Chapter 6

Basic Electricity and Electrical Analysis for Investigators

Section A: True/False

Directions: Write True or False on the blanks provided; if False, write the correct statement on the lines provided.

1. _____ Electricity flow is known as current (I) and is expressed in amperes (A). (169)

2. _____ On a parallel circuit, components may be added or removed from the circuit without interfering with the operation of other components. (171)

3. _____ In a simple parallel circuit, the switch controls the circuit. When the switch is open, the circuit is complete, and the lights are on. (171)

4. _____ Wire size is determined by the diameter of the wire in question. The numbers increase as the diameter of the wire increases. (173)

5. _____ Conductors must be of the appropriate length to carry the load required. (173)

6. _____ The presence of electrical equipment or wiring in or near the area of origin does indicate that the ignition source was electrical. (176)

7. _____ AC current is the type investigators will see most frequently when investigating building fires because it is found in most building electrical systems. (177)

8. _____ As the current in a transmission line is decreased, the resistance also decreases. (179)

_____

_____

9. _____ Transformers reduce commercial/industrial voltages of up to 600 volts to typical 120/240 volt levels. (179)

_____

_____

10. _____ Service wires that lead from the power company's lines to a building always include at least three conductors. (181)

_____

_____

11. _____ In a service conductor, the grounded neutral conductor is insulated. (182)

_____

_____

12. _____ Poor connections can result in increased resistance, which can increase heat and ignite nearby combustibles. (185)

_____

_____

13. _____ A short circuit is a path that does not allow flow of electricity between conductors. (189)

_____

_____

14. _____ The grounded neutral wire is required to be white or gray on the customer side. (195)

_____

_____

15. _____ Circuit breakers provide overcurrent protection and cannot be reset after they have tripped. (197)

_____

_____

Section B: Fill in the Blank

Directions: Write the correct answer on the blanks provided.

1. According to Ohm's law, voltage and _____ are directly proportional. (174)

2. Ohm's Law is used to calculate the voltage, current, or _____ in a circuit. (174)

3. A fire investigator can determine the load on a branch circuit by adding the _____ of the components connected to the circuit. (175)
4. Fire investigators may encounter step-down transformers used to reduce _____ AC electricity to various lower AC or DC voltages used to power appliances. (179)
5. The size of the service conductor is determined by the _____ of the service. (182)
6. *NEC*® Section 300.15 requires that all _____ and _____ be made in approved electrical boxes. (185)
7. Before examining any part of an electrical system at a scene, fire investigators should confirm that the system has been _____. (186)
8. A _____ can measure voltage, current, and resistance. (187)
9. The time required for a circuit breaker to trip depends on the amount of _____. (190)
10. If a conductor is close to an arc site, _____ may be present on its surface. (191)
11. In modern construction, the entire electrical system is grounded, from the _____ _____ through all of the branch circuits. (193)
12. Overcurrent protection that is properly sized and operating helps to prevent the electrical system from _____. (197)

Section C: Matching

Directions: Write the correct answers on the blanks provided.

Part I: Basic Concepts in Electricity

Match the electricity term with its definition.

Choices:

A. Electricity
B. Electrons
C. Conductors
D. Insulators
E. Circuit
F. Voltage

Definitions:

_____ 1. The electrical force that causes the flow. (168)

_____ 2. The path of travel for the charge, a closed-loop system where the electrons start and end at the same power source. (168)

_____ 3. Materials with atomic structures that do not allow the easy movement of electrons. (167)

_____ 4. Materials with electrons that are free to move from one atom to another. (167)

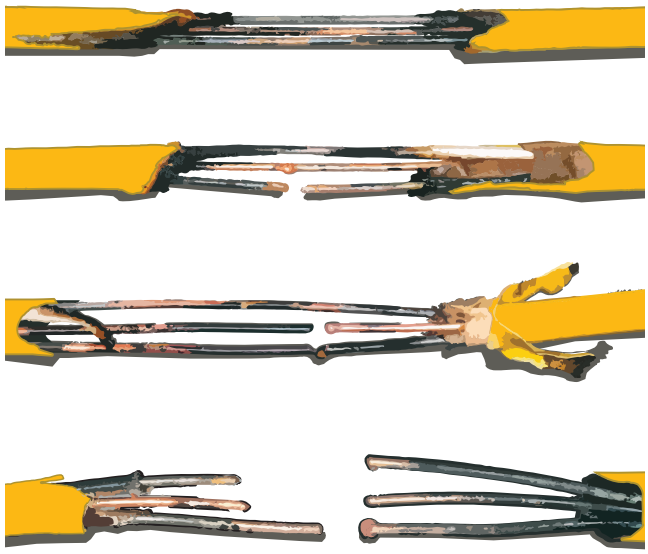
_____ 5. Small, negatively charged particles that revolve around the nucleus of atoms. (167)

_____ 6. The flow of electrons through a conductor. (167)

Part II: Picture identification —Arcing and Melting Damage

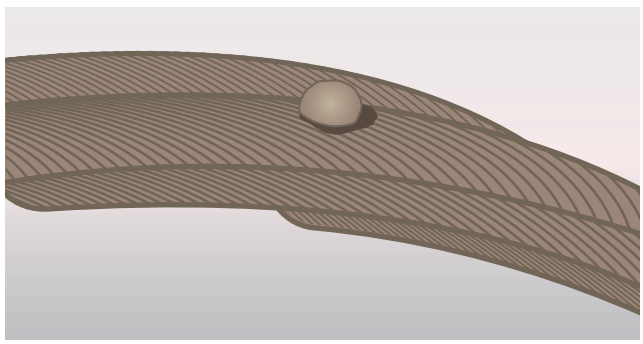
Name the phenomenon happening in the pictures (visible damage term that occur on the ends of a severed conductor) and then match the descriptor to the phenomenon.

There is one choice that will not be used.



Picture 1 _____

Picture 2 _____



Choices:

A. Beads

B. Globules

C. Spatter

Descriptors:

_____ 1. These are caused by melting as a result of non-localized heating such as from being exposed to a fire or an overloaded circuit. (191)

_____ 2. These have a characteristic sharp line of demarcation between the damaged and undamaged portion of the conductor. (191)

Section D: Multiple Choice

Directions: Write the correct answers on the blanks provided.

_____ 1. The amount of resistance in the electrical system is directly related to: (170)

A. the weight of the wire, the caliber of the wire, and the color of the wire.
B. the porosity of the wire, the thickness of the wire, and the material from which it is made.
C. the size (circumference) of the wire, the length (run) of the wire, and the material from which it is made.
D. the size (circumference) of the wire, the length (run) of the wire, and the color of the wire.

_____ 2. What is the simplest type of circuit in which current flows through all components? (170)

A. Series
B. Parallel
C. Continuous
D. Perpendicular

_____ 3. What are the most common circuits that investigators will encounter in which all components connected operate at the same voltage? (171)

A. Series
B. Parallel
C. Continuous
D. Perpendicular

_____ 4. What unit is used to measure resistance? (173)

A. Volt
B. Amp
C. Ohm
D. Watt

_____ 5. A large-diameter wire has: (173)

A. less resistance than a small-diameter wire and therefore can carry a greater amount of current before overheating.
B. more resistance than a small-diameter wire and therefore can carry a greater amount of current before overheating.
C. more resistance than a small-diameter wire and therefore can carry a lesser amount of current before overheating.
D. less resistance than a small-diameter wire and therefore can carry a lesser amount of current before overheating.

_____ 6. Which conductor has a lower resistance? (173)

A. Iron
B. Copper
C. Nichrome
D. Aluminum

_____ 7. In an electrical circuit, the amount of energy delivered over a given period of time is known as: (175)

A. power.
B. current.
C. voltage.
D. resistance.

_____ 8. What unit is used to measure power? (175)

A. Volt
B. Amp
C. Ohm
D. Watt

_____ 9. How do electrons flow in direct current (DC)? (177)

A. Both directions, from negative to positive
B. Both directions, from positive to negative
C. Only one direction, from negative to positive
D. Only one direction, from positive to negative

_____ 10. Fire investigators should keep in mind that the power into and out of a transformer is the same because of: (180)

A. Ohm's law.
B. the type of the transformer.
C. the law of conservation of mass.
D. the law of conservation of energy.

_____ 11. Most modern service connections to residential properties are made with three No. _____ AWG aluminum conductors. (182)

A. 2
B. 4
C. 6
D. 22

_____ 12. Article 230 of the NEC® allows the service disconnect panel or box to have up to _____ separate switches or circuit breakers. (183)

A. six
B. twelve
C. eighteen
D. twenty-four

_____ 13. Which is the most common cable found in residential properties? (183)

A. Coaxial cable
B. Metal-clad (MC) cable
C. Unshielded twisted pair (UTP)
D. Nonmetallic (NM) shielded cable

_____ 14. What is required by The NEC® to protect cables where access holes allow the potential for nails to touch the cable? (185)

A. Conduit
B. Metal plates for protection
C. Plastic plates for protection
D. Metal meshes for protection

_____ 15. What type of damage occurs over a wider area on the conductor with no defined line of demarcation and the conductor may become thinner where this damage is present? (191)

A. Arcing damage
B. Melting damage
C. Insulation damage
D. Mechanical damage

_____ 16. Grounding wires are required to be bare or insulated with what colors? (194)

A. Green, red, or green with a red stripe
B. Green, silver, or green with a silver stripe
C. Green, yellow, or green with a yellow stripe
D. Green, orange, or green with an orange stripe

_____ 17. According to the NEC®, a grounded conductor that runs through an electrical system is: (195)

A. commonly referred to as a hot wire and serves as a current return path for electrical services.

B. commonly referred to as a neutral wire and serves as a current return path for electrical services.

C. commonly referred to as a multiconductor wire and serves as a current return path for electrical services.

D. commonly referred to as an underground electrical wire and serves as a current return path for electrical services.

Section E: Short Answer

Directions: Write the correct answers on the lines provided.

1. What does the law of conservation of energy state? (180)

_____

_____

_____

_____

2. Branch circuits in a building are used for: (183)

_____

_____

_____

_____

3. What kind of individual branch circuits may supply directly to a specific device or appliance such as an electric water heater? (183)

_____

4. According to the NEC® Article 334, where is it not permitted to use nonmetallic sheathed cable? (185)

_____

_____

_____

_____

_____

_____

_____

5. What are three things that a multimeter set to resistance/ohms (ohmmeter) can be used to do? (187)

6. What are the three more common electrical incidents that may cause electrical systems and their components to become a source of ignition? (188)

7. What causes an electrical arc to occur? (188)

8. When does electrical heat energy occur? (189)

9. Which conditions may generate higher resistance than intended? (189)

10. What conditions can cause a short circuit? (189)

11. System grounding is used to protect against: (193)

12. What is a fuse? (197)

_____

_____

13. What are arc-fault circuit interrupters? (198)

_____

_____

14. According to NFPA 921, what are four indicators that electrical failure has occurred? (200)

_____

_____

_____

_____

Section F: Scenario

Directions: Answer the following questions based on the scenario below.

Scenario 1 (189)

On a fire scene you found the following:

1. A laptop
2. The power brick for that laptop
3. A lamp

Those were the only electrical appliances found close to the most intense part of the fire. On the wires leading up to the brick-cord connection you found visible melted copper. The laptop was plugged into an electrical outlet but the lamp was not. You also observed that 10 inches of insulation was barely melted from the copper melt location. The brick and the cord were covered with a large amount of burned material like certain kind of fabrics.

1. What condition could have caused a short circuit?

_____

_____

_____