint: Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or otherwise exercising their rights under the Act.

An employee who believes he has been discriminated against may file a complaint with the nearest OSHA office within 30 days of the alleged discrimination.

Citation: If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty: The Act provides for mandatory penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $10,000 or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity: While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce injuries and illnesses arising out of employment.

The Department of Labor encourages employers and employees to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries.

Such cooperative action would initially focus on the identification and elimination of hazards that could cause death, injury or illness to employees and supervisors. There are many public and private organizations that can provide information and assistance on this effort, if requested.

More Information: **Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations.**

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices and additional Area Office locations are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

Washington, D.C.
1981
OSHA 2203

Raymond J. Donovan
Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration
OFFICIAL BUSINESS

INFORMATION SHEET

E. Remove rings and other jewelry when working in the shop.

F. Conduct yourself in a manner conducive to safe shop practices.

G. Use soap and water frequently as a method of preventing skin diseases.

H. Use suitable helmets and goggles for welding.

I. Wear dust masks in dusty areas.

J. Wear hearing protection when subjected to continuous loud noise.

III. General safety rules

A. Keep all hand tools sharp, clean, and in safe working order.

B. Retain all guards and safety devices except with the specific authorization of the instructor.

C. Operate a hazardous machine only after receiving instruction on how to operate the machine safely in all working conditions.

D. Turn off the power before leaving a machine tool.

E. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool.

F. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning.

(NOTE: Tag out or lock out machine when being maintained.)

G. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it.

H. Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held.

I. Keep working areas clean and free of debris and other hazards.

J. Store tools, materials, and supplies safely in cabinets, on shelves, or other suitable areas.

K. Clean up any spilled liquids immediately.

L. Store oily rags or oily waste in self-closing or spring-lid metal containers.

M. Keep sufficient brooms, brushes, and other housekeeping equipment readily available.

INFORMATION SHEET

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INFORMATION SHEET

N. Clean the chips from a machine with a brush, not with a rag or bare hands.

O. Wear eye protection when using grinders and buffers.

P. Do not work overtime in the shop unless instructor is present.

Q. Consider the safety of others.

R. Do not throw objects while in the shop.

S. Wear gloves when handling equipment and materials with sharp edges.

T. Do not distract people operating machines.

U. Check all equipment before activating.

V. Be aware of surroundings before power tool is plugged in.

EXAMPLE: Are there any explosives or combustible materials in the area?

W. Work with adequate light.

X. Do not run over cords with dollies or carts.

IV. Shop conditions that should be reported

A. Defects on equipment

B. Any condition that can lead to an accident

C. All accidents

V. Things OSHA expects of an employer

A. To provide a hazard-free workplace and comply with occupational safety and health standards

B. To inspect job sites to assure they meet safety standards

C. To use properly color-coded signs to warn of danger

D. To keep required records of work-related injuries and to post an annual summary in February of each year

E. To report within 48 hours to OSHA any accident which is fatal or hospitalizes five or more workers

F. To post in a prominent place OSHA poster #2203 informing workers of their rights and responsibilities

INFORMATION SHEET

VI. Things OSHA expects of an employee

A. Read the OSHA poster #2203 and comply with its standards.

B. Follow employer safety and health rules and wear prescribed clothing or protective equipment on the job.

C. Report hazardous conditions to a supervisor.

D. Report all job-related injuries to a supervisor and seek prompt treatment if required.

E. Report to OSHA in a responsible manner any hazardous working situations which you feel the employer has not attended to properly.

VII. Colors of the safety color code and their uses

(NOTE: The following colors identify safe and unsafe conditions in the shop. Learn the color code because it could help you prevent accidents to yourself and fellow workers.)

A. Federal safety red — Basic color for identifying

1. Fire protection equipment and apparatus
2. Portable containers of flammable liquids
3. Emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

B. Federal safety yellow — Basic color for designating

1. Caution and for marking physical hazards
2. Waste containers for explosive or combustible materials
3. Caution against starting, using, or moving equipment under repair
4. Identification of the starting point or power source of machinery

C. Federal safety orange — Basic color for designating

1. Dangerous parts of machines
2. Safety starter buttons and parts of equipment that may produce electrical shock
3. The exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

INFORMATION SHEET

D. Federal safety purple — Basic color for designating radiation hazards

E. Federal safety green — Basic color for designating

1. Safety
2. Location of first aid equipment

(NOTE: This applies to equipment other than fire fighting equipment.)

F. Federal safety black and white — Basic colors for designating

1. Traffic flow
2. Housekeeping zones

(NOTE: These are used individually or in combination.)

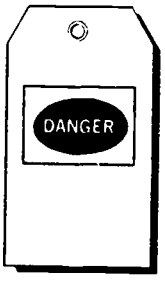
VIII. Color coding of safety tags or signs

A. Do not start tag

1. White tag
2. White letters on red square

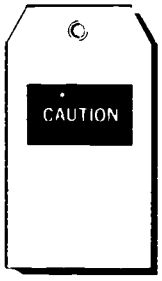
B. Danger tag

1. White tag
2. White letters in red oval, on black square



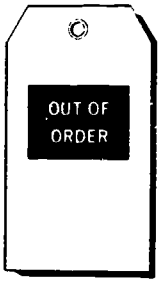
C. Caution tag

1. Yellow tag
2. Yellow letters on black background



D. Out of order tag

1. White tag
2. White letters on black background



INFORMATION SHEET

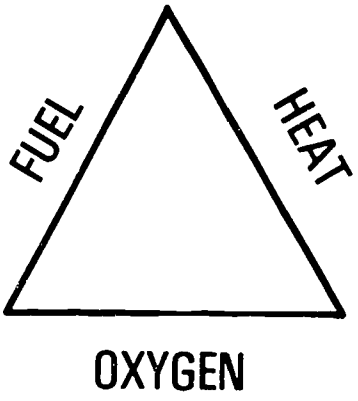
IX. Components of the fire triangle

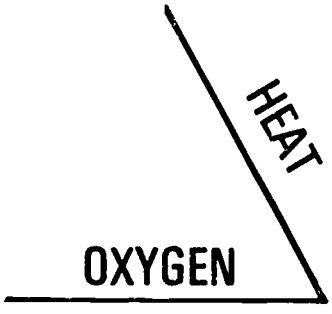
A. Fuel — Any combustible material

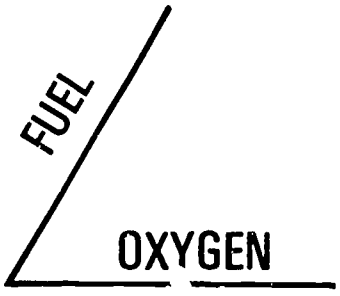
B. Heat — Enough to raise the fuel to its ignition temperature

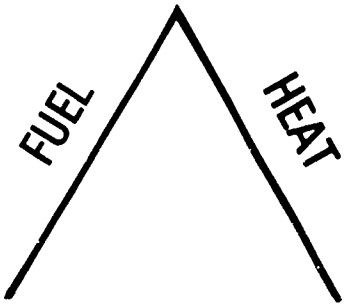
C. Oxygen — Necessary to sustain combustion

(NOTE: To produce fire, three things must be present at the same time. If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.)









INFORMATION SHEET

X. Types of fires and their classifications

A. Class A — Fires that occur in ordinary combustible materials

EXAMPLES: Wood, rags, paper, or trash

B. Class B — Fires that occur in flammable liquids

EXAMPLES: Gasoline, oil, grease, paints, and thinners

C. Class C — Fires that occur in electrical and electronic equipment

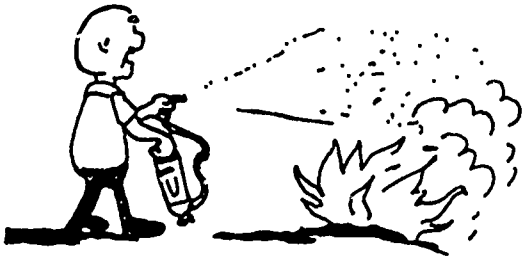
EXAMPLES: Motors, switchboards, circuit wiring, radios, and television sets

D. Class D — Fires that occur in combustible metals

EXAMPLES: Powdered aluminum and magnesium

XI. Types of fire extinguishers and their uses

A. Foam — Instead of spraying stream into the burning liquid, allow foam to fall lightly on the fire; use for class A or class B fires.

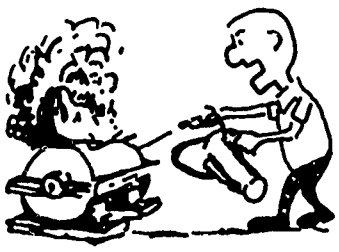


B. Carbon dioxide — Direct discharge as close to fire as possible, first at the edge of flames, then gradually forward and upward; use for class B or class C fires.

INFORMATION SHEET

C. Pump tank — Place foot on foot pump and direct stream at base of fire; use on **class A** fires only.

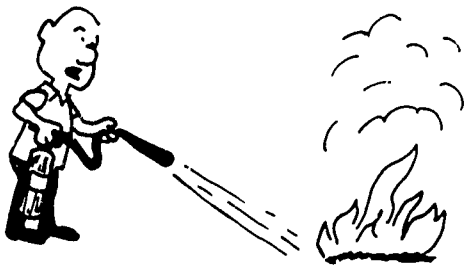
D. Dry chemical — Direct at the base of the flames; follow up by directing the dry chemicals at remaining materials that are burning; use for class B or class C fires.



E. Halon — Stand back ten feet, hold upright, and direct at the base of fire, sweeping from side to side; use for class C fires.

(NOTE: Halon is a clean, liquified gas which does not leave a residue.)

(CAUTION: A high concentration of burnt halon gas may be hazardous to your health.)

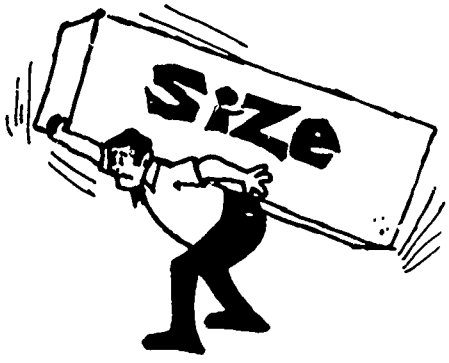


INFORMATION SHEET

XII. Factors contributing to back injuries and their causes

A. Weight — This usually results from overestimating your physical abilities and trying to lift more weight than you can handle, and sometimes it results from trying to be macho in front of fellow workers.

B. Size — This usually results from moving an object that may be within your weight capacity, but is too long, high, or wide to lift safely.



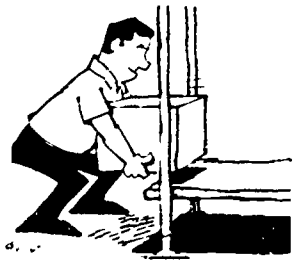
C. Shape — This usually results from moving an object that may be within your weight capacity, but has a cylindrical shape or other odd shape that makes safe lifting difficult.

INFORMATION SHEET

D. Obstructions — This usually results from stacking materials so high that vision is limited and obstructions in the pathway can't be seen.

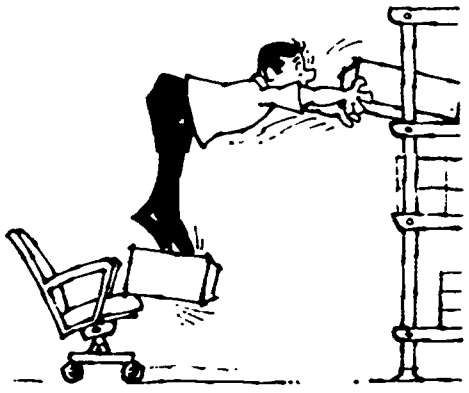
E. Improper position — This usually results from twisting or turning into an awkward position when lifting.

F. Improper storage — This results in strain caused by not storing heavy objects at least 12" off the floor.



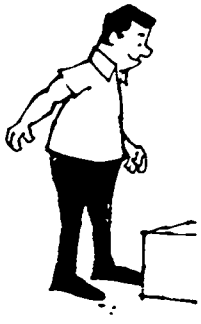
INFORMATION SHEET

G. Improper reaching — This usually results from carelessly using chairs or boxes to reach from instead of safely using a ladder.

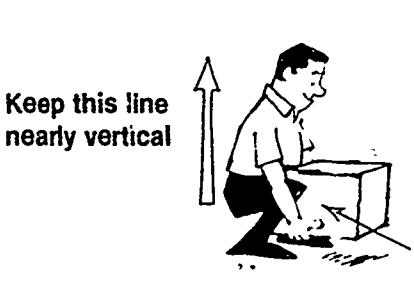


XIII. Steps in lifting safely

A. Size up the load to make sure you can safely handle it alone, and then place your feet close to the object and about 12" apart.

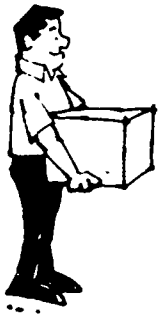


B. Bend your knees, get a good hand hold, then use both legs and back muscles to lift the load straight up as you push with your legs and keep the load close to your body.

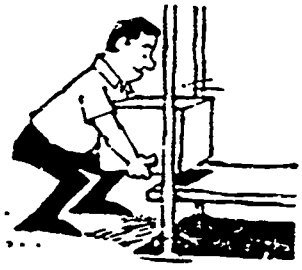


INFORMATION SHEET

C. Do not turn or twist until you have the load lifted into a carrying position, then move your feet to turn your body as you check your path of travel to make sure it is clear.



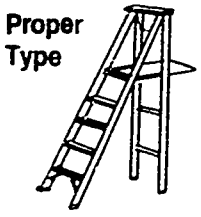
D. Lower the load by bending your knees, and remember to store heavy objects at least 12" off the floor



XIV. Safety practices for step ladders and extension ladders

A. Secure top of ladder when possible.

B. Make sure ladder is proper type, proper size, and properly equipped.



Properly Equipped

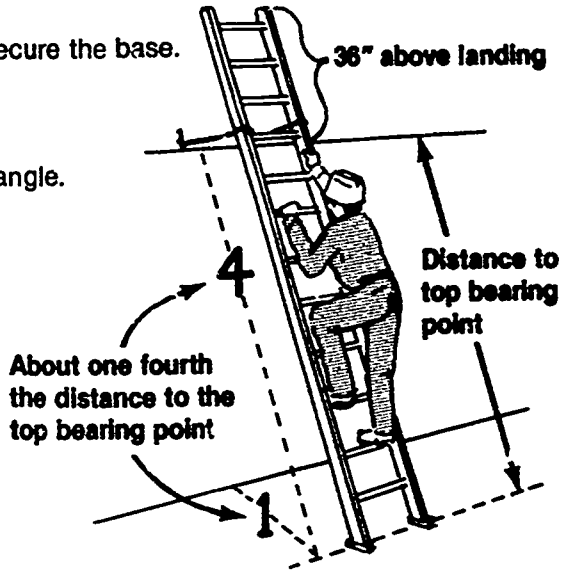
(NOTE: Top step should be platform height so that the worker can exit through rails rather than around ladder.)

INFORMATION SHEET

C. Use nonskid feet or secure the base.

D. Secure top of ladder.

E. Maintain safe ladder angle.



F. Never leave tools or equipment on footsteps or top.

G. Never stand on ladder tops.

H. Never use damaged ladders until repaired.

I. Set ladders on firm, level surface.

(NOTE: Block up legs if necessary to firm up a ladder.)

J. Never use aluminum ladders in electrical work.

K. Have attendant present if located in a walkway or roadway.

XV. **Safety practices for scaffolds**

A. Never climb a scaffold unless all four legs are on the ground.

B. Secure wheel locks before moving.

C. Get help when assembling the scaffold.

D. Never ride scaffold when it is being moved.

E. Always use proper planks when assembling.

(NOTE: See manufacturer's instructions before constructing scaffolds.)

INFORMATION SHEET

XVI. Safety practices for power lifts

A. Never lift over the weight-rated capacity of the lift.

B. Operate lift on smooth surfaces if possible.

C. Always check for objects in the pathway.

D. Never put arms or legs in lift.

E. Always use caution when moving lift.

XVII. Hazardous cleaners and lubricants

(NOTE: Many cleaners and lubricants contain petroleum, acids, and or alkaline bases which may be hazardous to your health. Read labels for proper use and storage.)

Cleaner	*Type*	*Application*
Alcohol, ethyl	Petroleum solvent	Cleaning solder connections Thinner for shellac and rosin
Acetone	Petroleum solvent	Removal of oily films, paints, and lacquer Lucite cement
Bright dip	Acid mixture containing sulfuric, hydrochloric, and nitric acids	Cleaning metal surfaces after etching or soldering
Butyl cellulose	Petroleum solvent	Thinner and wash-up for epoxy resin inks
Cyclohexanone	Petroleum solvent	Vinyl solvent and cement thinner
Hydrochloric acid	Diluted acid	Remove mill scale from steel Bright dip ingredient
Isophorone	Petroleum solvent	Wash-up for vinyl inks
Isopropyl alcohol	Petroleum solvent	For removing oil, grease, and flux from conductors and terminals both before and after soldering

INFORMATION SHEET

Cleaner	*Type*	*Application*
Kerosene	Petroleum solvent	Machine cutting fluid
Ketone, methyl ethyl	Petroleum solvent	Lacquer thinner and paint remover
Lacquer thinner	Petroleum solvent	Thinner and wash-up for lacquer and lacquer ink
Mineral spirits	Petroleum solvent	Wash-up and thinner for rubber, oil, ethyl cellulose inks, and alkyd enamels
Perchlorethylene	Chlorinated solvent	General-purpose cleaner and vapor degreaser
Phosphoric acid	Diluted acid	Remove milk scale from steel
Sodium hydroxide	Alkaline solvent	Cleaning and etching aluminum
Toluene	Petroleum solvent	Wash-up and thinner for rubber, oil, ethyl cellulose inks, and alkyd enamels
Trichloroethane	Chlorinated solvent	Wash-up layout dye and screen inks Ultrasonic cleaning
Trichlorethylene	Chlorinated solvent	General-purpose cleaner and vapor degreaser
Turpentine	Petroleum solvent	Machine cutting fluid
Xylene	Petroleum solvent	Thinner for acrylic printing inks Wash-up for synthetic enamels and photo resist ink

Lubricant	*Application*
WD40	General purpose lubricant
3-in-1 oil	General purpose lubricant

INFORMATION SHEET

XVIII. Storage of hazardous materials

A. Select an area that meets local, state, and national codes.

B. Store materials in metal cabinets.

C. Keep cabinet or storage area locked.

D. Store in an area away from open flame or excessive heat.

E. Always read labels for instructions on proper storage and use.

XIX. Hazardous materials that may be found at the job site

A. PCB's (Polychlorinated Biphenyls) — Are fire resistant and help to improve the coolant and dielectric properties of oil; they can be harmful if absorbed into the skin, and they are suspected of being cancer-causing agents

(NOTE: PCB's are considered serious environmental contaminants.)

B. Asbestos — Used on ceilings, boilers, and electrical wiring as a heat retardant; it is highly suspected of causing cancer

(NOTE: OSHA requires employers to test for asbestos fibers in the air. The results will determine what control measures will be taken to protect employees.)

XX. General guidelines for first aid emergencies

A. Before administering first aid, always have a reason for what you do.

B. Reassure the injured person that everything possible is being done.

(NOTE: Hearing the concerned voice of a co-worker is psychologically comforting to an injured person and can actually lessen the degree of shock.)

C. Make accurate notes about the accident including name of victim, time, place, cause or nature of the accident, and any first aid that was administered.

D. Do not notify the victim's family because this is the responsibility of the school, the job site supervisor, or the medical facility.

E. Report all accidents and injuries to your instructor or job site supervisor, no matter how minor they may seem.

(NOTE: Follow emergency procedures that have been adopted by local school board.)

INFORMATION SHEET

XXI. First aid for eye injuries

A. Every eye injury should receive immediate first aid attention.

B. Notify your supervisor or instructor immediately.

C. For an apparent minor object in the eye, have the person wink several times. If the tears produced by winking do not remove the object, assume that the object is embedded and use the following procedure:

1. Have the victim close his or her eyes.

2. Put a piece of moist cotton over the closed lid.

3. Place a bandage over the cotton.

4. Get the victim to a doctor as soon as possible.

D. When the eyeball has been obviously scratched or penetrated, apply a sterile dressing, bandage *loosely*, and get medical help immediately.

E. Never permit the victim of an eye injury to rub his or her eye.

F. When in doubt about any eye injury, seek the most immediate medical attention.

G. Even though damage may be confined to one eye, it is sometimes best to bandage both eyes with a sterile dressing so the victim will not have a tendency to move the damaged eye.

H. For chemical or acid splashes, flush the eyes immediately at an eye-flushing station or use a bottled, portable flushing solution, then seek immediate medical assistance.

GENERAL SAFETY
UNIT II

ASSIGNMENT SHEET #1 — COMPLETE A STUDENT SAFETY PLEDGE FORM

_____, who is enrolled in Vocational _____ _____, will as a part of his/her shop experience, operate machines, providing that the parent or guardian gives written permission.

It is important that each student will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it. The student must assume responsibility for following safe practices, and we therefore ask that the student subscribe to the following safety pledge.

1. I promise to follow all safety rules for the shop.
2. I promise never to use a machine without first having permission from the instructor.
3. I will not ask permission to use a particular machine unless I have been instructed in its use, and have made 100% on the safety test for that machine.
4. I will report any accident or injury to the teacher immediately.

Date _____ Student's signature _____

I hereby give my consent to allow my son or daughter to operate all machines and equipment necessary in carrying out the requirements of the course in which he or she is enrolled.

Date _____ Parent's signature _____

Parents are cordially invited to visit the shop to inspect the machines and to see them in operation.

GENERAL SAFETY
UNIT II

ASSIGNMENT SHEET #2 — IDENTIFY AND CORRECT SAFETY VIOLATIONS

NAME _____ SCORE _____

DIRECTIONS: The following conditions relate unsafe acts that may be found in the classroom. List the safety violations and the corrective measures which should have been taken to prevent them.

The morning class was loading materials and equipment for their school project house. John, one of the students, went to the tool room and got the ½" drill motor that had a red tag attached to the power cord. John noticed there was a stripped wire on the drill but he didn't think it was that bad. John pulled the red tag off the drill and threw it in the trash. Then John went to the tape cabinet to find some electrical tape. The bell rang so John placed the drill with the other tools and went to catch the bus. When the afternoon class arrived they finished loading the tools and materials in the bus and went to the project house. Jim was assigned to drill out the house. He picked up the drill that John had left with the other tools and started to drill. It was very hot that day so Jim removed his shoes. The plumbing students were also working in the house testing water lines and the floor was covered with water. While drilling in the bathroom, Jim pulled the drill cord through the water and received a severe electrical shock.

A. List the safety violations.

GENERAL SAFETY
UNIT II

ASSIGNMENT SHEET #3 — DRAW A LAYOUT OF YOUR SCHOOL SHOP AND APPLY SAFETY COLOR CODE

NAME _____ SCORE _____

DIRECTIONS: Draw a layout of your school shop including all machines, workbenches, tools, first aid kit, and fire prevention equipment. Use the federal safety color code to identify equipment, hazards, safety features, and exposed parts that could cause accidents.

GENERAL SAFETY
UNIT II

ASSIGNMENT SHEET #3 — DRAW A LAYOUT OF YOUR SCHOOL SHOP AND APPLY SAFETY COLOR CODE

NAME _____ SCORE _____

DIRECTIONS: Draw a layout of your school shop including all machines, workbenches, tools, first aid kit, and fire prevention equipment. Use the federal safety color code to identify equipment, hazards, safety features, and exposed parts that could cause accidents.

GENERAL SAFETY
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1 — Evaluated to the satisfaction of the instructor

Assignment Sheet #2

A.
1. Red warning tag was removed from drill
2. Did not report stripped wire on drill to instructor
3. Put drill with other tools
4. Was going to try to fix drill cord with electrical tape
5. Afternoon student did not check condition of drill before use
6. Shoes were removed on job site while work was being don
7. Water on floor was ignored

B.
1. John should have left red warning tag on drill.
2.-3. He should have reported the damaged tool to the instructor and it should have been removed from other tools until fixed.
4. Repair of tools should be handled by instructor or under instructor's supervision.
5. John should have checked the condition of the drill prior to plugging it in.
6. Never remove shoes on job site, especially when working with electrical equipment.
7. The water spill should have been cleaned up. If water was still running as a result of plumbing work, John should have reported condition to instructor and been assigned another job.

Assignment Sheet #3 — Evaluated to the satisfaction of the instructor

GENERAL SAFETY
UNIT II

TEST

NAME _____ SCORE _____

1. Match terms on the right with their correct definitions.

_____a.	A potential source of danger	1. Accident
_____b.	That which quickly puts out fires or at least smothers flames	2. Combustibles
_____c.	Any suddenly occurring, unintentional event which causes injury or property damage	3. CPR 4. Fire extinguisher
_____d.	Emergency procedure performed by trained individuals to aid a heart attack victim	5. First aid
_____e.	Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained	6. Hazard 7. OSHA 8. Safety
_____f.	Materials or liquids that catch fire easily	9. Shock
_____g.	State or condition of being safe; freedom from danger, risk, or injury	
_____h.	Federal legislation designed to insure safe and sanitary working conditions for employees	
_____i.	The sudden stimulation of the nerves and muscles caused by the discharge of electricity through the body	

2. Complete the following statements concerning personal safety rules by inserting the word(s) that best complete each statement.

   a. Wear shop _____ appropriate to the instructional activity being performed.

   b. _____ long hair before operating rotating equipment.

   c. Always wear safety _____ .

TEST

d. Remove _____ when working around machine tools or rotating equipment.

e. Remove _____ and other jewelry when working in the shop.

f. Conduct yourself in a manner conducive to safe _____ practices.

g. Use _____ and _____ frequently as a method of preventing skin diseases.

h. Wear _____ in dusty areas.

3. Select true statements concerning general safety rules by placing an "X" in the blanks preceding the true statements.

_____a. Keep all hand tools sharp, clean, and in safe working order.

_____b. Operate a hazardous machine before receiving instruction on how to operate the machine safely in all working conditions.

_____c. Turn off the power before leaving a machine tool.

_____d. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool.

_____e. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it.

_____f. Clean up any spilled liquids when you have time.

_____g. Store oily rags or oily waste in plastic containers.

_____h. Clean the chips from a machine with a rag or bare hands.

_____i. Wear eye protection when using grinders and buffers.

_____j. Do not work overtime in the shop unless instructor is present.

_____k. Wear gloves when handling equipment and materials with sharp edges.

_____l. Check all equipment after activating.

4. List three shop conditions that should be reported.

a. _____

b. _____

c. _____

TEST

5. Select true statements concerning things OSHA expects of an employer by placing an "X" in the blanks preceding the true statements.

_____a. To provide a hazard-free workplace and comply with occupational safety and health standards

_____b. To inspect job sites to assure there are no obvious safety violations

_____c. To use properly color-coded signs to warn of danger

_____d. To keep required records of work-related injuries and to post an annual summary in February of each year

_____e. To report within two weeks to OSHA any accident which is fatal or hospitalizes five or more workers

_____f. To post in a prominent place OSHA poster #2203 informing workers of their rights and responsibilities

6. Select from the following list things OSHA expects of an employee by placing an "X" in the blanks preceding the correct things.

_____a. Post in a prominent place OSHA poster #2203 informing workers of their rights and responsibilities.

_____b. Follow employer safety and health rules and wear prescribed clothing or protective equipment on the job.

_____c. Expect supervisor to notice hazardous conditions.

_____d. Report all job-related injuries to a supervisor, and seek prompt treatment if required.

_____e. Report to OSHA in a responsible manner any hazardous working situations which you feel the employer has not attended to properly.

TEST

7. Match the colors of the safety color code on the right with their correct uses.

_____a.	Designates caution and for marking physical hazards, waste containers for explosive or combustible materials, caution against starting, using, or moving equipment under repair, identification of the starting point or power source of machinery	1. Federal safety green
_____b.	Identifies fire protection equipment and apparatus, portable containers of flammable liquids, emergency stop bars, stop buttons, and emergency electrical stop switches on machinery	2. Federal safety white and black
_____c.	Designates safety and the location of first aid equipment	3. Federal safety orange
_____d.	Designates dangerous parts of machines, safety starter buttons, parts of equipment that may produce electrical shock, and the exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws	4. Federal safety purple
_____e.	Designates traffic flow, housekeeping zones	5. Federal safety red
_____f.	Designates radiation hazards	6. Federal safety yellow

8. Match the following safety tags or signs below with their correct color coding.

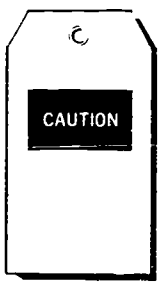
_____a. White tag, white letters on red square

_____b. White tag, white letters in red oval, on black square

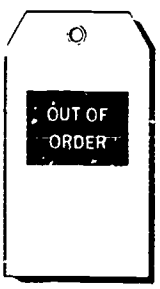
_____c. Yellow tag, yellow letters on black background

_____d. White tag, white letters on black background

1. 

2. 

3. 

4. 

TEST

9. List the three components of the fire triangle.

a. _____

b. _____

c. _____

10. Match types of fires on the right with their correct classifications.

_____a.	Fires that occur in electrical and electronic equipment	1. Class A
_____b.	Fires that occur in flammable liquids	2. Class B
_____c.	Fires that occur in ordinary combustible materials	3. Class C
_____d.	Fires that occur in combustible metals	4. Class D

11. Match types of fire extinguishers on the right with their uses.

_____a.	Place foot on foot pump and direct stream at base of fire; use on **class A** fires only.	1. Carbon dioxide
_____b.	Direct discharge as close to fire as possible, first at the edge of flames, then gradually forward and upward; use for class B or class C fires.	2. Halon
_____c.	Instead of spraying stream into the burning liquid, allow substance to fall lightly on the fire, use for class A or class B fires.	3. Pump tank
_____d.	Direct at the base of the flames and follow up by directing the dry chemicals at remaining material that is burning; use for class B or class C fires.	4. Dry chemical
_____e.	Stand back ten feet, hold upright and direct at the base of fire, sweeping from side to side; use for class C fires.	5. Foam

TEST

12. Match factors contributing to back injuries on the right with their causes.

_____a. This usually results from overestimating your physical abilities and trying to lift more weight than you can handle, and sometimes it results from trying to be macho in front of fellow workers.

_____b. This usually results from moving an object that may be within your weight capacity, but is too long, high, or wide to lift safely.

_____c. This usually results from moving an object that may be within your weight capacity, but has a cylindrical or other odd shape that makes lifting difficult.

_____d. This usually results from stacking materials so high that vision is limited and obstructions in the pathway can't be seen.

_____e. This usually results from twisting or turning into an awkward position when lifting.

_____f. This results in strain caused by not storing heavy objects at least 12" off the floor.

_____g. This usually results from carelessly using chairs or boxes to reach from instead of safely using a ladder.

1. Improper storage
2. Weight
3. Obstructions
4. Improper reaching
5. Size
6. Shape
7. Improper position

13. Arrange in order the steps in lifting safely. Write a "1" before the first step, a "2" before the second step, and so on.

_____a. Do not turn or twist until you have the load lifted into a carrying position, and then move your feet to turn your body as you check your path of travel and make sure it is clear.

_____b. Lower the load by bending your knees, and remember to store heavy objects at least 12" off the floor.

_____c. Bend your knees, get a good hand hold, then use both legs and back muscles to lift the load straight up as you push with your legs and keep the load close to your body.

_____d. Size up the load to make sure you can safely handle it alone, then place your feet close to the object and about 12" apart.

TEST

14. Select true statements concerning safety practices for step ladders and extension ladders by placing an "X" in the blanks preceding the true statements.

_____a. Never leave tools or equipment on footsteps or top.

_____b. Stand on ladder tops only when necessary.

_____c. Never use damaged ladders until repaired.

_____d. Be careful when using an aluminum ladder for electrical work.

_____e. Set ladder on a firm, level surface.

_____f. Step over broken or cracked footsteps.

_____g. Maintain safe ladder angle.

15. Select true statements concerning safety practices for scaffolds by placing an "X" in the blanks preceding the true statements.

_____a. Never ride a scaffold when it is being moved.

_____b. Scaffolding is easy to assemble and can be done alone.

_____c. Secure wheel locks before moving.

_____d. Always use the proper planks when assembling.

_____e. Never climb a scaffold unless three legs are on the ground.

16. Select true statements concerning safety practices for power lifts by placing an "X" in the blanks preceding the true statements.

_____a. Lifts should be operated on uneven surfaces.

_____b. Never lift over the weight-rated capacity of the lift.

_____c. Always check for objects in the pathway.

_____d. Never put arms or legs in lif

_____e. When moving lift, assume workers will get out of the way.

TEST

17. Select true statements concerning hazardous cleaners and lubricants by placing an "X" in the blanks preceding the true statements.

_____a. Acetone is an acid which cleans solder connections.

_____b. Kerosene may be used as a machine cutting fluid.

_____c. Mineral spirits is a petroleum solvent which acts as a thinner for rubber, oil, and alkyd enamels.

_____d. Bright dip is an acid mixture containing sulfuric, hydrochloric, and nitric acids.

_____e. Lacquer thinner may be used as a coolant.

_____f. Isophorone is used for oil and grease wash-up.

_____g. Ethyl alcohol is not petroleum based.

_____h. Hydrochloric acid is diluted acid which removes mill scale from steel.

_____i. Cyclohexanone is a vinyl solvent and cement thinner.

18. Complete the following statements concerning storage of hazardous materials by circling the word(s) that best complete each statement.

a. Select an area that meets local, state, and national (**opinions, codes**).

b. Store materials in (**metal cabinets, plastic baskets**).

c. Keep storage area (**locked, open**).

d. Store in an open area (**near, away from**) open flame or excessive heat.

e. Always read (**text, labels**) for instructions on proper storage use.

19. Distinguish between hazardous materials that may be found at the job site by placing a "P" for PCB's next to the correct description.

_____a. Used on ceilings, boilers, and electrical wiring as a heat retardant; highly suspected of causing cancer

_____b. Fire resistant and help to improve the coolant and dielectric properties of oil; can be harmful if absorbed into the skin; suspected of being cancer-causing agents

TEST

20. Complete the following statements concerning general guidelines for first aid emergencies by inserting the word(s) that best completes each statement.

    a. Before administering first aid, always have a _____ for what you do.

    b. _____ the injured person that everything possible is being done.

    c. Make _____ _____ about the accident including name of victim, time, place, cause or nature of the accident, and any first aid that was administered.

    d. Do not _____ the victim's family because this is the responsibility of the school, the job site supervisor, or the medical facility.

    e. Report all accidents and injuries to your instructor or job site supervisor, no matter how _____ they may seem.

21. Select true statements concerning first aid for eye injuries by placing an "X" in the blanks preceding the true statements.

    _____a. Every eye injury should receive immediate first aid attention.

    _____b. Notify your supervisor or instructor after first aid has been administered.

    _____c. For an apparent minor object in the eye, have the person wink several times. If the tears produced by winking do not remove the object, assume that the object is embedded and use the following procedure:

        1) Have the victim close his or her eyes.

        2) Put a piece of moist cotton over the closed lid.

        3) Place a bandage over the cotton.

        4) Get the victim to a doctor as soon as possible.

    _____d. When the eyeball has been obviously scratched or penetrated, apply a sterile dressing, bandage *tightly*, and get medical help immediately.

    _____e. Permit the victim of an eye injury to rub his or her eye.

    _____f. When in doubt about any eye injury, seek the most immediate medical attention.

    _____g. If damage is confined to one eye, it is best to bandage only that eye with a sterile dressing so the victim will be able to see.

    _____h. For chemical or acid splashes, flush the eyes immediately at an eye-flushing station or use a bottled, portable flushing solution, then seek immediate medical assistance.

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

22. Complete a student safety pledge form. (Assignment Sheet #1)

23. Identify and correct safety violations. (Assignment Sheet #2)

24. Draw a layout of your school shop and apply safety color code. (Assignment Sheet #3)

GENERAL SAFETY
UNIT II

ANSWERS TO TEST

1.
a.	6	f.	2
b.	4	g.	8
c.	1	h.	7
d.	3	i.	9
e.	5		

2.
a. Clothing
b. Confine
c. Glasses
d. Ties
e. Rings
f. Shop
g. Soap, water
h. Dust masks

3. a, c, d, e, i, j, k

4.
a. Defects on equipment
b. Any condition that can lead to an accident
c. All accidents

5. a, c, d, f

6. b, d, e

7.
a. 6
b. 5
c. 1
d. 3
e. 2
f. 4

8.
a. 1
b. 3
c. 2
d. 4

ANSWERS TO TEST

9. a. Fuel
   b. Heat
   c. Oxygen

10. a. 3
    b. 2
    c. 1
    d. 4

11. a. 3
    b. 1
    c. 5
    d. 4
    e. 2

12. a. 2
    b. 5
    c. 6
    d. 3
    e. 7
    f. 1
    g. 4

13. a. 3
    b. 4
    c. 2
    d. 1

14. a, c, e, g

15. a, c, d

16. b, c, d

17. b, c, d, h, i

18. a. Codes
    b. Metal cabinets
    c. Locked
    d. Away from
    e. Labels

ANSWERS TO TEST

19. b

20. a. Reason
    b. Reassure
    c. Accurate notes
    d. Notify
    e. Minor

21. a, c, f, h

22.-24. Evaluated to the satisfaction of the instructor

ELECTRICAL SAFETY
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to complete an electrical safety checklist and solve problems concerning electrical safety practices. Competencies will be demonstrated by completing the assignment sheets and the unit test with a minimum score of 100 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to electrical safety with their correct definitions.
2. List three major causes of electrical accidents.
3. Select from a list basic electrical safety practices.
4. Complete statements concerning electrical fire prevention practices.
5. Select true statements concerning safety practices around live circuits.
6. Select true statements concerning proper grounding.
7. List three facts about the importance of the third wire.
8. Explain ground fault interrupters.
9. List uses for lockout devices.
10. Complete statements concerning facts about electrical shock.
11. Select true statements concerning treating a victim of electrical shock.
12. Complete an electrical safety checklist. (Assignment Sheet #1)
13. Solve problems concerning electrical safety practices. (Assignment Sheet #2)

ELECTRICAL SAFETY
UNIT III

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Integrate the following activities throughout the teaching of this unit:

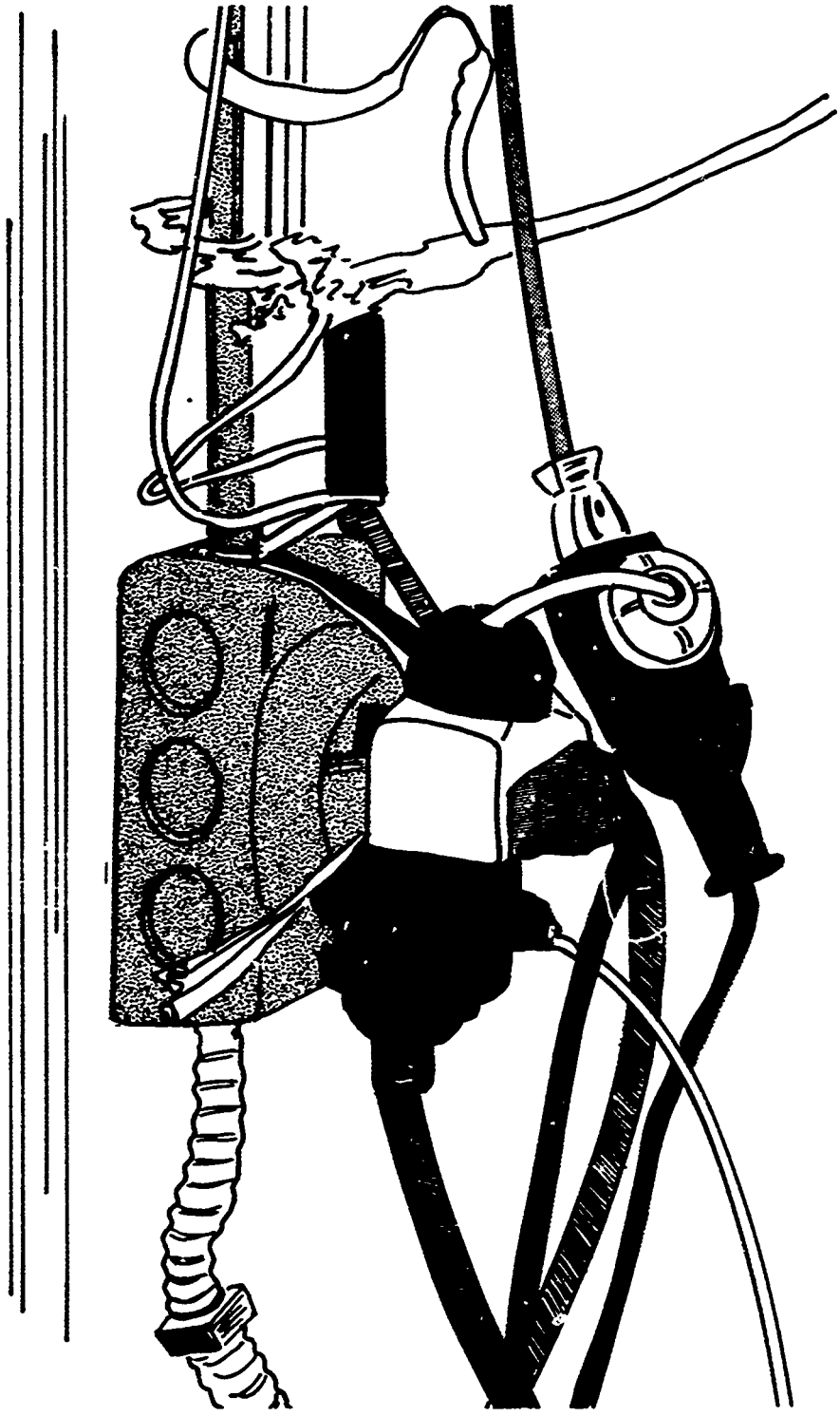
1. Demonstrate the proper use of lockout devices.
2. Set up scaffolding in the shop.
3. Demonstrate the function of a ground fault interrupter.
4. Have students survey the shop area for uses of ground fault interrupters.
5. Show students how to work safely with live voltages.
6. Have first aid personnel from local Red Cross or power supply company demonstrate rescue procedures for victims of electrical shock.
7. Have students make shop safety posters related to electrical safety.
8. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas for improvement.

H. Give test.

I. Evaluate test.

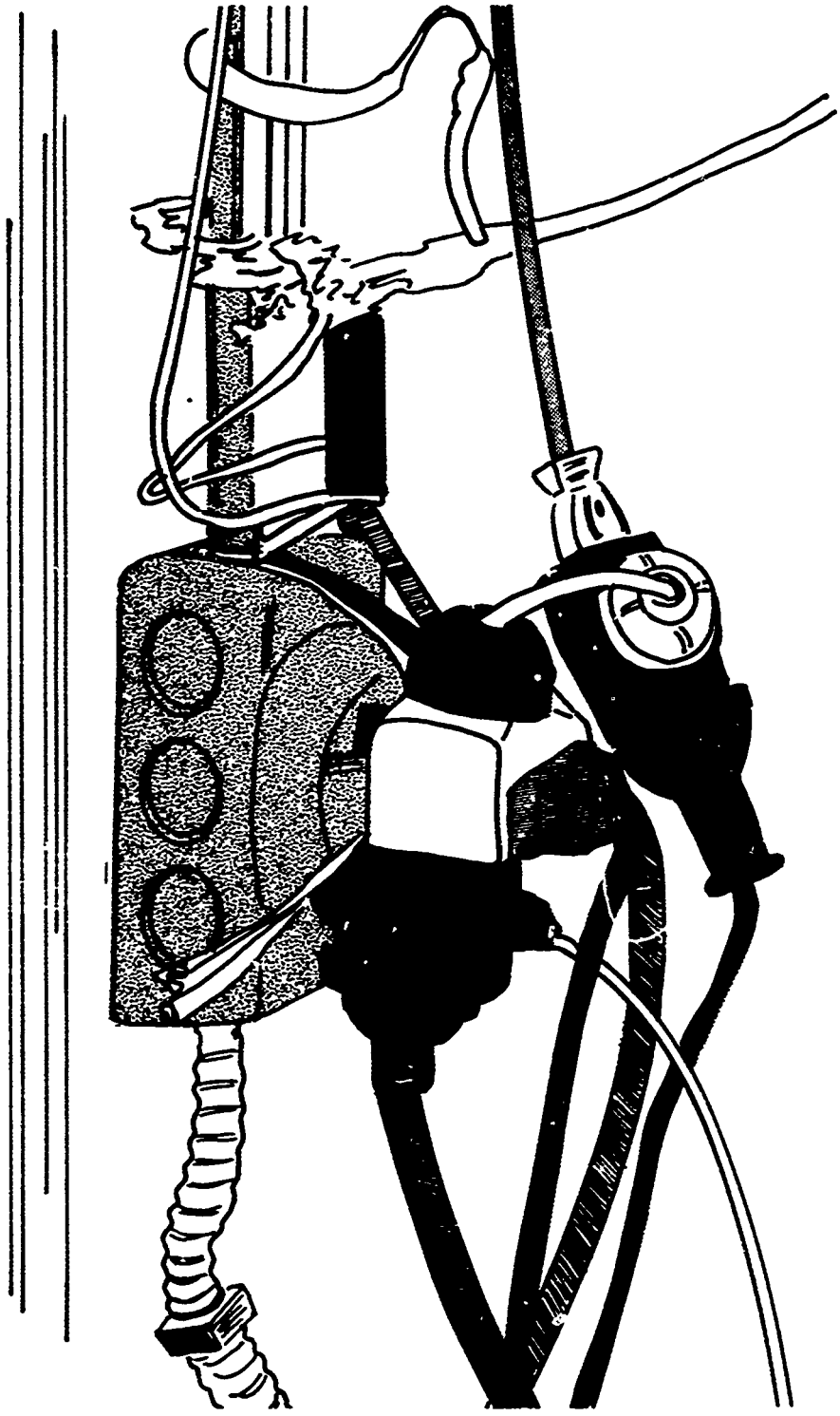
J. Reteach if necessary.

Fire Prevention



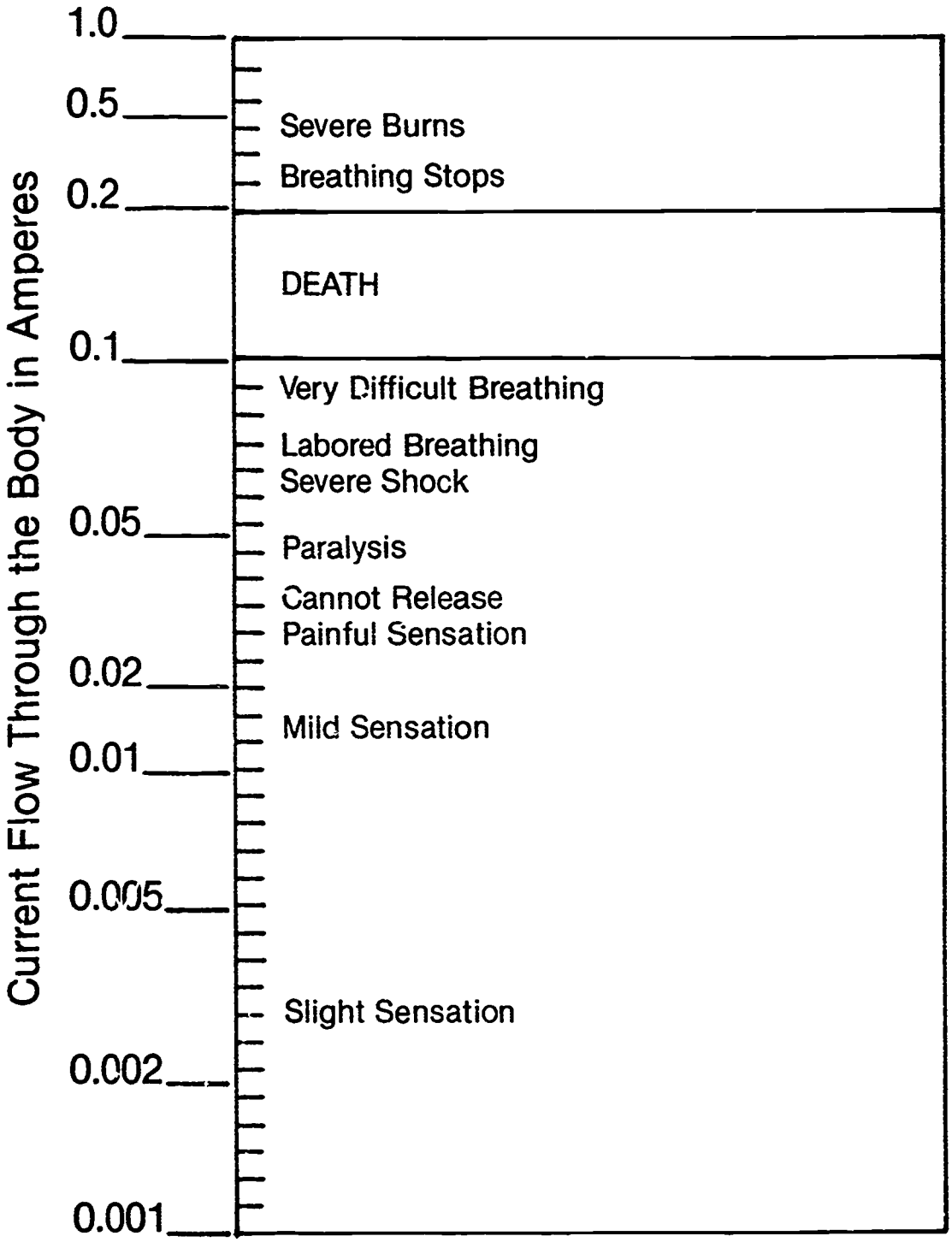
IMPROPER USE OF ELECTRICAL EQUIPMENT IS DANGEROUS

Fire Prevention

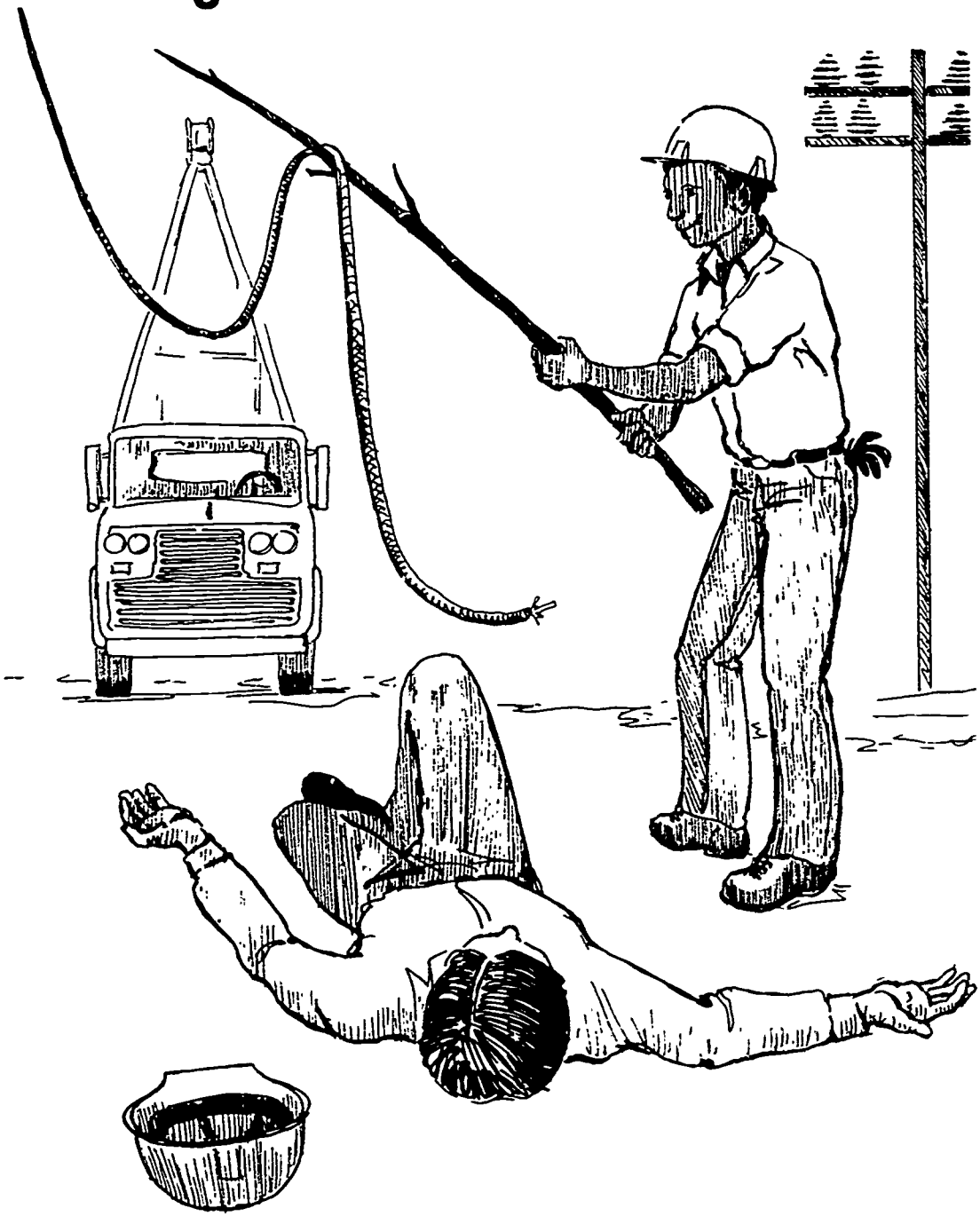


IMPROPER USE OF ELECTRICAL EQUIPMENT IS DANGEROUS

Electric Shock Versus Body Sensation

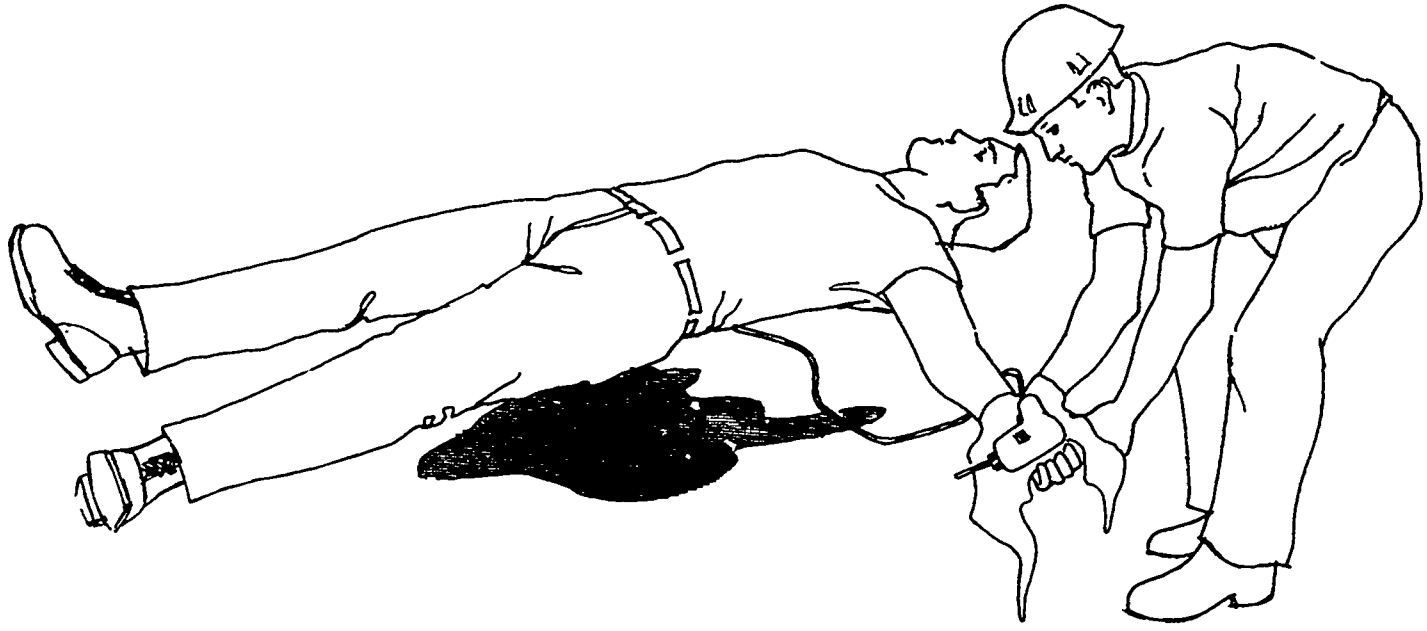


Dangers of Rescue Procedures



USE A NONCONDUCTOR TO SEPARATE VICTIM FROM ELECTRICAL CIRCUIT.
DO NOT TOUCH THE ELECTRICAL CIRCUIT OR THE VICTIM UNLESS THE POWER IS OFF OR YOU ARE INSULATED.

Dangers of Rescue Procedures (Continued)



DO NOT ATTEMPT TO REMOVE A VICTIM WITHOUT SOME FORM OF INSULATION SUCH AS PAPER OR CLOTH TO PROTECT YOURSELF

ELECTRICAL SAFETY
UNIT III

INFORMATION SHEET

I. **Terms and definitions**

A. Ampere — A measure of the intensity of electron flow

B. Conductor — A current carrying device such as wire or copper bars

C. Cube tap — A device that plugs into a receptacle and provides space for connection of two or more attachment plugs

D. Ground — A connection between an electrical circuit or equipment to the earth

E. Ground fault interrupter — Personal protection device that stops current flow when an imbalance occurs between current carrying conductors

F. Hertz — One complete positive to negative cycle in an alternating current circuit

G. Hydraulic — A system where the main operation of equipment is operated by fluids

H. Multi-outlet assembly — A type of surface or flush raceway designed to hold conductors and receptacles

I. Pneumatics — A system where the main operation of equipment is operated by air

J. Volt — Unit measure for electrical pressure

II. **Major causes of electrical accidents**

A. Carelessness

B. Misuse

C. Getting in a hurry

III. **Basic electrical safety practices**

A. Never underestimate the danger of 110v AC circuits.

(NOTE: More people die from 110v AC electrical shock than any other voltage. This is mostly due to a lack of respect.)

B. Watch out for electrical arcs; they can cause bad burns.

C. Do not operate equipment beyond its rated capacity.

D. Never install equipment that will overload a circuit.

INFORMATION SHEET

E. Never bypass a fuse.

F. Be sure all current carrying electric lines are well insulated.

G. Always check a circuit for voltage before servicing.

H. Know where all emergency shutdown switches are located.

I. Work on live circuits only when absolutely necessary.

J. Watch for burnt wires on electrical devices.

K. Never touch a conductor without first testing.

L. Look for loose conductors in electrical systems.

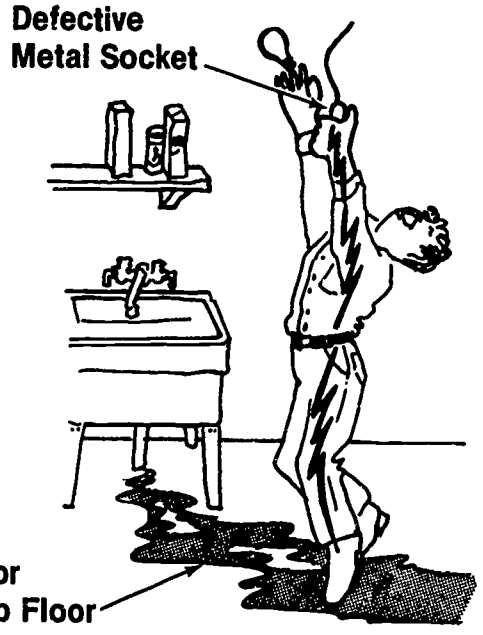
M. Do not make any adjustment or repairs to any electric equipment until all power has been disconnected or the electrical breaker has been turned off.

(NOTE: Adjustments or repairs should be done only by authorized persons.)

N. All electrical equipment and tools should be properly grounded to prevent any injury to the operator.

O. Do not operate electrical parts with wet gloves or wet clothing.

(NOTE: To prevent harmful body shocks, keep hands, feet, and clothing dry, and use a dry board or rubber mat when water, moisture, or perspiration cannot be avoided.)



P. Never work alone when working with more than 50 volts.

INFORMATION SHEET

IV. Electrical fire prevention practices

A. Use extension cords only within their designated rating.

B. Never let multi-outlet assemblies or cube taps cause overloads.

C. Never use frayed or deteriorated extension cords.

D. Never tamper with fuses to change their current carrying capacity.

V. Safety practices around live circuits

A. Use a reliable circuit tester or voltmeter to identify live circuits.

B. Stand on dry surface.

C. Use only one hand if possible.

D. Never keep tools lying around live conductors.

E. Wear suitable insulated hand covering.

F. Return all tools to pouch when through with them.

VI. Proper grounding

A. Properly grounded electrical equipment provides a pathway to ground for stray current that may otherwise go through the operator's body.

B. Loose wires that touch the case or housing in electrical equipment can cause an electrical shock to anyone who touches the equipment if it has not been properly grounded.

(NOTE: A faulty current to the housing will travel directly to ground. A worker touching the equipment is not likely to suffer a serious shock because the ground is a better current path than the human body.)

C. Loose connections can be detected by heat on conductors, a burning odor, carbon tracking, and conductors that are discolored.

D. Always check electrical equipment for proper grounding before working on them.

E. Proper grounding allows ground fault current to clear overcurrent device providing safety of operation.

INFORMATION SHEET

VII. Importance of third wire

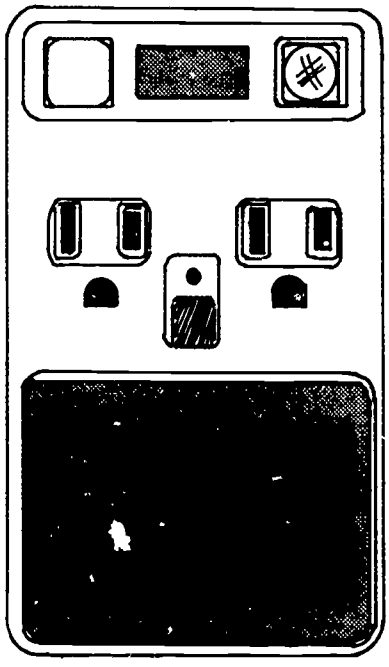
(NOTE: Always check for grounding or third wire before using electrical equipment to avoid electrical shock.)

A. Installed for personal protection

B. Provides alternate path for current in case of a short

C. Can save your life

VIII. Ground fault interrupters (GFI)



A. Personal safety devices

B. Required on 15 and 20 ampere receptacle outlets used for temporary power supply on construction sites

C. Stops current before severe personal injury occurs

(NOTE: When the ground fault interrupter works properly, the power is cut off so fast that the shock can be reduced to a few microseconds.)

INFORMATION SHEET

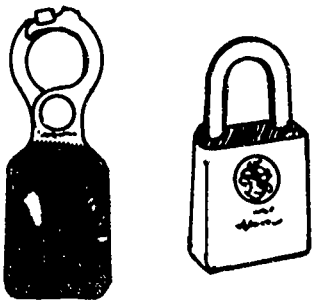
IX. Uses for lockout devices

A. Use if more than one power source is present.

B. Always use when hydraulic position could change.

C. Always use when pneumatic position could change.

D. Lock off all electrical devices before working on equipment.



X. Facts about electrical shock

A. High voltage (low current) tends to knock the victim away from the circuit, minimizing exposure time.

B. High current tends to cause the body to adhere to the circuit, so that the victim cannot let go.

1. At about 1 milliampere (0.0010 amperes), a slight shock will be felt.

2. At about 10 milliamperes (0.010 amperes) the shock is severe enough to paralyze muscles, but a person may be able to let go of the conductor.

3. At about 100 milliamperes (0.1 amperes) the shock is usually fatal if it lasts for one second or more.

(NOTE: Human body resistance varies from about 500,000 ohms when dry to about 300 ohms when wet. Because of this, voltages as low as 30 volts can cause enough current to be fatal. Any circuit with a potential of at least 30 volts must be considered dangerous.)

INFORMATION SHEET

XI. Treating a victim of electrical shock

A. Safely remove the victim from contact with the source of electricity using the following procedure.

(CAUTION: Do not touch the electrical circuit or the victim unless the power is off or you are insulated.)

1. Turn off the electricity by means of a switch or circuit breaker or cut cables or wires by means of a wood-handled axe or insulated cutters if available.

   (NOTE: This must be done quickly. After five minutes the chances of saving an individual will greatly decrease.)

2. Use a dry stick, rope, leather belt, coat, blanket, or any other nonconductor of electricity to separate the victim from the electrical circuit.

   (CAUTION: Do not take hold of the victim with your bare hand.)

B. Call for assistance

1. Others in the area may be more knowledgeable than you about treating the victim.

2. Another person can call for professional medical help while you administer first aid.

C. Check victim's breathing and heartbeat.

(NOTE: **TIME IS LIFE AT THIS POINT!**)

1. If pulse is detectable, but breathing has stopped, administer mouth-to-mouth resuscitation until medical help arrives.

2. If heartbeat has stopped, administer cardiopulmonary resuscitation, but only if you have been trained in the proper technique.

   (CAUTION: Cardiopulmonary resuscitation can sometimes cause more harm than good to a victim unless the person administering the first aid has been trained in the proper procedure.)

3. If both heartbeat and breathing have stopped, alternate between cardiopulmonary resuscitation and mouth-to-mouth resuscitation, but again only if you have been trained in this technique.

ELECTRICAL SAFETY
UNIT III

ASSIGNMENT SHEET #1 — COMPLETE AN ELECTRICAL SAFETY CHECKLIST

NAME _____ SCORE _____

Directions: Complete the following electrical safety checklist for your school shop area, and list safety violations that you find.

		Place a (✓) in the appropriate box	
		YES	NO
1.	Cords on all machines are properly connected.	☐	☐
2.	Extension cords are used within designated rating.	☐	☐
3.	Extension cords are in good working condition.	☐	☐
4.	Shop area is properly wired.	☐	☐
5.	All electrical hand tools are properly grounded.	☐	☐
6.	All electrical equipment is properly grounded.	☐	☐
7.	Ground fault interrupters are present and in working order.	☐	☐
8.	All machines are marked with safety operations.	☐	☐
9.	Shop safety rules are posted.	☐	☐
10.	Safety lanes are marked using proper color designations.	☐	☐
11.	Exits from shop area are properly marked.	☐	☐
12.	Fire extinguishers are properly charged.	☐	☐
13.	Fire extinguishers are easily accessible.	☐	☐
14.	Areas around electrical equipment are clean and dry.	☐	☐
15.	Areas around water fountains are clean and dry.	☐	☐
16.	First aid kit is properly stocked and marked for identification.	☐	☐
17.	Emergency numbers are posted at phone.	☐	☐
18.	General housekeeping practices are observed.	☐	☐

ELECTRICAL SAFETY
UNIT III

ASSIGNMENT SHEET #1 — COMPLETE AN ELECTRICAL SAFETY CHECKLIST

NAME _____ SCORE _____

Directions: Complete the following electrical safety checklist for your school shop area, and list safety violations that you find.

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3.	Extension cords are in good working condition.	☐	☐
4.	Shop area is properly wired.	☐	☐
5.	All electrical hand tools are properly grounded.	☐	☐
6.	All electrical equipment is properly grounded.	☐	☐
7.	Ground fault interrupters are present and in working order.	☐	☐
8.	All machines are marked with safety operations.	☐	☐
9.	Shop safety rules are posted.	☐	☐
10.	Safety lanes are marked using proper color designations.	☐	☐
11.	Exits from shop area are properly marked.	☐	☐
12.	Fire extinguishers are properly charged.	☐	☐
13.	Fire extinguishers are easily accessible.	☐	☐
14.	Areas around electrical equipment are clean and dry.	☐	☐
15.	Areas around water fountains are clean and dry.	☐	☐
16.	First aid kit is properly stocked and marked for identification.	☐	☐
17.	Emergency numbers are posted at phone.	☐	☐
18.	General housekeeping practices are observed.	☐	☐

ASSIGNMENT SHEET #1

Safety Violations

ELECTRICAL SAFETY
UNIT III

ASSIGNMENT SHEET #2 — SOLVE PROBLEMS CONCERNING ELECTRICAL SAFETY PRACTICES

NAME _____ SCORE _____

Directions: Solve the following problems concerning electrical safety practices. Refer to the Information Sheet in this unit to check your answers.

A. You are working on a project in the school shop and the person next to you shorts out his project and it catches fire. What are the safety procdures you should take?

_____

_____

_____

_____

B. While working at the project house, you hear a shout and turn to see a fellow worker has fallen to the floor with an electric line under his body. What is the very first thing you should do?

_____

_____

_____

_____

C. You are called out on a job after a storm to repair an electric pump in a basement which is flooded with water. List the things you should do before repairing the pump.

_____

_____

_____

_____

ELECTRICAL SAFETY
UNIT [illegible]

TEST

NAME _____ SCORE _____

1. Match the terms on the right with their correct definitions.

_____a.	Personal protection device that stops current flow when an imbalance occurs between current carrying conductors	1. Ampere
_____b.	A system where the main operation of equipment is operated by air	2. Conductor
_____c.	A measure of the intensity of electron flow	3. Cube tap
_____d.	Unit measure for electrical pressure	4. Ground
_____e.	One complete positive to negative cycle in an alternating current circuit	5. Ground fault interrupter
_____f.	A type of surface or flush raceway designed to hold conductors and receptacles	6. Hertz
_____g.	A device that plugs into a receptacle and provides space for connection of two or more attachment caps	7. Hydraulic
_____h.	A current carrying device such as wire or copper bars	8. Multi-outlet assembly
_____i.	A connection between an electrical circuit or equipment to the earth	9. Pneumatics
_____j.	A system where the main operation of equipment is operated by fluids	10. Volt

2. List three major causes of electrical accidents.

a. _____

b. _____

c. _____

TEST

3. Select from the following list basic electrical safety practices by placing an "X" in the blanks preceding the correct practices.

_____a. Since 110 volts is relatively low some safety rules can be ignored.

_____b. Watch out for electrical arcs; they can cause bad burns.

_____c. Know where all emergency shutdown switches are located.

_____d. Slight overloads are acceptable on most circuits.

_____e. Never bypass a fuse.

_____f. Always check a circuit for voltage before servicing.

_____g. Watch ror burnt wires on electrical devices.

_____h. Operate equipment beyond its rated capacity.

_____i. Work alone when working with high voltage.

4. Complete the following statements concerning electrical fire prevention practices by inserting the word that best completes each statement.

a. Use extension cords only within their _____.

b. Never let multi-outlet assemblies or cube taps cause _____.

c. Never use _____ or _____ extension cords.

d. Never tamper with _____ to change their current carrying capacity.

5. Select true statements concerning safety practices around live circuits by placing an "X" in the blanks preceding the true statements.

_____a. Use a reliable circuit tester or voltmeter to identify live circuits.

_____b. Stand on either wet or dry surface.

_____c. Use only one hand if possible.

_____d. Never keep tools lying around live conductors.

_____e. Wear suitable insulated hand covering.

TEST

6. Select true statements concerning proper grounding by placing an "X" in the blanks preceding the true statements.

   _____a. Properly grounded electrical equipment provides a pathway to ground for stray current that may otherwise go through the operator's body.

   _____b. Loose wires that touch the case or housing in electrical equipment cannot cause an electrical shock to anyone who touches the equipment if it has not been properly grounded.

   _____c. Loose connections can be detected by heat on conductors, a burning odor, carbon tracking, and conductors that are discolored.

   _____d. Always check electrical equipment for proper grounding before working on them.

7. List three facts about the importance of the third wire.

   a. _____

   b. _____

   c. _____

8. Explain ground fault interrupters.

   _____

   _____

   _____

   _____

9. List three uses for lockout devices.

   a. _____

   b. _____

   c. _____

TEST

10. Complete the following list of statements concerning facts about electrical shock by circling the word that best completes each statement.

    a. High **(current, voltage)** tends to knock the victim away from the circuit minimizing exposure time.

    b. High **(current, voltage)** tends to cause the body to adhere to the circuit so that the victim cannot let go.

    c. At about **(1,000, 100)** milliamperes the shock is severe enough to paralyze muscles, but a person may be able to let go of the conductor.

11. Select true statements concerning treating a victim of electrical shock by placing an "X" in the blanks preceding the true statements.

    _____a. To safely remove the victim from contact with the source of electricity, turn off the electricity by means of a switch or circuit breaker or cut cables or wires by means of a wood handled axe or insulated cutters.

    _____b. Call for assistance as others in the area may be more knowledgeable than you about treating the victim.

    _____c. Check victim's temperature.

    _____d. Check victim's breathing and heartbeat; if heart has stopped, administer cardiopulmonary resuscitation whether you have been trained in the proper technique or not.

    _____e. Use blankets or coats to help keep victim as warm and comfortable as possible while waiting for help.

    _____f. Raise victim's head slightly above body level to help prevent shock.

    _____g. If victim has suffered burns, wrap burned area firmly with sterile gauze or clean linen or towels.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

12. Complete an electrical safety checklist. (Assignment Sheet #1)

13. Solve problems concerning electrical safety practices. (Assignment Sheet #2)

ELECTRICAL SAFETY
UNIT III

ANSWERS TO TEST

1.

a.	5	f.	8
b.	9	g.	3
c.	1	h.	2
d.	10	i.	4
e.	6	j.	7

2.
a. Carelessness
b. Misuse
c. Getting in a hurry

3. b, c, e, f, g

4.
a. Designated rating
b. Overloads
c. Frayed, deteriorated
d. Fuses

5. a, c, d, e

6. a, c, d

7.
a. Installed for personal protection
b. Provides alternate path for current in case of a short
c. Can save your life

8. Answer should include the following:

Ground fault interrupters are personal safety devices which stop current before severe personal injury occurs. These devices are required on 15 and 20 ampere receptacle outlets which are used for temporary power supply on construction sites.

9. Any three of the following:

a. Use if more than one power source is present.
b. Always use when hydraulic position could change.
c. Always use when pneumatic position could change.
d. Lock off all electrical devices before working on equipment.

ANSWERS TO TEST

10. a. Voltage
    b. Current
    c. 100

11. a, b, e, g

12.-13. Evaluated to the satisfaction of the instructor

HAND TOOLS
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify, use, and care for common hand tools used in the electrical field. Competencies will be demonstrated by completing the job sheets and the unit tests with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to hand tools with their correct definitions.
2. Label common hand tools used in the electrical field.
3. Label electricity-specific hand tools used in the electrical field.
4. Match common hand tools with their correct uses.
5. Match electricity-specific hand tools with their correct uses.
6. List three factors to consider when purchasing hand tools
7. Select true statements concerning rules for care of various hand tools.
8. Demonstrate the ability to:
    a. Clean and lubricate an adjustable hand tool. (Job Sheet #1)
    b. Use a cutting-crimping tool. (Job Sheet #2)
    c. Adjust wire strippers. (Job Sheet #3)
    d. Set up and use a hacksaw. (Job Sheet #4)

OBJECTIVE SHEET

e. Cut rigid conduit with a pipe cutter. (Job Sheet #5)

f. Ream rigid conduit. (Job Sheet #6)

g. Bend EMT conduit. (Job Sheet #7)

h. Use a knockout punch. (Job Sheet #8)

i. Use a hole saw. (Job Sheet #9)

HAND TOOLS
UNIT IV

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information sheet.

F. Discuss information sheet.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Provide students with job sheets.

H. Discuss and demonstrate the procedures outlined in the job sheets.

I. Integrate the following activities throughout the teaching of this unit:

1. Invite local suppliers to show various tools.

2. Visit local tool suppliers.

3. Demonstrate the proper use and care of hand tools.

4. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas of improvement.

J. Give test.

K. Evaluate test.

L. Reteach if necessary.

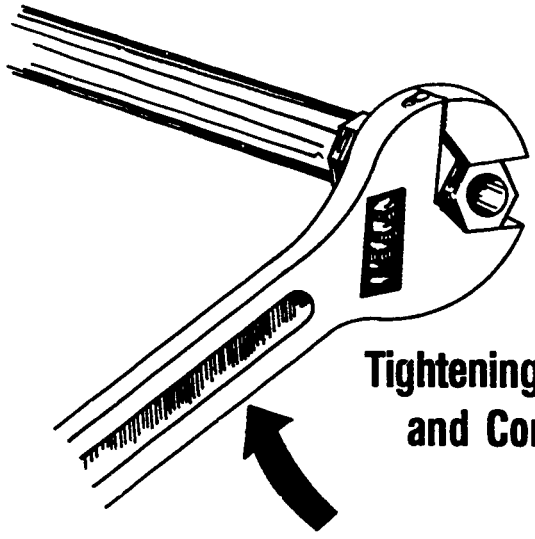
REFERENCES USED IN WRITING THIS UNIT

A. *Klein Tools Catalog.* Klein Tools, Inc., 7200 McCormick Blvd., Chicago, IL 60645. PH: (312) 677-9500.

B. Siebert, Leo N. *Introduction to Industrial Electricity-Electronics.* Stillwater, OK: Oklahoma Curriculum and Instructional Materials Center, 1981.

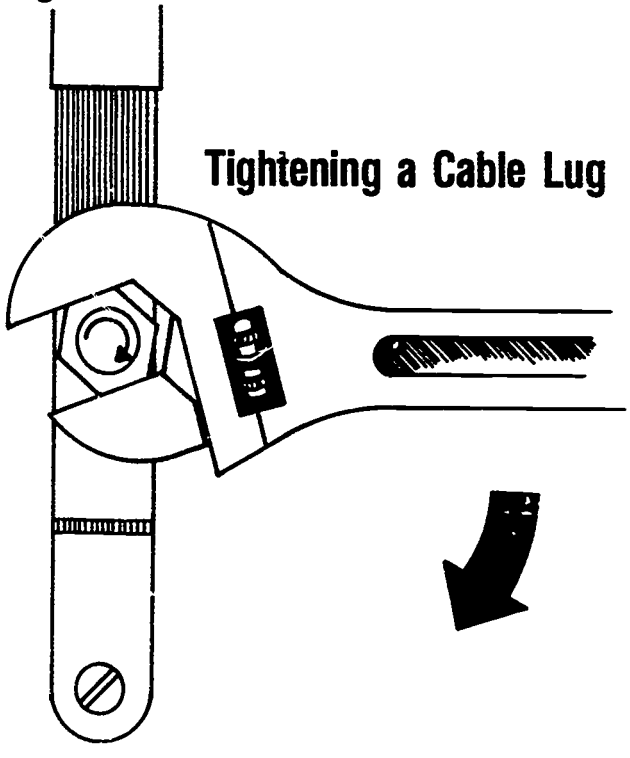
C. Taylor, Mark. *Residential Wiring.* Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1983.

Using an Adjustable Wrench



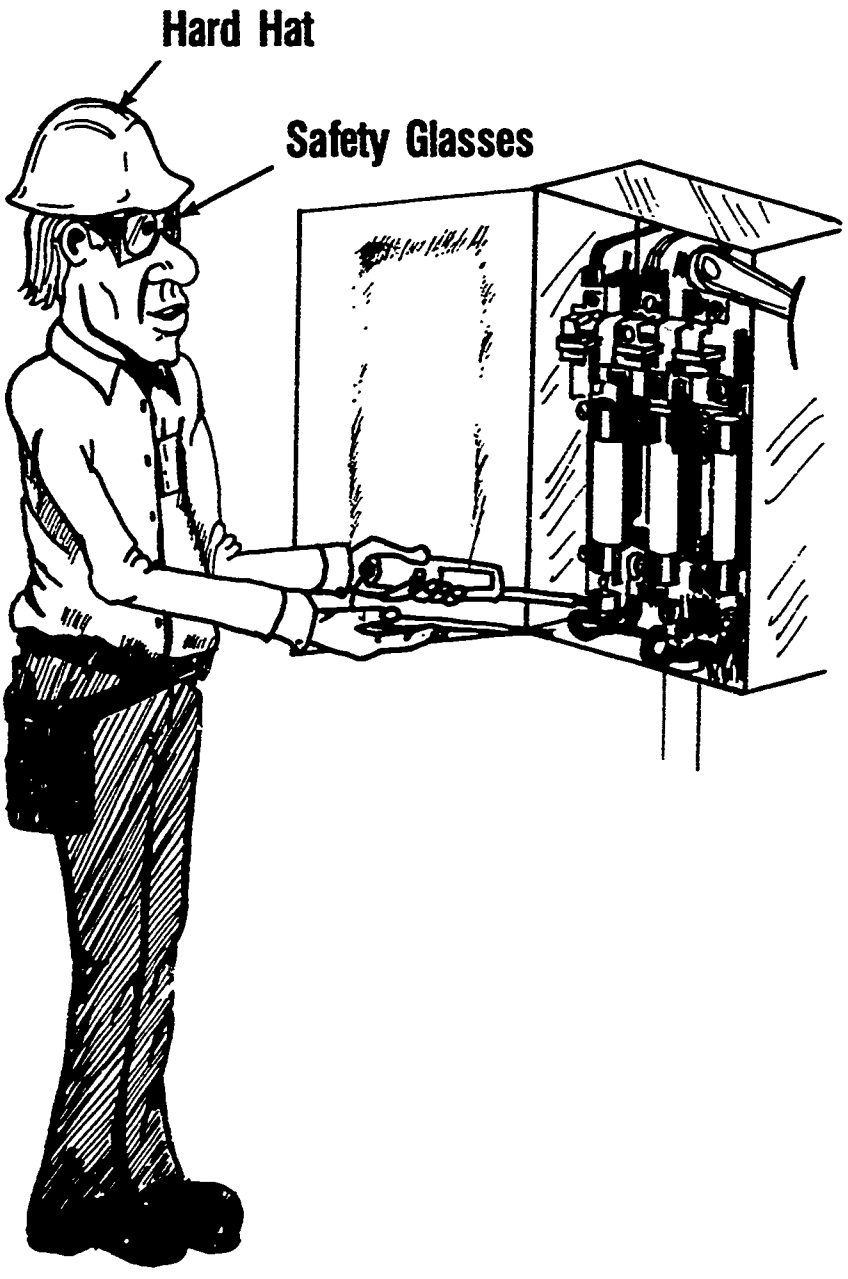
Tightening Couplings and Connectors

(NOTE: Always pull away from stationary jaw to avoid breaking or damaging wrench. Arrows indicate correct direction for wrenches in the current position.)



Tightening a Cable Lug

Using a Circuit Tester



HAND TOOLS
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Arbor — Shaft or spindle used to hold revolving cutting tool or the work to be cut

B. Cable-tie — Plastic straps with pull-through fasteners for binding together conductors or cables

C. Chuck — Device for holding a component of a tool rigid

D. Circuit box — Box where electrical connections are made, usually through circuit breakers

E. Conductor — Material through which electrons flow easily; used to connect components

F. Conduit — Pipe or tube which holds and protects wires or cables

G. Coupling — Mechanical device for connecting conduit and cabling

H. Fuse — Safety device placed in a circuit; in cases of excessive current, it melts, thus opening the circuit

I. Heat shrink — Nonconductive material placed around a conductor for insulation; shrinks when heated

J. Insulation — Nonconductive material that prevents leakage of electricity from a conductor and protects against accidental contact

K. Live circuit — Circuit with voltage applied

L. Plasterboard — Thin board formed of layers of plaster and paper; Sheetrock

M. Print — Industrial blueprint; industrial wiring diagram

N. Snap ring — Metal ring which fastens around or in a shaft to keep other parts stationary

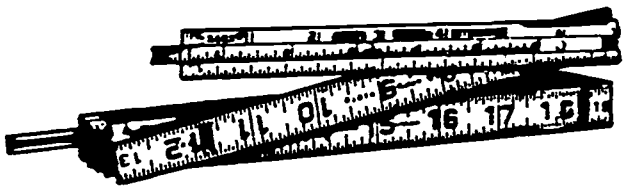
O. Spaghetti — Nonconductive material placed around a conductor for insulation; does not shrink

P. Wire lug — Metal connector crimped or soldered to a conductor; allows conductor to be fastened with a screw or bolt

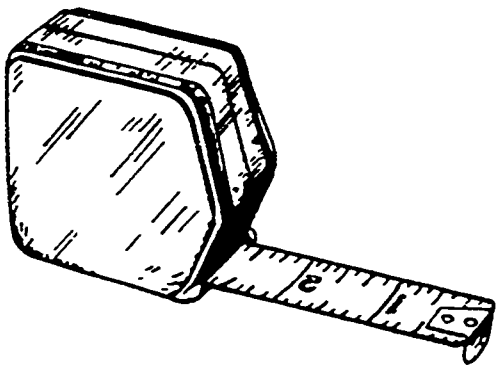
INFORMATION SHEET

II. Common hand tools used in the electrical field

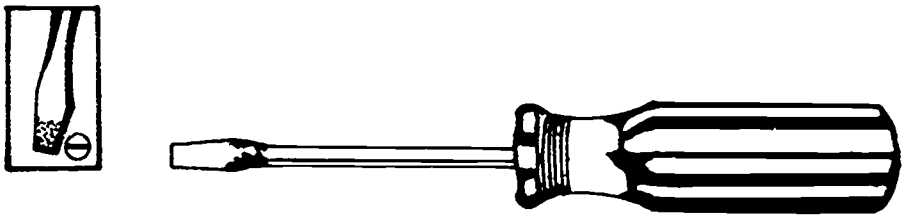
A. Folding rule



B. Tape measure

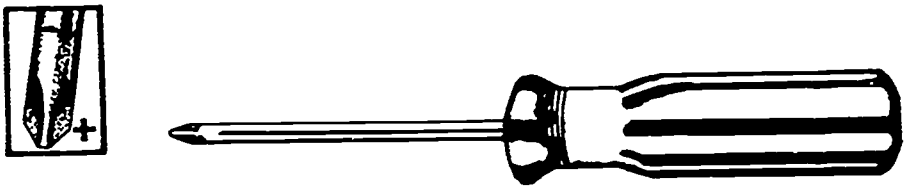


C. Flat-blade screwdriver

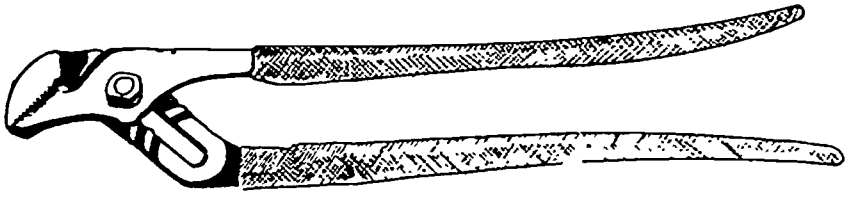


INFORMATION SHEET

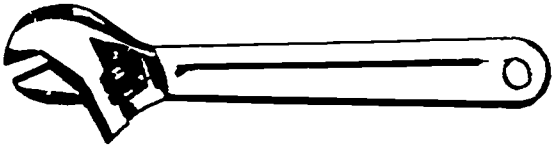
D. Phillips screwdriver



E. Pump pliers



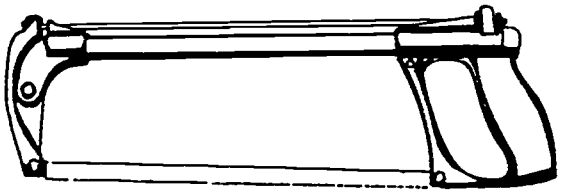
F. Adjustable wrench



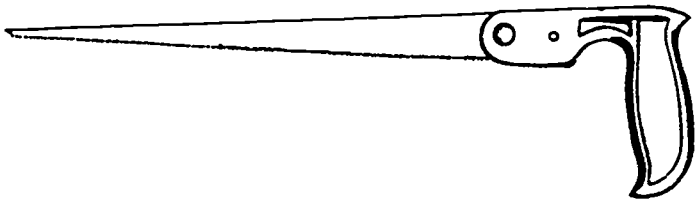
INFORMATION SHEET

G. Ball peen hammer

H. Hacksaw



I. Keyhole saw



INFORMATION SHEET

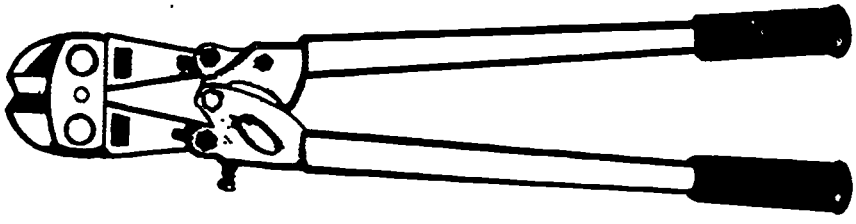
J. File

K. Chisel

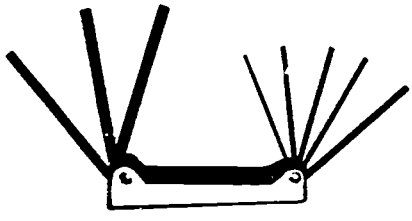
L. Center punch

INFORMATION SHEET

M. Bolt cutter



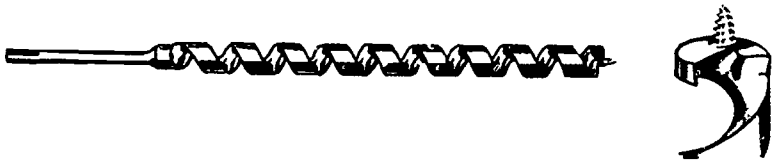
N. Hex key set (Allen wrenches)



O. Magnetic torpedo level

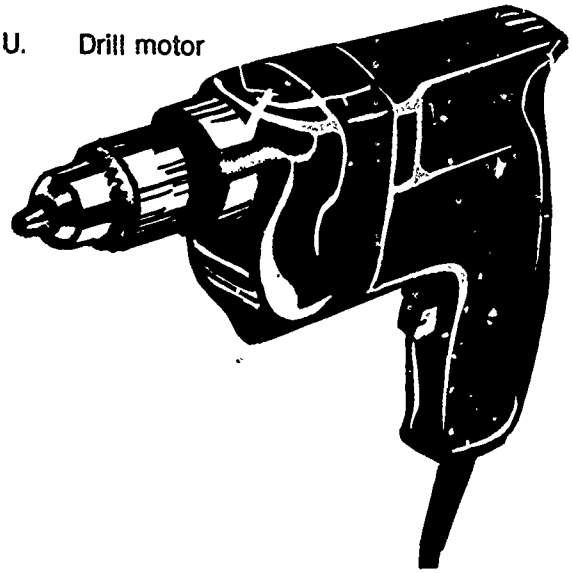
INFORMATION SHEET

S. Ship auger drill bit



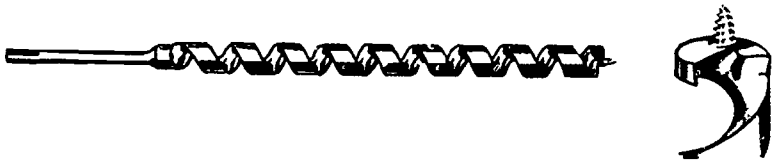
T. Tap tool

U. Drill motor



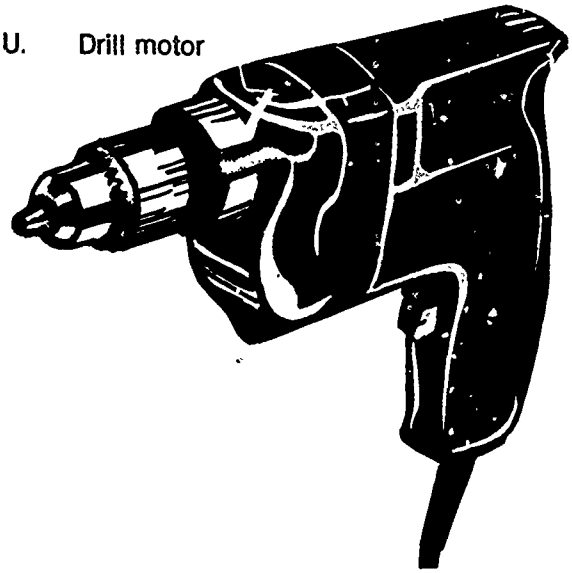
INFORMATION SHEET

S. Ship auger drill bit



T. Tap tool

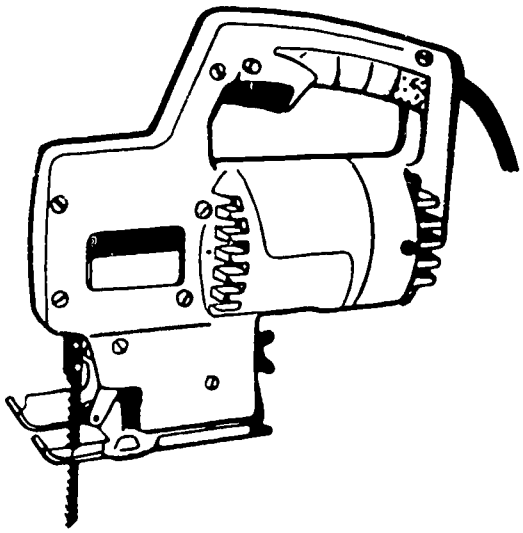
U. Drill motor



INFORMATION SHEET

V. Drill bit

W. Reciprocating saw

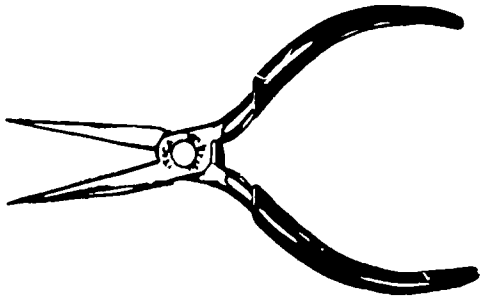


X. Screw-holding screwdriver

INFORMATION SHEET

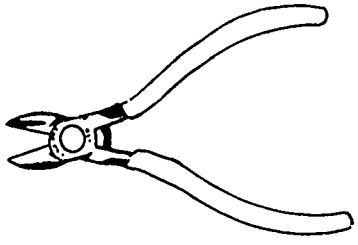
III. Electricity-specific hand tools used in the electrical field

A. Needle-nose pliers



(NOTE: This tool is available with 12 AWG stripper.)

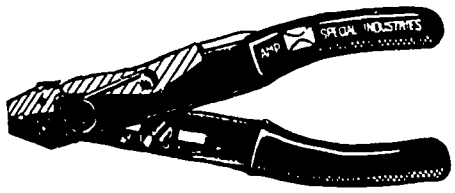
B. Diagonal pliers (dykes)



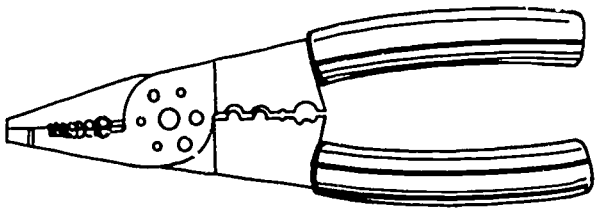
C. Lineman's pliers

INFORMATION SHEET

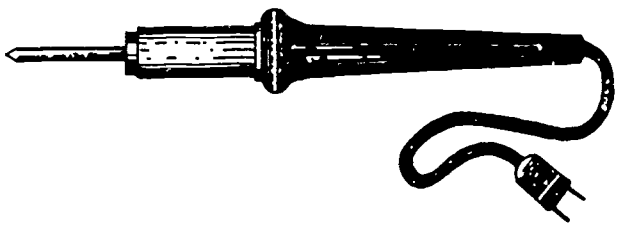
D. Adjustable wire stripper



E. Cutting/crimping tool

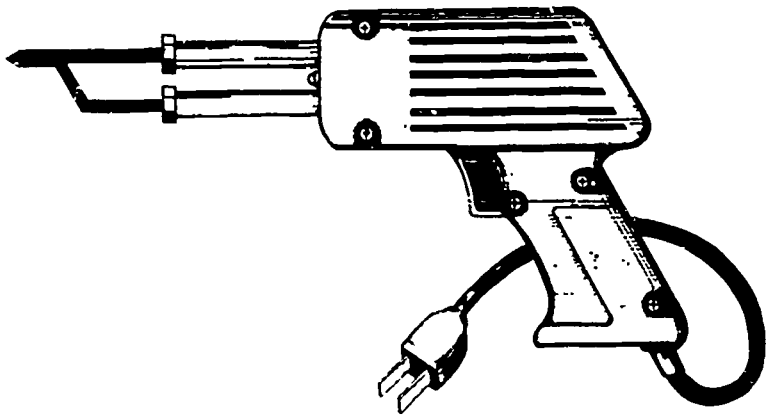


F Soldering iron (approximately 25 W)

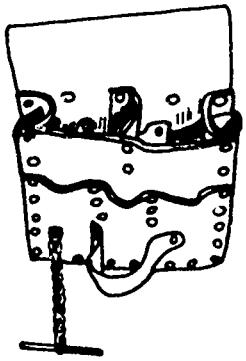


INFORMATION SHEET

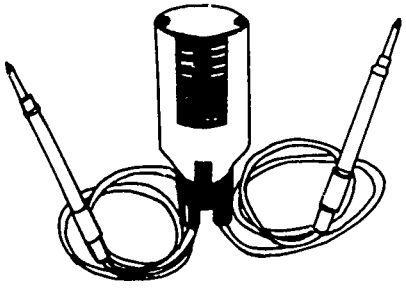
G. Soldering gun(250W)



H. Tool pouch

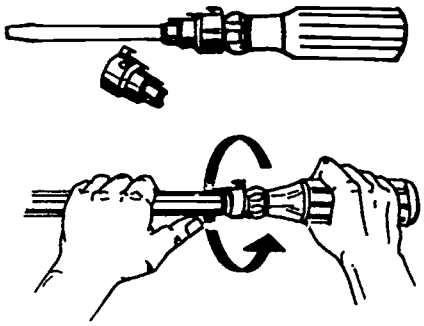


I. Circuit tester

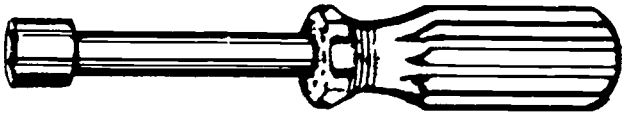


INFORMATION SHEET

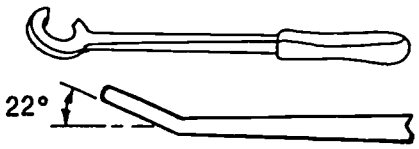
J. Conduit reamer



K. Nut driver

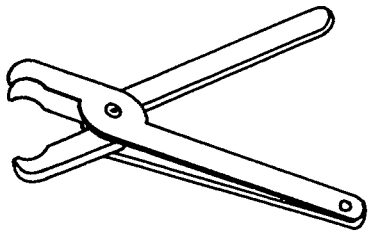


L. Cable benders

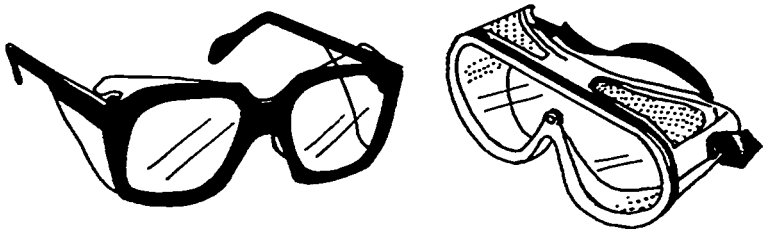


INFORMATION SHEET

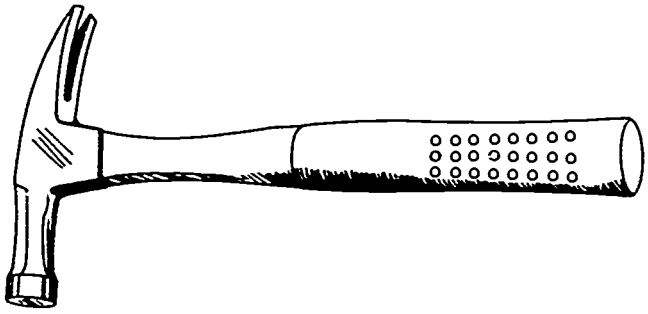
M. Fuse puller



N. Safety glasses and goggles

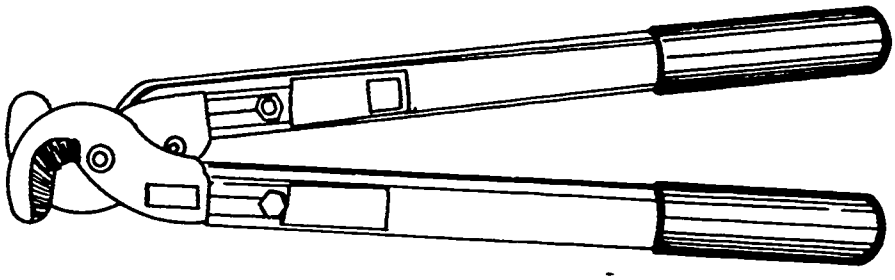


O. Electrician's hammer

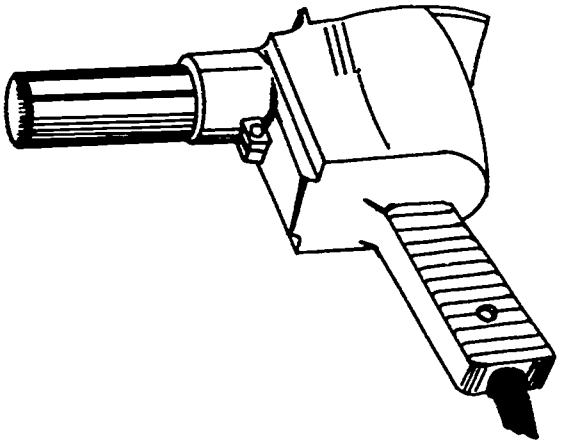


INFORMATION SHEET

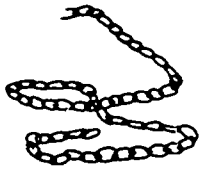
P. Cable cutter



Q. Heat gun

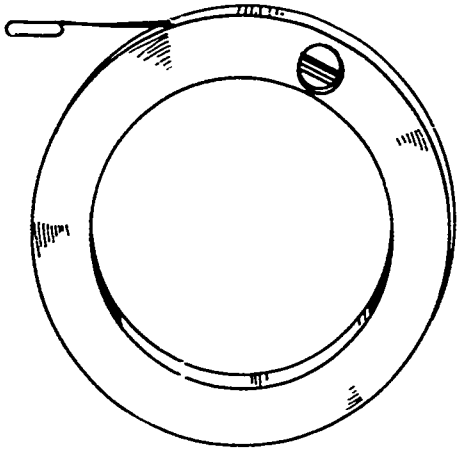


R. Drop chain

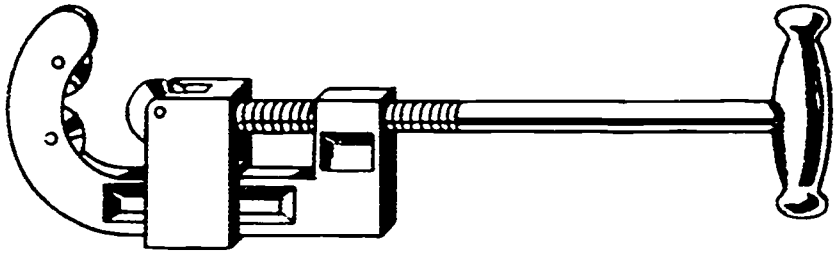


INFORMATION SHEET

S. Steel fish tape and reel

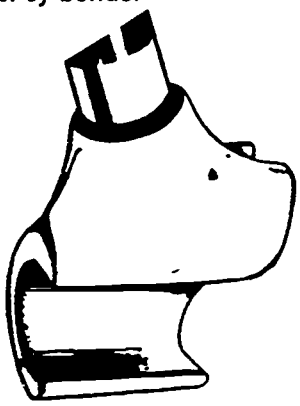


T. Pipe cutter

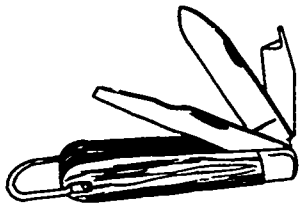


INFORMATION SHEET

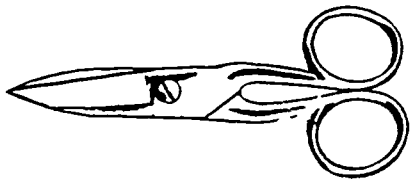
W. Hickey bender



X. Electrician's knife

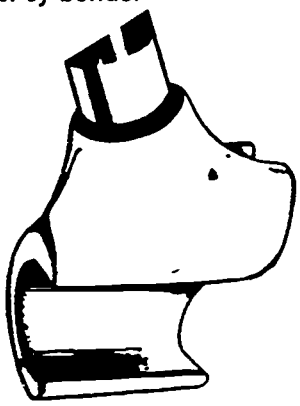


Y. Electrician's scissors

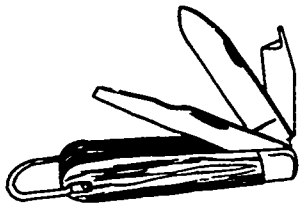


INFORMATION SHEET

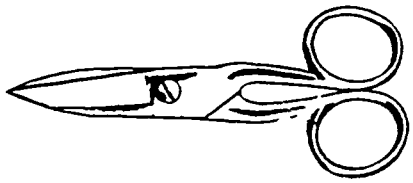
W. Hickey bender



X. Electrician's knife

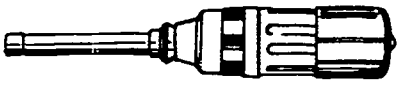


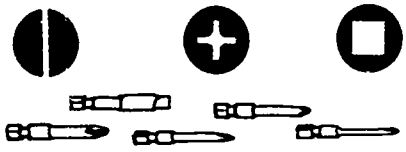
Y. Electrician's scissors



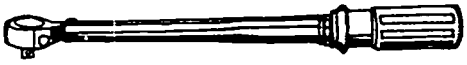
INFORMATION SHEET

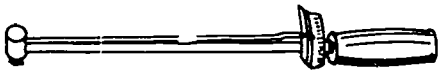
Z. Torque screwdriver





AA. Torque wrenches





IV. Common hand tools and their uses

A. Folding rule or tape measure — Measures distances on prints, conduit, cable, and so forth

B. Flat-blade screwdriver — Installs and/or removes slot-head screws

C. Phillips screwdriver — Installs and/or removes Phillips-head screws

D. Pump pliers

1. Hold couplings and conductors
2. Tighten couplings and conductors
3. Hold conduit
4. Tighten or turn conduit

E. Adjustable wrench — Used in place of other wrenches; versatile

INFORMATION SHEET

F. Hacksaw

1. Cuts large conductors or cables
2. Cuts conduit
3. Cuts metal for electronic cabinets

G. Keyhole saw — Cuts holes in plasterboard for circuit boxes; needs no electric power

H. File

1. Deburrs large conduit
2. Sharpens tools
3. Deburrs holes in circuit boxes
4. Cleans soldering iron or soldering gun tips

I. Chisel — Notches wood for boxes or cables

J. Center punch — Makes center tap for drilling

K. Bolt cutter — Cuts large bolts, chains, locks, and so forth

L. Hex key set (Allen wrenches) — Installs and/or removes Allen screws

M. Magnetic torpedo level

1. Levels conduit
2. Levels equipment

N. Knockout punch — Cuts large holes in metal boxes without drilling

(NOTE: Thick or very hard metal cannot be cut with a knockout punch. Also, in some areas it is too inconvenient to use a knockout punch.)

O. Hole saw — Cuts large holes in metal

P. Drill brace and drill — Bores holes for conduit or cable

Q. Tap tool

1. Equips drill holes with bolt threads
2. Retaps damaged threads
3. Determines bolt size

INFORMATION SHEET

R. Drill motor and drill — Drills holes for electronic cabinets; needs electric power

S. Reciprocating saw — Cuts holes in plasterboard; needs electric power

T. Screw-holding screwdriver — Holds screw for use in limited-space installation

V. Electricity-specific hand tools and their uses

A. Needle-nose pliers

1. Form loops on small conductors
2. Cut small conductors
3. Hold conductors while soldering
4. Can have #12 AWG stripper

B. Diagonal pliers (dykes)

1. Cut small conductors
2. Cut conductors in limited space

C. Lineman's pliers

1. Cut large conductors
2. Form loops on large conductors
3. Pull and/or hold large conductors

D. Adjustable wire stripper

1. Strips insulation from conductors
2. Cuts small conductors

E. Cutting/crimping tool

1. Strips insulation from conductors
2. Cuts small conductors
3. Cuts small bolts
4. Crimps wire lugs

INFORMATION SHEET

F. Soldering iron (approximately 25 W)

1. Solders small heat-sensitive components
2. Solders on printed circuit boards

G. Soldering gun

1. Solders large conductors
2. Splices cables

H. Tool pouch

1. Holds tools
2. Keeps tools organized

I. Circuit tester

1. Checks circuits for power
2. Checks fuses and breakers

J. Conduit reamer — Reams burrs from cut conduits and EMT

K. Nut driver

1. Installs and/or removes nuts and bolts
2. Tightens or loosens nuts on long bolts

L. Cable bender — Assists in bending large cables

M. Fuse puller — Removes fuses safely from equipment and circuit panels

(NOTE: Fuse pullers are insulated in order to prevent shock, but power must be turned off first for safety.)

N. Safety glasses and goggles — Protect eyes from foreign objects or liquids

O. Electrician's hammer

1. Drives and pulls nails
2. Opens wooden crates
3. Breaks plasterboard

P. Cable cutter — Cuts large cables

(NOTE: Cables must be either copper or aluminum.)

INFORMATION SHEET

Q. Heat gun

1. Dries electronic components and/or conductors
2. Shrinks heat shrink

R. Drop chain — Pulls cables through wall

S. Steel fish tape and reel

1. Pulls conductors through conduit
2. Pulls cables through insulated walls

T. Pipe cutter — Cuts conduit

U. Pipe reamer — Deburrs conduit

V. Conduit bender — Bends conduit for conductor installation

W. Hickey bender — Bends heavy conduit

X. Electrician's knife

1. Opens paper cartons
2. Strips large conductors
3. Strips cables
4. Tightens or loosens small screws when screwdriver is not available

(NOTE: Some electrician's knives are equipped with screwdriver blades.)

Y. Electrician's scissors

1. Cut small conductors
2. Remove insulation from small conductors
3. Cut paper, heat shrink, spaghetti, cable-tie, and so forth

Z. Torque screwdriver — Tightens slotted lugs and screws to manufacturer's torque specifications

AA. Torque wrenches — Tighten Allenhead and bolt type lugs to manufacturer's specifications

INFORMATION SHEET

VI. Factors to consider when purchasing tools

A. Size

(NOTE: Always purchase the correct sized tool for the work to be done.)

B. Design

EXAMPLES: Insulated handles, hammers with straight claws

(NOTE: Tool should be designed specifically for electrical work.)

C. Quality

(NOTE: The purchase of quality tools will save replacement cost.)

VII. Rules for care of various hand tools

(NOTE: All tools should be used only for the purpose intended.)

A. Screwdrivers

1. Discard worn or damaged flat-blade screwdrivers.
2. Discard Phillips screwdrivers with damaged tips.

B. Pliers

1. Keep clean and free of rust.
2. Keep cutting edges sharp.
3. Keep pliers working freely.
4. Replace damaged handle insulation.

C. Adjustable wrenches — Keep worm gears clean and lubricated.

D. Cutting tools

EXAMPLES: Saws, punches, chisels, drills, knives

1. Keep cutting edges sharp.
2. Protect cutting edges.
3. Keep tools clean and lubricated.

E. Electrically powered tools

1. Replace damaged cords.
2. Do not unplug by pulling cord.
3. Lubricate movable parts.
4. Keep clean.
5. Store properly.

HAND TOOLS
UNIT IV

JOB SHEET #1 — CLEAN AND LUBRICATE AN ADJUSTABLE HAND TOOL

A. Equipment and materials needed

1. Pliers, or other adjustable hand tool
2. Solvent
3. Oil
4. Solvent tray

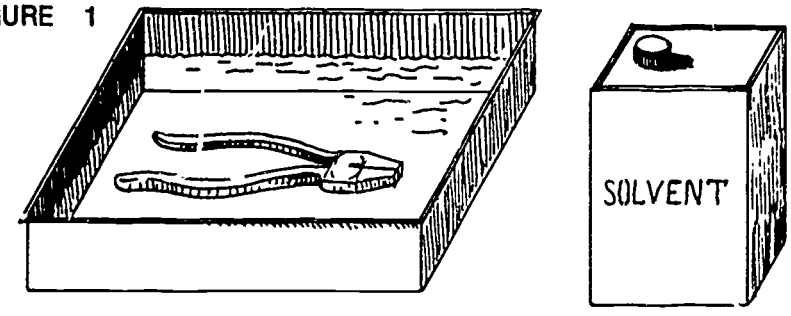
   (NOTE: An old rectangular cake pan works well.)
5. Protective gloves
6. Cleaning cloth
7. Safety glasses

B. Procedure

1. Put on protective gloves and safety glasses.
2. Lay pliers in tray.
3. Pour solvent into tray until pliers are submersed. (Figure 1)

   (NOTE: If pliers are equipped with cushion grips, only the head should be immersed.)

FIGURE 1

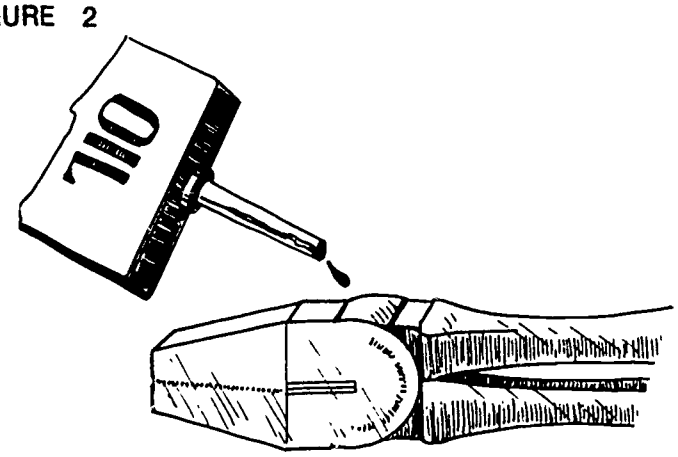


JOB SHEET #1

4. Open and close pliers several times while submersed.
5. Let pliers sit in solvent for two or three minutes.
6. Remove from solvent.
7. Open and close rapidly until pliers work freely.

   (NOTE: If pliers will not yet work, repeat steps B, C, D, and E.)
8. Wipe residue from plier joints with a cloth.
9. Apply a couple of drops of oil to joints, and work until oil has penetrated. (Figure 2)

FIGURE 2



10. Wipe excess oil from pliers.

    (NOTE: Have instructor check tool.)
11. Put away equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #2 — USE A CUTTING/CRIMPING TOOL

A. Equipment and materials needed

1. Cutting/crimping tool
2. Solid insulated conductor—12 to 18 gauge
3. Bolt—Size 6-32, 8-32, or 10-24, 10-32, 4-40
4. Wire lug—Same size as conductor
5. Safety glasses

B. Procedure

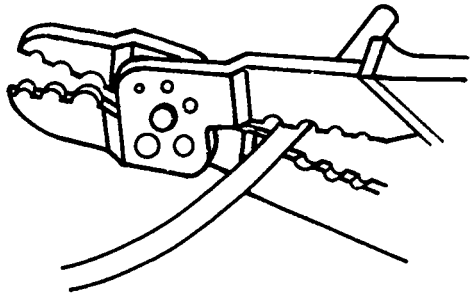
1. Examine cutting/crimping tool.
2. Locate stripping area of the cutting/crimping tool.
3. Locate correct-sized stripping slot for conductor.

   EXAMPLES: AWG-18, AWG-20 wire size

4. Put on safety glasses.
5. Open cutting/crimping tool and insert conductor into curved area of stripping slot. (Figure 1)

   (NOTE: Insert conductor approximately 1/4 inch from end of conductor.)

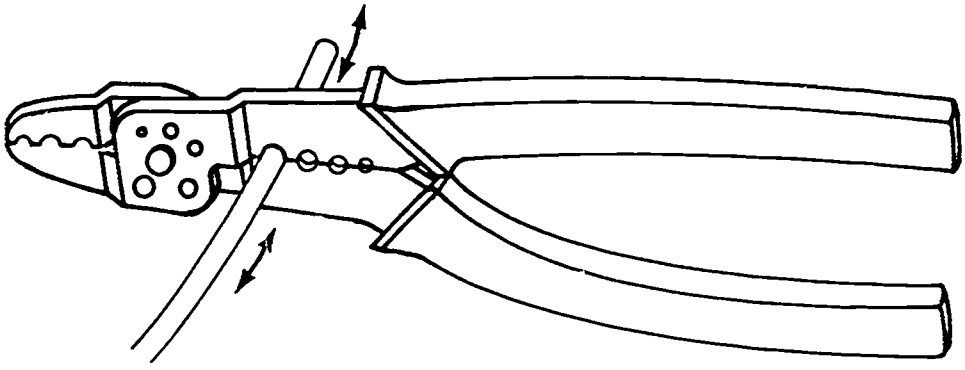
FIGURE 1



JOB SHEET #2

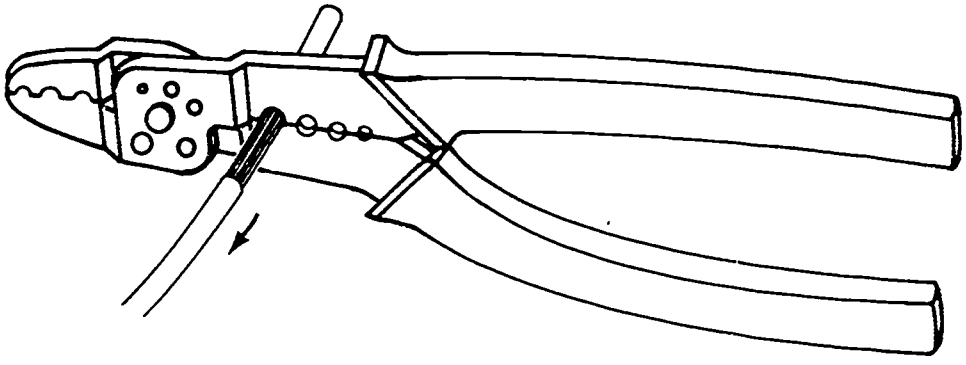
6. Slowly close cutting area by squeezing handles together. (Figure 2)

FIGURE 2



7. Pull conductor long lead away from cutting/crimping tool. (Figure 3)

FIGURE 3



(NOTE: If the correct stripping slot was chosen, insulation should easily slide from the conductor. Have the instructor check your work.)

JOB SHEET #2

11. Squeeze the handles together.

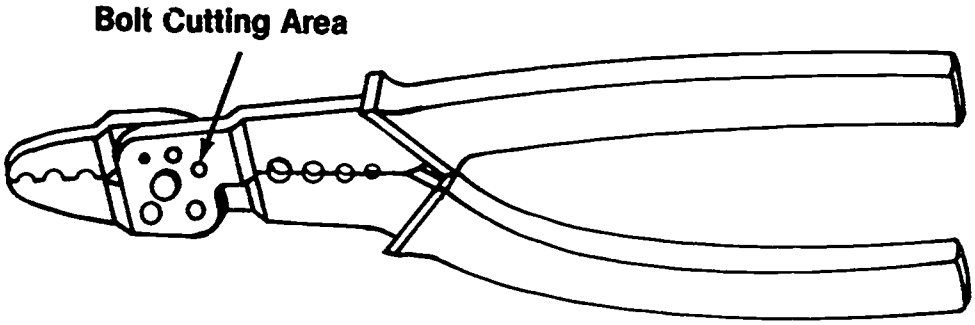
    (NOTE: This will crimp the wire lug onto the conductor.)

12. Remove cutting/crimping tool.

    (NOTE: Have instructor check your work.)

13. Locate bolt cutting area of cutting/crimping tool. (Figure 6)

FIGURE 6



14. Locate correct cutting slot for the bolt.

15. Screw bolt into cutting hole from the screw (threaded) side.

    (NOTE: On the cutting/crimping tool, one side is threaded and the other side is unthreaded.)

16. Screw the bolt into the cutting/crimping tool until desired length is at center-point of cutting tool.

17. Squeeze handles together until bolt is cut.

    (CAUTION: When bolt is cut, the unattached end may fly from cutter.)

18. Remove bolt from cutting/crimping tool.

    (NOTE: Have the instructor check your work.)

19. Put away equipment and materials.

JOB SHEET #2

11. Squeeze the handles together.

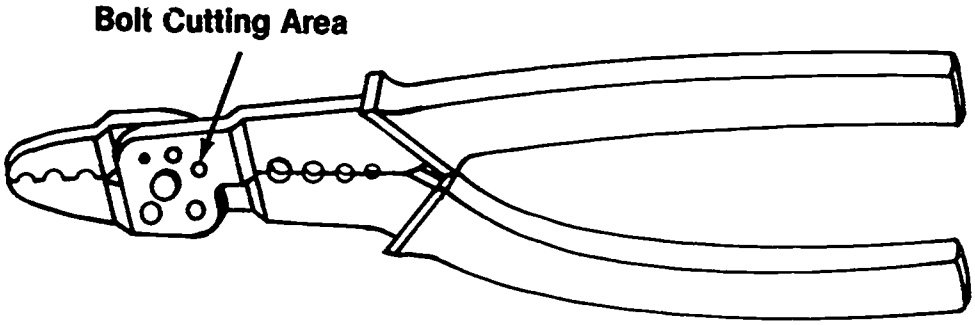
    (NOTE: This will crimp the wire lug onto the conductor.)

12. Remove cutting/crimping tool.

    (NOTE: Have instructor check your work.)

13. Locate bolt cutting area of cutting/crimping tool. (Figure 6)

FIGURE 6



14. Locate correct cutting slot for the bolt.

15. Screw bolt into cutting hole from the screw (threaded) side.

    (NOTE: On the cutting/crimping tool, one side is threaded and the other side is unthreaded.)

16. Screw the bolt into the cutting/crimping tool until desired length is at center-point of cutting tool.

17. Squeeze handles together until bolt is cut.

    (CAUTION: When bolt is cut, the unattached end may fly from cutter.)

18. Remove bolt from cutting/crimping tool.

    (NOTE: Have the instructor check your work.)

19. Put away equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #3 — ADJUST WIRE STRIPPERS

A. Equipment and materials needed

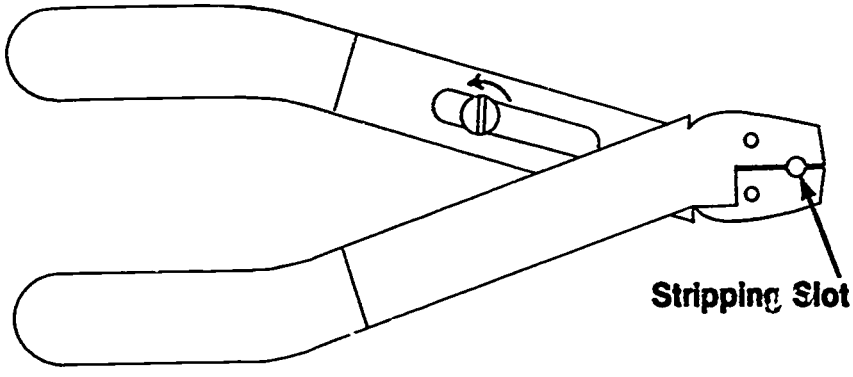
1. Adjustable wire strippers
2. Solid insulation conductor—12 or 14 gauge

   (NOTE: Strippers should be adjusted for stripping the most commonly used conductor in your area.)
3. Screwdriver or nut driver to fit adjustment screw

B. Procedure

1. Loosen adjustment screw. (Figure 1)

FIGURE 1

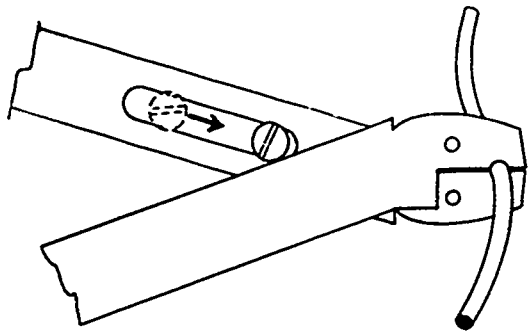


2. Insert conductor in stripping slot.
3. Close stripper jaws until you feel that you have reached the conductor.
4. Open the jaws slightly.

JOB SHEET #3

5. Slide adjustment screw down to its resting position. (Figure 2)

FIGURE 2

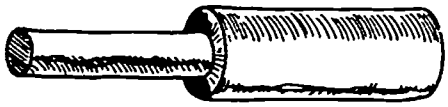


6. Strip off a fresh piece of insulation.

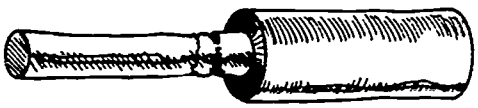
7. Check conductor for ring or nick. (Figure 3)

   (NOTE: If nick occurs, loosen adjustment screw, move it back slightly, retighten, and test again until insulation is cut without conducter damage.)

FIGURE 3



Correctly Adjusted



Incorrectly Adjusted

(NOTE: Have the instructor check your work.)

8. Put away equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #4 — SET UP AND USE A HACKSAW

A. Equipment and materials needed

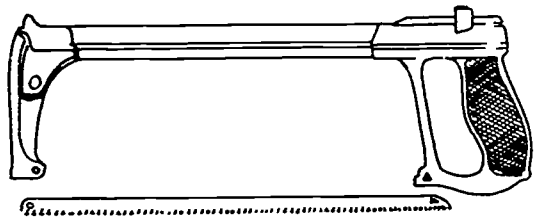
1. Hacksaw frame
2. Hacksaw blade

   (NOTE: For cutting pipe or conduit a 24 or 32 teeth/inch blade is recommended.)
3. Needle-nose pliers
4. Pipe or conduit
5. Safety glasses

B. Procedure

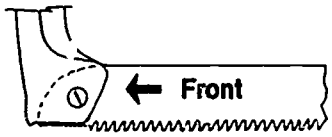
1. Put on safety glasses and gather tools and equipment.
2. Insert blade in frame. (Figure 1)

FIGURE 1



(NOTE: Be sure teeth angles are pointed toward the front of the saw. Figure 2.)

FIGURE 2

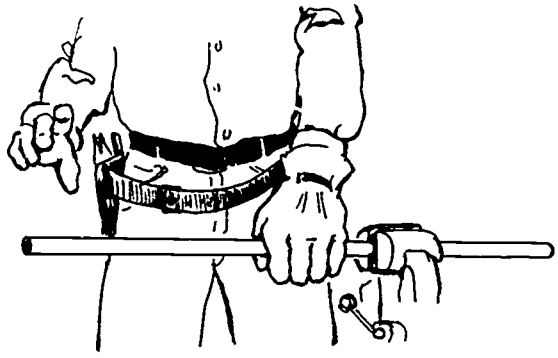


JOB SHEET #4

3. Secure pipe or conduit for cutting. (Figure 3)

   (NOTE: Short pieces of pipe are easier to cut in a vise.)

FIGURE 3



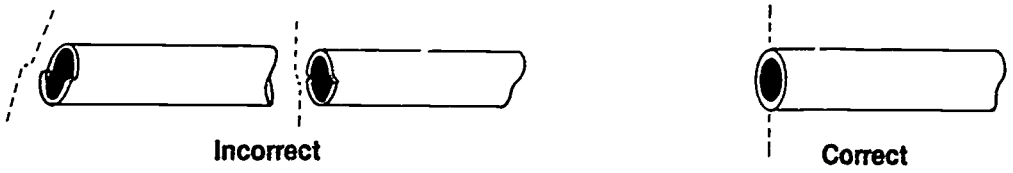
4. Rest blade on pipe or conduit at point to be cut.
5. Push forward gently until cut is started.

   (NOTE: Do not exert extra pressure on saw.)

6. Make reciprocal strokes until cut is finished.

   (NOTE: Excessive speed while cutting can ruin blades. Do not use over thirty full strokes per minute. Your cut should be straight and relatively smooth. Figure 4.)

FIGURE 4



   (NOTE: Have the instructor check your cut.)

7. Deburr cut end.
8. Put away equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #5 — CUT RIGID CONDUIT WITH A PIPE CUTTER

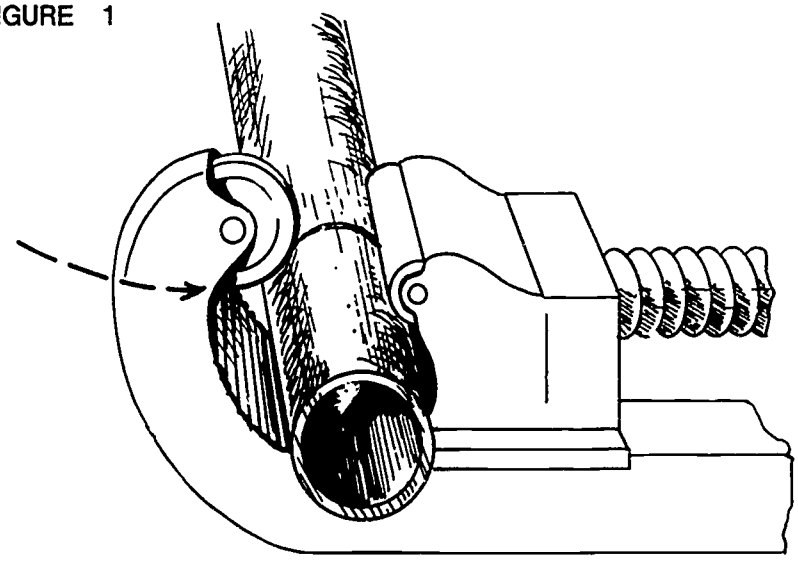
A. Equipment and materials needed

1. Pipe vise
2. Pipe cutter
3. Rigid conduit
4. Cutting oil
5. Safety glasses
6. Shop towel
7. Pencil

B. Procedure

1. Put on safety glasses and gather tools and equipment.
2. Secure conduit in vise.
3. Mark place for cut with pencil.
4. Open pipe cutter until it will fit over conduit.
5. Locate cutter wheel on the pencil mark. (Figure 1)

FIGURE 1

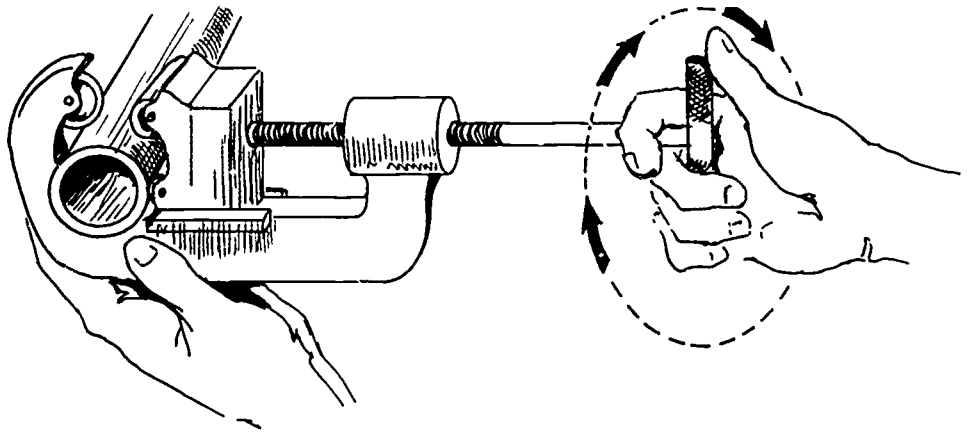


JOB SHEET #5

6. Snug cutter to conduit by rotating screw handle. (Figure 2)

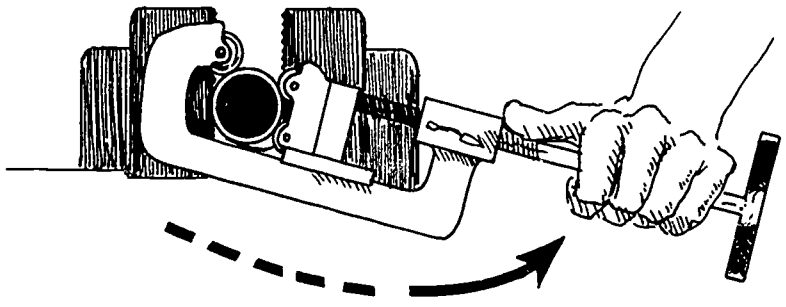
   (NOTE: Do not overtighten as this can break cutter wheel.)

FIGURE 2



7. Rotate cutter counterclockwise to start groove. (Figure 3)

FIGURE 3



8. Tighten cutter handle ¼ of a turn for each full revolution around the pipe.

   (NOTE: Overtightening can cause cutters to break.)

9. Add a small amount of cutting oil to the groove.

   (CAUTION: When cutting short pieces of conduit, be careful not to cut your arm while rotating the cutter around the pipe.)

JOB SHEET #5

10. Continue process until conduit is cut.

    (NOTE: Be prepared to catch free piece of conduit.)

11. Clean conduit and cutter with shop towel.

    (NOTE: Have instructor inspect work.)

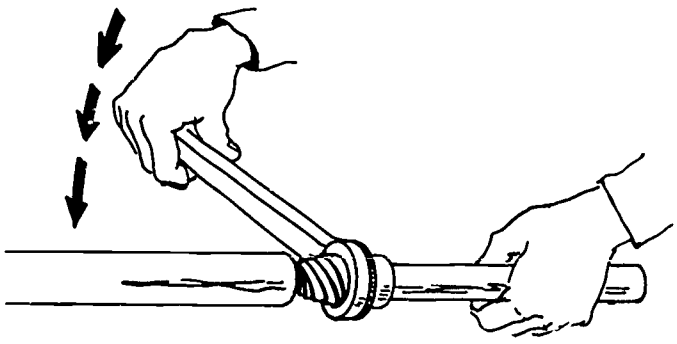
12. Put away equipment and materials.

JOB SHEET #6

4. Start rotating reamer. (Figure 2)

   (NOTE: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.)

FIGURE 2

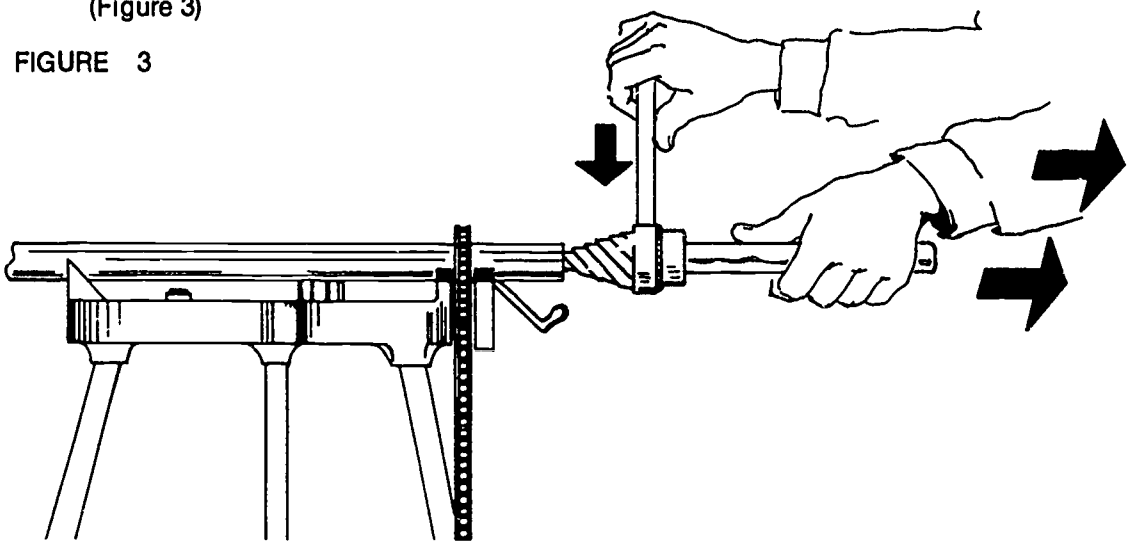


5. Rotate reamer until burrs are removed.

   (NOTE: This is a developed skill; the reamer can be pulled out and your progress inspected.)

6. Pull reamer back while continuing to rotate to prevent reamer from leaving a burr. (Figure 3)

FIGURE 3



(NOTE: Have your instructor check your work.)

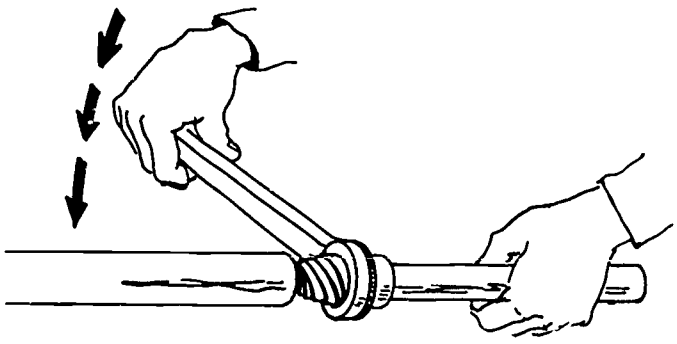
7. Put away all equipment and materials.

JOB SHEET #6

4. Start rotating reamer. (Figure 2)

   (NOTE: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.)

FIGURE 2

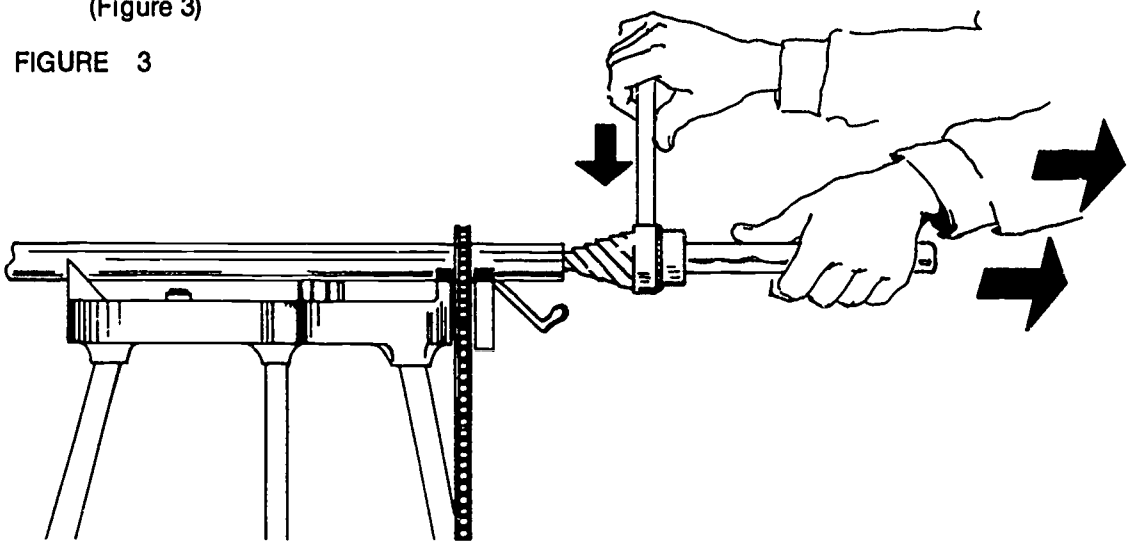


5. Rotate reamer until burrs are removed.

   (NOTE: This is a developed skill; the reamer can be pulled out and your progress inspected.)

6. Pull reamer back while continuing to rotate to prevent reamer from leaving a burr. (Figure 3)

FIGURE 3



(NOTE: Have your instructor check your work.)

7. Put away all equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #7 — BEND EMT CONDUIT

(NOTE: Because of the difference in bender shoe markings, the height of this bend and its determination will be left to the instructor.)

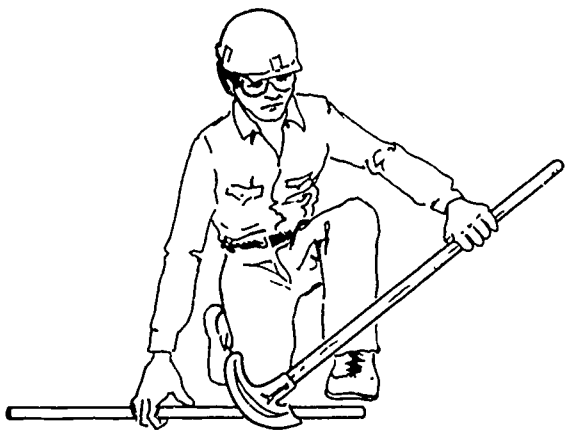
A. Equipment and materials needed

1. ½" EMT bender
2. ½" EMT (length optional)
3. Safety glasses

B. Procedure

1. Put on safety glasses and gather tools and equipment.
2. Place conduit in bender jaw. (Figure 1)

FIGURE 1

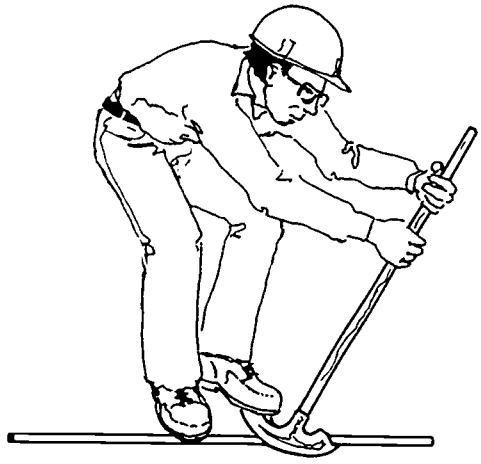


3. Apply light pressure on handle to hold conduit in place.
4. Place one foot on bender kick pad.

JOB SHEET #7

5. Place other foot on conduit. (Figure 2)

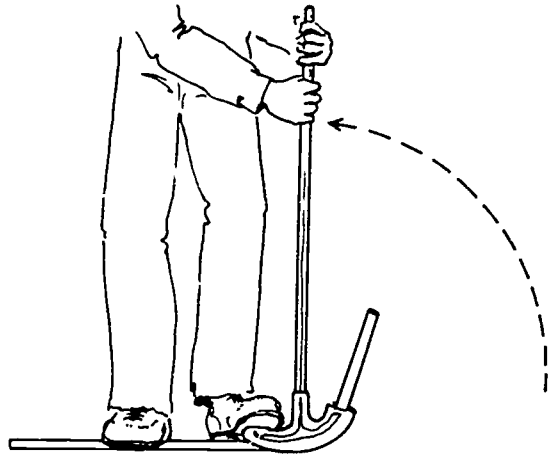
FIGURE 2



6. Apply heavy pressure on bender kick pad while pulling handle to a straight up position. (Figure 3)

   (NOTE: If pressure is not applied solidly to kick pad, conduit can wrinkle or collapse.)

FIGURE 3



JOB SHEET #7

7. Reposition feet for comfort.

8. Reapply kick pad and bender handle pressure until bend is completed. (Figure 4)

   (NOTE: A square can be used to evaluate your accuracy until you develop your skills.)

FIGURE 4

(NOTE: Have instructor check your work.)

9. Put away all equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #8 — USE A KNOCKOUT PUNCH

A. Equipment and materials needed

1. Knockout punch
2. Drill motor
3. Metal drill

   (NOTE: Drill must be large enough to let the knockout punch bolt through the opening it makes.)

4. 10" adjustable wrench or ½" ratchet with socket to fit drive nut
5. Metal to be punched

   (NOTE: Most punches are rated up to 10 gauge metal.)

6. Vise

   (NOTE: A vise is needed if material to be cut is not fastened to a wall or is too small to stand on to hold.)

7. Safety glasses
8. Extension cord

B. Procedure

1. Put on safety glasses and gather materials and equipment.
2. In the center of the space you are going to punch, drill a hole slightly larger than the KO punch bolt.

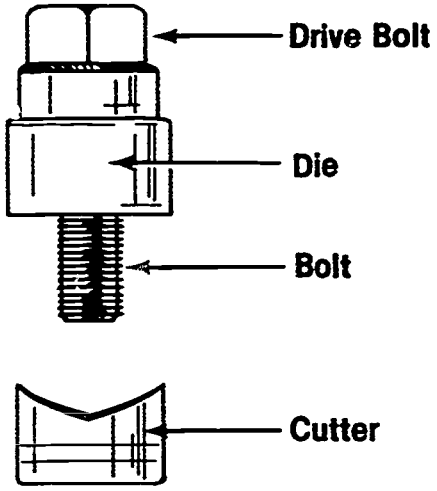
   (NOTE: A center punch should be used to make an indentation for your drill to start in.)

   (CAUTION: Hold the drill motor firmly while drilling. A loose grip could cause an accident. Remember that the drill will be hot; use caution around it until it cools.)

JOB SHEET #8

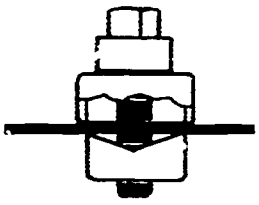
3. Separate the knockout punch cutter from the die and bolt. (Figure 1)

FIGURE 1



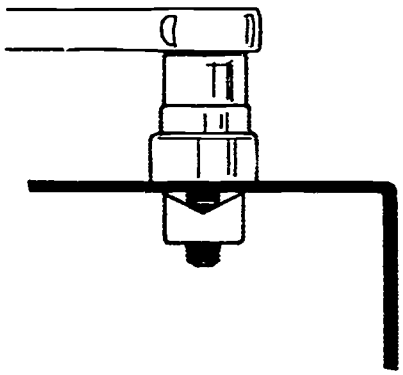
4. Insert bolt through drilled hole and put cutter back on screw. (Figure 2)

FIGURE 2



5. Tighten drive bolt with wrench or socket. (Figure 3)

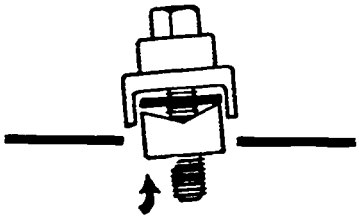
FIGURE 3



JOB SHEET #8

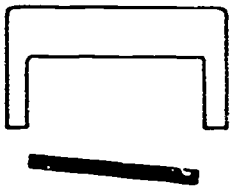
6. When cutter is finally pulled through, knockout punch is easily removed (Figure 4)

FIGURE 4



7. Remove cutter from bolt and shake out punched metal. (Figure 5)

FIGURE 5



8. Lubricate cutter, if needed, and replace.

   (NOTE: Have instructor check your work.)

9. Put away equipment and materials.

HAND TOOLS
UNIT IV

JOB SHEET #9 — USE A HOLE SAW

A. Equipment and materials needed

1. Hole saw and arbor—Size determined by instructor
2. Drill motor
3. Center punch
4. Metal to be cut

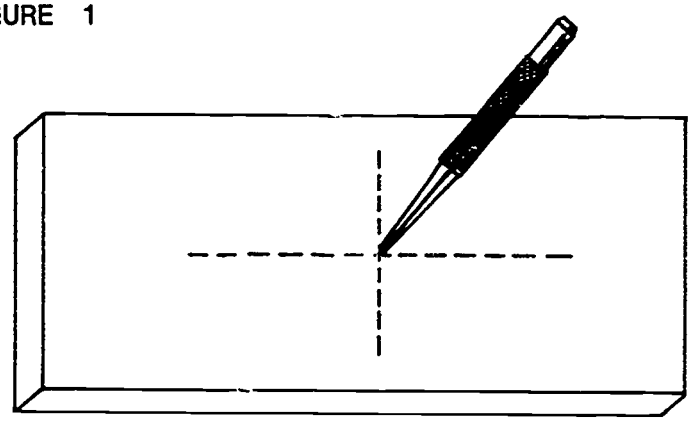
   (NOTE: Most hole saws can drill through any machinable material up to 1 1/8 inches thick.)

5. Safety glasses
6. Hammer

B. Procedure

1. Put on safety glasses.
2. Locate point on metal where hole is to be cut.
3. Place center punch on center point of hole to be cut. (Figure 1)

FIGURE 1



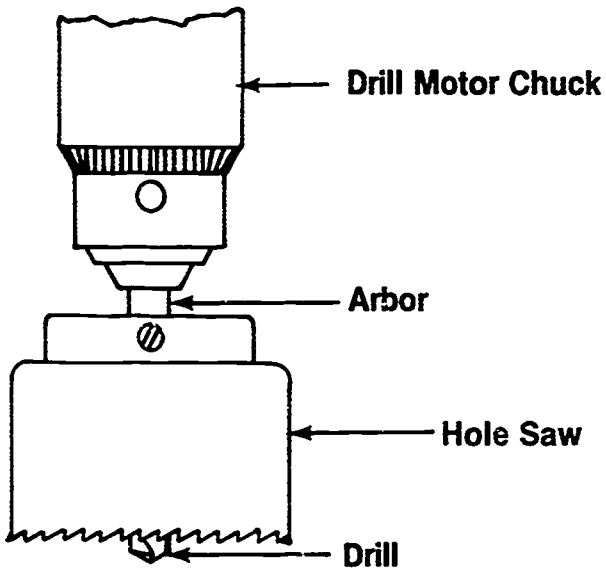
JOB SHEET #9

4. Strike center punch with hammer.

   (NOTE: How hard the center punch is struck is determined by the type and thickness of the metal being used. If struck too hard, softer, thinner metal will bend easily.)

5. Insert hole saw arbor into the drill motor chuck. (Figure 2)

FIGURE 2



(CAUTION: Be sure chuck is tight, and chuck key is removed before drilling.)

6. Place tip of drill in hole made by the center punch.

   (NOTE: If material to be cut is not fastened solidly, put material in vise before cutting.)

   (CAUTION: While drilling, hold the drill motor firmly with both hands. The hole saw can become jammed causing the drill motor to spin.)

7. Turn on drill motor until hole saw has cut completely through metal being cut. Use cutting oil on heavy metal.

   (NOTE: Have instructor check your work.)

8. Put away equipment and materials.

JOB SHEET #1 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Pliers clean				
	4	3	2	1
Pliers work freely				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

JOB SHEET #1 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Pliers clean				
	4	3	2	1
Pliers work freely				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT V

PRACTICAL TEST
JOB SHEET #2 — USE A CUTTING/CRIMPING TOOL

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Used correct stripping slot.	_____	_____
4. Used correct crimp connector.	_____	_____
5. Used correct cutting slot.	_____	_____
6. Checked in/put away tools and materials.	_____	_____
7. Cleaned the work area.	_____	_____
8. Used proper tools correctly.	_____	_____
9. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
10. Practiced safety rules throughout procedure.	_____	_____
11. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____ _____

JOB SHEET #2 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
	4	3	2	1
Bolt cut square				
	4	3	2	1
Threads true				
	4	3	2	1
Crimp sleeve properly installed and secure				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #3 — ADJUST WIRE STRIPPERS

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Adjusted stripper properly.	_____	_____
4. Stripped conductor properly.	_____	_____
5. Checked in/put away tools and materials.	_____	_____
6. Cleaned the work area.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
9. Practiced safety rules throughout procedure.	_____	_____
10. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #3 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
	4	3	2	1
Conductor is not scored				
	4	3	2	1
Approximately 3/8" stripped				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #4 – SET UP AND USE A HACKSAW

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Installed blade correctly.	_____	_____
4. Secured pipe or conduit for cutting.	_____	_____
5. Cut pipe straight.	_____	_____
6. Deburred cut end.	_____	_____
7. Checked in/put away tools and materials.	_____	_____
8. Cleaned the work area.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____
12. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #4 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
	4	3	2	1
Blade teeth slope away from handle				
	4	3	2	1
Cut at 90° angle				
	4	3	2	1
Cut end deburred				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #5 — CUT RIGID CONDUIT WITH A PIPE CUTTER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Secured conduit in vise properly.	_____	_____
4. Adjusted cutter properly.	_____	_____
5. Made cut properly.	_____	_____
6. Cleaned conduit and cutter with shop towel.	_____	_____
7. Checked in/put away tools and materials.	_____	_____
8. Cleaned the work area.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____
12. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #5 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:	4	3	2	1
Made proper cut on conduit				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #6 — REAM RIGID CONDUIT

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Placed conduit in vise properly.	_____	_____
4. Reamed conduit properly.	_____	_____
5. Checked in/put away tools and materials.	_____	_____
6. Cleaned the work area.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
9. Practiced safety rules throughout procedure.	_____	_____
10. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____ _____

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #7 — BEND EMT CONDUIT

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Placed EMT in jaw properly.	_____	_____
4. Used proper foot placement.	_____	_____
5. Used solid foot pressure on kick pad and reapplied until bend completed.	_____	_____
6. Checked in/put away tools and materials.	_____	_____
7. Cleaned the work area.	_____	_____
8. Used proper tools correctly.	_____	_____
9. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
10. Practiced safety rules throughout procedure.	_____	_____
11. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #7 — BEND EMT CONDUIT

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Placed EMT in jaw properly.	_____	_____
4. Used proper foot placement.	_____	_____
5. Used solid foot pressure on kick pad and reapplied until bend completed.	_____	_____
6. Checked in/put away tools and materials.	_____	_____
7. Cleaned the work area.	_____	_____
8. Used proper tools correctly.	_____	_____
9. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
10. Practiced safety rules throughout procedure.	_____	_____
11. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #7 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
	4	3	2	1
Accomplished 90° bend				
	4	3	2	1
No crimps in pipe				

EVALUATOR'S COMMENTS: _____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #8 — USE A KNOCKOUT PUNCH

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Center punched hole.	_____	_____
4. Drilled proper size hole.	_____	_____
5. Operated knockout punch properly.	_____	_____
6. Lubricated cutter as needed.	_____	_____
7. Checked in/put away tools and materials.	_____	_____
8. Cleaned the work area.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____
12. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #8 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
	4	3	2	1
Cut clean				
	4	3	2	1
Cut proper size				
	4	3	2	1
Cut in proper location				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

PRACTICAL TEST
JOB SHEET #9 — USE A HOLE SAW

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Center punched properly.	_____	_____
4. Tightened drill chuck securely.	_____	_____
5. Cut hole completely through metal.	_____	_____
6. Checked in/put away tools and materials.	_____	_____
7. Cleaned the work area.	_____	_____
8. Used proper tools correctly.	_____	_____
9. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
10. Practiced safety rules throughout procedure.	_____	_____
11. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #9 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:				
	4	3	2	1
Hole cut cleanly				
	4	3	2	1
Hole proper size				
	4	3	2	1
Hole in proper location				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

HAND TOOLS
UNIT IV

TEST

NAME _____ SCORE _____

1. Match the terms on the right with their correct definitions.

_____a.	Industrial blueprint; industrial wiring diagram	1. Arbor
_____b.	Circuit with voltage applied	2. Cable-tie
_____c.	Metal connector crimped or soldered to a conductor; allows conductor to be fastened with a screw or bolt	3. Chuck
_____d.	Nonconductive material that prevents leakage of electricity from a conductor and protects against accidental contact	4. Circuit box
_____e.	Device for holding a component of a tool rigid	5. Conductor
_____f.	Nonconductive material placed around a conductor for insulation; does not shrink	6. Conduit
_____g.	Box where electrical connections are made, usually through circuit breakers	7. Coupling
_____h.	Safety device placed in a circuit; in cases of excessive current, it melts, thus opening the circuit	8. Fuse
_____i.	Pipe or tube which holds and protects wires or cables	9. Heat shrink
_____j.	Shaft or spindle used to hold a revolving cutting tool or the work to be cut	10. Insulation
_____k.	Nonconductive material placed around a conductor for insulation; shrinks when heated	11. Live circuit
_____l.	Metal ring which fastens around or in a shaft to keep other parts stationary	12. Plasterboard
		13. Print
		14. Snap ring
		15. Spaghetti
		16. Wire lug

TEST

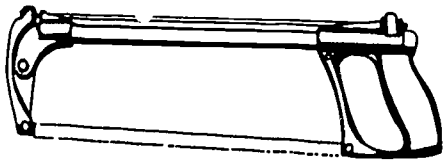
_____m. Mechanical device for connecting conduit and cabling

_____n. Material through which electrons flow easily; used to connect components

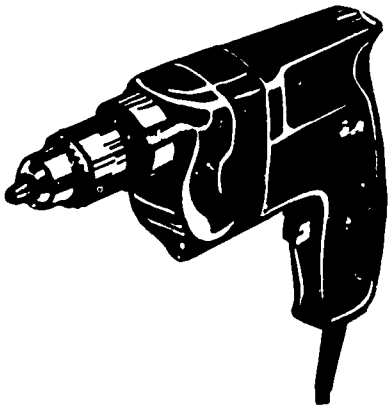
_____o. Plastic straps with pull-through fasteners for binding together conductors or cables

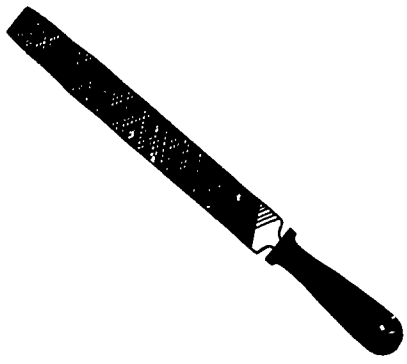
_____p. Thin board formed of layers of plaster and paper; Sheetrock

2. Label the following common hand tools used in the electrical field. Write the correct names in the spaces provided.



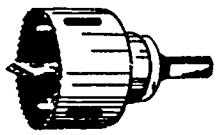
a. _____ b. _____

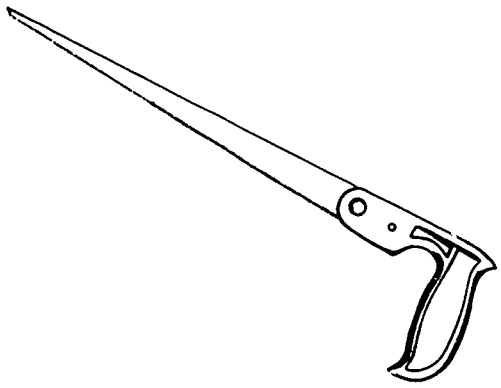




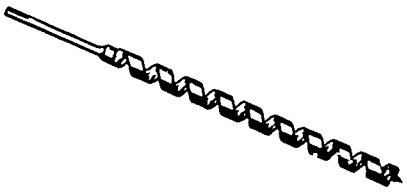
c. _____ d. _____

TEST

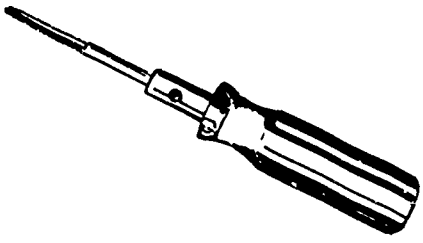


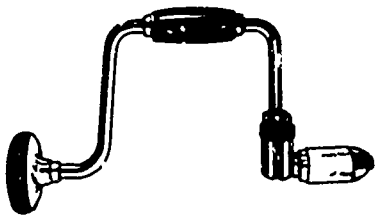


e. _____ f. _____



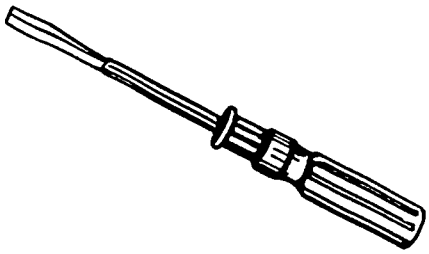
g. _____ h. _____



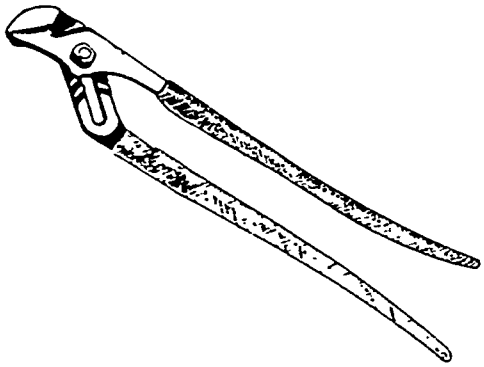


i. _____ j. _____

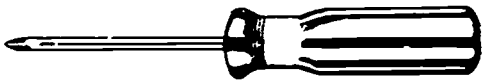
TEST



k. _____

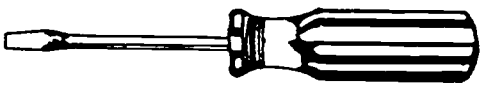


l. _____

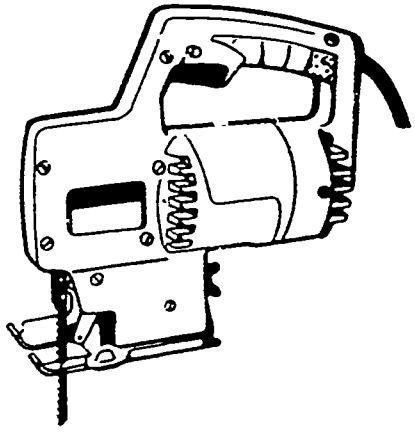


m. _____

n. _____

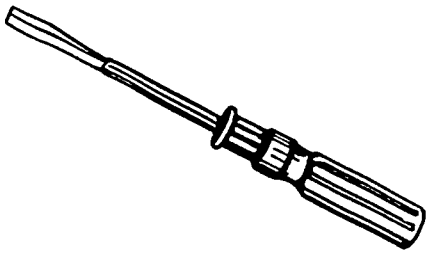


o. _____

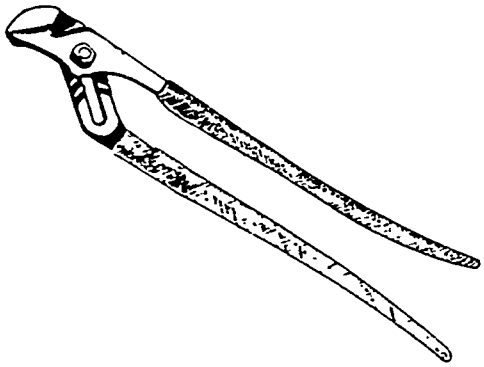


p. _____

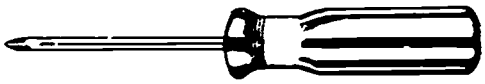
TEST



k. _____

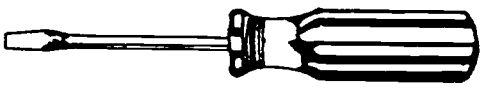


l. _____

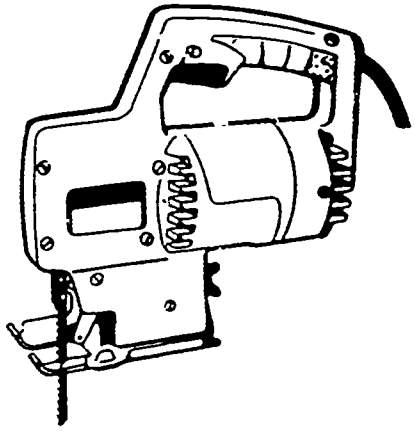


m. _____

n. _____

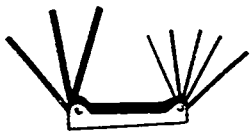


o. _____



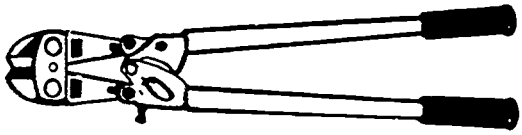
p. _____

TEST

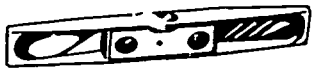


q. _____

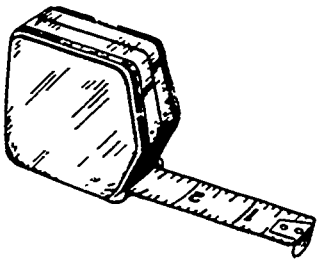
r. _____



s. _____



t. _____



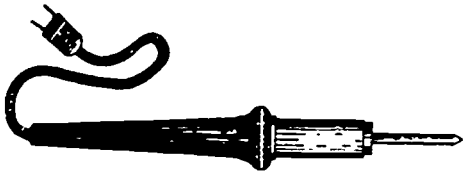
u. _____

v. _____

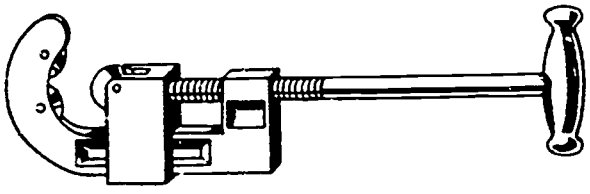
TEST

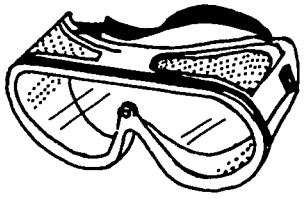
w. _____ x. _____

3. Label the following electricity-specific hand tools used in industrial maintenance. Write the correct names in the spaces provided.



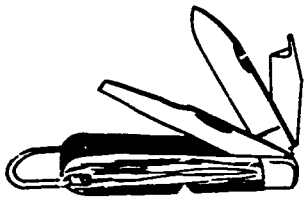
a. _____ b. _____



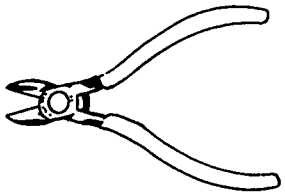


c. _____ d. _____

TEST

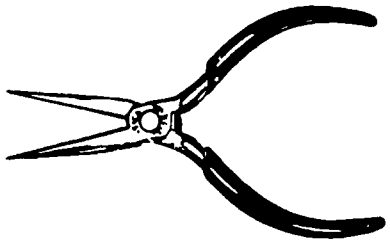


e _____

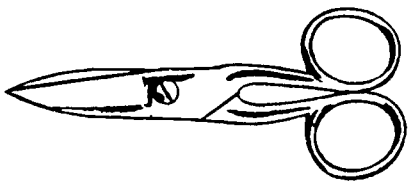


f. _____

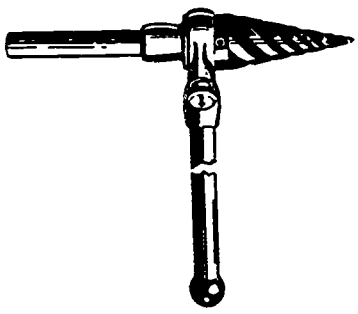
g. _____



h. _____

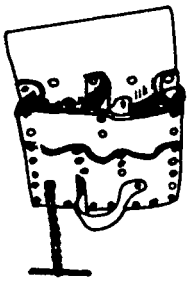


i. _____

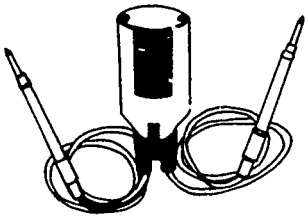


j. _____

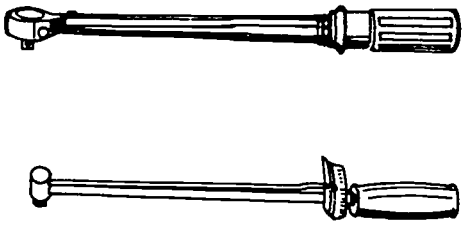
TEST



k. _____



l. _____



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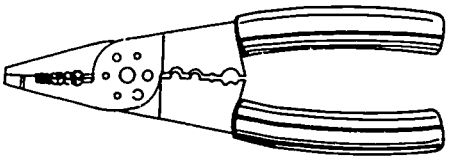
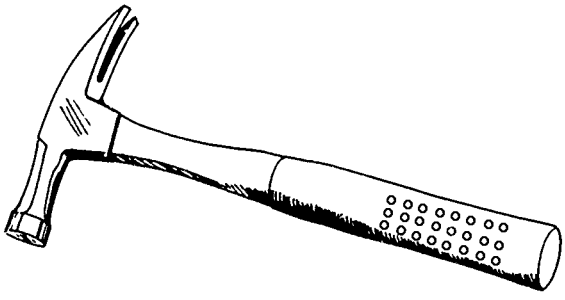
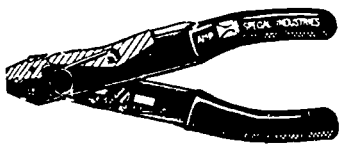


n. _____

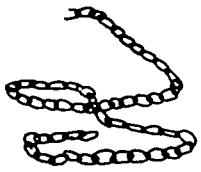


o. _____



p. _____

TEST



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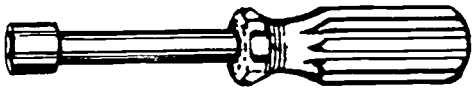

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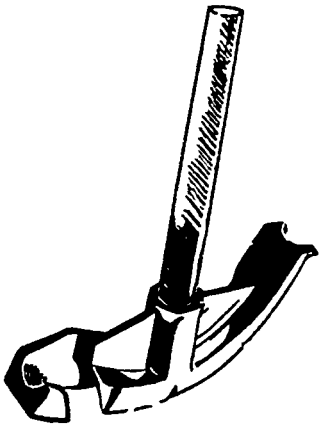

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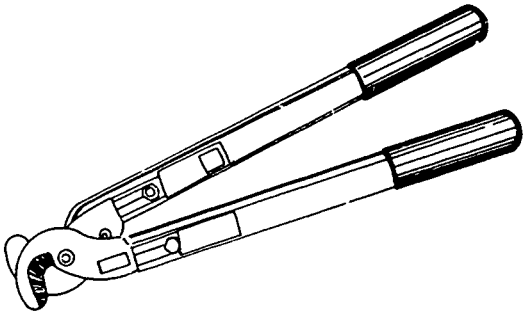

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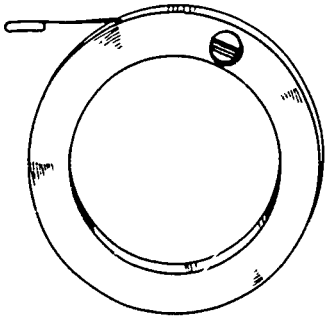
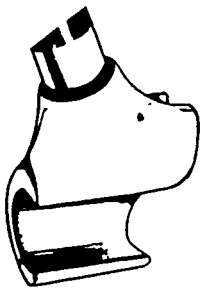
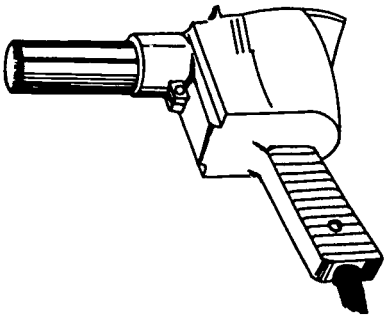


u. _____



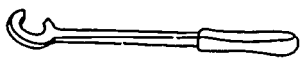
v. _____

TEST

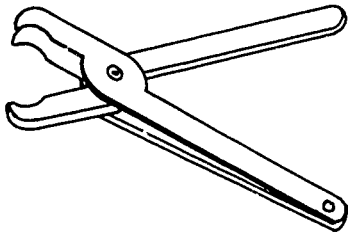


w. _____

x. _____



y. _____



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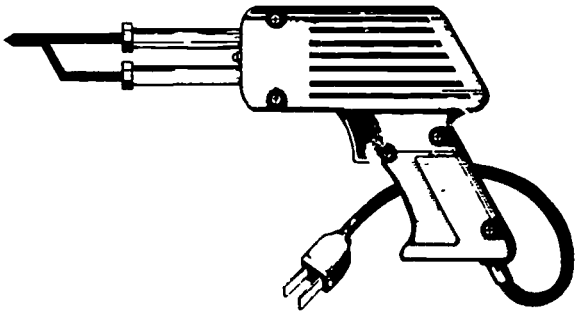

aa. _____

TEST

4. Match common hand tools on the right with their correct uses. Write the correct numbers in the blanks. Some numbers may be used more than once. Uses are continued on the next page.

_____a.	Cuts holes in plasterboard; needs electric power
_____b.	Makes center tap for drilling
_____c.	Cuts large holes in metal boxes without drilling
_____d.	Installs and/or removes slot-head screws
_____e.	Hold couplings and conductors
_____f.	Cuts large conductor or cables
_____g.	Cleans soldering iron or soldering gun tips
_____h.	Equips drill holes with bolt threads
_____i.	Drills holes for electronic cabinets; needs electric power
_____j.	Holds screws for use in limited-space installation
_____k.	Bores holes for conduit or cable
_____l.	Cuts large bolts, chains, locks, and so forth
_____m.	Levels conduit
_____n.	Measures distances on prints, conduit, cable, and so forth
_____o.	Installs and/or removes Phillips-head screws
_____p.	Tightens or turns conduit
_____q.	Cuts metal for electronic cabinets
_____r.	Cuts holes in plasterboard for circuit boxes; needs no electric power
_____s.	Deburrs large conduit

1. Folding rule or tape measure
2. Flat-blade screwdriver
3. Phillips screwdriver
4. Pump pliers
5. Adjustable wrench
6. Hacksaw
7. Keyhole saw
8. File
9. Chisel
10. Center punch
11. Bolt cutter
12. Hex key set (Allen wrenches)
13. Magnetic torpedo level
14. Knockout punch
15. Hole saw
16. Drill brace and drill
17. Tap tool
18. Drill motor and drill
19. Reciprocating saw
20. Screw-holding screwdriver

TEST

_____t. Cuts conduit

_____u. Installs and/or removes Allen screws

_____v. Cuts large holes in metal

_____w. Levels equipment

_____x. Retaps damaged threads

_____y. Notches wood for boxes or cables

_____z. Determines bolt size

_____aa. Sharpens tools

_____bb. Tighten couplings and connectors

_____cc. Used in place of other wrenches; versatile

_____dd. Deburrs holes in circuit boxes

_____ee. Hold conduit

5. Match electricity-specific hand tools on the right with their correct uses. Write the correct numbers in the blanks. Some numbers may be used more than once. Tools and uses are continued on the next page.

_____a. Cut(s) small conductors

_____b. Deburrs conduit

_____c. Drives and pulls nails

_____d. Shrinks heat shrink

_____e. Removes fuses safely from equipment and circuit panels

_____f. Cuts small bolts

_____g. Reams burrs from EMT

_____h. Splices cables

_____i. Crimps wire lugs

1. Needle-nose pliers
2. Diagonal pliers (dykes)
3. Lineman's pliers
4. Adjustable wire stripper
5. Cutting/crimping tool
6. Soldering iron (approximately 25 W)
7. Soldering gun
8. Cable bender
9. Conduit reamer

TEST

_____j. Pulls cables through wall

_____k. Pulls cables through insulated walls

_____l. Bends conduit for conductor installation

_____m. Installs and/or removes nuts and bolts

_____n. Opens wooden crates

_____o. Bends heavy conduit

_____p. Cuts conduit

_____q. Cut paper, heat shrink, spaghetti, cable-tie, and so forth

_____r. Form loops on small conductors

_____s. Cut large conductors

_____t. Strips insulation from conductors

_____u. Solders large conductors

_____v. Opens paper cartons

_____w. Bends large cables

_____x. Strips large conductors

_____y. Holds conductors while soldering

_____z. ..otects eyes from foreign objects and liquids

_____aa. Tightens or loosens nuts on long bolts

_____bb. Checks circuits for power

_____cc. Cuts large cables

_____dd. Pulls conductors through conduit

_____ee. Dries electronic components and/or conductors

10. Safety glasses and goggles
11. Nut driver
12. Torque screwdriver
13. Circuit tester
14. Electrician's hammer
15. Cable cutter
16. Heat gun
17. Torque wrenches
18. Steel fish tape and reel
19. Pipe cutter
20. Pipe reamer
21. Conduit bender
22. Hickey bender
23. Electrician's scissors
24. Electrician's knife
25. Drop chain
26. Fuse puller

(NOTE: Uses are continued on the next page.)

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

8. Demonstrate the ability to:

   a. Clean and lubricate an adjustable hand tool. (Job Sheet #1)

   b. Use a cutting/crimping tool. (Job Sheet #2)

   c. Adjust wire strippers. (Job Sheet #3)

   d. Set up and use a hacksaw. (Job Sheet #4)

   e. Cut rigid conduit with a pipe cutter. (Job Sheet #5)

   f. Ream rigid conduit. (Job Sheet #6)

   g. Bend EMT conduit. (Job Sheet #7)

   h. Use a knockout punch. (Job Sheet #8)

   i. Use a hole saw. (Job Sheet #9)

TEST

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

8. Demonstrate the ability to:

   a. Clean and lubricate an adjustable hand tool. (Job Sheet #1)

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   i. Use a hole saw. (Job Sheet #9)

ANSWERS TO TEST

4.

a.	19	i.	18	q.	6	y.	9
b.	10	j.	20	r.	7	z.	17
c.	14	k.	16	s.	8	aa.	8
d.	2	l.	11	t.	6	bb.	4
e.	4	m.	13	u.	12	cc.	5
f.	6	n.	1	v.	15	dd.	8
g.	8	o.	3	w.	13	ee.	4
h.	17	p.	4	x.	17		

5.

a.	1,2,4,5,23	k.	18	u.	7	ee.	16
b.	20	l.	21	v.	24	ff.	24
c.	14	m.	11	w.	8	gg.	14
d.	16	n.	14	x.	24	hh.	6
e.	26	o.	22	y.	1	ii.	3
f.	5	p.	19	z.	10	jj.	17
g.	9	q.	23	aa.	11	kk.	6
h.	7	r.	1	bb.	13	ll.	2
i.	5	s.	3	cc.	15	mm.	3
j.	25	t.	5	dd.	18	nn.	12

6.
a. Size
b. Design
c. Quality

7. a, b, c, f

8. Performance skills evaluated to the satisfaction of the instructor

ANSWERS TO TEST

4.

a.	19	i.	18	q.	6	y.	9
b.	10	j.	20	r.	7	z.	17
c.	14	k.	16	s.	8	aa.	8
d.	2	l.	11	t.	6	bb.	4
e.	4	m.	13	u.	12	cc.	5
f.	6	n.	1	v.	15	dd.	8
g.	8	o.	3	w.	13	ee.	4
h.	17	p.	4	x.	17		

5.

a.	1,2,4,5,23	k.	18	u.	7	ee.	16
b.	20	l.	21	v.	24	ff.	24
c.	14	m.	11	w.	8	gg.	14
d.	16	n.	14	x.	24	hh.	6
e.	26	o.	22	y.	1	ii.	3
f.	5	p.	19	z.	10	jj.	17
g.	9	q.	23	aa.	11	kk.	6
h.	7	r.	1	bb.	13	ll.	2
i.	5	s.	3	cc.	15	mm.	3
j.	25	t.	5	dd.	18	nn.	12

6.
a. Size
b. Design
c. Quality

7. a, b, c, f

8. Performance skills evaluated to the satisfaction of the instructor

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify and use common specialty tools, power equipment, rules, scales, and test equipment. Competencies will be demonstrated by completing the assignment sheets, job sheets, and the unit tests with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to specialty tools and equipment with their correct definitions.
2. List typical power equipment.
3. Select true statements concerning general safety rules for using powe. equipment.
4. Label the parts of a hydraulic knockout set.
5. Cc plete statements concerning specific safety rules for using hydraulic knockout sets.
6. Label the parts of a hydraulic pipe bender.
7. Select true statements concerning specific safety rules for using hydraulic pipe benders.
8. Label the parts of an electrical polyvinyl chloride (PVC) heater.
9. Complete statements concerning specific safety rules for using electric polyvinyl chloride (PVC) heaters.

OBJECTIVE SHEET

10. Label the parts of a power drill.
11. Select true statements concerning specific safety rules for using power drills.
12. Label the parts of a power threader.
13. Complete statements concerning specific safety rules for using power threaders.
14. Identify typical rules and scales.
15. Identify typical test equipment.
16. Measure objects using a rule. (Assignment Sheet #1)
17. Determine lengths of lines using an architect's scale. (Assignment Sheet #2)
18. Demonstrate the ability to:
    a. Use a hydraulic knockout punch. (Job Sheet #1)
    b. Bend a 90-degree stub using a hydraulic pipe bender. (Job Sheet #2)
    c. Make offset and 90-degree bends using an electric PVC heater. (Job Sheet #3)
    d. Cut, ream, and thread rigid conduit with a power threader. (Job Sheet #4)
    e. Measure resistance using a VOM. (Job Sheet #5)
    f. Measure DC voltages using a VOM. (Job Sheet #6)
    g. Measure AC voltages using a VOM. (Job Sheet #7)
    h. Measure amperage using a clamp-on ammeter. (Job Sheet #8)
    i. Determine the current of a multiple-loop clamp-on ammeter. (Job Sheet #9)
    j. Check conductor insulation with a megger. (Job Sheet #10)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Provide students with job sheets.

H. Discuss and demonstrate the procedures outlined in the job sheets.

I. Integrate the following activities throughout the teaching of this unit:

1. Invite a local electrical tool salesperson to show specialty tools and equipment to class.

2. Obtain tool catalogs from local suppliers.

3. Obtain test equipment catalogs from local suppliers.

4. Discuss the proper care and maintenance of specialty tools, power equipment, and test equipment with class.

5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas of improvement.

J. Give test.

K. Evaluate test.

L. Reteach if necessary.

REFERENCES USED IN WRITING THIS UNIT

A. *Using Electrical Test Equipment.* Rockville, MD: NUS Training Corporation, A Halliburton Company, 1980.

B. Siebert, Leo N. *Introduction to Industrial Electricity-Electronics.* Stillwater, OK: Oklahoma Curriculum and Instructional Materials Center, 1981.

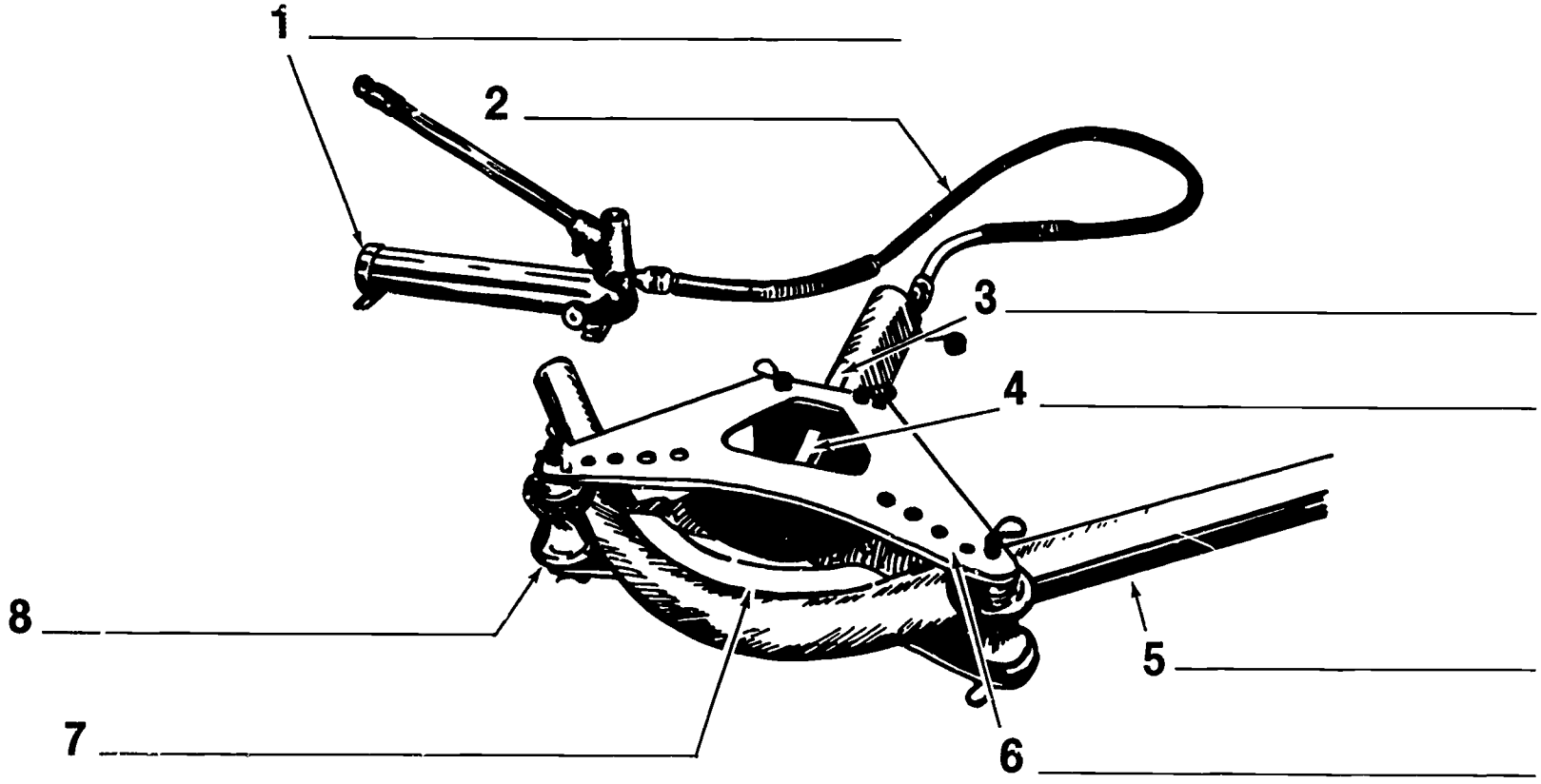
C. Taylor, Mark. *Residential Wiring.* Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1983.

D. Teague, Cash and Garner Pewewardy. *Industrial Electricity: In-Plant Distribution.* Stillwater, OK: Oklahoma Curriculum and Instructional Materials Center, 1984.

SUGGESTED SUPPLEMENTAL MATERIAL

Publication — Klein Tool Catalog No. 129, Klein Tools Inc., 7200 McCormick Blvd., Chicago, IL 60645.

Hydraulic Pipe Bender



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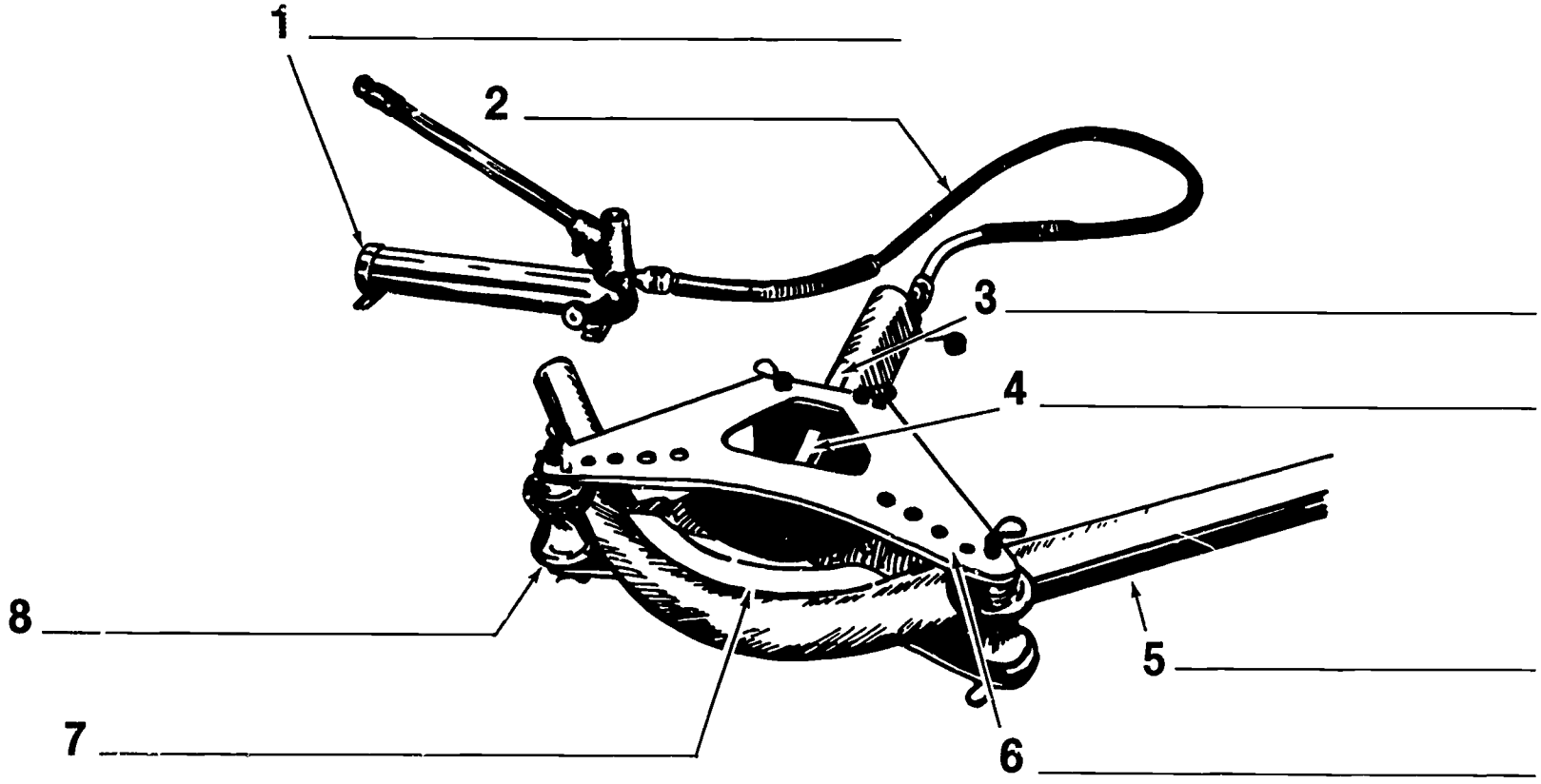
TM 2
Objective V

BW-201

Hydraulic Pipe Bender

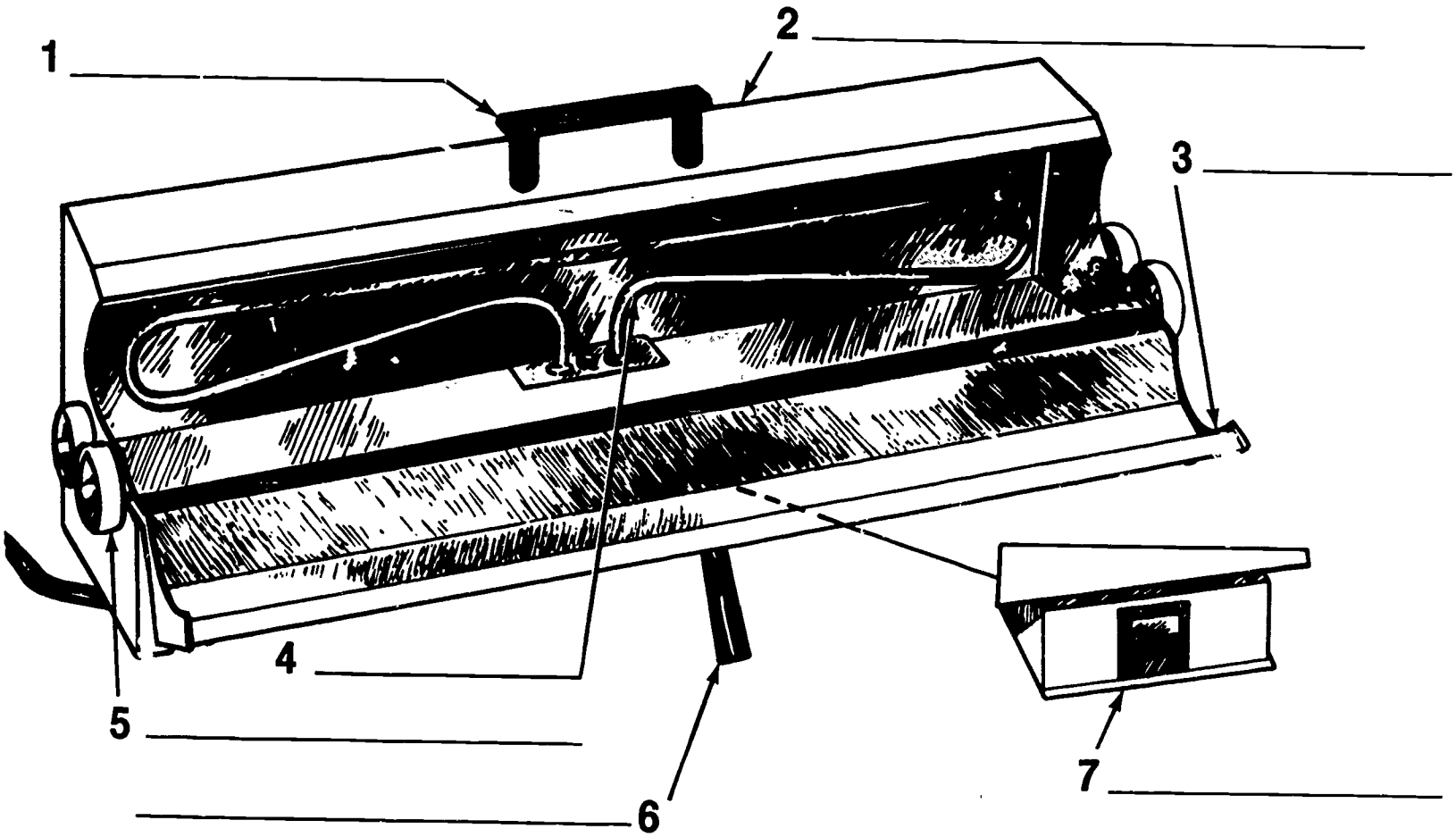


213

TM 2
Objective V

BW-201

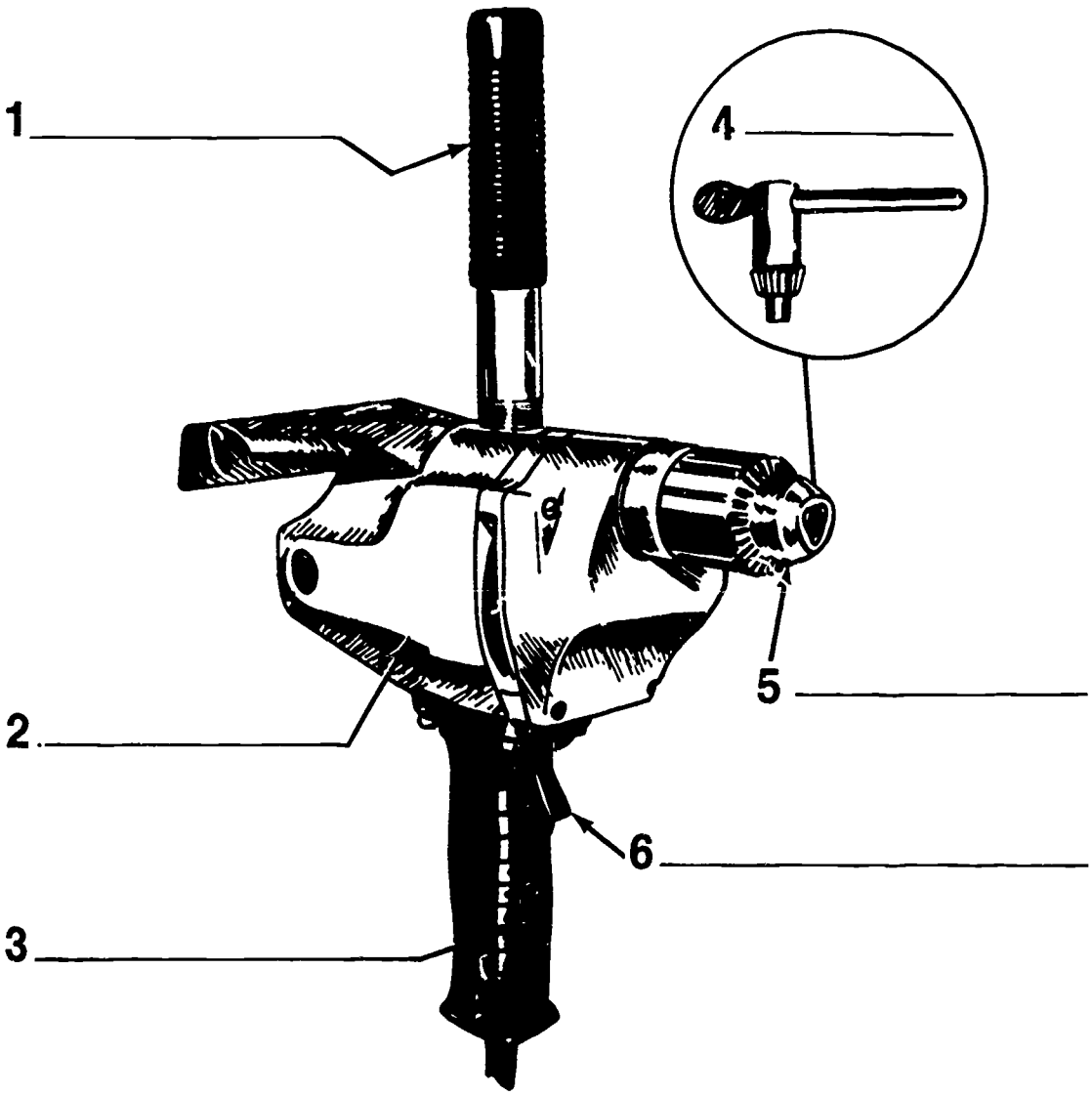
Electric PVC Heater



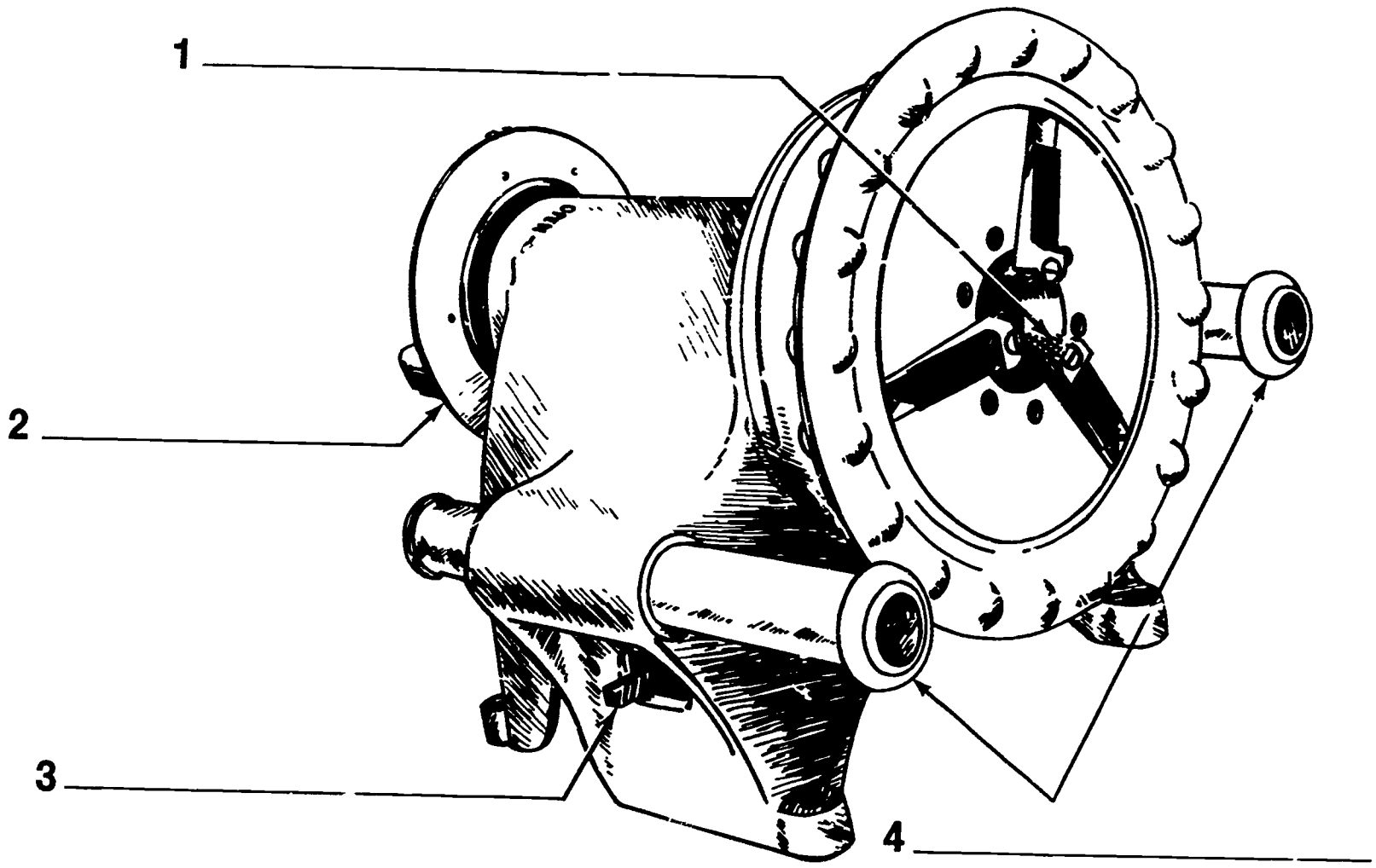
TM 3
Objective VIII

BW-203

Power Drill

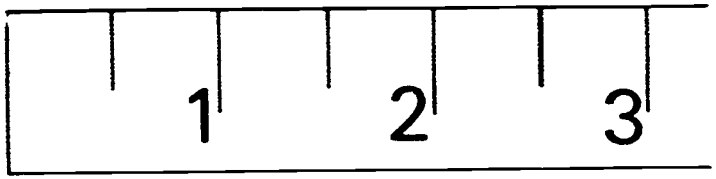


Power Threader

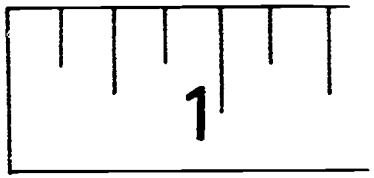


Graduations on a Rule

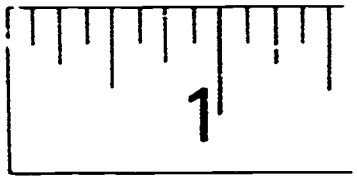
Halves



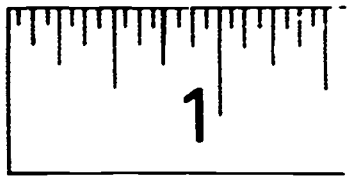
Quarters



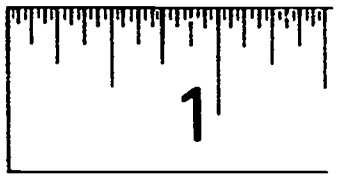
Eighths

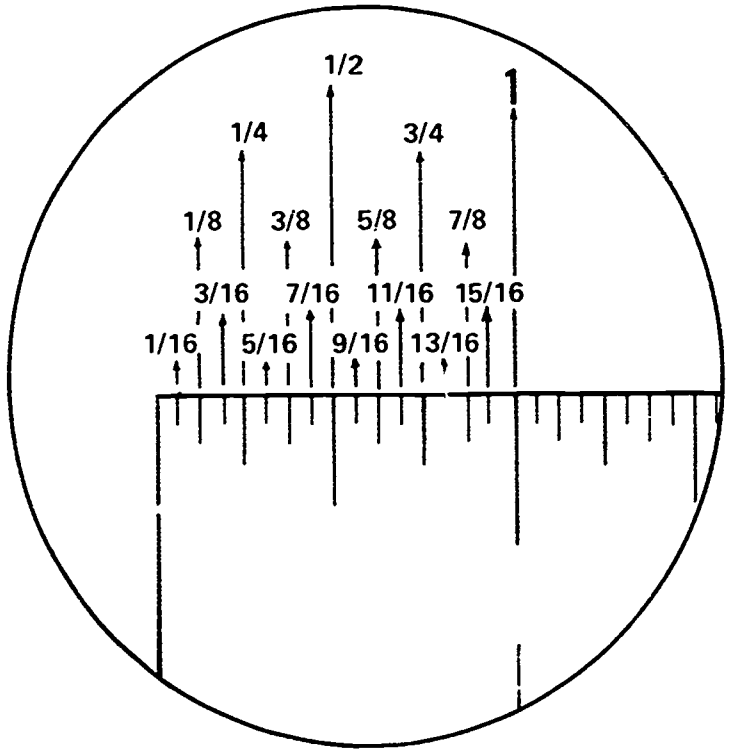


Sixteenths



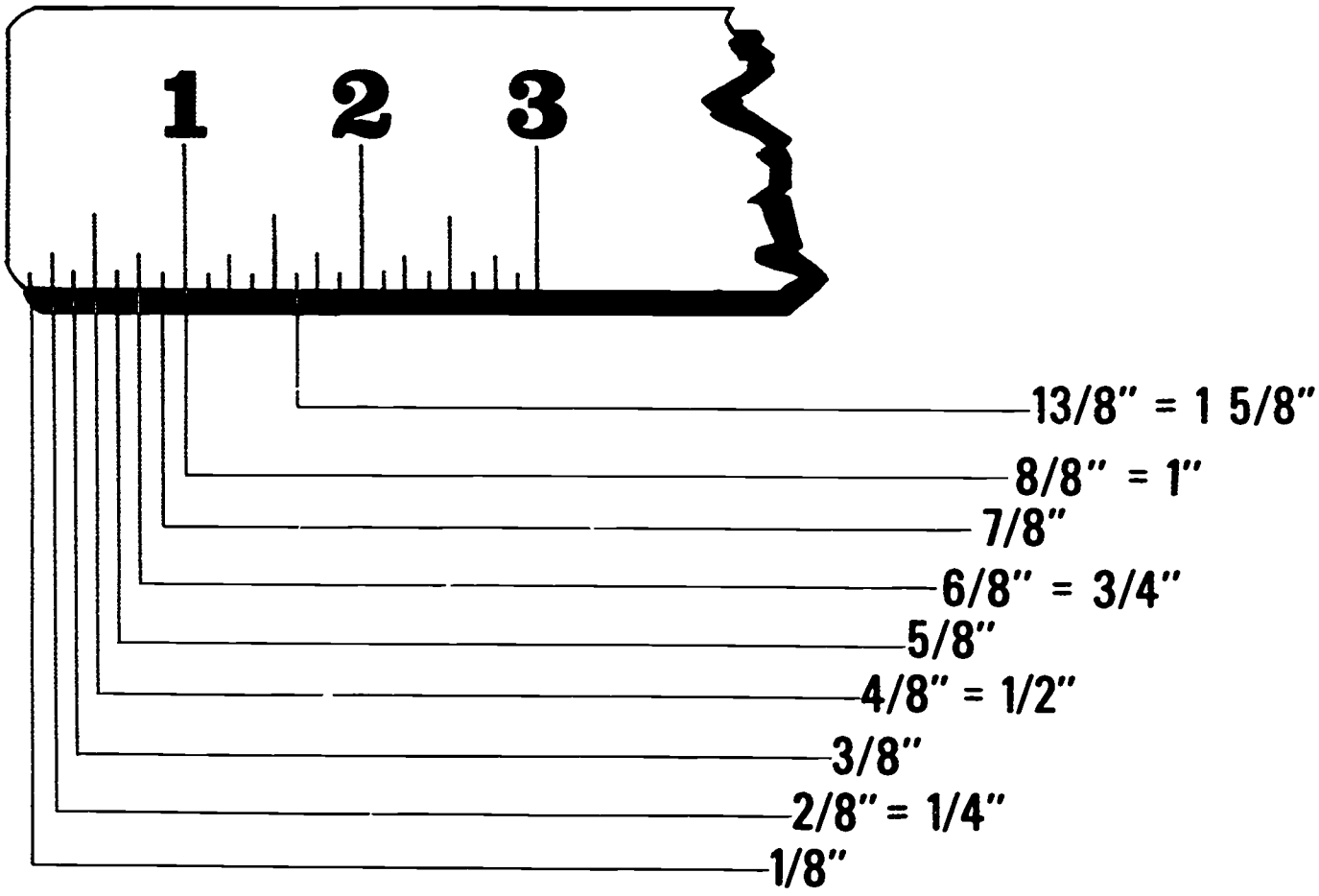
Thirty-Seconds



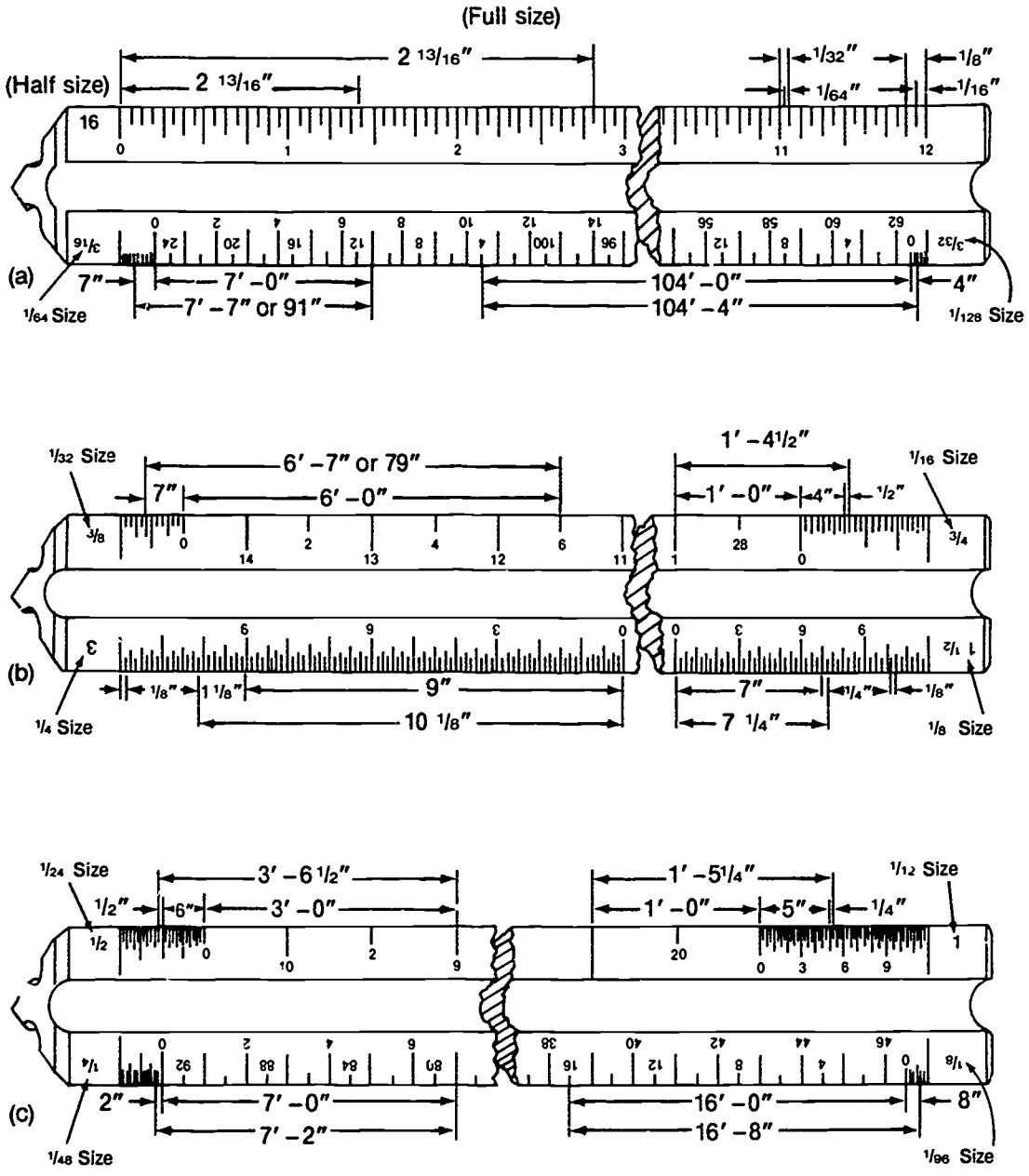


Graduations Applied to a Rule

Reading the Eighths Rule

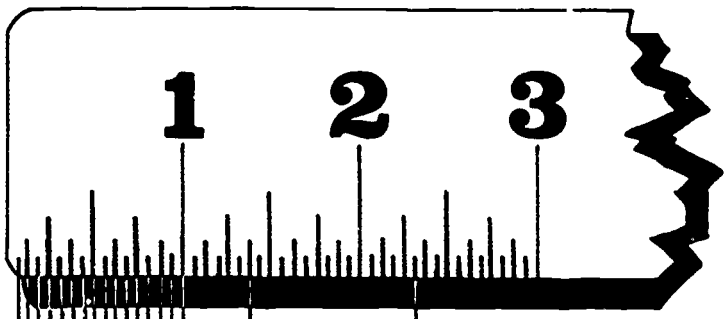


Architect's Scale



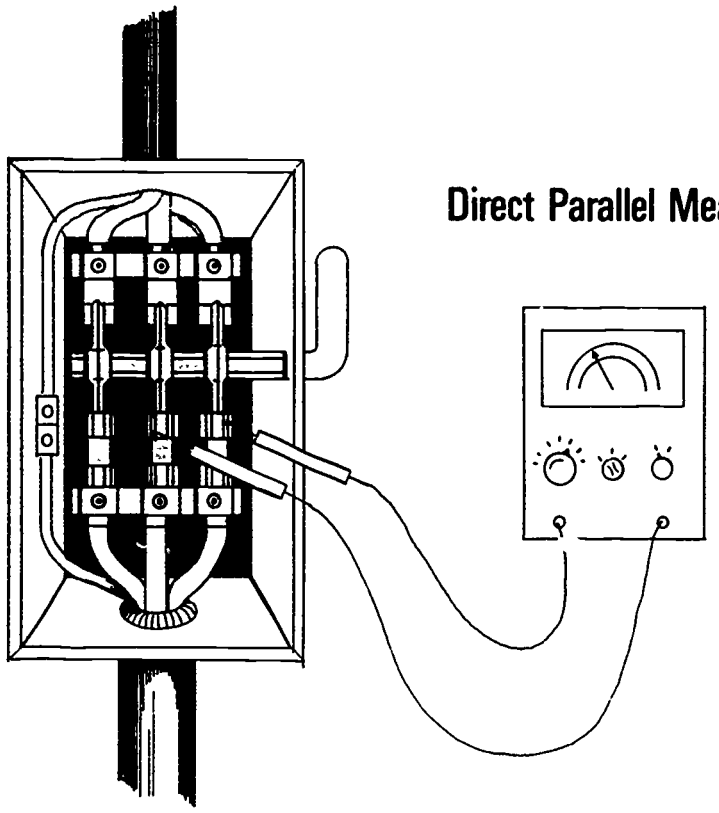
This is how the Architect's Scale should look.

Reading the Sixteenths Rule



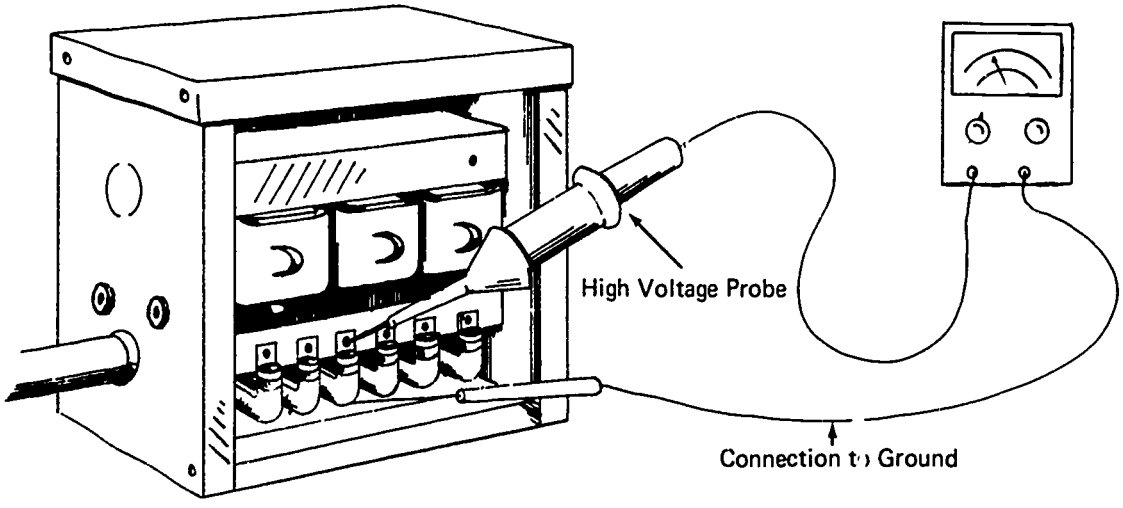
37/16" = 2 5/16"
22/16" = 1 6/16"
16/16" = 1"
15/16"
14/16" = 7/8"
13/16"
12/16" = 3/4"
11/16"
10/16" = 5/8"
9/16"
8/16" = 1/2"
7/16"
6/16" = 3/8"
5/16"
4/16" = 1/4"
3/16"
2/16" = 1/8"
1/16"

Voltage Measurement Techniques

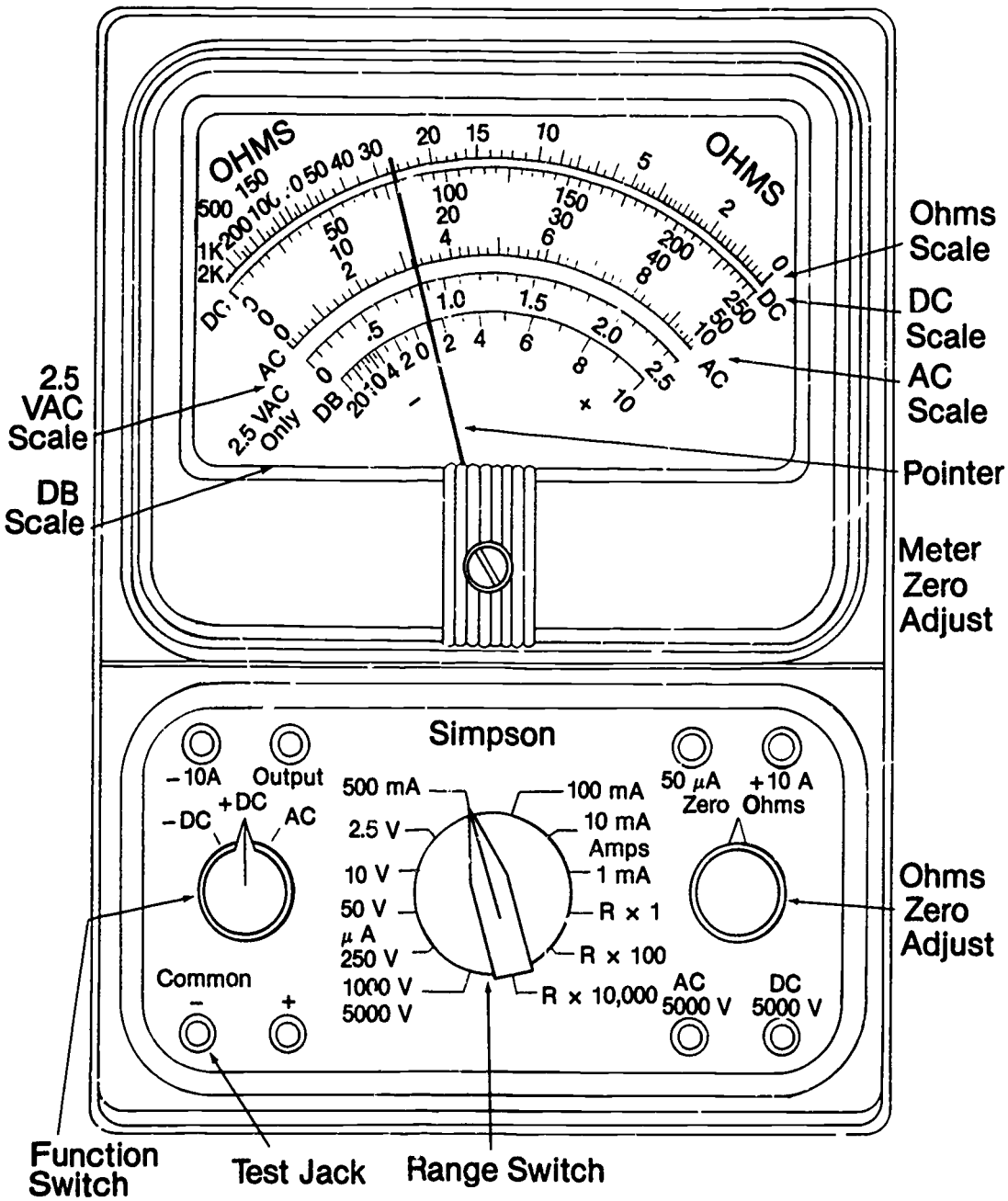


Direct Parallel Measurement

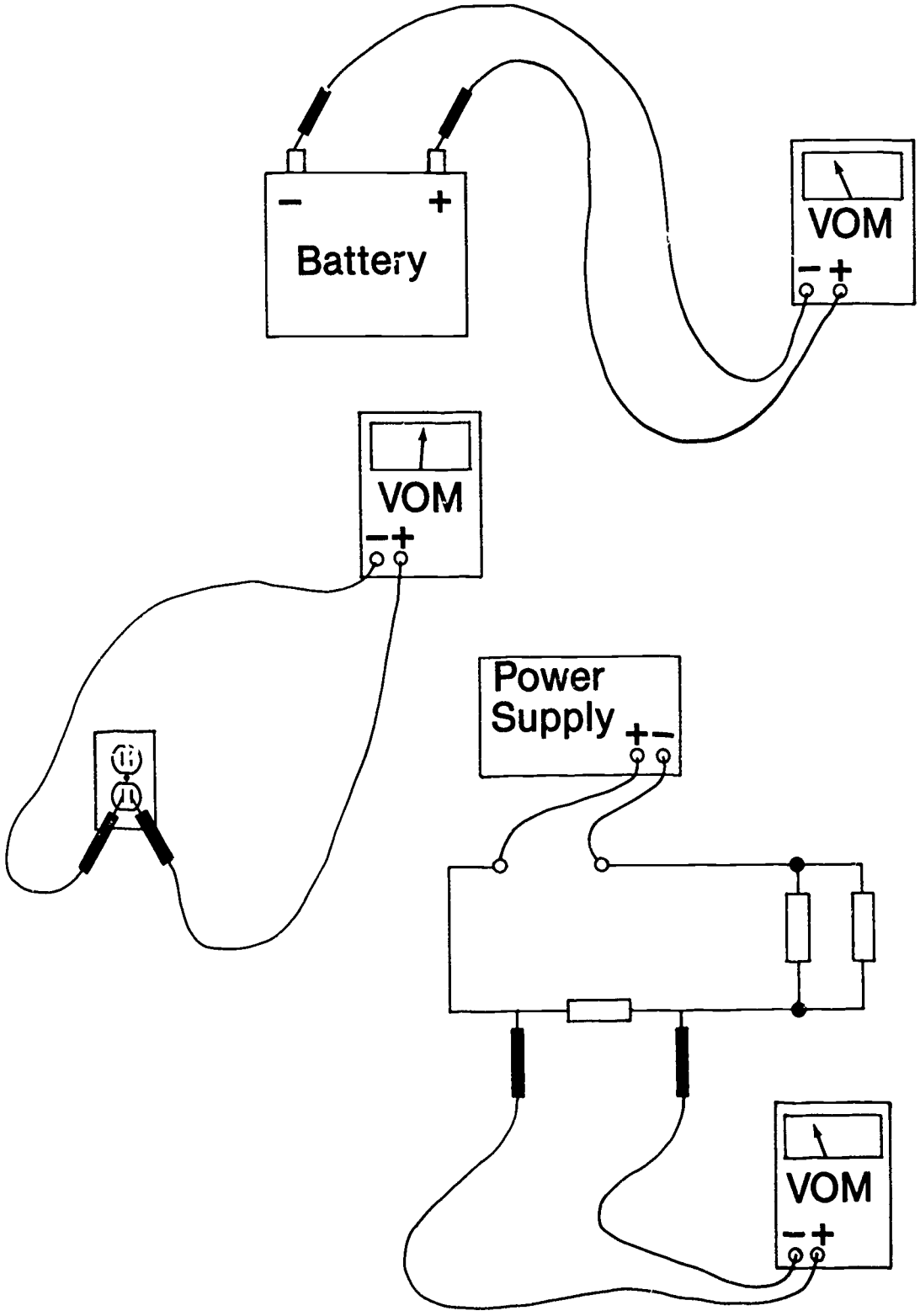
High Voltage Probe



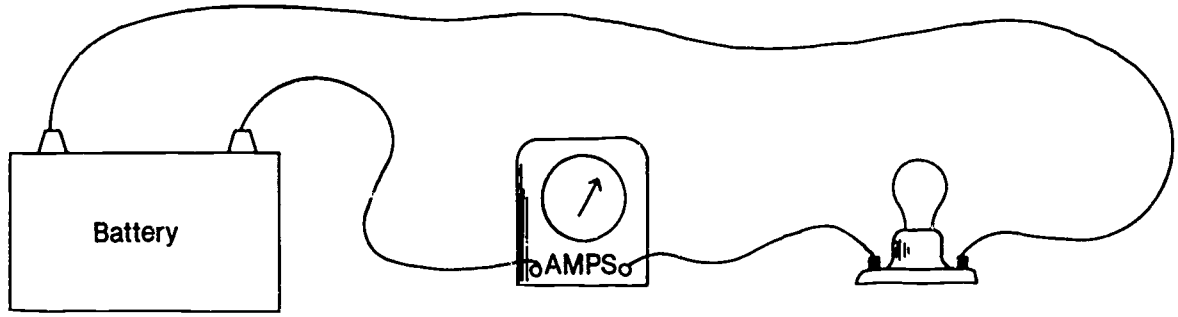
Permanent Magnet Moving Coil Multimeter



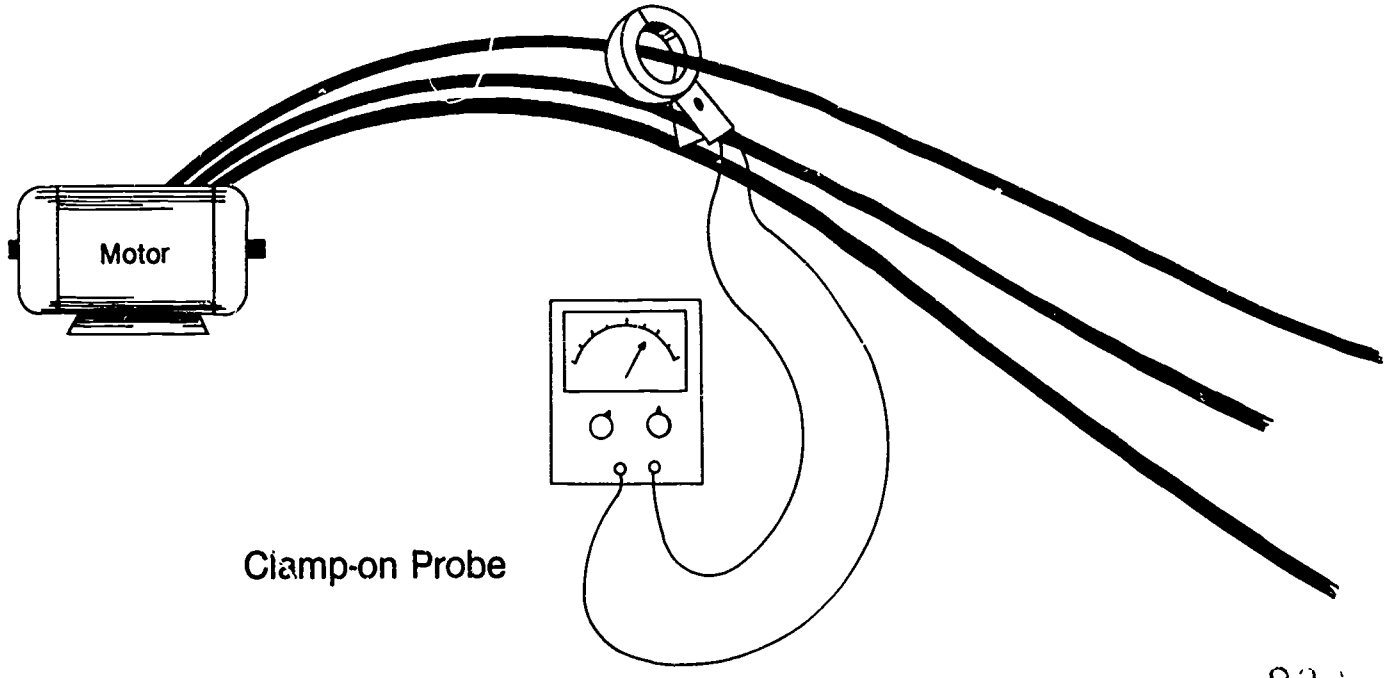
Correct Voltage Measurements



Amperage Measurement Techniques



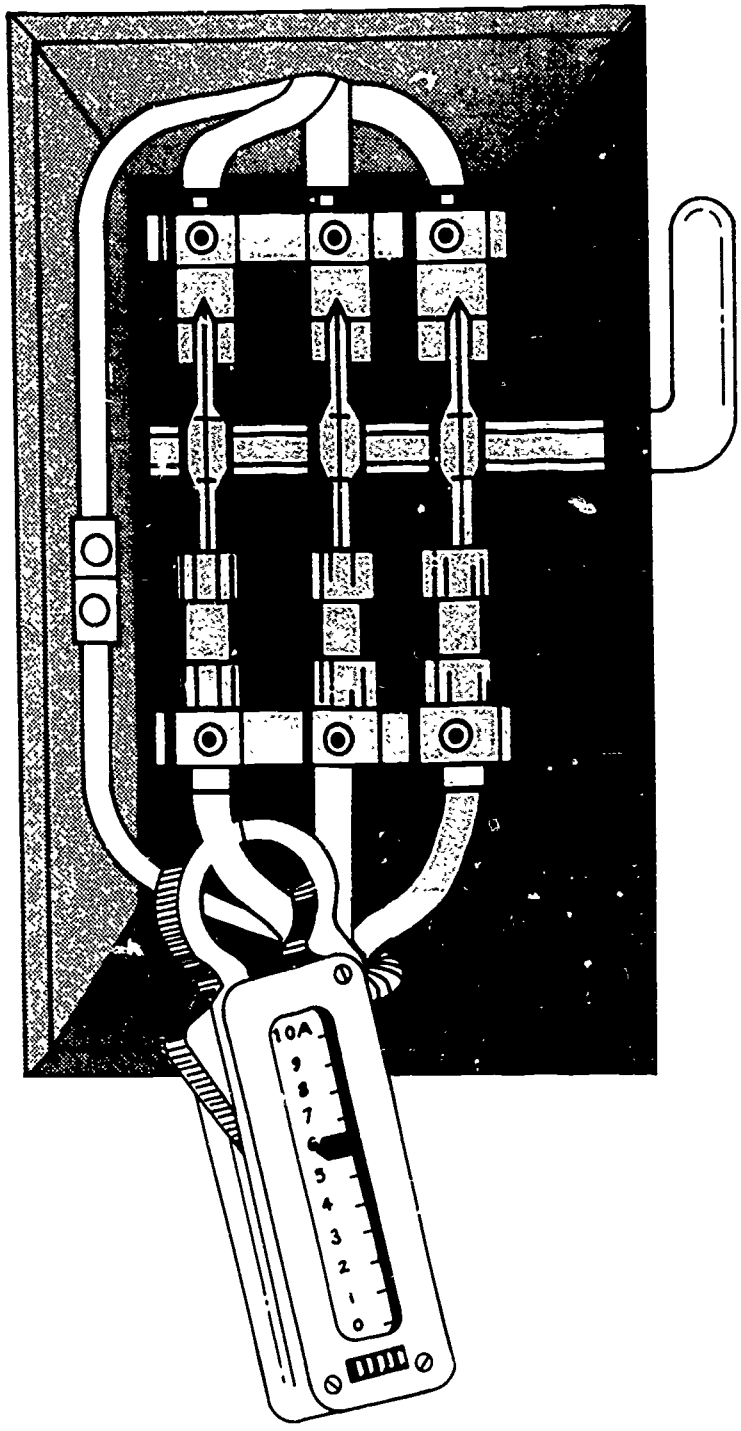
Series Ammeter



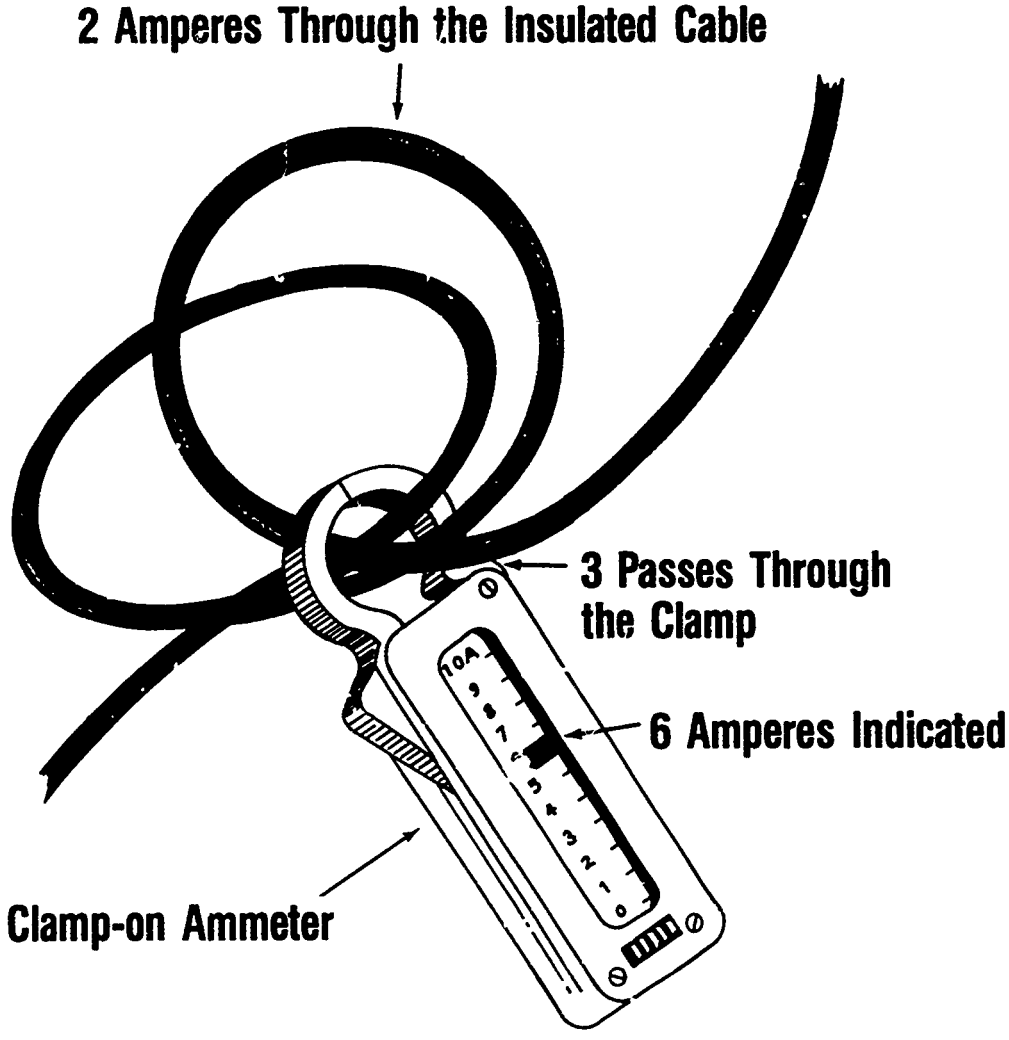
Clamp-on Probe

Clamp-on Ammeter

Measuring Current In A
Safety Switch Using Clamp-on Ammeter



Determining Current of a Multiple Loop Using a Clamp-on Ammeter



(NOTE: The loops should be wrapped tightly together at the point of measurement with electrical tape.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Accuracy — How near the instrument reading is to the actual value

B. Amperage — Electricity; electrical current flow; electron flow; must be measured at a point within a circuit

C. Bender — Tool used to make various angles or bends in conduit

D. Calibration — Technique of testing and adjusting an instrument by referencing it to another instrument or device of known accuracy and precision

E. Chuck — Portion of drill that holds the bit

F. Cross handle — Handle set across a power tool to prevent the tool from turning

G. Cutter — Hardened steel device used to cut holes in metal boxes

H. Die — Component that backs up cutter on opposite side of metal box

I. Error — How far the measurement is from the actual value

J. Ground — Electrical point or any good conductor that is connected to a common chassis with zero relative voltage; usually conductors are connected to the earth

K. Hydraulic — Using pressurized fluid to accomplish work

L. Hydraulic oil — Specially formulated oil for hydraulic pumps

(NOTE: No oil or fluid should ever be substituted for hydraulic oil.)

M. Knockout punch — Device used to make openings for conduit in metal enclosures

N. Multimeter — Instrument capable of measuring a "multiple" of values

EXAMPLES: Amperage, voltage, and resistance with several measurement ranges

O. Parallax correction — Viewing analog VOM from directly above the needle to avoid the possibility of wrong readings due to depth perception

P. Pinch point — Any opening that may close and bind a finger or hand

Q. Polyvinyl chloride (PVC) — Plastic pipe

INFORMATION SHEET

R. Precision — Instrument consistency

EXAMPLE: A "precision meter" might not be accurate. It may measure 1 volt at 1.20 volts, but each time the reading will be precisely 1.20, not 1.21 or 1.19. A calibration adjustment could correct the meter reading to 1.00 at 1 volt and would then precisely repeat a 1.00 reading.

S. Ram — Device used to transfer hydraulic pressure to a mechanical device

T. Resistance — Opposition to electrical current flow; measured in units of ohms; must be measured from one point to another

U. Resolution — How well an instrument will indicate a small change in the measured value

EXAMPLE: A precise, accurate, and sensitive meter may respond by moving the meter hand 1/16" for a small change in measured amperage. If the scale is marked only one division per inch, the meter would still lack "resolution" since the operation could not determine what amount of current change this represents.

V. Voltage — Electromotive force (emf); force that drives electricity through conductors; must be measured across, between, or be referenced to a second point

EXAMPLE: Ground

II. Typical power equipment

A. Hydraulic knockout

B. Hydraulic bender

C. Electric PVC heater

D. Power drill

E. Power threader

III. General safety rules for using power equipment

A. Always follow manufacturer's operating instructions.

B. Never place hands in a pinch point.

C. Use eye protection.

INFORMATION SHEET

D. Wear gloves when working with hot equipment or materials.

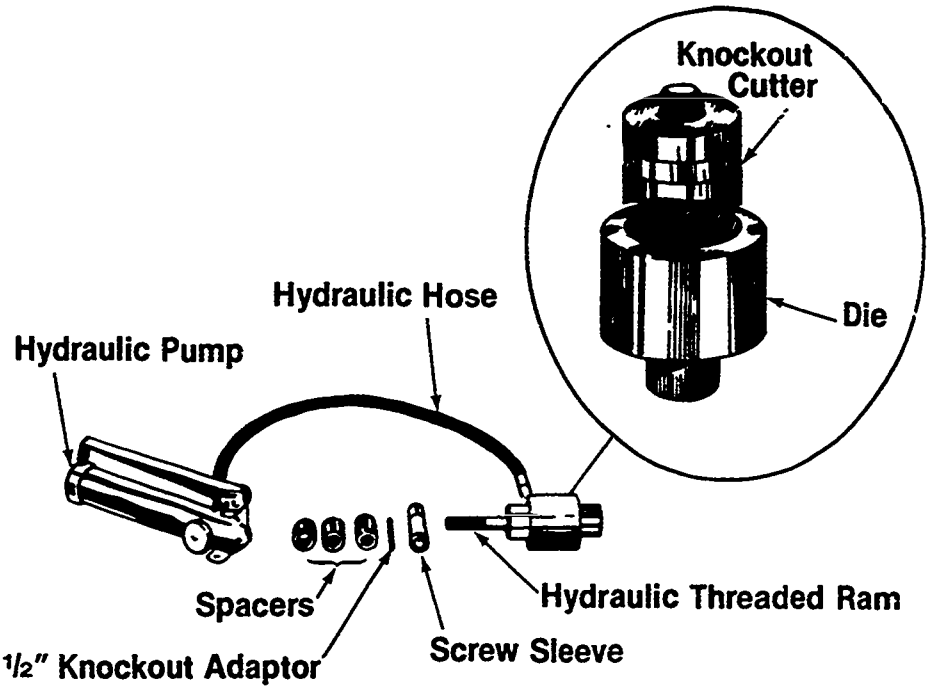
E. Always secure loose clothing such as shirt sleeves and shirttails.

F. Never exceed rated capacity of equipment.

G. Never leave running equipment unattended.

H. Never remove protective guards from equipment.

IV. Parts of a hydraulic knockout set



V. Specific safety rules for using hydraulic knockout sets

A. Never substitute brake fluid for hydraulic oil.

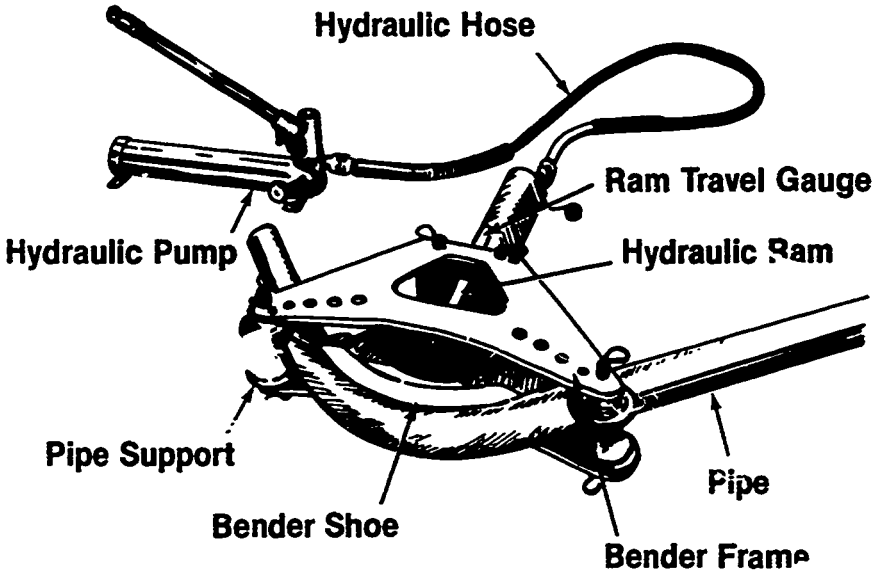
B. Never disconnect hose when it is under pressure.

C. Do not use near live electrical parts.

D. Never force pump handle.

INFORMATION SHEET

VI. Parts of a hydraulic pipe bender



VII. Specific safety rules for using hydraulic pipe benders

A. Never substitute brake fluid for hydraulic oil.

B. Never disconnect hose when it is under pressure.

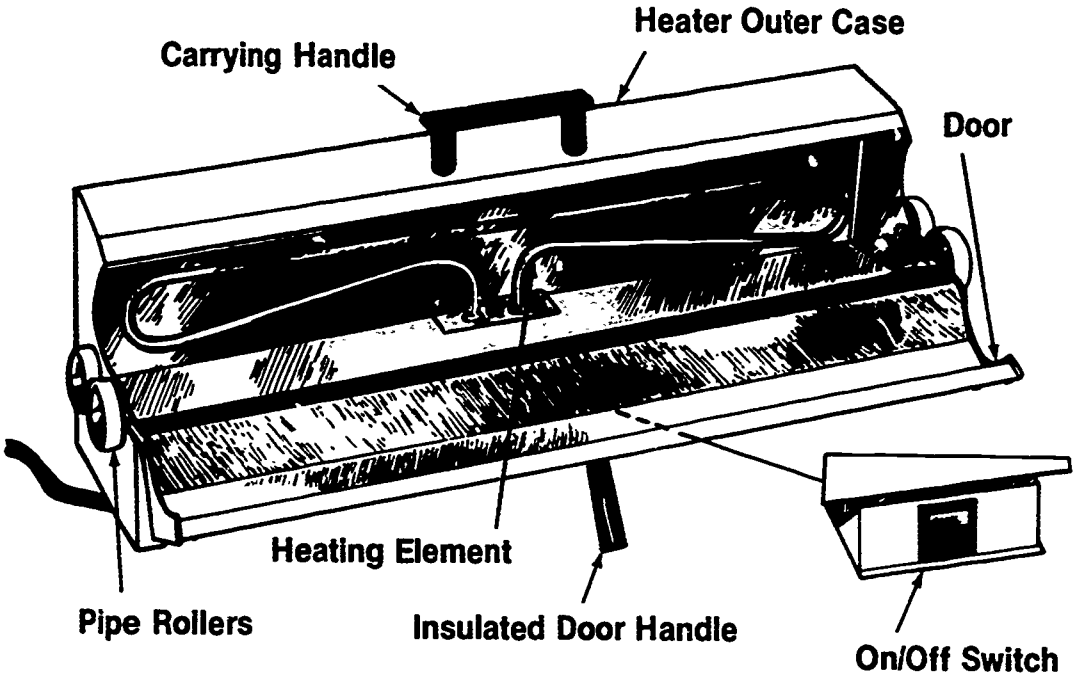
C. Never place hands near ram or shoe while bending.

D. Always use proper side of conduit shoe and support.

E. Be sure that floor area is clear for pipe movement.

INFORMATION SHEET

VIII. Parts of an electric polyvinyl chloride (PVC) heater



IX. Specific safety rules for using electric polyvinyl chloride (PVC) heaters

A. Never use in wet locations.

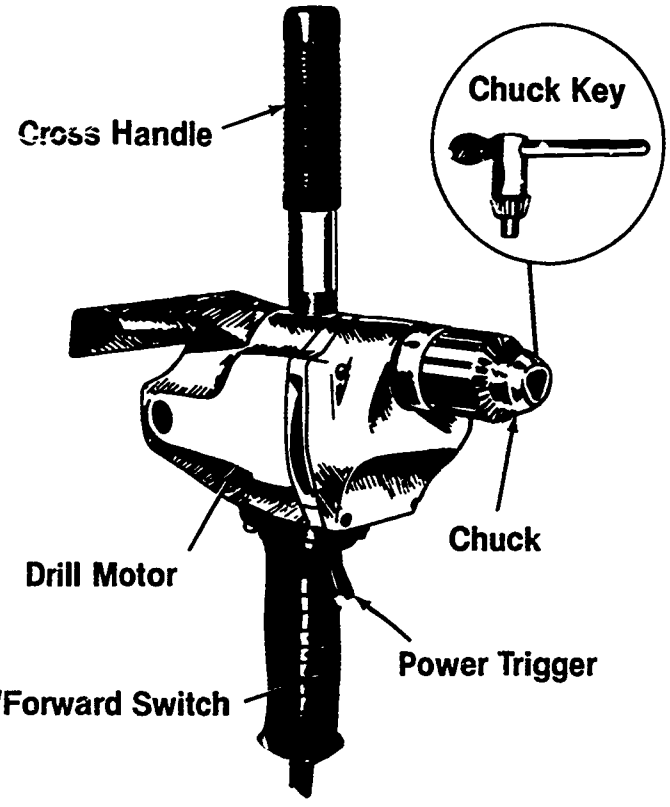
B. Always wear gloves when handling hot water or pipe.

C. Use only with PVC conduit.

D. Always turn bender off when not in use.

INFORMATION SHEET

X. **Parts of a power drill**



XI. **Specific safety rules for using power drills**

A. Always wear eye protection.

B. Check area to be drilled for hidden wires or pipes.

C. Hold drill securely with both hands.

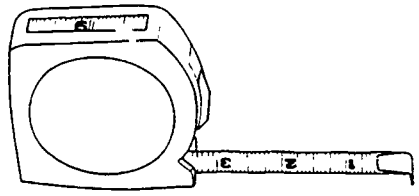
D. Never drill while off balance.

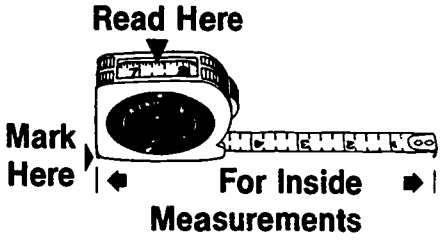
E. Place small objects to be drilled in a vise.

INFORMATION SHEET

XIV. Typical rules and scales

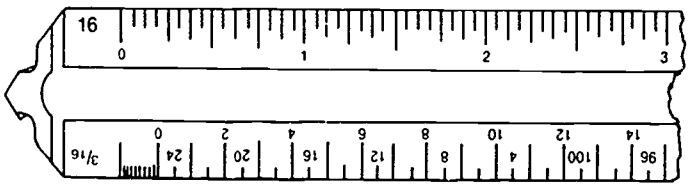
A. Sixteen foot tape





(NOTE: Tapes are normally graduated into 1/16" increments.)

B. Architect's scale



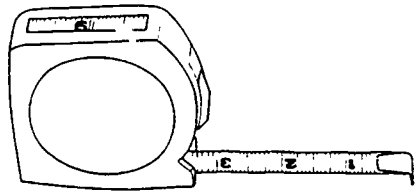
Scale ratios found on architect's scale

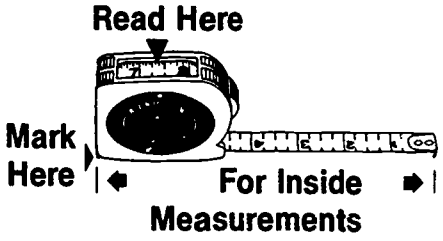
12" = 1'–0" — Full size
6" = 1'–0" — Half size
3" = 1'–0" — 1/4 size
1 1/2" = 1'–0" — 1/8 size
1" = 1'–0" — 1/12 size
3/4" = 1'–0" — 1/16 size
1/2" = 1'–0" — 1/24 size
3/8" = 1'–0" — 1/32 size
1/4" = 1'–0" — 1/48 size
3/16" = 1'–0" — 1/64 size
1/8" = 1'–0" — 1/96 size
3/32" = 1'–0" — 1/128 size

INFORMATION SHEET

XIV. Typical rules and scales

A. Sixteen foot tape





(NOTE: Tapes are normally graduated into 1/16" increments.)

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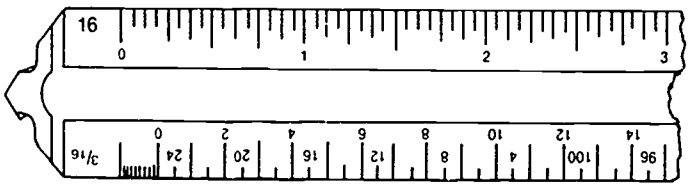

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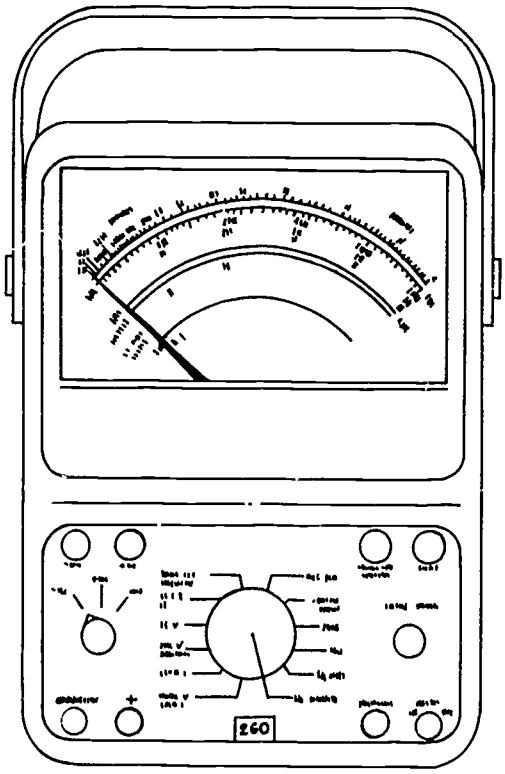
1/2" = 1'–0" — 1/24 size
3/8" = 1'–0" — 1/32 size
1/4" = 1'–0" — 1/48 size
3/16" = 1'–0" — 1/64 size
1/8" = 1'–0" — 1/96 size
3/32" = 1'–0" — 1/128 size

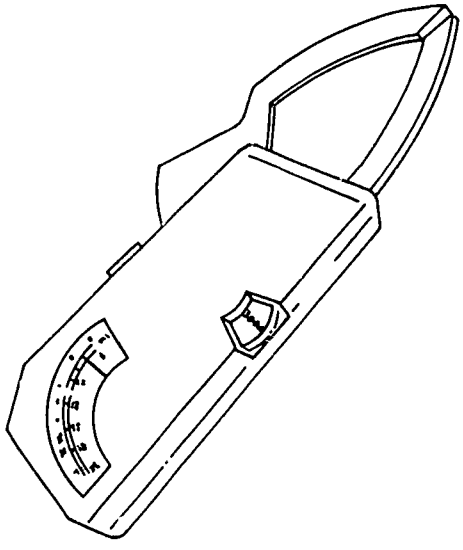
INFORMATION SHEET

B. Permanent magnet moving coil multimeter (VOM) — A VOM is an instrument that is designed to indicate specific quantities of voltage, resistance, or amperage

(NOTE: VOM indicates volt-ohm-meter.)

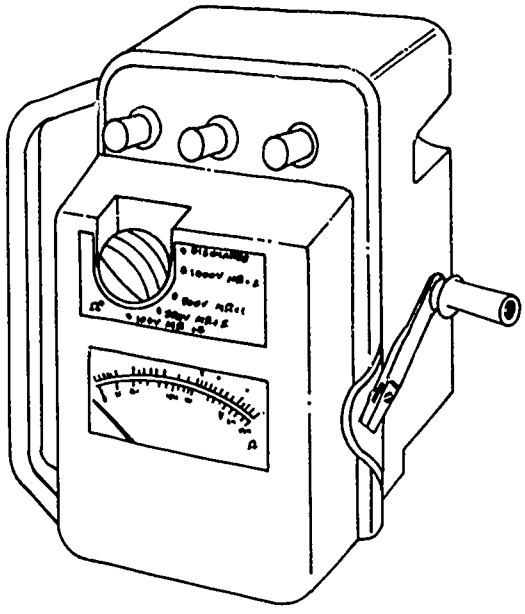


C. Clamp-on ammeter — Designed to clamp around an energized conductor and indicates the value of the current flowing through the conductor; it can measure higher current values than a VOM can.



INFORMATION SHEET

D. Megometer (Megger) — Able to measure resistance of several million ohms. The instrument is typically used to test conductor insulation.



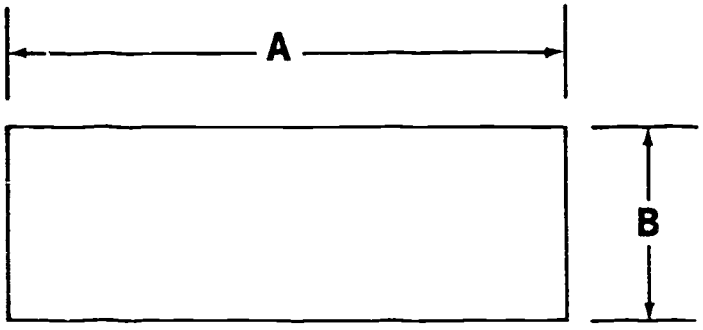
SPECIALTY TOOLS AND EQUIPMENT
UNIT V

ASSIGNMENT SHEET #1 — MEASURE OBJECTS USING A RULE

NAME _____ SCORE _____

Directions: Using a rule with one-sixteenth inch graduations, measure the following objects.

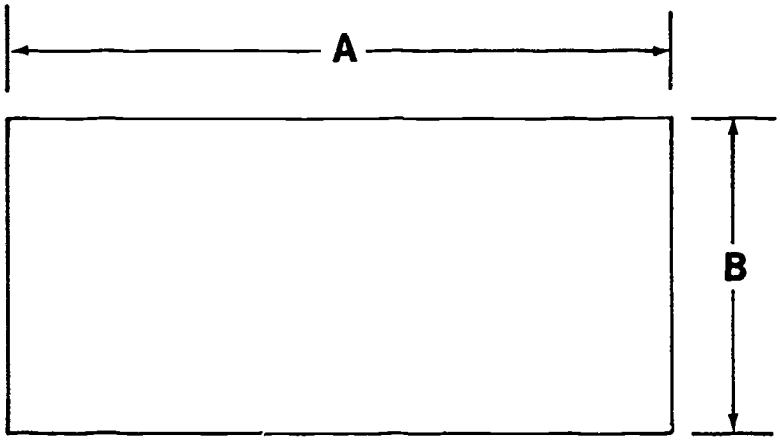
1.



a. Length _____

b. Height _____

2.

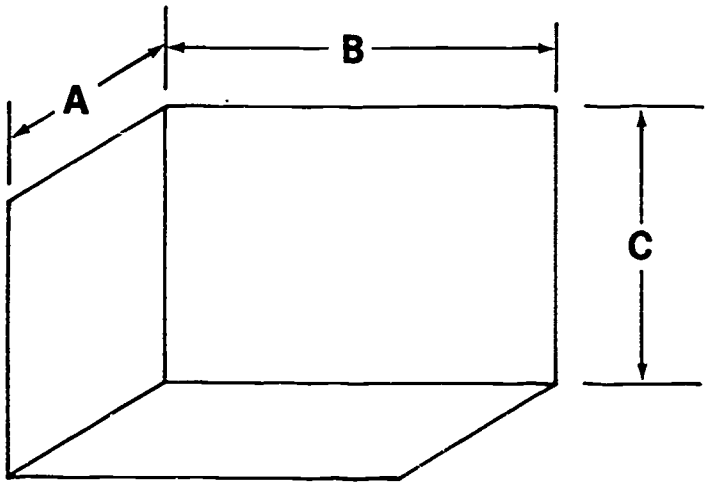


a. Length _____

b. Height _____

ASSIGNMENT SHEET #1

3.

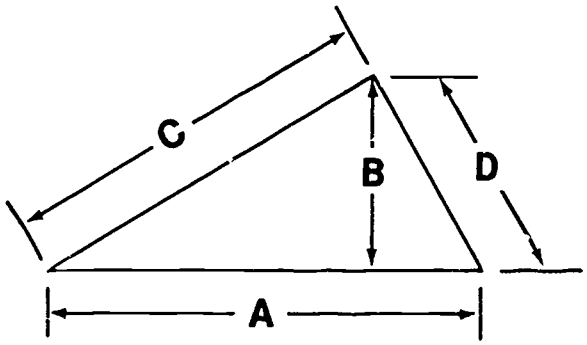


a. Width _____

b. Length _____

c. Height _____

4.



a. Base _____

b. Height _____

c. Slope #1 _____

d. Slope #2 _____

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

ASSIGNMENT SHEET #2 — DETERMINE LENGTHS OF LINES USING AN ARCHITECT'S SCALE

NAME _____ SCORE _____

Directions: Measure the lines A through J to the scale heading each column in the table. Print the scale readings above the lines in the table.

(NOTE: Readings must be accurate or they will be considered wrong.)

3/32 = 1′ A

1/8 = 1′ B

1/4 = 1′ C

3/16 = 1′ D

1/2 = 1′ E

1″ = 1′ F

1 1/2 = 1′ G

3/4 = 1′ H

1/4 = 1′ I

1/8 = 1′ J

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. A. 3″
   B. 1″

2. A. 3 9/16″
   B. 1 3/8″

3. A. 1″
   B. 2 1/8″
   C. 1 7/16″

4. A. 2 3/8″
   B. 1″
   C. 2 1/16″
   D. 1 3/16″

Assignment Sheet #2

A. 65′
B. 38′6″
C. 15′11″
D. 23′6″
E. 10′10 1/2″
F. 3′5″
G. 1′6 1/2″
H. 1′9 1/2″
I. 2′11″
J. 2′

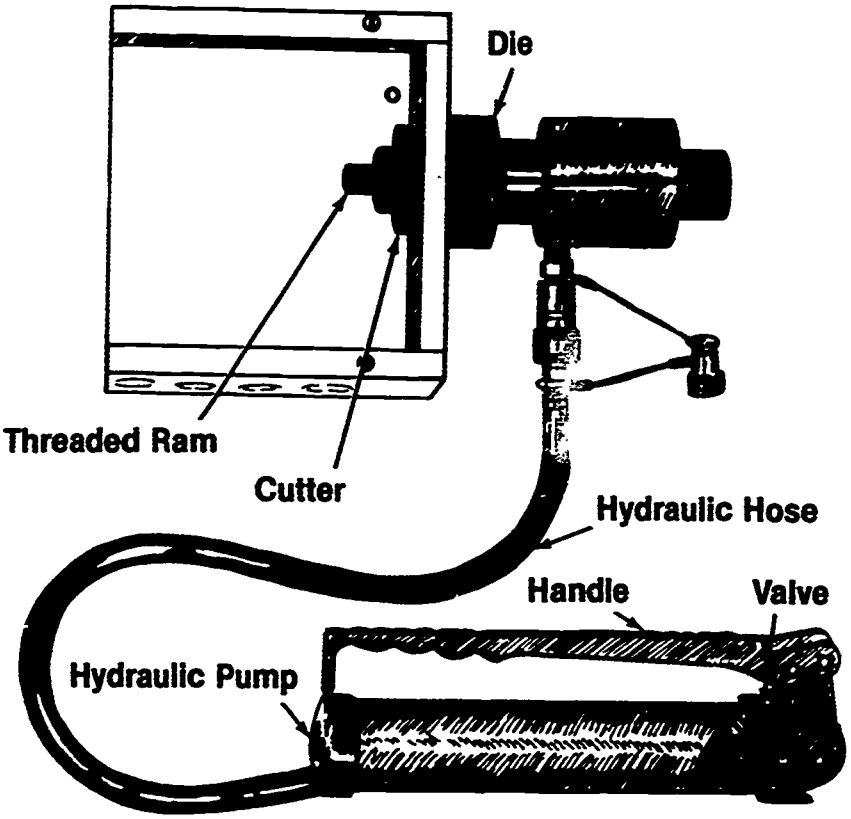
SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #1 — USE A HYDRAULIC KNOCKOUT PUNCH

A. Equipment and materials needed

1. Hydraulic knockout punch with hand pump (Figure 1)

FIGURE 1



2. Instructions for knockout punch
3. Drill motor
4. Metal drill bit

   (NOTE: The drill bit must be large enough to accept the knockout punch bolt.)

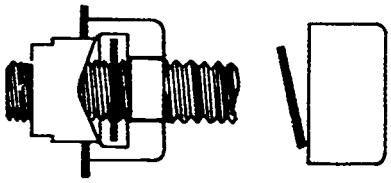
5. Metal to be punched

   (NOTE: Most punches are rated up to 10-gauge metal.)

JOB SHEET #1

11. Open valve and remove cutter from threaded ram; shake out punched metal. (Figure 2)

FIGURE 2



Slug falls free in die **Tip die to remove slug**

12. Replace cutter on ram, making sure that it is properly lubricated.

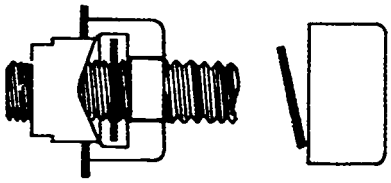
(NOTE: Have the instructor evaluate your work.)

13. Clean work area, and put away equipment and materials.

JOB SHEET #1

11. Open valve and remove cutter from threaded ram; shake out punched metal. (Figure 2)

FIGURE 2



Slug falls free in die **Tip die to remove slug**

12. Replace cutter on ram, making sure that it is properly lubricated.

(NOTE: Have the instructor evaluate your work.)

13. Clean work area, and put away equipment and materials.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #2 — BEND A 90-DEGREE STUB USING A HYDRAULIC PIPE BENDER

A. Equipment and materials needed

1. Hydraulic pipe bender
2. 5 feet of 1-inch rigid galvanized conduit
3. Tape
4. Marking pencil

B. Procedure

(NOTE: The procedure that follows is specifically for a Greenlee #880 bender. Other benders may vary slightly in measurements, but the procedure will be basically the same.)

1. Assemble hydraulic bender using a 1-inch shoe and pipe supports.
2. Check chart on bender for minimum stub length, required deduction for stub, and ram travel measurement. Record data.
   a. Minimum stub length = _____
   b. Stub deduction = _____
   c. Ram travel = _____
3. Mark stub length (24 inches) on pipe.
4. Subtract stub deduction measurement from 24-inch mark, and make a second mark at that point.
5. Place pipe in bender shoe, matching center mark of shoe with second mark on pipe.
6. Close hydraulic pump valve, and pump handle until ram travel gauge indicates amount of travel for a 1-inch pipe with a 90-degree bend.
7. Release hydraulic pump valve, and allow ram to return fully before removing pipe.
8. Check height of stub and accuracy of 90-degree bend.

   (NOTE: Show work to instructor for evaluation.)
9. Disassemble bender, clean work area, and return equipment and materials to their proper places.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #3 — MAKE OFFSET AND 90-DEGREE BENDS USING AN ELECTRIC PVC HEATER

A. Equipment and materials needed

1. 10 feet of ½-inch PVC conduit

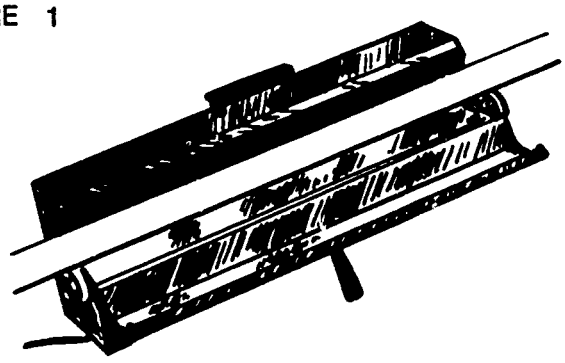
   (NOTE: Check code reference on minimum radius for PVC.)

2. Electric PVC heater
3. Instructions for PVC heater
4. Small pail of water
5. Shop rag or sponge
6. Piece of board at least 1 inch thick and as wide as desired offset
7. Nails to tack up piece of board
8. Eye protection
9. Gloves

B. Procedure — Heat conduit and make a 90-degree bend.

1. Read instructions for PVC heater.
2. Put on eye protection and gloves.
3. Plug in PVC heater and turn on; allow unit to preheat for fifteen minutes in closed position.
4. Open unit and insert PVC as shown in Figure 1.

FIGURE 1

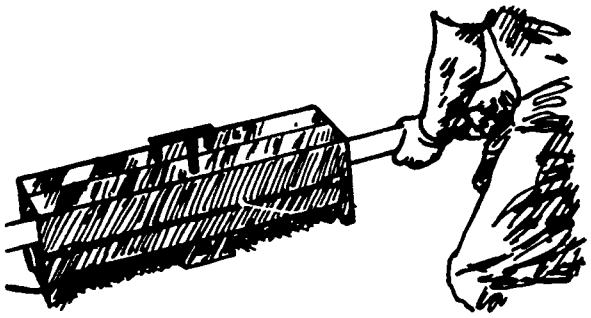


JOB SHEET #3

5. Close unit, and rotate PVC for one to two minutes or until it becomes pliable enough for bending. (Figure 2)

   (NOTE: Constantly turn conduit as it heats.)

   FIGURE 2



6. Remove PVC from heating chamber when it becomes soft and is easily bent.

   (NOTE: Experience will help in determining when PVC is pliable for bending. Make sure that conduit is adequately heated. Larger pieces of conduit tend to kink unless adequately heated.)

   (CAUTION: Conduit will be very hot. Handle it carefully to avoid burns.)

7. Turn off PVC heater.

8. Form the 90-degree bend by hand on a flat surface.

   (NOTE: Another method of forming the 90-degree bend is to push the conduit into a corner of the room, leaving the desired amount of straight conduit on each side of the bend.)

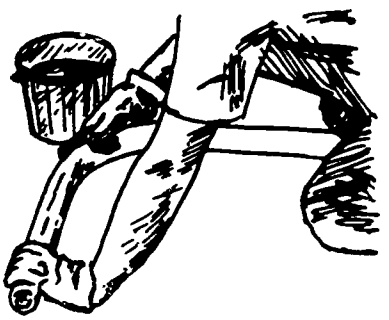
JOB SHEET #3

9. Apply water-soaked rag or sponge to PVC to set the bend (Figure 3)

   (CAUTION: Do not use water next to the electric heater because of shock hazard.)

   (NOTE: If bend is made in the corner of the room, an alternate method of setting the bend is to use straight boards to hold the conduit against the wall until it cools and hardens.)

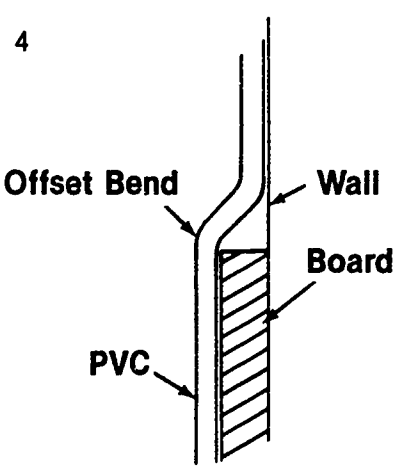
   FIGURE 3



C. Procedure — Heat conduit and make an offset bend.

1. Determine amount of offset desired.
2. Turn on PVC heater and allow it to preheat for fifteen minutes in closed position.
3. Nail prepared piece of board to wall so that PVC may be shaped by placing it against the wall and then bending it away from the wall to lie parallel to outer edge of board as shown in Figure 4.

FIGURE 4



JOB SHEET #3

4. Open PVC heater, and insert PVC.

5. Close unit, and rotate PVC for one to two minutes or until it becomes pliable enough for bending.

6. Remove PVC from heating chamber when it becomes soft and is easily bent.

   (CAUTION: Conduit will be very hot. Handle it carefully to avoid burns.)

7. Turn off PVC heater.

8. Lay conduit against wall and against board as shown in Figure 4, holding the ends against the board and the wall until PVC cools and hardens.

   (NOTE: Show work to instructor for evaluation and comment.)

9. De-energize PVC heater.

10. Clean work area and put away all equipment and materials.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #4 — CUT, REAM, AND THREAD RIGID CONDUIT WITH A POWER THREADER

A. Equipment and materials needed

1. Power threader
2. Stand for power threader
3. Pipe cutter accessory
4. Pipe reamer accessory
5. Adjustable die head accessory
6. Tool carriage accessory
7. Carriage lever accessory
8. Instructions for power threader and accessories
9. Oiler and thread-cutting oil
10. Clean cloth
11. Eye protection
12. Gloves
13. Length of steel pipe

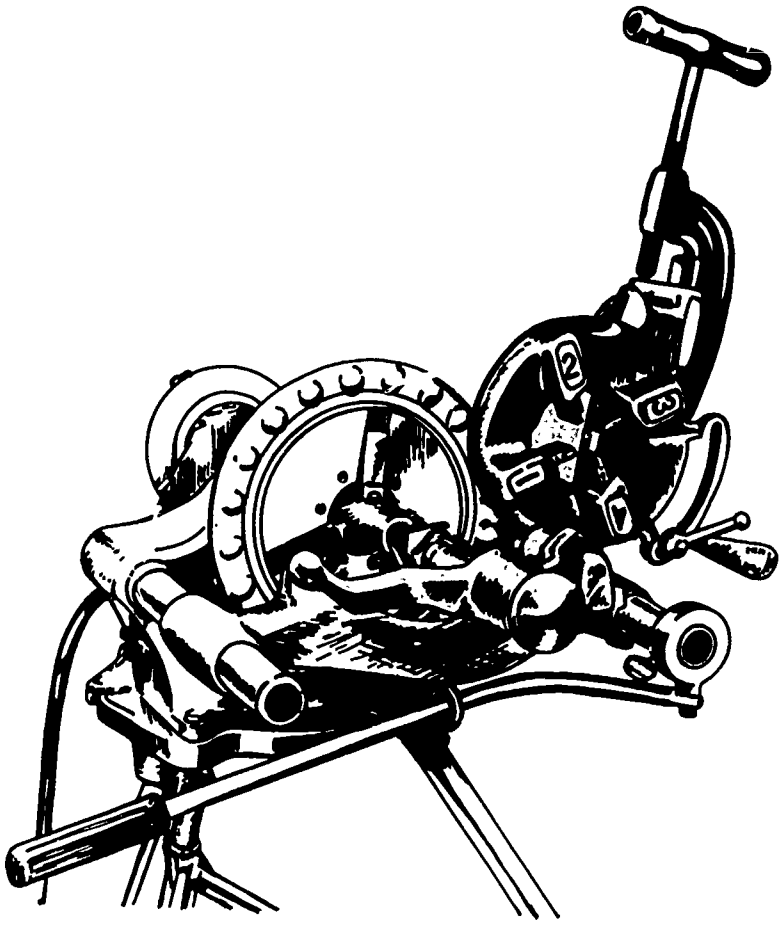
B. Procedure

1. Read instructions for power threader and accessories.
2. Install power threader on stand.

JOB SHEET #4

3. Install pipe cutter, pipe reamer, adjustable die head, tool carriage, and carriage lever on power threader. (Figure 1)

FIGURE 1



4. Put on eye protection and gloves.
5. Insert pipe into power threader, allowing pipe to extend far enough to clear chuck; tighten chuck jaws and rear centering device.
6. Mark pipe at point where cut is to be made.
7. Put tool support bar in position to support cutter handle.
8. Apply cutter to pipe, allowing cutter handle to rest on tool support bar.
9. Tighten cutter blade to contact pipe at marked point.
10. Energize power threader.

JOB SHEET #4

11. Turn power drive switch to FORWARD; turn cutter blade into pipe until pipe cut is completed.

12. Turn off motor, and lay cutter against tool rest.

13. Place reamer in pipe end, allowing reamer handle to rest against tool support bar.

14. Turn on motor.

15. Press reamer into pipe to remove burrs.

16. Turn off motor, and lay reamer against tool rest.

17. Place threader die head on pipe.

18. Cut required number of threads, keeping oil on die stock until threads are cut.

19. Turn off motor.

    (CAUTION: Always allow machine to come to a complete stop before reversing direction.)

20. Turn on motor, turn power drive switch to REVERSE, and remove threader from pipe.

21. De-energize power threader.

    (NOTE: Show threaded pipe to instructor for evaluation and comments.)

22. Dismantle equipment, clean work area, and put away all materials and equipment.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #6 — MEASURE DC VOLTAGES USING A VOM

A. Equipment and materials needed

1. VOM with test leads
2. DC power source (power supply or battery)

B. Procedure

1. Position meter to correct function.

   EXAMPLES: -DC, +DC, or AC

2. Observing polarity, connect meter leads to meter.
3. Determine correct range scale.

   (NOTE: Use highest range if voltage is unknown.)

4. Turn power supply on.
5. Adjust the output to any voltage less than 50 volts.
6. Observing polarity, connect meter leads to circuit to be tested.

   (NOTE: Always hook VOM across the components or power source to be tested. If the indicator needle moves to the left, the lead polarity is wrong.)

7. Record results below:

   a. DC source = _____

   b. Voltage reading = _____

8. Change the source voltage or measure a second battery.

   a. DC source = _____

   b. Voltage reading = _____

   (NOTE: Show your results to your instructor.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #6 — MEASURE DC VOLTAGES USING A VOM

A. Equipment and materials needed

1. VOM with test leads
2. DC power source (power supply or battery)

B. Procedure

1. Position meter to correct function.

   EXAMPLES: -DC, +DC, or AC

2. Observing polarity, connect meter leads to meter.
3. Determine correct range scale.

   (NOTE: Use highest range if voltage is unknown.)

4. Turn power supply on.
5. Adjust the output to any voltage less than 50 volts.
6. Observing polarity, connect meter leads to circuit to be tested.

   (NOTE: Always hook VOM across the components or power source to be tested. If the indicator needle moves to the left, the lead polarity is wrong.)

7. Record results below:

   a. DC source = _____

   b. Voltage reading = _____

8. Change the source voltage or measure a second battery.

   a. DC source = _____

   b. Voltage reading = _____

   (NOTE: Show your results to your instructor.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #7 — MEASURE AC VOLTAGES USING A VOM

PART 1: Single-Phase Power Source

A. Equipment and materials needed

1. VOM with test leads
2. Alternating current power source

   EXAMPLE: Duplex receptacle

B. Procedure

1. Position meter to correct function.

   EXAMPLES: -DC, +DC, or AC

2. Observing polarity, connect meter leads to meter.
3. Determine correct range scale.

   (NOTE: Use highest range if voltage is unknown.)

4. Connect meter leads to circuit to be tested.

   (NOTE: Lead polarity is not important when measuring AC voltages because polarity changes at a rate of 60 cycles per second [USA].)

5. Measure "line voltage" of power receptacle. (See Figure 1)

   (CAUTION: 120 volts can cause injury or death. DO NOT touch the metal parts of the test leads while measuring.)

6. Set meter on lowest scale at which it will register.
7. Record the readings below.

   a. Voltage between slotted jacks _____

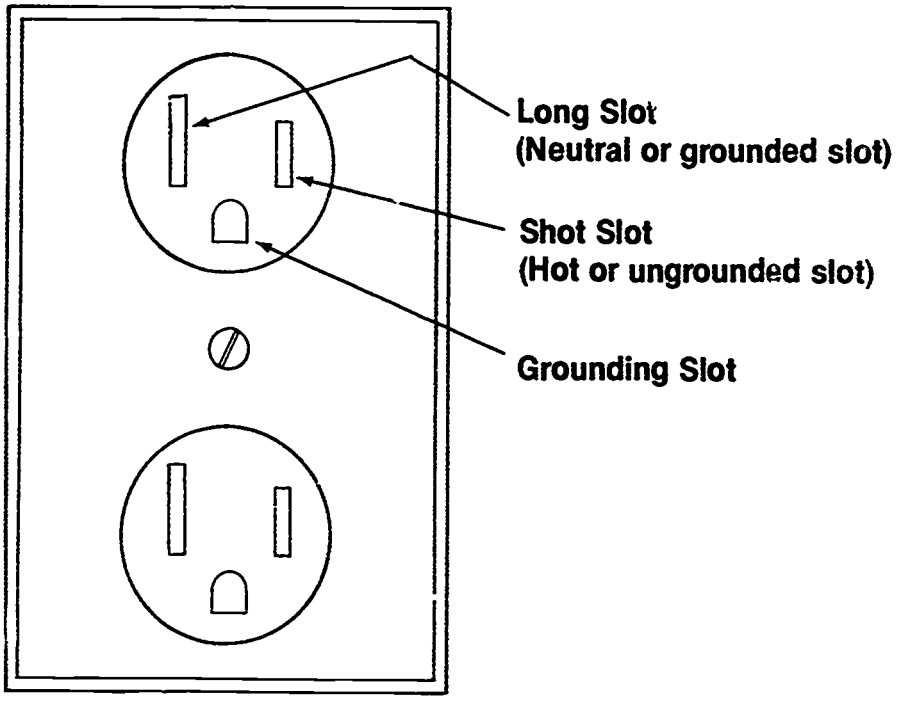
   b. Voltage between short slot and grounding slot _____

   c. Voltage between long slot and ground slot _____

8. Disconnect meter leads.
9. Turn off meter.

JOB SHEET #7

FIGURE 1



PART 2: Three-Phase Power Source

A. Equipment and materials needed

1. VOM with test leads
2. Source of three-phase AC power such as a fused disconnect
3. Safety glasses

B. Procedure

(NOTE: The instructor must supervise each student.)

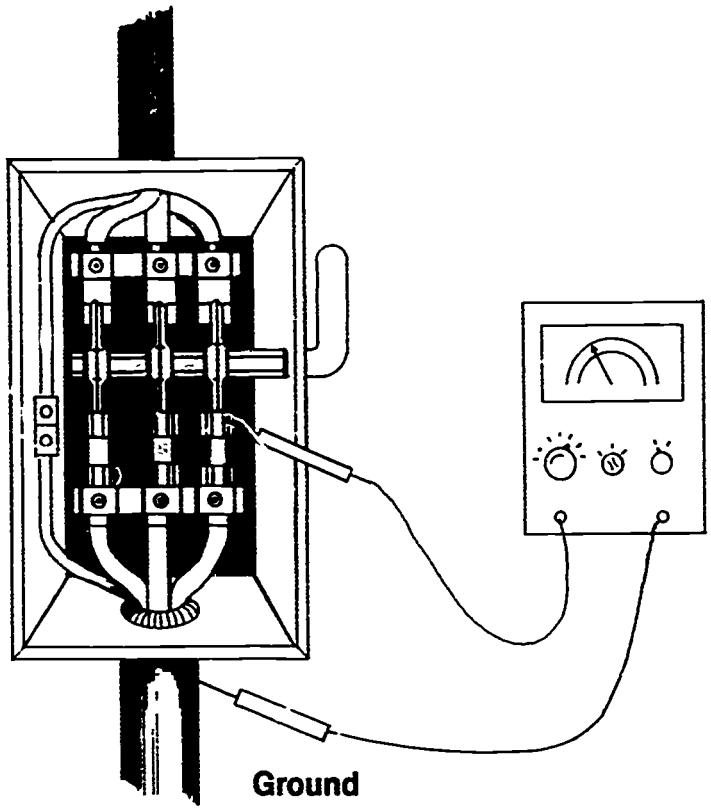
1. Set multimeter for AC voltage measurement.

   (NOTE: Be sure setting is correct.)

2. With instructor watching, *carefully* measure between each of the three terminals at the top of the disconnect and a ground terminal; record your measurements. (Figure 2)

JOB SHEET #7

FIGURE 2



Voltages from terminals to ground

a. _____

b. _____

c. _____

3. Measure between first and second, first and third, and second and third terminals; record the readings below:

Voltages between terminals

a. 1 to 2 _____

b. 1 to 3 _____

c. 2 to 3 _____

(NOTE: Show your measurements to your instructor.)

JOB SHEET #7

4. Disconnect meter leads.
5. Turn off meter.
6. Put equipment and materials away.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #8 — MEASURE AMPERAGE USING A CLAMP-ON AMMETER

A. Equipment and materials needed

1. Clamp-on ammeter
2. Source of three-phase AC power

B. Procedure

1. Position meter to highest scale.
2. Clamp the tongs around the live conductor.

   (CAUTION: Use extreme care when clamping the tongs around the conductor. Remember live circuits can KILL or INJURE you.)

   (NOTE: Place the tongs around only one conductor; failure to do so could result in inaccurate measurements.)
3. Reposition the scale to the lowest readable scale.
4. Record measurements below:

   a. Line 1 _____

   b. Line 2 _____

   c. Line 3 _____
5. Put away equipment and materials.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #9 — DETERMINE THE CURRENT OF A MULTIPLE-LOOP CLAMP-ON AMMETER APPLICATION

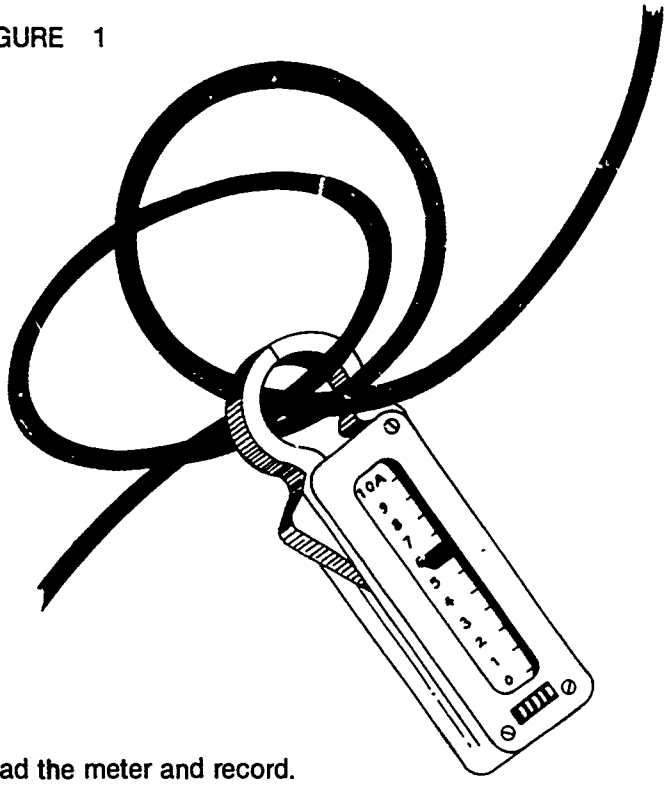
A. Equipment and materials needed

1. Clamp-on ammeter
2. AC power source with a load (see the instructor)

B. Procedure

1. Form three (3) loops in one conductor feeding the load.
2. Tape the loops tightly together.
3. Clamp the tongs through the loops. (Figure 1)

FIGURE 1



4. Read the meter and record.

Initial measurement = _____

JOB SHEET #9

5. Divide reading by the number of loops (three) and record the actual current value.

   Actual current value = _____ _____

   (NOTE: Show your results to the instructor.)

6. Put equipment and materials away.

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

JOB SHEET #10 — CHECK CONDUCTOR INSULATION WITH A MEGGER

A. Equipment and materials needed

1. Megger
2. 20′ run of conduit with 3 #12 THHN conductors (one conductor should have a slight nick in the insulation approximately midway)
3. Pouch tools

B. Procedure

1. Isolate each conductor. Be sure conductor ends do not touch each other or the conduit.
2. Clamp the red lead to the conduit.
3. Clamp the black lead to one of the conductors.
4. Record reading.
5. Repeat steps 3 and 4 with the other two conductors.

   Conductor 1 _____

   Conductor 2 _____

   Conductor 3 _____
6. From your readings, determine which conductor is bad.

   (NOTE: Show your results to the instructor.)
7. Put equipment and materials away.

JOB SHEET #1 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Drilled proper size hole				
	4	3	2	1
Hole in correct location				
	4	3	2	1
Punched metal removed				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

JOB SHEET #1 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Drilled proper size hole				
	4	3	2	1
Hole in correct location				
	4	3	2	1
Punched metal removed				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #2 — BEND A 90-DEGREE STUB USING A HYDRAULIC PIPE BENDER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Assembled bender properly.	_____	_____
4. Checked bender chart.	_____	_____
5. Performed subtraction properly.	_____	_____
6. Bent 1" conduit properly.	_____	_____
7. Replaced bender in case properly.	_____	_____
8. Checked in/put away tools and materials.	_____	_____
9. Cleaned the work area.	_____	_____
10. Used proper tools correctly.	_____	_____
11. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
12. Practiced safety rules throughout procedure.	_____	_____
13. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #2 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
90° bend true				
	4	3	2	1
Pipe not crimped				
	4	3	2	1
Length of stub accurate				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #3 — MAKE OFFSET AND 90-DEGREE BENDS USING AN ELECTRIC PVC HEATER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Put on protective gloves.	_____	_____
4. Bent offset properly.	_____	_____
5. Bent 90° stub properly.	_____	_____
6. Checked in/put away tools and materials.	_____	_____
7. Cleaned the work area.	_____	_____
8. Used proper tools correctly.	_____	_____
9. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
10. Practiced safety rules throughout procedure.	_____	_____
11. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #3 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Offset correct				
	4	3	2	1
Offset not flattened				
	4	3	2	1
90-degree bend correct				
	4	3	2	1
90-degree bend not flattened				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #4 — CUT, REAM, AND THREAD RIGID CONDUIT WITH A POWER THREADER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Put on protective gloves.	_____	_____
4. Cut pipe properly.	_____	_____
5. Reamed pipe properly.	_____	_____
6. Threaded pipe properly.	_____	_____
7. Checked in/put away tools and materials.	_____	_____
8. Cleaned the work area.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____
12. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #4 PRACTICAL TEST

PRODUCT EVALUATION

'EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Threaded to proper length				
	4	3	2	1
Reamed pipe correctly				
	4	3	2	1
Threads true and clean				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #5 — MEASURE RESISTANCE USING A VOLT-OHM-METER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Positioned meter to correct function.	_____	_____
4. Inserted lead properly (polarity).	_____	_____
5. Zero adjusted meter.	_____	_____
6. Read meter correctly (proper scale).	_____	_____
7. Checked in/put away tools and materials.	_____	_____
8. Cleaned the work area.	_____	_____
9. Used proper tools correctly.	_____	_____
10. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
11. Practiced safety rules throughout procedure.	_____	_____
12. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #5 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:	4	3	2	1
Obtained accurate meter readings				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled -- Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #6 — MEASURE DC VOLTAGES USING A VOM

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Set meter correctly for DC measurements.	_____	_____
4. Checked in/put away tools and materials.	_____	_____
5. Cleaned the work area.	_____	_____
6. Used proper tools correctly.	_____	_____
7. Performed steps in a timely manner (__hrs. ___min. ___sec.)	_____	_____
8. Practiced safety rules throughout procedure.	_____	_____
9. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____.

_____

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #7 — MEASURE AC VOLTAGES USING A VOM

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Set meter correctly for AC measurements.	_____	_____
4. Checked in/put away tools and materials.	_____	_____
5. Cleaned the work area.	_____	_____
6. Used proper tools correctly.	_____	_____
7. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
8. Practiced safety rules throughout procedure.	_____	_____
9. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #7 — MEASURE AC VOLTAGES USING A VOM

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Set meter correctly for AC measurements.	_____	_____
4. Checked in/put away tools and materials.	_____	_____
5. Cleaned the work area.	_____	_____
6. Used proper tools correctly.	_____	_____
7. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
8. Practiced safety rules throughout procedure.	_____	_____
9. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #7 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:	4	3	2	1
Obtained correct AC measurements				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #8 — MEASURE ALTERNATING CURRENT USING A CLAMP-ON AMMETER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Chose proper scale.	_____	_____
4. Repositioned to lowest readable scale.	_____	_____
5. Checked in/put away tools and materials.	_____	_____
6. Cleaned the work area.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
9. Practiced safety rules throughout procedure.	_____	_____
10. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #8 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:

	4	3	2	1
Obtained correct readings				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #9 — DETERMINE THE CURRENT OF A MULTIPLE-LOOP CLAMP-ON AMMETER APPLICATION

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Formed proper number of loops.	_____	_____
4. Taped loops.	_____	_____
5. Checked in/put away tools and materials.	_____	_____
6. Cleaned the work area.	_____	_____
7. Used proper tools correctly.	_____	_____
8. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
9. Practiced safety rules throughout procedure.	_____	_____
10. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #9 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:	4	3	2	1
Obtained correct reading				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

PRACTICAL TEST
JOB SHEET #10 — CHECK CONDUCTOR INSULATION WITH A MEGGER

STUDENT'S NAME _____ DATE _____

EVALUATOR'S NAME _____ ATTEMPT NO. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

(EVALUATOR NOTE: Place a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.)

The student:	YES	NO
1. Checked out proper tools and materials.	_____	_____
2. Put on safety glasses.	_____	_____
3. Connected leads correctly.	_____	_____
4. Checked in/put away tools and materials.	_____	_____
5. Cleaned the work area.	_____	_____
6. Used proper tools correctly.	_____	_____
7. Performed steps in a timely manner (___hrs. ___min. ___sec.)	_____	_____
8. Practiced safety rules throughout procedure.	_____	_____
9. Provided satisfactory responses to questions asked.	_____	_____

EVALUATOR'S COMMENTS: _____

_____

JOB SHEET #10 PRACTICAL TEST

PRODUCT EVALUATION

(EVALUATOR NOTE: Rate the student on the following criteria by circling the appropriate numbers. Each item must be rated at least a "3" for mastery to be demonstrated. (See performance evaluation key below.) If the student is unable to demonstrate mastery, student materials should be reviewed and another product must be submitted for evaluation.)

Criteria:	4	3	2	1
Recorded readings correctly	4	3	2	1
Determined bad conductor correctly				

EVALUATOR'S COMMENTS: _____

_____

PERFORMANCE EVALUATION KEY
4 — Skilled — Can perform job with no additional training. 3 — Moderately skilled — Has performed job during training program; limited additional training may be required. 2 — Limited skill — Has performed job during training program; additional training is required to develop skill. 1 — Unskilled — Is familiar with process, but is unable to perform job.

(EVALUATOR NOTE: If an average score is needed to coincide with a competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria.)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

TEST

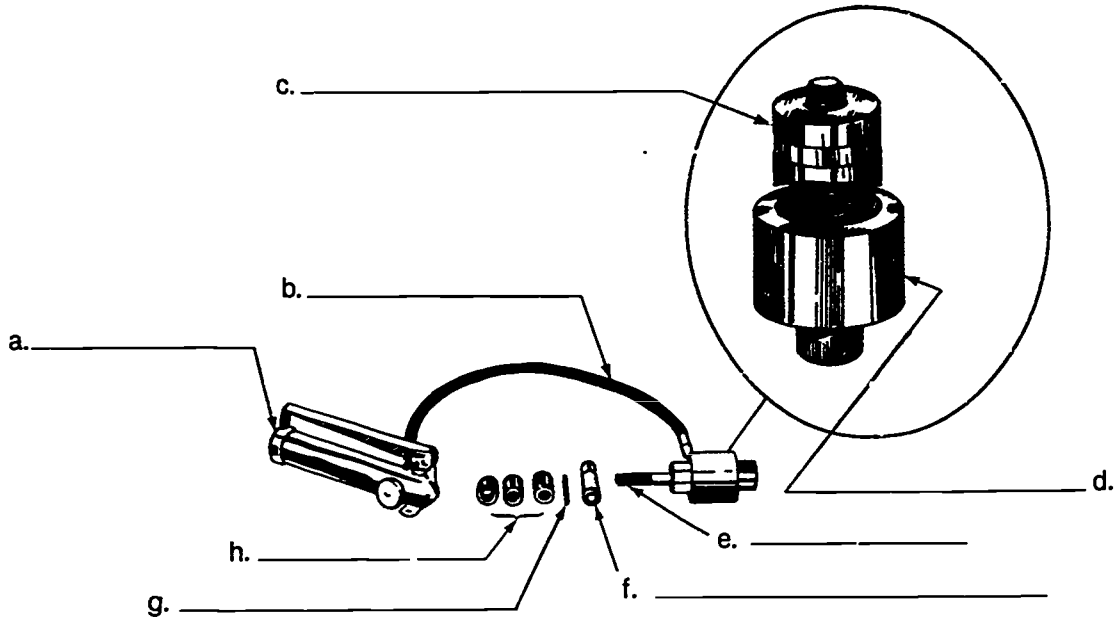
NAME _____ SCORE _____

1. Match the terms on the right with their correct definitions.

_____a.	Electromotive force (emf), force that drives electricity through conductors; must be measured across or referenced to a second point.	1. Accuracy
_____b.	Opposition to electrical current flow; measured in units of ohms; must be measured from one point to another	2. Amperage
_____c.	Device used to transfer hydraulic pressure to a mechanical device	3. Bender
_____d.	How well an instrument will indicate a small change in the measured value	4. Calibration
_____e.	Instrument consistency	5. Chuck
_____f.	Instrument capable of measuring a "multiple" of values	6. Cross handle
_____g.	Any opening that may close and bind a finger or hand	7. Cutter
_____h.	Electrical point or any good conductor that is connected to a common chassis with zero relative voltage; usually conductors are connected to the earth	8. Die
_____i.	Plastic pipe	9. Error
_____j.	Device used to make openings for conduit in metal enclosures	10. Ground
_____k.	Component that backs up cutter on opposite side of metal box	11. Hydraulic
_____l.	How far the measurement is from the actual value	12. Hydraulic oil
_____m.	Portion of drill that holds the bit	13. Knockout punch
_____n.	Tool used to make various angles or bends in conduit	14. Multimeter
		15. Parallax correction
		16. Pinch point
		17. Polyvinyl chloride (PVC)
		18. Precision
		19. Ram (PVC)
		20. Resistance
		21. Resolution
		22. Voltage

TEST

4. Label the parts of the hydraulic knockout set illustrated below.



5. Complete the following statements concerning specific safety rules for using hydraulic knockout sets by inserting the word(s) that best complete each statement.

   a. Never substitute brake fluid for _____ _____ .

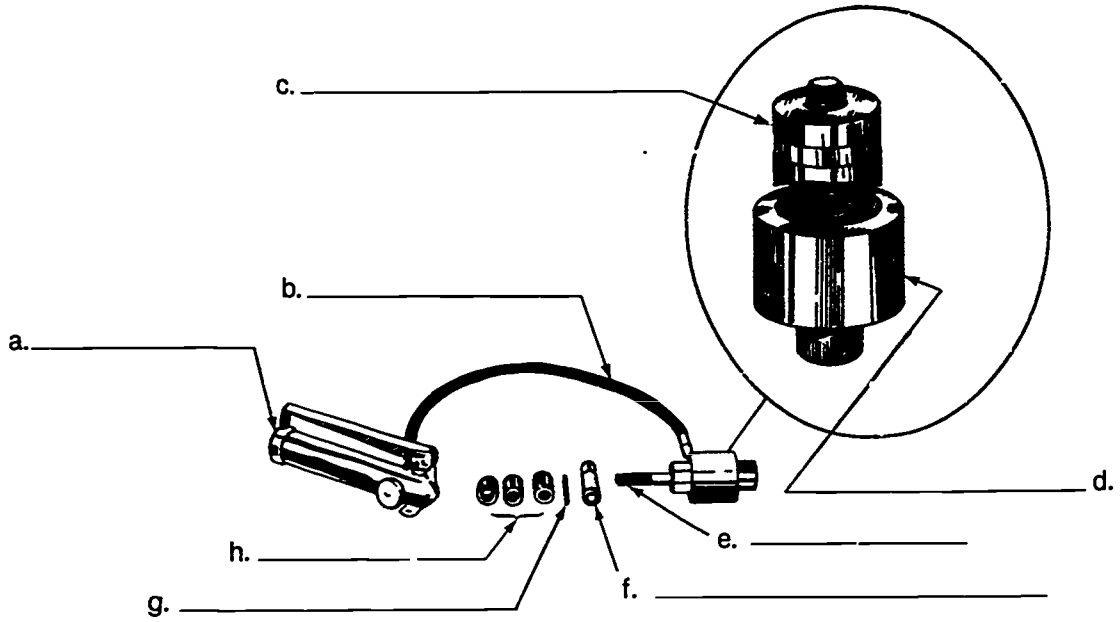
   b. Never disconnect hose when it is _____ _____ .

   c. Do not use near _____ electrical parts.

   d. Never _____ pump handle.

TEST

4. Label the parts of the hydraulic knockout set illustrated below.



5. Complete the following statements concerning specific safety rules for using hydraulic knockout sets by inserting the word(s) that best complete each statement.

   a. Never substitute brake fluid for _____ _____ .

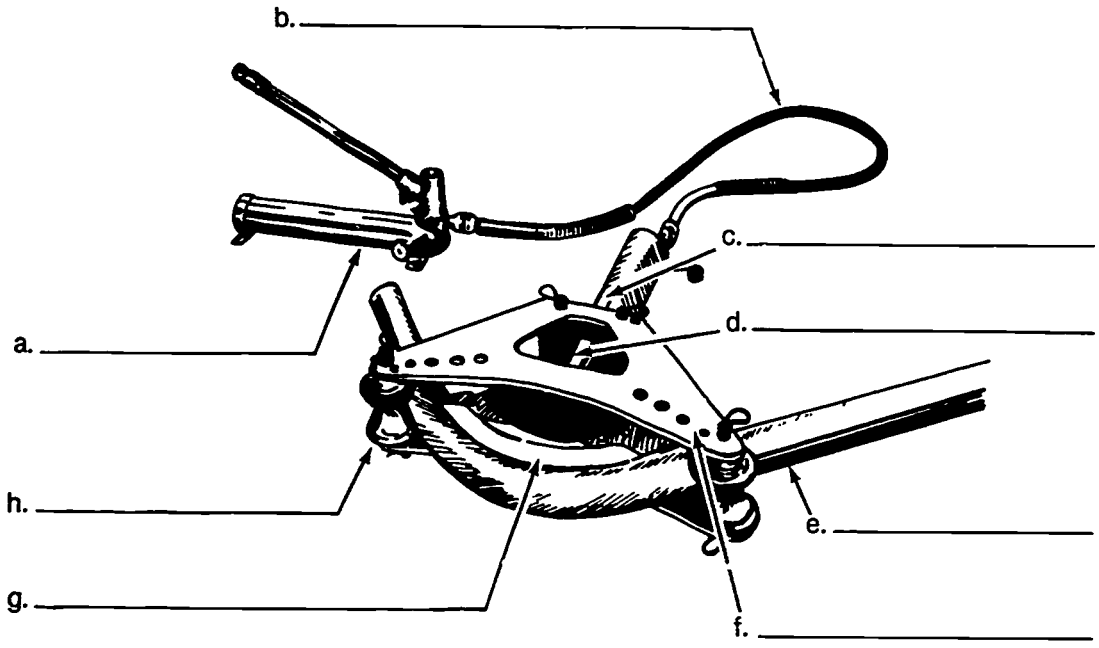
   b. Never disconnect hose when it is _____ _____ .

   c. Do not use near _____ electrical parts.

   d. Never _____ pump handle.

TEST

6. Label the parts of the hydraulic pipe bender illustrated below.



7. Select true statements concerning specific safety rules for using hydraulic pipe benders by placing an "X" in the blanks preceding the true statements.

_____a. Substitute brake fluid for hydraulic oil.

_____b. Never disconnect hose when it is under pressure.

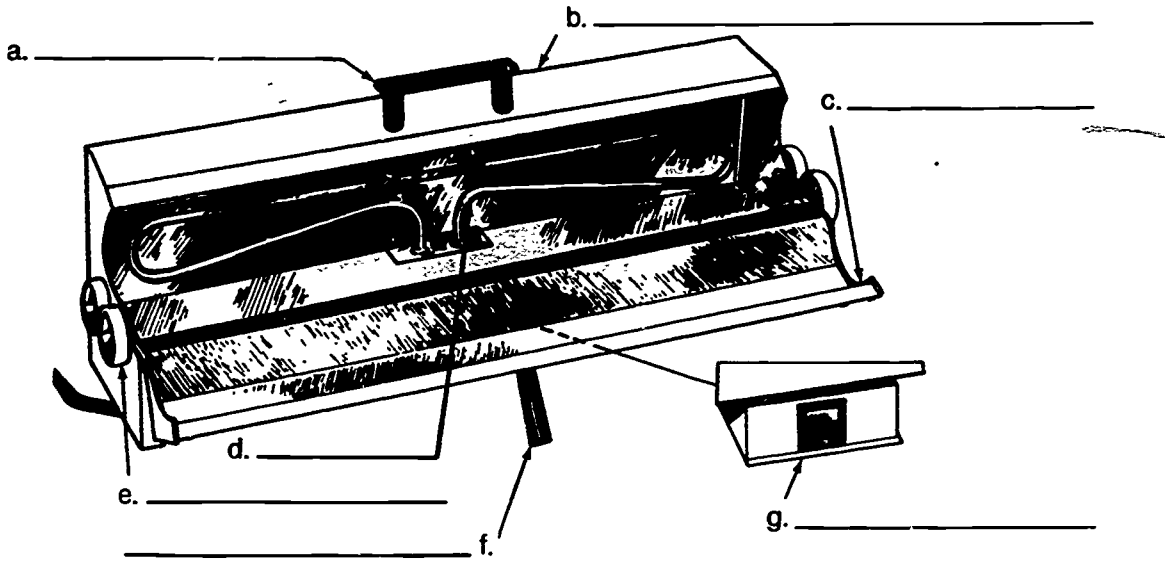
_____c. Never place hands near ram or shoe while bending.

_____d. Always use proper side of conduit shoe and support.

_____e. Be sure that floor area is clear for pipe movement.

TEST

8. Label the parts of a polyvinyl chloride (PVC) heater illustrated below.



9. Complete the following statements concerning specific safety rules for using electric polyvinyl chloride (PVC) heaters by circling the word that best completes each statement.

   a. Never use in (**dry, wet**) locations.

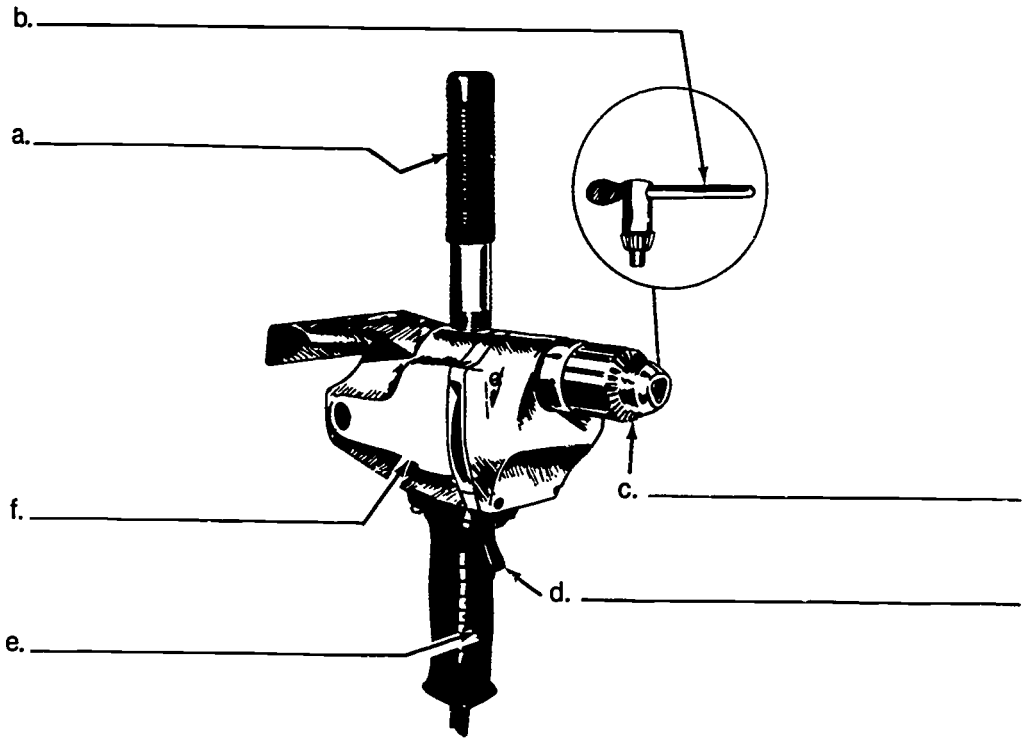
   b. Always wear (**safety glasses, gloves**) when handling hot heater or pipe.

   c. Use only with (**PVC, EMT**) conduit.

   d. (**Always, Occasionally**) turn bender off when not in use.

TEST

10. Label the parts of the power drill illustrated below.



11. Select true statements concerning specific safety rules for using power drills by placing an "X" in the blanks preceding the true statements.

_____a. Always wear gloves.

_____b. Check area to be drilled for hidden wires or pipes.

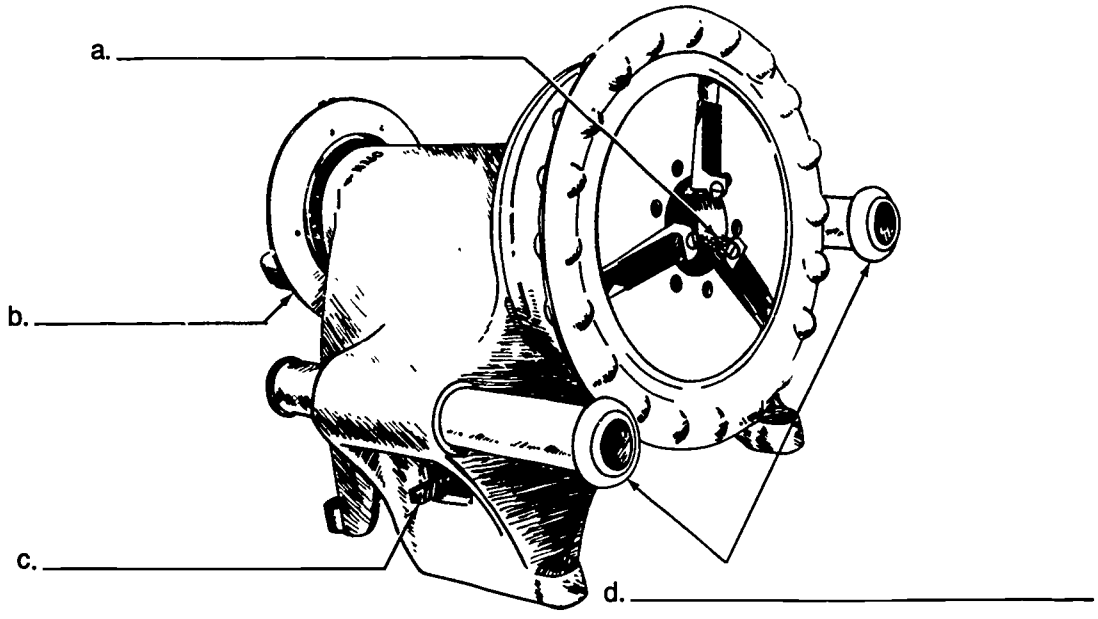
_____c. Hold drill securely with one hand.

_____d. Never drill while off balance.

_____e. Place all objects to be drilled in a vise.

TEST

12. Label the parts of the power threader illustrated below.



13. Complete the following statements concerning specific safety rules for using power threaders by inserting the word(s) which best complete each statement.

    a. Always wear _____.

    b. Always wear _____ clothing.

    c. Use _____ when handling pipe.

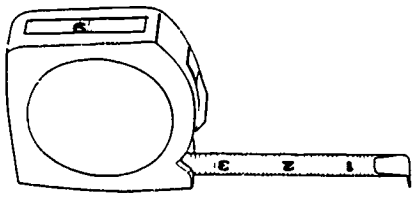
    d. Never place _____ near turning pipe.

    e. Let threader come to a complete stop before removing pipe or _____.

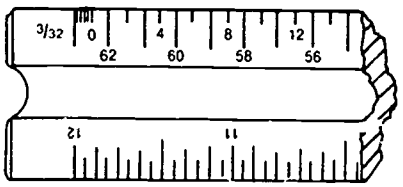
    f. Always use a _____ to clear thread cuttings.

TEST

14. Identify the typical rules and scales illustrated below.

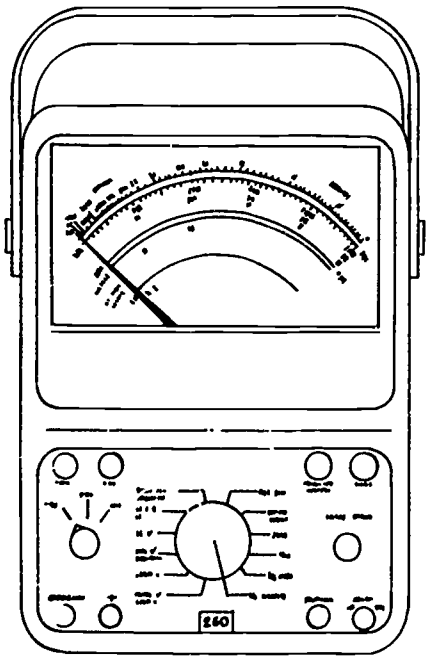


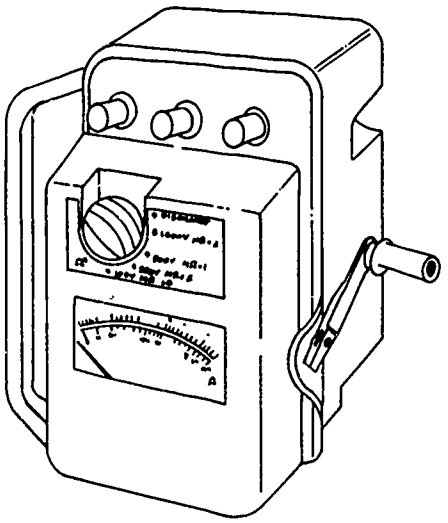
a. _____



b. _____

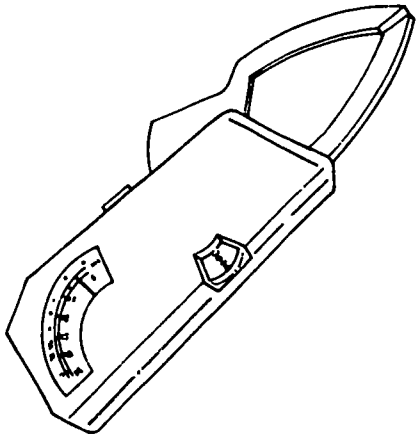
15. Identify the typical test equipment illustrated below.

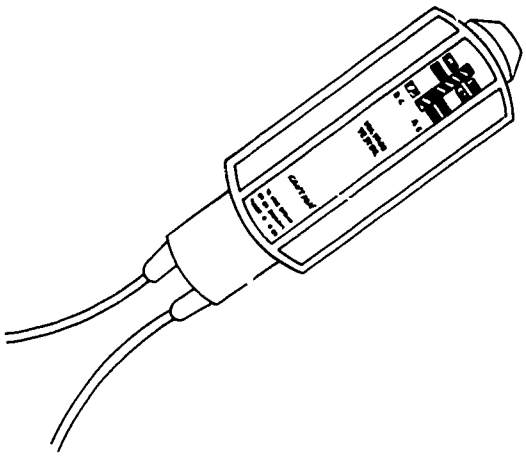




a. _____ b. _____

TEST





c. _____ d. _____

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

16. Measure objects using a rule. (Assignment Sheet #1)

17. Determine lengths of lines using an architect's scale. (Assignment Sheet #2)

18. Demonstrate the ability to:

    a. Use a hydraulic knockout punch. (Job Sheet #1)

    b. Bend a 90-degree stub using a hydraulic pipe bender. (Job Sheet #2)

    c. Make offset and 90-degree bends using an electric PVC heater. (Job Sheet #3)

    d. Cut, ream, and thread rigid conduit with a power threader. (Job Sheet #4)

    e. Measure resistance using a VOM. (Job Sheet #5)

    f. Measure DC voltages using a VOM. (Job Sheet #6)

    g. Measure AC voltages using a VOM. (Job Sheet #7)

    h. Measure amperage using a clamp-on ammeter. (Job Sheet #8)

    i. Determine the current of a multiple-loop clamp-on ammeter application. (Job Sheet #9)

    j. Check conductor insulation with a megger. (Job Sheet #10)

SPECIALTY TOOLS AND EQUIPMENT
UNIT V

ANSWERS TO TEST

1.

a.	22	f.	14	k.	8	p.	1	u.	12
b.	20	g.	16	l.	9	q.	6	v.	15
c.	19	h.	10	m.	5	r.	7		
d.	21	i.	17	n.	3	s.	4		
e.	18	j.	13	o.	2	t.	11		

2.
a. Hydraulic knockout
b. Hydraulic bender
c. Electric PVC heater
d. Power drill
e. Power threader

3. b, c, d, e

4.
a. Hydraulic pump
b. Hydraulic hose
c. Knockout cutter
d. Die
e. Hydraulic threaded ram
f. Screw sleeve
g. 1/2-inch knockout adapter
h. Spacers

5.
a. Hydraulic oil
b. Under pressure
c. Live
d. Force

6.
a. Hydraulic pump
b. Hydraulic hose
c. Ram travel gauge
d. Hydraulic ram
e. Pipe
f. Bender frame
g. Bender shoe
h. Pipe support

7. b, c, d, e

8.
a. Carrying handle
b. Heater outer case
c. Door
d. Heating element
e. Pipe rollers
f. Insulated door handle
g. On/off switch

ANSWERS TO TEST

9. a. Wet
   b. Gloves
   c. PVC
   d. Always

10. a. Cross handle
    b. Chuck key
    c. Chuck
    d. Power trigger
    e. Reverse/forward switch
    f. Drill motor

11. b, d

12. a. Front pipe chuck
    b. Rear pipe chuck
    c. Forward/reverse/off switch
    d. Tool support bars

13. a. Eye protection
    b. Tight-fitting
    c. Gloves
    d. Hands
    e. Reversing direction
    f. Brush

14. a. Sixteen foot tape
    b. Architect's scale

15. a. Voltage tester
    b. Multimeter (VOM)
    c. Clamp-on ammeter
    d. Megometer (megger)

16.-17. Evaluated to the satisfaction of the instructor

18. Performance skills evaluated to the satisfaction of the instructor.

OBJECTIVE SHEET

11. Locate allowable ampacities for various conductors using the NEC as a reference. (Assignment Sheet #4)

12. Interpret conduit fill tables using the NEC as a reference. (Assignment Sheet #5)

13. Find information in the NEC. (Assignment Sheet #6)

USING TRADE INFORMATION
UNIT VI

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Provide students with objective sheet.

C. Discuss unit and specific objectives.

D. Provide students with information and assignment sheets.

E. Discuss information and assignment sheets.

F. Integrate the following activities throughout the teaching of this unit:

1. Provide students with a copy of the National Electrical Code and stress its importance.

2. Prepare activity sheets covering service drop clearance, sizing grounded conductors, and working clearances for use as a group activity in finding and interpreting the appropriate codes.

   (NOTE: A good source for activities is *Illustrated Changes of the 1987 NEC* by James G. Stallcup. See reference list.)

3. Invite a local inspector to speak to the class.

4. Provide students with copies of local codes.

5. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas of improvement.

G. Give test.

H. Evaluate test.

I. Reteach if necessary.

REFERENCES USED IN WRITING THIS UNIT

A. *National Electrical Code, 1987.* Quincy, MA: National Fire Protection Association, 1986.

B. Stallcup, James G. *Illustrated Changes of the 1987 NEC.* Homewood, IL: American Technical Publishers, Inc., 1986.

C. Taylor, Mark. *Residential Wiring.* Stillwater, OK: Mid-America Vocational Curriculum Consortium. 83.

D. Teague, Cash and Garner Pewewardy. *Industrial Electricity: In-Plant Distribution.* Stillwater, OK: Oklahoma Curriculum and Instructional Materials Center, 1984.

SUGGESTED SUPPLEMENTAL MATERIAL

Text — Schram, Peter J. *The National Electrical Code Handbook, 1987.* Quincy, MA: National Fire Protection Association, 1986.

USING TRADE INFORMATION
UNIT VI

INFORMATION SHEET

I. **Terms and definitions**

A. American National Standards Institute (ANSI) — Develops standards for electrical equipment and supplies

B. American Standard Association (ASA) — Develops standards for electrical machinery and equipment

C. Bonding — Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed

D. Bonding jumpers — Pieces of wire or other conductors that connect different metal parts

E. Bonding jumper circuit — Connections between portions of a conductor in a circuit to maintain required ampacity of the circuit

F. Bonding jumper equipment — Connections between two or more portions of the equipment grounding conductors

G. Building code — Standards developed to provide for safe building construction practices

H. Grounded — Connected to earth or to some conducting body that serves in place of the earth

I. Grounded conductor — Intentionally grounded system or circuit conductor (neutral)

J. Grounding conductor — Conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes

K. Grounding electrode conductor — Conductor used to connect the grounding electrode to the equipment grounding conductor or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system

L. Jurisdiction — Power, right, or authority to interpret the law (code)

M. Mandatory enforcement — Governmental authority to demand compliance with the National Electrical Code requirements for electrical installations

N. National Electrical Code (NEC) — Book containing electrical specifications endorsed by NFPA and ANSI; used for legal and regulatory purposes in the interest of life and property protection

INFORMATION SHEET

O. National Electrical Manufacturers Association (NEMA) — Develops electrical equipment standards

P. National Fire Protection Association (NFPA) — Develops and publishes fire and industrial safety standards

Q. Underwriters Laboratories (UL) — Test equipment and list items for use in specified situation

(NOTE: There are other approved testing labs.)

II. **Purpose of the National Electrical Code** — Sets minimum standards for safeguarding persons and property from hazards arising from the use of electricity

III. **Factors that are not covered by the NEC**

A. Efficiency

B. Convenience

C. Good service

IV. **Intent of the National Electrical Code regarding mandatory enforcement** — The code is intended to be suitable for mandatory enforcement by the governmental authority having jurisdiction. Mandatory rules are characterized by the word "SHALL"

(NOTE: The legal inspector may grant exceptions [special permission] to code requirements, provided safety standards are maintained. States and municipalities may adopt their own electrical codes as long as these codes improve upon, not lessen the requirements of the NEC.)

V. **NEC chapter numbers and their areas of application**

A. Chapters 1 through 4 — General application, may be modified in later chapters

B. Chapter 5 — Hazardous locations

C. Chapter 6 — Special equipment

D. Chapter 7 — Special conditions

E. Chapter 8 — Communications systems

F. Chapter 9 — Tables and examples

INFORMATION SHEET

VI. Sequence of organizational components of NEC information

A. **Chapter** — Covers broad area of code

EXAMPLE:: Chapter — Wiring Design and Protection

B. **Article** — Covers a specific part of the chapter

EXAMPLE: Article 210 — Branch circuits

C. **Parts** — Covers a specific item of the article

EXAMPLE: Part B — Branch circuit ratings

D. **Numbered paragraphs** — Cover a specific item of the part

EXAMPLE: Paragraph 19 — Conductors — Minimum ampacity and size

E. **Numbered (1) or lower case lettered (a) subparagraphs**

EXAMPLE: Subparagraph [b] — Household ranges and cooking appliances

VII. Steps for finding information in the NEC

(NOTE: The examples following the steps concern the proper method of grounding a service entrance panel.)

A. Refer to index for appropriate area of code.

EXAMPLE: Service entrance equipment

B. Locate specified area in question.

EXAMPLE: Grounding of services

C. Turn to article and section as designated

EXAMPLE: Service equipment — grounding — 230-63
Multiple circuit connections — 250-62

D. Read all related areas and exceptions.

INFORMATION SHEET

E. Cross-reference if code refers to another article.

EXAMPLE: Service-entrance eqiupment (Disconnecting means and over-current protection)

Definition, Art. 100
Disconnecting means, 230-H
- Approved type, 230-70
- Connections ahead of, 230-82
- Connections to terminals, 230-81
- Disconnection of grounded conductor, 230-75
- Electrically operated, 230-94, Ex. 6
- Externally operable, 230-78
- Ground-fault, protection at, 230-95
- Indicating, 230-77
- Location, 230-72(c), (d)
- Multiple occupancy buildings, 230-72(d)
- Over 600V, 230-205, 230-206
- Rating, 230-79
- Safeguard, emergency supply, 230-83
- Simultaneous openings, 230-74
- Six switch rule, 230-71
- Two or more buildings, single management, 230-84

Grounding, bonding, guarding, 230-G, 230-63, 250-62
Overcurrent protection, 230-J
- Location, 230-91, 230-92
- Over 600V, 230-208
- Relative location, 230-94
- Specific circuits, 230-93
- Two or more buildings, single management, 230-90(c)
- Undergrounded conductors, 230-90(a)

Panelboards, as, 384-F

(NOTE: It is imperative that all cross references be found and read, otherwise the improper answer may be used.)

USING TRADE INFORMATION
UNIT VI

ASSIGNMENT SHEET #1 — USE THE *NATIONAL ELECTRICAL CODE* (NEC) INDEX

NAME _____ SCORE _____

The electrician must be able to use the *Code* in order to answer questions on proper wiring procedures.

Directions: Use the *National Electrical Code* index to answer the following questions. Write the correct answers in the blanks.

A. What article covers aircraft hangers?

Article _____

B. What section covers bonding jumpers?

Code section _____

C. What section covers boxes over 600 volts?

Code section _____

D. What section covers support of busways?

Code section _____

E. What section covers light fixtures in clothes closets?

Code section _____

F. What section covers the clearances of recessed lighting fixtures?

Code section _____

G. What section covers overload protection in panelboards?

Code section _____

H. What section covers appliance accessibility in recreational vehicles?

Code section _____

I. What section covers construction specifications for rheostats?

Code section _____

J. What sections cover guarding and grounding on x-ray equipment?

Code sections _____ and _____

USING TRADE INFORMATION
UNIT VI

ASSIGNMENT SHEET #2 — USE THE *NATIONAL ELECTRICAL CODE* (NEC) INTRODUCTION AND FIRST CHAPTER

NAME _____ SCORE _____

Directions: Find the following information using the *National Electrical Code* table of contents, introduction, and first chapter. Indicate the code section number(s) that apply to each statement.

A. The purpose of this code is the practical _____ of persons and property from hazards arising from the use of electricity.

Code section _____

B. Tables and examples are found in _____ _____

C. Define the following terms. *Code* section _____

1. Ampacity — _____

_____

_____

2. Branch circuit — _____

_____

_____

3. Outlet — _____

_____

_____

4. Service cable — _____

_____

_____

5. Bonding — _____

_____

_____

ASSIGNMENT SHEET #2

6. Covered conductor — _____

_____

_____

7. Receptacle — _____

_____

_____

8. Service drop — _____

_____

_____

9. Device — _____

_____

_____

10. Disconnecting means — _____

_____

_____

11. Equipment — _____

_____

_____

12. Overload — _____

_____

_____

13. Service lateral — _____

_____

_____

ASSIGNMENT SHEET #2

14. Thermally protected — _____

_____

_____

15. Weatherproof — _____

_____

_____

16. Ventilated — _____

_____

_____

17. Thermal cutout — _____

_____

_____

18. Service raceway — _____

_____

_____

19. Readily accessible — _____

_____

_____

20. Enclosed — _____

_____

_____

USING TRADE INFORMATION
UNIT VI

ASSIGNMENT SHEET #3 — ANSWER QUESTIONS RELATED TO RESIDENTIAL WIRING PRACTICES USING THE NEC AS A REFERENCE

NAME _____ SCORE _____

Directions: Give article number and answer to questions.

(NOTE: The problem solving steps listed below are taken from Objective VII on the Information Sheet.)

EXAMPLE: Are ground-fault circuit interrupters required on 125 volt single phase 20 amp temporary construction receptacles

Step 1: Refer to index: "Ground-Fault Interrupters" is located and "Construction Sites" is listed.

Step 2: Note listing of article.

Step 3: Turn to table of contents and locate article number.

Step 4: Read across to page number.

Step 5: Find the page number for the article on branch circuits; turn to it.

Step 6: Find section number by turning pages in article.

Answer: From the article on branch circuits, 20 amp receptacles on temporary poles do require ground-fault circuit interrupters.

Problems

1. Do boxes made of metal need to be corrosion resistant?

   Answer:

2. What is the definition of "ampacity"?

   Answer:

3. Can a branch circuit used for lighting purposes and rated at 20 amps have a 12 amp dishwasher or other fixed appliance connected to it?

   Answer:

USING TRADE INFORMATION
UNIT VI

ASSIGNMENT SHEET #5 — INTERPRET CONDUIT FILL TABLES USING THE NEC AS A REFERENCE

NAME _____ SCORE _____

Directions: List the maximum number of conductors allowed in the following conduits.

1/2" conduit

1. 14 THHN _____
2. 10 THWN _____
3. 6 TW _____

3/4" conduit

4. 10 THWN _____
5. 4 THWN _____

1" conduit

6. 6 TW _____
7. 3 TW _____
8. 6 THWN _____

2" conduit

9. 4/0 THWN _____
10. 4/0 TW _____

USING TRADE INFORMATION
UNIT VI

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5. 4 THWN _____

1" conduit

6. 6 TW _____
7. 3 TW _____
8. 6 THWN _____

2" conduit

9. 4/0 THWN _____
10. 4/0 TW _____

USING TRADE INFORMATION
UNIT VI

ASSIGNMENT SHEET #6 — FIND INFORMATION IN THE NEC

NAME _____ SCORE _____

PART I

Directions: Use the *National Electrical Code*, Article 250, to find the following information. Write the correct answers in the appropriate blanks.

A. Article 250-1 covers general and specific requirements for grounding and bonding of electrical installation.

List the six specific requirements detailed in the *Code*.

Article part _____ *Code* section _____

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

B. Portable generators (in some instances) are not required to be grounded to earth.

Article part _____ *Code* section _____

True _____ False _____

ASSIGNMENT SHEET #6

C. In grounding separately derived AC systems, "the grounding electrode shall be as near as practicable to and preferably in the same area as the grounding conductor connection to the system."

Article part _____ _____ *Code* section _____

True _____ False _____

D. "Bonding shall be _____ where necessary to assure electrical continuity and the capacity to conduct safely any _____ _____ likely to be imposed."

Article part _____ *Code* section _____

E. "The metal covering of service cable having an _____ grounded service conductor in continuous electrical contact with its metallic armor or tape shall be considered to be grounded."

Article part _____ *Code* section _____

F. "An equipment bonding _____ shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded box." How many exceptions are there? _____

Article part _____ *Code* section _____

G. "Main and equipment bonding jumpers shall be of _____ or other corrosion-resistant material."

Article part _____ *Code* section _____

H. "The size of copper, aluminum, or copper-clad aluminum equipment grounding conductors shall not be less than given in Table 250-95." Give the sizes of copper equipment grounding conductors for 100-ampere, 200-ampere, and 400-ampere circuits.

Article part _____ *Code* section _____

100 A = _____

200 A = _____

400 A = _____

I. "_____ or _____ of instrument transformers shall be grounded where accessible to other than qualified persons."

Article part _____ *Code* section _____

ASSIGNMENT SHEET #6

J. In making grounding conductor connections, "required grounding conductors and bonding jumpers shall be connected by pressure connectors, clamps, or other approved means. Connection devices or fittings that depend on solder shall _____ be used."

Article part _____ *Code* section _____

PART II

Directions: Use the *National Electrical Code*, Articles 336 through 364, to find the following information. Write the correct answers in the appropriate blanks.

A. Type NM cable shall not be run in a shallow chase in masonry walls.

True _____ False _____ *Code* section _____

B. Protective guard strips are required for Romex and NM cable within 7 feet of the nearest edge of an accessible attic entrance; however, where the space is not accessible by permanent stairs or ladders, the guard strips shall be within _____ feet of the attic entrance.

Code section _____

C. Intermediate metal conduit is not acceptable as an equipment grounding conductor.

True _____ False _____ *Code* section _____

D. Aluminum fittings and enclosures are permitted on steel rigid metallic conduit runs.

True _____ False _____ *Code* section _____

E. Rigid metallic conduit threads are to be tapered at 3/4 inch per foot.

True _____ False _____ *Code* section _____

F. Rigid nonmetallic conduit sizes 1/2 inch to 1 inch are to be supported at 3-foot intervals.

True _____ False _____ *Code* section _____

G. Electrical metallic tubing (EMT) conduit shall not be threaded.

True _____ False _____ *Code* section _____

H. Flexible metallic tubing runs shall not be over 6 feet.

True _____ False _____ *Code* section _____

ASSIGNMENT SHEET #6

I. Three-eighths-inch flexible metal conduit runs are limited to 6 feet in length.

True _____ False _____ *Code* section _____

J. A busway is considered to be a grounded metal enclosure containing factory-mounted bare or insulated conductors.

True _____ False _____ *Code* section _____

PART III

Directions: Use the *National Electrical Code*, Articles 430 through 501, to find the following information. Write the correct answers in the appropriate blanks.

A. In marking motors, the nameplate is to show both voltage and full-load current; for multispeed motors, the nameplate is to show full-load amperage for each speed.

True _____ False _____ *Code* section _____

B. The circuit of a control apparatus that carries the electric signals directing the performance of the controller, but does not carry the main power current, is called _____ _____ _____

Code section _____

C. The disconnecting means for a torque motor shall have an ampere rating of 125 percent of the motor nameplate current.

True _____ False _____ *Code* section _____

D. The branch circuit for an air conditioner compressor unit may have a short circuit protection device rated at 225 percent of the motor-rated load.

True _____ False _____ *Code* section _____

E. The ampacity of generator phase wires to the first overcurrent device shall not be less than 125 percent of the nameplate current rating.

True _____ False _____ *Code* section _____

F. Water pipes intended for vault fire protection or transformer cooling are permitted in a transformer vault.

True _____ False _____ *Code* section _____

G. A sealed cell or battery may have a vent opening but no opening to add battery fluid.

True _____ False _____ *Code* section _____

ASSIGNMENT SHEET #6

H. Class 1 hazardous locations are those having to do with hazardous gases or vapors.

True _____ False _____ *Code* section _____

I. Conduit seals in Class 1, Division 1, hazardous locations may be 24 inches from an enclosure for switching.

True _____ False _____ *Code* section _____

PART IV

Directions: Use the *National Electrical Code* to find the following information. Answers may be found throughout the *Code*.

A. Generally, service entrance conductors shall not be spliced. How many exceptions to this rule are permitted?

Number _____ *Code* section _____

B. A #18 fixture wire is considered to be protected by a 200-ampere breaker.

True _____ False _____ *Code* section _____

C. "Conduit bodies having provisions for less than three conduit entries shall not contain splices, taps, or devices unless they comply with the provisions of *Code* section 370-6(b) and are supported in a rigid and secure manner."

True _____ False _____ *Code* section _____

D. "In completed installations each outlet box shall have a cover, _____, or fixture canopy."

Code section _____

E. "The allowable ampacities in Tables 310-16 through 310-19 are based on temperature alone and do not take voltage drop into consideration."

True _____ False _____ *Code* section _____

F. Where type NM cable (Romex) is installed in accessible attics, "the installation of cable in accessible attics or roof spaces shall comply with *Code* section _____."

Code section _____

ASSIGNMENT SHEET #6

G. Capacitors 600 volts nominal and under shall be provided with a means of draining the stored charge to 50 volts or less within _____ _____ after being disconnected from power source.

Code section _____

H. Hazardous locations Class II are those that are hazardous because of the presence of combustible dust.

True _____ False _____ *Code* section _____

I. "All 120-volt receptacles located within 15 feet of the inside walls of a swimming pool shall be protected by a ground-fault circuit-interrupter."

True _____ False _____ *Code* section _____

USING TRADE INFORMATION
UNIT VI

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A.	513	F.	410-8
B.	250-79	G.	384-16
C.	370-D	H.	551-24
D.	364-5	I.	430-82(c)
E.	410-8	J.	517-151, 660-D

Assignment Sheet #2

A. Safeguarding; code section 90-1(a)
B. Chapter 9
C. Code section 100-A
   1. "Current-carrying capacity of electric conductors expressed in amperes"
   2. "The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s)"
   3. "A point on the wiring system at which current is taken to supply utilization equipment"
   4. "Service conductors made up in the face of a cable"
   5. "The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be impose :."
   6. "A conductor encased within material of composition or thickness that is not recognized by this Code as electrical insulation"
   7. "A contact device installed at the outlet for the connection of a single attachment plug"
   8. "The overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service-entrance conductors at the building or other structure"
   9. "A unit of an electrical system which is intended to carry but not utilize electric energy"
   10. "A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of plenty"
   11. "A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as part of, or in connection with, an electrical installation"
   12. "Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity which, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload"

ANSWERS TO ASSIGNMENT SHEETS

13. "The underground service conductors between the street main, including any risers at a pole or other structure or from transformers, and the first point of connection to the service-entrance conductors in a terminal box or meter or other enclosure with adequate space, inside or outside the building wall. Where there is no terminal box, meter, or other enclosure with adequate space, the point of connection shall be considered to be the point of entrance of the service conductors into the building"
14. "The words 'thermally protected' appearing on the nameplate of a motor-compressor indicate that the motor is provided with a thermal protector"
15. "So constructed or protected that exposure to the weather will not interfere with successful operation"
16. "Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors"
17. "An overcurrent protective device that contains a heater element in addition to and affecting a renewable fusible member which opens the circuit. It is not designed to interrupt short-circuit currents"
18. "The raceway that encloses the service-entrance conductors"
19. "Capable of being reached quickly for operation, renewal, or inspections, without requiring those whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc."
20. "Surrounded by a case, housing, fence, or wall which will prevent persons from accidentally contacting energized live parts"

Assignment Sheet #4

1.	25 (cannot be fused over 20A)	5.	30
2.	165	6.	25 (cannot be fused over 20A)
3.	195	7.	125
4.	50 (cannot be fused over 30A)	8.	55

Assignment Sheet #5

1.	9	6.	4
2.	6	7.	2
3.	1	8.	6
4.	11	9.	4
5.	2	10.	3

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #6

PART I

A. Article part A, *Code* section 250-1
   1. "Systems, circuits, and equipment required, permitted, or not permitted to be grounded"
   2. "Circuit conductor to be grounded on grounded systems"
   3. "Location of grounding connections"
   4. "Types and sizes of grounding and bonding conductors and electrodes"
   5. "Methods of grounding and bonding"
   6. "Conditions under which guards, isolation, or insulation may be substituted for grounding"

B. Article part B; *Code* section 250-6(a); True
C. Article part C; *Code* section 250-26(c); True
D. Provided; fault current; Article part G; *Code* section 250-70
E. Uninsulated; Article part G; *Code* section 250-73
F. Jumper; four exceptions; Article part G; *Code* section 250-74
G. Copper; Article part G; *Code* section 250-79(a)
H. Article part J; *Code* section 250-95; #8, #6, #3
I. Cases or frames; Article part L; *Code* section 250-122
J. Not; Article part K; *Code* section 250-113

PART II

A. True; *Code* section 336-3(a)
B. 6 feet; *Code* section 336-9, ref. to 333-12(a)
C. False; *Code* section 345-3(a), ref. to 250-91(b)
D. True; *Code* section 346-1(b) exception
E. True; *Code* section 346-7(b)
F. True; *Code* section 347-8, table
G. True; *Code* section 348-7
H. True; *Code* section 349-4
I. True; *Code* section 350-3, exception #3
J. True; *Code* section 364-2

PART III

A. True; *Code* section 430-7(a)(2)
B. Motor control circuit; *Code* section 430-71
C. False; *Code* section 430-110(b)
D. True; *Code* section 440-22(a)
E. False; *Code* section 445-5

ANSWERS TO ASSIGNMENT SHEETS

F. True; *Code* section 450-47
G. True; *Code* section 480-2
H. True; *Code* section 500-4
I. False; *Code* section 501-5(a)(1)

PART IV

A. Five; *Code* section 230-46
B. True; *Code* section 240-4
C. True; *Code* section 370-6(c)
D. Faceplate; *Code* section 370-15
E. True; Note 12 tc tables 310-16 through 310-19
F. 333-12; *Code* section 336-9
G. One minute; *Code* section 460-6(a)
H. True; *Code* section 500-5
I. True; *Code* section 680-6(a)(3)

USING TRADE INFORMATION
UNIT VI

TEST

NAME _____ SCORE _____

1. Match terms related to using trade information with their correct definitions. Definitions are continued on the following page.

_____a.	Develops electrical equipment standards	1. ANSI (American National Standards Institute)
_____b.	Develops standards for electrical machinery and equipment	2. ASA (American Standard Association)
_____c.	Develops and publishes fire and industrial safety standards	3. Bonding
_____d.	Develops standards for electrical equipment and supplies	4. Bonding jumpers
_____e.	Test equipment and list items for use in specified situations	5. Bonding jumper circuit
_____f.	Standards developed to provide for safe building construction practices	6. Bonding jumper equipment
_____g.	Intentionally grounded system or circuit conductor	7. Building code
_____h.	Book containing electrical specifications endorsed by NFPA and ANSI; used for legal and regulatory purposes in the interest of life and property protection	8. Grounded
_____i.	Permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed	9. Grounded conductor
_____j.	Conductor used to connect the grounding electrode to the equipment grounding conductor or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system	10. Grounding conductor
_____k.	Connections between two or more portions of the equipment grounding conductors	11. Grounding electrode conductor
_____l.	Power, right, or authority to interpret the law (code)	12. Jurisdiction
_____m.	Connections between portions of a conductor in a circuit to maintain required ampacity of the circuit	13. Mandatory enforcement
		14. NEC (National Electrical Code)
		15. NEMA (National Electrical Manufacturers Association)
		16. NFPA (National Fire Protection Association)
		17. UL (Underwriters Laboratories)

TEST

_____n. Governmental authority to demand compliance with the *National Electrical Code* requirements for electrical installations

_____o. Conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes

_____p. Pieces of wire or other conductors that connect different metal parts

_____q. Connected to earth or to some conducting body that serves in place of the earth

2. State the purpose of the National Electrical Code.

_____

_____

_____

3. List factors that are not covered by the NEC.

a. _____

b. _____

c. _____

4. State the intent of the NEC regarding mandatory enforcement.

_____

_____

_____

5. Match *National Electrical Code* chapter numbers on the right with their correct areas of application.

_____a.	Communications systems	1. Chapters 1 through 4
_____b.	Special equipment	2. Chapter 5
_____c.	General application	3. Chapter 6
_____d.	Tables and examples	4. Chapter 7
_____e.	Special conditions	5. Chapter 8
_____f.	Hazardous locations	6. Chapter 9

TEST

6. Arrange in order the organizational components of *National Electrical Code* information. Write a "1" before the first step, a "2" before the second step, and so on.

   _____a. Numbered paragraphs

   _____b. Article

   _____c. Chapter

   _____d. Parts

   _____e. Numbered or lowercase lettered subparagraphs

7. Arrange in order the steps for finding information in the *National Electrical Code*. Write a "1" before the first step, a "2" before the second step, and so on.

   _____a. Turn to article and section as designated.

   _____b. Read all related areas and exceptions.

   _____c. Refer to index for appropriate area of code.

   _____d. Cross-reference if code refers to another article.

   _____e. Locate specified area in question.

(NOTE: If the following activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

8. Use the National Electrical Code (NEC) index. (Assignment Sheet #1)

9. Use the National Electrical Code (NEC) introduction and first chapter. (Assignment Sheet #2)

10. Answer questions related to residential wiring practices using the NEC as a reference. (Assignment Sheet #3)

11. Locate allowable ampacities for various conductors using the NEC as a reference. (Assignment Sheet #4)

12. Interpret conduit fill tables using the NEC as a reference. (Assignment Sheet #5)

13. Find information in the NEC. (Assignment Sheet #6)

USING TRADE INFORMATION
UNIT VI

ANSWERS TO TEST

1.

a.	15	f.	7	k.	6	p.	4
b.	2	g.	9	l.	12	q.	8
c.	16	h.	14	m.	5		
d.	1	i.	3	n.	13		
e.	17	j.	11	o.	10		

2. Sets minimum standards for safeguarding persons and property from hazards arising from the use of electricity

3. a. Efficiency
   b. Convenience
   c. Good service

4. The code is intended to be suitable for mandatory enforcement by the governmental authority having jurisdiction. Mandatory rules are characterized by the word "SHALL".

5.

a.	5	d.	6
b.	3	e.	4
c.	1	f.	2

6. a. 4
   b. 2
   c. 1
   d. 3
   e. 5

7.

a.	3	d.	5
b.	4	e.	2
c.	1		

8.-13. Evaluated to the satisfaction of the instructor

BASIC EQUIPMENT
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify and install electrical boxes and enclosures used in the electrical field. Competencies will be demonstrated by completing the assignment sheet, job sheets, and the unit tests with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to.

1. Match terms related to basic equipment with their correct definitions.
2. Identify classes of outlet boxes used in electrical wiring.
3. List information needed to calculate boxfill.
4. Match types of enclosures with their correct conditions for use.
5. State the purposes of controller enclosures.
6. Label types of devices commonly used in electrical wiring.
7. Label types of covers and plates used in electrical wiring.
8. Identify supports and anchors commonly used in electrical wiring.
9. Identify screws, bolts, and nuts commonly used in electrical wiring.
10. Identify classes of box mounting devices for steel structures.
11. Determine the correct number of conductors for boxfill. (Assignment Sheet #1)

OBJECTIVE SHEET

12. Demonstrate the ability to:

    a. Install outlet boxes on wood studs on a framed wall. (Job Sheet #1)

    b. Install outlet boxes on steel structures and rods using caddy clips. (Job Sheet #2)

    c. Install outlet boxes on steel studs using caddy metal stud clips for switch boxes. (Job Sheet #3)

    d. Install masonry boxes in a block wall. (Job Sheet #4)

BASIC EQUIPMENT
UNIT VII

SUGGESTED ACTIVITIES

A. Obtain additional materials and/or invite resource people to class to supplement/reinforce information provided in this unit of instruction.

(NOTE: This activity should be completed prior to the teaching of this unit.)

B. Make transparencies from the transparency masters included with this unit.

C. Provide students with objective sheet.

D. Discuss unit and specific objectives.

E. Provide students with information and assignment sheets.

F. Discuss information and assignment sheets.

(NOTE: Use the transparencies to enhance the information as needed.)

G. Provide students with job sheets.

H. Discuss and demonstrate the procedures outlined in the job sheets.

I. Integrate the following activities throughout the teaching of this unit:

1. Devise additional job sheets for applications based on the wiring method of the locality.

2. Discuss slang terms associated with basic equipment.

3. Show examples of outlet boxes and electrical devices to class.

4. Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas of improvement.

J. Give test.

K. Evaluate test.

L. Reteach if necessary.

REFERENCES USED IN WRITING THIS UNIT

A. Adams, James E. and Gordon Rockmaker. *Industrial Electricity Priniciples and Practices*. Third Edition. New York: McGraw-Hill Book Co., 1985.

B. *National Electrical Code, 1987*. Quincy, MA: National Fire Protection Association, 1986.

C. Taylor, Mark. *Residential Wiring*. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1983.

D. Teague, Cash and Garner Pewewardy. *Industrial Electricity: In-Plant Distribution*. Stillwater, OK: Oklahoma Curriculum and Instructional Materials Center, 1984.

SUGGESTED SUPPLEMENTAL MATERIAL

Catalogs

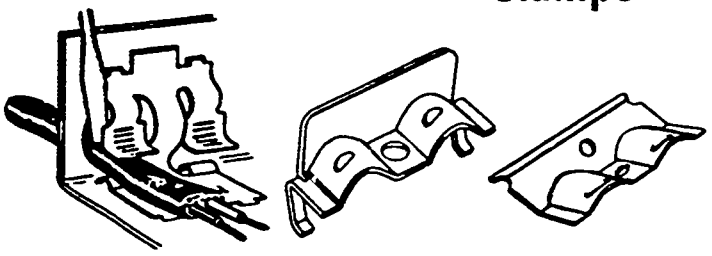
A. *Holub Catalog No. 23*, ITT Holub Industries, Sycamore, Illinois.

B. *Roco Steel Box Catalog No. B-774*, Roco Inc., South Bend, Indiana.

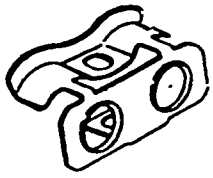
C. *Leviton Catalog D-100*, Leviton Manufacturing Co., Brooklyn, New York.

Box Design Features

Clamps

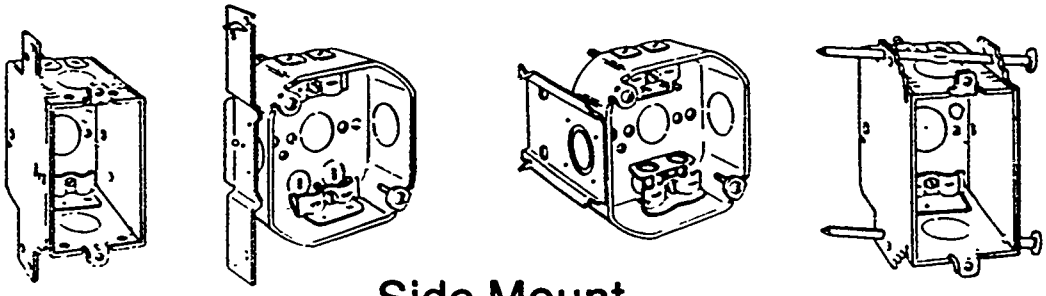


Nonmetallic
Cable Clamps

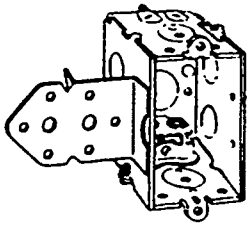


Metallic
Cable Clamp

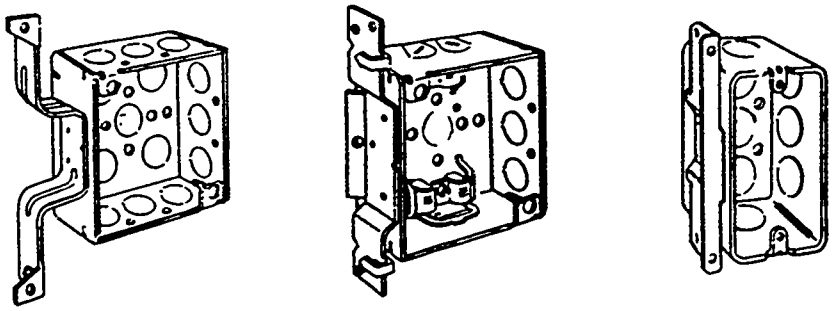
Brackets



Side Mount



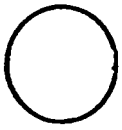
Front
Mount



Side and Front Mount

Box Design Features
(Continued)

Box Openings

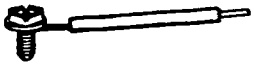


Knockout

Pry-Out

Grounding Equipment

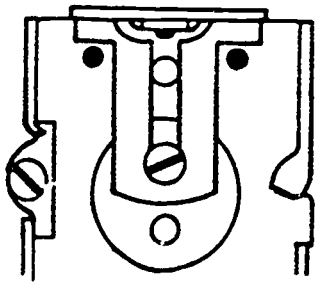
Screw



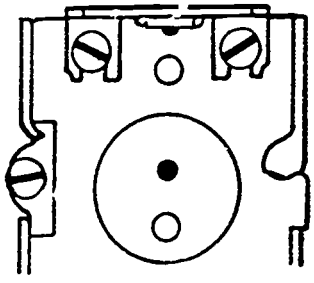
Screw with Pigtail

Clip

Plaster Ears



One-Screw Design



Two-Screw Design

BASIC EQUIPMENT
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Boxfill — Number of conductors of a certain size permitted in a box; number is based on cubic inches of box

B. Cabinet — Enclosure designed either for surface or flush mounting; provided with a frame, mat, or trim in which a swinging door or doors may be hung

C. Disconnecting means — Device or group of devices, or other means by which circuit conductors can be disconnected from their source of supply

D. Dustproof — So constructed or protected that dust will not interfere with successful operation

E. Dusttight — So constructed that dust will not enter the enclosing case

F. Explosionproof — Capable of containing hot explosive flames within the enclosure to prevent explosions in the surrounding atmosphere

G. Joint Industry Conference (JIC) boxes — Boxes or enclosures made to Joint Industry Conference Standards for such uses as junction boxes and housing terminal blocks

H. Junction boxes — Enclosures designed for conduit or cable entrances to enclose the conductor splices and taps

I. Knockout (KO) — Partially cut out piece of metal or plastic that can be forced out when a hole is needed

J. NEMA enclosures — Electrical enclosures specifically designed to standards for use in specific locations and various conditions such as indoor, outdoor, dusty, corrosive, wet, and explosive conditions

K. Outlet boxes — Electrical boxes designed for the mounting of receptacles, switches, light fixtures, or other devices

L. Rainproof — So constructed, protected, or treated as to prevent rain from interfering with successful operation

M. Raintight — So constructed or protected that exposure to a beating rain will not result in the entrance of water

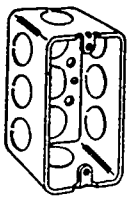
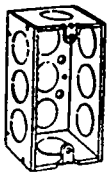
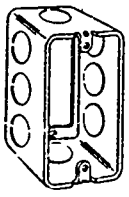
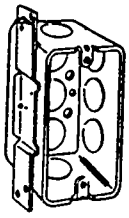
INFORMATION SHEET

II. Classes of outlet boxes used in electrical wiring (NEC Article 370)

A. Outlet boxes (device boxes)

(NOTE: Most boxes can be purchased in metal or in a nonmetallic composition such as fiber, plastic, nylon, or rubber.)

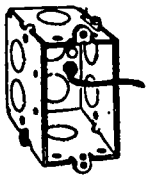
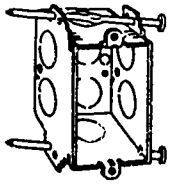
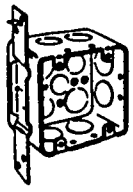
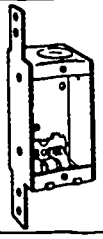
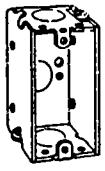
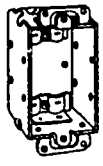
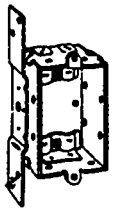
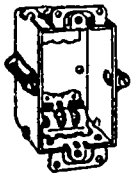
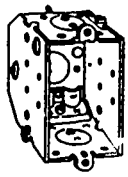
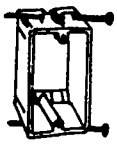
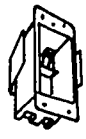
1. Handy boxes

One-Piece Molded Construction	One-Piece Welded Construction	Extension	Box with Bracket
			

INFORMATION SHEET

2. Switch boxes

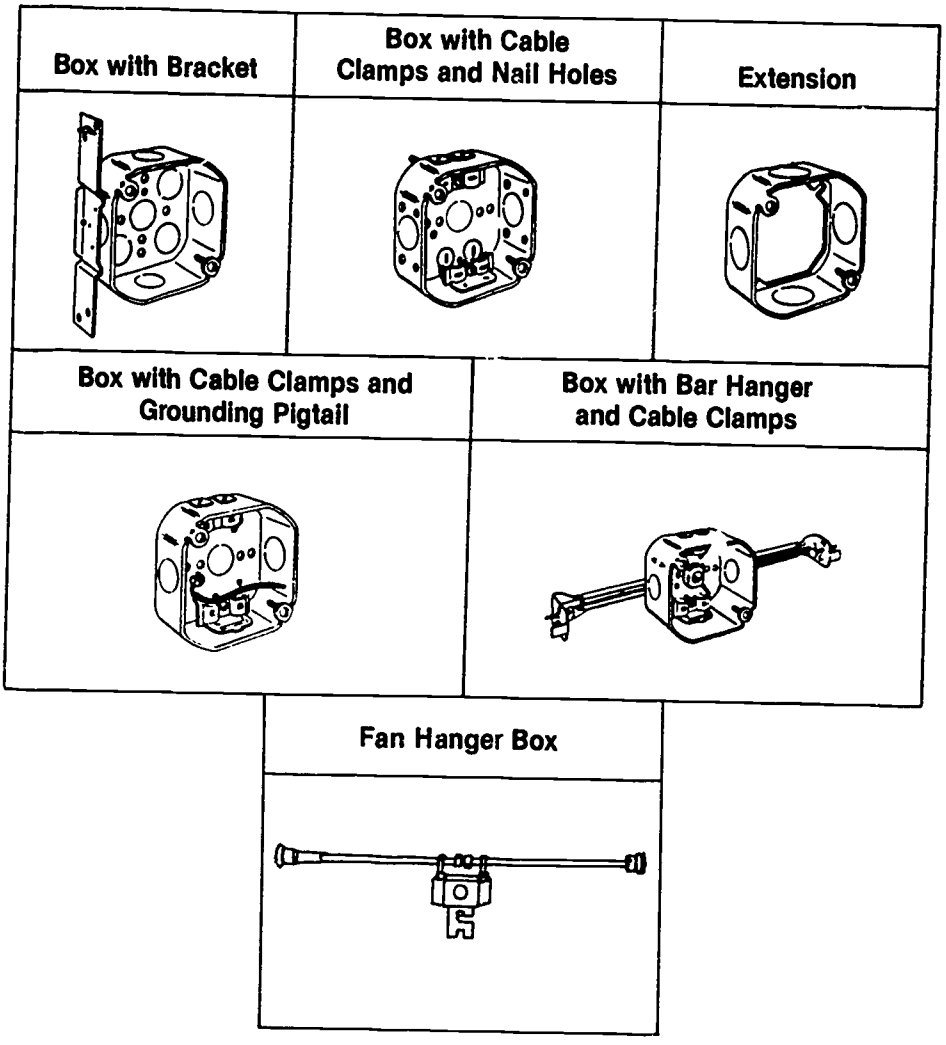
(NOTE: Switch boxes are available in steel, plastic, and Bakelite.)

Gangable with Grounding Pigtail	Nail-On	Solid Two-Gang Bracket
		
Nongangable Bracket with Cable Clamps	**Gangable with Nail Holes**	**Gangable with Ears and Cable Clamps**
		
Gangable Bracket with Cable Clamps	**Box with Drywall Grips, Cable Clamps, and Ears**	**Beveled Corner with Clamps and Ears**
		
Single Gang Fiber Nail-Up	**Three-Gang Fiber Nail-Up**	**Single Gang Fiber Cut-In Box**
		

INFORMATION SHEET

B. Octagon boxes

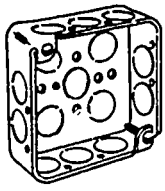
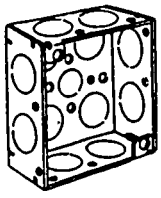
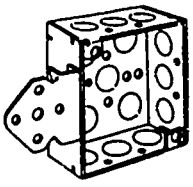
(NOTE: Octagon boxes, like switch boxes, can be either metallic or nonmetallic; like switch boxes, they can be purchased in many different depths.)

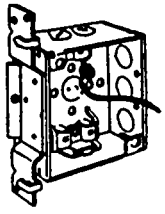
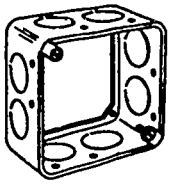


INFORMATION SHEET

C. Square boxes

(NOTE: Square boxes are used in conjunction with covers designed for special purposes.)

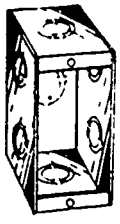
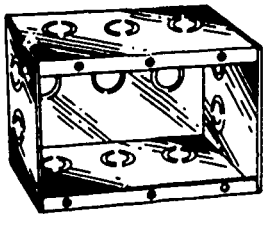
One-Piece Molded Construction	One-Piece Welded Construction	Box with Bracket
		

Box with Bracket, Cable Clamps, and Grounding Pigtail	Extension
	

D. Masonry boxes

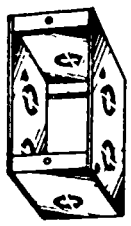
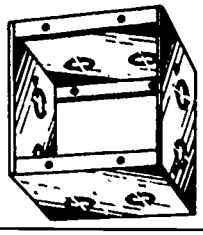
(NOTE: Masonry boxes have square corners that are easier to cut and save installation time. The boxes are deep so that conduit will position in the voids.)

1. Regular masonry boxes

Single-Gang	Three-Gang
	

INFORMATION SHEET

2. Masonry through-the-wall boxes

Single-Gang	Two-Gang
	

III. **Information needed to calculate boxfill**

A. Cubic inches of box

(NOTE: Multiplying width times height times depth gives cubic inches.)

B. Size of wire

C. Number of devices and grounds

IV. **Types of enclosures and their conditions for use**

A. General duty — For normal use in locations without excessive dust, moisture, or corrosive atmospheres

B. Dustproof — For use where dust could interfere with normal operation

EXAMPLES: Feed mill, cement plant

C. Weatherproof — For use where rain or dust could interfere with normal operation

EXAMPLE: Irrigation motor controller

D. Watertight — For use in wet locations

EXAMPLES: Milk plant, mines

E. Corrosionproof — For use in locations having corrosive atmospheres (NEC Article 300-6)

EXAMPLES: Galvanizing plant, fertilizer plant

F. Explosionproof — For use in hazardous locations (NEC Article 500)

EXAMPLES: Grain elevators, oil refineries, chemical plants

INFORMATION SHEET

V. Purposes of controller enclosures

A. Keeping boxes and enclosures clean

(NOTE: Relays and contactors should be cleaned periodically to ensure continued operation.)

B. Keeping boxes and enclosures dry

(NOTE: Moisture is one of the greatest enemies of electrical insulation. Moisture due to condensation may collect inside a sealed enclosure. Heaters are often used to correct this condition.)

C. Protecting boxes and enclosures from accidental contact

(CAUTION: Never bring metal or other objects into contact with live parts.)

D. Preventing injuries

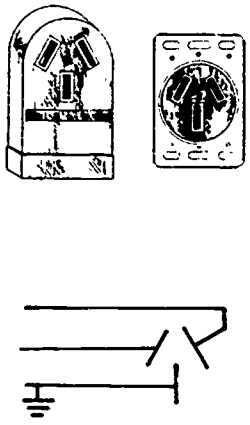
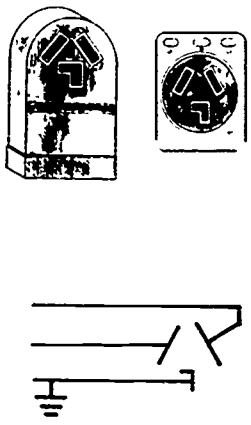
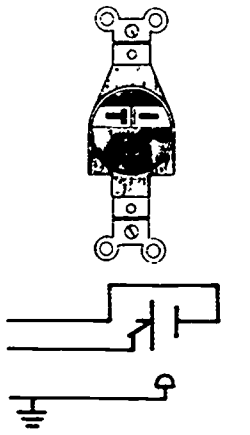
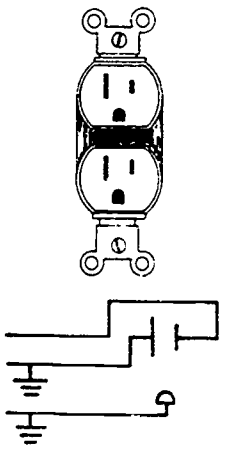
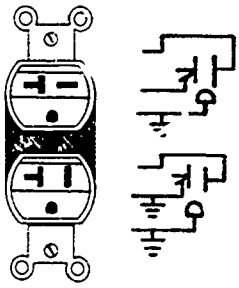
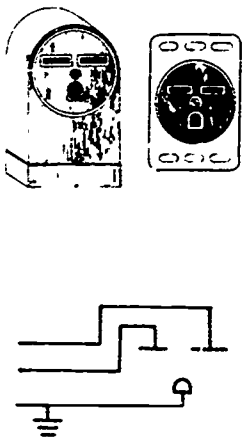
(CAUTION: To avoid personal injury, protective covers must be in place when system is in operation.)

INFORMATION SHEET

VI. Types of devices commonly used in electrical wiring

(NOTE: Manufacturers make different grades of devices. Price and quality vary with the grades. Specification grade is the most expensive. Befo: installing devices, check the grade requested in the job bid.)

A. Receptacles

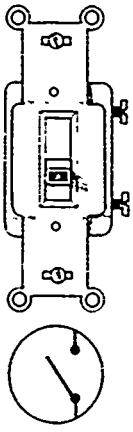
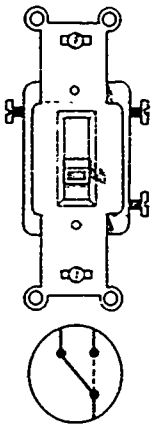
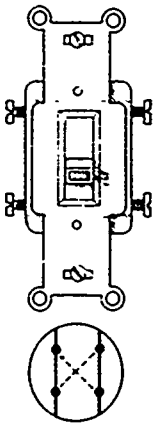
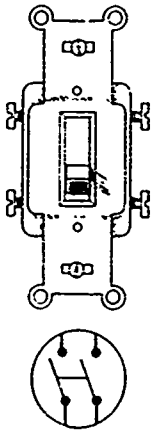
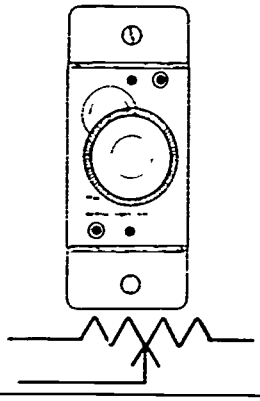
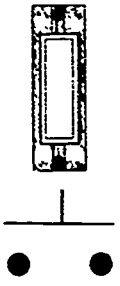
125/250 V, 50 A	125/250 V, 30 A	250 V, 20 A
		
Duplex Grounding 125 V, 15 A	**Dual Voltage 125/250 V, 20 A**	**250 V, 30 A**
		

(NOTE: NEC Articles 250-74, 410-58 and 501-12 deal with specific installation of receptacles.)

EXAMPLE: 410-58(a) grounding-type receptacles, cord connectors, and attachment plugs shall be provided with one fixed grounding pole in addition to the circuit poles.

INFORMATION SHEET

B. Switches

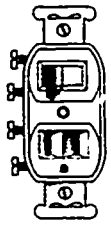
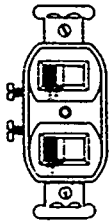
Single Pole	Three-Way	Four-Way
		
Double Pole	**Dimmer**	**Low-Voltage Push Button**
		

(NOTE: Article 380 of the NEC covers switches.)

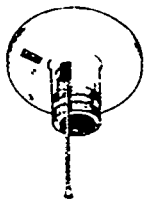
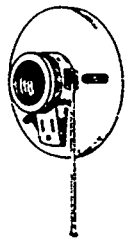
EXAMPLE: 380-2 three-way and four-way switches shall be wired that all switching is done only in the ungrounded circuit conductor. Where in metal enclosures, wiring between switches and outlets shall be run with both polarities in the same enclosure.

INFORMATION SHEET

C. Combination devices

Switch and Receptacle	Two Switches	Switch and Pilot Light
		

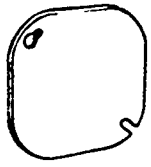
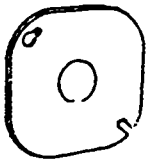
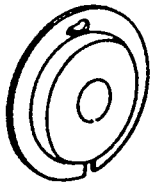
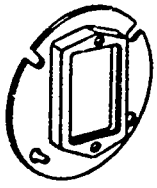
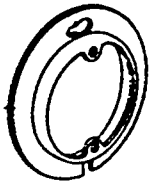
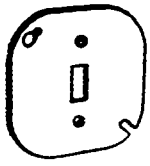
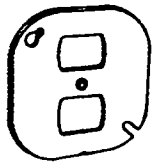
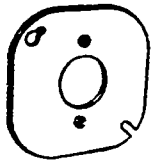
D. Sockets

Keyless Pigtail	Keyless Cover
	
Pull-Chain Cover	**Pull-Chain Cover with Grounding-Type Receptacle**
	

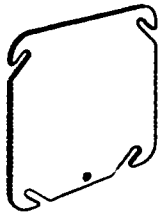
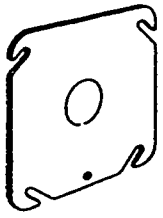
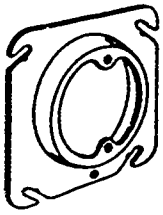
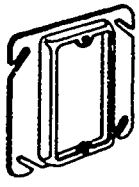
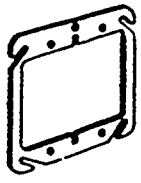
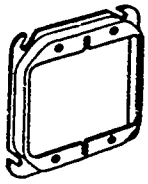
INFORMATION SHEET

VII. Types of covers and plates used in electrical wiring

A. Round covers

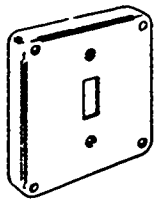
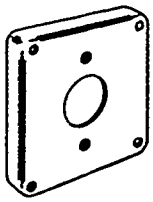
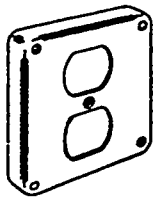
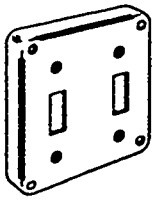
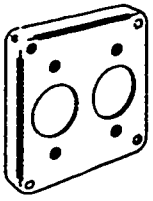
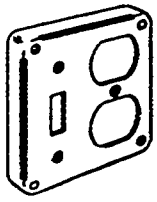
Flat Blank	Flat Blank with Knockout	Raised with Knockout	Raised for Single Device
			
Raised Open	**Flat Toggle**	**Flat Duplex Receptacle**	**Flat Single Receptacle**
			

B. Square covers

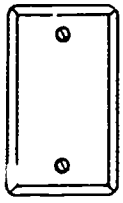
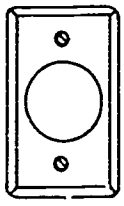
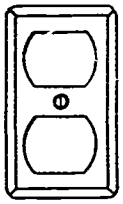
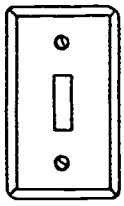
Flat Blank	Flat Blank with Knockout	Raised Open	Flat for Single Device
			
Raised for Single Device	**Flat for Two Devices**	**Raised for Two Devices**	
			

INFORMATION SHEET

C. Exposed work raised square covers

Single Toggle	Single Receptacle	Duplex Receptacle
		
Two-Toggle	**Two-Receptacle**	**Toggle and Duplex Receptacle**
		

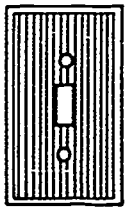
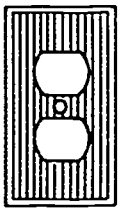
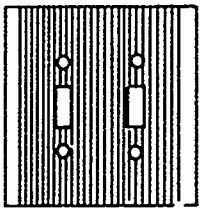
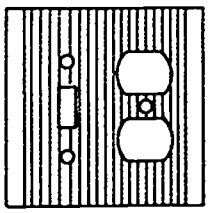
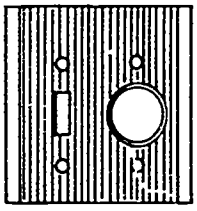
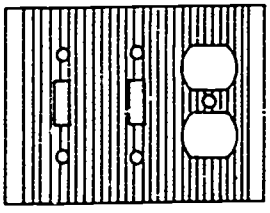
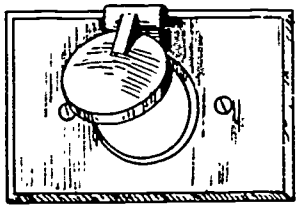
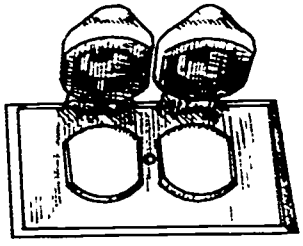
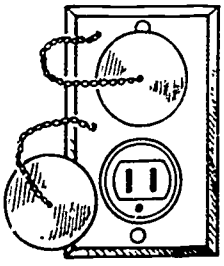
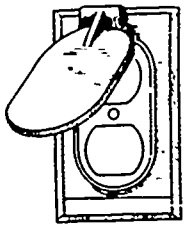
D. Handy box covers

Blank	Single Receptacle
	
Duplex Receptacle	**Single Toggle**
	

INFORMATION SHEET

E. Wall plates

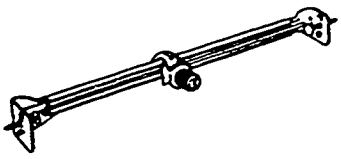
(NOTE: These are usually available in plastic or metal, but also come in decorator types for interior walls which are often made from wood.)

Single Toggle	Duplex Receptacle	Two-Toggle	Single Toggle and Duplex Receptacle
			
Single Toggle and Single Receptacle		**Two-Toggle and Duplex Receptacle**	
			
Weatherproof Single Receptacle		**Weatherproof Duplex Receptacle (Horizontal)**	
			
Weatherproof Duplex Receptacle with Screw Covers		**Weatherproof Duplex Receptacle (Vertical)**	
			

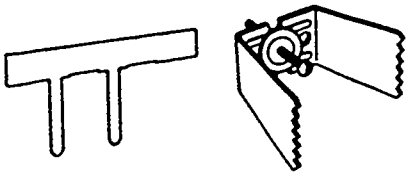
INFORMATION SHEET

VIII. Supports and anchors commonly used in electrical wiring

A. Bar hanger

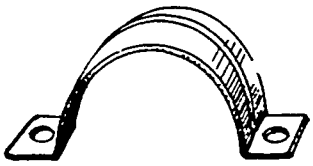


B. Switch-box supports

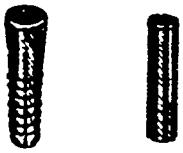


C. One-hole strap

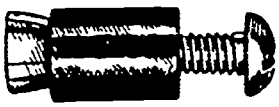
D. Two-hole strap



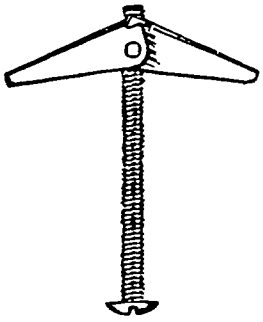
E. Plastic anchors



F. Lead anchor



G. Toggle bolt



H. Molly bolt

I. Drive stud

INFORMATION SHEET

IX. Screws, bolts, and nuts commonly used in electrical wiring

A. Screws

1. Sheet metal screw

2. Self-drilling screw

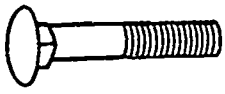
3. Wood screw

4. Machine screw

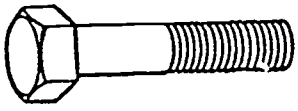
5. Setscrew

B. Bolts

1. Carriage bolt



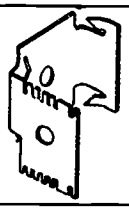
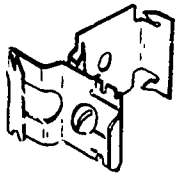
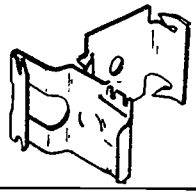
2. Hex-head bolt

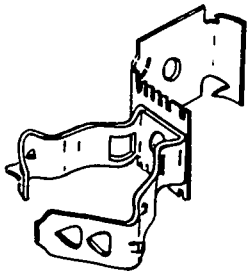


3. Hex-socket-head bolt

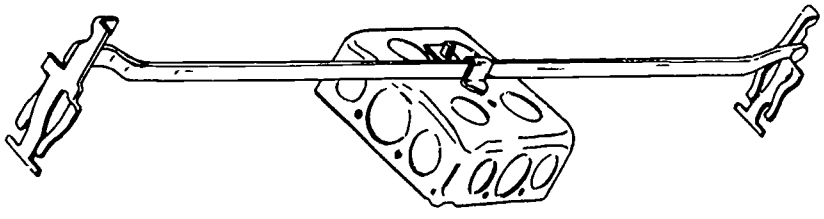
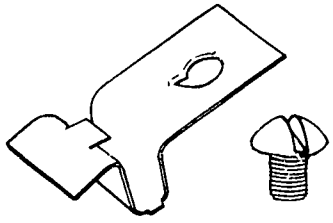
INFORMATION SHEET

B. MF clips for switch boxes (metal stud fasteners)

1/4"-20 Thread Impression to Metal Stud	With Screw Adjustable 1/4" through 3/4"	Riveted for Flush Wall or 1/4" to 3/4" Dry Wall
		

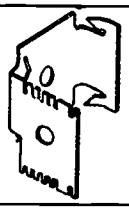
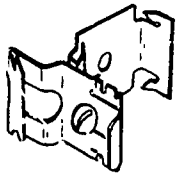
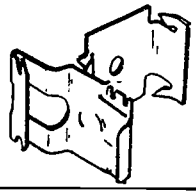
Conduit on BX to Metal Stud	1/2" to 1" Conduit to Metal Stud
	

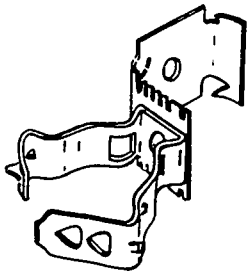
C. Acoustical tee-bar electrical box hanger and mounting clip

Acoustical "Tee-Bar" Electrical Box Hanger

Mounting Clip


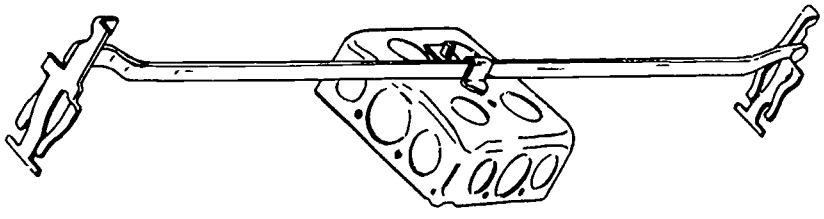
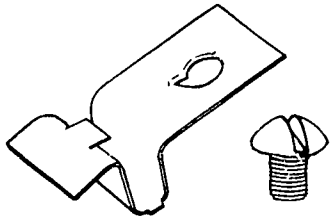
INFORMATION SHEET

B. MF clips for switch boxes (metal stud fasteners)

1/4"-20 Thread Impression to Metal Stud	With Screw Adjustable 1/4" through 3/4"	Riveted for Flush Wall or 1/4" to 3/4" Dry Wall
		

Conduit on BX to Metal Stud	1/2" to 1" Conduit to Metal Stud
	

C. Acoustical tee-bar electrical box hanger and mounting clip

Acoustical "Tee-Bar" Electrical Box Hanger

Mounting Clip


BASIC EQUIPMENT
UNIT VII

ASSIGNMENT SHEET #1 — DETERMINE THE CORRECT NUMBER OF CONDUCTORS FOR BOXFILL

NAME _____ SCORE _____

The electrical worker must be able to choose a box of correct size and then determine the number of conductors permitted according to the *National Electrical Code*, Article 370-6.

Directions: Determine the correct number of conductors for boxfill for the problems below. To find boxfill, subtract one conductor per device and one conductor per one or more grounds from the maximum allowed number of conductors.

(NOTE: Assume 1 ground wire for each problem.)

EXAMPLE: 4" x 2 1/8" square box, two devices, #12 wire

1. Referring to box dimensions and wire size,locate the maximum number of conductors on chart in Article 370-6 (maximum number = 13).
2. Subtract one conductor for each device (13 – 2 = 11).
3. Subtract one conductor for ground (11 – 1 = 10).
4. Answer equals boxfill (boxfill = 10 conductors).

A. 4" x 2 1/8", no device, round box, cable clamp, #12 wire

Boxfill = _____ conductors

B. 3 3/4" x 2" x 3 1/2", one device, masonry box, #12 wire

Boxfill = _____ conductors

BASIC EQUIPMENT
UNIT VII

ASSIGNMENT SHEET #1 — DETERMINE THE CORRECT NUMBER OF CONDUCTORS FOR BOXFILL

NAME _____ SCORE _____

The electrical worker must be able to choose a box of correct size and then determine the number of conductors permitted according to the *National Electrical Code*, Article 370-6.

Directions: Determine the correct number of conductors for boxfill for the problems below. To find boxfill, subtract one conductor per device and one conductor per one or more grounds from the maximum allowed number of conductors.

(NOTE: Assume 1 ground wire for each problem.)

EXAMPLE: 4" x 2 1/8" square box, two devices, #12 wire

1. Referring to box dimensions and wire size,locate the maximum number of conductors on chart in Article 370-6 (maximum number = 13).
2. Subtract one conductor for each device (13 – 2 = 11).
3. Subtract one conductor for ground (11 – 1 = 10).
4. Answer equals boxfill (boxfill = 10 conductors).

A. 4" x 2 1/8", no device, round box, cable clamp, #12 wire

Boxfill = _____ conductors

B. 3 3/4" x 2" x 3 1/2", one device, masonry box, #12 wire

Boxfill = _____ conductors

ASSIGNMENT SHEET #1

C. 3″ x 2″ x 1 1/2″, one device, #10 wire

Boxfill = _____ conductors

D. 4″ x 2 1/8″ x 1 7/8″, one device, #10 wire

Boxfill = _____ conductors

E. 4 11/16″ x 1 1/2″, two device, square box, #12 wire

Boxfill = _____ conductors

F. 4″ x 1 1/4″, round box, #12 wire

Boxfill = _____ conductors

G. 3″ x 2″ x 2 1/2″, no device, #10 wire

Boxfill = _____ conductors

ASSIGNMENT SHEET #1

H. 3″ x 2″ x 3 1/2″, no device, #10 wire

Boxfill = _____ conductors

I. 4 x 2 1/8″ x 1 1/2″, no device, #12 wire

Boxfill = _____ conductors

J. 4″ x 1 1/4″, two devices, square box, #12 wire

Boxfill = _____ conductors