10 ELECTRICAL SAFETY

ANSWERS—QUIZ 1

1. a
2. a
3. b
4. b
5. b
6. a
7. a
8. c
9. d
10. b
11. b
12. a
13. Current flow and time are the factors that cause injuries in electrical shock. The severity of electrical shock is determined by the amount of current that flows through the victim and by the length of time that the body receives the current.
14. Ventricular fibrillation means loss of the heart's pumping action, loss of pulse, and risk of death from ineffective rapid beating of the heart's ventricles. Typical current pathways for heart risk are from head to foot and from hand to opposite foot.
15. Death or internal injury from electric shock may result from the following effects of current on the body:
    - Contraction of chest muscles, which may interfere with breathing to such an extent that death will result from asphyxiation when the contraction is prolonged.
    - Temporary paralysis of the nerve center, which may result in failure to breathe, a condition that often continues long after the victim is freed from the circuit.
    - Interference with the normal rhythm of the heart, causing ventricular fibrillation. In this condition, the fibers of the heart muscle, instead of contracting in a coordinated manner, contract separately and at different times. Blood circulation ceases and, unless proper resuscitation efforts are made, death occurs. The heart cannot spontaneously recover from this condition.
    - On contact with heavy current, the muscular contractions of the heart stop. In this case, the heart may resume its normal rhythm when the victim is freed from the circuit.
    - Hemorrhages and destruction of tissues, nerves, and muscles from heat due to heavy current along the electrical circuit's path through the body.
    - Severe burns may result from contact with the low-voltage systems in cars, trucks, and lift trucks when metal, wrenches, or jewelry make contact with current-carrying conductors. Considerable current is likely to flow from high-voltage sources. In general, only very short exposure can be tolerated if the victim is to be revived.
16. An interlock is a device that interacts with another device or mechanism to govern succeeding operations. Interlocks should meet the following criteria: be equipped with fail-safe features since failure of the interlock mechanism, loss of power, short circuit, or malfunction of equipment will cause the circuit to be interrupted; have a visible disconnect, or opening, in the primary power circuit; and have a locking arrangement that makes attempts to circumvent the interlock impractical.
17. Circuit breakers fall into two general categories-thermal and magnetic.
18. Student might mention three of the following: Wet electrical cord-to-tool connection of extension cords; wet power tools; outdoor GFCIs not protected from rain or water sprays; defective electrical equipment with case-to-hot conductor faults; too many power tools on one GFCI branch; resistive heaters; coiled extension cords; poorly installed GFCIs; defective or damaged GFCIs; electromagnetic-induced current near high-voltage lines; portable GFCI plugged into a GFCI-protected branch circuit; defective power tools.
19. A motor can be overloaded by excessive friction within the motor itself, using the motor for the wrong kind of job, an obstruction in the driving or driven machine, or pushing the machine to perform beyond the motor's capacity.
20. A fuse is a wire or strip of metal with known electrical resistance, usually set in a plug, placed in an electrical circuit as a safeguard. As the electrical current increases, the metal's resistance to flow causes it to heat until it reaches the point where the metal melts, breaking the current at the rated amperage. Types of fuses include link, plug, and cartridge fuses.

ANSWERS—QUIZ 2

1. a
2. b
3. a
4. a
5. b
6. b
7. a
8. b
9. d
10. b
11. c
12. a
13. Connect interlocks, or other devices that remove power from the equipment whenever an access door is open, into the control circuit. This protects the operator from contacting any electrical or high frequency energy. Have material to be heated by induction carried by revolving hopper feeds or by conveyors to the heating coil. The heating coil is enclosed with a shield and cannot be reached by the operator. Locate high frequency generators some distance from the work position. A waveguide or transmission line then conveys the high frequency energy. Insulate conductive coils or equipment surfaces with compatible insulation materials suitable for the application. Insulation protects the user in case of accidental contact with the coils or with the equipment surface.
14. According to the *NEC*, grounding is required for refrigerators and similar equipment; appliances using water, such as washers; hand-held power tools; motor operated appliances, such as clippers; any equipment used in damp areas; portable handlamps with metallic ground guards; and some parts of nonelectrical equipment, such as frames.
15. A receptacle circuit tester checks the receptacle for proper connection of ground wire, correct polarity, and faults in any of the three wires.
16. Two ways to reduce the chance of explosions from electrical sources are to remove or isolate the potential ignition sources from the flammable material and control the atmosphere at the ignition source. For an explosion to occur, combustible material must be present in sufficient amounts and the proper concentration to provide an ignitable atmosphere and an ignition source powerful enough to ignite the combustible materials.
17. Before each use check for punctures, tears or abrasions. For on-the-job tests, roll up the cuffs and force air into the finger and palms of the gloves to check for air leaks. Have electrical workers wear leather protectors over rubber gloves to protect them from mechanical damage, oil, and grease.
18. Student must mention three of the following: Service entrance panel; system grounding, wiring; electrical equipment/machinery; small power tools; receptacles; lighting; GFCI protection; switches; extension cords; protectors.
19. When inspecting electrical equipment, employees should not wear loose clothing because it may become entangled in couplings, coils, or other moving parts. They should remove watches, rings, and metal pens and pencils and not carry a metal flashlight.
20. Student might present the following, as found in the text: Alert the operator and other users of the system or equipment that is about to be shut off. Plan the shutdown to ensure that the system will be off. Have all users place their padlocks on the control switch, lever, valve, or energy control device. Test the lockout/tagout procedure implemented to be sure the system is really off, and all energy sources have been de-energized, released, blocked, etc. When through working, have each user remove his or her padlock equipment and process. Never permit users to remove another's padlock. Verify that the equipment is clear and post a watch if necessary. Re-energize the system.

ANSWERS—CASE STUDY

1. Current flow and time are the factors that cause injuries in electrical shock. The severity of electrical shock is determined by the amount of current that flows through the victim and by the length of time that the body receives the current. Because current flow depends on voltage and resistance, these factors are also important. Other factors that affect the extent of injury are the parts of the body involved, and, if alternating current is used, the frequency of shock.
2. Internal injuries: Death or injury from electric shock may result from the following effects of current on the body:

- Contraction of chest muscles, which may interfere with breathing to such an extent that death will result from asphyxiation when the contact is prolonged.
- Temporary paralysis of the nerve center, which may result in failure to breathe, a condition that often continues long after the victim is freed from the circuit.
- Interference with the normal rhythm of the heart, causing ventricular fibrillation. In this condition, the fiber of the heart muscle, instead of contracting in a coordinated manner, contract separately and at different times. Blood circulation ceases and, unless proper resuscitation efforts are made, death occurs. The heart cannot spontaneously recover from this condition.
- On contact with heavy current, the muscular contractions of the heart stop. In this case, the heart may resume its normal rhythm when the victim is freed from the circuit.
- Hemorrhages and destruction of tissues, nerves, and muscles from heat due to heavy current along with the electrical circuit's path through the body.
- Severe burns may result from contact with the low-voltage systems in cars, trucks, and lift trucks when metal, wrenches, or jewelry make contact with current-carrying conductors. Considerable current is likely to flow from high-voltage sources. In general, only very short exposure can be tolerated if the victim is to be revived.

  Skin and eye injuries: Another type of injury is burns from electrical flashes. Such burns are usually deep and slow to heal and may involve large areas of the body. Even persons at a reasonable distance from the arc may receive eye burns.

  Injuries from falls: Other injuries from electrical shock include falls from one level to another.

3. A ground is an object that connects a piece of electrical equipment to earth or some conducting body that serves in place of earth. A ground serves to complete the electrical circuit and prevent the hazard of electrical shock. The electrical system is grounded in order to prevent the occurrence of excessive voltages from such sources a lightning, line surges, or accidental contact with higher voltage lines. Both the electrical system and metallic enclosures are grounded to cause overcurrent devices to operate in the event of a ground fault occurring from an insulation failure. According to the *NEC*, grounding is required for refrigerators and similar equipment, appliances using water, hand held power tools, motor-operated appliances, any equipment used in damp areas, portable handlamps with metallic ground guards, and some parts of nonelectrical equipment, such as frames. However, grounding is not required for the above listed if they are approved and labeled double-insulated, or for insulated transfer tools of less than 50v.