WEST VIRGINIA
MINE ELECTRICIANS
CERTIFICATION PROGRAM

Study Guide

Twelfth Edition
Reprinted - 2012

WEST VIRGINIA

MINE ELECTRICIANS

CERTIFICATION PROGRAM

STUDY GUIDE

Prepared by the

WEST VIRGINIA OFFICE OF MINERS' HEALTH, SAFETY AND TRAINING

and the

WV Board of Miner Training, Education and Certification

Produced with Assistance from

WEST VIRGINIA UNIVERSITY

Twelfth Edition
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WEST VIRGINIA OFFICE of MINERS' HEALTH, SAFETY and TRAINING

MINE ELECTRICIANS CERTIFICATION PROGRAM

STUDY GUIDE

This is the sole official version of the ***Electrician's Study Guide*** that has been approved by the West Virginia Office of Miners' Health, Safety and Training. This official version will replace any and all other study guides previously in use.

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INTRODUCTION

This Guide contains information about the West Virginia Mine Electricians Certification Program. This program has two parts:

1. The **WRITTEN** portion is a computer-based examination in which the computer will randomly select test questions from this study guide for each person taking the exam. A copy the National Electric Code will be supplied at the test site to be used as a reference during the exam. **You may bring a slide rule or a calculator** to assist in working out the computations. In order to pass the written portion, you must score at least 80% on each of the 7 parts.
2. The **HANDS-ON** portion includes the actual testing and trouble shooting of electrical circuits and is described in detail on page 280.
   Bring your low voltage electrical gloves and a multimeter.

An answer key containing the correct answers for each question is provided at the end of each section of questions.

Prior to taking the examination an individual must submit an application to the West Virginia Miners Health, Safety and Training Regional Office in which the test is to be taken.

A fee is required in order to take the examination. As of this printing the fee is fifteen dollars and may be changed without notice.

There are two excellent sources of materials for training programs in West Virginia. The Mining Extension Service has an extensive series of coal miner training materials, study guides, textbooks, slide-tapes, and slide-tape texts.
For more information about miner training materials, contact:

Mining Extension Service
College of Mineral and Mining Resources
West Virginia University
P.O. Box 6070
Morgantown, West Virginia 26506-6070

The National Mine Health and Safety Academy has an extensive collection of materials for mine electrical training. For information, contact:

U.S. Department of Labor
National Mine Health and Safety Academy
P.O. Box 1166
Beckley, West Virginia 25801

EXAMINATION QUESTIONS FOR THE ELECTRICAL TEST

Multiple Choice question(s).
Read the question and select the appropriate answer from the list provided.

1. What type of 3-phase AC motor is used most often around a mine?

   a. Squirrel-cage induction motor.
   b. Wound-rotor induction motor.
   c. Split-phase motor.
   d. Compound-wound motor.

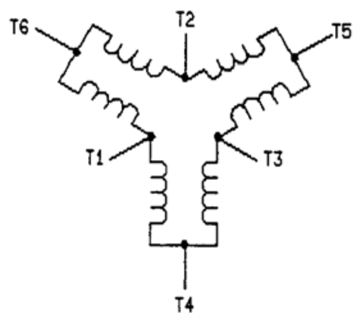
2. Which of the following is not needed when using an ohmmeter to determine if a motor is grounded?

   a. Set the selector switch on the meter to ohms.
   b. Disconnect the motor leads from the line leads at the motor junction box.
   c. Remove and lockout the power.
   d. Disconnect the frame-grounding conductor.

3. A wound-rotor induction motor has all the following EXCEPT:

   a. Slip rings.
   b. Squirrel-cage rotor.
   c. Poles.
   d. Brushes.

4. A 3-phase, 2 speed, constant torque motor is running at fast speed. The motor windings are connected wye for fast speed. Motor leads T4, T5 and T6 are connected to the line leads. Motor leads T1, T2 and T3 should be:



   a. T1 and T2 tied together and T3 left open.
   b. Connected to T4, T5 and T6.
   c. Tied together.
   d. Left open.

5. What type motor is a wound-rotor induction motor?

   a. Compound.
   b. D.C.
   c. A.C.
   d. Split phase.

6. When troubleshooting a circuit with a bank of capacitors, what precautions must be taken?

   a. Fuses should be removed from the control circuit.
   b. The capacitors should be discharged.
   c. Make sure the voltmeter is set to DC.
   d. Observe proper polarity.

7. The property of an electrical circuit that opposes any change in voltage is called:

   a. Inductance.
   b. Capacitance.
   c. Resistance.
   d. RMS.

8. What is the danger when working around capacitors?

   a. Black lung due to dust involved.
   b. Diode in capacitor may explode.
   c. Pneumonia hazard due to high discharge wind.
   d. An electrical shock hazard may exist.

9. What is a capacitor?

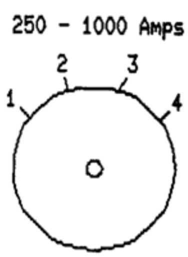
   a. A sticker on a cap.
   b. A device used to store electrical energy.
   c. A repair unit for torn caps.
   d. Acid used on blasting caps.

10. The combined capacitance of two capacitors in parallel is:

    a. Between the values of the two capacitors.
    b. Half the sum of the two capacitors.
    c. The sum of the two capacitors.
    d. Half the value of the smaller capacitor.
    e. Less than the capacitance of either capacitor.

11. If the adjustable breaker provides an instantaneous trip protection for a No. 4 cable, at what point would the electrician set the trip value?

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



APPENDICES

1. Table taken from 30 CFR 75.601-1

Conductor size AWG or MGM	Maximum allowable circuit breaker instantaneous setting (amperes)
14	50
12	75
10	150
8	200
6	300
4	500
3	600
2	800
1	1,000
1/0	1,250
2/0	1,500
3/0	2,000
4/0	2,500
250	2,500
300	2,500
350	2,500
400	2,500

12. Three-phase AC underground cables must be provided with overcurrent protection using a:

a. Overcurrent release coils.
b. Donut transformer.
c. Circuit Breaker.
d. Dual-element fuse.

13. Why is 440-volt, three-phase power more commonly used in mining than 220-volt, three-phase power?

a. Because 440-volt power is more convenient.
b. Because 440-volt power draws less current so cables and control circuit wiring can be smaller.
c. Because 440-volt power draws more current and produces more power than 220-volt power.
d. Because 440-volt power is easier to control.

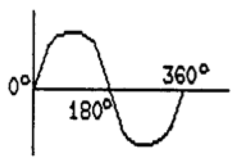
14. Current that changes periodically in direction is:

a. Rectified current.
b. Alternating current.
c. Direction current.
d. Direct current.

15. Define alternating current:

    a. Current that flows in one direction only.
    b. Current produced by a rectifier.
    c. Current changing constantly in magnitude and periodically in direction.
    d. Current that changed from one current to another.

16. The wave form shown below is a:



    a. Sine wave of rectified voltage.
    b. Sine wave of DC voltage.
    c. Sine wave of 3-phase AC voltage.
    d. Sine wave of single-phase AC voltage.

17. The property of an electric circuit that opposes any change in current is called:

    a. Inductance.
    b. Capacitance.
    c. RMS.
    d. Resistance.

18. What position of a selector switch using a voltmeter would you select to check a 120-volt AC circuit to obtain the most accurate reading?

    a. 100 volts AC.
    b. 100 volts DC.
    c. 1,000 volts AC.
    d. 200 volts AC.
    e. 200 volts DC.

19. Operating coils, motors, transformers, relays and solenoids depend upon:

    a. Electro-magnetism for their operation.
    b. Aluminum cores for their operation.
    c. Capacitance for their operation.
    d. Direct current for their operation.

20. Alternating current may be defined as:

    a. Current that changes constantly in magnitude and periodically in direction.
    b. Current that flows in only one direction.
    c. Current that is always positive.
    d. Current that is always negative.

21. Current in an AC circuit may be measured by:

    a. Voltmeter.
    b. Clamp-on ammeter.
    c. Ohmmeter.
    d. Megger.

22. The most reliable method to use to determine whether or not the heart has stopped is by checking the:

    a. Radial pulse located in the wrist.
    b. Temporal pulse located in the temple.
    c. Carotid pulse, which is located in the neck next to the Adam's apple.

23. What is the first step to be followed in aiding a victim of electrical shock?

    a. Begin artificial respiration.
    b. Begin CPR.
    c. Check for burns where the victim made contact.
    d. Check to make sure that the victim is not still in contact with the electricity.

24. Which of the following is NOT a symptom of electrical shock?

    a. Absence of respiration.
    b. Hyperventilation.
    c. Sudden loss of consciousness.
    d. Weak pulse.

25. At what rate should mouth-to-mouth resuscitation be applied?

    a. 15 to 19 times a minute.
    b. 20 to 24 times a minute.
    c. 12 to 15 times a minute.
    d. 8 to 11 times a minute.

26. A burn causing a blister is classified as a:

    a. Second-degree burn.
    b. First-degree burn.
    c. Third-degree burn.
    d. Minor burn.

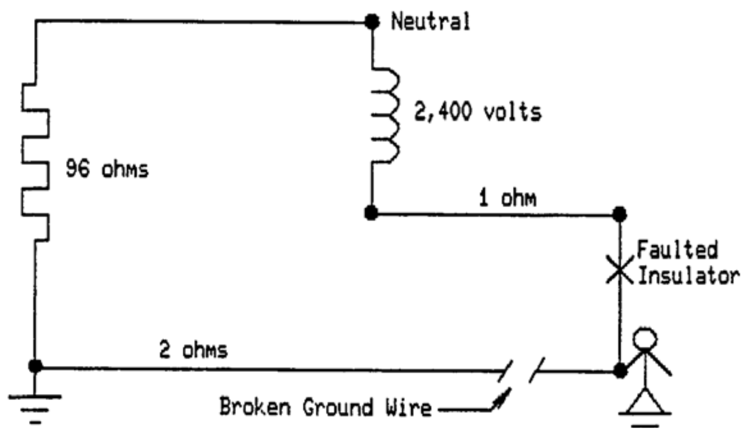
27. How can you tell if a victim receiving mouth-to-mouth resuscitation is getting air into the lungs?

    a. The chest should rise or inflate.
    b. The stomach should rise or inflate.
    c. The victim should soon become conscious.
    d. There is no way of checking, but failure to continue may result in death.

28. How should clothing be removed from a burn?

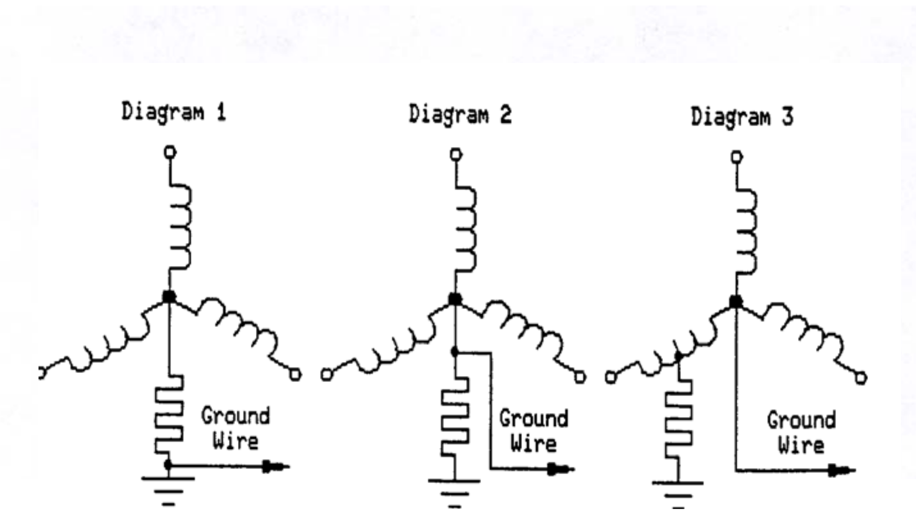
    a. Cut around clothing that has adhered to the burned area.
    b. Loosen clothing that has adhered to the burned area with antiseptic oils.
    c. Moisten with water to loosen clothing that has adhered to the burned area.
    d. Gently peel off clothing that has adhered to the burned area.

29. No current flows through the ground wire. If a miner touches a power center mounted on rubber tires, what, if any, voltage does the miner feel?



a. 1,380 volts.
b. No voltage.
c. 2,400 volts.
d. 1,730 volts.

30. Which illustration shows a properly installed grounding resistor?



a. Diagram 2.
b. Diagram 3.
c. Diagram 1 and diagram 2.
d. Diagram 1.

31. Under fault conditions, the grounding resistor in a high voltage circuit limits the voltage drop in the grounding circuit external to the resistor to not more than:

a. 100 volts.
b. 120 volts.
c. 96 volts.
d. 48 volts.

32. What should the duty rating of a grounding resistor be?

a. Varying.
b. Continuous.
c. Periodic.
d. Intermittent.

33. If current were flowing through a grounding resistor in a 440-volt, resistance-grounded system, this would probably be because:

    a. Grounded phase and ground fault devices were not operating.
    b. Grounded phase and short-circuit devices were not operating.
    c. Grounded phase and undervoltage devices were not operating.
    d. It is normal for current to flow in the grounding resistor.

34. Where should grounding resistors be located?

    a. At the bottom of a borehole.
    b. At the source transformer.
    c. At the bottom of the slope.
    d. In the drift mouth.

35. Should a ground fault occur, what device can be installed to limit the current in the neutral of a three-phase AC system?

    a. A ground check relay.
    b. A circuit breaker.
    c. A grounding resistor.
    d. A blocking diode.

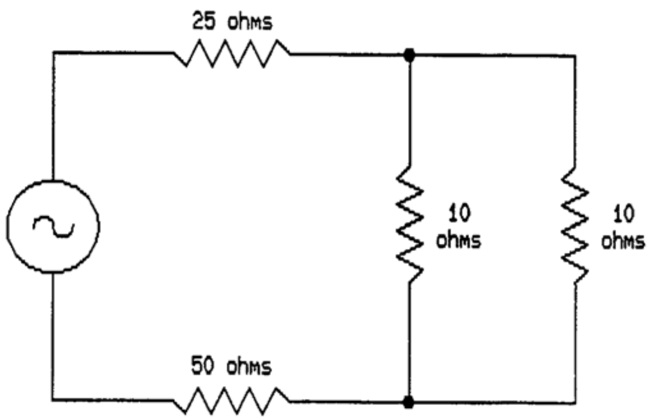
36. High voltage is used to transmit power over long distances:

    a. Because larger wire must be used to carry the larger current.
    b. Because smaller wire can be used to carry the larger current.
    c. Because smaller insulators can be used.
    d. Because less current flowing at high voltage causes less line loss per kilowatt.

37. The neutral ground-bed electrical power system of an underground mine should be separated from the lightning arrestor grounds by at least:

    a. 50 feet.
    b. 75 feet.
    c. 25 feet.
    d. 100 feet.
    e. 10 feet.

38. What is the equivalent resistance of the circuit?



a. 90 ohms.
b. 80 ohms.
c. 85 ohms.
d. 95 ohms.

39. Which of the following does a squirrel cage induction motor have?

a. Slip rings.
b. Stator windings.
c. Brushes.
d. Wound rotor.

40. How do you change the direction of a 3-phase AC motor?

a. Reverse the starting windings.
b. Reverse any two-phase leads.
c. Reverse the series field.
d. Change the brushes.

41. The following motor leads are brought out of a 3-phase motor (T1, T2, T3, T4, T5, T6). This motor is probably for:

    a. Two speeds.
    b. Two-phase operation.
    c. Single-phase operation.
    d. Single voltage

42. The speed of an alternating current, squirrel-cage induction motor is:

    a. Twice as fast as direct current motors.
    b. Nearly constant.
    c. Variable.
    d. Controlled by voltage.

43. What happens to a motor that is connected to a three-phase cable when two of the cable's leads are reversed?

    a. The motor will run at reduced speed.
    b. The motor rotation is reversed.
    c. The motor will run, but not start.
    d. The motor starting torque will be reduced.

44. If any two-phase wires are reversed on a three-phase motor, the motor will:

    a. Overload and cause the breaker to trip.
    b. Stop.
    c. Reverse its rotation.
    d. Short circuit.

45. Which of the following is NOT true about AC power?

    a. It provides good speed control.
    b. It can be rectified.
    c. It can be stepped up or down easily using transformers.
    d. It provides excellent transmission with less voltage loss.

46. A solenoid coil is:

    a. A voltage source.
    b. Another name for a diode.
    c. An electromagnet.
    d. A permanent magnet.

47. The standard frequency of power supplied by the power company is:

    a. 120 cycles per second (120 Hertz).
    b. 60 cycles per second (60 Hertz).
    c. 240 cycles per second (240 Hertz).
    d. 30 cycles per second (30 Hertz).

48. The standard frequency of alternating current used at a mine is:

    a. 25 Hertz
    b. 120 Hertz
    c. 60 Hertz
    d. 50 Hertz

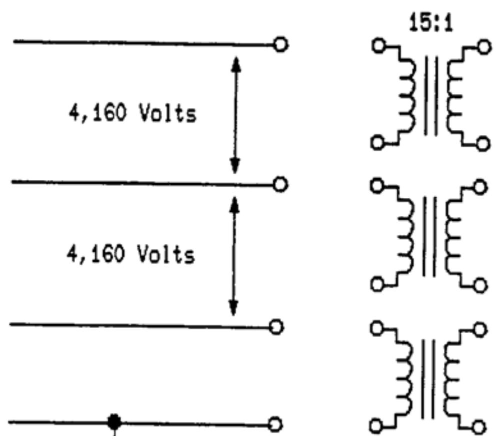
49. The minimum allowable size for trailing cables for mobile haulage equipment powered by alternating current is:

    a. No. 6 AWG.
    b. No. 4 AWG.
    c. No. 8 AWG.
    d. No. 2 AWG.

50. A transformer has 2,000 turns in the primary and 500 turns in the secondary. The primary voltage is 3,200 volts. What is the secondary voltage?

    a. 2,000 volts.
    b. 10,000 volts.
    c. 500 volts.
    d. 800 volts.

51. How should the 3 transformers be wired to obtain 480 volts, phase-to-phase, in the secondary?



a. Wye-Delta.
b. Delta-Delta.
c. Delta-Wye.
d. Wye-Wye.

52. When not connected to a load, the secondary leads of a current transformer should be:

a. Taped.
b. Left open.
c. Shunted and taped.
d. Cut-off.

53. The primary leads of a single-phase transformer should be connected to the:

a. H terminals.
b. Grounding terminals.
c. X terminals.
d. T terminals.

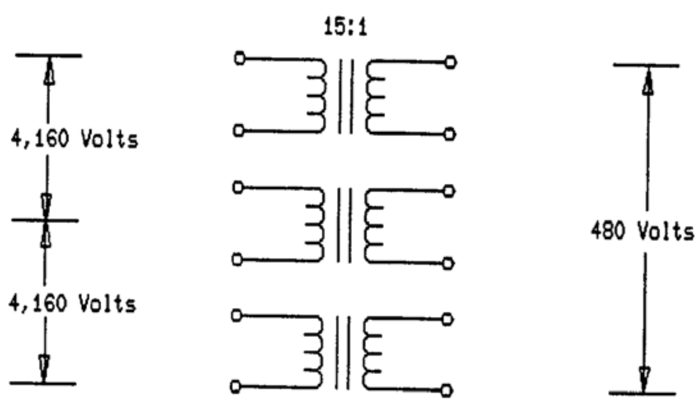
54. Two 10-hp induction motors are operating on 460 volts AC. One motor is connected by single-phase; the other is connected in three-phase. The three-phase will:

   a. Draw less current.
   b. Draw less voltage.
   c. Draw more current.
   d. Operate with equal current voltage.
   e. Draw more voltage.

55. To protect against overcurrent in a three-phase circuit, overcurrent protection must be provided for:

   a. Either 3-phase or none.
   b. At least two phases.
   c. Only one phase.
   d. Either one or two phases.

56. How would you connect the power transformers to obtain the secondary voltage shown below?



   a. Wye-Delta.
   b. Delta-Delta.
   c. Delta-Wye.
   d. Wye-Wye.

57. Compared to the secondary of a loaded, step-down transformer, the primary has:

    a. Higher current and higher voltage.
    b. Lower current and lower voltage.
    c. Lower current and higher voltage.
    d. Higher current and lower voltage.

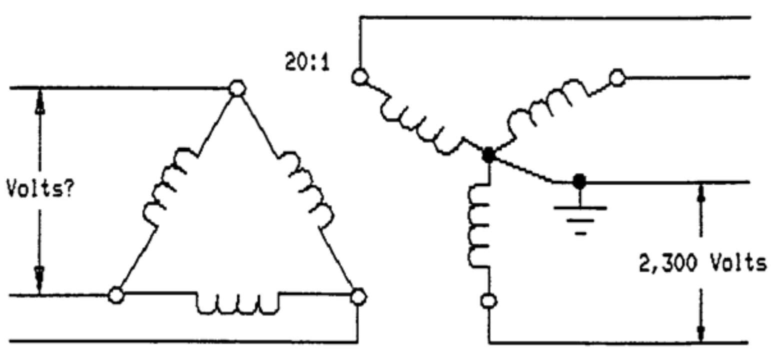
58. If a voltmeter were placed between two phase leads of a three-phase 480-volt system, the meter would read:

    a. 277 volts.
    b. Zero volts.
    c. 480 volts.
    d. 220 volts.

59. A transformer with 10 turns on the primary coil and 100 turns on the secondary is classified as:

    a. A step-up transformer.
    b. A zig-zag transformer.
    c. A step-down transformer.
    d. An auto transformer.

60. In the figure below, the secondary phase-to-neutral voltage is 2,300 volts. What is the primary line voltage?



    a. 46,000 volts.
    b. 79,580 volts.
    c. 115 volts.
    d. 4,600 volts.

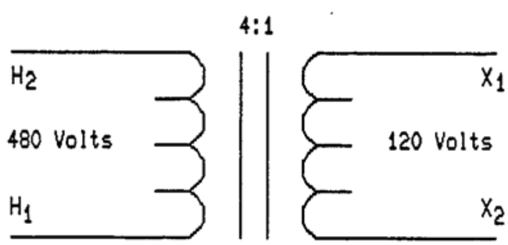
61. A transformer has a primary voltage of 2,800 volts and a secondary reading of 140 volts. If there are 2,000 turns on the primary, how many turns are on the secondary?

    a. 20 turns.
    b. 800 turns.
    c. 100 turns.
    d. 1,000 turns.

62. If 13,200 volts are measured from phase-to-phase across a wye-connected secondary, what is the phase-to-ground voltage?

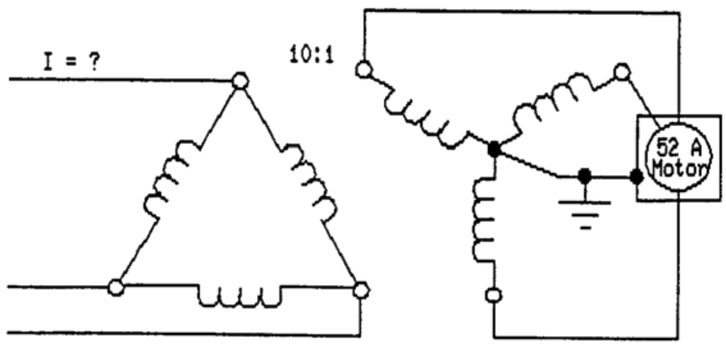
    a. 76,300 volts.
    b. 22,800 volts.
    c. 7,630 volts.
    d. 76.3 volts.

63. Shown below is a single-phase transformer with a turns ratio of 4:1. If the electrician were to connect 480 volts to X1 and X2 terminals, what voltage would be measured across the H1 and H2 terminals?



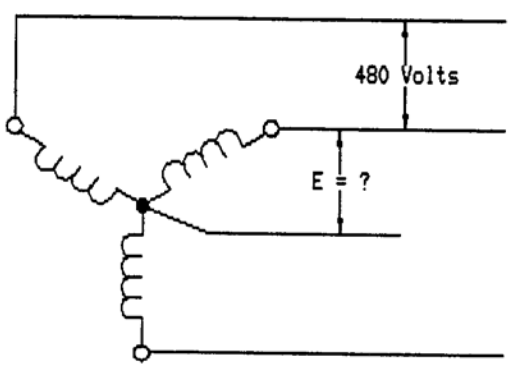
    a. 30 volts.
    b. 1920 volts.
    c. 480 volts.
    d. 120 volts.

64. Under full load conditions the motor draws 52 amps. What is the line current of the primary?



a. 3 amps.
b. 9 amps.
c. 5.2 amps.
d. 7 amps.

65. Shown below is a 3-phase wye connected circuit. If the line-to-line voltage is 480 volts; what is the line-to-neutral voltage?

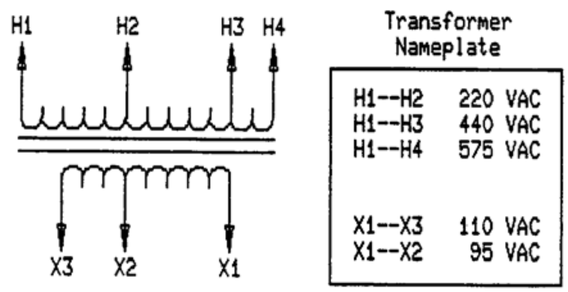


a. 575.
b. 277.
c. 0.
d. 480.

66. The current on the primary side of a step-down transformer with a 4:1 ratio will be:

a. The current and voltage will be greater on the primary side.
b. Four times greater than that of the secondary.
c. The current will be the same; only the voltage will differ.
d. Four times less than that of the secondary.

67. If a 440 VAC power source was to be used to supply the transformer below, to what terminals on the transformer would one connect the line leads to obtain a 110 VAC secondary voltage?



a. H1-H2.
b. H1-H4.
c. H1-H3.
d. H2-H3.
e. H2-H4.

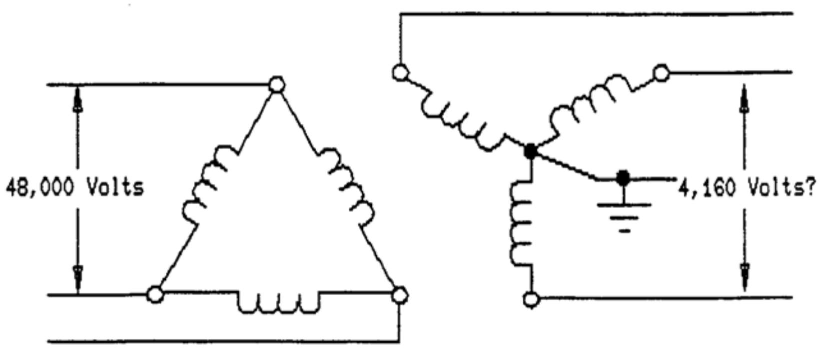
68. What steps up or steps down AC voltage?

a. Hi-lift truck.
b. Rectifier.
c. Battery.
d. Transformer.

69. Surface transformer installations, unless constructed to eliminate shock hazards, must be installed at least:

a. 10 feet off the ground.
b. 6 feet off the ground.
c. 8 feet off the ground.
d. 12 feet off the ground.

70. What would be the ratio of the transformers shown?



a. 20:1
b. 15:1
c. 11.5:1
d. 10:1

71. The load to which the secondary winding of a current transformer was connected has opened. The secondary leads should be:

a. Disconnected.
b. Opened.
c. Short-circuited after power has been removed.
d. Reversed.

72. The primary function of a power transformer is to provide:

a. Single-phase DC voltage.
b. Step current down for ammeter.
c. Full-load, three-phase voltage.
d. Step voltage down for voltmeter.

73. What value of voltage will be measured from phase-to-phase, in a wye-connected secondary, if 2,300 volts is measured from phase-to-ground?

a. 3,979 volts.
b. 2,300 volts.
c. 397 volts.
d. 1329.4 volts.

74. A current transformer has a ratio of 350:5. If the phase current is 70 amperes, what would be the secondary current?

    a. 1 amp.
    b. 350 amps.
    c. 70 amps.
    d. 5 amps.

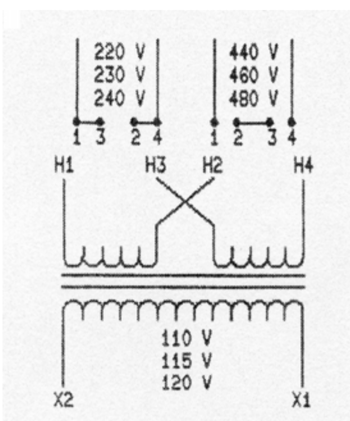
75. The size of a transformer is measured in:

    a. Kilovolt ampere (KVA).
    b. Meg ohms.
    c. Kilovolt ampere reactive (KVAR).
    d. Kilowatt (KW).

76. If a voltmeter is connected between a phase lead and the ground of a three-phase 480-volt system, the meter will read:

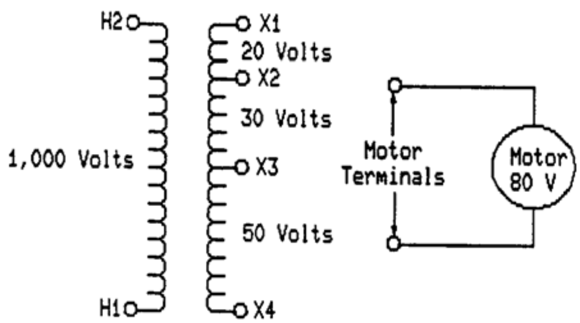
    a. 277 volts.
    b. 220 volts.
    c. Zero volts.
    d. 480 volts.

77. How should the transformer shown below be connected to obtain 115 volts on the secondary side if the input voltage is 460 volts?



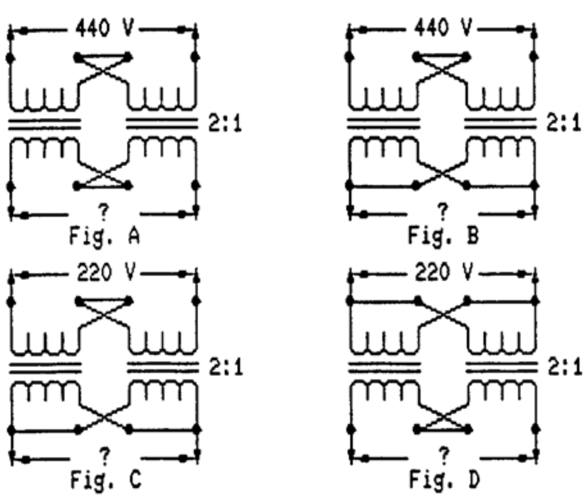
    a. H2 and H3 jumpered together-Input on H1 and H4
    b. H1 and H2 jumpered together-Input on H3 and H4.
    c. H3 and H4 jumpered together-Input on H1 and H2.
    d. H1 and H2 jumpered together, H3 and H4 jumpered together-Input on H1 and H4.

78. Which terminals should be connected to the motor terminals to provide the correct motor voltage?



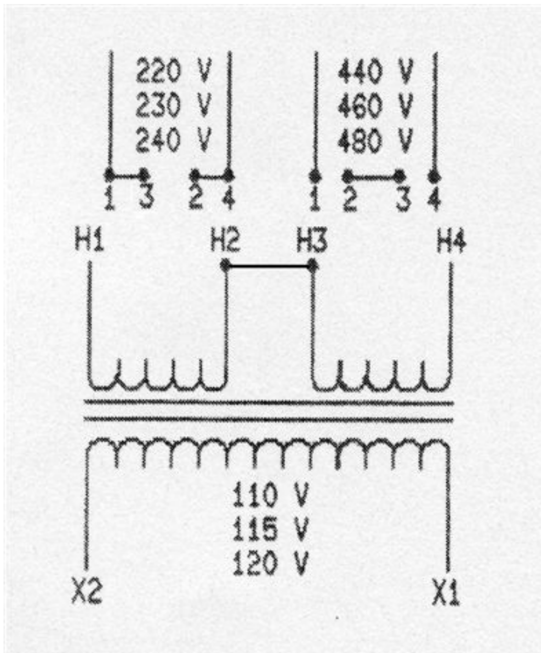
a. X1 and X3.
b. H2 and H1.
c. X1 and X4.
d. X2 and X4.

79. Which of the following connections would produce a 110 VAC secondary?



a. Figure C.
b. Figure B.
c. Figure A.
d. Figure D.

80. The transformer shown below has two primary windings. If 240 volts is applied to the primary terminals H1 and H4, what will be the secondary output voltage?

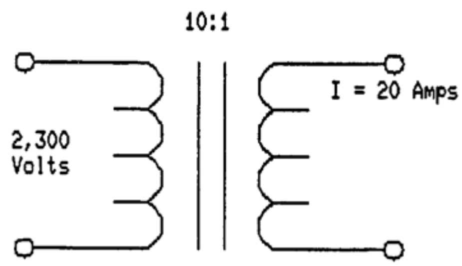


a. 115 volts.
b. 60 volts.
c. 120 volts.
d. 110 volts.

81. AC voltage is raised or lowered by means of:

a. Transformers.
b. Alternators.
c. Batteries.
d. Generators.

82. What is the current on the primary side?

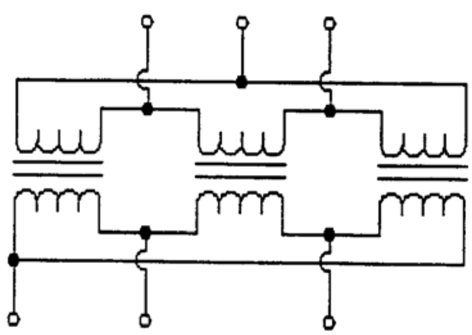


a. 2 amps.
b. 10 amps.
c. .2 amps.
d. 200 amps.

83. The main function of CT's and PT's on a main substation is to:

a. Provide power to the smaller loads beyond the main sub.
b. Provide power to control circuit.
c. Handle full-load conditions for larger mining equipment.
d. Allow for metering voltage and current.

84. The transformers in the diagram are connected:



a. Wye-Delta.
b. Delta-Delta.
c. Wye-Wye.
d. Delta-Wye.

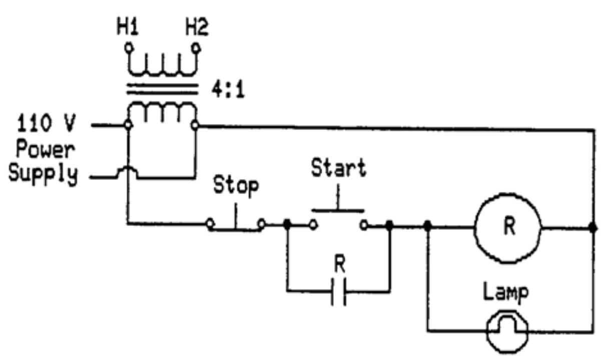
85. The transformer used only to measure voltage is a:

    a. Power transformer.
    b. Current transformer.
    c. Potential transformer.
    d. Zig-zag transformer.

86. A transformer has a primary voltage of 2,400 volts and a secondary reading of 120 volts. If there are 1,500 turns on the primary, how many turns are on the secondary?

    a. 150 turns.
    b. 20 turns.
    c. 75 turns.
    d. 30,000 turns.

87. If a 110-volt power supply were connected to trouble shoot the control circuit in the diagram below, the voltage at H1-H2 on the primary side of the transformer would be:



    a. 440 volts.
    b. 460 volts.
    c. 120 volts.
    d. Zero.

88. A control power transformer:

    a. Provides single-phase power to smaller loads such as lights, heaters, etc.
    b. Is merely used in back-up systems for ground-fault detection.
    c. Serves a metering function only, providing power to no loads.
    d. Has a single turn primary.

89. A transformer has 1,600 turns in the primary and 400 turns in the secondary. The primary voltage is 2,400 volts. What is the secondary voltage?

    a. 600 volts.
    b. 9,600 volts.
    c. 400 volts.
    d. 1,600 volts.

90. Current transformers, or CT's, are used to:

    a. Reduce high AC current to lower values and provide isolation between high voltage circuits and metering.
    b. Increase AC current.
    c. Reduce DC current.
    d. Increase DC current.

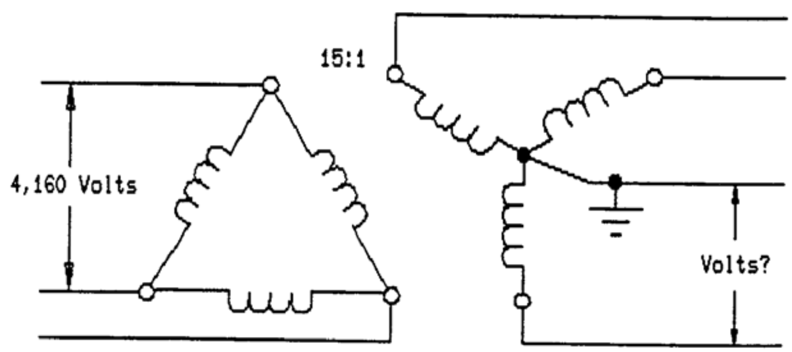
91. A transformer with a 1:1 ratio is usually a (an):

    a. Current transformer.
    b. Isolation transformer.
    c. Step-up transformer.
    d. Equalizing transformer.
    e. Step-down transformer.

92. All transformers step voltage up or down by:

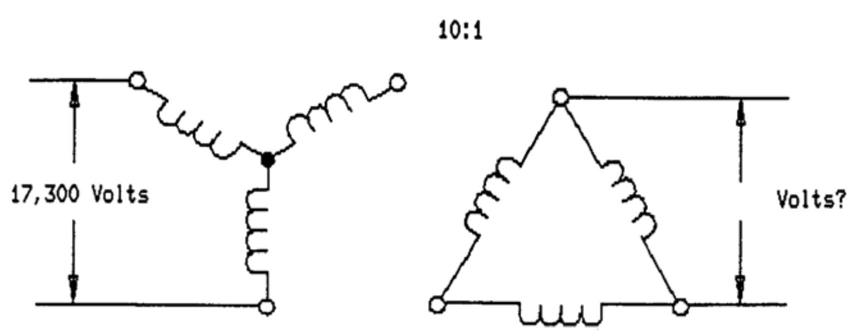
    a. Capacitance.
    b. Impedance.
    c. Inductance.
    d. Rectification.

93. How much voltage will be measured phase-to-ground in the figure below?



a. 480 volts.
b. 115 volts.
c. 230 volts.
d. 277 volts.

94. What is the voltage across the secondary of this transformer?



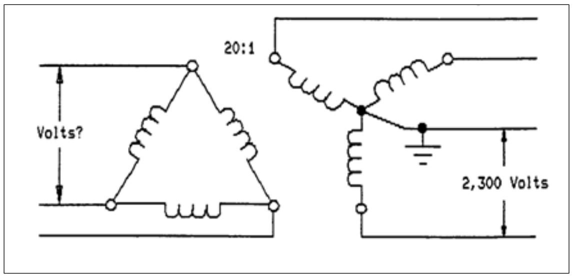
a. 1,730 volts.
b. 100 volts.
c. 173 volts.
d. 1,000 volts.

95. When connecting 3 single-phase transformers into a three-phase system, which of the following is NOT required for the single-phase transformers.

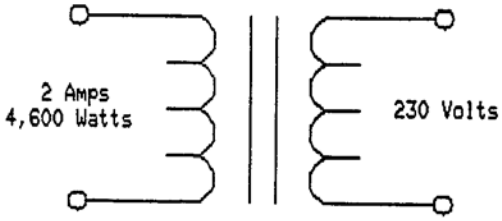
    a. They should be made by the same manufacturer.
    b. They should have the same impedance.
    c. They should have the same voltage ratings.
    d. They should have the same KVA ratings.

96. The following transformers are connected how:

    a. Wye-Wye.
    b. Wye-Delta.
    c. Delta-Wye.
    d. Delta-Delta.

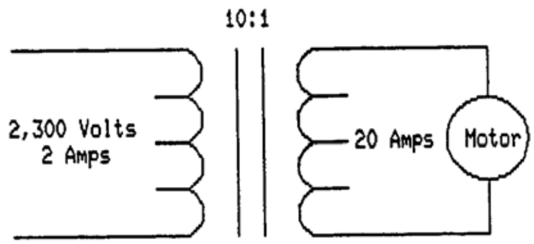


97. What is the turns ratio of the single-phase transformer shown below?



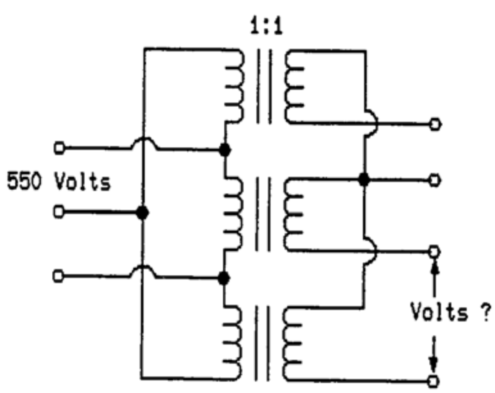
    a. 20:1.
    b. 15:1.
    c. 25:1.
    d. 10:1.

98. What voltage will be supplied to the motor shown below?



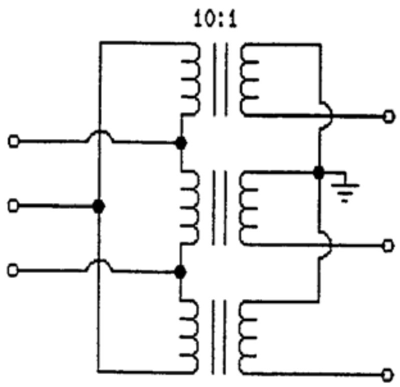
a. 23,000 volts.
b. 23 volts.
c. 230 volts.
d. 2,300 volts.

99. What would be the phase-to-phase voltage of the secondary?



a. 1,100 volts.
b. 953 volts.
c. 55 volts.
d. 550 volts.

100. If the line current in the primary is 34 amps, what would be the line current in the secondary?

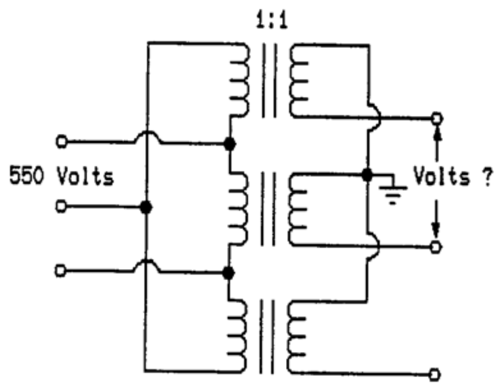


a. 590 amps.
b. 196 amps.
c. 59 amps.
d. 340 amps.

101. The secondary windings on a 10:1 step-down transformer will have a wire size:

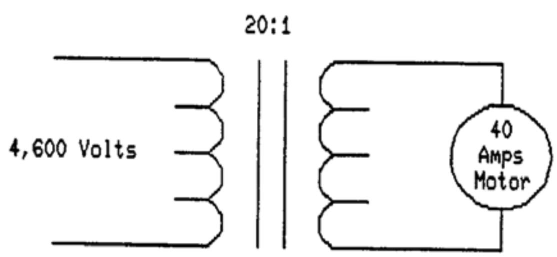
a. Not related to that found in the primary winding.
b. Smaller than that found in the primary winding.
c. Larger than that found in the primary winding.
d. Equal to that of the primary winding.

102. What voltage is measured across the secondary if the primary voltage of a three-phase transformer is 550 volts?



a. About 1,650 volts.
b. About 950 volts.
c. About 1,100 volts.
d. About 318 volts.

103. Below is a single-phase transformer with a turns ratio of 20:1. What is the primary current?



a. 2 amps.
b. 5.7 amps.
c. 115 amps.
d. 230 amps.

104. A transformer with 3,000 turns in the primary winding has a primary voltage of 4,800 volts and a secondary voltage of 240 volts. How many turns are in the secondary winding?

   a. 150 turns.
   b. 1500 turns.
   c. 300 turns.
   d. 6,000 turns.

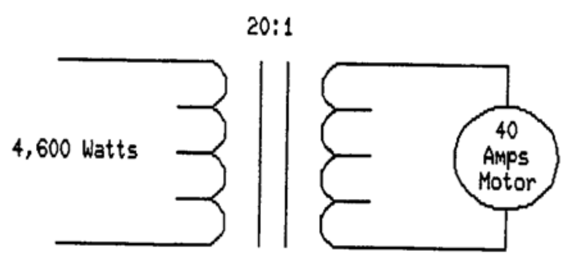
105. Find the turns ratio of a single-phase transformer with the following values: Primary power of 10 KW, secondary current of 200 amps, and primary voltage of 250 volts.

   a. 2.5:1.
   b. 50:1.
   c. 25:1.
   d. 5:1.

106. 460 volts AC is required to operate two motors, one connected in single-phase and the other connected in three-phase. The three-phase motor will:

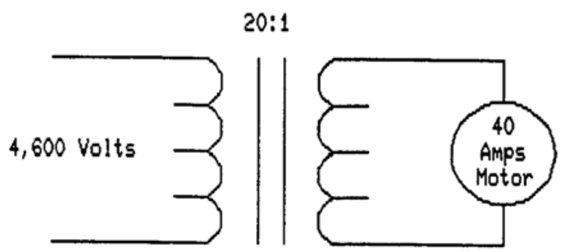
   a. Draw more voltage.
   b. Draw less voltage.
   c. Operate with equal current voltage.
   d. Draw less current.
   e. Draw more current.

107. Shown below is a single-phase transformer with a turns ratio of 20:1. What will be the voltage measured across the motor?



a. 440 volts.
b. 230 volts.
c. 115 volts.
d. 800 volts.

108. Shown below is a single-phase transformer with a turns ratio of 20:1. How much power is used in the secondary circuit?



a. 230 watts.
b. 2,300 watts.
c. 23,000 watts.
d. 4,600 watts.
e. 9,200 watts.

109. Using a 10:1 ratio transformer, the terminals on the secondary side or lower voltage side would be marked:

a. S.
b. P.
c. X.
d. H.

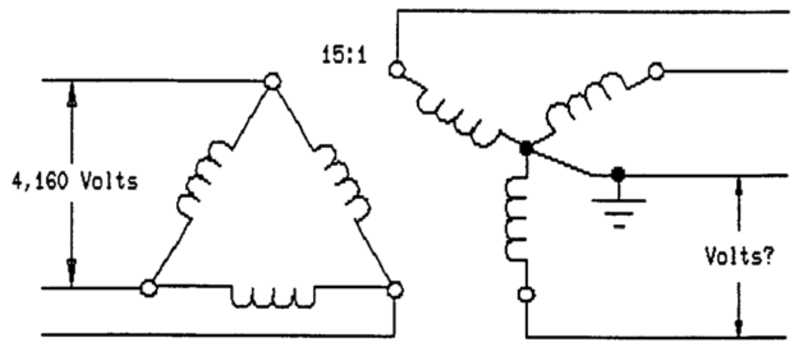
110. If the conductors of a balanced, three-phase circuit pass through a current transformer, how many amps will flow in the transformer?

a. The sum of the amperage in the three phase currents.
b. The phase current divided by 1.73.
c. Zero amps.
d. The same as in the phase current.

111. Which of the following is NOT an acceptable method for the installations of surface transformers?

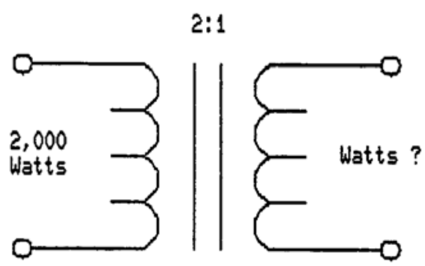
a. They must be surrounded by a locked fence 6 feet high.
b. They must be installed at least 7 feet above the ground.
c. They must be constructed so as to eliminate shock hazards.
d. They must be constructed inside a locked building.

112. What is the phase-to-neutral voltage in the secondary of the transformer below?



a. 7,200 volts.
b. 277 volts.
c. 62,400 volts.
d. 480 volts.

113. If 2,000 watts is read in the primary of a single-phase transformer, what is the wattage in the secondary? (Assuming no losses.)



a. 2,000 watts.
b. 1,000 watts.
c. 30,000 watts.
d. 133 watts.

114. The purpose of a zig-zag transformer is to:

a. Supply control voltage for circuit breakers
b. Derive a neutral for grounding purposes.
c. Supply trip voltage for shunt trip units.
d. Furnish control voltage for ground monitoring systems.

115. Compared to the secondary of a loaded, step-down transformer, the primary has:

    a. Higher current and higher voltage.
    b. Lower current and lower voltage.
    c. Lower current and higher voltage.
    d. Higher current and lower voltage.

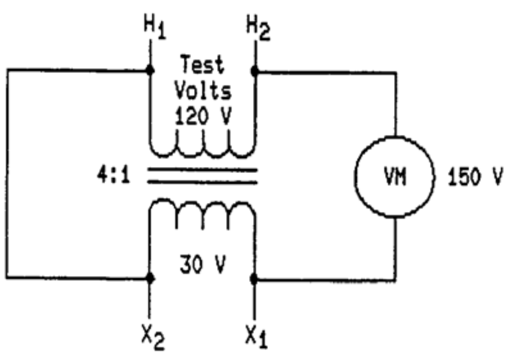
116. Find the turns ratio of a single-phase transformer with the following values: Primary power of 5KW, secondary current of 100 amps, and primary voltage of 250 volts.

    a. 5:1
    b. 25:1
    c. 20:1
    d. 50:1

117. A transformer with 1,500 turns in the primary winding has a primary voltage of 2,400 volts and a secondary voltage of 120 volts. How many turns are in the secondary winding?

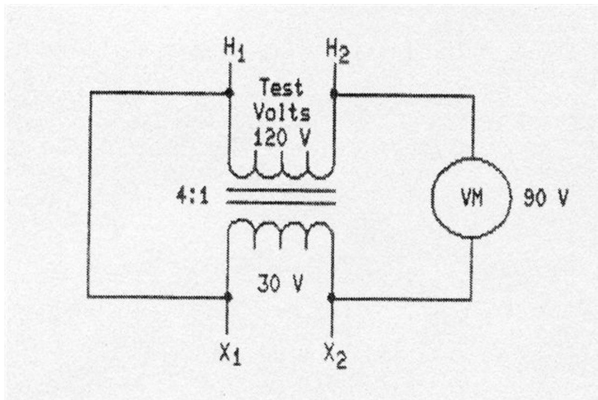
    a. 75 turns.
    b. 3,000 turns.
    c. 750 turns.
    d. 300 turns.

118. The single-phase transformer shown below has:



    a. South pole polarity.
    b. Subtractive polarity.
    c. Additive polarity.
    d. North pole polarity.

119. The single-phase transformer shown below has:

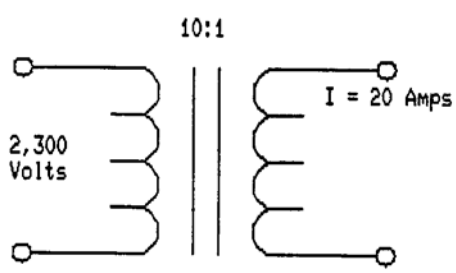


a. South pole polarity.
b. North pole polarity.
c. Subtractive polarity.
d. Additive polarity.

120. If you use a clamp-on ammeter or tong tester around all three-phase wires of an energized three-phase circuit simultaneously:

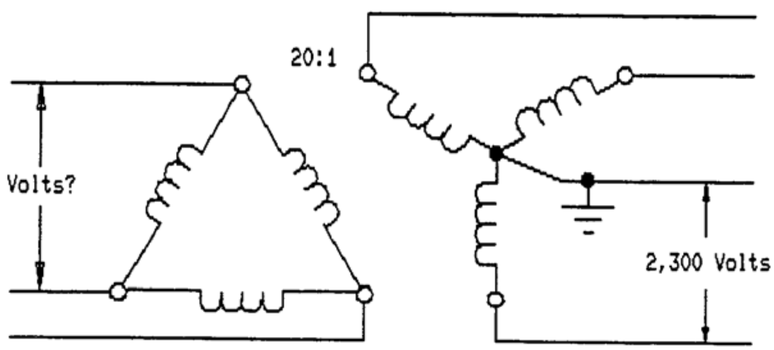
a. The voltage will read full voltage.
b. The current reading would be three times that of one phase.
c. The current will read zero.
d. The voltage will read zero.
e. The current will read full current.

121. The voltage in the primary side is 2,300 volts. What is the voltage on the secondary side?



a. 115 volts.
b. 2,300 volts.
c. 230 volts.
d. 23,000 volts.

122. What is the phase-to-phase voltage of the primary?



a. 79,580 volts.
b. 46,000 volts.
c. 115 volts.
d. 7,200 volts.

ANSWER GUIDE
AC Theory and Application

Question	Answer	Question	Answer	Question	Answer
1	A	44	C	87	A
2	D	45	A	88	A
3	B	46	C	89	A
4	C	47	B	90	A
5	C	48	C	91	B
6	B	49	A	92	C
7	B	50	D	93	D
8	D	51	C	94	D
9	B	52	C	95	A
10	C	53	A	96	C
11	C	54	A	97	D
12	C	55	B	98	C
13	B	56	C	99	B
14	B	57	C	100	B
15	C	58	C	101	C
16	D	59	A	102	B
17	A	60	A	103	A
18	D	61	C	104	A
19	A	62	C	105	D
20	A	63	B	106	D
21	B	64	B	107	C
22	C	65	B	108	E
23	D	66	D	109	C
24	B	67	C	110	C
25	C	68	D	111	B
26	A	69	C	112	B
27	A	70	A	113	A
28	A	71	C	114	B
29	C	72	C	115	C
30	D	73	A	116	A
31	A	74	A	117	A
32	B	75	A	118	C
33	A	76	A	119	C
34	B	77	A	120	C
35	C	78	D	121	C
36	D	79	B	122	B
37	C	80	B		
38	B	81	A		
39	B	82	A		
40	B	83	D		
41	A	84	B		
42	B	85	C		
43	B	86	C		

Multiple Choice question(s).
Read the question and select the appropriate answer from the list provided.

1. Which of the following motors are considered to be constant or nearly constant speed?

    a. Compound-wound and shunt-wound.
    b. Series-wound and shunt-wound.
    c. Series-wound and compound-wound.
    d. Series-wound only.

2. The best insulator against the lines of magnetic force is:

    a. Distance.
    b. Lead.
    c. Glass.
    d. Mica.

3. Like poles of a magnet will:

    a. Repel each other.
    b. Attract each other.
    c. Act in the same way as unlike poles of a magnet.
    d. Neither attracts nor repel.

4. Which of the following motors CANNOT be run without a load?

    a. Series-wound.
    b. Universal motor.
    c. Compound-wound.
    d. Shunt-wound.

5. Unlike poles of a magnet will:

   a. Neither attract nor repel.
   b. Act in the same way as like poles of a magnet.
   c. Repel each other.
   d. Attract each other.

6. How can the resistance of a trolley system be lowered?

   a. Install circuit breakers.
   b. Install trolley wire guards.
   c. Install cutout switches.
   d. Install track bonds and cross bonds.

7. The armature of a direct current motor, when running, generates:

   a. A very low frequency DC voltage.
   b. A high frequency DC voltage.
   c. A counter-EMF.
   d. An EMF.

8. A triac is?

   a. A polarity diode.
   b. A special type fuse.
   c. A bi-directional device that can pass current in either direction.
   d. A capacitor

9. Which of the following is NOT an electro-magnet?

   a. Relay coil with an iron core.
   b. A solenoid.
   c. A contactor coil with an iron core.
   d. A wire wound resistor.

10. A trolley system is an electrical system with:

    a. Two main conductors, a feed wire and a return.
    b. Some feed wires and two return wires.
    c. A ground check conductor with two return wires.
    d. One main conductor.

11. The specific gravity of the electrolyte of a fully charged battery should be:

    a. 1.175 to 1.200.
    b. 1.260 to 1.280.
    c. 1.200 to 1.225.
    d. 1.100 to 1.110.

12. Storage battery charging stations must be provided with what kind of current protection?

    a. Forward.
    b. Alternating.
    c. Reverse.
    d. Under.

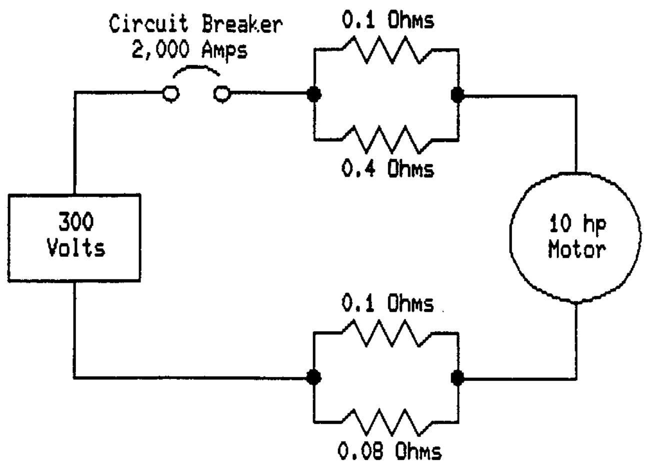
13. The instrument used to check the electrolyte of a battery is a:

    a. Galvanometer.
    b. Electrometer.
    c. Tong-tester.
    d. Hydrometer.

14. A battery capable of producing 20 amperes steadily for 20 hours at 80 degrees Fahrenheit would have an ampere-hour rating of:

    a. 40 ampere-hours.
    b. 400 ampere-hours.
    c. 20 ampere-hours.
    d. 160 ampere-hours.

15. If a short circuit occurs at the motor terminals, does the circuit breaker open or remain closed?

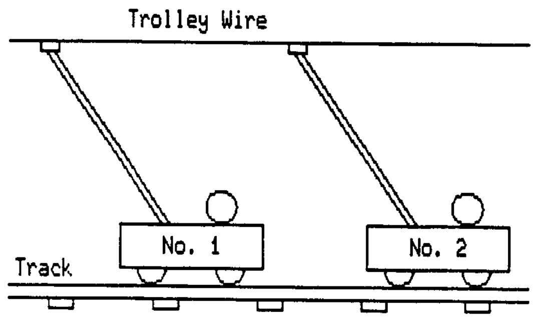


a. The breaker will not open because the trip setting is too high.
b. No, the breaker will not open because this circuit is grounded.
c. Yes, the breaker will open because the short-circuit exceeds the setting of the breaker.
d. Need more information to answer this question.

16. The unit of measurement of current is:

a. Watts.
b. Volts.
c. Amperes.
d. Ohms.

17. The track equipment in the diagram is connected electrically and would be classified as being connected:



   a. In series with one another.
   b. In a series-parallel circuit.
   c. Parallel to one another.

18. Power is measured with a:

   a. Wattmeter.
   b. Voltmeter.
   c. Ammeter.
   d. Ohmmeter.

19. Resistance is measured with a:

   a. Wattmeter.
   b. Voltmeter.
   c. Ammeter.
   d. Ohmmeter.

20. Which of the following stays the same in all parts of a series circuit?

    a. Voltage.
    b. Power.
    c. Current.
    d. Resistance.

21. What is Ohm's Law?

    a. R=EI.
    b. E=IR.
    c. W=EI.
    d. I=ER.

22. Define current:

    a. The opposition to voltage.
    b. The movement of electrons in a circuit.
    c. Opposition to the flow of current.
    d. Electromotive force.

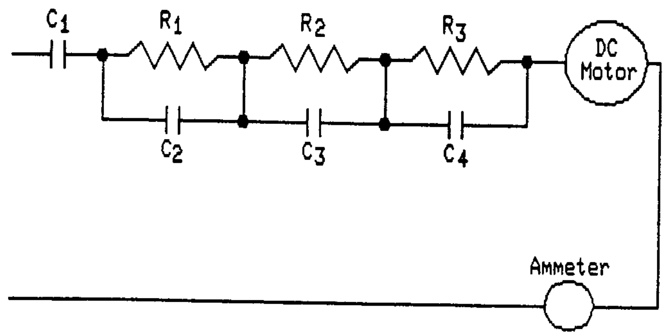
23. Define direct current:

    a. Current that operates the single-phase relay.
    b. Current that flows in one direction only.
    c. Current produced by a transformer.
    d. Current changing constantly in magnitude and periodically in direction.

24. What is the hazard of pouring water into battery acid “electrolyte”?

    a. There is a hazard of blowing the contents back into your face, “explosive reaction”.
    b. There is no hazard.
    c. The mixture will produce methane gas.

25. The instant each contactor closes, the ammeter reading should:



a. Remain the same.
b. Show an increase in current.
c. Show a decrease in current.

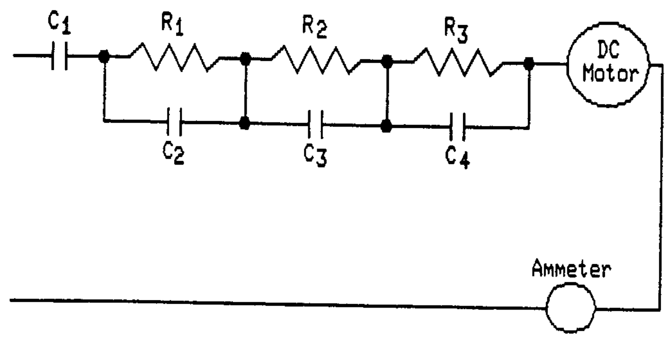
26. Define direct current:

a. Current that flows in only one direction.
b. All currents except sine-wave current.
c. Current that never changes in magnitude.
d. Current that constantly changes in magnitude and periodically in direction.

27. The unit of measurement of resistance is?

a. Ohms.
b. Amperes.
c. Watts.
d. Volts.

28. The contactors in this diagram close sequentially. The motor should read full voltage when contactor:



a. C4 closes.
b. C1 opens.
c. C1 closes.
d. C3 closes.
e. C2 closes.

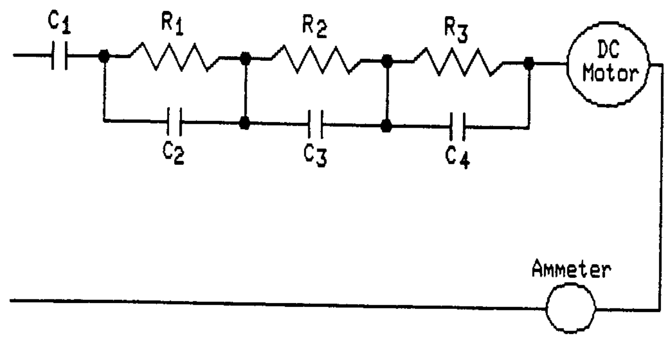
29. When should water be added to a battery?

a. After charging
b. Before charging.
c. During charging
d. Never.

30. What is the flow of electrons in a conductor?

a. Resistance.
b. Voltage.
c. Current.
d. Power.

31. With each closing of a contactor, the motor voltage should:



a. Decrease.
b. Remain the same.
c. Increase.

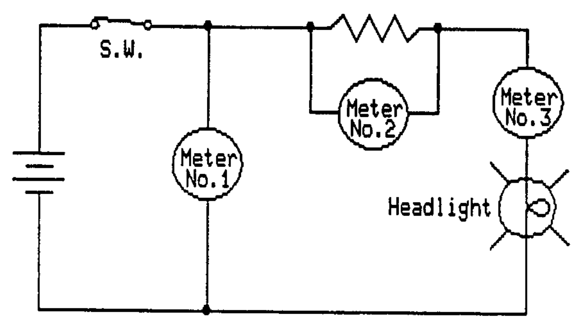
32. What is the opposition to flow of electric current?

a. Current.
b. Power.
c. Voltage.
d. Resistance.

33. What is the rate that work is done or heat is dissipated?

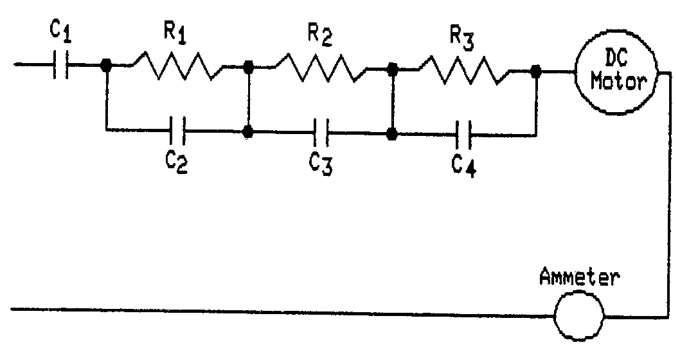
a. Current.
b. Resistance.
c. Power.
d. Voltage.

34. Meter number 3 measures what?



a. Current.
b. Continuity.
c. Voltage.
d. Resistance.

35. When contactor "C1" closes, the motor will receive:

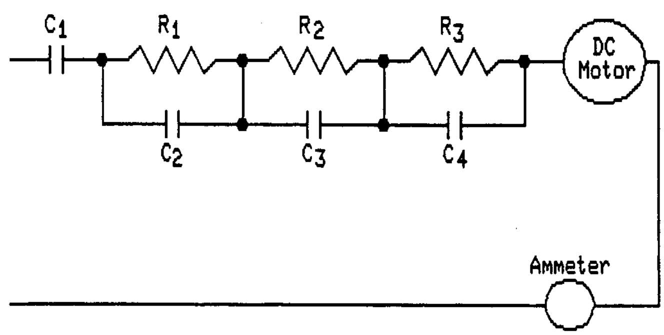


a. Partial voltage and partial current.
b. Full voltage and partial current.
c. Full voltage and current.
d. Full current and partial voltage.

36. Which current flows in only one direction?

    a. Alternating current.
    b. Indirect current.
    c. Direct current.
    d. Stray current.

37. When contactor C1 is closed and C2, C3, and C4 remain open, the motor will be running at what speed?



    a. The motor will not be running.
    b. Slow speed.
    c. Full speed.
    d. The contactor sequence has no control over speed.

38. What is the unit of electromotive force or electric pressure?

    a. Power.
    b. Resistance.
    c. Voltage.
    d. Current.

39. The unit of measurement of power is:

    a. Volts.
    b. Ohms.
    c. Watts.
    d. Amperes.

40. Define resistance:

    a. The opposition to flow of electrons in a circuit.
    b. The flow of current in a circuit.
    c. Electromotive force.
    d. The opposition to the flow of voltage through a circuit.

41. Current is measured with a(an):

    a. Voltmeter.
    b. Ohmmeter.
    c. Ammeter.
    d. Wattmeter.

42. Resistors are rated in ohms and:

    a. Farads.
    b. Hertz.
    c. Volts.
    d. Watts.

43. Voltage is measured with a:

    a. Ammeter.
    b. Wattmeter.
    c. Voltmeter.
    d. Ohmmeter.

44. Which of the following is NOT a requirement of an explosion-proof enclosure?

    a. It must protect the enclosure from damage.
    b. It must prevent ignition of surrounding methane atmosphere.
    c. It must prevent internal explosions.
    d. It must prevent discharge of flame.

45. Which of the following is a requirement of an explosion-proof enclosure?

    a. It must prevent damage to surrounding work area.
    b. It must prevent ignition of surrounding methane atmosphere.
    c. It must prevent damage to major machine parts.
    d. It must prevent personal injury.

46. Which of the following is NOT true about electrical shocks?

    a. Burns will appear only at the point where contact is made to the energized circuit.
    b. The heart beat may alter.
    c. Nerves that control breathing can be paralyzed.
    d. The heart may stop beating.

47. Chemical burns caused by battery acid should be washed with clean water for at least:

    a. 2 minutes.
    b. 15 minutes.
    c. 1 minute.
    d. 3 minutes.

48. What should be used in treating an eye injury caused by battery acid?

    a. Neutralizing solutions.
    b. Dilute boric acid.
    c. Medicated cream.
    d. Clean water.

49. How long should treatment for shock be continued?

    a. Until the victim is quiet and in a stable condition.
    b. Until the victim's breathing returns to normal.
    c. Until the victim receives medical attention.
    d. Until the victim feels that it is no longer necessary.

50. The first step in treating a chemical burn, such as one caused by battery acid, is to:

    a. Cool and disinfect with a cream or salve.
    b. Apply cold applications.
    c. Dress with a loose cloth.
    d. Flush thoroughly with water.

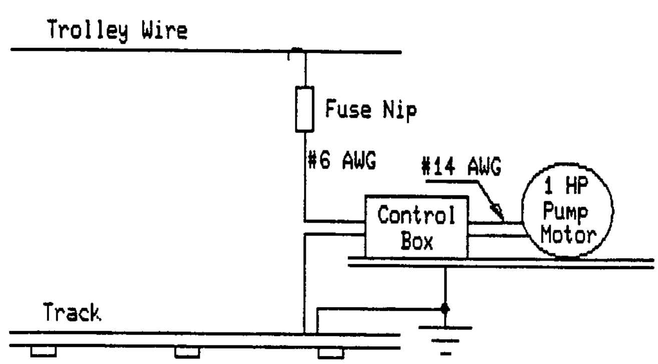
51. What is the first step in treating a chemical burn of the eye?

    a. Flush the burn the clean water.
    b. Wash the burn with diluted hydrogen peroxide
    c. Apply a dressing.
    d. Transport the victim to the surface.

52. If the victim of an electrical shock has been burned while in contact with electricity, the first treatment you should apply, if the victim's heart and respiratory system are still functioning, is to:

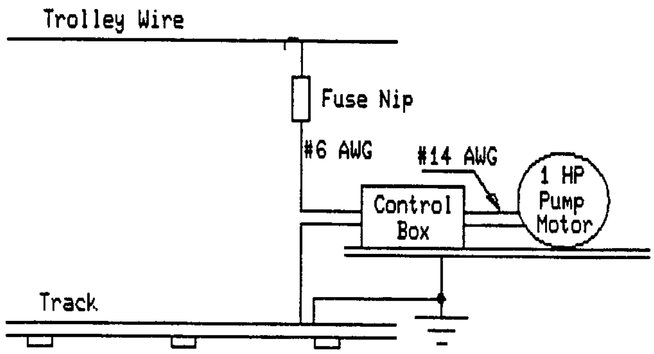
    a. Treat for physical shock.
    b. Treat the burn.
    c. Transport the victim at once.
    d. Apply CPR.

53. The fuse located in the nip provides protection for:



    a. The cable leading to the control box and the pump motor.
    b. The cable leading to the control box.
    c. The pump motor
    d. The trolley wire.

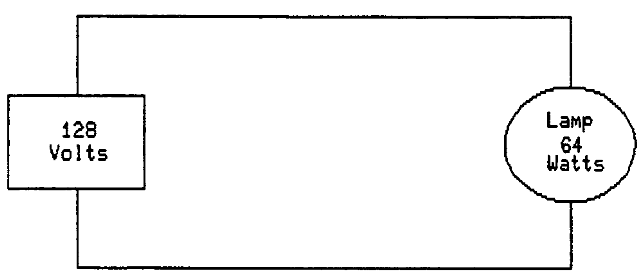
54. What would be the maximum-sized fuse you would use in the trolley nip according to the information provided?



Conductor size (AWG or MGM)	Single conductor cable		Two conductor cable	
	Ampacity	Max. fuse rating	Ampacity	Max. fuse rating
14			15	15
12			20	20
10			25	25
8	60	60	50	50
6	85	90	65	70
4	110	110	90	90
3	130	150	105	110
2	150	150	120	125
1	170	175	140	150
1/0	200	200	170	175
2/0	235	250	195	200
3/0	275	300	225	225
4/0	315	350	260	300
250	350	350	285	300
300	395	400	310	350
350	445	450	335	350
400	480	500	360	400
450	515	600	385	400
500	545	600	415	450

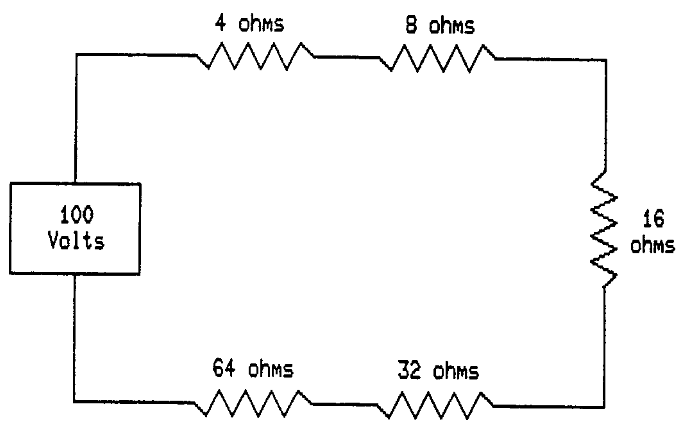
a. 65-amp.
b. 90-amp.
c. 70-amp.
d. 85-amp.

55. What is the resistance of the permissible lamp shown below?



a. 64 ohms.
b. 256 ohms.
c. 128 ohms.
d. 5 ohms.

56. What is the voltage drop across the 64-ohm resistor?



a. 55.1 volts
b. 51.2 volts
c. 48.8 volts
d. 25.6 volts

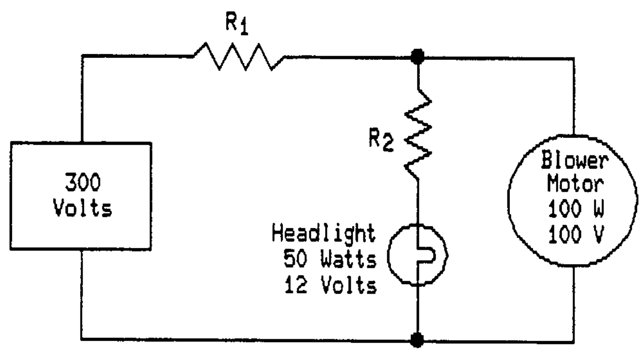
57. How many watts are in one horsepower?

a. 2,000 watts.
b. 1,000 watts.
c. 746 watts.
d. 373 watts.

58. How many kilowatts are used to develop 50 horsepower?

a. 44.8 kilowatts
b. 60.6 kilowatts
c. 37.3 kilowatts
d. 55.5 kilowatts

59. What value resistor must be used as R1 in order to supply the proper voltage in the circuit shown below?

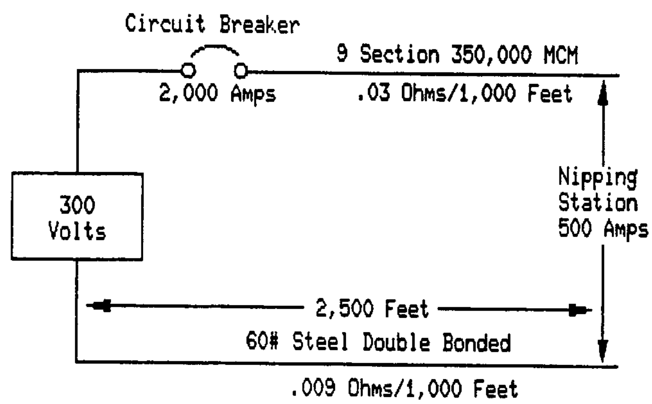


a. 38 ohms.
b. 28 ohms.
c. 27 ohms.
d. 42 ohms.

60. You have three 9-volt batteries. How should you connect them in order to supply 27 volts?

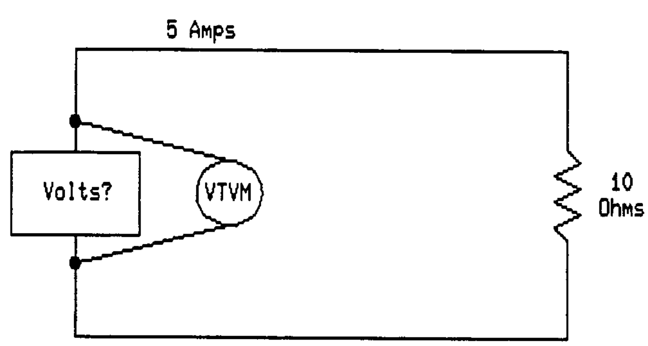
a. In series.
b. Straight across.
c. In series-parallel.
d. In parallel.

61. What is the voltage at the nip station?



a. 251 volts.
b. 225 volts.
c. 300 volts.
d. 275 volts.

62. What voltage would be read on the voltmeter connected to the circuit shown below?

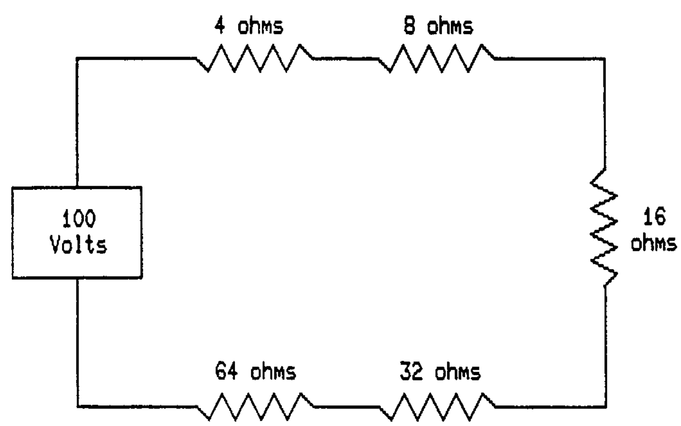


a. 75 volts.
b. 50 volts.
c. 45 volts.
d. 100 volts.

63. What voltage would be required to force 10 amps through a 50-ohm resistor?

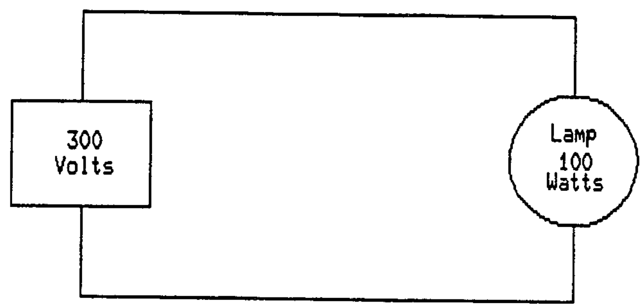
    a. 120 volts.
    b. 300 volts.
    c. 500 volts.
    d. 60 volts.

64. Find the current flow in the figure below.



    a. 7.5 amps.
    b. 10.0 amps.
    c. 9.0 amps.
    d. 0.8 amps.

65. What is the resistance of the lamp?

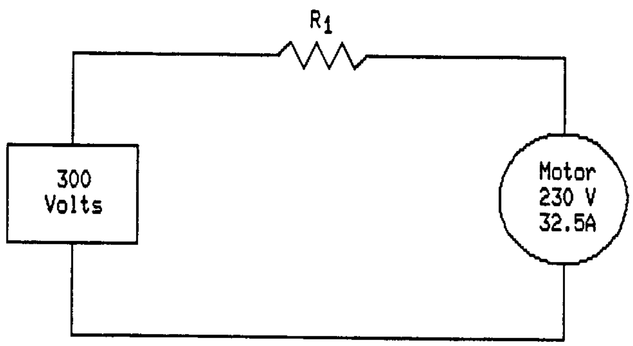


a. 3 ohms.
b. 909 ohms.
c. 1,000 ohms.
d. 999 ohms.

66. What is the total voltage of eight 12-volt batteries connected in series?

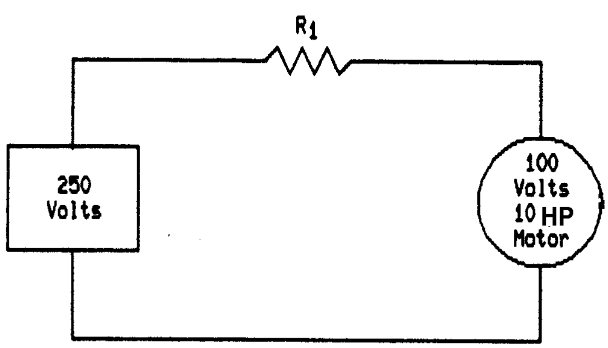
a. 12 volts.
b. 96 volts.
c. 48 volts.
d. 812 volts.

67. The motor draws 32.5 amps under full load conditions. How much voltage will the resistor R1 have to drop in order to apply proper voltage to the motor?



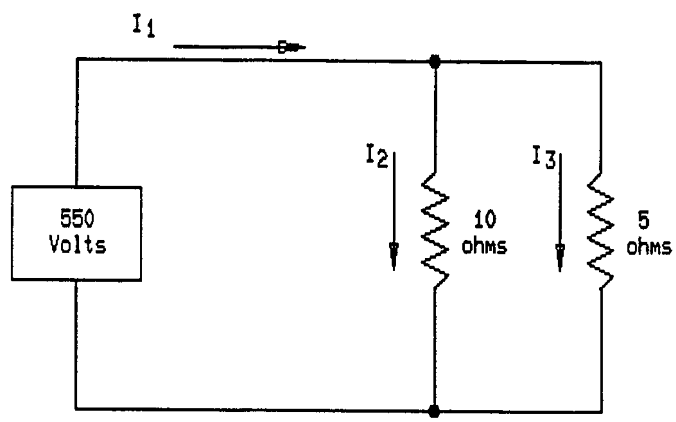
a. 250 volts.
b. 50 volts.
c. 300 volts.
d. 70 volts.

68. How much power will be consumed by R1? (Allow 746 watts per horsepower.)



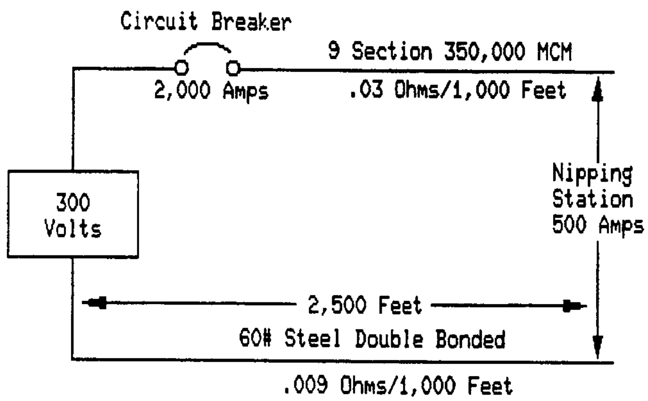
a. 11,190 watts.
b. 4,000 watts.
c. 1,500 watts.
d. 10,000 watts.

69. What is the value of I1 in the circuit shown below?



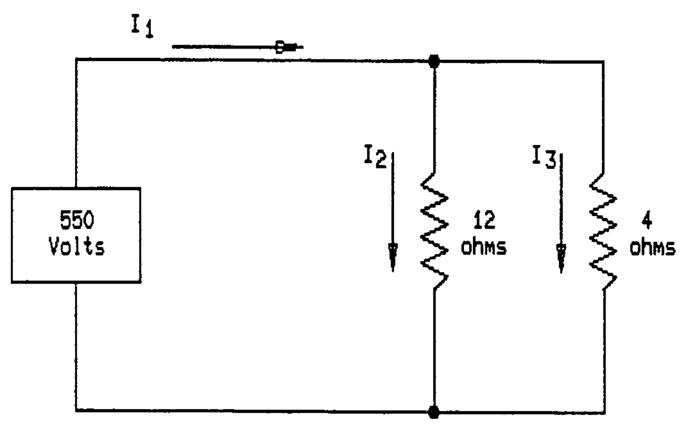
a. 165 amps.
b. 850 amps.
c. 270 amps.
d. 185 amps.

70. If a short circuit occurs at the nip station, how much fault current will flow?



a. 2,150 amps.
b. 3,076 amps.
c. 3,500 amps.
d. 2,500 amps.

71. How much power will be consumed by the 4-ohm resistor in the circuit shown below?

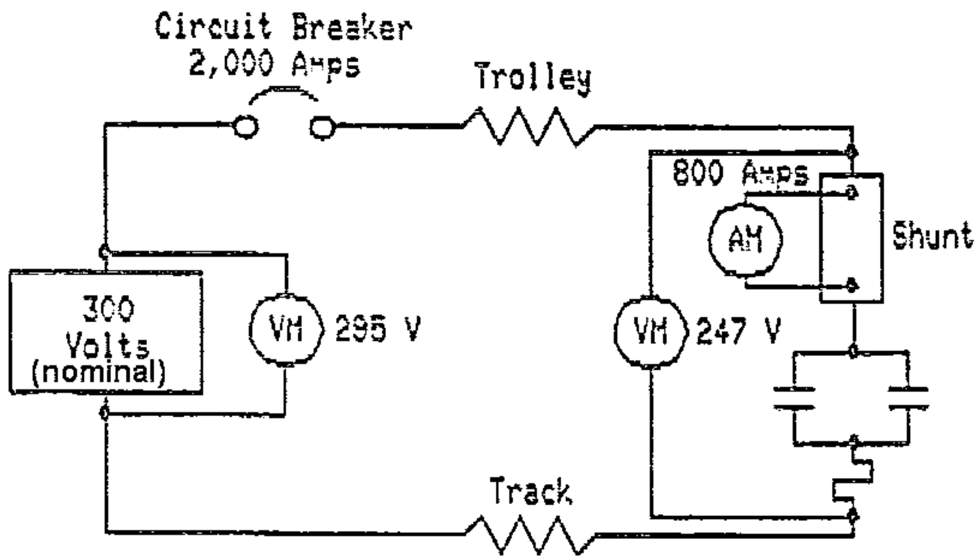


a. 7,562 watts.
b. 756 watts.
c. 75,625 watts.
d. 75 watts.

72. Batteries connected in parallel provide:

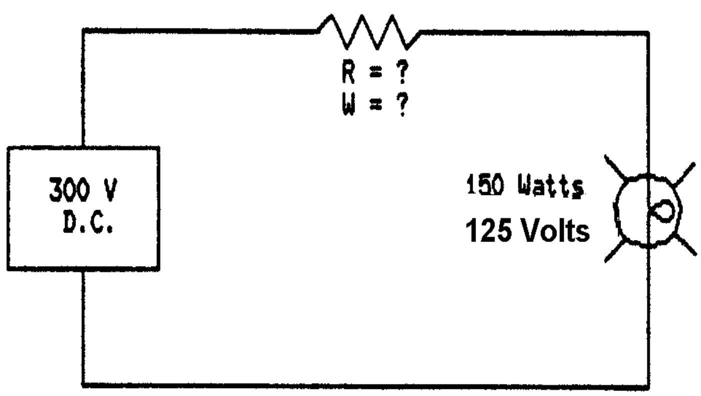
a. Higher voltage, current unchanged.
b. No change in either voltage or current.
c. Both current and voltage are increased.
d. Higher current with voltage remaining the same.

73. A voltage drop test was conducted on the circuit shown below. If the voltage drop of the system is 48 volts at a load current of 800 amps, what would be the resistance of the trolley system?



a. 16.67 ohms.
b. 6 ohms.
c. 0.375 ohms.
d. 0.06 ohms.

74. Determine the ohmic resistance and wattage rating of the resistor needed to limit the voltage drop across the headlight to 125 volts. The headlight is rated at150 watts.

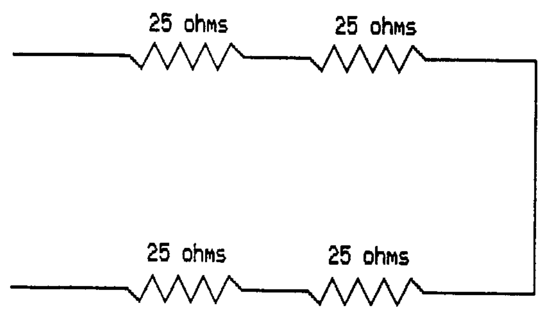


a. 175 ohms, 150 watts
b. 146 ohms, 210 watts
c. 1.2 ohms, 300 watts
d. 150 ohms, 175 watts

75. In a parallel circuit:

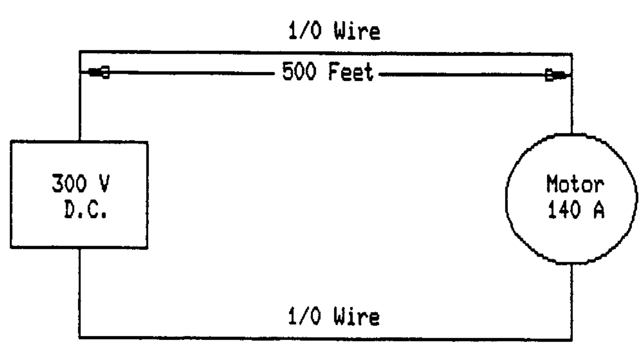
a. Total resistance is less than the smallest resistor.
b. Total resistance is the total of all resistors.
c. Total resistance is more than the greatest resistor.
d. Total resistance is equal to the greatest resistor.

76. What is the total resistance of four 25-ohm resistors connected in series?



a. 25 ohms.
b. 50 ohms.
c. 6.25 ohms.
d. 100 ohms.

77. A 1/0, 1-conductor cable is used to feed a 140 amp motor load. The resistance of 1/0 single-conductor is 0.102 ohms per 1,000 feet. The cable is 500 feet long. What is the voltage drop in the cable?

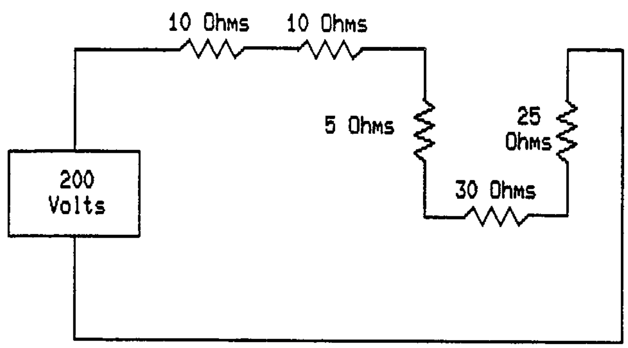


a. 140 volts.
b. 14.28 volts.
c. 250 volts.
d. 300 volts.

78. The combined resistance of two resistors in parallel is:

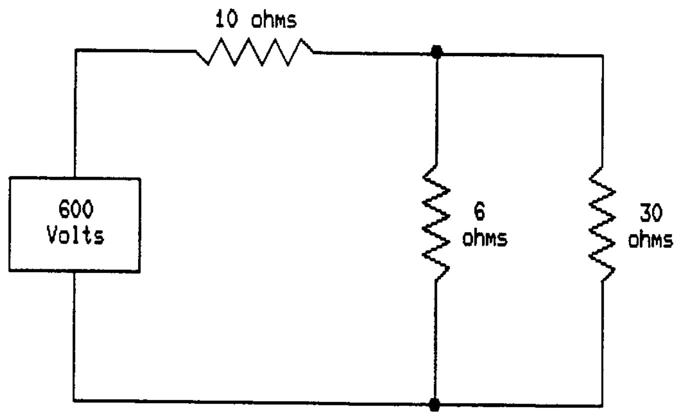
    a. Larger than the resistance of either resistor.
    b. Half the sum of the two resistors.
    c. Between the values of the two resistors.
    d. Less than the resistance of either resistor.
    e. The sum of the two resistors.

79. How many amps flow through the 5-ohm resistor in this circuit?



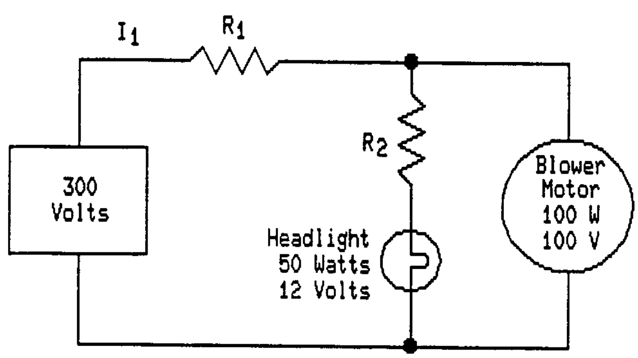
    a. 2.5 amps.
    b. 5.0 amps.
    c. 40.0 amps.
    d. 8.0 amps.

80. How much power is consumed by the 10-ohm resistor?



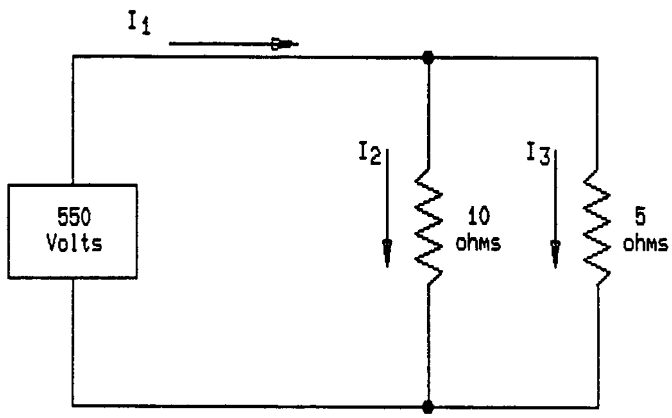
a. 13,000 watts.
b. 16,000 watts.
c. 24,000 watts.
d. 15,000 watts.

81. What is the value of I1 in the circuit shown below?



a. 5.2 amps.
b. 4 amps.
c. 2.1 amps.
d. 3 amps.

82. What is the value of I3 in the circuit shown below?



a. 90 amps.
b. 110 amps.
c. 150 amps.
d. 2,550 amps.

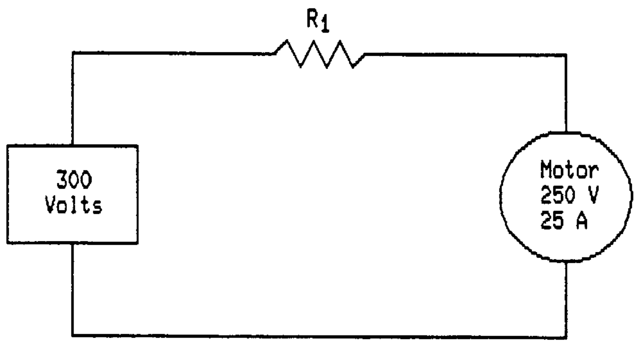
83. What is the total resistance of three 16-ohm resistors connected in series?

a. 48 ohms.
b. 8 ohms.
c. 32 ohms.
d. 16 ohms.

84. If the cross-sectional area of a conductor is increased, its resistance will:

a. Stay the same.
b. Increase.
c. Decrease.
d. Change color.

85. In the circuit shown below the resistor (R1) must drop 50 volts. What should be the ohmic value of the resistor?

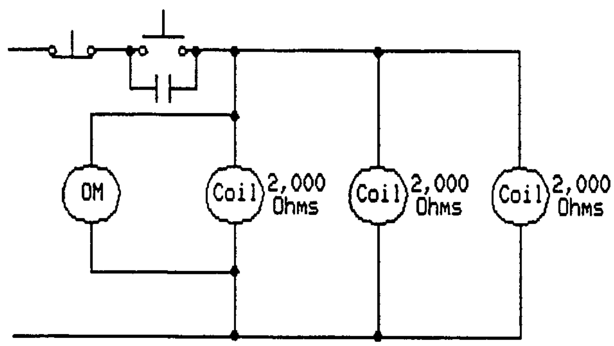


a. 2 ohms.
b. 12 ohms.
c. 10 ohms.
d. 50 ohms.

86. The longer the conductor, the greater the:

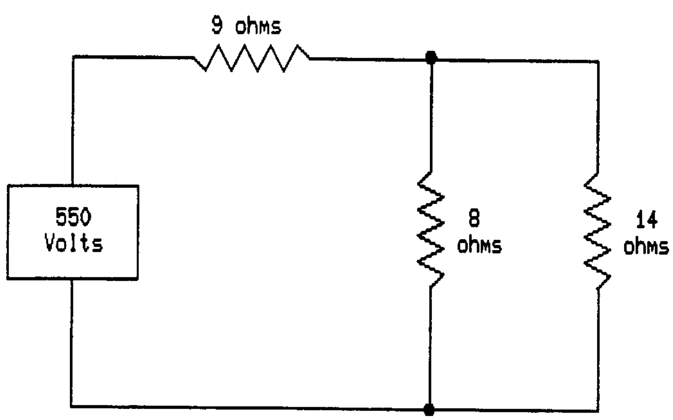
a. Electrons.
b. Power factor.
c. Amperes.
d. Resistance.

87. An ohmmeter is connected as shown below. Each coil has a resistance of 2,000 ohms. What would be the approximate reading of the ohmmeter?



a. 6,000 ohms.
b. 250 ohms.
c. 2,000 ohms.
d. 667 ohms.

88. How much power is consumed by the 9-ohm resistor?

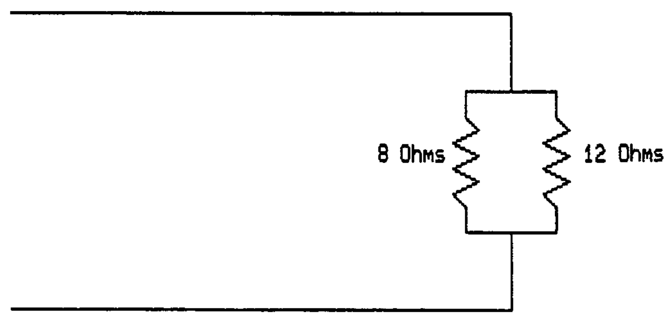


a. 13,710 watts.
b. 20,000 watts.
c. 9,870 watts.
d. 15,890 watts.

89. How must two 12-volt batteries be connected in order to increase the current capacity?

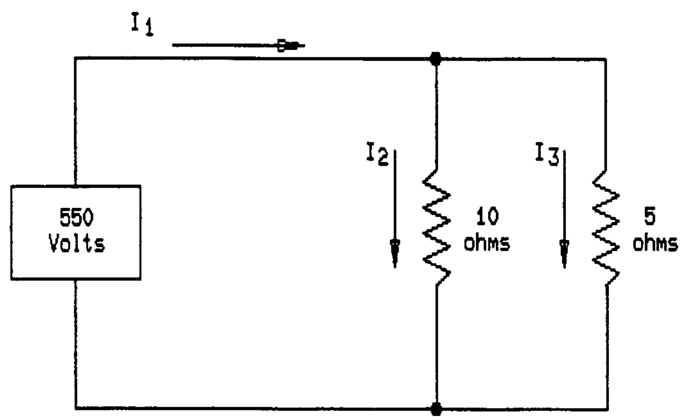
    a. In parallel.
    b. In series.
    c. Current capacity is fixed.
    d. In series-parallel.

90. What is the equivalent resistance of an 8-ohm and a 12-ohm resistor connected in parallel?



    a. 0.2 ohms.
    b. 4.8 ohms.
    c. 20.0 ohms.
    d. 96.0 ohms.

91. What is the value of I2 in the circuit shown below?

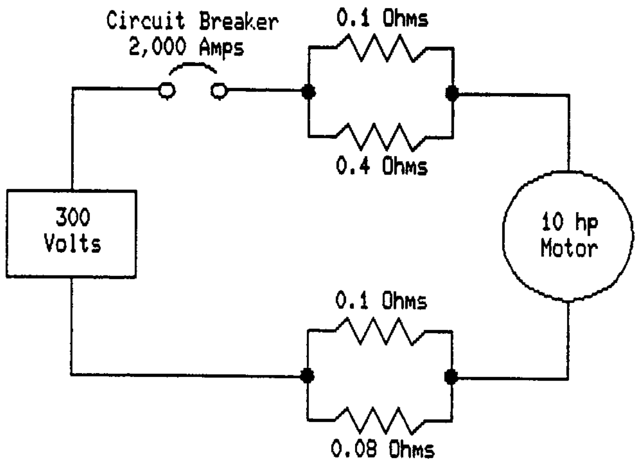


a. 75 amps.
b. 55 amps.
c. 35 amps.
d. 80 amps.

92. What voltage would be required to force 10 amps through a 20-ohm resistor?

a. 160 volts
b. 200 volts
c. 100 volts
d. 30 volts

93. How much voltage will be measured at the motor terminals? Allow 4 amps per horsepower:



a. 280 volts.
b. 275 volts.
c. 295 volts.
d. 265 volts.

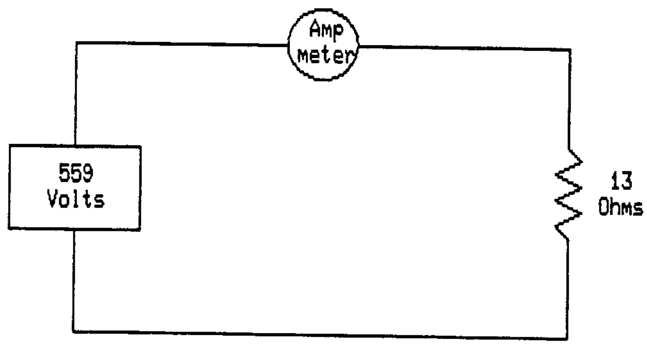
94. What is the equivalent resistance of two 8-ohm resistors connected in parallel?

a. 4.0 ohms.
b. 21.2 ohms.
c. 16.0 ohms.
d. 64.0 ohms.

95. What is the total resistance of four 15-ohm resistors connected in series?

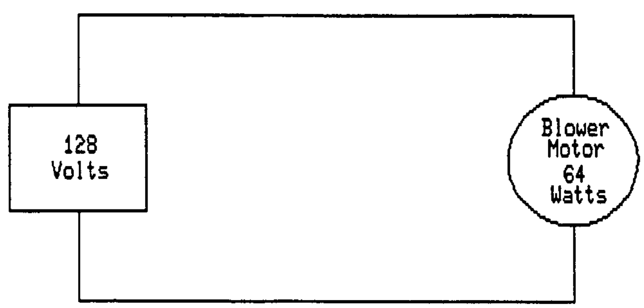
a. 60 ohms.
b. 15 ohms.
c. 30 ohms.
d. 3.75 ohms.

96. What should the ammeter in this circuit read?



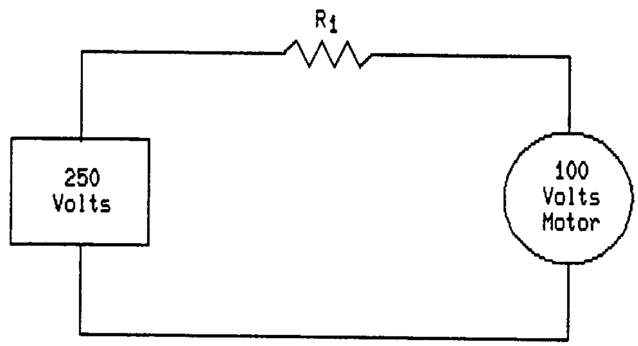
a. 52 amps.
b. 43 amps.
c. 41 amps.
d. 33 amps.

97. How much current flows through the blower motor in the circuit shown below?



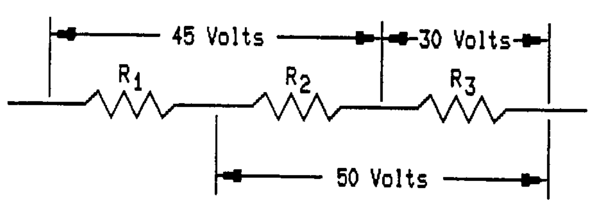
a. 0.5 amps.
b. 5.0 amps.
c. 2.0 amps.
d. 25.0 amps.

98. The motor draws 40 amps under full load conditions. How much voltage will the resistor R1 have to drop in order to apply proper voltage to the motor?



a. 250 volts.
b. 100 volts.
c. 150 volts.
d. 200 volts.

99. What is the voltage across R1?

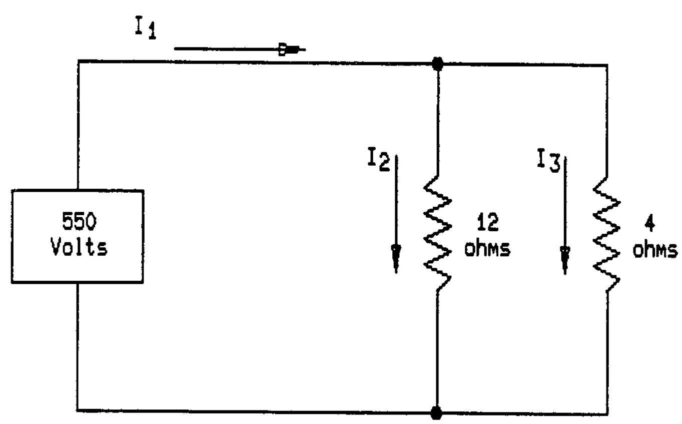


a. 25 volts.
b. 20 volts.
c. 30 volts.
d. 75 volts.

100. Current in a series circuit:

a. Stays the same.
b. Does not exist.
c. Makes difference.
d. Adds up.

101. Find the source current I1 in the circuit diagram below.

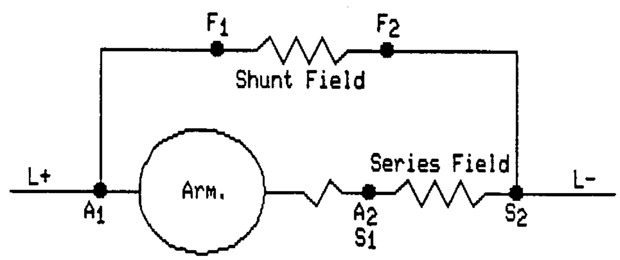


a. 11.4 amps.
b. 183.0 amps.
c. 34.3 amps.
d. 48.8 amps.

102. Voltage in a parallel circuit:

a. Is different.
b. Stays the same.
c. Steps up and down.
d. Add up.

103. How should the circuit below be changed in order to reverse the rotation of the motor?



a. Interchange L+ and L-.
b. Interchange A1 and A2.
c. Interchange A1 and S2.
d. Interchange F1 and A1.

104. The maximum distance allowed between track crossbonds is:

a. 2,000 feet.
b. 100 feet.
c. 200 feet.
d. 500 feet.

105. The purpose of bonding a track is to provide:

a. Undervoltage protection.
b. A path of high resistance.
c. A path of low resistance.
d. Short-circuit protection.

106. The advantage of DC over AC is that DC offers:

a. Easier step-up or step-down using transformers.
b. Less arcing.
c. Better speed control on motors.
d. Smaller voltage losses in transmission.

107. Trailing cable on DC-powered mobile haulage equipment must be at least:

   a. No. 8 AWG.
   b. No. 4 AWG.
   c. No. 2 AWG.
   d. No. 6 AWG.

108. The minimum allowable size of trailing cable on DC-powered mobile haulage equipment is:

   a. No. 4 AWG.
   b. No. 8 AWG.
   c. No. 6 AWG.
   d. No. 2 AWG.

109. The most common reason that solid state devices fail is:

   a. Moisture
   b. Corrosion
   c. Heat
   d. None of the above

110. The dangerously explosive gas emitted by charging a lead-acid storage battery is:

   a. Methane.
   b. Hydrogen.
   c. Nitrogen.
   d. Silicone.

111. The core of an electro-magnet should be made of:

   a. Soft iron.
   b. Hard steel.
   c. Aluminum.
   d. Stainless steel.

112. The explosive gas that is generated when a battery is charging is:

  a. Helium.
  b. Carbon monoxide.
  c. Pure oxygen.
  d. Nitrogen.
  e. Hydrogen.

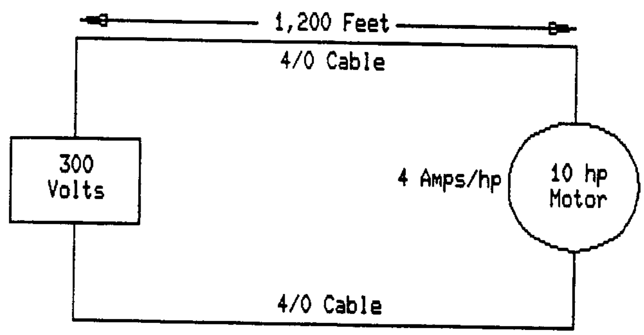
113. What must be provided at underground battery charging stations?

  a. Ventilation.
  b. A soda-acid fire extinguisher.
  c. Hydrogen detectors.
  d. Lightning arrestors.

114. What is the equivalent resistance of two 16-ohm resistors connected in parallel?

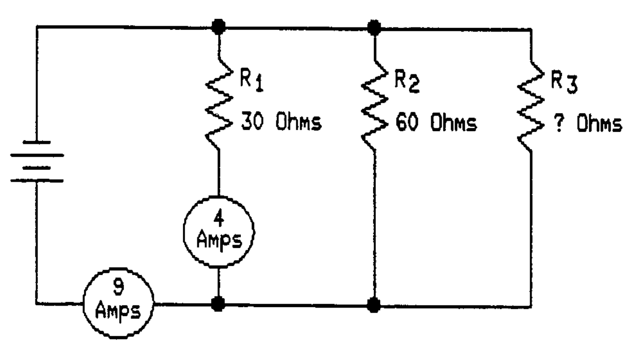
  a. 8 ohms.
  b. 32 ohms.
  c. 12 ohms.
  d. 16 ohms.

115. A 10 hp motor is connected to a 300-volt DC source through 1,200 feet of two-conductor, number 4/0 cable. Under full load conditions, what voltage will be measured at the motor terminals? (Resistance of 4/0 wire is 0.051 per 1,000 feet)



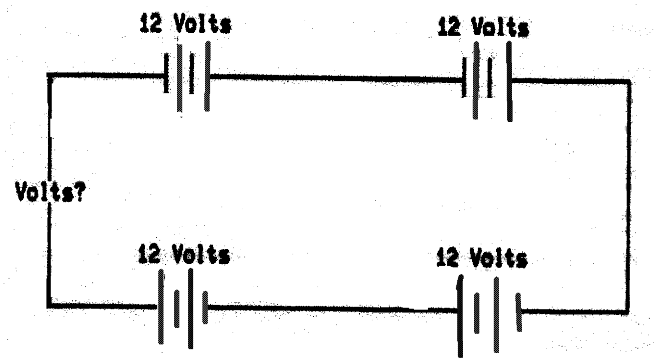
a. 295 volts.
b. 300 volts.
c. 280 volts.
d. 275 volts.

116. Find R3 in the circuit shown below.



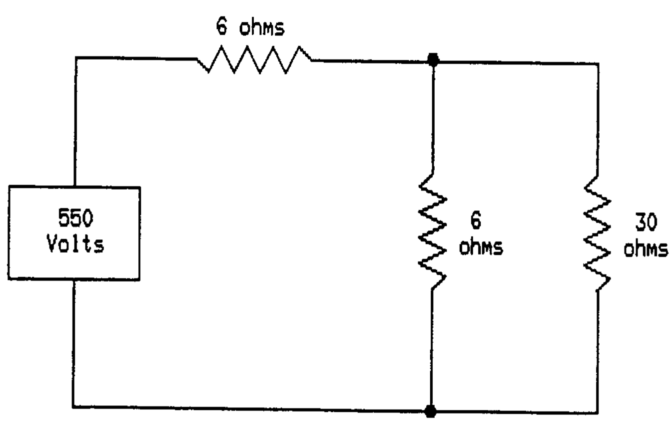
a. 30 ohms.
b. 40 ohms.
c. 20 ohms.
d. 50 ohms.

117. What is the total voltage of four 12-volt batteries connected in series?



a. 48 volts.
b. 36 volts.
c. 12 volts.
d. 24 volts.

118. How much current will flow through the 30-ohm resistor?

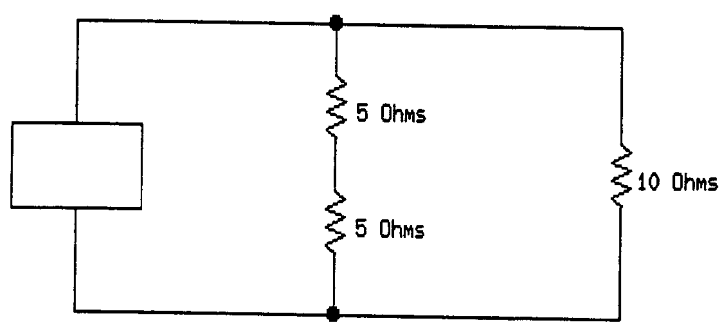


a. 6.00 amps.
b. 18.33 amps.
c. 8.33 amps.
d. 11.00 amps.

119. What is the total voltage of four 9-volt batteries connected in a series?

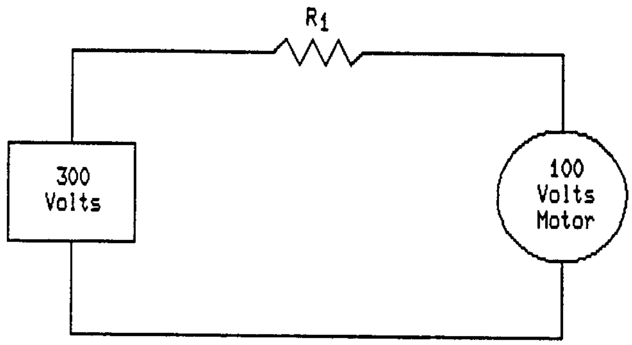
a. 27 volts.
b. 18 volts.
c. 36 volts.
d. 9 volts.

120. Find the total resistance of the parallel circuit shown below.



a. 10 ohms.
b. 20 ohms.
c. 15 ohms.
d. 5 ohms.

121. What resistance must be used for R1 on order to supply 100 volts to the motor terminals? The motor draws 40 amps under full-load conditions.



a. 7 ohms.
b. 10.0 ohms.
c. 5 ohms.
d. 2 ohms.

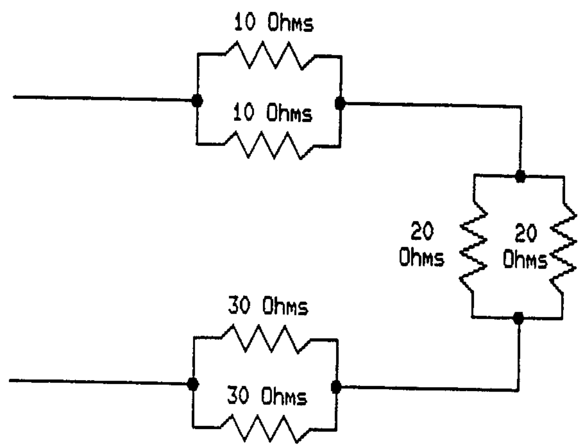
122. What voltage is required to force 5 amps through a 15-ohm resistor?

a. 300 volts.
b. 90 volts.
c. 60 volts.
d. 75 volts.

123. You have three 12-volt batteries. How should you connect them in order to supply 36 volts?

a. In series-parallel.
b. In parallel.
c. In series.
d. Straight across.

124. Find the total resistance of the circuit shown below.

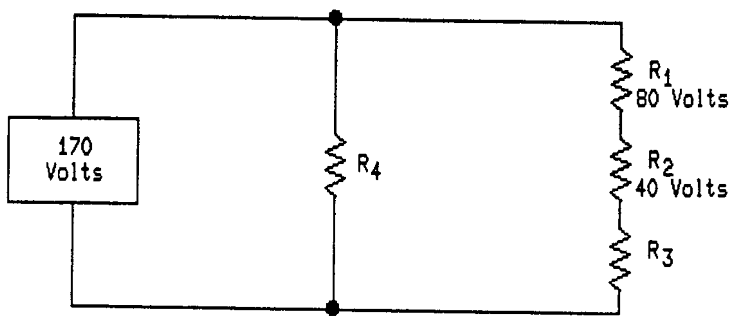


a. 120 ohms.
b. 60 ohms.
c. 30 ohms.
d. 50 ohms.

125. What is the total voltage of two 6-volt batteries connected in parallel?

a. 6 volts.
b. 8 volts.
c. 3 volts.
d. 12 volts.

126. How much voltage would be measured across R3?



a. 120 volts.
b. 170 volts.
c. 40 volts.
d. 50 volts.

ANSWER GUIDE
DC Theory and Application

Question	Answer	Question	Answer	Question	Answer
1	A	44	C	87	D
2	A	45	B	88	A
3	A	46	A	89	A
4	A	47	B	90	B
5	D	48	D	91	B
6	D	49	C	92	B
7	C	50	D	93	C
8	C	51	A	94	A
9	D	52	A	95	A
10	A	53	B	96	B
11	B	54	B	97	A
12	C	55	B	98	C
13	D	56	B	99	A
14	B	57	C	100	A
15	C	58	C	101	B
16	C	59	A	102	B
17	C	60	A	103	B
18	A	61	A	104	C
19	D	62	B	105	C
20	C	63	C	106	C
21	B	64	D	107	B
22	B	65	B	108	A
23	B	66	B	109	C
24	A	67	D	110	B
25	B	68	A	111	A
26	A	69	A	112	E
27	A	70	B	113	A
28	A	71	C	114	A
29	A	72	D	115	A
30	C	73	D	116	B
31	C	74	B	117	A
32	D	75	A	118	C
33	C	76	D	119	C
34	A	77	B	120	D
35	A	78	D	121	C
36	C	79	A	122	D
37	B	80	B	123	C
38	C	81	A	124	C
39	C	82	B	125	A
40	A	83	A	126	D
41	C	84	C		
42	D	85	A		
43	C	86	D		

Multiple Choice question(s)
Read the question and select the appropriate answer from the list provided.

1. Which of the following is NOT a proper cable connection?

    a. Compression-type sleeves.
    b. Bolted connectors.
    c. Splice rings.
    d. Square knots.

2. What is the effect of dust and dirt between joints of permissible equipment?

    a. The flame of an explosion, if one occurs, may blow the material out.
    b. Dust and dirt can destroy the gasket material.
    c. Joints cannot be closed tightly enough to get the required cooling action; therefore permissibility is destroyed.
    d. Dust and dirt prevent the explosion from blowing out, therefore destroying the cooling effect.

3. If you read an open circuit between A1 and A2 of a DC motor, it indicates that:

    a. The motor is good.
    b. The armature leads A1 and A2 have been reversed.
    c. The armature circuit is open.
    d. The armature is grounded.

4. What happens if the two line leads to a DC series motor are reversed?

    a. The motor will reverse direction.
    b. Direction of rotation remains the same.
    c. The motor will speed up.
    d. The motor will blow up.

5. The direction in which a motor rotates depends upon the:

   a. Direction of the current flow through the armature.
   b. Resistance in the circuit.
   c. Type of generator used in that system.
   d. Value of the voltage in the circuit.

6. To reverse the direction of a DC motor:

   a. Reverse incoming power.
   b. Reverse the polarizing diode.
   c. Reverse either the armature or the series field leads.
   d. Reverse both the armature and the series field leads.

7. If you read a low resistance between leads S1 and S2 of a series motor, means that:

   a. The armature circuit is good.
   b. The series field is good.
   c. The series field is open.
   d. The shunt field is good.

8. How is the rotation of a direct current, series motor reversed?

   a. By connecting the motor to a higher or lower voltage source.
   b. Be reversing any two motor leads.
   c. By changing the direction of the current flow in either the armature or series field.
   d. By reversing the positive and negative power source leads.

9. Thirty-five horsepower is equal to:

   a. 26.11 KW.
   b. 16.16 KW.
   c. 18.65 KW.
   d. 20.40 KW.

10. Which would require the largest wiring?

    a. A 25-HP, 995-volt motor.
    b. A 20-HP, 440-volt motor.
    c. A 15-HP, 220-volt motor.
    d. A 20-HP, 550-volt motor.

11. Five kilowatts equal how many watts?

    a. 5,000 watts.
    b. 50 watts.
    c. 2,500 watts.
    d. 500 watts.

12. The thermal heater element of an overload relay is generally connected in:

    a. Series with the motor lead.
    b. Parallel with the contactor tips.
    c. Series with the operating coil.
    d. Parallel with the circuit breaker.

13. A hot stick shall be electrically tested:

    a. Twice every calendar year.
    b. Every three months.
    c. Once every calendar year.
    d. Every month.

14. A separate field is often excited by a small DC generator called a:

    a. House Exciter.
    b. Speed Generator.
    c. Voltage Regulator.
    d. House Generator.

15. When compared to the resistance of the series fields and armature circuit, the shunt fields of a motor will have:

    a. Lower resistance.
    b. Twice the resistance of series fields.
    c. The same resistance.
    d. Higher resistance.

16. When we control the DC generator of the control system, what we are actually controlling is:

    a. Whichever aspect of the system we access through the control mechanisms.
    b. The conversion process accomplished by the DC generator.
    c. The amplification provided by the SCR firing package.
    d. The error detector.

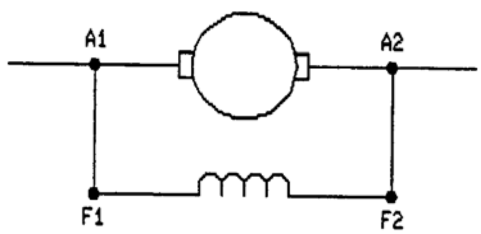
17. "Class 2" rated high voltage gloves:

    a. Are electrically tested at 20,000 volts.
    b. Are electrically tested at 10,000 volts.
    c. Are electrically tested at 4,160 volts.
    d. Are electrically tested at 1,000 volts.

18. One practical method used to protect the generator against overloads is to add a series field winding also called:

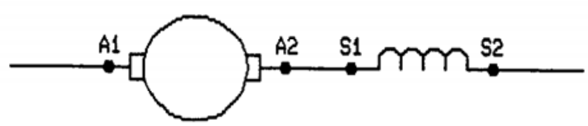
    a. An exciter.
    b. A differential.
    c. An overcurrent relay.
    d. A circuit breaker.

19. The symbol below represents:



a. A series DC motor.
b. A compound DC motor.
c. A Shunt motor.
d. A three-phase motor.

20. The symbol below represents:



a. A shunt DC motor.
b. A three-phase motor.
c. A compound DC motor.
d. A series DC motor.

21. Shunt fields of a DC motor are identified by:

a. C1 and C2 leads.
b. S1 and S2 leads.
c. F1 and F2 leads.
d. A1 and A2 leads.

22. Current limiting circuits in a DC generator control system help prevent damage to the:

    a. Generator only.
    b. Generator and the motor.
    c. Motor only.
    d. Motor control circuit.

23. Rubber gloves are fabricated from:

    a. Natural rubber.
    b. Synthetic rubber.
    c. Plastic.
    d. Silicone.

24. When dealing with electrical equipment, grounding:

    a. Provides a return path for the voltage to the frames.
    b. Prevents the equipment from being destroyed.
    c. Provides a return path to the earth and prevents voltage from existing on the frames of the equipment.
    d. Is rather ineffective.

25. Tested electrical gloves that have been properly stored for four (4) months can be put in service and used:

    a. For six (6) months before retesting
    b. for eight (8) months before retesting.
    c. for one (1) year before retesting.
    d. for three (3) months before retesting.

26. A ground fault is a phase-to-ground short in the output of:

    a. An overcurrent relay.
    b. A surge arrestor.
    c. An electrical system.
    d. A resistor.

27. A drum control works by:

    a. Connecting power lines to the motor directly.
    b. Removing resistance from a circuit by shorting together the taps on a large resistor.
    c. Adding resistance to a circuit.
    d. Decreasing resistance from a circuit.

28. The shelf life for tested electrical gloves that have been properly stored is:

    a. Three (3) years.
    b. Six (6) months.
    c. Two (2) years.
    d. One (1) year.

29. Tested electrical gloves that have been properly stored for ten (10) months can be put in service and used:

    a. For six (6) months before retesting.
    b. For one (1) year before retesting.
    c. For two (2) months before retesting.
    d. For ten (10) months before retesting.

30. A solid state device most commonly used to control power output in a DC circuit is a:

    a. Silicon controlled rectifier.
    b. Electronically controlled rectifier.
    c. AC power rectifier.
    d. Manually controlled rectifier.

31. When a generator takes mechanical energy from the connection to the synchronous motor, it:

    a. Converts that energy back to electrical energy.
    b. Produces mechanical energy that must be controlled.
    c. Therefore, produces mechanical energy.
    d. Produces both mechanical and electrical energy.

32. What is the purpose of a frame ground in a trailing cable?

    a. To separate the positive and negative leads in a cable.
    b. To provide a path for return current flow.
    c. To protect the operator from shock by keeping the equipment at earth potential.
    d. To add strength to the cable.

33. When comparing the resistance of the shunt field of a DC motor to the series field, the shunt field resistance is usually:

    a. Higher.
    b. Not able to be compared.
    c. Lower.
    d. The same value.

34. Most equipment in an underground mine is:

    a. Powered by batteries
    b. Powered by trailing cables
    c. Powered by solar energy
    d. Powered by diesel engines

35. When moving equipment, by a trolley powered rail system, continuity must be maintained between the frames of track-mounted equipment and off-track equipment being moved to provide:

    a . A control circuit.
    b. An electrical circuit.
    c. A moving path.
    d. A proper ground.

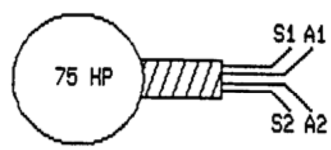
36. The element of a closed-loop DC generator control system that compares the motor's output voltage setting with its operating speed, is:

    a. a signal indicator.
    b. a master switch.
    c. An error detector.
    d. a loop regulator.

37. If the shunt field of a compound motor opens, the motor usually:

    a. Reverses.
    b. Speeds up.
    c. Slows down.
    d. Stops.

38. What type of motor would this drawing represent?



    a. Series motor.
    b. Shunt motor.
    c. Single-phase motor.
    d. Compound motor.

39. Series field leads of a DC motor are identified by:

    a. F1 and F2.
    b. S1 and S2.
    c. C1 and C2.
    d. A1 and A2.

40. What purpose is served by a starting resistor in a motor circuit?

    a. It controls the speed after the motor is at rated load.
    b. It increases the voltage during start-up.
    c. It limits the starting current during start-up by reducing the voltage.
    d. It increases the current during start-up.

41. Pumps and section equipment are grounded by a:

    a. Solid connection to a grounded conduit.
    b. Solid connection to a grounding conductor.
    c. Continuous connection to a grounded tap.
    d. A conductor connected to the system ground.

42. Using a shunt motor enables you to control:

    a. Both speed and direction.
    b. Direction only.
    c. Neither speed nor direction.
    d. Speed only.

43. At the instant the operator turns the master switch full on in a DC generator control system, the motor isn't yet turning, the generator would produce:

    a. Normal current.
    b. No current.
    c. Very high current.
    d. Very low current.

44. With a shunt motor, speed is controlled by:

    a. Increasing the generated voltage.
    b. A variable resistance in a separate field circuit.
    c. Reversing the polarity of generated voltage.
    d. Changing the direction of the current flow through the armature.

45. The motor better suited to control hoisting is:

    a. A compound motor.
    b. A series motor.
    c. A shunt motor.
    d. Either a series or a shunt motor.

46. In a DC generator control system, at the instant the operator turns the master switch full on, the motor voltage is:

    a. + 18 volts.
    b. 20 percent of the full voltage.
    c. Zero, since at this moment the motor isn't turning.
    d. - 18 volts.

47. The static control has:

    a. Static electricity as its power.
    b. No moving parts, but employs moving parts to bring about motor actions.
    c. Only two moving parts.
    d. Many moving parts.

48. To start a shunt motor from rest, it is better to:

    a. Increase the voltage.
    b. Keep the voltage at full value.
    c. Reduce, then increase the voltage.
    d. Reduce the voltage.

49. If the cross-sectional area (size) of a wire is decreased, its resistance will

    a. Stay the same
    b. Increase then decrease
    c. Increase
    d. Decrease

50. If an equipment frame grounding wire was not provided:

    a. There's little chance of a problem since most equipment rests on the ground.
    b. There would be a real potential for electrical shock.
    c. The equipment could be damaged with no hazard to miners.
    d. There is a hazard to miners only if the equipment does not rest on the ground.

51. Which of the following is NOT true concerning the treatment of burns from electrical shock?

    a. Treat for shock.
    b. Apply antiseptic salve or cream to keep the burn from becoming infected.
    c. Cover the burn area loosely with a moist, sterile dressing.
    d. Apply cold applications to help relieve pain.

52. Proper treatment for most dislocations includes all of the following EXCEPT:

    a. Application of dressings and/or splints.
    b. Straighten the affected limb.
    c. Immobilization in the line of deformity.
    d. Treatment for shock.

53. Which of the following methods is NOT recommended for removing a victim from contact with electricity?

    a. Push the victim off with a nonconductive object.
    b. Loop your battery belt around the victim's arm or leg to pull the victim away.
    c. Knock the victim off with a nonconductive object.
    d. Pull the electrical wire or cable away from the victim.

54. In most cases, if an electrical shock occurs and breathing stops, what method of artificial respiration should be used?

    a. Mouth-to mouth.
    b. Holger-Nielsen.
    c. Schaffer.
    d. Silvester.

55. In general, how should bandages be applied to a burn?

    a. Loosely.
    b. With a knot tied over the compress.
    c. Firmly, but not tightly.
    d. Over a large area to avoid putting pressure on the burn.

56. Regardless of what method of artificial respiration is applied, the first step to take is to:

    a. Treat for shock.
    b. Clear the air passage.
    c. Place the victim on a stretcher or broken-back board.
    d. Call for medical assistance at once.

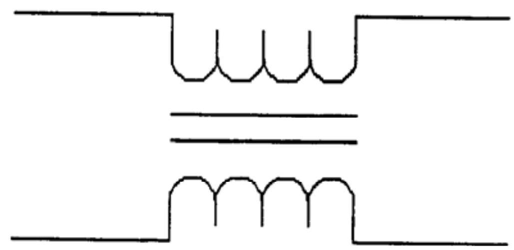
57. Through what piece of equipment is alternating current fed in order to lower its voltage?

    a. Rectifiers.
    b. Generators.
    c. Rheostats.
    d. Transformers.

58. Transformers are used to:

    a. Step up or step down AC voltage.
    b. Step up or step down DC voltage.
    c. Change DC voltage to AC voltage.
    d. Change AC voltage to DC voltage.

59. The following symbol would represent which of the following?



a. Circuit breaker.
b. Thermal overload.
c. Linestarter.
d. Transformer.

60. Trolley systems are grounded by a:

a. Solid connection to the mine track.
b. Continuous connection to a ground tap.
c. Solid connection to a grounding conductor.
d. Solid connection to grounded equipment.

61. If 1,100 amps leave a rectifier on one conductor, how many amps will return to that rectifier on the other conductor?

a. Zero amps.
b. 2,200 amps.
c. 1,100 amps.
d. 550 amps.

62. Sagging trolley wires may be caused by:

a. The roof taking on weight.
b. Hangers being too close together.
c. Hanger coming loose from the roof.
d. Weight from the nips.

63. Between the trolley wire and the track, the voltage is:

    a. 600 to 800 volts.
    b. 200 to 400 volts.
    c. 250 to 600 volts.
    d. 100 to 500 volts.

64. When carrying tools in an area where trolley wire is present, you should:

    a. Carry them at waist level.
    b. Carry them on your shoulder.
    c. Drag them.
    d. Carry them in the most comfortable way.

65. The solution to an overheating problem in a trolley system is:

    a. A cutout switch.
    b. The fuse nip.
    c. A bridged-out fuse.
    d. An overcurrent protective device.

66. Trolley wire usually sags because:

    a. Of the weight from the nips.
    b. Hangers come loose from the roof.
    c. Hangers are too close together.
    d. The roof takes on weight.

67. Circuit breakers will protect trolley wires and trolley feeder wires against:

    a. Overvoltage.
    b. Overloading, heating and short-circuits.
    c. Undercurrent conditions.
    d. Arcing only.

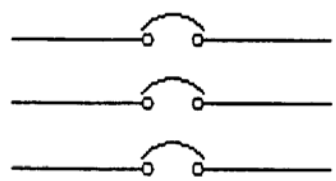
68. If switches on electrical equipment remain on during connection to a trolley wire, the current at the time of connection:

    a. Would pose no serious safety problem, but equipment may be slowed.
    b. Could cause an arc.
    c. May result in an overload situation.
    d. Will cause an explosion.

69. Trolley feeder wire is installed on:

    a. Insulated J-Hooks.
    b. Insulators.
    c. Grounding connections.
    d. Conductors

70. The following symbol would represent which of the following?



    a. Circuit breaker.
    b. Thermal overload.
    c. Linestarter.
    d. Transformer.

71. Thermal overloads are used for:

    a. Short circuit protection.
    b. Mechanical protection.
    c. Overload and single-phase protection on three-phase circuits.
    d. Basic hydraulic circuits only.

72. The function of the capacitor trip device and circuit is to:

    a. Provide sufficient energy to trip the breaker, even after the power goes off.
    b. Provide a protection for DC power.
    c. Detect a power outage in advance and turn off the system ahead of time.
    d. Allow for a restart of the system once the power is returned to full strength.

73. If the overcurrent condition continues for a long time, and at a great enough magnitude, an overcurrent device will trip the:

    a. Surge-arrestor.
    b. Resistor.
    c. Air switch.
    d. Circuit breaker.

74. When a circuit breaker is tripped:

    a. No ground-fault protection is provided.
    b. No current flows beyond it into the circuit.
    c. Reduced voltage flows into the circuit.
    d. It reduces the current to a sufficiently low level.

75. If circuit breakers are too small for the equipment they are protecting:

    a. No problems will arise.
    b. The circuit breaker will not stay closed.
    c. The equipment will function even with too much current.
    d. The equipment will be overheated.

76. It has been determined by a voltage drop test that 4,600 amps would flow under a fault condition in the trolley system. If upon inspection of the system it was found to be in good shape, what should be the maximum setting of the circuit breaker?

    a. 3,450 amps.
    b. 2,500 amps.
    c. 4,600 amps.
    d. 2,300 amps.

77. The instantaneous setting of a circuit breaker is:

    a. The overload setting.
    b. The setting for welding purposes.
    c. The short circuit setting.
    d. Not important.

78. The ampere capacity of a circuit breaker is:

    a. The amount of current that a breaker can carry under normal conditions.
    b. The short circuit setting.
    c. The maximum amount of current that the breaker can interrupt without damage.
    d. Meaningless.

79. Magnetic trip units of a circuit breaker provide what protection?

    a. Open circuit.
    b. Under voltage.
    c. Ground check.
    d. Short circuit.

80. The most commonly used short-circuit protective device for trailing cables is:

    a. A single-element fuse.
    b. A circuit breaker.
    c. A dual-element fuse.
    d. A pull fuse.

81. When an overcurrent device detects an overload condition, the breaker should trip:

    a. Only the phase (phases) affected by the overcurrent condition.
    b. 2 phases at a time.
    c. All three phases at the same time.
    d. 1 phase at a time.

82. The difference between a time delay and an instantaneous overcurrent relay:

    a. Lies primarily in how quickly they trip an air switch.
    b. Is in name only.
    c. Is that the delay relay trips a circuit breaker when a short circuit occurs, and the instantaneous relay does not.
    d. Lies primarily in how quickly they trip a circuit breaker.

83. A blown fuse or a tripped circuit breaker could indicate all of the following EXCEPT:

    a. Overload.
    b. Overvoltage.
    c. Defective circuit.
    d. Short circuit.

84. The idea behind a capacitor trip device and circuit is to:

    a. Provide sufficient energy to trip the breaker, even after power goes off.
    b. Reactivate power after the breaker has been tripped.
    c. Detect a power outage in advance and turn off the system ahead of time.
    d. Cause continuous current to flow through the breaker.

85. When a circuit breaker has an overload trip, what causes the circuit breaker to de-energize the circuit?

    a. A fuse element burns open.
    b. A magnetic field is created causing a metal disc to move.
    c. The undervoltage release coil will activate.
    d. A thermal element heats up and actuates the contacts.

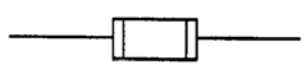
86. Thermal heater strips in circuit breakers or line starters are used to provide what protection?

    a. Split phase.
    b. Overcurrent.
    c. Overvoltage.
    d. Undervoltage.

87. A wire is marked "14 AWG”. The number “14” refers to:

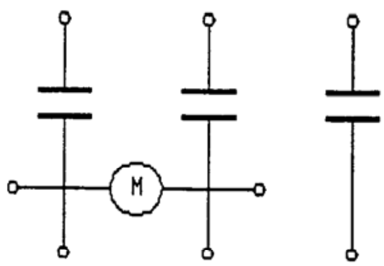
    a. The size of the conductor.
    b. The thickness of the wire.
    c. The number of amps than can safely flow through the wire.
    d. The number of strands in the wire, which in this case would be fourteen.

88. The symbol below represents:



    a. A fuse.
    b. A grounding resistor.
    c. A contactor.
    d. A line starter.

89. The following symbol would represent which of the following?

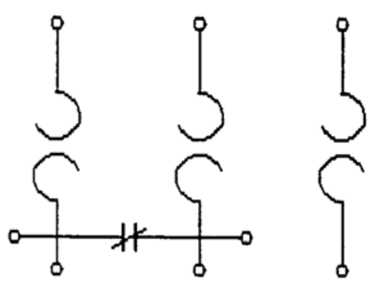


a. Thermal overload.
b. Transformer.
c. Linestarter.
d. Circuit breaker.

90. A 3-phase motor continues to operate when one lead has been severed or cut in two; then, when stopped, will not start again. The motor is said to be:

a. Split phased.
b. Shunt tripped.
c. Single phase.
d. Out of phase.

91. The following symbol would represent which of the following?



a. Circuit breaker.
b. Line starter.
c. Transformer.
d. Thermal overload.

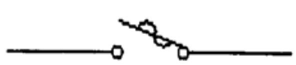
92. You have just replaced a fuse. As you re-energize the circuit from the trolley wire, a large flash occurs at the nip and the fuse blows. What would you expect to find?

    a. Problems in the trolley wire.
    b. An overload.
    c. A short in the nip.
    d. A short circuit.

93. What does the following symbol represent?

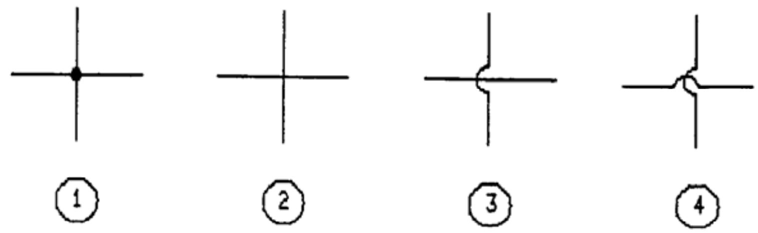
    a. Transformer.
    b. Silicon Controlled Rectifier (SCR).
    c. Diode.
    d. Metal Oxide Varistor (MOV).

94. This symbol means:



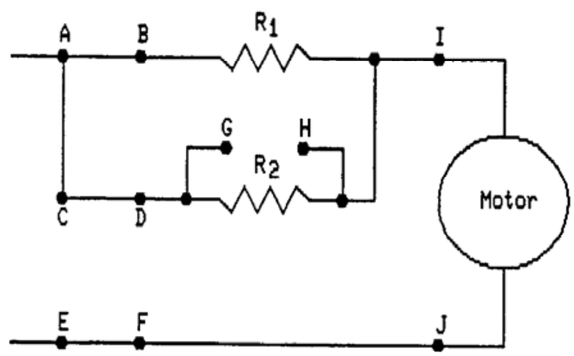
    a. Air Switch.
    b. Circuit Breaker.
    c. Lightning (Surge) Arrestor.
    d. Fuse.
    e. Fused switch.

95. Which of the three diagrams below shows a wire making a physical electrical connection?



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

96. If you were to install a voltmeter to measure the voltage for the "R2" resistor only, you would make your connections across points:

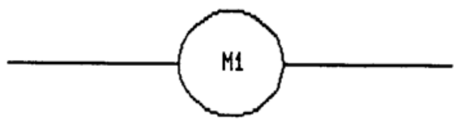


a. G and H.
b. A and B.
c. C and D.
d. I and J.
e. E and F.

97. If under normal load a 30-amp fuse becomes hot, the most likely reason for this is:

    a. The clips holding the fuse are loose.
    b. The fuse is defective and needs replaced.
    c. The fuse used is too large and should be replaced with one of a smaller current rating.
    d. The fuse needs to be replaced with one of higher current rating.

98. The symbol below represents:



    a. A coil.
    b. A diode.
    c. A fuse.
    d. A circuit breaker.

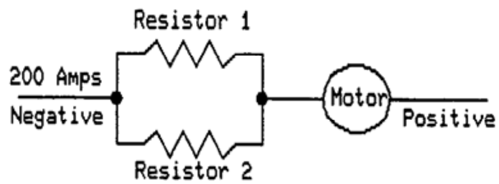
99. Voltage is checked with an instrument called a (an):

    a. Ammeter.
    b. Ohmmeter.
    c. Voltmeter.
    d. Wattmeter.

100. If a 120-volt direct current source is connected to a 10:1 step-down transformer, the output on the secondary side is:

    a. 1,200 volts DC.
    b. 12 volts AC.
    c. Zero volts.
    d. 1,300 volts AC.
    e. 12 volts DC.

101. Two resistors (Resistor 1 and Resistor 2) are connected in parallel and Resistor 2 burns open. What would happen?



a. Both resistors would soon become warm.
b. Current in the circuit would be reduced.
c. Both resistors would soon become cool.
d. Resistor 2 would heat up.

102. If an ohmmeter shows continuity across an SCR with no gate voltage applied, the SCR is probably:

a. Grounded.
b. Shorted.
c. Open.
d. Normal.

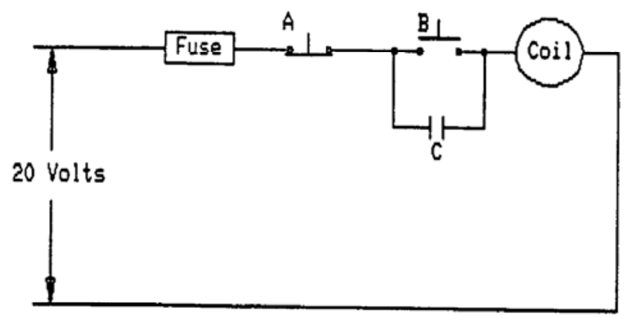
103. This symbol means:

a. Fuses Switch.
b. Fuse.
c. Circuit breakers.
d. Lightning (Surge) Arrestors.
e. Air Switch.

104. This symbol means:

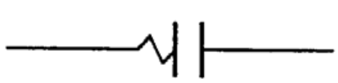
a. Circuit Breaker.
b. Lightning (Surge) Arrestor.
c. Air Switch.
d. Fused Switch.
e. Fuse.

105. To energize this circuit you would:



a. Not be able to because there is no way to close the circuit.
b. Depress push button "A".
c. Depress push button "B".
d. De-energize the coil.

106. The symbol below represents:

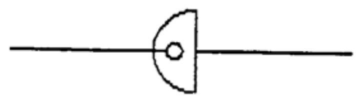


a. A mercury tube.
b. A diode.
c. A coil.
d. A single pole contact.

107. The motor overload relay contacts are connected in:

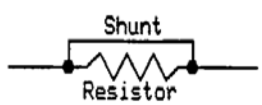
a. Parallel with the supply line.
b. Parallel with the motor circuit.
c. Series with the motor circuit.
d. Series with the operating coil.

108. The symbol represents:



a. A normally open time delay closing mercury tube.
b. A normally open instantly closed mercury tube.
c. A normally closed instantly open mercury tube.
d. A normally closed time delay opening mercury tube.

109. If you were to shunt-out a resistor, the resistor would:



a. Not cause a voltage drop.
b. Cause half the voltage drop, since it is in parallel with the shunt.
c. Burn open.
d. Burn closed, causing it to short circuit.

110. The symbol below represents:

a. A normally open instantly closed mercury tube.
b. A normally open time delay closing mercury tube.
c. A normally closed time delay opening mercury tube.
d. A normally closed instantly open mercury tube.

111. The master contactors in a DC circuit are usually labeled as:

a. P1 and P2.
b. M1 and M2.
c. H1 and H2.
d. 1A and 2A.

112. The accelerating contactors in a DC circuit are usually labeled:

a. 1A and 2A.
b. M1 and m2.
c. S1 and S2.
d. X1 and X2.

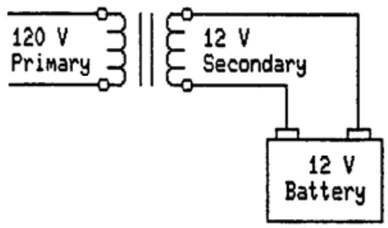
113. Current is checked with an instrument called a (an):

a. Voltmeter.
b. Ammeter.
c. Wattmeter.
d. Ohmmeter.

114. Which of the following is a true statement concerning the operational characteristics of an SCR?

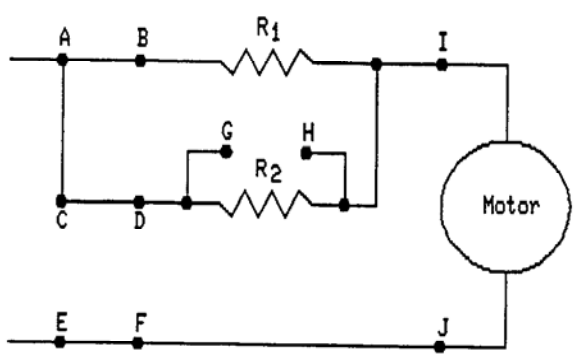
a. It will allow current flow in either direction once it is gated.
b. It will allow current flow in only one direction once it is gated.
c. It does not have to be gated to allow current flow.
d. It will not allow current flow in either direction when gated.

115. Charging a 12-volt battery from a 12-volt AC source will:



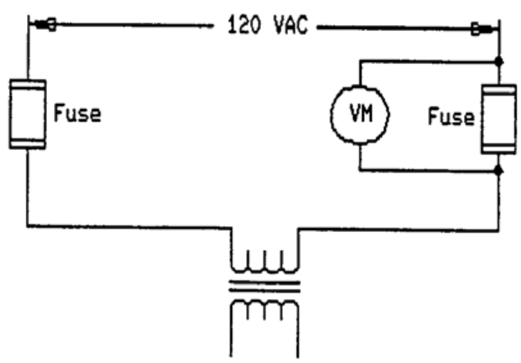
a. Charge the battery.
b. Charge the battery only if a resistor is added.
c. Not charge the battery.
d. Charge the batter only if a capacitor is added.

116. If you were to install an ammeter to measure the current flowing through the "R2" resistor you would make your connections between points:



a. A and B.
b. E and F.
c. E and J.
d. C and D.
e. G and H.

117. As shown below, what does a zero reading on a voltmeter indicate?

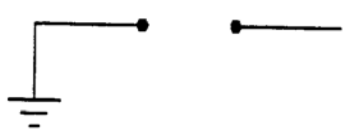


a. A blown fuse.
b. A short circuit.
c. A good fuse.
d. An open circuit.

118. Heat sinks on a rectifier are provided to:

a. Limit current.
b. Limit voltage.
c. Cool the rectifier.
d. Keep the rectifier warm.

119. This symbol means:



a. Fuse.
b. Air Switch.
c. Fused Switch.
d. Circuit Breaker.
e. Lightning (Surge) Arrestor.

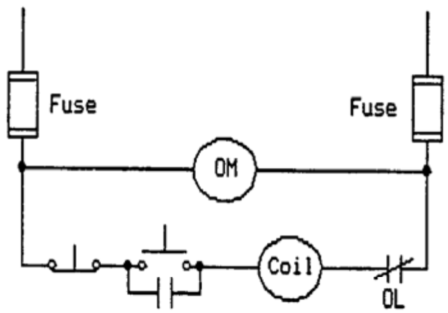
120. The symbol represents:

a. A contactor.
b. A diode.
c. A mercury tube.
d. A line starter

121. The symbol below represents:

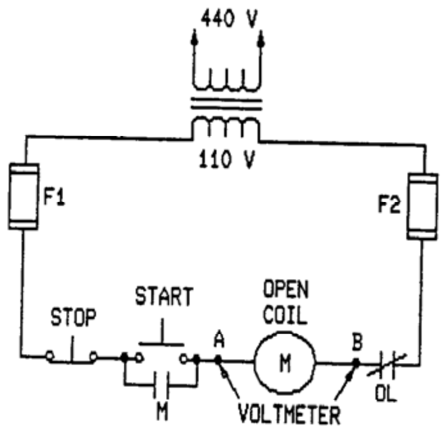
a. A coil.
b. A resistor.
c. A diode.
d. A contactor.

122. In the following circuit, what would be the ohmmeter reading?



a. 125 ohms.
b. 250 V.
c. Infinity or open circuit.
d. 0 ohms.

123. What would the voltmeter below read if the start switch were closed and the voltmeter placed across points A and B?

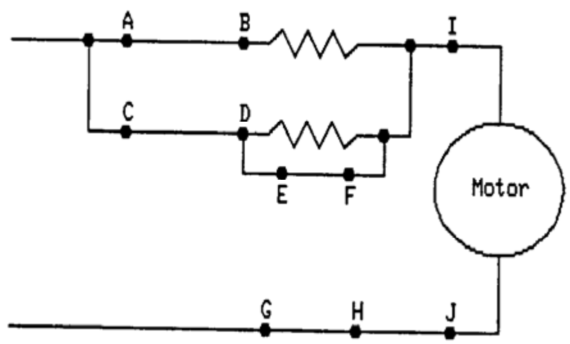


a. Zero.
b. 220.
c. 440.
d. 110.

124. The heater element in a motor circuit overload relay is connected in:

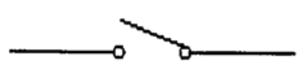
a. Parallel with the motor circuit.
b. Series with the motor circuit.
c. Parallel with the supply line.
d. Series with the operating coil.

125. If you were to install an ammeter to continuously monitor the current in the motor, you should connect it between points:



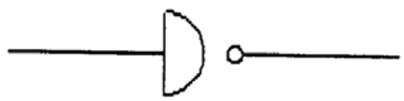
a. G and H.
b. E and G.
c. F and H.
d. A and B.
e. I and J.

126. This symbol means:



a. Lightning (Surge) Arrestor.
b. Fuse.
c. Circuit Breaker.
d. Fused Switch.
e. Air Switch.

127. The symbol below represents:

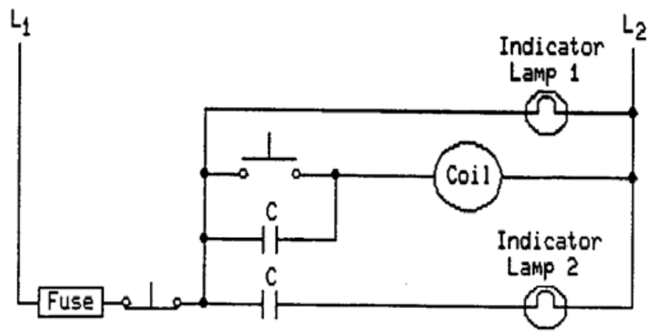


a. A normally closed instantly open mercury tube.
b. A normally open time delay closing mercury tube.
c. A normally open instantly closed mercury tube.
d. A normally closed time delay opening mercury tube.

128. A ground monitor circuit is used to:

a. Interrupt continuity of the grounding circuit.
b. Provide a ground conductor.
c. Test grounding diodes.
d. Insure continuity of the grounding circuit.

129. If neither indicating light were on, and the coil would not energize, what component is most likely defective?



a. The push button to energize the coil.
b. The fuse.
c. The lights.
d. The coil.

130. A dual element fuse provides:

a. Short circuit and ground check protection.
b. Undercurrent protection.
c. Short circuit and overload protection.
d. Two elements for power switching purposes.

131. Fuses should be replaced with:

a. Larger fuses.
b. Proper fuses.
c. Trolley wire.
d. Shooting wire.

132. What is wrong with replacing a blown fuse with a piece of copper wire?

a. The equipment will not operate with the fuse replaced by copper wire.
b. The copper wire will not provide adequate overcurrent protection.
c. The holders are not designed to accept copper wire.
d. The wire may disrupt violently if an overload occurs.

133. If a system designed for a 20-amp fuse blows, and an electrician replaces it with one rated at 30 amps:

a. No damage will result if the fuse holder is designed to handle the 30-amp fuse.
b. A fire may result or the equipment may become damaged.
c. The circuit will pull more current under normal load.
d. Greater protection will be given to the system since the fuse will be stronger.

134. When fuses are too big for the current requirement of the equipment being protected:

a. Too much current could be allowed to pass through, overheating. equipment and burning off insulation.
b. No problems will exist when the fuse is too big- only when too small.
c. Equipment will constantly shut off due to too little power.
d. The equipment will get more power and runs more powerfully.

135. A single element fuse provides:

a. Open circuit protection.
b. Over load protection.
c. Short circuit protection.
d. Undervoltage protection.

136. If a trailing cable builds up on one spot of the spool, this would indicate that:

   a. There is a problem with the spooling device.
   b. The spool is binding.
   c. The reel is functioning properly.
   d. The cable or splice may be too large.

137. What type of direct current motor is best suited for tramming of mining equipment?

   a. Compound-wound.
   b. Shunt-wound.
   c. Series-wound.
   d. Universal.

138. What is used to prevent the Forward and Reverse contactors in a motor reversing control from operating at the same time?

   a. Reverse phase protectors.
   b. Electrical and/or mechanical interlocks.
   c. Reverse current relays.
   d. Lockout relays.

139. The DC motor that uses both a series and shunt winding and combines the characteristics of both is called a:

   a. Universal motor.
   b. Compound motor.
   c. Repulsion motor.
   d. Synchronous motor.

140. What will happen to a DC shuttle car series wound motor if the chain or drive shaft would break?

   a. The shunt fields will be destroyed.
   b. It would cause excessive wear of contactor tips.
   c. The motor will overspeed to the point of destruction.
   d. A control circuit fuse would blow.

141. To reduce the hazard of electrical shock, which of the following should be installed?

   a. Circuit breaker.
   b. Fuse.
   c. Thermal overload.
   d. Frame ground conductor.

142. What device may be installed in the neutral of a three-phase wye connected system to limit the current if a ground fault occurs?

   a. Blocking diode.
   b. Grounding resistor.
   c. Ground check relay.
   d. Circuit breaker.

143. When checking resistance in an AC circuit when troubleshooting, what initial precaution must be taken?

   a. Close the start switch.
   b. Short the transformer windings.
   c. Disconnect the source voltage.
   d. Disconnect the motor leads.

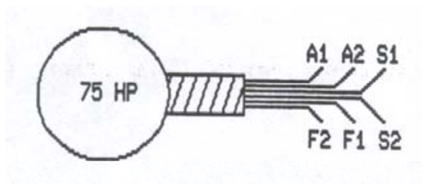
144. Speed of DC motors can be controlled by:

   a. Changing the number of poles while the motor is running.
   b. Regulating the applied voltage.
   c. By regulating the frequency.
   d. Changing the air gap in the motor while running.

145. The overload relay contacts of a thermal overload are generally connected in:

   a. Series with the motor lead.
   b. Series with the operating coil.
   c. Parallel with the fuses.
   d. Parallel with the operating coil.

146. What type of motor would this drawing represent?

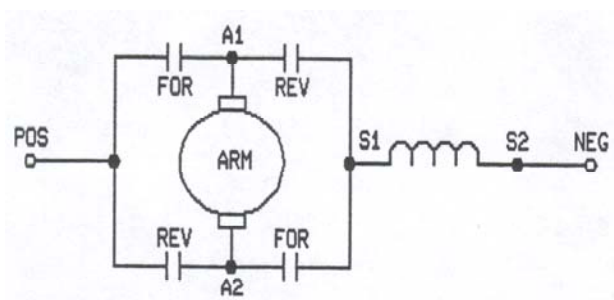


a. Shunt motor.
b. Series motor.
c. Compound motor.
d. Single-phase motor.

147. An "across-the-line" or "accelerator" contactor usually:

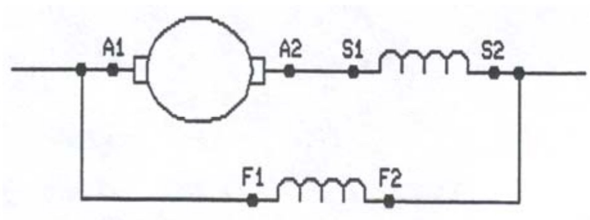
a. Takes a motor off resistance.
b. Starts a motor.
c. Reverses a motor.
d. Stops a motor.

148. The following symbol represents:



a. A speed control system for a series motor.
b. Reversing contactors for a series motor.
c. A four-speed system for motor control.
d. Two speed forward and reverse contactor system.

149. The symbol below represents:



a. A shunt DC motor.
b. A three-phase motor.
c. A series DC motor.
d. A compound motor.

150. When two DC motors are connected series-parallel for speed control, the series connection is usually:

a. High speed.
b. Slow speed.
c. Used only in reverse.
d. Medium speed.

151. Which of the following is not a characteristic of a series motor?

a. Variable torque.
b. Current remains the same at all loads.
c. Variable speed.
d. Will run away if run without a load.

152. What is used to limit the starting current of a DC motor?

a. Capacitors.
b. The series field.
c. Transformers.
d. Resistors.

153. Three-pole single-throw disconnect switches have how many knife blades?

a. Two.
b. None.
c. One.
d. Three.

154. If a coal feeder does not run long enough to empty the coal from the feeder, the electrician should:

    a. Adjust the timer.
    b. Shunt out a resistor.
    c. Adjust the momentary start button.
    d. Increase the speed of the motor by gear reduction.

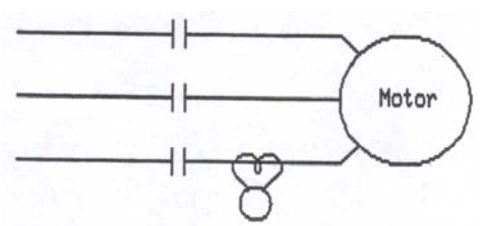
155. Arc chutes on contactors contain heavy copper coils that are called:

    a. Arcing horns.
    b. Blowout coils.
    c. Contacts.
    d. Flux actuators.

156. A starter operates a 50-hp motor. Which of the starter's contactors would you expect to be the largest?

    a. Both are the same size.
    b. The main line contactors.
    c. The auxiliary contactors for the control circuit.
    d. Motors are not started through contactors.

157. The component attached to the donut coil on one phase lead, between the contactors and motor, is normally used as a (an):

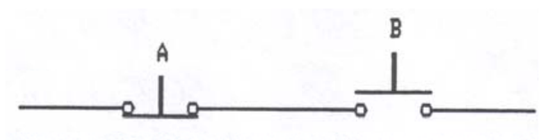


    a. Ammeter.
    b. Voltmeter.
    c. Ohmmeter.
    d. Wattmeter.

158. If a thermal overload activates, causing a circuit to be de-energized, what must you do before the circuit can be re-energized?

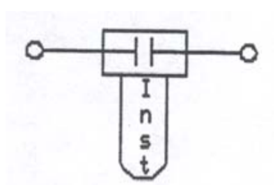
a. Allow it to cool.
b. De-energize the circuit.
c. Replace the fuse.
d. Replace the overload.

159. This start/stop push button is set up in which of the following manners?



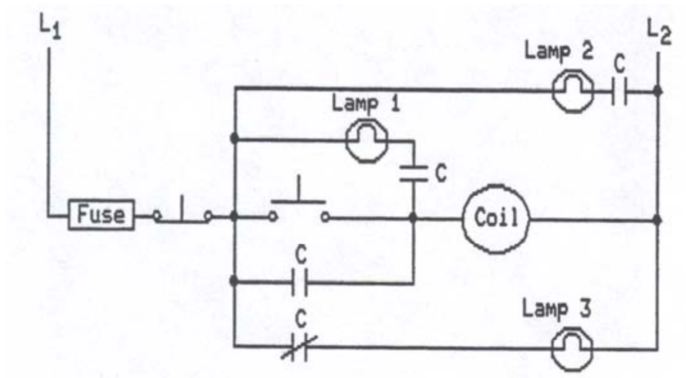
a. Button "A" is for stop and "B" is for start.
b. Either button A or B can be used as start/stop.
c. Button "B" is for stop and "A" is for start.
d. Both buttons are interlocked to function together.

160. When a component is shown like this on a diagram, it means that the component is normally:



a. Closed and will remain closed when the circuit is energized.
b. Open and will remain open when the circuit is energized.
c. Closed and will open when the circuit is energized.
d. Open and will close when the circuit is energized.

161. Which of the following indicating lights (No. 1, No. 2, No.3) will remain lit when the coil is NOT energized?

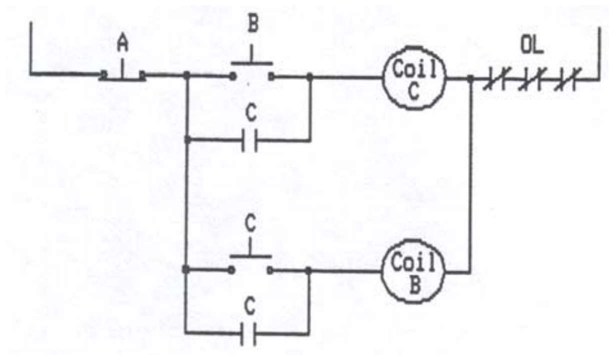


a. Light No. 3.
b. Light No. 2.
c. None will light until the coil is energized.
d. Light No. 1.

162. If you were to peel the insulation off a No. 14 AWG stranded conductor, you would expect to find:

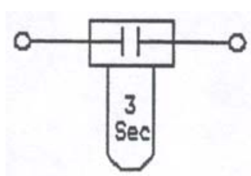
a. Smaller wires which are not insulated from one another.
b. One strand of solid No. 14 wire.
c. Many No. 14 AWG size wires which are wrapped to make one large conductor.
d. Many No. 14 AWG size wires which are insulated from one another.

163. Which button, when depressed, will energize coil "B" and keep it energized after the button is released?



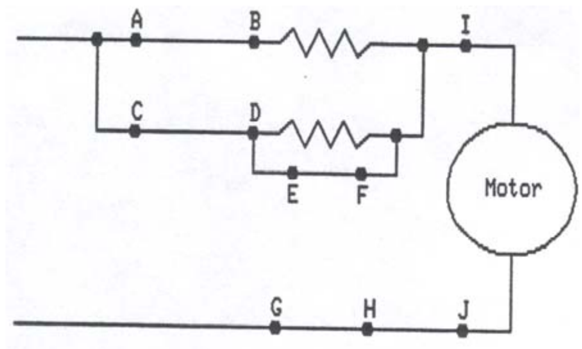
a. Push button "C".
b. Push button "B".
c. Push button "A".
d. Both push buttons "B" and "C".

164. This symbol found on an electrical diagram means that:



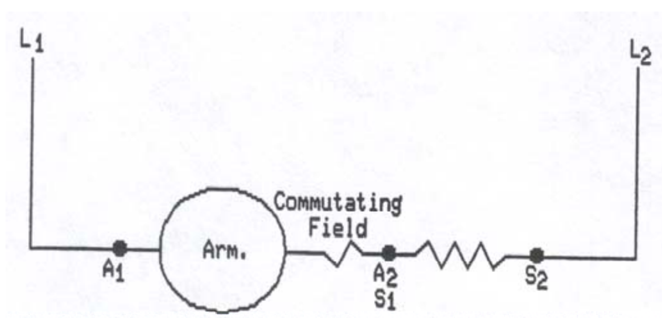
a. The circuit will close three (3) seconds after the coil has been energized.
b. The circuit will remain closed for three (3) seconds and then reopen.
c. The circuit will be closed for three (3) seconds and then reopen.
d. The circuit will open three (3) seconds after being energized.

165. If you were to install a voltmeter to measure the voltage at the motor, you should connect it between points:



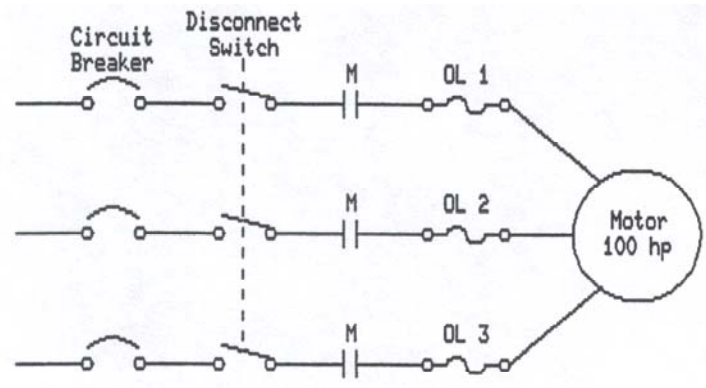
a. A and B.
b. E and F.
c. C and D.
d. I and J.
e. G and H.

166. This is a schematic of a:



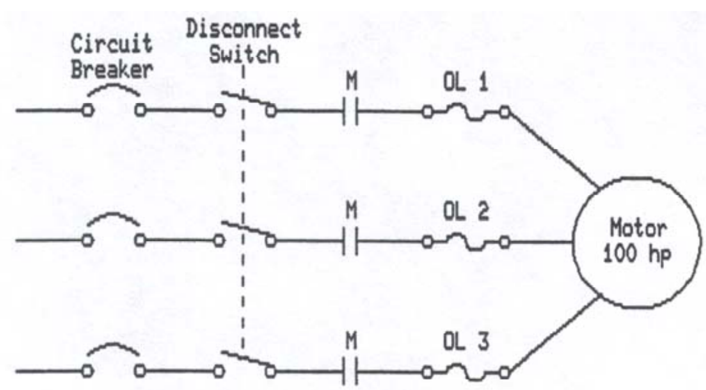
a. Shunt motor.
b. Compound motor.
c. Squirrel cage motor.
d. Series motor.

167. The diagram indicates that the motor is operated by:



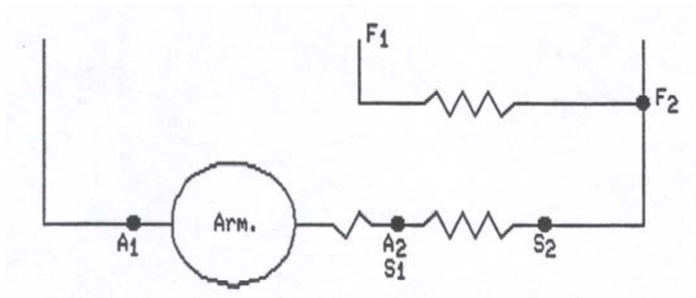
a. A single-phase power source.
b. A three-phase power source.
c. Direct current.
d. Direct current three pole.

168. If you were to lockout and tag the motor to begin repair work, the safest and most convenient place to do this would be at the:



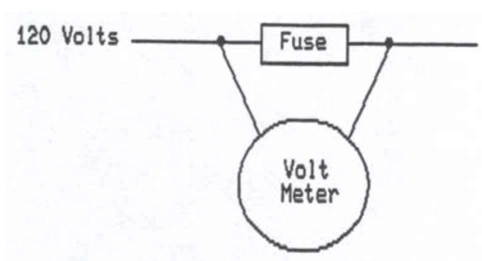
a. Circuit breaker located in the motor control center.
b. Overload devices.
c. Control panel where the motor contactors are located.
d. Disconnect switch located near the motor.

169. This schematic represents:



a. An alternating current motor.
b. A time delay relay.
c. A three-phase motor with armature.
d. A direct current motor.

170. If a voltmeter were placed across the fuse and no voltage was indicated, you could correctly assume that:

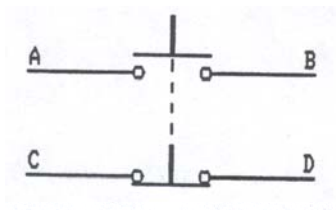


a. The fuse was good.
b. The voltmeter is defective.
c. The fuse was blown.
d. You made a wrong connection.

171. A tool used to bend metal conduits is called a:

a. Bender.
b. Condulet.
c. Ratchet
d. Rebend.

172. If a circuit is created across "AB" when the button is depressed, the circuit "CD" will:

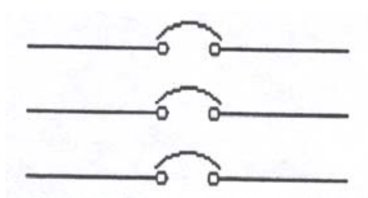


a. Close.
b. Both "AB" and "CD" will create a circuit.
c. Remain closed.
d. Open.

173. What is the same in all parts of a series circuit?

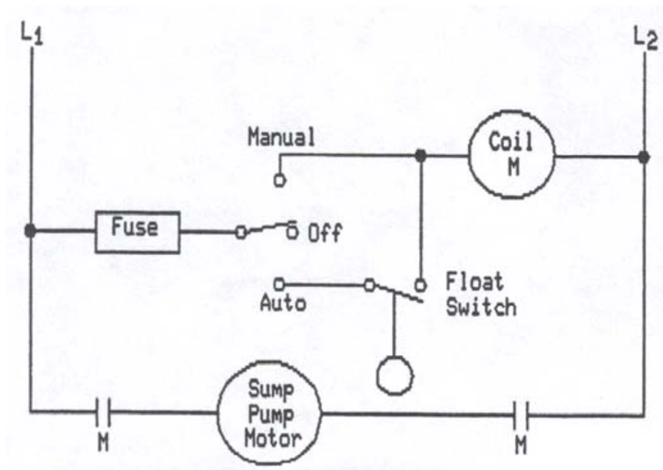
a. Current.
b. Wattage.
c. Voltage.
d. Resistance.

174. This symbol stands for a:



a. Thermal overload.
b. Circuit breaker.
c. Fuse.
d. Disconnect switch.

175. The purpose of the float switch shown in the diagram is to:

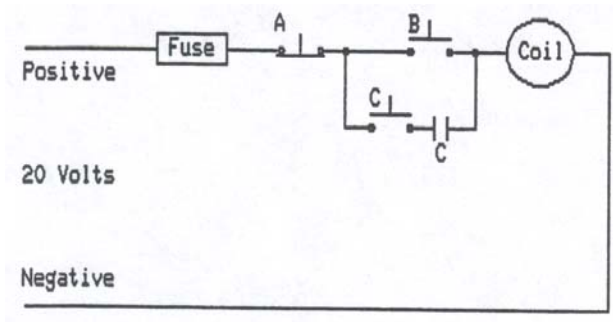


a. Start the motor when the water level gets high enough to close the float switch.
b. Cause the motor to run continuously.
c. Shut off the water if the water level gets high enough to flood the motor.
d. Stop the motor if the water gets too high.
e. Provide current-limiting protection.

176. The duty cycle of a motor refers to its characteristic:

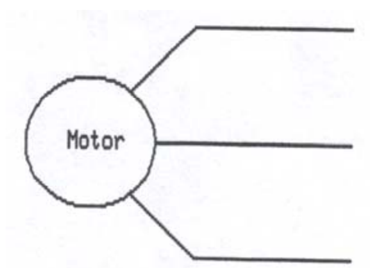
a. Torque-ratio qualities.
b. Maximum time period it can safely operate.
c. Cycle of alternating current on which it operates.
d. Current-carrying capacity.

177. If push buttons "B" were depressed, the coil would:



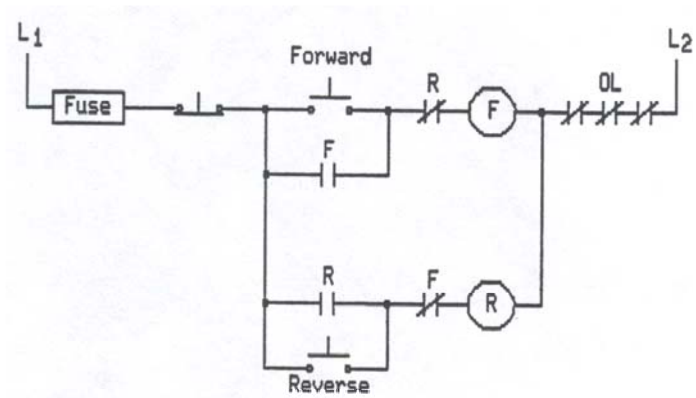
a. Energize and remain energized.
b. Remain energized as long as the button remained depressed.
c. De-energize.
d. Nothing would happen.

178. This symbol indicates:



a. A single-phase motor.
b. A three-phase motor.
c. A split-phase direct current shunt motor.
d. A motor with one hot line, one common line, and a ground wire.

179. Contact "F" is normally closed. What is its purpose?

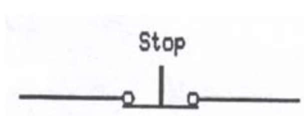


a. It is needed to hold in or keep coil "F" energized when the push button is released.
b. To prevent coil "F" from becoming energized while coil "R" is energized.
c. It is needed to hold in or keep coil "R" energized when the push button is released.
d. To prevent coil "R" from becoming energized while coil "F" is energized.

180. A solenoid operates in the same way as a:

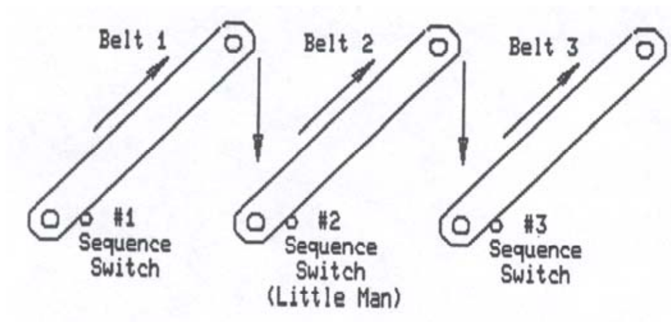
a. Limit switch.
b. Relay.
c. Pressure switch.
d. Float switch.

181. This stop switch is classified as:



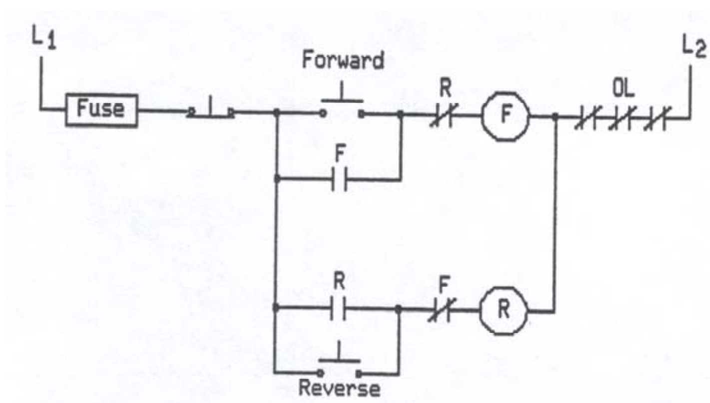
a. Timed open/normally closed.
b. Momentary.
c. Interlocking magnetically.
d. Interlocking mechanically.

182. The purpose of the No. 2 sequence switch (which is sometimes called the little man) is to:



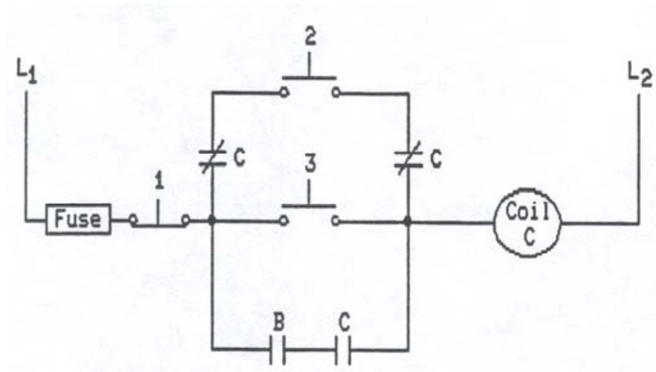
a. Stop the No. 1 belt if the No.2 belt malfunctions.
b. Stop the No.2 belt if it malfunctions.
c. Stop all belt conveyors.
d. Stop the No. 3 belt if the No.2 belt malfunctions.

183. Which of the following statements would be true if the forward push button were depressed?



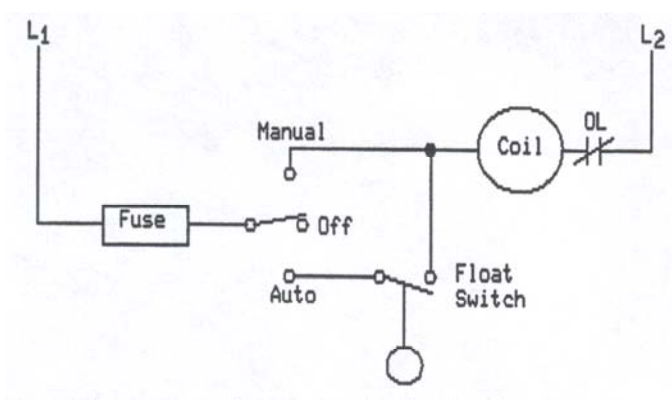
a. Nothing will energize since contactor "F" is open. No circuit can be made.
b. Both coils "F" and "R" will become energized.
c. Coil "F" will energize and remain energized.
d. Coil "F" will remain energized only as long as the forward push button is depressed.

184. Which of the following push buttons will energize coil "C" while the button is depressed and de-energize coil "C" when the push button is released?



a. Push button 3.
b. Push button 2.
c. Push button 1.

185. If you want this pump to operate only when the water level reaches a certain depth, you should set the selection switch at what position?



a. Off position.
b. Auto position.
c. You should never leave a pump unattended.
d. Manual position.

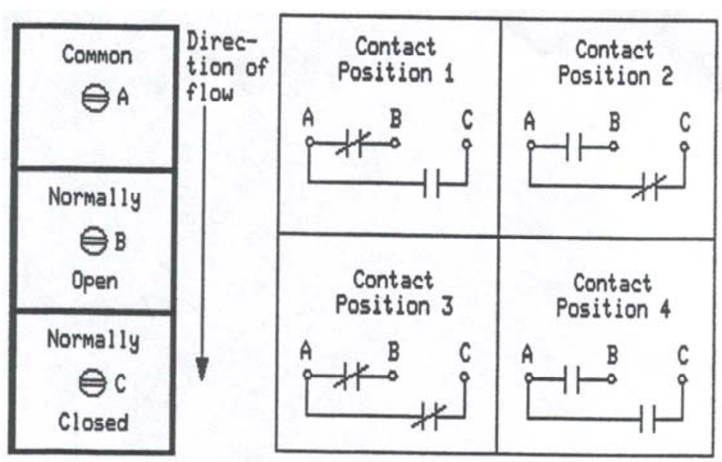
186. Meggers are used to check:

a. Insulation resistance.
b. Conductor ampacity.
c. Capacitance.
d. Inductance.

187. The system using one ground wire and three hot wires, whose voltage is balanced 120 degrees apart is called:

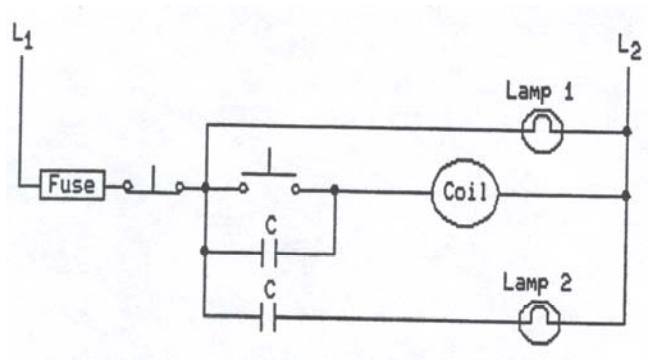
a. Single-phase.
b. Double-phase.
c. Split-phase.
d. Three-phase.

188. Which of the following contact positions match the contact position plate in the diagram below?



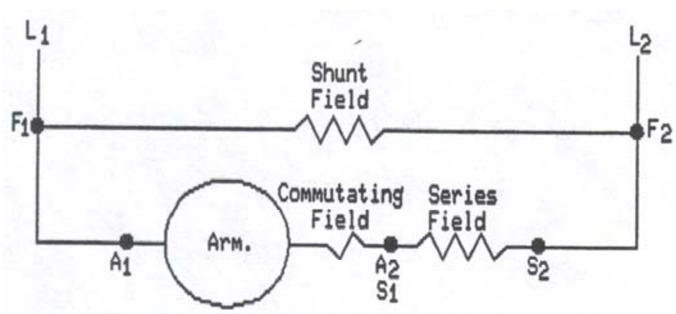
a. Contact position No. 2.
b. Contact position No. 3.
c. Contact position No. 1.
d. Contact position No. 4.

189. In the circuit shown in the diagram, if all components were functioning properly, which light(s) would be lit if the coil were energized?



a. Neither lights.
b. Both lights.
c. Light No. 1.
d. Light No. 2.

190. This is a schematic of a:

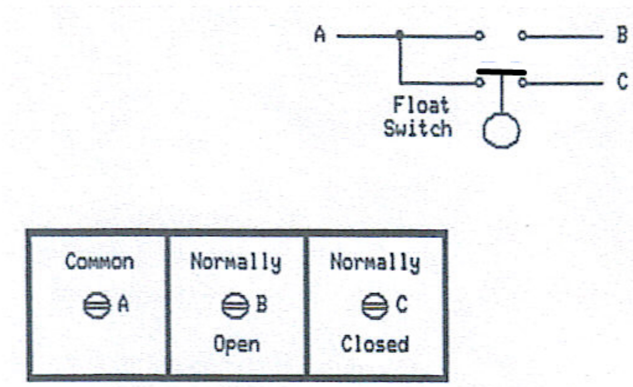


a. Compound motor.
b. Series motor.
c. Squirrel cage motor.
d. Shunt motor.

191. The safest way to de-energize a motor running on full load is:

a. By opening the disconnect switch.
b. By opening the circuit ground check circuit.
c. Through the control circuit which will open the line contactors.
d. By de-energizing the source located at the main transformer.

192. If you wanted to energize a pump motor to operate when the water level got high enough to cause the float switch to close, you would connect your leads to what terminals on the float switch in the diagram below?



a. A and C.
b. B and C.
c. A and B.

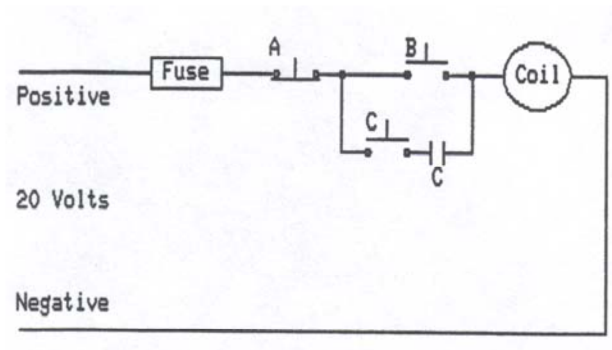
193. Which system requires only two power conductors and is generally used for control, lighting, and small loads?

a. Single-phase power.
b. Two-phase power.
c. Three-phase power.
d. Delta-phase power.

194. A magnetic relay is either closed or opened by:

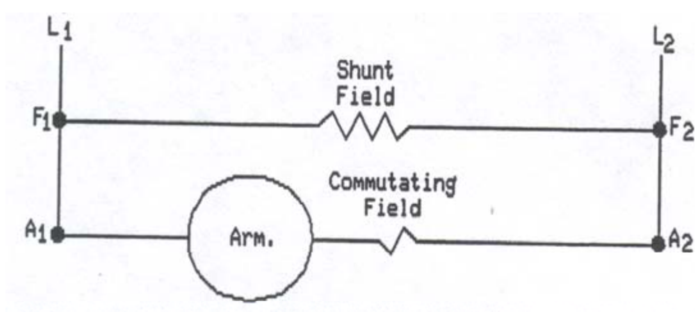
a. Photoelectric cells.
b. Capacitive action.
c. An electromagnetic field.
d. Thermal action.

195. Push button "B" would be classified as:



a. A stop push button
b. A jog push button
c. An interlock push button
d. A start push button

196. This is a schematic of a:



a. Squirrel cage motor
b. Compound motor
c. Series motor
d. Shunt motor

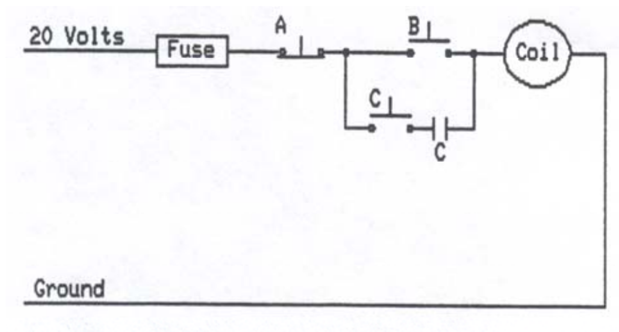
197. If a float switch on a pump closes because the water level rises:

a. The pump motor would go faster because the float switch cut out resistance to the motor
b. The pump motor should start because the float switch opened the circuit
c. The motor would stop because the float switch contacts would open
d. The pump should start because the float switch completed an electrical circuit

198. The purpose of a slip switch on a belt is to:

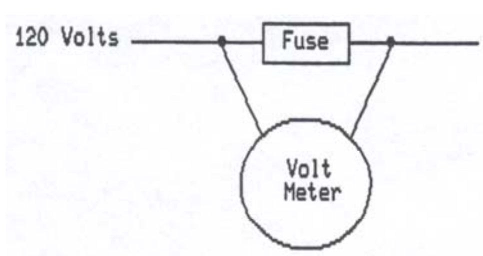
a. Stop the drive when the belt is slipping.
b. Stop all belts on the system.
c. Stop the belt when overloaded.
d. Take up belt slippage when starting.

199. Push button "A" would be classified as:



a. A start push button.
b. A JOG push button.
c. A stop push button.
d. An interlock push button.

200. If a voltmeter were placed across the fuse and the scale indicated 120 volts, you could correctly assume that:

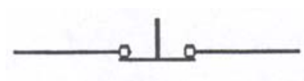


a. The fuse was good.
b. The fuse was blown.
c. The voltmeter is defective.
d. You made a wrong connection.

201. Of the devices listed below, what will change single-phase AC to DC?

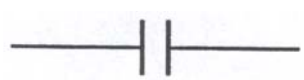
a. Rectifiers.
b. Transformers.
c. Capacitors.
d. Resistors.

202. The symbol below represents:



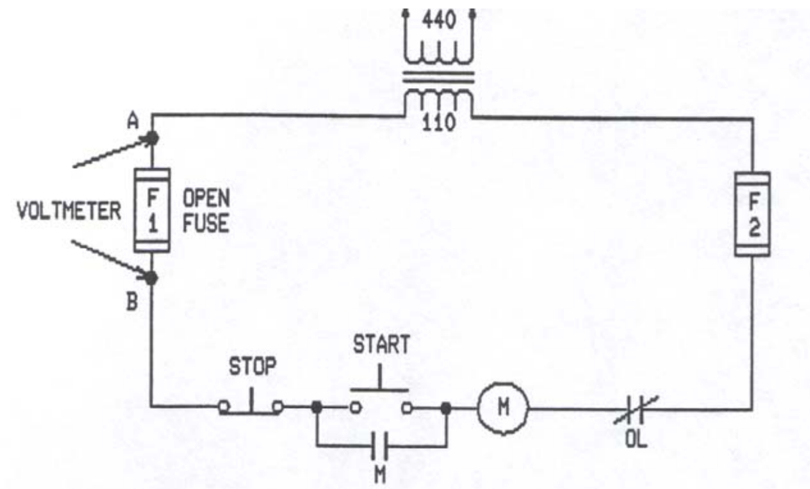
a. A stop button.
b. A jog button.
c. A normally open switch.
d. A start button.

203. The following symbol would represent:



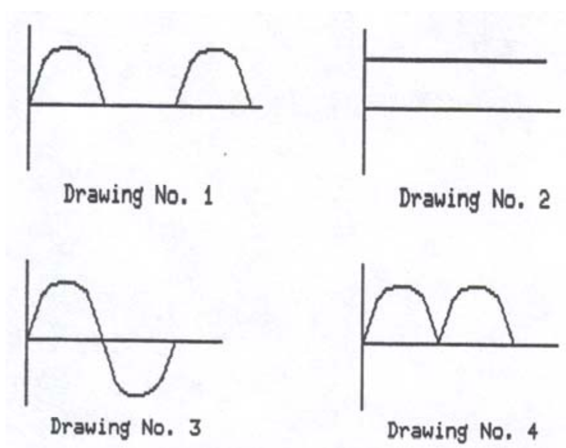
a. A normally open contact.
b. A normally closed contact.
c. A normally closed, timed-open contact.
d. A normally open, time-delay open contact.

204. What would the voltmeter below read if the start switch were closed and the meter connected to points A and B?



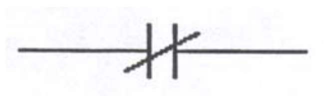
a. 110.
b. 440.
c. 220.
d. Zero.

205. Which of the following waveforms would be representative of a single-phase, half-wave, diode rectifier?



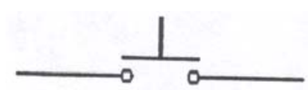
a. Drawing No. 1.
b. Drawing No. 4.
c. Drawing No. 3.
d. Drawing No. 2.

206. The following symbol would represent:



a. A normally closed contact.
b. A normally open contact.
c. A normally open, time delayed closing.
d. A normally closed, timed open.

207. The symbol below represents:



a. A start button.
b. A diode.
c. A rectifier.
d. A stop button.

208. A rectifier does what:

a. Steps up or steps down AC current.
b. Steps up or steps down AC voltage.
c. Changes DC current to AC current.
d. Changes AC current to DC current.

209. What is electrolysis?

a. The build-up of excessive stray current.
b. The method of improving ground fields.
c. The action of an electrical current which carries away particles of a conductor.
d. The acid found in a battery.

210. A diode blocks:

   a. Voltage in both directions.
   b. Current in one direction.
   c. Current in both directions.
   d. Voltage in one direction.

211. When testing a diode with an ohmmeter, what will be the reading of a good diode?

   a. There should be a very high reading in both directions.
   b. There should be a very low reading in both directions.
   c. A low resistance reading in one direction and a very high reading in the other direction.
   d. An ohmmeter is never used to check a diode.

212. If a diode reads continuity in one direction and open in the other, it is probably:

   a. Bad.
   b. Good.
   c. Open.
   d. Shorted.

213. What purpose is served by a blowout coil used as a DC contactor?

   a. It blows out when an overload occurs.
   b. It helps to hold the contactor closed.
   c. It helps to extinquish the arc when the contactor opens.
   d. It causes the contactor to open when power is removed.

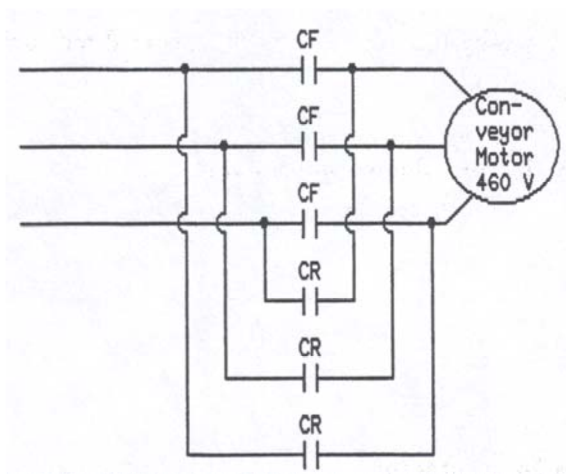
214. Electrical pressure or electromotive force is defined as:

   a. Voltage.
   b. Current.
   c. Wattage.
   d. Resistance.

215. The current used for charging storage batteries is:

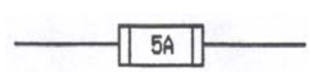
a. Alternating current.
b. Single-phase current.
c. Direct current.
d. Three-phase current.

216. This circuit supplies power to the conveyor motor. Which of the following is NOT true?



a. Contactors CF and CR will operate independently.
b. All six contactors will close at once.
c. This is a three-phase motor.
d. This motor is equipped to operate in either direction.

217. This symbol represents a 5-amp:



a. Circuit breaker.
b. Fuse.
c. Disconnect switch.
d. Thermal overload.

218. A wire used for a temporary connection is termed a:

a. Fuse element.
b. Connector.
c. Jumper.
d. Jack.

219. Which of the following is NOT a good conductor of electricity?

a. Oil.
b. Acid.
c. Carbon.
d. Mine water.

220. A small sump pump blows a 20-amp fuse. The pump under full load draws 12 amps of current and receives its power through a No. 12 AWG cable. After repairing the problem, you discover you only have a 15-amp and a 30-amp fuse. You should:

a. Install the 15-amp fuse.
b. Install the 30-amp fuse so it won't blow out as fast.
c. Bridge out the fuse.
d. Install either fuse.

221. The unit of measurement meaning "electrical pressure or force" is the:

a. Amp.
b. Watt.
c. Volt.
d. Ohm.

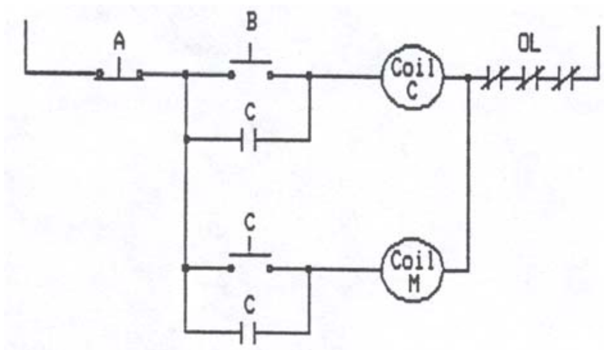
222. The wires of a transformer have a 10:1 ratio. When stretched out side by side:

a. The wires would be equal in length but different in diameter size.
b. The wires would be equal in both thickness and length.
c. One wire would be ten times the length of the other.
d. You would find one continuous wire.

223. The material used to separate one electrical wire from another in a cable is called:

a. Installation barrier.
b. Internal resistance barrier.
c. Insulation.
d. Impedance barrier.

224. If push button "C" is depressed:



a. Both coils "C" and "M" will energize but will de-energize as soon as the push button is released.
b. Only coil "M" will energize and remain energized after the push button is Released.
c. Both coils "C" and "M" will become energized and will remain energized after the push button is released.
d. Only coil "M" will be energized and remain energized as long as the button is depressed.

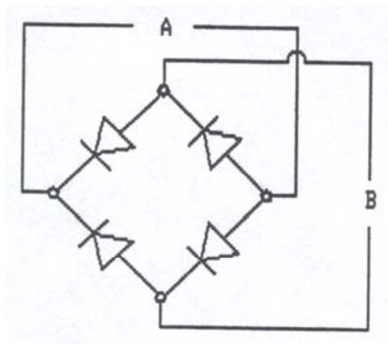
225. If you checked a resistor marked 50 ohms and your meter read the resistance extremely high (your meter would not measure the amount), you would be most correct in assuming that:

a. Your ohmmeter is not working.
b. The resistor has burned closed.
c. The resistor is marked incorrectly.
d. The resistor has burned open.

226. If four cables all have the same insulation and circular mil value, which cable would be the most flexible?

a. 2 strands.
b. 200 strands.
c. 20 strands.
d. A solid conductor.

227. Which of the following is represented by the symbol shown?



a. Diodes in parallel.
b. Oscillator.
c. Full wave rectifier.
d. Thermal overload.
e. Series diode.

228. A shuttle car tramming up a steep grade at the feeder blows a fuse. Before knocking the power and tagging-out the circuit you must:

a. Insulate yourself from ground with a rubber mat.
b. Block the machine so it doesn't move.
c. Equip yourself with a fire extinguisher.
d. Make a methane check.

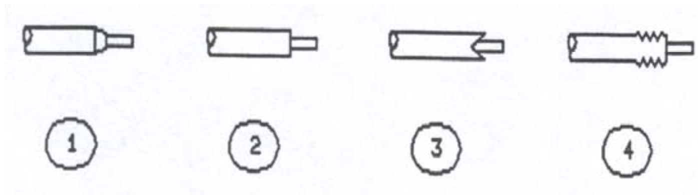
229. The part of a disconnect switch which has metal blades that pivot at one end is called a (an):

a. Toggle switch.
b. Knife switch.
c. Electrical interlock.
d. Impulse switch.

230. The safest way to check an electrical load to see if it is an open circuit is with a (an):

a. Voltmeter with power on.
b. Ohmmeter with power off.
c. Voltmeter with power off.
d. Ohmmeter with power on.

231. Which of the four methods below is recommended for removing the insulation on a cable?



a. Cut the insulation diagonally (3).
b. Pencil-point the insulation (1).
c. Make a square cut so the connector can be kept snug against the insulation (2).
d. Skin back the cable so the connector ring will be covered with insulation (4).

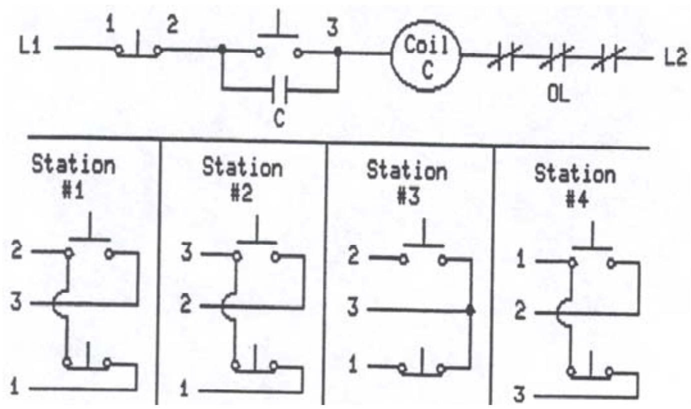
232. Which of the following is a good conductor of electricity?

a. Carbon.
b. Fiberglass.
c. shellac.
d. leather.

233. If a circuit breaker with thermal overload protection has just tripped and you immediately try to re-energize the circuit and find that the breaker will not hold in, you should:

a. Assume that you have a short circuit and immediately begin to look for the problem.
b. Wait for the thermal element in the breaker to cool sufficiently so that it will hold in the tripping mechanism.
c. Notify your supervisor that the circuit breaker is defective.
d. Assume that something serious is wrong because the breaker will not hold.

234. Which of the push button stations below is wired according to the diagram?



- a. Station No. 3.
- b. Station No. 2.
- c. Station No. 1.
- d. Station No. 4.

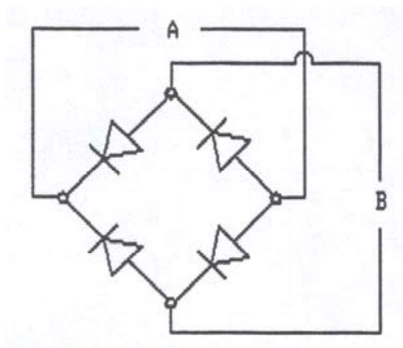
235. The power of a transformer is rated by its:

- a. KVA rating.
- b. Power factor rating.
- c. Current rating.
- d. Voltage rating.

236. There are three types of electrical diagrams. Which of the following is NOT an electrical diagram?

- a. Single or one line diagram.
- b. Wiring diagram.
- c. Power diagram.
- d. Schematic diagram.

237. In the leads at point "A", you would expect to find:



a. The current bucking or opposing itself.
b. Alternating current.
c. Direct current.
d. Half wave rectification.

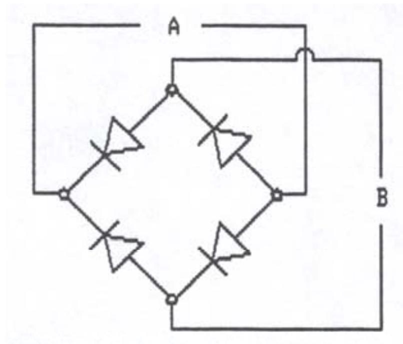
238. A transformer has primary windings of 460 volts and secondary windings of 115 volts. What can you correctly assume about wire size?

a. The windings would be the same size since the power on each side is equal.
b. The secondary windings would be larger in size (AWG) than those on the primary side.
c. The primary windings would be larger in size than those on the secondary side.
d. The primary and secondary wires are not separated but are combined as one.

239. The main function of a thermal overload is to:

a. Protect the cable from overload.
b. Protect all electrical components on the machine from overload.
c. Protect the motor from overload.
d. Act as a heat sink for temperature buildup in the motor.

240. What type of current would you expect to find at the leads of Point "B"?

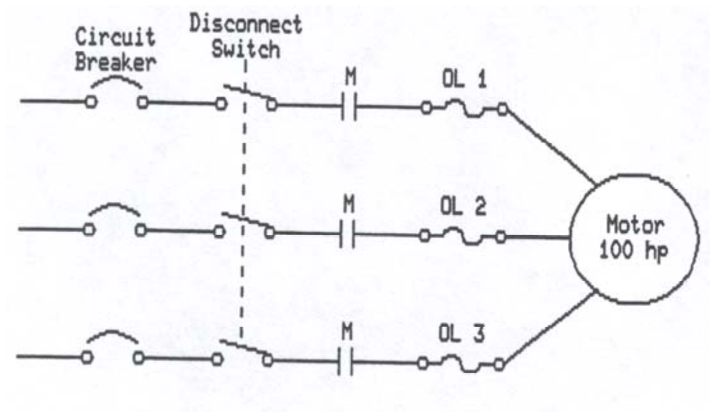


a. No current.
b. Direct current.
c. Alternating current.
d. Both alternating and direct current.

241. The device that makes or breaks a circuit feeding a load is called a:

a. Tripping device.
b. Contactor.
c. Fuse.
d. Regulator.

242. If the motor developed an internal "direct short" between phases, the device to de-energize the circuit would be the:

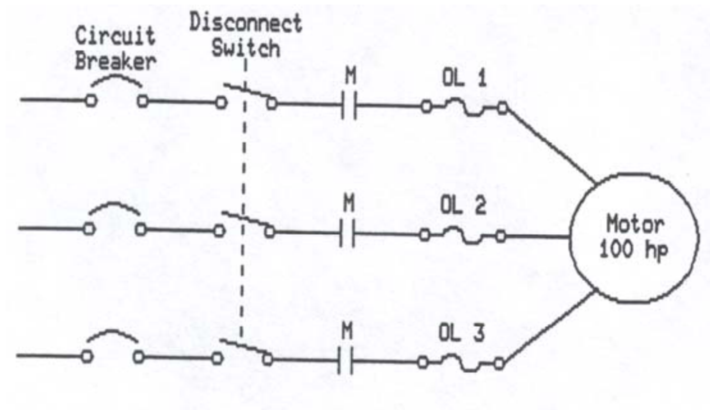


a. Line contactors.
b. Disconnect switch.
c. Overloads.
d. Circuit breaker.

243. If you wanted to check the insulation on wire for damage, the instrument you would use is a (an):

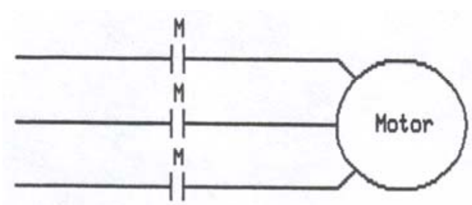
a. Megger.
b. Voltmeter.
c. Ohmmeter.
d. Galvanometer.

244. The main purpose of the overloads is to protect the:



a. Phase leads.
b. Motor.
c. Cable leading to the motor.
d. Circuit breaker.

245. The "M" line contactors should be physically located in:

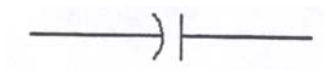


a. The starter.
b. The disconnect switch.
c. The motor.
d. The circuit breaker.

246. If a belt conveyor loaded with coal was turned on, the starting torque would be greatest when the motor:

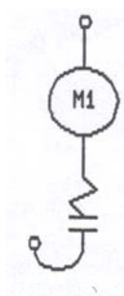
a. Runs at full speed
b. Stops
c. Runs at half speed
d. First starts

247. This is a symbol for a:



a. Capacitor.
b. Resistor.
c. Contactor.
d. Thermal overload.

248. The symbol shown below represents:

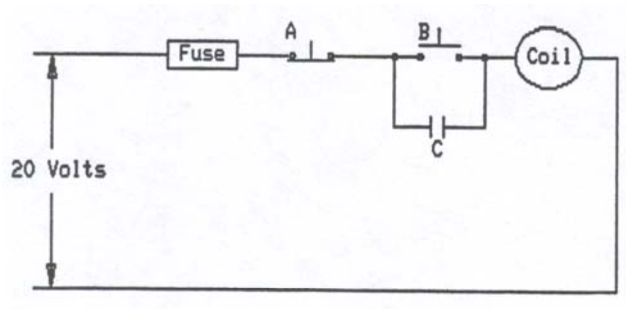


a. A series motor.
b. A single pole contactor.
c. A mercury tube.
d. A double pole contactor.

249. A current that changes in magnitude but not in direction is called?

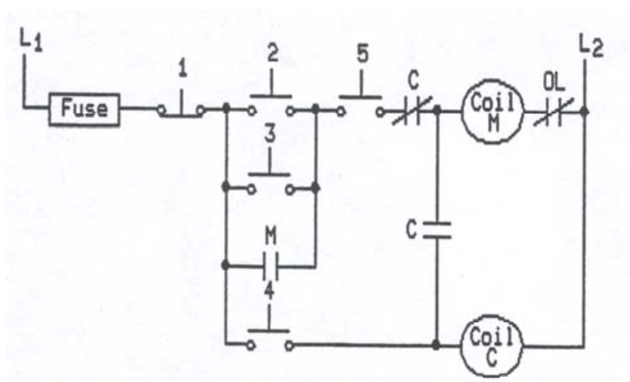
a. Pulsating current.
b. Erratic current.
c. Alternating current.
d. Magnetic flux.

250. To stop or de-energize this circuit in a normal manner you would:



a. Depress push button "A".
b. Depress push button "B".
c. Pull push button "B" back open.
d. Disconnect the fuse.

251. Which of the four push button stations will cause coil "M" to be energized only while that push button is depressed?

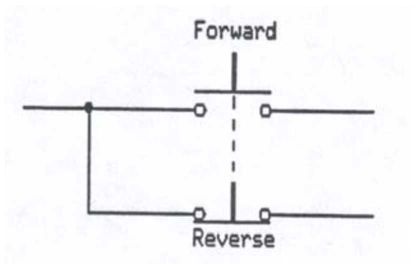


a. Push button 2.
b. Push button 4.
c. Push button 3.
d. Push button 1.

252. The unit of measurement of resistance to the flow of electricity is the:

a. Amp.
b. Watt.
c. Ohm.
d. Farad.

253. These push buttons are:

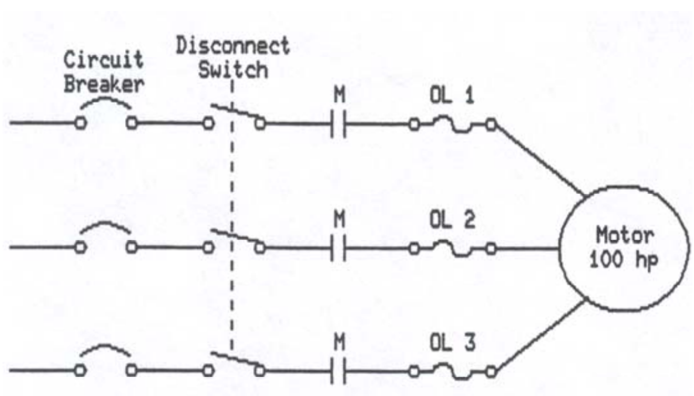


a. Shown incorrectly.
b. Made for plugging or jog operation.
c. The momentary type.
d. Mechanically interlocked.

254. What is the same across each part of a parallel circuit?

a. Power.
b. Voltage.
c. Resistance.
d. Current.

255. Across-the-line starting of this motor is achieved by:

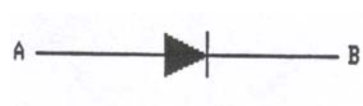


a. The M contactors.
b. The circuit breaker.
c. The disconnect switch.
d. Overloads OL1, OL2, and OL3.

256. The unit of measurement generally used when rating a capacitor is the:

a. Microfarad.
b. Henry.
c. Coulomb.
d. Amp.

257. According to the electron theory, the diode in this diagram will block:



a. voltage flowing from B to A.
b. current flowing from A to B.
c. voltage flowing from A to B.
d. current flowing from B to A.

258. If you wanted to find information concerning a motor's duty cycle characteristics, you could find it most easily by:

a. Looking it up in your reference manual.
b. Checking the size of the motor windings.
c. Calling the representative of the company which manufactures the motor.
d. Looking at the tag attached to the motor housing

259. Resistance is checked with an instrument called a(an):

a. Wattmeter.
b. Ohmmeter.
c. Voltmeter.
d. Ammeter.

260. If the continuous miner stops operating, and the only component that is energized on the miner is its methane monitor, you could do all of the following EXCEPT:

a. Begin re-establishing ventilation.
b. Notify the foreman.
c. Jumper-out the methane monitor.
d. De-energize the power to the miner.

261. Which will cause the power center circuit breaker for a continuous miner to trip faster?

a. The miner is sumping deep into the coal.
b. The miner is tramming up a steep grade.
c. The shuttle car runs over the miner cable causing two conductors to come in contact with each other.
d. The miner cuts into an extremely hard area of rock.

262. This is a symbol for a:

a. Resistor
b. Fuse
c. Magnetic auxiliary relay
d. Thermal overload

263. If a transformer was believed to be shorted because of a breakdown in its insulation, what instrument would you use to check it?

a. An ammeter.
b. A galvanometer.
c. A voltmeter.
d. A megger.

264. Electron flow in a conductor is defined as:

a. Current.
b. Power.
c. Resistance.
d. Voltage.

265. If the cross-sectional area (size) of a wire is decreased, its resistance will:

a. Increase.
b. Double.
c. Not change.
d. Decrease.

266. The element of a closed-loop DC generator control system that compares the motor's output voltage setting with its operating speed, is:

a. A signal indicator.
b. A master switch.
c. An error detector.
d. A loop regulator.

267. Most equipment in an underground mine is:

a. Not powered by trailing cables.
b. Powered by trolley wire.
c. Powered by trailing cables.
d. Powered by special cables similar to trailing cables.

ANSWER GUIDE
Electrical Equipment and Circuits

Question	Answer	Question	Answer	Question	Answer	Question	Answer
1	D	44	B	87	A	130	C
2	C	45	C	88	A	131	B
3	C	46	C	89	C	132	B
4	B	47	B	90	C	133	B
5	A	48	C	91	D	134	A
6	C	49	C	92	D	135	C
7	B	50	B	93	B	136	A
8	C	51	B	94	E	137	C
9	A	52	B	95	C	138	B
10	C	53	C	96	A	139	B
11	A	54	A	97	A	140	C
12	A	55	A	98	A	141	D
13	C	56	B	99	C	142	B
14	A	57	D	100	C	143	C
15	D	58	A	101	B	144	B
16	B	59	D	102	B	145	B
17	A	60	A	103	B	146	C
18	B	61	C	104	A	147	A
19	C	62	C	105	C	148	B
20	D	63	C	106	D	149	D
21	C	64	A	107	D	150	B
22	B	65	D	108	C	151	B
23	A	66	B	109	A	152	D
24	C	67	B	110	B	153	D
25	A	68	B	111	B	154	A
26	C	69	B	112	A	155	B
27	B	70	A	113	B	156	B
28	D	71	C	114	B	157	A
29	C	72	A	115	C	158	A
30	A	73	D	116	D	159	A
31	A	74	B	117	C	160	D
32	C	75	B	118	C	161	A
33	A	76	A	119	E	162	A
34	B	77	C	120	B	163	B
35	D	78	A	121	B	164	A
36	C	79	D	122	C	165	D
37	B	80	B	123	D	166	D
38	A	81	C	124	B	167	B
39	B	82	D	125	A	168	D
40	C	83	B	126	E	169	D
41	D	84	A	127	C	170	A
42	A	85	D	128	D	171	A
43	C	86	B	129	B	172	D

ANSWER GUIDE
Electrical Equipment and Circuits

Question	Answer	Question	Answer	Question	Answer
173	A	216	B	259	B
174	B	217	B	260	C
175	A	218	C	261	C
176	B	219	A	262	A
177	B	220	A	263	D
178	B	221	C	264	A
179	D	222	C	265	A
180	B	223	C	266	C
181	B	224	D	267	C
182	A	225	D		
183	C	226	B		
184	A	227	C		
185	B	228	B		
186	A	229	B		
187	D	230	B		
188	A	231	B		
189	B	232	A		
190	A	233	B		
191	C	234	C		
192	C	235	A		
193	A	236	C		
194	C	237	C		
195	B	238	B		
196	D	239	C		
197	D	240	C		
198	A	241	B		
199	C	242	D		
200	B	243	A		
201	A	244	B		
202	A	245	A		
203	A	246	D		
204	A	247	A		
205	A	248	B		
206	A	249	A		
207	A	250	A		
208	D	251	B		
209	C	252	C		
210	B	253	D		
211	C	254	B		
212	B	255	A		
213	C	256	A		
214	A	257	B		
215	C	258	D		

Multiple-choice question(s).
Read the question and select the appropriate answer from the list provided

1. When lightning strikes a transmission line, causing a sudden surge of voltage into the system, circuit protection is provided by:

   a. A transformer.
   b. An air switch.
   c. A surge arrestor.
   d. A ground resistor.

2. The main substation, which provides power for the entire pit:

   a. May be fixed or portable.
   b. Is never permanently located.
   c. Is always portable.
   d. Is always fixed.

3. The voltages provided by the various substations are:

   a. Always the same.
   b. Never less than 80% of the incoming power.
   c. Dependent upon the needs of that part of the system.
   d. Never less than the 6 kV of the incoming power.

4. A portable substation normally receives power from a:

   a. Utility company.
   b. Main substation.
   c. Distribution box.
   d. Generator

5. Insulated tools:

   a. Protect the user against even the highest voltage.
   b. Can provide an extra measure of protection when working on equipment.
   c. Provide no protection and are difficult to handle.
   d. May not be used if the voltage is below 220.

6. The type of grounding system that involves drilling a hole to a level below the coal seam, then extending a heavy ground wire to the bottom of the hole is a:

   a. Borehole ground system.
   b. Ground rod system.
   c. Ground grid system.
   d. Type of system that does not provide a very effective ground and should never be used.

7. Main substations are:

   a. Usually mounted on one skid.
   b. Portable only.
   c. Either fixed or portable.
   d. Stationary only.

8. Circuit protection against a tremendous surge of additional voltage through a distribution system is provided by:

   a. Circuit breakers.
   b. Surge arrestors.
   c. PT's.
   d. CT's.

9. Transmission lines provided by an electrical utility company often carry as much as:

   a. 138,000 volts.
   b. 100,000 volts.
   c. 50,000 volts.
   d. 22,900 volts.

10. The first skid in a three-skid main substation usually houses the:

   a. Air switch.
   b. Dragline.
   c. Circuit breaker.
   d. Transformer.

11. The objective of grounding is to provide a constant electrical connection between the:

    a. Equipment frames and the equipment itself.
    b. Equipment and the circuit.
    c. Every piece of equipment.
    d. Equipment frames and the earth.

12. The grounding system stipulated in the Mine Safety and Health Act for both surface and underground mines is the:

    a. Equipment frame grounded system.
    b. Resistance (impedance) grounded system.
    c. Field grid system.
    d. Borehole grounded system.

13. To further reduce the voltage provided by the various substations:

    a. Another step-down transformer is used.
    b. Step-up transformers are used.
    c. A resistor is used.
    d. The equipment being powered is capable of doing this.

14. The voltages provided by the utility are:

    a. Changed to meet the system requirements.
    b. Used as received at the various subsystem.
    c. Used as received at the main sub.
    d. Reduced at the main sub only.

15. A capacitor, after it is disconnected from a circuit:

    a. Will create a magnetic induction field.
    b. Will hold a dangerous charge.
    c. Will be destroyed if not discharged.
    d. Will deenergize immediately.

16. How often must circuit breakers be tested and examined?

    a. Everyday.
    b. Once a month.
    c. Every 6 months.
    d. Once a week.

17. Circuit breakers, protecting high-voltage circuits entering an underground area of a coal mine:

    a. Must be located on the surface.
    b. May be located within a drift.
    c. Can be located either on the surface or underground.
    d. Must be located underground.

18. A high-voltage circuit, which supplies power to portable or mobile equipment, must be protected by:

    a. A load-break switch.
    b. Arc traps
    c. A circuit breaker.
    d. A disconnecting switch.

19. High-voltage circuits to stationary equipment must be protected against overload by:

    a. Circuit breakers or fuses.
    b. Fuses only.
    c. Air switches.
    d. Circuit breakers only.

20. Molded case, and oil or oil blast are two types of:

    a. Circuit breakers.
    b. Current transformers.
    c. Transformers.
    d. Air switches.

21. A high-voltage circuit, which supplies power to stationary equipment on the surface, must be protected by:

    a. Neither a circuit breaker nor fuse.
    b. Fuses but not a circuit breaker.
    c. Either a circuit breaker or fuses.
    d. A circuit breaker but not fuses.

22. Circuit breakers at disconnect switches which protect high-voltage circuits:

    a. Need not be labeled since it is obvious which equipment they are protecting.
    b. Must always be labeled to show what equipment is being controlled by which circuit.
    c. May need to be labeled depending on which equipment they are protecting.
    d. Can be labeled if deemed necessary.

23. Circuit breakers serving high-voltage circuits to portable or mobile equipment must be tested:

    a. Every six months.
    b. At least once a month.
    c. Three times a year.
    d. Once a week.

24. Where should circuit breakers, protecting high-voltage circuits entering an underground area of any coal mine, be located?

    a. On the surface.
    b. At the mouth of each section.
    c. At the beginning of each branch circuit.
    d. Underground at the first switch box.

25. Circuit breaker and disconnecting devices underground are to be:

    a. Worked often to prevent rusting.
    b. Connected phase-to-ground.
    c. Installed in the return.
    d. Marked for identification.

26. Circuit breakers for high-voltage circuits entering an underground mine should provide protection for all of the following EXCEPT:

    a. Short circuit and overcurrent.
    b. Over voltage.
    c. Undervoltage.
    d. Grounded phase.

27. If high-voltage circuit is equipped with a circuit breaker, and if this circuit supplies power to portable or mobile equipment, then the circuit breaker must be tested and examined by a qualified person at least:

    a. Once each week.
    b. Once each month.
    c. Twice each month.
    d. Once each day.

28. Circuit breakers and disconnecting switches underground should be:

    a. Color-coded.
    b. Marked for identification.
    c. Explosion-proof.
    d. Dustproof.

29. Circuit breakers protecting high-voltage lines entering an underground area of any coal mine must provide all of the following EXCEPT:

    a. Single-phase protection.
    b. Short-circuit and overcurrent protection.
    c. Grounded-phase protection.
    d. Undervoltage protection.

30. To protect against a short circuit or overcurrent situation, there's a:

    a. Circuit breaker in the main sub.
    b. Circuit breaker at the output end of each substation.
    c. Circuit breaker at the input end at each substation.
    d. Fuse at the input end of each substation.

31. Cable couplers should be constructed so that the conductor which "breaks" first when the coupler is being uncoupled is the:

    a. Power conductor.
    b. Ground check conductor.
    c. Static conductor.
    d. Phase conductor.

32. Cable couplers should be constructed in the following manner:

    a. Ground check conductors should be broken last.
    b. All conductors, including ground, should be broken at the same time.
    c. Phase leads should be broken separately.
    d. Ground check conductor should be broken first.

33. A stress cone is used in high-voltage cable termination to:

    a. Protect the shield from mechanical damage.
    b. Produce corona.
    c. Insulate the pilot wire.
    d. Reduce electric field concentrations.

34. Cables couplers should be constructed so that the conductor which “breaks” last when the coupler is being uncoupled is the:

    a. Static conductor.
    b. Power conductor.
    c. Ground conductor.
    d. Phase conductor.

35. High-voltage cable couplers with any metal exposed should be:

    a. Grounded to the earth through a grounding resistor.
    b. Grounded to an external ground rod that is driven nearby.
    c. Grounded to the ground conductor in the cable.
    d. Equipped with a ground check monitor.

36. All exposed metal on metallic couplers should be grounded to:

    a. A grounding rod.
    b. Any low-resistance ground.
    c. The ground conductor in the cable.
    d. Protect against mechanical damage.

37. Disconnecting or cutout switches on energized high-voltage surface lines should be operated only with:

    a. A slate bar, while wearing rubber gloves.
    b. Insulated sticks or fuse tongs.
    c. Automatic dropouts.
    d. Any stick made of dry wood.

38. The beginning of each high-voltage branch circuit must be equipped with:

    a. A disconnecting device.
    b. A ground monitor.
    c. A fire suppression system.
    d. An isolation transformer.

39. Under a full load, air switches:

    a. Are usually intended to be opened.
    b. Are usually not intended to be opened.
    c. Are never intended to be closed.
    d. Present no potential problem.

40. One function of the main sub is to provide protection to both the system and the mine personnel by the use of:

    a. Transmission lines.
    b. Air switches and circuit breakers.
    c. Trailing cables.
    d. Transformers.

41. Where high-voltage circuits enter the underground portion of a mine, disconnecting devices should be installed:

    a. Within 200 feet of the mine entrance.
    b. Within 300 feet of the mine entrance.
    c. Within 100 feet of the mine entrance.
    d. Within 500 feet of the mine entrance.

42. An air switch is:

    a. Not a visible disconnect.
    b. A visible disconnect.
    c. An automatically operating switch.
    d. A switch with thermal protection.

43. Disconnecting devices shall be installed at:

    a. The middle of each branch line is high-voltage circuits.
    b. Both the end and beginning of each branch line in high-voltage circuits.
    c. The end of each branch line in high-voltage circuits.
    d. The beginning of each branch line in underground high-voltage circuits.

44. High-voltage disconnecting devices must be installed:

    a. So that opening the disconnect signals an alarm to the dispatcher.
    b. At the beginning of all branch lines.
    c. Where miners regularly work.
    d. On all power centers.

45. An air switch located between the utility's transmission and the main substation is used to isolate:

    a. Portable substations.
    b. Specific power lines.
    c. The entire mine's underground power distribution system.
    d. Feeders.

46. A manually operated air switch:

    a. Can be opened either under load or not.
    b. Is made to be opened under load.
    c. Can be opened under load if it is located in surface.
    d. Should not be opened under load.

47. All branch lines in underground high-voltage circuits:

    a. Should have disconnecting devices which require the use of a test instrument to determine whether a line is de-energized.
    b. Need not have disconnecting devices.
    c. Are not required to be provided with disconnecting devices when the main lines are properly protected.
    d. Must have disconnecting devices designed so that you can tell be visual observation that a line is de-energized.

48. Which of the following is NOT a symptom of physical shock?

    a. The skin is pale.
    b. The skin is cold and clammy.
    c. Breathing is abnormally deep.
    d. The pulse is weak and rapid.

49. Only after trying all other procedures used to stop or control bleeding should you:

    a. Apply a tourniquet.
    b. Pinch the artery together.
    c. Apply direct pressure.
    d. Use the pressure points.

50. Which of the following should NOT be done when applying mouth-to-mouth resuscitation?

   a. Clear the victim's air passage.
   b. Secure the victim's tongue in a forward position.
   c. Pinch the victim's nostrils together.
   d. Pull the victim's lower jaw until it points straight up.

51. Burns received from electrical shock should never be:

   a. Rubbed to stimulate.
   b. Wrapped with a loose covering.
   c. Cooled with wet applications.
   d. Treated for shock.

52. When treating for shock, never allow a victim to:

   a. Sit or stand up.
   b. Loosen his or her clothing.
   c. Become too comfortable
   d. Have a stimulant by inhalation.

53. When dressing a burn of the fingers or toes, do all of the following EXCEPT:

   a. Permit burned surfaces to come in contact with each other.
   b. Protect any blisters.
   c. Apply dressing loosely over entire area of burn.
   d. Check the dressing frequently since swelling may cause it to tighten.

54. A victim is unconscious after being pulled from contact with an electrical shock. Which method may NOT be used to detect if the victim's heart has stopped?

   a. Check the victim's pulse at the wrist on the left, with your middle and index finger.
   b. Check the victim's pulse by using the middle and index fingers next to the victim's Adam's apple.
   c. Check the victim's pulse at the wrist on the right with your thumb.

55. The maximum voltage used for ground check circuits in high-voltage systems should never exceed:

   a. 40 volts.
   b. 48 volts.
   c. 96 volts.
   d. 100 volts.

56. The grounding method that involves burying a network of conductors and connecting this network to the system is called:

    a. Equipment frame ground.
    b. Borehole ground.
    c. Ground field grid.
    d. Buried copper grid.

57. If a window-type current transformer is used for ground-fault detection on a high-voltage cable, the following conductors must pass through the opening:

    a. Two of the three phase conductors.
    b. Three phase conductors and the cable shield.
    c. The three phase conductors and the ground wire.
    d. The three phase conductors.

58. A high-voltage, ground-monitoring system:

    a. Is limited to 40 volts.
    b. Closes the breaker whenever either the ground or pilot check wire is broken.
    c. Opens the breaker whenever either the ground or pilot check wire is broken.
    d. May be eliminated if a ground fault produces no hazard.

59. If a high-voltage circuit utilizes resistance grounding, then the system must include:

    a. A monitor that measures the resistance of the grounding resistor.
    b. A fail-safe potential transformer in shunt with the grounding resistor.
    c. A zig-zag transformer.
    d. A window or donut current transformer
    e. A fail-safe ground check circuit or another device that is at least as effective.

60. The insulation rating, for ground check conductors used with high-voltage trailing cables, must be at least:

    a. 600 volts.
    b. 200 volts.
    c. 400 volts.
    d. 1000 volts.

61. The component which continuously checks the ground wires in trailing cables is the:

    a. Circuit breaker.
    b. Grounding resistor.
    c. Ground monitor.
    d. Surge arrestor.

62. What is the maximum voltage that can be used for high-voltage ground check circuits?

    a. 96 volts.
    b. 100 volts.
    c. 40 volts.
    d. Equal to phase-to-ground voltage.

63. How must electrical enclosures of stationary, portable, or mobile underground AC equipment and frames supporting these structures be grounded?

    a. Grounded to copper feeder.
    b. Grounded to bore hole casing.
    c. Grounded to mine track.
    d. Grounded to high-voltage ground.

64. On a resistance-grounded power system, single-phase loads should be connected:

    a. Line-to-neutral.
    b. In series with the zig-zag transformer.
    c. Phase-to-ground.
    d. Across the neutral resistor.
    e. Phase-to-phase.

65. Underground high-voltage cables used in resistance grounding should be equipped with:

    a. A metallic shield around the ground check circuit.
    b. A metallic shield around each power conductor.
    c. A metallic shield at the splicing joint.
    d. A metallic shield around the ground wire.

66. If a high-voltage circuit includes a grounding resistor, under fault condition it must limit the voltage drop in the grounding circuit external to the resistor to not more than:

    a. 48 volts.
    b. 75 volts.
    c. 96 volts.
    d. 40 volts.
    e. 100 volts.

67. If resistance grounding is used in a high-voltage circuit, then the grounding resistor must be rated for:

    a. 150% of maximum fault current.
    b. 125% of maximum fault current.
    c. Maximum fault current continuously.
    d. Maximum fault current intermittently.

68. In impedance and resistance grounding systems, an important part, which functions by limiting the ground-fault current from one phase of the system to the ground, is the:

    a. Overcurrent relay.
    b. Grounding resistor.
    c. Time delay overcurrent relay.
    d. Donut current transformer.

69. On low and medium voltage circuits when a ground-fault occurs, if both the grounding transformer and the resistor in the impedance-grounded system are good, the maximum ground fault tripping current shall not exceed:

    a. 25 amps.
    b. 250 amps.
    c. 100 amps.
    d. 45 amps.

70. The grounding circuit of a high-voltage circuit extending underground must:

    a. Connect to all phase leads.
    b. Originate at the grounded side of the grounding resistor.
    c. Be a No. 10 conductor.
    d. Be within 100 feet of the point where it enters the mine.

71. High-voltage circuits that supply power to portable or mobile equipment should:

    a. Contain either a direct or a derived neutral that is grounded through a resistor.
    b. Contain a neutral that is grounded through a suitable circuit breaker.
    c. Contain a delta that is grounded at one corner.
    d. Contain a neutral that is grounded through a suitable inductor.

72. The neutral grounding resistor in a high-voltage circuit must be insulated from ground for a voltage equal to:

    a. The phase-to-phase voltage of the system.
    b. Twice the line-to-line ground voltage.
    c. The phase-to-neutral voltage of the system
    d. 150% of the phase-to-phase voltage.

73. Can messenger wire that is to be used to suspend high-voltage cable also be used as a grounding medium in an ungrounded system?

    a. Yes, if the messenger wire is grounded.
    b. Only if no other means of grounding is available.
    c. Only if the messenger wire is of proper size.
    d. No, messenger wire may not be used as a ground.

74. What is the minimum size of an insulated internal ground check conductor that may be used for the ground continuity check circuit?

    a. No. 12 AWG.
    b. No. 6 AWG
    c. No. 6 AWG.
    d. No. 10 AWG

75. According to federal law, if a high-voltage cable does not contain an insulated conductor for the ground continuity check circuit, an external conductor may be used if it is:

    a. Not smaller than No. 10 AWG.
    b. Not smaller than No. 8 AWG.
    c. Not smaller than No. 14 AWG.
    d. Not smaller than No. 12 AWG.

76. The total cross-sectional area of the ground conductor in a high-voltage trailing cable must be:

    a. Equal to the cross-sectional area of one power conductor.
    b. More than three-fourths of the cross-sectional area of a power conductor.
    c. Not less than one-half of the cross-sectional area of a power conductor.
    d. Less than one-half of the cross-sectional area of one power conductor.

77. The protective devices required (when working on an energized high-voltage surface line) are rubber and they must have dielectric strength of:

    a. 15,000 volts or more.
    b. 10,000 volts or more.
    c. 20,000 volts or more.
    d. 25,000 volts or more.

78. Flexible steel conduit as protection for high-voltage circuits:

    a. May be used in non-hazardous situations.
    b. May never be used.
    c. Should always be used.
    d. Can be used if approved by the mine operator.

79. When handling high-voltage trailing cables:

    a. Leather gloves should be worn.
    b. Any kind of gloves can be used.
    c. Rubber or lineman’s gloves (rated to at least 20,000 volts) must be worn.
    d. Gloves are not necessary.

80. Rubber gloves used to work on high-voltage lines for extended periods should be visually inspected for defects by the person using them no less than:

    a. Twice each week.
    b. Once each day.
    c. Twice each day.
    d. Once each month.

81. Each rubber protective device employed in making repairs to energized high-voltage lines must have a dielectric strength of at least:

    a. 25,000 volts.
    b. Twice the line-to-line voltage.
    c. Line-to-neutral voltage.
    d. Twice the line-to-neutral voltage.
    e. 20,000 volts.

82. A boom or a mast may not be operated within:

    a. 10 feet of an energized power line.
    b. 8 feet of any power line.
    c. 5 feet of an energized power line.
    d. 6 feet of an energized power line.

83. How many feet outby the high voltage trailing cable, packing gland, is hose conduit required?

    a. 3 feet.
    b. 4 feet.
    c. 5 feet.
    d. 8 feet.
    e. 10 feet.

84. If work is to be done on energized high-voltage lines, it must be done by:

    a. Any electrician in the presence of a supervisor.
    b. A trained person.
    c. A specially qualified person.
    d. An experienced electrician with at least six months on the job.

85. Rubber gloves used to work on energized high-voltage surface lines must be electrically tested:

    a. Every 6 months.
    b. Once each month.
    c. Every 3 months.
    d. Once each year.

86. Repairs can only be made to power circuits with a phase-to-phase nominal voltage of:

    a. No more than 15,000 volts.
    b. No less than 10,000 volts.
    c. No more than 10,000 volts.
    d. No less than 15,000 volts.

87. If a high-voltage cable contains three power conductors, it must contain:

    a. Two metallic shields.
    b. Three metallic shields.
    c. One metallic shield.
    d. One or three metallic shields.

88. When equipment must be moved or operated near energized surface high-voltage power lines, minimum clearance must be:

    a. 15 feet.
    b. 20 feet.
    c. 10 feet.
    d. 5 feet.

89. Which of the following is NOT an acceptable way to store high-voltage rubber gloves?

    a. In a special place.
    b. Wrong side out.
    c. In a very dry place.
    d. In the supply house.

90. When two persons are working on an energized high-voltage line at the same time within reach of each other, they:

    a. Should work on different phases.
    b. Must use extra precautions when working on different phases or on equipment with different potentials.
    c. Cannot work on different phases or on equipment with different potentials.
    d. Must work under close supervision.

91. All personnel working on energized high-voltage lines:

    a. Should, under special circumstances, wear protective clothing.
    b. Are required to wear protective clothing.
    c. Should wear protective clothing if they feel it is necessary.
    d. Need not wear protective clothing if working on the surface.

92. Live-line tools must be used on all circuits with a phase-to-phase nominal voltage of:

    a. 5,000 volts or more.
    b. 10,000 volts.
    c. 15,000 volts.
    d. 1,000 volts.

93. How often must rubber sleeves be tested for use with high voltage?

    a. Every 2 months.
    b. Once a year.
    c. Every 3 months.
    d. Every 6 months.

94. High-voltage lines are considered safely de-energized for maintenance when so determined by:

    a. A qualified person.
    b. An electrician.
    c. The electrical foreman.
    d. An experienced person.

95. Energized high-voltage surface lines may be repaired:

    a. Only on weekends.
    b. When the voltage is less than 20,000 volts.
    c. By qualified persons in accordance with procedures and safeguards.
    d. When necessary to keep the mine opening.

96. Work on energized high-voltage lines underground is:

    a. Prohibited by law.
    b. Permitted in most mines.
    c. Permitted when accomplished by trained electricians.
    d. Permitted when accomplished by qualified persons.

97. What precautions must be taken when two or more persons are working within reach of each other on energized high-voltage lines?

    a. Mine electricians are not allowed to work in energized high-voltage lines.
    b. They must not wear high-voltage gloves and insulated hard-toed boots.
    c. They must not wear high-voltage gloves and insulated hard hats.
    d. They must not work on equipment with different potentials.

98. High-voltage power lines which are located above driveways and railroad tracks must be installed to provide a:

    a. Maximum clearance of 10 feet.
    b. Minimum clearance of 20 feet.
    c. Minimum clearance of at least 12 feet.
    d. Minimum clearance of 15 feet.

99. Before performing work on high-voltage lines on the surface or underground, the lines should be:

    a. De-energized and inspected.
    b. De-energized and grounded.
    c. Grounded through the grounding resistor.
    d. Inspected by a qualified person.

100. The person responsible for making out the special report concerning the repair of high-voltage lines is the:

    a. Electrician supervisor.
    b. Mine operator.
    c. Person who made the repairs.
    d. Foreman.

101. Must a record be kept of repair work done on energized high-voltage surface lines?

    a. No.
    b. Only if power is deenergized.
    c. Yes.
    d. Only if two people are working on separate phases.

102. In no event should any high-voltage power line be installed above ground at a height less than:

a. 13 feet
b. 15 feet.
c. 12 feet.
d. 10 feet.

103. Where the voltage of overhead power lines is less than 69,000 volts, the booms and masts of equipment operated on the surface should be operated no closer to the power lines than:

a. 9 feet.
b. 10 feet.
c. 7 feet.
d. 8 feet.

104. Transmission lines provided by the electrical utility company often carry as much as:

a. 138,000 volts.
b. 22,900 volts.
c. 100,000 volts.
d. 50,000 volts.

105. A requirement for working on energized high-voltage surface lines is:

a. The mine operator must provide, test, and maintain protective devices used in making such repairs.
b. The electrician cannot wear a wedding ring.
c. All work must be done according to the National Electrical Code.
d. The electrician making such repairs must have five years experience as a certified electrician.

106. The shop area of an underground mine must have the power necessary to operate underground mining equipment because:

a. As this equipment is repaired, it's often necessary to run it to make sure the equipment is operating properly.
b. Some underground equipment may use the power.
c. This equipment is often used in surface mining operations.
d. Most underground equipment receives its power from the shop.

107. The term “high voltage” means that the voltage is:

a. More than 1,000 volts.
b. More than 661 volts.
c. More than 950 volts.
d. More than 1,000 volts but less then 4,160 volts.

108. How high must unguarded, high-voltage cables be from the mine floor and rail where people pass under them?

a. 5 ½ feet.
b. 4 ½ feet.
c. 6 ½ feet.
d. 8 ½ feet.

109. The main substation for power distribution of an underground mine receives electrical power from:

a. On-site generators.
b. An underground distribution system.
c. Transmission lines provided by the electrical utility company.
d. The underground mine distribution center.

110. When splices are made in high-voltage cables:

a. They must be made in accordance with the manufacturer’s specifications.
b. Only cold splices will be allowed.
c. They must be made by a qualified foreman.
d. They must be temporary splices.

111. Temporary splices in high-voltage trailing cables:

a. May be used when the cable is used as trailing cable.
b. Are not permitted under any circumstances.
c. Can be used for 24 hours.
d. Are allowed for short periods of time.

112. Which of the following is the only acceptable method of splicing a copper wire to an aluminum wire?

a. By using a special connector that prevents contact of dissimilar conductors.
b. By brazing or welding.
c. By soldering with a fusible metal or alloy.
d. By twisting wires together tightly and taping.

113. A 1,200-volt trailing cable can have how many temporary splices?

a. None.
b. One, for a 24-hour period.
c. Five, then it must be replaced.
d. One, indefinitely.

114. May temporary splices be used in high-voltage trailing cables?

a. Only for a 24-hour period.
b. Yes.
c. Only for 1 shift.
d. No.

115. Each power conductor of high-voltage trailing cables must be surrounded by:

a. A metallic shield.
b. Any type of shield.
c. A plastic shield.
d. A rubber shield.

116. When high-voltage cables are used as trailing cables:

a. They can only be used outside.
b. They can have no temporary splices.
c. They must be suspended on hangers.
d. Machines must be run by a certified electrician.

117 An air switch is:

a. Not a visible disconnect.
b. An automatic operating switch.
c. A switch with thermal protection.
d. A visible disconnect.

118. Where may high-voltage cables be installed underground?

a. Only in regularly inspected air courses.
b. Only in return entries.
c. If buried, they may be placed in returns.
d. Anyplace, if placed 6 ½ feet above floor or rail.

119. High-voltage cables should be installed in:

a. Belt or track entries.
b. The return.
c. Regularly inspected air courses.
d. A separate split of air that is directly vented to the return.

120. All high-voltage transmission cables used underground must be installed:

a. Only in regularly inspected air courses and haulage ways.
b. With communication wires.
c. In return airways.
d. Opposite side of the trolley wire.

121. Why must a power center be located outby the last open crosscut in intake air?

a. So that the trailing cables will not be run over by mobile equipment.
b. So it does not ignite explosive gases which could be found inby the last open crosscut.
c. So it will not be hit or damaged by moving equipment.
d. To keep it isolated.

122. Which of the following is NOT a requirement for the location of a power distribution center?

a. The location must be dry.
b. The location must be well rock-dusted.
c. The location must be in the return air.
d. The location must be free of combustible materials.

123. To accomplish a voltage reduction, from 25kv to a more usable level of 7.2kv or 6.9kv, a portable substation must include a:

a. Step-down transformer.
b. Distribution cable.
c. Pump substation.
d. Resistor.

. 124. Most transformers used in mining situations are:

a. Delta:delta wired.
b. Delta: wye wired.
c. Wye:delta wired.
d. Zig-zag wired.

125. The type of transformer which is circular in shape and similar to a donut, is the:

a. Current transformer.
b. Flux PT.
c. Oil-cooled transformer.
d. Air-cooled transformer.

126. A donut CT is also called a "flux" CT, since it:

a. Detects an unbalance in the phases.
b. Can actually detect current in two-phases only.
c. Cannot detect current in three-phase conductors.
d. Can actually detect current in one-phase only.

127. Which of the following is NOT a requirement of transformers enclosed by a 6-foot fence:

a. The enclosure must be effectively grounded.
b. The gate must be locked unless authorized persons are present.
c. The enclosed unit must be well lighted.
d. The gate must be included in the grounding system.

128. Which device will detect the smaller current under fault conditions:

a. The transformer.
b. Current transformer.
c. Relay pairs.
d. Potential transformer.

129. Before portable substations and transformers are moved from one location to another, they should be:

a. Phase-inverted.
b. De-energized.
c. Grounded.
d. Discharged.
e. Neutralized.

130. A donut current transformer on the neutral grounding conductor will detect a grounded phase condition even if:

a. Less than 1 amp of fault current flows.
b. The neutral grounding resistor is shorted.
c. The neutral grounding resistor is open.
d. The power is off.

131. A "derived neutral" on a transformer with a delta-connected secondary can be obtained through the use of:

a. A zigzag transformer.
b. An auto-transformer.
c. A potential transformer connected line-to-ground.
d. A push-pull circuit.
e. A balanced-flux current transformer.

132. If an unbalanced condition occurs, the donut CT will detect the condition and cause the:

a. Ground monitor to open the circuit.
b. Fuses to blow.
c. Ground relay to open the circuit.
d. Automatically operating switch to open the circuit.

133. With a potential relay ground fault system, a potential transformer takes the remaining voltage and steps it down to 120 volts, it can use this voltage to
:

a. Blow a fuse.
b. Activate its own voltage-sensitive relay to trip the oil circuit breakers.
c. In turn, activate the relay pairs.
d. Activate switched to open the circuit.

134. Alternating current is changed to direct current by means of a:

a. Transformer.
b. Rectifier.
c. Current transformer.
d. Voltage regulator.

ANSWER GUIDE
High Voltage

Question	Answer	Question	Answer	Question	Answer	Question	Answer
1	C	44	B	87	B	130	B
2	A	45	C	88	C	131	A
3	C	46	D	89	B	132	C
4	C	47	D	90	C	133	B
5	B	48	C	91	B	134	B
6	A	49	A	92	A		
7	C	50	B	93	C		
8	B	51	A	94	A		
9	A	52	A	95	C		
10	A	53	A	96	A		
11	D	54	C	97	D		
12	B	55	C	98	D		
13	A	56	C	99	B		
14	A	57	D	100	C		
15	B	58	C	101	C		
16	B	59	E	102	B		
17	A	60	A	103	B		
18	C	61	C	104	A		
19	A	62	A	105	A		
20	A	63	D	106	A		
21	C	64	E	107	A		
22	B	65	B	108	C		
23	B	66	E	109	C		
24	A	67	C	110	A		
25	D	68	B	111	B		
26	B	69	A	112	A		
27	B	70	B	113	A		
28	B	71	A	114	D		
29	A	72	A	115	A		
30	B	73	A	116	B		
31	B	74	D	117	D		
32	D	75	B	118	A		
33	D	76	C	119	C		
34	C	77	C	120	A		
35	C	78	B	121	B		
36	C	79	C	122	C		
37	B	80	C	123	A		
38	A	81	E	124	B		
39	B	82	A	125	A		
40	B	83	E	126	A		
41	C	84	C	127	C		
42	B	85	B	128	D		
43	D	86	A	129	B		

Multiple Choice question(s)
Read the question and select the appropriate answer
From the list provided.

1. High-voltage equipment in use underground, including supporting structures, must be grounded to:

   a. A borehole casing.
   b. Track.
   c. Metal water line.
   d. A high-voltage neutral.

2. When electrical equipment is powered by a single-phase, 110-volt or 220-volt circuit:

   a. Several grounding methods can be used.
   b. Only one grounding method is used-a separate grounding conductor to the grounded center tap.
   c. Grounding is unnecessary.
   d. Can be the same grounding methods as the three-phase power circuit.

3. What should be provided at storage battery charging stations to prevent the storage batteries from energizing the power circuits in the event of a power failure?

   a. Automatic disconnect switches or circuit breakers.
   b. Reverse current protection.
   c. Undervoltage release coils or undervoltage relays.
   d. Emergency power supply.

4. Diode grounding can be used on:

   a. AC machinery only.
   b. DC machinery with one polarity permanently grounded.
   c. Face equipment only.
   d. Rubber-tired dog sleds.

5. When electrical equipment is operated inby the last open crosscut, a test for methane shall be taken at intervals not to exceed:

   a. 20 minutes.
   b. 15 minutes.
   c. 10 minutes.
   d. 30 minutes.

6. If a DC power system is feeding an offtrack DC machine, the grounded polarity of the power system:

   a. Cannot be used as a grounding medium.
   b. Can be used as grounding medium and need not be approved.
   c. Is an approved grounding medium for the frame.
   d. Can be used for grounding only in a few situations.

7. If the power conductor is smaller than No. 6 AWG, the cross-sectional area of the grounding wire must be:

   a. Equal to that of the power conductor.
   b. One-half the size of the power conductor.
   c. Larger that the power conductor.
   d. Three-fourths the size of the power conductor.

8. How far from the portal must a disconnecting device that is serving a high-voltage circuit be located?

   a. 500 feet.
   b. Within 100 feet.
   c. 2,000 feet.
   d. 1,000 feet.

9. All metallic frames, casing or enclosures of electrical equipment:

   a. Need not be grounded when no hazards exist.
   b. Must be grounded to ensure no difference of potential between the equipment and the earth.
   c. Need not be grounded if the equipment rests on the ground.
   d. Should be grounded under certain circumstances.

10. The fence surrounding all surface transformer installations should be at least:

    a. 6-feet high.
    b. 8-feet high.
    c. 4-feet high.
    d. 5-feet high.

11. If a piece of electrical equipment has the approval plate missing, it:

    a. Should be taken outside to the shop within 24 hours.
    b. Is not permissible.
    c. Is permissible.
    d. Is still approved but a new plate should be obtained.

12. Where should cross bonds be placed?

    a. Not more than 300 feet apart.
    b. Not more than 2,000 feet apart.
    c. Not more than 500 feet apart.
    d. Not more than 200 feet apart.

13. The connection of lightning arrestors to the surface grounding must be located:

    a. No more than 25 feet from the neutral grounds entering the mine.
    b. At least 50 feet from the neutral grounds entering the mine.
    c. More than 50 feet from the neutral grounds entering the mine.
    d. At least 25 feet from the neutral grounds entering the mine.

14. Which of the following is NOT true concerning movement of energized power centers and transformers?

    a. Energized power center and transformers must be examined prior to movement and they must be grounded during movement.
    b. Power centers and transformers can never be moved while energized.
    c. A permit is required to move energized power centers and transformers.
    d. Energized power centers and transformers must be moved under the supervision of a qualified person.

15. Before work is performed on any power circuit, what precaution should be taken?

    a. Open and lockout visible disconnects.
    b. Open molded case circuit breaker.
    c. Check for frame ground.
    d. Notify mine management.

16. When grounding diodes, overcurrent devices, and polarizing diodes are installed on permissible equipment, they should be placed in:

    a. Flame-resistant compartments.
    b. Dustproof compartments.
    c. Explosion-proof compartments.
    d. Water-proof compartments.

17. Mobile equipment with two conductor cables and grounding diodes should be checked weekly by the following method EXCEPT:

    a. Reversing the incoming power to make sure that the diodes block the power to the frame.
    b. Passing current through the frame grounding diodes to prove the circuit is operating properly.
    c. Checking the value of the current flow through the diodes.
    d. With the incoming power reversed, try to start the machine to make sure that the polarizing diode is working.

18. Where should lightning arrestors be provided for underground mine phones?

    a. At each phone.
    b. At the point of entry.
    c. At the substation.
    d. 200 feet outby phone.

19. Why must only permissible equipment be used at the face?

    a. To prevent dust from accumulating in the electrical components.
    b. To avoid the hazards of electrical shock.
    c. To prevent explosive gases from being ignited.
    d. The use of only permissible equipment is mandatory in all parts of an underground mine.

20. Sheaths, armors, and conduits which are made of metal and which enclose power conductors:

    a. Must be grounded because it is the law and also for safety reasons.
    b. Need not be grounded.
    c. Should be grounded when required by the mine operator.
    d. Should be grounded when required by an electrician supervisor.

21. In which one of the following may gaskets be used between two surfaces forming a flame-arresting path?

    a. Low-voltage switches.
    b. Enclosures less than 45 cubic inches.
    c. Headlights.
    d. J-boxes.

22. Incandescent lamps must be installed in weatherproof sockets when they are used:

    a. To illuminate all underground areas.
    b. In a track or belt entry or near track entries to illuminate special areas other than structures.
    c. In underground areas of a mine except in a track or belt entry.
    d. For illumination in any area of a surface or underground mine.

23. Before any welding or cutting is performed inby the last open crosscut:

    a. An examination for methane must be made.
    b. All individuals not involved in performing the task must be withdrawn from the affected area.
    c. Equipment must be removed outby the last open crosscut.
    d. The area must be wetted down.

24. All circuits supplying power to underground three-phase portable or mobile equipment must contain a grounding circuit . This circuit must:

    a. End at the ungrounded side of the grounding resistor.
    b. End at the grounded side of the grounding resistor.
    c. Begin at the ungrounded side of the grounding resistor.
    d. Begin at the grounded side of the grounding resistor.

25. All underground electrical equipment should be examined:

    a. During each working shift.
    b. Weekly.
    c. Monthly.
    d. Daily.

26. All electrical equipment must be equipped with:

    a. Back-up lights.
    b. High tram.
    c. A frame ground.
    d. Rubber tires.

27. Electrical conductors should be joined together by:

    a. Electrical tape.
    b. Square knots.
    c. Tie wires.
    d. Suitable connectors.

28. The entire electric system of a mine:

    a. Need not be shown on a mine map.
    b. Should be indicated on a mine map only if it is a surface mine.
    c. Must be indicated on a mine map according to the law.
    d. Should be indicated on a mine map when deemed necessary by the operator.

29. The purpose of the grounding circuit in a portable or mobile equipment circuit is to:

    a. Serve as a conductor.
    b. Be used on 3-phase equipment only.
    c. Serve as a grounding conductor for the frames of the equipment receiving power from that circuit.
    d. Be used on low-, medium-voltages only.

30. All single-phase loads must be connected:

    a. Phase-to-ground.
    b. In parallel-series.
    c. In series.
    d. Phase-to-phase

31. When changes in the electrical system are made, those changes must be made on the mine map:

    a. No later than the end of the workday following completion of the change.
    b. By the end of the month in which the change was made.
    c. Within three days.
    d. Within one week.

32. Which of the following would NOT create a safety hazard when charging batteries?

    a. A flame safety lamp around batteries.
    b. Battery-box covers were lined with a flame-resistant insulating material.
    c. Battery trays not frame grounded while charging.
    d. Charging station not ventilated properly.

33. What type of resistor is provided with power-factor capacitors?

    a. Bleed-off resistors.
    b. Carbon resistors.
    c. Series resistors.
    d. Parallel resistors.

34. Each ungrounded, exposed power conductor that leads underground must be equipped with lightning arrestors that are located within:

    a. 500 feet of where the circuit enters the mine.
    b. 100 feet of where the circuit enters the mine.
    c. 400 feet of where the circuit enters the mine.
    d. 200 feet of where the circuit enters the mine.

35. Frame grounds and return grounds of direct current powered equipment:

    a. Must be tied under the same clamp.
    b. Are the same leads.
    c. Should be separated.
    d. Should be cut out of all splices.

36. The current-carrying capacity of a conductor found in an underground mine must be determined by the standards set by the:

    a. National Electrical Code.
    b. UMWA Safety Committee.
    c. Underwriter's Laboratory.
    d. State Mine Law.

37. What type of controls are required for belt conveyors used to transport people?

    a. Switches every 500 feet.
    b. Switches every 1,000 feet.
    c. Switches every 200 feet.
    d. Continuous controls.

38. The cross-sectional area of any grounding wire must be at least:

    a. One-half the cross-sectional area of the power conductors.
    b. One-fourth the cross-sectional area of the power conductor.
    c. Three-fourths the cross-sectional area of the power conductor.
    d. Three-fifths the cross-sectional area of the power conductor.

39. An electrician is to perform work underground on an idle day. What must be done within three hours before the electrician can enter the mine?

    a. The area must be declared safe by a fire boss.
    b. The area must be provided with additional support.
    c. The ventilation must be increased.
    d. Nothing needs to be done on idle days when no production is scheduled.

40. When telephone wires cross over or under power lines, they must:

    a. Be twisted together to prevent an inductive build-up.
    b. Be grounded.
    c. Telephone wires are not permitted to cross power lines.
    d. Be properly insulated.

41. A de-energization device, required on self-propelled electric face equipment, is used to:

    a. Slowly restart the motor.
    b. Gradually stop the motor.
    c. Quickly restart the motor.
    d. Stop the motor immediately when necessary.

42. Incandescent lamps powered from trolley or DC feeder circuits need not be provided with short-circuit protection, as long as the lamp is:

    a. Of substantial construction in a glass enclosure.
    b. Not more than 8 feet from the circuit.
    c. Installed in an explosion-proof enclosure.
    d. Installed in a weather-proof socket.

43. If insulated wires other than cables are used, the entry holes to metal frames:

    a. Must have insulated bushings to protect the wires from friction.
    b. Need not be bushed for small power wires.
    c. Need not have bushings since there is no friction at this point.
    d. Need not be bushed.

44. Which of these power wires must be supported on insulators?

    a. Ordinary cables to power non-mobile equipment.
    b. Trailing cables for mobile equipment.
    c. Bare ground wires.
    d. Specially designed high voltage cables to underground transformers.
    e. Insulated ground wires.

45. A polarizing diode is used on DC equipment:

    a. To prevent the machine from being operated with the trailing cable leads reversed.
    b. Because it is cheap.
    c. To polarize any stray current which could affect the grounding system.
    d. To keep the surge current off of the lights.

46. When insulated wires, other than cables, pass through metal frames, the holes:

    a. Must be substantially bushed with insulated bushings.
    b. Should be bushed with material other than insulation.
    c. Need not be bushed.
    d. Should be bushed only if they are power wires.

47. When not in use, power circuits underground should be deenergized on idle days and idle shifts, EXCEPT those used on:

    a. Trolley wire
    b. Belts
    c. Rectifiers and transformers
    d. Ground check monitors

48. If an electrician observes an electrical hazard, that electrician should first:

    a. Begin repairing the cable immediately.
    b. Deenergize the circuit.
    c. Tag-out the machine.
    d. Notify the foreman or supervisor.

49. All power wires-with some exceptions:

    a. Should be kept out of the way of workers.
    b. Must be insulated wherever they touch the ground.
    c. Will be supported on well-installed insulators and must not contact combustible material, roof or ribs.
    d. Need not be specially supported.

50. If in some special situations where energized power centers and portable transformers must be moved, relocation must be done under the direct supervision of a:

    a. Mine supervisor.
    b. Qualified person.
    c. Trained person.
    d. Mine operator.

51. All of the following are required electrical devices on belts, EXCEPT:

    a. Belt alignment switches.
    b. Sequence switches.
    c. Slippage switches.
    d. Automatic fire sensors.

52. The panic bar or lever on self-propelled electric face equipment, which actuates the emergency stop switch, must extend a sufficient distance in each direction to permit:

    a. An increase in power.
    b. A quick de-energization of tramming motors.
    c. A reduction in power.
    d. A gradual de-energization of tramming motors.

53. All ungrounded exposed power conductors and telephone wires must be equipped with:

    a. Suitable lightning arrestors that are properly installed and grounded.
    b. Ungrounded lightning arrestors.
    c. Guards.
    d. Lightning arrestors connected to a high-resistance ground.

54. The panic bar or lever on self-propelled electric face equipment must be reachable from:

    a. Both right and left sides of the equipment.
    b. The left side of the equipment.
    c. The right side of the equipment.
    d. All locations from which the equipment can be operated.

55. Underground power circuits must:

    a. Remain energized unless they are not in use more than two hours.
    b. Be energized during shift changes and down time.
    c. Remain energized at all times.
    d. Be de-energized on idle days and idle shifts.

56. In most instances, before power centers and portable transformers are moved they:

    a. Need not be de-energized.
    b. Must be de-energized.
    c. Should be de-energized only when there are hazardous conditions.
    d. Need not be de-energized if they are moved by electricians.

57. Protection devices that do not meet NEC requirements would:

    a. Not be considered adequate under the law.
    b. Probably be safe to use only underground.
    c. Probably be safe to use only on the surface.
    d. Probably still be adequate under the law.
    e. Probably be safe to use in most situations.

58. Self-propelled electric face equipment that is equipped with a substantially constructed cab:

    a. Must be equipped with a de-energized device if used underground.
    b. Must be equipped with a de-energization device.
    c. Need not be equipped with a de-energization device.
    d. Must be equipped with a de-energization device if used on the surface.

59. When adjusted to provide protection to the smallest conductor, one circuit breaker may be used to protect:

    a. Only two branch circuits.
    b. Two or more branch circuits.
    c. Not more than four branch circuits.
    d. Only one branch circuit.

60. When can one circuit breaker be used to protect two or more branch circuits?

    a. Two circuits cannot be connected to one circuit breaker.
    b. When the circuit breaker is adjusted to afford protection for the smallest conductor.
    c. Only when the largest conductor is protected.
    d. When the circuit breaker is set at maximum.

61. Circuit breakers and their components and auxiliary devices:

    a. Need not be visually inspected.
    b. Need not be visually inspected if they are checked manually.
    c. Must be manually checked.
    d. Must be visually inspected.

62. From the following charts listed in the Code of Federal Regulations, what would be the maximum allowable circuit breaker setting that could be used for providing short-circuit protection using a No. 6 AWG single conductor?

75.601-1

Conductor size AWG or MGM	Maximum allowable circuit breaker Instantaneous setting (amperes)
14	50
12	75
10	150
8	200
6	300
4	500
3	600
2	800
1	1,000
1/0	1,250
2/0	1,500
3/0	2,000
4/0	2,500
250	2,500
300	2,500
350	2,500
400	2,500
450	2,500
500	2,500

Conductor size	Single Conductor cable		Two Conductor cable	
AWG or MGM	Ampacity	Max fuse rating	Ampacity	Max fuse rating
14	..	..	15	15
12	..	..	20	20
10	..	..	25	25
8	60	60	50	50
6	85	90	65	70
4	110	110	90	90
3	130	150	105	110
2	150	150	120	125
1	170	175	140	150
1/0	200	200	170	175
2/0	235	250	195	200
3/0	275	300	225	225
4/0	315	350	260	300
250	350	350	285	300
300	395	400	310	350
350	445	450	335	350
400	480	500	360	400
450	515	600	385	400
500	545	600	415	450

a. 85
b. 300
c. 70
d. 65

63. All electric equipment and circuits must be protected from a short circuit by:

    a. Proper grounding.
    b. Automatic circuit breakers or fuses.
    c. Fuses only.
    d. Air switches.

64. What must be provided on a power unit having different sized circuit breakers?

    a. Different types of circuit breakers.
    b. Means to prevent the connections of wrong sized cable to wrong sized circuit breaker.
    c. Separate distribution compartments for different sized breakers.
    d. A protective conductive mat.

65. Underground low- and medium-voltage alternating current, serving portable or mobile three-phase alternating current equipment, must be protected by:

    a. Circuit breakers.
    b. Dual-element fuses.
    c. Fuses.
    d. Either fuses or circuit breakers.

66. One circuit breaker used to protect two or more branch circuits:

    a. Must provide overcurrent protection for the smaller conductor.
    b. Must provide overvoltage protection for both conductors.
    c. Must provide overvoltage protection for the smaller conductor.
    d. Must provide overcurrent protection for the largest conductor.

67. Three-phases motors must be equipped with overload protection that de-energizes:

    a. The phase (phases) that is (are) overloaded.
    b. One-phase when an overload occurs.
    c. All three phases when any phase is overloaded.
    d. At least two-phases when there's an overload.

68. Automatic circuit-breaking devices or fuses of the correct type and capacity must be installed to:

    a. Protect equipment and circuits against overloads and short circuits.
    b. Enable equipment to operate under an overload condition.
    c. Help the conductor carry overloads.
    d. Reduce the heat of the equipment when overload occurs.

69. Circuit breakers used in low- and medium-voltage AC circuits, must be tested at least:

    a. Every three months by a qualified person.
    b. Once a year by an electrician.
    c. Once a month by a qualified person.
    d. Every other month by an electrician.

70. Circuits that are used to power portable or mobile three- phase AC equipment must be protected against overcurrent by:

    a. Circuit breakers only.
    b. Circuit breakers or fuses.
    c. Fuses only.
    d. Over voltage relays.

71. Who should change the adjustment on a circuit breaker for a continuous miner?

    a. The miner operator.
    b. An electrician.
    c. The foreman.
    d. A miner experienced in proper equipment operation.

72. Circuit breakers and disconnecting switches that protect high-voltage circuits:

    a. Should be labeled only to some special equipment.
    b. Must be labeled to show which equipment they control.
    c. Can be labeled for convenience.
    d. Need not be labeled because it is obvious which equipment they control.

73. Cable couplers must be designed so that when they are uncoupled, the:

    a. Ground check continuity conductor is broken first and the ground conductor last.
    b. Ground conductor is broken first and the ground check continuity conductor is broken last.
    c. Either the ground conductor or the ground check continuity conductor is broken first.
    d. Ground conductor and the ground continuity conductor are broken simultaneously.

74. Couplers used in medium- or high-voltage circuits must be of the:

    a. Three-phase type and be enclosed in a full metallic shell.
    b. Three-phase type and need not be enclosed.
    c. Could be either two- or three-phase and should be enclosed.
    d. Two-phase type and need not be enclosed.

75. Since couplers must carry the same load as the cables with which they are used:

    a. They should be used only when absolutely necessary.
    b. Their current and voltage ratings should never exceed that of the cables.
    c. They must be adequate for the voltage and current of the circuit.
    d. It is not at all practical to use couplers.

76. Couplers that are used with medium- or high-voltage power circuits must be adequate for the voltage and current expected as well as being:

    a. Two-phase.
    b. One-phase.
    c. Three-phase.
    d. Either one- or three-phase.

77. Disconnecting devices used to disconnect trailing cables should be designed or equipped so that you can tell by:

    a. Using test equipment when the power is disconnected.
    b. A flashlight when the power is disconnected.
    c. Visual observation when the power is disconnected.
    d. The sound of an alarm when the power is disconnected.

78. When main power circuits enter the underground mine through a shaft or a borehole, the disconnecting device is installed:

    a. On the surface.
    b. Underground, within 500 feet of the bottom.
    c. Underground within 1000 feet of the bottom of the shaft or borehole.
    d. Either underground or on the surface.

79. During an electrical work session, disconnecting devices should be locked-out, if possible, and tagged by:

    a. Any certified person trained to perform electrical work.
    b. Any qualified person trained to perform electrical work.
    c. The equipment operator.
    d. Only the person performing the electrical work.

80. Disconnecting switches or cutout switches on energized lines can be opened:

    a. With bare hands in most cases.
    b. With leather gloves.
    c. With bare hands only on the surface.
    d. Only with insulated sticks, fuse tongs or pullers.

81. Disconnecting devices used to disconnect power from trailing cables should be:

    a. Plainly marked and identified
    b. Adjusted to protect cable against short circuits
    c. Locked-out when not in use
    d. Within sight of the person performing the electrical work

82. Disconnecting devices should be installed in conjunction with the circuit breaker in order to provide:

    a. Visual evidence that the power is disconnected.
    b. Protection in case the circuit breaker should fail.
    c. Greater overcurrent protection in the machine.
    d. Greater overcurrent protection in the cable.

83. When underground, the disconnecting device must be located within:

    a. 500 feet of the bottom of the shaft or borehole.
    b. 1000 feet of the bottom of the shaft or borehole.
    c. 200 feet of the bottom of the shaft or borehole.
    d. 400 feet of the bottom of the shaft or borehole.

84. When a main power circuit enters the underground mine the disconnecting switch is installed:

    a. On the surface within 100 feet of the entry point.
    b. Underground.
    c. Either on the surface or underground.
    d. On the surface within 1000 feet of the entry point.

85. How often should main mine fans be checked for mechanical and electrical reliability?

    a. Every 6 months.
    b. Weekly.
    c. Daily.
    d. Monthly.

86. Records of daily fan inspection must be kept for at least:

    a. 3 years.
    b. 1 year.
    c. 7 years.
    d. 5 years.

87. Electrically-operated main mine fans should be equipped with all of the following EXCEPT:

    a. A pressure recording gauge.
    b. An audible warning device.
    c. A fan slippage alarm.
    d. An independent power source.

88. How often should automatic closing doors on main mine fans be checked?

    a. Once a day.
    b. Once a month.
    c. Once each six months.
    d. Once a week.

89. Who should make the daily inspection of ventilation fans?

    a. A certified electrician or a competent person.
    b. A fire boss.
    c. A mine foreman.
    d. The superintendent.

90. What fire-fighting equipment must be located at each temporary electrical installation of an underground coal mine?

    a. One portable fire extinguisher.
    b. One portable fire extinguisher and 240 lbs. of rock dust.
    c. Water and 240 lbs. of rock dust.
    d. None, if it is a temporary installation.

91. When examining fire extinguishers, the date of such examinations should be recorded:

    a. On the mine map.
    b. In a special book provided by the State Department of Mines.
    c. On a permanent tag attached to the extinguisher.
    d. In the daily report kept by the mine officials.

92. The minimum fire-fighting protection that must be provided where welding or cutting is being performed is:

    a. Two portable fire extinguishers.
    b. Rock dust and one portable fire extinguisher.
    c. One portable fire extinguisher and water.
    d. An acid-soda fire extinguisher.

93. Permanent electrical installations must be provided with at least:

    a. One portable fire extinguisher and 240 lbs. of rock dust.
    b. One portable fire extinguisher.
    c. Two portable fire extinguishers.
    d. Two portable fire extinguishers and 240 lbs. of rock dust.

94. All unattended loading points where electrically driven hydraulic systems are used must utilize:

    a. Fireproof oil or emulsion
    b. DOT-approved oil.
    c. Standard hydraulic oil.
    d. Synthetic oil.

95 How often must fire extinguishers be examined?

a. At least once every six months.
b. At least twice every year.
c. At least once every year.
d. At least once every month.

96 What fire protection must be provided at all temporary electrical installations?

a. One portable fire extinguisher or 240 pounds of rock dust.
b. One portable fire extinguisher and 240 pounds of rock dust.
c. Two pails of water and a carton of hot hogs.
d. Two portable fire extinguishers.

97. Which of the following types of power wire need not be supported on well-installed insulators and prevented from coming in contact with combustible material, roof, or ribs?

a. Special high-voltage cables.
b. Trolley feeder wires.
c. Signal wires.
d. Special low-voltage and medium-voltage cables.

98. Insulated power cables used along belt conveyors can be suspended by insulated J-hooks for:

a. As long as needed.
b. 3 months.
c. 6 months.
d. 1 year.

99. How long can insulated power wires remain on insulated J-hooks?

a. 6 months.
b. Insulated power wires cannot be placed on insulated J-hooks.
c. 1 year.
d. Permanently, as long as the cable has not been damaged or is not in danger of being damaged.

100. To protect trailing cables from damage and to prevent strain on electrical connections:

    a. The cable should be clamped to the machine.
    b. The cable should have a loosely made splice in it which will pull apart when excessive strain is exerted on the cable.
    c. The cable must be adequately guarded.
    d. The cable must be on a cable reel.

101. What should be done to trailing cables in order to protect them from damage, and to prevent strain on the electrical connections?
    a. They should be isolated from machinery.
    b. They should be clamped to machines.
    c. They should be guarded and grounded.
    d. They should be insulated.

102. All power wire must be supported on well-installed insulators and must not contact combustible material, roof, or ribs. Which one of the following is an exception to this rule?

    a. Control wires.
    b. Telephone wires.
    c. Signal wires.
    d. Return power wires.

103. Communication cables:

    a. Must not contact combustible material, roof or ribs.
    b. Must be supported on insulated hangers or on insulated J-hooks.
    c. Should be kept off the ground.
    d. Need not be supported.

104. What must be done to protect a trailing cable from damage and to prevent strain on the electrical connection?

    a. The cable should be snubbed for support.
    b. The cable should be clamped to the machines.
    c. The cable should be hung on insulated J-hooks.
    d. A loose splice should be made, which will easily pull apart if strain is applied to the cable.

105. Telephone lines and cables should be:

   a. Not be permitted to come in contact with combustible material.
   b. Hung on insulators and kept 6 inches outside the track gauge line.
   c. Carried on insulators and installed on the opposite side from power or trolley wires.
   d. Hung on insulators and not permitted to touch the roof, rib, or crossbars.

106. How long may insulated control cables such as those used along belt conveyors be installed on insulated J-hooks?

   a. Permanently.
   b. Never.
   c. 6 months.
   d. 1 year.

107. Most fail-safe monitoring devices, that assure continuity, will NOT cause the circuit breaker to open if:

   a. Only the pilot check wire is broken.
   b. Both the ground and pilot check wires are broken.
   c. Power line is broken.
   d. Only the ground wire is broken.

108. Ground check relays used to provide undervoltage protection must be designed to trip when the line voltage decreases:

   a. 30 percent to 40 percent.
   b. 25 percent to 50 percent.
   c. 40 percent to 60 percent.
   d. 70 percent to 75 percent.

109. Ground check circuits:

   a. Prevent arcing between equipment frames.
   b. Assure the continuity of the grounding conductor.
   c. Provide frame-ground protection.
   d. Prevent single phasing if a power conductor is broken.

110. Power conductor cables, monitored by impedance monitors, must have at least:

   a. One insulated ground check conductor.
   b. Two insulated ground check conductors.
   c. Three insulated ground check conductors.
   d. Four insulated ground check conductors.

111. What is the maximum voltage that may be used for ground check circuits on high-voltage, resistance-grounded systems?

   a. 48 volts.
   b. 115 volts.
   c. 96 volts.
   d. 24 volts.

112. The fail-safe ground check monitor should cause the circuit breaker to open when:

   a. The voltage of the machine frame exceeds 100 volts.
   b. Either the ground or ground check wire opens.
   c. At least 15 amps of ground current flows.
   d. The ground bed resistance rises above 25 ohms.
   e. Only the ground check wire opens.

113. Underground low and medium-voltage ground check circuits should not exceed:

   a. 100 volts.
   b. 1,000 volts.
   c. 40 volts.
   d. 96 volts.

114. When used with high-voltage power cables, external ground check conductors must be no smaller than:

   a. 8 AWG.
   b. 10 AWG.
   c. 14 AWG.
   d. 6 AWG.

115. In high-voltage circuits, the voltage used for ground check circuits has a:

a. Maximum of 96 volts.
b. Maximum of 50 volts.
c. Minimum of 96 volts.
d. Minimum of 50 volts.

116. Which of the following is NOT true concerning a ground check circuit?

a. It monitors the grounding circuit continuously to assure continuity.
b. If the ground wire is broken it will cause the circuit breaker to open.
c. It can detect an imbalance in phases that will cause the circuit breaker to open.
d. If the pilot check wire is broken it will cause the circuit breaker to open.

117. What is the purpose of ground check circuits?

a. To prevent arcing between equipment frames.
b. To provide frame-ground protection.
c. To assure the continuity of the grounding conductor.
d. To prevent single phasing if a power conductor is broken.

118. In underground low and medium-voltage systems, the voltage for ground check circuits must never exceed:

a. 60 volts.
b. 120 volts.
c. 40 volts.
d. 20 volts.

119. Ground continuity protection for resistance grounded systems is provided by:

a. Fuses.
b. A fail-safe ground check circuit.
c. A circuit breaker only.
d. An air switch.

120. Any ground check circuit used in a resistance grounded system:

    a. Should monitor the power line to assure continuity.
    b. Should use some type of fail-safe device that will open circuit breakers when ground continuity is interrupted.
    c. Should detect overload conditions.
    d. Will monitor the circuit continuously whether or not it includes a device to open the circuit breakers.

121. The maximum voltage permitted for ground check circuits in a high-voltage system:

    a. Cannot exceed 80 volts.
    b. Cannot exceed 48 volts.
    c. Cannot exceed 96 volts.
    d. Can exceed 100 volts.

122. Most ground check circuits cannot:

    a. Detect an imbalance in phases which will cause the circuit breaker to open.
    b. Monitor the grounding circuit continuously to assure continuity.
    c. Open the circuit breaker if the ground wire is broken.
    d. Open the circuit breaker if the pilot check wire is broken.

123. The maximum voltage for a high-voltage ground check circuit is:

    a. 48 volts.
    b. 96 volts.
    c. 24 volts.
    d. 660 volts or lower.

124. The purpose of a fail-safe ground check circuit is to:

    a. Continuously monitor the grounding circuit to assure continuity.
    b. Simply ground the equipment.
    c. Be used on low-voltage equipment only.
    d. Ground the equipment when ground circuit is broken.

125. When line voltage decreases by 40% of the rated voltage:

    a. It causes the ground check relay to drop out..
    b. Ground check relays cannot be used to provide under-voltage protection.
    c. Fuses are used for under-voltage protection.
    d. Equipment will gradually stop because there is no protection against under-voltage.

126. Metal borehole casings or other substance that has low resistance to earth can:

    a. Be used as a method of grounding when a solid connection is assured.
    b. Never be used for grounding.
    c. Be used for grounding in very special situations.
    d. Be used for grounding if only which is approved by an authorized representative of the secretary.

127. What are two methods of preventing voltage from appearing on the frame of off-track direct current equipment?

    a. Diodes and under-voltage relays.
    b. Ground check relay and monitor wire.
    c. Grounding conductor and grounding diodes.
    d. Circuit breakers and fuses.

128. 550-volts, three-phase, alternating current equipment used underground must be grounded to:

    a. A high-voltage ground.
    b. The grounded side of the resistor at the source transformer.
    c. Metal water line.
    d. Mine track.

129. What method of grounding will be approved where single-phase 110-220 volt circuits feed electrical equipment?

    a. A separate conductor connected to the low-voltage ground.
    b. A separate conductor connected to the grounding resistor neutral.
    c. A separate conductor connected to the section track.
    d. A separate conductor connected to the center-tap of the transformer.

130. Which of the following words means "to connect with the ground to make the earth part of the circuit?"

a. Bonding.
b. Grounding.
c. Phasing.
d. Neutralizing.

131. Ground-fault voltage should be limited to what value in a circuit external to the resistor in high-voltage circuits extending underground?

a. 25 volts.
b. 150 volts.
c. 100 volts.
d. 50 volts.

132. High-voltage circuit grounding resistors should be designed to limit fault voltage to:

a. 25 volts.
b. The rating of the circuit breaker.
c. 25 amps.
d. 100 volts.

133. The voltage drop, external to the high voltage grounding resistor, cannot be more than:

a. 100 volts under fault conditions.
b. 500 volts under fault conditions.
c. 200 volts under fault conditions.
d. 50 volts under fault conditions.

134. Where must the grounding resistor be located?

a. At the source transformer.
b. In the ground conductor.
c. Any place in the circuit.
d. At the equipment being monitored.

135. Low- and medium-voltage, three-phase, alternating current circuits extending underground must be provided with a grounding resistor in the grounding circuit to limit ground-fault current to a maximum of:

    a. 100 amps.
    b. 25 amps.
    c. 50 amps.
    d. 15 amps.

136. The total cross-sectional area of ground conductors for trailing cables and all power cables must be:

    a. At least three-fourths the cross-sectional area of the power conductor.
    b. No less than one-half the cross-sectional area of the power conductor.
    c. No less than one-fourth the cross-sectional area of the power conductor.
    d. Must be the same as the cross-sectional area of the power conductor.

137. How should grounding wires be attached to mine track?

    a. By using separate clamps.
    b. They should be attached to the cross bond.
    c. By bonding.
    d. They should be secured by an angle bar.

138. According to the West Virginia mining laws, if a three-phase high-voltage system is powered by three 2/0 conductors, the minimum-sized ground check wire must be:

    a. Less than half the size of the power wire.
    b. No. 10 AWG or larger.
    c. No. 12 AWG or larger.
    d. Half the size of the power conductor.

139. What is the minimum size of an insulated internal ground check conductor that may be used for for the ground continuity check circuit?

    a. No. 6 AWG.
    b. No. 12 AWG.
    c. No. 8 AWG.
    d. No. 10 AWG.

140. What records (if any) are required to be kept for the oxygen and gas tanks used in a mine?

   a. Date and number of tanks taken underground.
   b. No records are required.
   c. Dates such tanks are taken into the mine and the dates such tanks are removed from the mine.
   d. Type and capacity of tanks taken underground and dates such tanks are taken underground.

141. Before being taken out service, defective cylinders, torches, and accessories must be:

   a. Emptied.
   b. Tagged "defective".
   c. Placed in a special container.
   d. Made inoperable so that no one will use them.

142. Gas cylinders should NOT be stored or left unattended:

   a. But must be properly moved to the outside.
   b. In any underground coal mine.
   c. In any area except at a permanent oil and grease station.
   d. In any area inby the last open crosscut.

143. Which of the following should NOT be done when compressed gas is used in any area where oil, grease, or coal dust is present?

   a. A heavy coat of rock dust should be spread within 10 feet of the work site.
   b. Equipment should be taken in by the last open crosscut.
   c. Oil and grease deposits should be removed where practicable.
   d. A fire extinguisher should be provided.

144. Each qualified person assigned to perform welding, cutting, or burning with compressed gas must be equipped with all of the following, EXCEPT:

   a. A wrench specifically designed for use with gas cylinders.
   b. A regulating gauge.
   c. A suitable torch tip cleaner.
   d. A wire brush.

145. Tests for leaks on the hose valves or gauges of liquefied and nonliquefied compressed gas cylinders should only be made:

   a. With a soft brush and soapy water or soapsuds.
   b. By smelling near the areas believed defective.
   c. By immersing them in warm water.
   d. By listening and feeling for air leaks.

146. When storing partially filled and nonliquefied compressed gas cylinders, which of the following is NOT necessary?

   a. That they be stored without gauges and hoses attached.
   b. That they be taken outside to be stored.
   c. That they be chained and secured in an upright position when the height of the seam permits.
   d. That they be protected against damage from heat or fallen material.

147. The minimum distance from a mine opening that compressed or liquefied gas, oil, gasoline or other petroleum products can be stored is:

   a. 1,000 feet.
   b. 100 feet.
   c. 200 feet.
   d. 500 feet.

148. When working on equipment:

   a. You can assume someone has de-energized the equipment.
   b. Make sure all circuits feeding power to that equipment are de-energized.
   c. Take extra precautions when the equipment is energized.
   d. De-energizing the equipment is unnecessary.

149. For testing and trouble shooting purposes only, power circuits:

   a. Must be de-energized.
   b. Can be energized.
   c. Must be tested before energizing.
   d. Must be shunted.

150. All permissibility checks must be conducted by a qualified person:

   a. Daily.
   b. Weekly.
   c. Yearly.
   d. Monthly.

151. It is important to _______ when welding or cutting.

   a. Wear clothing free from excessive oil and grease.
   b. Wear MSHA-approved respirators.
   c. Wear an approved burning or welding apron and gloves.
   d. Wear noncombustible clothing.

152. Lubricating machinery while in motion:

   a. Is prohibited at any time.
   b. Is not permitted underground.
   c. Is permitted if machinery is equipped with extended fittings or cups.
   d. Is permitted when caution is observed while working in proximity to moving parts.

153. All persons performing work on energized high-voltage surface lines should wear:

   a. Snug-fitting clothing, protective leather gloves, and eye protection.
   b. Eye protection and snug-fitting clothing.
   c. Leather gloves, hard-toed shoes, eye protection, and self-rescuer.
   d. Protective rubber gloves, sleeves, and climber guards if climbers are worn.

154. Stop and start control switches should be installed on belt conveyors that do not transport miners. These switches should not be farther apart than:

   a. 1,000 feet.
   b. 1,250 feet.
   c. 1,500 feet.
   d. 2,000 feet.

155. Disconnecting devices should be locked out and tagged by:

   a. A qualified person.
   b. The foreman.
   c. The person doing the work.
   d. A trained person.

156. Locking out and tagging should be done by:

  a. The foreman.
  b. The person doing the work.
  c. Anyone working in the area.
  d. Electrician supervisor.

157. Safety rules have been made:

  a. For electricians only.
  b. For your own protection.
  c. To be broken.
  d. As an unnecessary part of most jobs.

158. The qualified person doesn't have to work on electrical distribution circuits and equipment himself:

  a. Therefore, he is relieved of all responsibility.
  b. So the responsibility for the work being done properly falls on the mine operator.
  c. But he does bear the responsibility for the work being done properly by an apprentice electrician.
  d. But at least should be present physically at all times as the work is actually performed.

159. When performing testing procedures on power circuits, the circuits:

  a. Must be de-energized.
  b. Can be energized.
  c. Must be tested before energizing.
  d. Must be shunted.

160. Inspection or cover plates on electrical equipment:

  a. May be removed for testing or repair and must be replaced when such work is completed.
  b. Can be removed for testing only.
  c. Should never be removed.
  d. Should be removed in emergency situations only.

161. When equipment is moved in areas where energized trolley wires are present and if the height of the coal seam does not permit 12 inches of vertical clearance, a miner must be stationed:

a. Beside the equipment at all times during the move.
b. At the first automatic circuit breaker protecting the circuit where equipment is being moved.
c. At the point of relocation.
d. Behind the equipment at all times during move.

162. Exposed moving machine parts that may be contacted by and cause injury to persons should be:

a. Guarded as required by law.
b. Fenced off and a danger board posted.
c. De-energized and tagged out.
d. Replaced.

163. Transformer stations:

a. Need not be enclosed if properly posted with "Danger High Voltage" signs.
b. Need not be posted with "Danger High Voltage" signs if enclosed.
c. Must be posted with "Danger High Voltage" signs and must be enclosed to prevent contact with energized parts.
d. Present no potential hazards and do not require an enclosure.

164. The examination tests required for surface electrical equipment must be conducted:

a. Every 3 months.
b. Every 2 months.
c. Every 6 months.
d. At least once a month.

165. The testing, maintenance and repair of electrical equipment must be performed by:

a. An electrician with at least 6 months' experience.
b. An electrical supervisor.
c. An experienced person.
d. A qualified person.

166. Power must be removed from electric equipment before work is performed on such equipment EXCEPT when:

   a. Replacing fuses.
   b. Making temporary splices.
   c. Changing low-voltage headlight bulbs.
   d. Trouble shooting and testing.

167. When equipment is moved in areas where energized trolley wires are present and if the height of the coal seam does not permit 12 inches of vertical clearance, a miner must be stationed at the first circuit breaker and he:

   a. Must be in direct contact with the people making the move and be able to communicate with responsible workers on the surface.
   b. Must be able to communicate with the responsible workers on the surface only.
   c. Must be able to communicate with the mine operator.
   d. Should be able to contact the people making the move only.

168. Electrical circuits must be de-energized, locked out, and tagged, while repairs are performed except for what?:

   a. Grounding and testing.
   b. Emergency work so as not to stop production.
   c. Troubleshooting and testing.
   d. When no one is looking.

169. Low voltage rubber gloves, in use, must be tested electrically:

   a. Every month.
   b. Every three months.
   c. At least every two months.
   d. Every six months.

170. Insulated platforms must be placed:

   a. At all stationary machinery where shock hazards may exist.
   b. At underground transfer points.
   c. When working on "hot " cables.
   d. At derails and switch throws.

171. Rubber blankets must be tested electrically:

  a. Every 6 months.
  b. Once a year.
  c. Every month.
  d. Every 3 months.

172. Before working on electrical equipment the power should be removed, except when:

  a. Hand lubricating.
  b. Trouble shooting and testing.
  c. Performing mechanical work.
  d. Cleaning.

173. When electrical equipment is tagged and locked-out, who should remove the tag and lock?

  a. The person who installed the tag and lock.
  b. Any electrician.
  c. The mine management.
  d. The mine foreman or the mine foreman's assistant.

174. Guards that protect persons from exposed moving machine parts must be:

  a. In place anytime the machine is operating.
  b. In place except when testing the machine.
  c. On the machine whether or not the machine is operating.
  d. Dangered-off and removed from service.

175. Dry insulating platforms of rubber or other suitable nonconductive material are required on all of the following, EXCEPT:

  a. Pump stations.
  b. Transformer stations.
  c. Nip stations.
  d. Mobile equipment.
  e. Telephone stations.

176. Where should insulated platforms be placed?

  a. At all track switch throws.
  b. At stationary machinery where shock hazards may exist.
  c. At all mobile and stationary machinery where shock hazards may exist.
  d. Only at high-voltage potentials where shock hazards may exist.

177. You should protect yourself and the equipment you're working on by:

  a. Locking out and tagging the circuit breaker only when deemed necessary.
  b. Telling everyone in the work area what you are doing.
  c. Asking someone to make sure no one closes the circuit that powers the equipment you're working on.
  d. Locking out and tagging the visible disconnect device at the power source.

178. During repair on energized surface high-voltage lines the regulations for rubber gloves inspection is:

  a. Before the shift begins and at least once during the shift.
  b. Once every 24-hour.
  c. Three times every day.
  d. Once a week.

179. Who is permitted to perform electrical work on low-, medium-, or high-voltage distribution circuits or equipment?

  a. A section foreman.
  b. A mechanic.
  c. A mine foreman.
  d. A qualified person.

180. Persons who repair energized trolley wires:

  a. Must have been a mine electrician for at least 6 months.
  b. Must work with an experienced electrician.
  c. Will have been trained to perform electrical work and maintain electrical equipment.
  d. Will work in close proximity to a trained person.

181. When equipment is moved in areas where energized trolley wires are present and if the height of the coal seam does not permit 12 inches of vertical clearance, the only people allowed in by equipment being moved are those:

  a. Moving the equipment.
  b. Working in the area.
  c. Allowed by the mine supervisor.
  d. Operating the continuous miner.

182. Where should "Danger: High-Voltage" signs be posted?

   a. At all high voltage installations.
   b. At all electrical installations.
   c. At all nip stations.
   d. At the beginning of all branch circuits.

183. Switches or other controls that are safely designed, constructed, and installed should be provided for:

   a. Stationary equipment only.
   b. All electrical equipment.
   c. Mobile equipment only.
   d. Face equipment only.

184. If inadequate conductors were used:

   a. It would not matter if used as a temporary conductor.
   b. It would not matter in most instances.
   c. The insulation could be damaged and result in a short circuit.
   d. It would be possible but not probable that damage could result.

185. Switchboard access openings:

   a. Should be locked if the mine operator determines a hazard is presented.
   b. Shall be guarded except when located in locked buildings or locked rooms.
   c. Need not be locked or guarded.
   d. Must be guarded always.

186. The minimum distance from a mine opening that any combustible material OTHER THAN compressed or liquefied gas, oil, or other petroleum products may be kept is:

   a. 25 feet.
   b. 500 feet.
   c. 100 feet.
   d. 200 feet.

187. If a defect is found in protective equipment, it must be:

    a. Reported to the shift foreman.
    b. Immediately repaired with electrician's tape.
    c. Repaired by the end of the workday.
    d. Immediately discarded and replaced with proper equipment before work is continued.

188. Persons who perform welding, cutting, or burning operations should:

    a. Wear an approved burning or welding apron and gloves.
    b. Wear clothing free from excessive oil and grease.
    c. Wear MSHA-approved respirators.
    d. Wear noncombustible clothing.

189. According to federal law, actuating of at least two of the auxiliary protective relays for a high-voltage circuit breaker must be done:

    a. Once a month.
    b. Every two weeks.
    c. Once a week.
    d. Every two months.

190. The purpose of the polarizing diode in diode-grounding installations is:

    a. To protect the grounding diode.
    b. To prevent the frame from becoming energized.
    c. To prevent the machine from being operated when the polarity of the trailing cable is reversed.
    d. To prevent over-voltage.

191. When working on an energized trolley wire:

    a. Protective clothing is not necessary.
    b. Be sure to wear rubber gloves and protective shoes.
    c. Protective clothing need not be worn if made by an experienced person.
    d. Rubber gloves could be helpful but protective shoes are not needed.

192. Rubber sleeves must be tested electrically:

    a. Every three months.
    b. Every six months.
    c. Every two months.
    d. Once a month.

193. Even though off-track equipment can be moved into active working areas the equipment:

    a. Must be examined by a foreman.
    b. Need not be examined since it would not be underground if it were unsafe.
    c. Must be examined by a certified person.
    d. Should be checked out by a trained person.

194. When the lighting is inadequate for the job you're doing:

    a. Go on to another job.
    b. Take the time to set up portable lights.
    c. Take extra precautions when doing the job.
    d. Continue with the job as best you can under the circumstances.

195. In addition to de-energizing, what other precaution must be observed when maintenance or repair work is to be performed on machinery?

    a. The machinery must be inspected for permissibility.
    b. The machinery must always be removed from the face areas.
    c. The machinery must be blocked against motion.
    d. No other precaution need be observed.

196. If a potentially dangerous condition is found on a piece of electric equipment, what shall be done?

    a. It shall be removed from service until it can be repaired.
    b. Run it to the end of that shift only.
    c. Warn the operator to be very careful.
    d. Report it to the maintenance foreman.

197. Electric equipment must be examined and tested weekly by:

   a. A trained person.
   b. An experienced person.
   c. A qualified person.
   d. Anyone using the equipment.

198. How many turns of cable should remain on the cable reel when the cable of a hoist is extended to its maximum working length?

   a. At least 5 full turns.
   b. At least 3 full turns.
   c. At least 1 full turn.
   d. At least 2 full turns.

199. While performing work in or over shafts, miners should wear:

   a. Safety belts.
   b. Rubber boots.
   c. Eye protection.
   d. Ear plugs.

200. Fans and hoisting equipment for personnel use must be checked:

   a. Monthly.
   b. Daily.
   c. Weekly.
   d. When necessary.

201. Which of the following does NOT describe an acceptable cage for hoisting miners?

   a. The sides of the hoist are enclosed to a height of 6 feet.
   b. The sides of the hoist are enclosed to a height of 5 feet.
   c. The sides of the hoist are enclosed to a height of 8 feet.
   d. The sides of the hoist are enclosed to a height of 10 feet.

202. Hoisting equipment used for hoisting people must be examined:

   a. Once each shift.
   b. Daily.
   c. Weekly.
   d. Monthly.

203. How often must safety catches on a hoist be examined?

 a. Monthly.
 b. Weekly.
 c. Daily.
 d. Every shift.

204. Who is required to inspect hoisting equipment?

 a. An electrical engineer.
 b. A qualified electrician.
 c. A fire boss.
 d. A mine foreman.

205. Define high voltage:

 a. From 0 to 660 volts.
 b. More than 1000 volts.
 c. From 661 to 1000 volts.
 d. From 4160 to 7200 volts.

206. Define low voltage:

 a. Less than 4160 volts.
 b. From 661 to 1000 volts.
 c. From 0 to 660 volts.
 d. More than 1000 volts.

207. Which of the following equipment may remain energized on idle days and idle shifts even when not in use?

 a. Porta-buses and jeeps.
 b. Starters and stoppers.
 c. Transformers, rectifiers, and automatically controlled pumps.
 d. Belt drives and hoists.

208. "An integral part of an electrical machine or accessory that is essential to the functions of the machine or accessory" defines a (an):

 a. Component.
 b. Distributive device.
 c. Device.
 d. Interlock.

209. Each mine map showing the mine electrical system must show all of the following, EXCEPT:

a. Telephones.
b. Permanent pumps.
c. Permanent cables.
d. Transformers.

210. 1,000 volts is classified as:

a. Medium voltage.
b. Low voltage.
c. High voltage.
d. Intrinsically safe voltage.

211. "Low voltage" means any voltage:

a. Up to and including 660 volts.
b. Up to and including 550 volts.
c. From 661 to 1,000 volts.
d. Over 1,000 volts.

212. The maximum speed permitted for belt conveyors used to transport people, where the clearance is 24 inches or more, is:

a. 300 FPM.
b. 500 FPM.
c. 250 FPM.
d. 400 FPM.

213. Permanent splices in trailing cables must be:

a. Wrapped with electrical tape.
b. Enclosed in conduit.
c. Vulcanized or treated with suitable material.
d. Made in a workmanlike manner.

214. How many temporary splices are allowed in a trailing cable?

a. None.
b. One, for a twenty-four hour production period.
c. Twenty-four, for a one-hour production period.
d. Depends on the inspector.

215. Semi-conducting electrical tape has been designed specifically to:

a. Insulate low-voltage electrical connections.
b. Reduce dielectric stress under cable shields.
c. Insulate conductors in a splice.
d. Shrink tightly around a joint if heated.
e. Repair cable jackets.

216. Splices in conductors on cables should be reinsulated at least to the same degree of protection as:

a. The largest conductor in the cable.
b. The smallest conductor in the cable.
c. The ground monitoring wire.
d. The remainder of the wire.

217. What procedures should be followed when a potentially dangerous condition is found in electrical equipment?

a. The equipment must be removed from service until such condition is corrected.
b. Report the condition to the foreman.
c. Complete the shift and repair the equipment at the end of the shift.
d. Repair the equipment at the earliest convenience.

218. No temporary splices are allowed:

a. On a machine with diode grounding.
b. In a coal mine.
c. Within 25 feet of a machine without a reel.
d. In three conductor cables.

219. How many temporary splices may be used in the same cable for the "next" 24-hour period?

a. As many as necessary.
b. Two.
c. One.
d. Three.

220. A temporary splice may be used in a trailing cable for:

a. 60 hours.
b. 48 hours.
c. 12 hours.
d. 24 hours.

221. How many permanent splices are allowed in a trailing cable?

    a. None.
    b. One.
    c. No limit.
    d. Four.

222. One of the most frequent safety errors found on mine sites is:

    a. Non-labeled circuit breakers.
    b. Improper splices of cables or conductors.
    c. Fuses too small for the job.
    d. Circuit breakers that are too small for the job.

223. Temporary splices may not be made on low- or medium-voltage trailing cables within ________ of where the cable enters the machine, if the machine does not have a cable reel.

    a. 20 feet.
    b. 30 feet.
    c. 15 feet.
    d. 25 feet.

224. A temporary splice within 25 feet of the reel on a low- or medium-voltage cable cannot be left in place for more than:

    a. 48 hours.
    b. 1 week.
    c. 24 hours.
    d. 1 shift.

225. A splice on a low- or medium-voltage cable is within 25 feet of the reel. This splice:

    a. Can be temporary.
    b. Must be permanent.
    c. Cannot be made; the cable must be reentered.

226. If a low- or medium-voltage trailing cable were pulled apart 15 feet from where it entered the machine, and the machine does not have a cable reel, an electrician must NOT:

    a. Make any splice but must reenter the cable.
    b. Make a temporary splice.
    c. Make a permanent splice.

227. A permanent splice can be made:

    a. Anywhere in a cable.
    b. No closer than 25 feet of a machine.
    c. For high-voltage cables only.
    d. Without adequate flexibility.

228. Which of the following is NOT required when using tape to insulate existing power wire?

    a. The tape should be fireproof.
    b. The tape should be applied half-lapped.
    c. The tape should be moisture-resistant.
    d. The tape should be self-adhesive.

229. A temporary splice in a drag cable may not be made within:

    a. 35 feet of operating equipment.
    b. 25 feet of operating equipment.
    c. 10 feet of operating equipment.
    d. 15 feet of operating equipment.

230. Allowing a trailing cable to trail in water may:

    a. Cause a voltage drop.
    b. Create a voltage build-up.
    c. Cause no harm if it is a specially-designed cable.
    d. Result in a very dangerous condition.

231. Any underground trailing cable, regardless of cable size, can be a length of:

    a. 800 feet long.
    b. 500 feet long.
    c. 600 feet long.
    d. 1,000 feet long.

232. Trailing cables that supply power to both low and high-voltage equipment must have:

    a. Three or more ground conductors.
    b. No more than one ground conductor.
    c. One or more ground conductors.
    d. Two or more ground conductors.

233. At an intersection where other vehicles pass, a trailing cable can best be protected from damage by:

    a. Suspending the cable from the rib.
    b. Placing the cable next to the rib.
    c. Suspending the cable from the roof.
    d. Placing warning signs in the intersection.

234. Cables without shields may be used on reel equipment for medium voltage if the insulation has a rating of:

    a. 5000 volts or more.
    b. 3000 volts or more.
    c. 2000 volts or more.
    d. 1000 volts or more.

235. Before unplugging a trailing cable:

    a. The under-voltage release coil should be energized.
    b. The circuit breaker should not be tripped.
    c. The cable should be de-energized.
    d. The machine should be de-energized.

236. To protect trailing cables from damage by moving equipment, the cables:

    a. Should be positioned to prevent damage from moving equipment.
    b. Can be run over by most moving equipment without fear of damage.
    c. Must be laid out so they are never in close proximity to moving equipment.
    d. Should always be buried at least 24-inches deep.

237. Trailing cables:

    a. Can be run over by equipment without resulting damage.
    b. Are almost impervious to damage.
    c. Are very small cables and cannot cause serious hazard.
    d. Must always be protected from damage.

238. In areas where work is regularly conducted, trolley wires:

    a. Must not be present.
    b. Should be guarded when required by mine supervisor.
    c. Must be guarded.
    d. Need not be guarded but extra precautions must be used.

239. Persons making repairs to energized trolley wires should wear:

    a. Approved and tested insulated shoes and wireman's gloves.
    b. Approved and tested hard hats and rubber boots.
    c. Loose-fitting clothing.
    d. Leather gloves and leather boots.

240. Which of the following represents a safe trolley wire guard condition?

    a. The guard extends above and below the wire and should be equipped with holes for drainage.
    b. The guard extends above and below the wire on both sides.
    c. The trolley wire extends 1 inch below the guard.
    d. The trolley wire extends above the guard.

241. Trolley wires need not be guarded adequately:

    a. On both sides of doors and stoppings.
    b. At places where telephone lines cross it.
    c. At places where men are working or passing regularly.
    d. At man-trip stations.

242. Tests and calibration of automatic circuit interrupting devices in trolley wire systems must take place:

    a. Every three months.
    b. At least once every six months.
    c. Once a year.
    d. Every two months.

243. What is the maximum distance allowed between a trolley wire splice and hanger?

    a. 3 feet.
    b. 2 feet.
    c. 6 feet.
    d. 4 feet.

244. Cutout switches should be provided on trolley wires and trolley feeder wires at intervals of not more than:

   a. 2,000 feet.
   b. 1,500 feet.
   c. 500 feet.
   d. 1,000 feet.

245. Where a trolley wire or feeder wire exists, protection must be provided on both sides of doors and stoppings by:

   a. De-energizing when miners cross under.
   b. Installing adequate guards.
   c. Short-circuit protection.
   d. Moving the power wire away from where miners cross.

246. Trolley taps should be clearly marked to show:

   a. Who manufactured them.
   b. Their allowable ampacity rating.
   c. Which machines they are connected to.
   d. Their voltage rating.

247. Trolley wires, feeder wires and bare signal wires, when they pass through doors and stoppings:

   a. Should never be insulated.
   b. Should be insulated only under certain circumstances.
   c. Must be adequately insulated.
   d. Need not be insulated when there is adequate clearance.

248. At mantrip stations, trolley wires and trolley feeder wires:

   a. Should be guarded if deemed necessary by the mine operator.
   b. Need not be guarded because the wires are heavily insulated.
   c. Must be guarded-usually with yellow plastic or vinyl covers.
   d. Need not be guarded since there's little chance of contact with the wires.

249. What is the minimum distance that trolley wire can be installed next to the track gauge line?

   a. 5 inches.
   b. 3 inches.
   c. 6 inches.
   d. 4 inches.

250. Trolley and feeder wires must have cutout switches at intervals not to exceed:

a. 2500 feet.
b. 2000 feet.
c. 1000 feet.
d. 5000 feet.

251. Which of the following statements about work being performed on energized trolley wire is false?

a. Trolley wire can never be energized while work is being performed.
b. Work on energized trolley wire must be performed by persons trained to do such work.
c. Persons performing such work must wear approved and tested insulated gloves.
d. Persons performing such work must wear approved and tested insulated shoes.

252. Trolley wires and trolley feeder wires are required to have cutout switches that are no farther apart than:

a. 6000 feet.
b. 1000 feet.
c. 2000 feet.
d. 4000 feet.

253. Trolley wires and trolley feeder wires should be provided with cutout switches near the beginning of all branch lines and at intervals of not more than:

a. 2,500 feet.
b. 1,000 feet.
c. 2,000 feet.
d. 500 feet.

254. If a trolley wire or feeder wire is located where miners are required to work or pass under regularly, protection must be provided by:

a. Installing adequate guards.
b. De-energizing when miners cross under.
c. Short-circuit protection.
d. Moving the power wire away from where miners cross.

255. Trolley wires and trolley feeder should be provided with:

a. Overcurrent protection.
b. Undervoltage protection.
c. Undercurrent protection.
d. Ground-fault protection.

256. Training in the repair and maintenance of live trolley wires must include instruction in all of the following, EXCEPT:

a. The current-limiting factors.
b. The protective clothing needed to guard against hazards.
c. The hazards involved in making such repairs.
d. The limitations of protective clothing.

257. Where should trolley wire hangers on the main line be placed in regard to a splice?

a. Within 2 feet on both sides.
b. Within 5 feet on both sides.
c. Within 3 feet on both sides.
d. Within 3 feet on one side.

258. Trolley system wires, high-voltage cables and transformers, must be at least:

a. 50 feet from pillar workings.
b. 100 feet from pillar workings.
c. 150 feet from pillar workings.
d. 200 feet from pillar workings.

259. Trolley wires, trolley feeder wires, high-voltage cables, and transformers can be located:

a. Within 1500 feet of pillar workings.
b. Within 150 feet of pillar workings.
c. In return air.
d. Within 15 feet of the last open breakthrough.

260. Trolley system wires, high-voltage cables and transformers:

a. Can be located inby the last open crosscut in most circumstances.
b. May be located anywhere underground provided the special precautions are closely observed.
c. Cannot be located in or inby the last open crosscut.
d. Are permitted inby the last open crosscut under certain circumstances.

261. Permanent pumps, battery charging stations, underground shops, and transformer stations must:

a. Be vented into fresh air.
b. Be isolated so fumes or smoke will not enter the intake or return.
c. Not be permitted underground in mines classified as gassy.
d. Be housed in fireproof structures or areas.

262. Permanent pumps, battery charging stations, underground shops, and transformer stations must:

a. Be vented directly into the return.
b. Not be permitted underground in mines classified as gassy.
c. Be vented into fresh air.
d. Be isolated so fumes or smoke will not enter the intake or return.

ANSWER GUIDE
Legal Requirements

Question	Answer	Question	Answer	Question	Answer	Question	Answer
1	D	44	A	87	C	130	B
2	B	45	A	88	B	131	C
3	B	46	A	89	A	132	D
4	B	47	C	90	B	133	A
5	A	48	B	91	C	134	A
6	C	49	C	92	C	135	B
7	A	50	B	93	C	136	B
8	B	51	A	94	A	137	A
9	B	52	B	95	A	138	B
10	A	53	A	96	B	139	D
11	B	54	D	97	A	140	C
12	D	55	D	98	C	141	B
13	D	56	B	99	A	142	D
14	B	57	A	100	A	143	B
15	A	58	C	101	B	144	D
16	C	59	B	102	D	145	A
17	C	60	B	103	B	146	B
18	B	61	D	104	B	147	B
19	C	62	B	105	C	148	B
20	A	63	B	106	A	149	B
21	C	64	B	107	C	150	B
22	B	65	A	108	C	151	A
23	A	66	A	109	B	152	C
24	D	67	C	110	A	153	D
25	B	68	A	111	C	154	A
26	C	69	C	112	B	155	C
27	D	70	A	113	C	156	B
28	C	71	B	114	A	157	B
29	C	72	B	115	A	158	C
30	D	73	A	116	C	159	B
31	A	74	A	117	C	160	A
32	B	75	C	118	C	161	B
33	A	76	C	119	B	162	A
34	B	77	C	120	B	163	C
35	C	78	B	121	C	164	D
36	A	79	D	122	A	165	D
37	D	80	D	123	B	166	D
38	A	81	A	124	A	167	A
39	A	82	A	125	A	168	C
40	D	83	A	126	A	169	D
41	D	84	A	127	C	170	A
42	B	85	C	128	B	171	A
43	A	86	B	129	D	172	B

ANSWER GUIDE
Legal Requirements cont.

Question	Answer	Question	Answer	Question	Answer
173	A	216	D	259	A
174	B	217	A	260	C
175	D	218	C	261	D
176	B	219	C	262	A
177	D	220	D		
178	A	221	C		
179	D	222	B		
180	C	223	D		
181	A	224	C		
182	A	225	A		
183	B	226	B		
184	C	227	A		
185	B	228	A		
186	A	229	B		
187	D	230	D		
188	B	231	B		
189	A	232	C		
190	C	233	C		
191	B	234	C		
192	A	235	C		
193	C	236	A		
194	B	237	D		
195	C	238	C		
196	A	239	A		
197	C	240	B		
198	B	241	B		
199	A	242	B		
200	B	243	A		
201	B	244	A		
202	B	245	B		
203	C	246	C		
204	B	247	C		
205	B	248	C		
206	C	249	C		
207	C	250	B		
208	A	251	A		
209	A	252	C		
210	A	253	C		
211	A	254	A		
212	A	255	A		
213	C	256	A		
214	B	257	C		
215	B	258	C		

Multiple Choice question(s).
Read the question and select the appropriate answer from the list provided.

1. The frame-grounding conductor in a DC trailing cable is usually colored:

   a. Green.
   b. Black.
   c. White.
   d. Red.

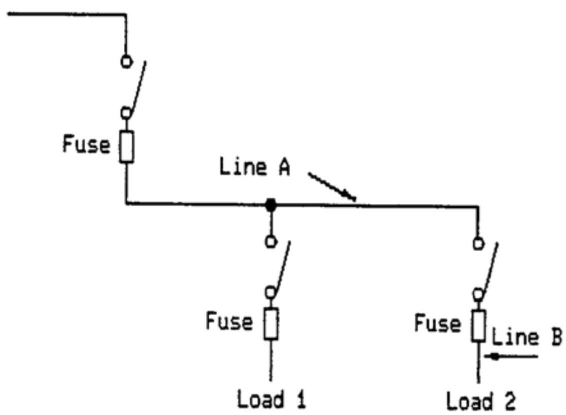
2. What is the purpose of a thermal strip in an AC linestarter?

   a. To provide overload protection.
   b. To provide short-circuit protection.
   c. To provide overvoltage protection.
   d. To prevent moisture from accumulating in the starting box.

3. In most cases, the voltage to ground on branch circuits supplying lampholders, fixtures, or standard receptacles of 15 amps or less should not exceed:

   a. 110 volts.
   b. 150 volts.
   c. 220 volts.
   d. 117 volts.

4. According to the diagram below:



a. Lines "A" and "B" are both branch circuits.
b. Line "A" is a feeder circuit and line "B" is a branch circuit.
c. Line "B" is a feeder line and "A" is a branch circuit.
d. Lines "A" and "B" are both feeder circuits.

5. If a branch circuit were protected by a 20-amp fuse, what would be the allowable continuous load of the circuit?

a. 24 amps.
b. 25 amps.
c. 16 amps.
d. 20 amps.

6. The voltage drop to the most remote outlet of a branch circuit should not exceed what value for power, heating, lighting, or combinations thereof?

a. 3 percent.
b. 2 percent.
c. 10 percent.
d. 6 percent.

7. The part of the wiring system extending beyond the last overcurrent protective device is called the:

   a. Busbar.
   b. Open wiring.
   c. Feeder circuit.
   d. Branch circuit.

8. A ______________ is that part of the wiring system extending beyond the last overcurrent protective device.

   a. Feeder circuit.
   b. Open wiring.
   c. Busbar.
   d. Branch circuit.

9. The minimum wire size of a 15-amp branch circuit is:

   a. No. 12 AWG.
   b. No. 8 AWG.
   c. No. 14 AWG.
   d. No. 10 AWG.

10. What is the minimum-sized grounding conductor that may be used in a DC system?

   a. 9 AWG.
   b. 8 AWG.
   c. 10 AWG.
   d. 11 WG.

11. Within one minute after a 550-volt capacitor is disconnected, its residual voltage must be reduced to:

   a. 100 volts or less.
   b. 50 volts or less.
   c. 85 volts or less.
   d. 75 volts or less.

12. A 500-volt capacitor is disconnected. Its residual voltage must be reduced to the permitted voltage or less within:

    a. 1 minute.
    b. 5 minutes.
    c. 2 minutes.
    d. 3 minutes.

13. The circuit breaker setting is the value of the:

    a. Current and voltage at which it is set to trip.
    b. Resistance of the breaker.
    c. Voltage at which it is set to trip.
    d. Current at which it is set to trip.

14. What is the standard shipping length, including one coupling, of rigid conduit?

    a. 8 feet.
    b. 10 feet.
    c. 12 feet.
    d. 16 feet.

15. Which of the following is required when the conductor bushing at the entrance of a cabinet, junction box, or pull box is made entirely of insulating materials?

    a. Conductors must be securely connected to the terminals.
    b. A locknut must be installed on the conduit both inside and outside the enclosure to which the conduit is attached.
    c. The conduit must have a diameter of at least 1 inch.
    d. There are no special requirements.

16. Conduit must be firmly fastened within how many feet of each outlet box, junction box, cabinet, or fitting?

    a. 3 feet.
    b. 5 feet.
    c. 10 feet.
    d. 7 feet.

17. What is the maximum-sized electrical metallic tubing that may be used?

    a. 2 1/2 inches.
    b. 6 inches.
    c. 2 inches.
    d. 4 inches.

18. Which device protects the wire from abrasion where conduit enters a disconnect switch box?

    a. Bushings.
    b. Locknuts.
    c. Connections.
    d. Reamed edges.

19. What is the maximum distance allowed between supports for one-inch diameter rigid metal conduits?

    a. 12 feet.
    b. 14 feet.
    c. 10 feet.
    d. 16 feet.

20. Conduit must be clearly and durably identified every:

    a. 10 feet.
    b. 15 feet.
    c. 12 feet.
    d. 18 feet.

21. What is the minimum-sized metallic tubing that may be used?

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

22. What is the minimum-sized diameter allowed for rigid metal conduit?

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

23. Rigid metal conduit up to 3/4-inch in size must be firmly fastened within 3 feet of each outlet box or fitting and be supported at what minimum interval?

    a. Every 15 feet.
    b. Every 5 feet.
    c. Every 10 feet.
    d. Every 12 feet.

24. A run of conduit less than one inch in diameter must be supported at least every:

    a. 10 feet.
    b. 15 feet.
    c. 18 feet.
    d. 12 feet.

25. Rigid metal conduit 1/2-inch in diameter must be supported every:

    a. 15 feet.
    b. 10 feet.
    c. 18 feet.
    d. 12 feet.

26. What is the maximum number of bends allowed in one run of conduit, between outlet and outlet, fitting and fitting, or fitting and outlet?

    a. 1 quarter bend (90 degrees).
    b. 6 quarter bends (540 degrees).
    c. 4 quarter bends (360 degrees).
    d. 2 quarter bends (180 degrees).

27. "Grounded conductors" (not the frame ground) will be identified by their color, which is:

    a. Green or green with one or more yellow stripes.
    b. Black.
    c. White or natural gray.
    d. Red.
    e. Green.

28. What minimum length of free conductor should be left at each outlet and switch point for making up joints, or connecting fixtures or devices?

    a. 4 inches.
    b. 6 inches.
    c. 3 inches.
    d. 10 inches.

29. Individually covered or insulated grounding conductors should have a continuous outer finish that is:

    a. Red.
    b. Green and black.
    c. Black.
    d. Either green or green with one or more yellow stripes.
    e. White or natural gray.

30. The secondary winding of a single-phase transformer has a full load current of 30 amperes. The power leads are single conductor, type TW rated at 60 centigrade. What would be the minimum size conductor used on the secondary?

    a. No. 10 AWG.
    b. No. 12 AWG.
    c. No. 14 AWG.
    d. No. 8 AWG.

31. In most cases, the minimum-sized (solid or stranded) conductor allowed when wiring a control panel is:

    a. No. 16 wire.
    b. No. 18 wire.
    c. No. 12 wire.
    d. No. 14 wire.

32. What color insulation is associated with the frame-grounding conductor?

    a. Green.
    b. Black.
    c. White.
    d. Orange.

33. Conductors that supply one or more resistance welders must be protected by an overcurrent device rated or set at not more than:

    a. 300% of the conductor rating.
    b. 100% of the conductor rating.
    c. 125% of the conductor rating.
    d. 200% of the conductor rating.

34. What color insulation is associated with the grounded, current-carrying conductor?

    a. White.
    b. Green.
    c. Black.
    d. Orange.

35. When reference is made to conductors in the NEC, what type of material is assumed?

    a. Copper.
    b. Iron.
    c. Aluminum.
    d. Tungsten.

36. An electrician knowing a conductor's "AWG" can determine the:

    a. Allowable current-carrying capacity.
    b. Voltage rating.
    c. Interrupting capacity.
    d. Application and insulation rating.

37. "THW" marked on a conductor refers to that conductor's:

    a. Allowable current-carrying capacity.
    b. Maximum voltage rating.
    c. Allowable ampacity rating
    d. Application and insulations.

38. Derating of conductors begins when the number of current-carrying conductors pulled into a conduit exceeds:

    a. Four.
    b. Three.
    c. Six.
    d. Five.

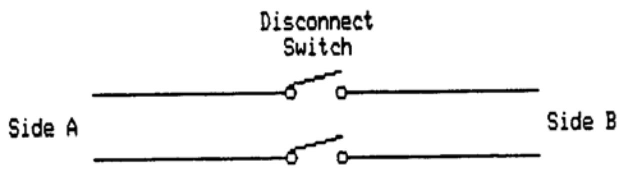
39. Branch-circuit conductors supplying a single motor should have an ampacity of not less than _______ of the motor full-load rating.

    a. 125 percent.
    b. 115 percent.
    c. 150 percent.
    d. 100 percent.

40. What is the maximum number of service disconnects allowed on a single service entrance?

    a. Three.
    b. Six.
    c. Ten.
    d. Four.

41. According to the diagram below, the disconnect switch must be connected:



a. So that side B is connected to the line.
b. So that side B is connected to the load.

42. Single-throw knife switches are mounted hinge-end down so that:

a. The circuit is prevented from de-energizing.
b. Protective fuses or circuit breaker will trip.
c. Gravity will not tend to close them.
d. The switch will close automatically.

43. Flexible metal conduit must be secured within _________ of each outlet box or fitting.

a. 12 inches.
b. 6 inches.
c. 3 feet.
d. 10 feet.

44. The continuous load supplied by a branch circuit should not exceed a rating of:

    a. 40 percent.
    b. 80 percent.
    c. 115 percent.
    d. 125 percent.

45. An enclosure constructed, protected, or treated so as to prevent rain from interfering with successful operation of the apparatus is termed:

    a. Rainproof.
    b. Weather-tight.
    c. Rain tight.
    d. Vapor-proof.

46. An electrical apparatus enclosed in a case that is capable of withstanding an explosion from a specified gas or vapor is termed:

    a. Vapor-tight.
    b. Weather-proof.
    c. Explosion-proof.
    d. Vapor-proof.

47. According to the National Electrical Code, "dustproof" means so constructed or protected that:

    a. No dust can enter the enclosure.
    b. Dust 200-mesh or smaller may enter the enclosure.
    c. Dust will not interfere with successful operation.
    d. Only float dust can enter the enclosure.

48. According to the National Electrical Code, "dust-tight" means:

    a. Dust 200-mesh or smaller may enter the enclosure.
    b. Dust may enter the casing but will not affect operation.
    c. Dust will not enter the enclosing case.
    d. Only float dust will enter the casing.

49. Locations that are hazardous due to the presence of combustible dust are classified by the NEC as:

    a. Class II.
    b. Class IV.
    c. Class I.
    d. Class III.

50. A Class II location refers to:

    a. Combustible dust locations.
    b. Ignitable fiber locations.
    c. Flammable gas or vapor locations.

51. Electrical equipment used in atmospheres containing hazardous concentrations of gases and vapors are classified as:

    a. Class II.
    b. Class I.
    c. Class IV.
    d. Class III.

52. Thermal overload relays are designed to provide what type of protection?

    a. Ground-fault and single-phase.
    b. Single-phase and short-circuit.
    c. Overload and single-phase.
    d. Overload and short-circuit.

53. Plug fuses and fuseholders may not be used in circuits exceeding ___________ between conductors.

    a. 110 volts.
    b. 175 volts.
    c. 125 volts.
    d. 220 volts.

54. Cartridge fuses are rated and marked for all of the following, EXCEPT:

    a. The ampere rating.
    b. The type of current (AC or DC).
    c. The name or trademark of the manufacturer.
    d. The voltage rating.

55. When fuses and thermal cutouts are both used in a motor circuit:

    a. The thermal cutouts protect the motor against "dead" shorts.
    b. The fuses protect the motor against light overloads.
    c. The fuses protect the motor and circuit against shorts.
    d. The thermal cutouts protect the motor and circuit against shorts.

56. Except where rock bottom is encountered, grounding pipes or rods should be driven to a depth of at least:

    a. 9 feet.
    b. 6 feet.
    c. 8 feet.
    d. 4 feet.

57. The resistance of a pipe electrode to ground (a made electrode) should not be:

    a. Less than 25 ohms.
    b. Greater than 100 ohms.
    c. Greater than 3 ohms.
    d. Greater than 25 ohms.

58. What is the minimum-sized diameter allowed for grounding electrodes made of either steel or iron rods?

    a. 5/8 inch.
    b. 3/4 inch.
    c. 1/2 inch.
    d. 3/8 inch.

59. Which of the following is NOT an appropriate material for grounding electrode conductors?

    a. Aluminum.
    b. Copper-clad aluminum.
    c. Steel.
    d. Copper.

60. When used as a ground, the resistance of made electrodes should be:

    a. 25 ohms or less to ground.
    b. Less than 6 ohms to ground.
    c. 1 ohms or less to ground.
    d. Less than 3 ohms to ground.

61. What is the minimum-sized diameter allowed for grounding electrodes made of galvanized iron, steel pipe, or rigid conduit?

    a. 3/8 inch.
    b. 1/2 inch.
    c. 3/4 inch.
    d. 5/8 inch.

62. Which of the following is NOT a good grounding electrode?

    a. A nonferrous rod not less than 1/2 inch in diameter.
    b. Iron or steel grounding rod at least 5/8 inch in diameter.
    c. An 8-foot roof bolt driven into moist ground.
    d. Pipe or rigid conduit at least 3/4 inch in diameter.

63. According to the NEC, the resistance of a pipe electrode to ground (a made electrode) should be:

    a. 3 ohms or less.
    b. 100 ohms or less.
    c. Not greater than 25 ohms.
    d. 5 ohms or less.

64. Which of the following is NOT a good electrode for obtaining a ground field?

    a. Pipe electrode.
    b. Plate electrode.
    c. Roof bolt electrode.
    d. Copper rod electrode.

65. Cable or wire insulation is NOT rated for:

    a. Voltage.
    b. Current.
    c. Moisture resistance.
    d. Heat resistance.

66. According to the National Electrical Code, "continuous load" is defined as a load where the maximum current is expected to continue for"

    a. 3 hours or more.
    b. 24 hours or more.
    c. 12 hours or more.
    d. 8 hours or more.

67. All wiring and electrical equipment must meet the requirements of the:

    a. Mine Operator.
    b. National Electrical Code that is in effect at the time of installation.
    c. Wiring and Electric Equipment Code.
    d. Electrical Supervisor.

68. The National Electrical Code is:

    a. A recognized guideline for health and safety.
    b. The law.
    c. A recognized guideline for electrical installations.
    d. To be followed in only a few instances.

69. The NEC generally applies to:

    a. Pit distribution only.
    b. Fixed installations.
    c. Mine electrical equipment only.
    d. Electrical mobile equipment.

70. The NEC does not apply to:

    a. Fixed installations.
    b. Pit distribution or electrical mobile equipment.
    c. Pit distribution only.
    d. The tipple and shop.

71. Operation of equipment in excess of the 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, is termed:

    a. A ground fault.
    b. An overload.
    c. A short-time duty overload.
    d. A short circuit.

72. Which one of the following methods of splicing is NOT allowed when the splicing conductors are made of the same material?

    a. Joining with approved splicing devices.
    b. Soldering with fusible metal or alloy.
    c. Twisting the conductors securely and taping.
    d. Brazing or welding with fusible metal or alloy.

73. What is the approved method for splicing conductors made of the same material?

    a. Twisting the conductors and then securely taping.
    b. Brazing or welding with fusible metal or alloy.
    c. Bonding with larger diameter insulation and taping.
    d. Overlapping the conductors and then securely taping.

74. Overcurrent protection of single-phase transformers under 600 volts should not exceed what percentage of the full load secondary current?

    a. 100%.
    b. 250%.
    c. 500%.
    d. 115%.

ANSWER GUIDE
National Electric Code

Question	Answer	Question	Answer
1	A	44	B
2	A	45	A
3	B	46	C
4	B	47	C
5	C	48	C
6	A	49	A
7	D	50	A
8	D	51	B
9	C	52	C
10	B	53	C
11	B	54	B
12	A	55	C
13	D	56	C
14	B	57	D
15	B	58	A
16	A	59	C
17	D	60	A
18	A	61	C
19	A	62	C
20	A	63	C
21	B	64	C
22	A	65	B
23	C	66	A
24	A	67	B
25	B	68	C
26	C	69	B
27	C	70	B
28	B	71	B
29	D	72	C
30	A	73	B
31	D	74	B
32	A		
33	A		
34	A		
35	A		
36	A		
37	D		
38	B		
39	A		
40	B		
41	A		
42	C		
43	A		

Multiple Choice question(s).
Read the question and select the appropriate answer from the list provided.

1. Non-permissible Incandescent lamps:

    a. Cannot be used in a track entry or belt entry.
    b. Are used for illumination in the working place.
    c. May be used inby the last open crosscut.
    d. Cannot be used inby the last open crosscut.

2. Devices to be used to illuminate the coal mine without approval by the Secretary or the Secretary's representative:

    a. Can be used in most instances.
    b. Will not be permitted in the mine.
    c. Can be used if approved by the mine operator.
    d. Can be used anywhere.

3. The maximum surface temperature of all components on machines approved under Schedule 2G is:

    a. 150 degrees Centigrade.
    b. 175 degrees Centigrade.
    c. 300 degrees Centigrade.
    d. 250 degrees Centigrade.

4. All mobile equipment that is powered by a trailing cable and travels in excess of 2.5 mph must be provided with:

    a. Headlights only.
    b. A cable reel.
    c. A headlight on the front and a red taillight on the rear.
    d. Red-reflecting material on the front and the rear only.

5. The "dead-man" type switch on a hand-held tool functions by:

    a. Closing with hand pressure and opening if pressure is released.
    b. Turning the switch off and on manually.
    c. Turning the switch off and on automatically.
    d. Opening with pressure and closing when pressure is released.

6. Battery boxes:

    a. Must be adequately ventilated.
    b. Cannot have any holes in the bottom.
    c. Should be ventilated in certain situations.
    d. Should never be ventilated because of moisture.

7. Each wire or cable leaving a battery box on storage battery operated equipment shall have:

    a. Short-circuit protection, not enclosed.
    b. Short-circuit protection in an explosion-proof enclosure.
    c. Over-voltage protection in an explosion-proof enclosure.
    d. Under-current protection.

8. What should be provided in the bottom of each battery box?

    a. Plugs.
    b. Bushings.
    c. Rubber belting.
    d. Drainage holes.

9. Battery box covers:

    a. Need not be insulated.
    b. Must be lined with a flame-resistant insulating material preferably bonded to the inside of the cover.
    c. Need not be secured in a closed position.
    d. Shall be covered on the outside of the cover.

10. Battery-box covers must meet all of the following requirements, EXCEPT:

    a. Be made of a non-sparking material.
    b. Be provided with a means of securing them in the closed position.
    c. Have adequate ventilation.
    d. Have flame-resistant insulating material bonded to the inside of the cover.

11. The purpose of hose conduit is to:

    a. Provide for a continuous ground.
    b. Provide for mechanical protection.
    c. Prevent electrical arcs.
    d. Prevent methane from entering electrical compartments.

12. How should hose conduit be marked to indicate it is flame-resistant?

    a. Flame-resistant USBM - Not exceeding 12 feet.
    b. Flame-resistant USBM - Not exceeding 10 feet.
    c. Flame-resistant USBM - Not exceeding 30 feet.
    d. Flame-resistant USBM - Not exceeding 3 feet.

13. To meet the requirements of Schedule 2G, all conduit hose on equipment:

    a. Must not have less than 1/2-inch inside diameter.
    b. Must be flame-resistant.
    c. Must have side walls 1/4-inch thick.
    d. Must be oil-resistant.

14. The minimum thickness of hose conduit allowed is:

    a. 1/8 inch.
    b. 1/4 inch.
    c. 3/16 inch.
    d. 5/32 inch.

15. Conduit hose must be marked flame resistant:

    a. Every twenty-four feet.
    b. Every three feet.
    c. Every six feet.
    d. Every twelve feet.

16. Conduit hose is used for:

    a. The mechanical protection of a cable.
    b. The electrical protection of a cable.
    c. Color-coding of cables.
    d. Larger machines only.

17. Conductors must have current-carrying capacities that meet:

    a. IPCEA standards.
    b. MSHA standards.
    c. The requirements of the mine operator.
    d. UL specifications.

18. To protect the trailing cable from being run over by mobile equipment, all self-propelled equipment:

    a. Must be equipped with cable reels.
    b. Must not move faster than 2.5 mph.
    c. Which moves faster than 2.5 mph must be equipped with cable reels.
    d. Which moves faster than 6.0 mph must be equipped with cable reels.

19. A cable reel is required on self-propelled equipment that travels at a speed exceeding:

    a. 3 mph.
    b. 5 mph.
    c. 2.5 mph.
    d. 6 mph.

20. What is the maximum tramming speed permitted for a continuous miner?

    a. 5 1/2 MPH.
    b. 2 1/2 MPH.
    c. 3 MPH.
    d. 6 MPH.

21. Any underground machine traveling faster than how many MPH must be equipped with a cable reel?

    a. 6 MPH.
    b. 10 MPH.
    c. 2.5 MPH.
    d. 4 MPH.

22. What is the minimum distance that a 1/2-inch bolt can extend into the threaded portion of the hole on a permissible enclosure?

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

23. An electric motor that is a power source for a permissible mining machine:

    a. Must be explosion-proof.
    b. Need not be enclosed if its power is less than 50 mph.
    c. Need not be permissible when the equipment it powers is permissible.
    d. Need not be enclosed.

24. Control panels and electrical motors are equipped with access openings and inspection covers:

    a. So they can be considered permissible.
    b. To make installation an easier job.
    c. So maintenance personnel can more readily check for damaged or worn parts.
    d. To make cover removal and motor disassembly an easier job.

25. Circuit breakers, fuses and other electrical control devices, located on permissible equipments:

    a. Should be fastened securely to a solid wood structure.
    b. Should be fastened securely to the equipment being controlled (but not necessarily enclosed).
    c. Must be contained in a control panel box.
    d. Will be located at least 500 feet from the equipment being controlled.

26. When a bolt with a diameter larger than 3/8-inch is used, thread engagement should be:

    a. Equal to or greater than the diameter of the bolt.
    b. Equal to but not greater than the diameter of the bolt.
    c. Less than the diameter of the bolt.
    d. Equal to or greater than 3/8-inch.

27. What type of packing glands should be locked?

    a. All glands.
    b. Slip fit glands.
    c. Straight fit glands.
    d. Angle fit glands.

28. What is the maximum radial clearance that should be allowed when installing a typical plug for spare lead entrance holes?

    a. .009 inch.
    b. .004 inch.
    c. .003 inch.
    d. .006 inch.

29. To check a plane flange joint you would use what size feeler gauge?

    a. 0.005 inch.
    b. 0.004 inch.
    c. 0.002 inch.
    d. 0.006 inch.

30. Since certain electrical components almost always spark when in operation, they:

    a. Can never be classified as "permissible."
    b. Will not present potential hazards.
    c. Must be placed in explosion-proof enclosures before they are considered "permissible."
    d. Can never be used underground.

31. A permissible box must withstand an explosion pressure of:

    a. 10 tons.
    b. 100 psi.
    c. 150 psi.
    d. 12 pounds.

32. If the threads are stripped out of the cover of an explosion-proof box, which of the following methods is not an accepted method of repair?

    a. Weld up, drill and tap to the correct size bolt.
    b. Drill and retap to next size hole if all other requirements are met.
    c. Heli coils or proto-threaded inserts.
    d. Drill hole through and use bolt nut.

33. Each bolt, stud or screw used to fasten a cover to an explosion-proof enclosure must be provided with a:

    a. Protective covering.
    b. Lock washer to help hold it in position.
    c. Packing gland.
    d. Packing gland nut.

34. A permissible joint that is made of a large screw with five or six threads is called a:

    a. Plane flange joint.
    b. Step flange joint.
    c. Screw type joint.
    d. Riveted joint.

35. The maximum clearance between the lid and the box of a step-flange joint is:

    a. 0.004 inch.
    b. 0.005 inch.
    c. 0.006 inch.
    d. 0.007 inch.

36. How far should a 1/2-inch bolt extend into the threaded portion of the hole?

    a. At least 2 inches.
    b. At least 3/4 inch.
    c. At least 1 inch.
    d. At least 1/2 inch.

37. If the cover of the permissible compartment has a step shape, it is:

    a. A screw type joint.
    b. Hard to handle.
    c. A step flange joint.
    d. A plane flange joint.

38. All unused holes in permissible compartments must be:

    a. Closed with specially designed fittings or plugs.
    b. Kept clean.
    c. Closed with untreated asbestos packing.
    d. Left unused.

39. When a bolt with a diameter smaller than 3/8-inch is used, the minimum permissible thread engagement is:

    a. More than 3/8-inch.
    b. 3/8-inch.
    c. 1/2-inch.
    d. Smaller than 3/8-inch when a bolt with a diameter larger than 3/8-inch is used.

40. If there are damaged threads on a screw-type cover:

    a. Threads must be retapped or lock washers used.
    b. Screws must be replaced with a larger size.
    c. The cover must be replaced.
    d. Screws must be tightened.

41. When a bolthole in an explosion-proof enclosure is stripped out, it:

    a. Is no longer considered permissible.
    b. Is still permissible in most situations.
    c. Must have additional bushings to remain classified as an explosion-proof enclosure.
    d. May be permissible if approved by mine operator.

42. Lenses for headlights used on mining machines must be constructed of glass or other suitable material with physical characteristics:

    a. 1/2-inch thick tempered glass.
    b. 1/8-inch thick tempered glass.
    c. 3/8-inch thick tempered glass.
    d. 1/4-inch thick tempered glass.

43. Inspection covers or screw type joints must be:

    a. Checked yearly.
    b. Welded in place.
    c. Threaded in snug and locked in place.
    d. Used on all compartments.

44. What is the minimum thread engagement of bolts for an enclosure which is greater than 124 inches?

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

45. End bells on motors and reset switches are typical examples of:

    a. Step flange joints.
    b. Stuffing boxes.
    c. Plane flange joints.
    d. Threaded joints.

46. Most end bells on explosion-proof motors should be checked with a _____ feeler gauge.

    a. .005 inch.
    b. .007 inch.
    c. .004 inch.
    d. .006 inch.

47. To check a step flange joint you should use what size feeler gauge?

    a. 0.005 inch.
    b. 0.004 inch.
    c. 0.007 inch.
    d. 0.006 inch.

48. If the threads in the boltholes of a permissible enclosure are stripped out, which of the following is NOT an acceptable means of repair?

    a. Use heli coils.
    b. Drill and retap the next size hole, if all other requirements are met.
    c. Weld, redrill, and tap.
    d. Drill a hole through and use a nut and bolt.

49. Plane flange joints on explosion-proof enclosures cannot exceed a separation distance of:

    a. .004 inch.
    b. .007 inch.
    c. .005 inch.
    d. .006 inch.

50. The primary purpose of a breather on explosion-proof compartments is:

    a. To provide inspection openings.
    b. To let methane out of the compartment.
    c. To allow harmful gases that cause corrosion to escape.
    d. To keep the parts cool.

51. The use of bolts with more than one lock washer in a control panel box is considered:

    a. An acceptable method of securing a cover.
    b. Permissible except in a few rare situations.
    c. An improper assembly.
    d. Permissible only in a few situations.

52. Which of the following is allowed to be under a permissible bolt?

    a. Wires.
    b. Springs.
    c. Lock washers.
    d. Chains.

53. Which of the following is NOT a requirement of cables between machine components?

    a. They must be less than 6 feet in length.
    b. They must be isolated from hydraulic lines.
    c. They must be clamped in place to prevent undue movement.
    d. They must be protected from mechanical damage and sharp edges.

54. What is the minimum distance a 1/2-inch bolt can extend into the threaded portion of the hole of a permissible enclosure?

    a. 1/2 inch.
    b. 3/4 inch.
    c. 3/8 inch.
    d. 7/16 inch.

55. Electrical components that normally arc during operation:

    a. Must be properly enclosed to be considered permissible.
    b. Are often used inby the last open crosscut.
    c. Can never be used underground.
    d. Need not to be properly enclosed to be considered permissible.

56. What minimum clearance must be maintained between the packing gland nut and the stuffing box?

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

57. Breathers or pressure-relief devices are installed on an explosion-proof enclosure to:

    a. Be used on DC equipment only.
    b. Provide an access hole for electrical checks.
    c. Not permitted.
    d. Relieve pressure, ventilate, or drain.

58. Permissible compartments are designed to be:

    a. Air tight.
    b. Water tight.
    c. Dust tight.
    d. Explosion proof.

59. What is the minimum distance from the interior of an enclosure to the edge of a bolt hole (more than 124 cubic inches)?

    a. 7/16 inch.
    b. 3/8 inch.
    c. 1/2 inch.
    d. 3/4 inch.

60. A plane flange joint has a maximum clearance between the box and the lid of:

    a. 4000 inch.
    b. 0.0004 inch.
    c. 0.004 inch.
    d. 0.04 inch.

61. The packing material in a stuffing box is compressed tightly against the cable, by:

    a. Gluing the packing material and the cable together.
    b. The force of the cable against the opening.
    c. Tamping with a special wooden tool.
    d. Tightening the packing gland nut.

62. A flat metal to metal joint is a:

    a. Step Flange Joint.
    b. Screw Type Joint.
    c. Stiff Joint.
    d. Plane Flange Joint.

63. Stuffing boxes are drilled into the walls of the explosion-proof enclosures in such a way that:

    a. When the cable enters the enclosure, the opening is air-tight.
    b. There's space for packing material to be placed around the cable.
    c. There's enough play around the cable for it to be removed easily.
    d. The diameter of the opening cannot be larger than the diameter of the cable.

64. A screw type joint cannot be used if:

    a. The threads are damaged.
    b. It is locked in place.
    c. It has class I (coarse, loose fitting) threads.
    d. It has less than six threads.

65. Because of the electrical wiring inside headlights, the lens rings:

    a. Are sealed on some permissible equipment.
    b. Need not be sealed.
    c. Should be mechanically tight and sealed or padlocked.
    d. Should be sealed, but need not to be mechanically tight.

66. Plane flange joints and step flange joints are the types of joints formed:

    a. At all the permissible equipment (for fastening a explosion-proof enclosure).
    b. At the corners of explosion-proof enclosures.
    c. When two pieces of metal come together.
    d. When two pieces of wood come together.

67. All bolts in a permissible enclosure must have:

    a. Paint.
    b. Lock washer.
    c. Springs.
    d. Brakes.

68. The maximum clearance of a plane flange joint allowed for permissibility is:

    a. 0.0004 inch.
    b. 0.04 inch.
    c. 0.4 inch.
    d. 0.004 inch.

69. When a bolthole in an explosion-proof enclosure is stripped out, and re-tapping it to the next larger size:

    a. The metal is likely to break.
    b. The threads will never fit the bolt properly.
    c. 7/16 of an inch of metal from the interior of the enclosure to the closest edge of the hole must be maintained.
    d. The job can be accomplished but the equipment will no longer be permissible.

70. When a standard packing gland is properly packed, the minimum clearance permitted between the shoulder of the packing nut and the top of the stuffing box is:

    a. 1/8 inch.
    b. 3/16 inch.
    c. 3/8 inch.
    d. 1/4 inch.

71. What is the minimum size of asbestos packing material allowed?

    a. 3/16-inch diameter if round and 3/16 x 3/16-inch if square.
    b. 1/4-inch diameter if round and 1/4 x 1/4-inch if square.
    c. Only a minimum of 1/4-inch diameter round packing material is permitted.
    d. 3/16-inch diameter if round and 3/8 x 3/8-inch if square.

72. What is the maximum-sized clearance of a plane flange joint on a shuttle car allowed by law?

    a. .005 inch.
    b. .007 inch.
    c. .004 inch.
    d. .006 inch.

73. Insulated wires should pass through metal walls of electric compartments only through:

    a. Proper clamps.
    b. Insulated bushings.
    c. Rubber hoses.
    d. Smooth holes.

74. What size feeler gauge should be used to check plane flange joints?

    a. .004 inch.
    b. .006 inch.
    c. .005 inch.
    d. .003 inch.

75. A .007-inch feeler gauge is used by an inspector to check:

    a. Cylindrical fit joints.
    b. Step flange joints.
    c. Plane flange joints.
    d. 1-inch long push rods.

76. Permissible electrical equipment is equipment which:

    a. Has been tested by rigid methods and been approved by Underwriters Laboratories.
    b. Will not spark.
    c. Is similar in all respects to that which has been approved by the USBM.
    d. Has been tested by the State Department of Mines.

77. When 1/4-inch packing is used in a stuffing box, the maximum allowable diametrical clearance between the cable and the holes in the stuffing box and the packing nut is:

    a. 1/2 inch.
    b. 3/16 inch.
    c. 3/8 inch.
    d. 1/4 inch.

78. Packing material used in stuffing boxes should be:

    a. Any flame-resistant material.
    b. An approved packing material.
    c. Any synthetic fiber.
    d. Treated asbestos.

79. Cast or welded enclosures should be designed to withstand a minimum internal pressure of:

    a. 140 PSI.
    b. 100 PSI.
    c. 125 PSI.
    d. 150 PSI.

80. The maximum clearance allowed for push rods on push buttons with flame paths measuring 1 inch is:

    a. .010 inch.
    b. .011 inch.
    c. .008 inch.
    d. .009 inch.

81. What is the maximum-sized opening permitted for a plane flange joint?

    a. .004 inch.
    b. .005 inch.
    c. .008 inch.
    d. .006 inch.

82. How thick must lenses for headlights be?

    a. 7/16 inch.
    b. 1/2 inch.
    c. 3/8 inch.
    d. 3/16 inch.

83. What is the maximum-sized spacing permitted for bolts securing enclosure covers with joints all in one plane?

    a. 4 inches with a 1-inch flame path.
    b. Up to 8 inches, if approved.
    c. 6 inches.
    d. 4 inches.

84. A .005-inch feeler gauge is used to check:

    a. Plane flange joints.
    b. Slip fit joints.
    c. Threaded joints.
    d. Step flange joints.

85. What size feeler gauge should be used to check end bells on most motors?

    a. .004 inch.
    b. .005 inch.
    c. .007 inch.
    d. .006 inch.

86. The minimum clearance between the shoulder of the nut and the top of a stuffing box in a properly packed, standard packing gland is:

    a. 1/8 inch.
    b. 3/8 inch.
    c. 3/16 inch.
    d. 1/2 inch.

87. The minimum amount of packing that should be in a packing gland along a conductor is:

    a. 3/4 inch.
    b. 1/4 inch.
    c. 1/2 inch.
    d. 1 inch.

88. Before electric face equipment is deemed permissible, the equipment must meet the:

    a. Requirements of the mine operator.
    b. Requirements of the electrician supervisor.
    c. Requirements of the state where the mine is located.
    d. Specifications set forth by the Secretary.

89. All electric equipment used in return air outby the last open crosscut:

    a. Must be permissible.
    b. Will be permissible only when deemed necessary by the mine operator.
    c. Need not be permissible.
    d. Will be permissible only when deemed necessary by the electrical foreman.

90. The maintenance required to keep equipment in permissible condition is the responsibility of the:

    a. Secretary.
    b. Mine operator.
    c. Electrical foreman.
    d. Electrician with the most experience.

91. Permissibility is required for electrical equipment and components:

    a. Inby the last open crosscut only.
    b. Inby the last open crosscut and in return air.
    c. In return air only.
    d. Out by the last open crosscut.

92. Permissible electric face equipment is defined as:

    a. Only handheld equipment used underground.
    b. Only the equipment used in return air outby the last open crosscut.
    c. Any equipment that is taken underground.
    d. Equipment which has been tested and approved.

93. Headlights used on permissible mining machines to provide illumination in the direction of travel:

    a. Need not be permissible.
    b. Should be permissible only in specified situations.
    c. Must be permissible.
    d. Need not be permissible if the headlights are mechanically strong enough (used on mining machines.)

94. What is the minimum distance from combustible material that unattended enclosed motors, rectifiers, and transformers may be placed?

    a. 2 feet.
    b. 5 feet.
    c. 3 feet.
    d. 4 feet.

95. Cable grips or insulated clamps shall be provided on:

    a. Portable trailing cables.
    b. Trolley wire and feeder wire.
    c. All cables, high-, medium-, and low-voltage.
    d. Telephone cables.

96. When mounting ground wires:

    a. Wrap them around permissible bolts.
    b. Wedge them solidly with half headers.
    c. Always use terminals or clamps.
    d. Secure them to water pipes.

97. All trailing cables and drop cables must have:

    a. Three conductors.
    b. Temporary splices.
    c. A restraining clamp in permissible condition.
    d. Red insulation.

98. The primary function of a strain clamp is to:

    a. Transfer most of the strain from the trailing cable to the frame of the equipment it feeds.
    b. Reduce the need for cable reels.
    c. Protect trolley wires from damage.
    d. Totally eliminate strain or tension.

99. In low-and medium-voltage, three-phase AC systems, the maximum ground-fault tripping current should not exceed:

    a. 25 amps.
    b. 10 amps.
    c. 100 amps.
    d. 3 amps.

100. The frame to ground potential of any off-track machine must not exceed:

a. 25 volts.
b. 40 volts.
c. 15 volts.
d. 30 volts.

101. A tool or switch that is held in an operator's hand or supported against an operator's body will NOT be approved if the nameplate rating on the tool or switch exceeds:

a. 300 volts DC or AC.
b. 500 volts.
c. 275 volts DC and 220 volts single-phase AC.
d. 200 volts AC.

102. The term "intrinsically safe circuits" refers to circuits that:

a. Provide protection against shock.
b. Do not create an electrical spark.
c. Do spark but will not ignite a methane-air mixture.
d. Have current-limiting components.

103. Tools or switches held in the operators hand or supported against his body:

a. Cannot have a nameplate voltage rating of more than 300 volts.
b. Must be protected against single-phase condition.
c. May only be controlled hydraulically.
d. Should never be used.

104. Material that will burn when held in a flame but will cease burning when the flame is removed is defined as:

a. Flame-proof.
b. Inflammable.
c. Flame-resistant.
d. Nonflammable.

105. What is the most violent explosive percent of methane?

a. 10%.
b. 20%.
c. 5%.
d. 100%.

106. "Flame-resistant," as applied to trailing cables and conduit hose, means:

a. Cables and hose are flame-proof.
b. Cables and hose will not burn when held in a flame.
c. Arcs and sparks will not ignite cables and hose.
d. Cables and hose will burn when held in a flame, but will cease burning when removed from flame.

107. The maximum operating temperature of the external surface of a machine is:

a. 150 Centigrade or 302 Fahrenheit.
b. 100 Centigrade or 212 Fahrenheit.
c. 200 Centigrade or 392 Fahrenheit.
d. 0 Centigrade or 32 Fahrenheit.

108. What is the explosive range of methane?

a. 5% to 15%.
b. 10% to 100%.
c. 6% to 60%.
d. 2% to 12%.

109. The maximum speed of travel of a machine receiving power from a trailing cable underground is:

a. 2.5 MPH.
b. 4 MPH.
c. 6 MPH.
d. 10 MPH.

110. Which of the following is a requirement of a temporary splice?

a. It must be vulcanized.
b. It must be mechanically strong and well-insulated.
c. It must be effectively insulated and sealed against moisture.
d. It must not break under 200 ft./lbs. of force.

111. Which of the following is NOT a requirement of a permanent splice?

a. It must be more than 25 feet from the machine (except cable reel).
b. It must mechanically strong with adequate electrical conductivity.
c. It must be vulcanized or otherwise treated.
d. It must be effectively insulated and sealed to exclude moisture.

112. Which of the following is a requirement of a permanent splice?

a. It must be more than 25 feet from machinery (except cable reels).
b. It must not break under 400 ft./lbs. of force.
c. It must be mechanically strong with adequate conductivity.
d. It must be fire-proof.

113. The number of temporary splices permitted in a single length of trailing cable is:

a. Three.
b. Two.
c. One.
d. Four.

114. Which of the following is NOT a requirement of a temporary splice made in a trailing cable?

a. It must be mechanically strong and well-insulated.
b. It must be more than 25 feet from the machine (except cable reel).
c. It must be vulcanized.
d. It must be made in a workmanlike manner.

115. What is the maximum allowable speed of travel of a machine that receives power through a trailing cable?

    a. 6 mph.
    b. 10 mph.
    c. 8 mph.
    d. 12 mph.

116. The minimum-sized trailing cable permitted for direct current powered mobile haulage units is:

    a. No. 2 AWG.
    b. No. 6 AWG.
    c. No. 4 AWG.
    d. No. 8 AWG.

117. The maximum length permitted for trailing cables (4/0 and larger) is:

    a. 500 feet.
    b. 1,000 feet.
    c. 2,500 feet.
    d. 1,500 feet.

118. When a trailing cable is used to power an underground mining machine, that machine must not move faster than:

    a. 10 mph.
    b. 4.5 mph.
    c. 6 mph.
    d. 2.5 mph.

119. What is the minimum-sized trailing cable permitted for AC-powered mobile haulage units?

    a. No. 8 AWG.
    b. No.10 AWG.
    c. No. 6 AWG.
    d. No.12 AWG.

120. The maximum length permitted for 1/0 trailing cable is:

   a. 600 feet.
   b. 800 feet.
   c. 1,000 feet.
   d. 1,200 feet.

121. If trailing cables are run over by mobile face equipment:

   a. Arcing or sparking could result which, in turn, could set off an explosion or cause a fire.
   b. It would be a freak accident since mobile face equipment moves forward only.
   c. The trailing cables will be damaged only and no other problems will exist.
   d. No problem will exist since the cables are designed to withstand the weight of the heavy equipment.

122. Flame resistant as applied to trailing cables and hose conduit means:

   a. It will burn when held in a flame but will cease when the flame is removed.
   b. The cable and hose conduit will not burn if heated electrically.
   c. The cable and hose conduit will not burn.
   d. Will burn only if a short circuit exists.

123. All trailing cables used to conduct electrical energy to face equipment shall conform to the following EXCEPT:

   a. Have at least 3 power wires and one ground wire.
   b. Be flame resistant.
   c. Be of adequate current carrying capacity.
   d. Be protected from short-circuit.

124. In most cases, the length of a portable cable should not exceed:

   a. 700 feet.
   b. 500 feet.
   c. 1,000 feet.
   d. 550 feet.

125. Trailing cables must be marked:

    a. Fire-proof.
    b. Flame-resistant.
    c. Flame-proof.
    d. Oil-proof.

126. A No. 6 AWG trailing cable should be no longer than:

    a. 400 feet.
    b. 250 feet.
    c. 550 feet.
    d. 1000 feet.

127. What is the minimum-sized trailing cable permitted for DC-powered mobile haulage units?

    a. No. 6 AWG.
    b. No. 4 AWG.
    c. No. 8 AWG.
    d. No. 10 AWG.

ANSWER GUIDE
Permissibility

Question	Answer	Question	Answer	Question	Answer
1	D	44	B	87	C
2	B	45	A	88	D
3	A	46	B	89	A
4	B	47	C	90	B
5	A	48	D	91	B
6	A	49	A	92	D
7	B	50	C	93	C
8	D	51	C	94	A
9	B	52	C	95	A
10	A	53	A	96	C
11	B	54	A	97	C
12	D	55	A	98	A
13	B	56	B	99	A
14	C	57	D	100	B
15	B	58	D	101	A
16	A	59	A	102	C
17	A	60	C	103	A
18	C	61	D	104	C
19	C	62	D	105	A
20	B	63	B	106	D
21	C	64	A	107	A
22	B	65	C	108	A
23	A	66	C	109	C
24	C	67	B	110	B
25	C	68	D	111	A
26	A	69	C	112	C
27	A	70	A	113	C
28	C	71	A	114	C
29	A	72	C	115	A
30	C	73	B	116	C
31	C	74	C	117	B
32	D	75	B	118	C
33	B	76	C	119	C
34	C	77	B	120	B
35	C	78	B	121	A
36	D	79	D	122	A
37	C	80	A	123	A
38	A	81	A	124	B
39	B	82	B	125	B
40	C	83	C	126	C
41	A	84	A	127	B
42	A	85	C		
43	C	86	A		

APPENDIX

WEST VIRGINIA MINE ELECTRICIANS CERTIFICATION
THE PRACTICAL EXAMINATION

The West Virginia Mine Electrician Certification Program has a practical, hands-on, portion. This practical examination consists of troubleshooting problems on panel boards.

At the time this Guide was prepared, the practical examination consisted of four (4) panel board problems. These may be changed, or new ones may be added, at any time without further notice. The four used now are:

No. 1. A simulated 3-phase 120-volt A.C. panel.

No. 2. A simulated 120-volt A.C. / 300-volt D.C. panel.

No. 3. A simulated A.C. power center panel.

No. 4. A simulated high voltage panel.

Authorized personnel from the State Office of Miners' Health, Safety and Training will give the examination to each person separately. For each panel, the applicant is given:

- a card, which describes a problem with the panel,
- copy of the wiring diagram for that panel, and
- a worksheet or answer sheet.

The applicant is told to read the description on the card, examine the panel, and use the schematic diagram and a volt-ohmmeter to determine the exact nature of the problem, and to fill out the worksheet or tell the answer orally to the examiner. In order to pass the practical portion of the certification examination, the applicant must be able to answer.

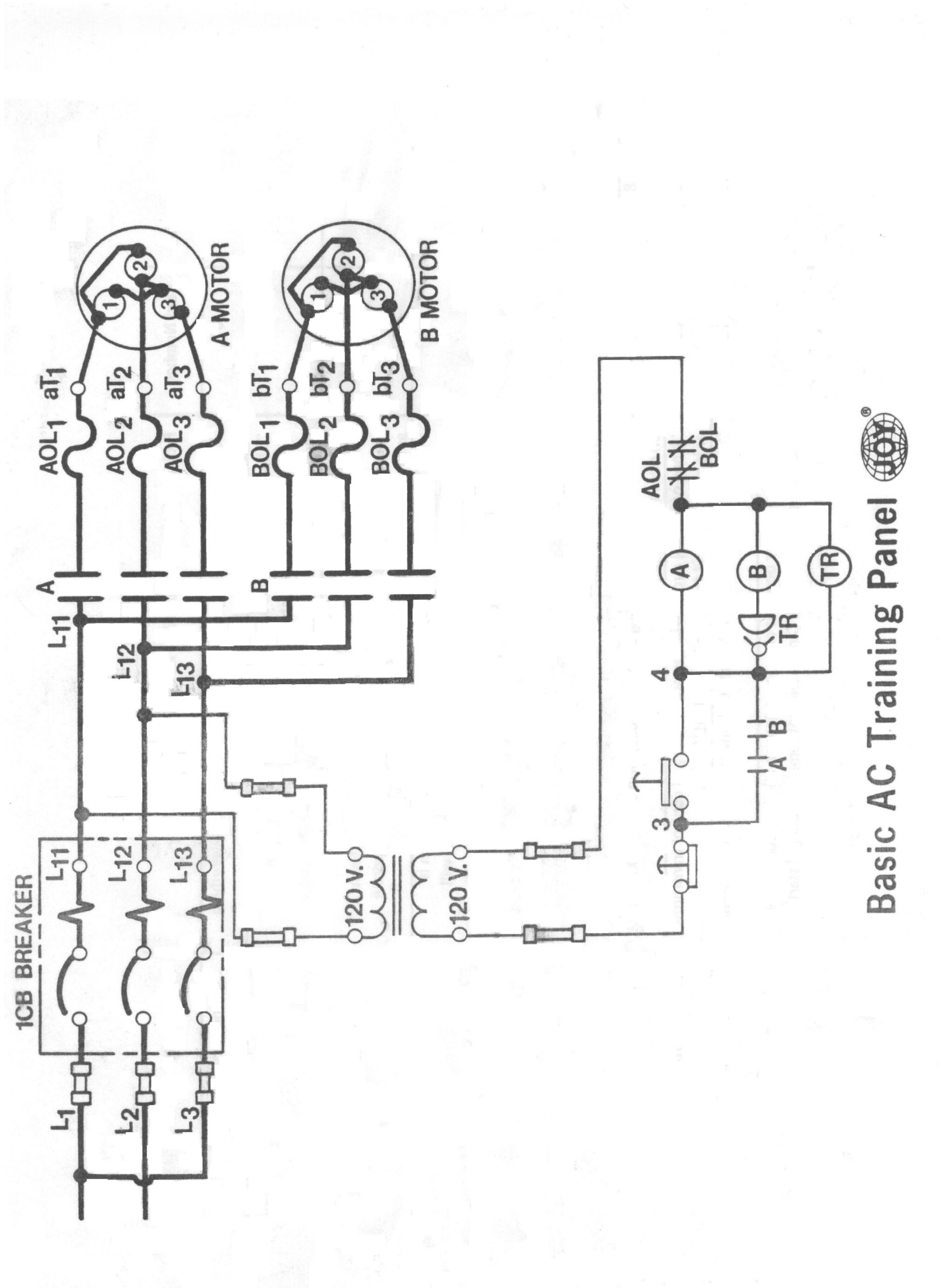
What is wrong?
How the condition could be corrected.

The rest of this section contains sample diagrams of the three panels now used in the practical portion of the examination. Also, there are two additional items provided in this section:

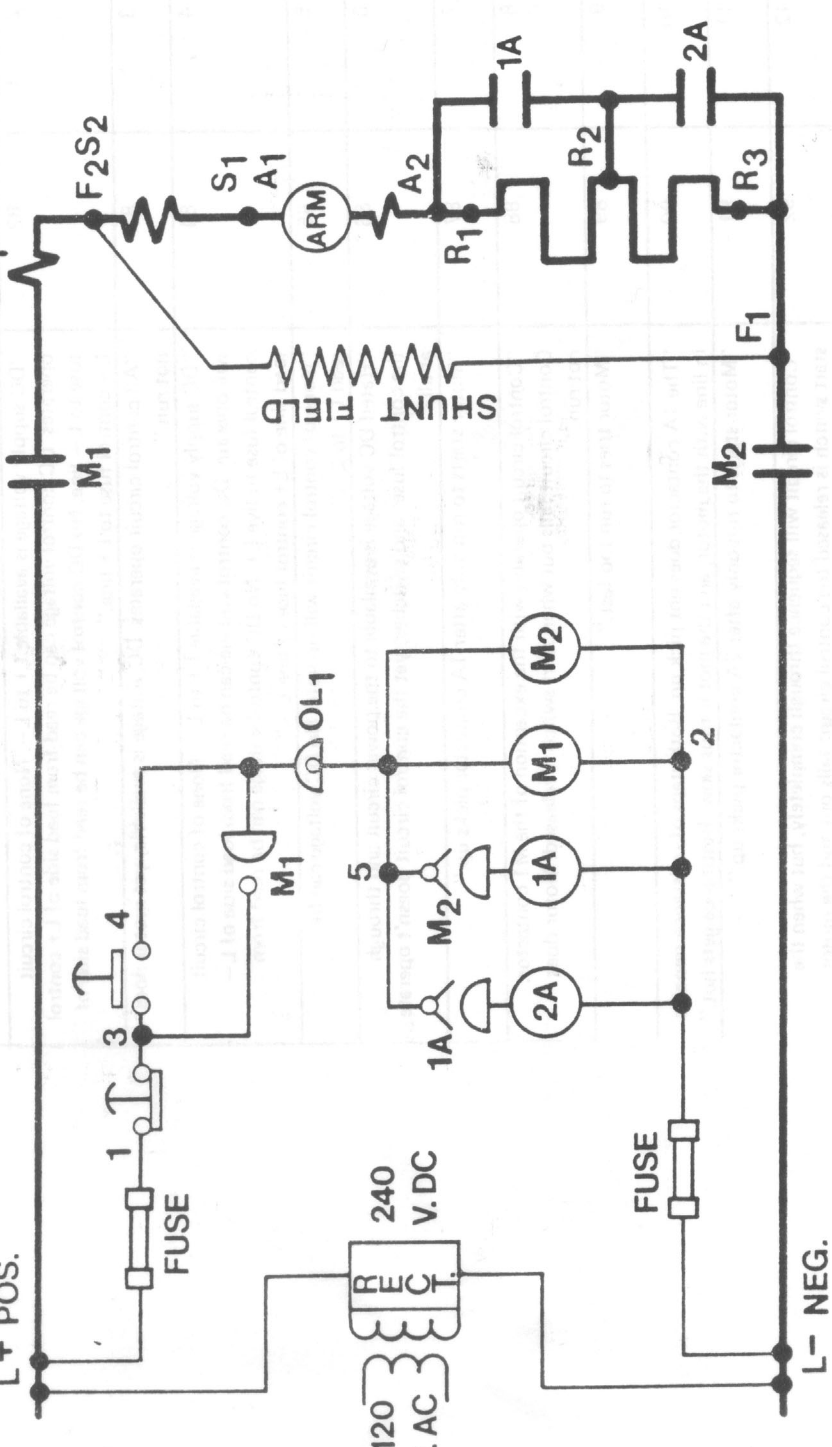
No. 5. A photograph of the new hands-on test panel. An ampacity chart is also provided.

No. 6 A diagram for providing power to a borehole from high-voltage, 3-phase incoming A.C power.

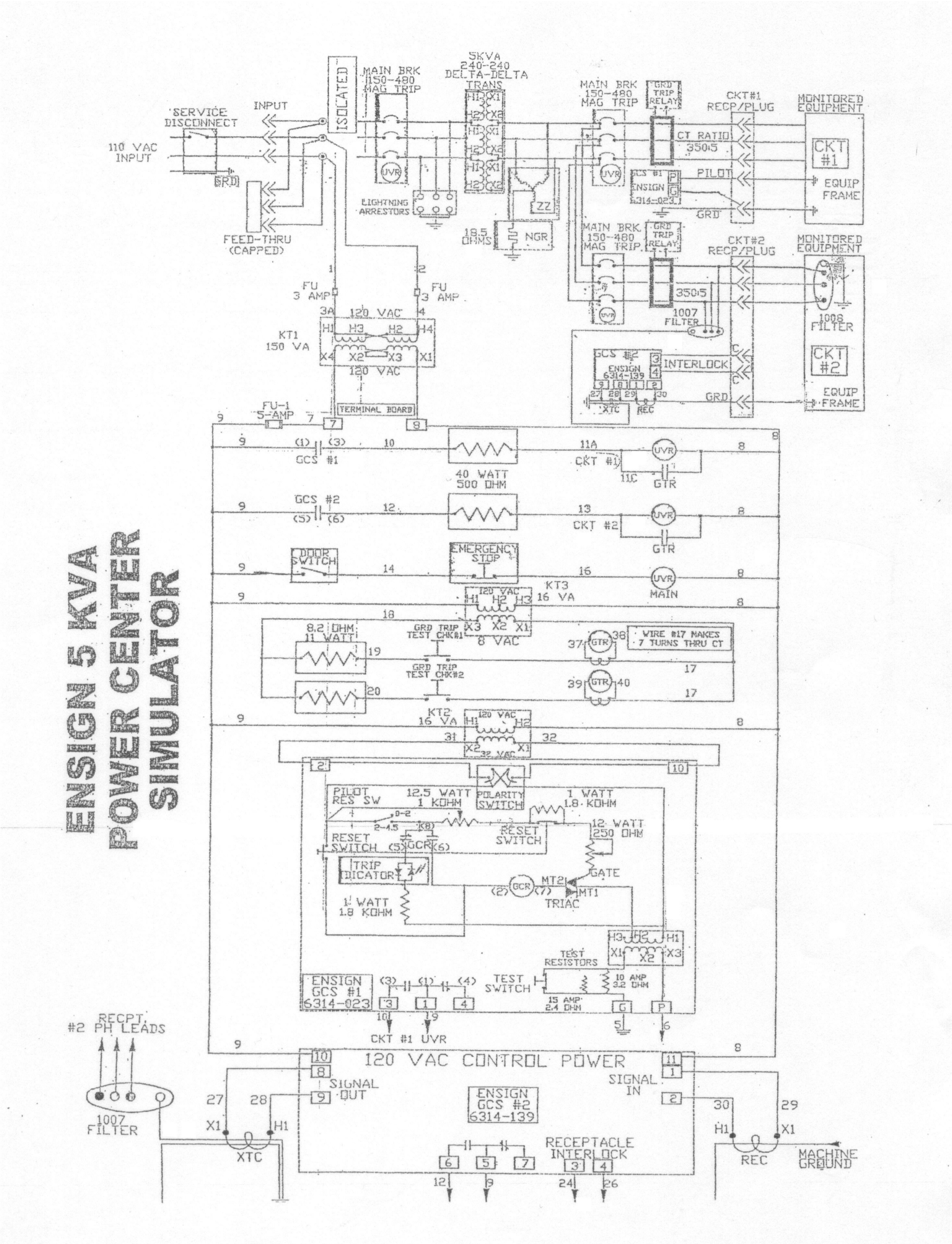
Additional problems may be added to the practical examination at any time without notice. All applicants for West Virginia mine electrician certification should become familiar with all the diagrams in this section of the Guide

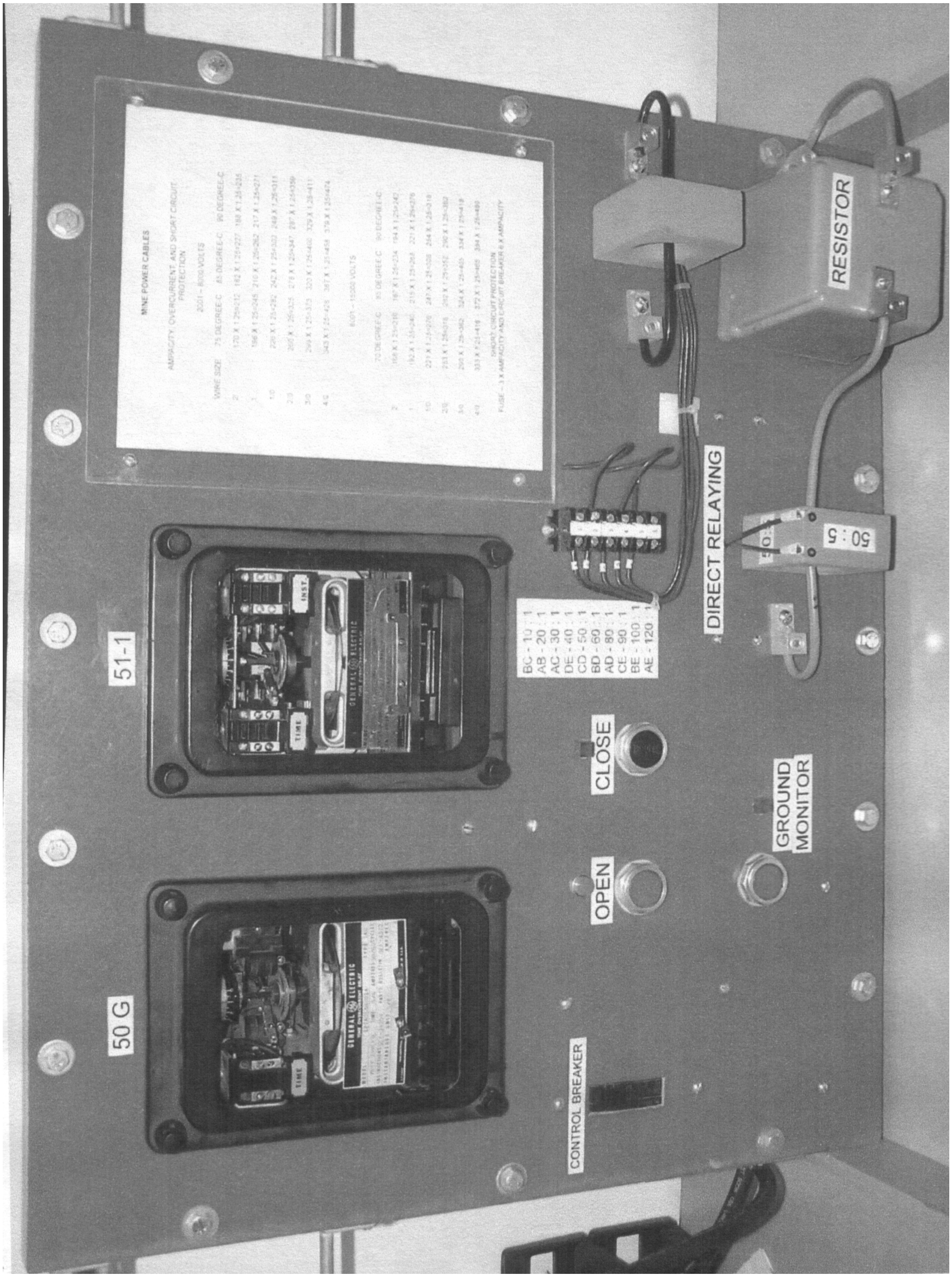

Basic AC Training Panel
JOY
A MOTOR
B MOTOR
1CB BREAKER
120 V.
120 V.
L_1
L_2
L_3
L_{11}
L_{12}
L_{13}
AOL_1
AOL_2
AOL_3
BOL_1
BOL_2
BOL_3
aT_1
aT_2
aT_3
bT_1
bT_2
bT_3
A
B
AOL
BOL
TR
3
4

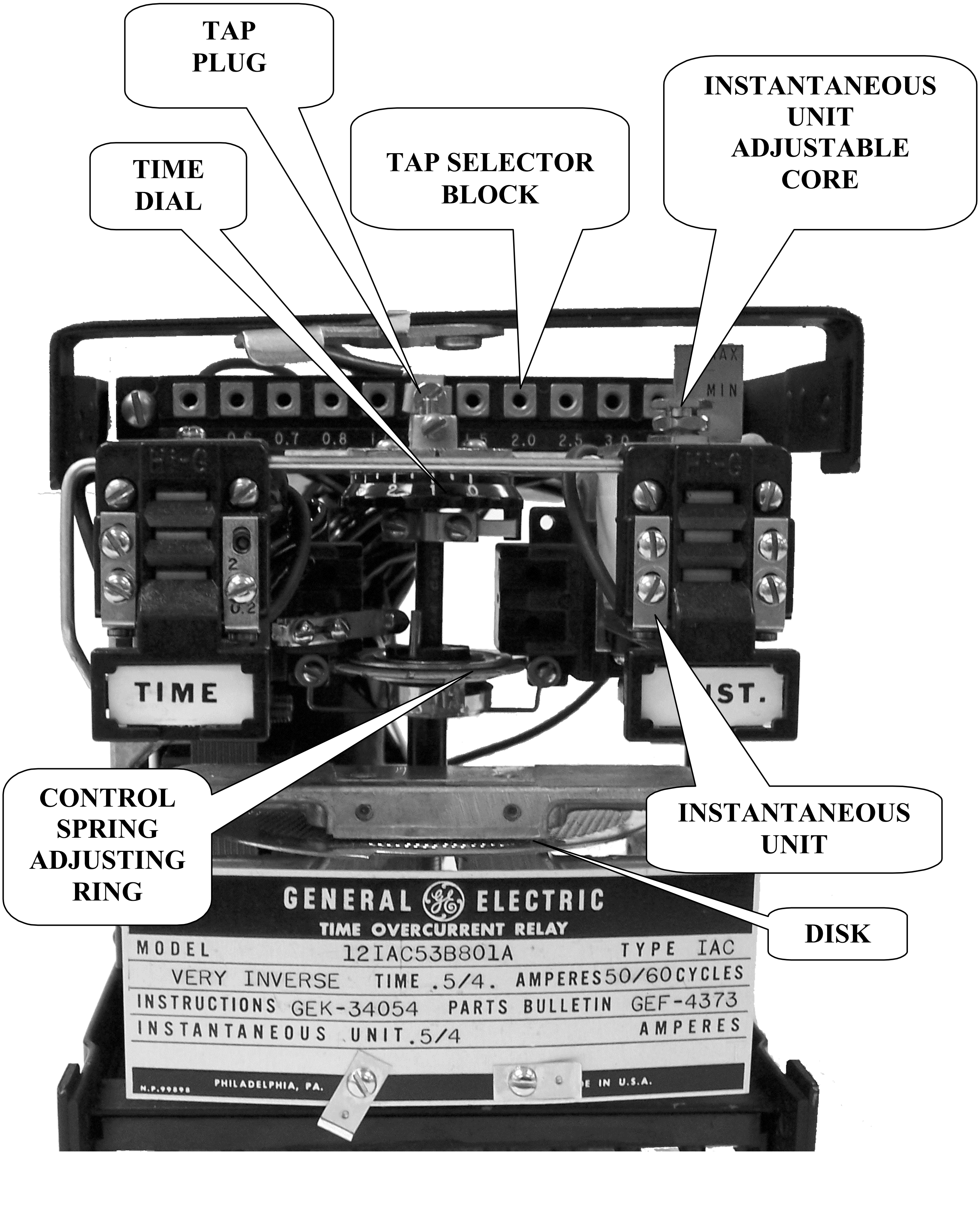
B.1



Basic DC Training Panel JOY®


ENSIGN 5 KVA
POWER CENTER
SIMULATOR
SERVICE DISCONNECT
110 VAC INPUT
INPUT
GRD
ISOLATED
FEED-THRU (CAPPED)
MAIN BRK 150-480 MAG TRIP
5KVA 240-240 DELTA-DELTA TRANS
LIGHTNING ARRESTORS
18.5 OHMS
NGR
ZZ
GRD TRIP RELAY
CT RATIO 350:5
CKT#1 RECP/PLUG
MONITORED EQUIPMENT
CKT #1
PILOT
EQUIP FRAME
CKT#2 RECP/PLUG
350:5
1007 FILTER
1008 FILTER
CKT #2
GCS #2 ENSIGN 6314-139
INTERLOCK
XTC
REC
FU 3 AMP
120 VAC
KT1 150 VA
TERMINAL BOARD
FU-1 5-AMP
GCS #1
40 WATT 500 OHM
CKT #1
GTR
UVR
GCS #2
CKT #2
DOOR SWITCH
EMERGENCY STOP
MAIN
KT3 16 VA
8.2 OHM 11 WATT
GRD TRIP TEST CHK#1
GRD TRIP TEST CHK#2
8 VAC
WIRE #17 MAKES 7 TURNS THRU CT
KT2 16 VA
32 VAC
PILOT RES SW
12.5 WATT 1 KOHM
POLARITY SWITCH
1 WATT 1.8 KOHM
12 WATT 250 OHM
RESET SWITCH
TRIP DICATOR
GCR
GATE
MT2
MT1
TRIAC
TEST RESISTORS
10 AMP 3.2 OHM
15 AMP 2.4 OHM
ENSIGN GCS #1 6314-023
TEST SWITCH
CKT #1 UVR
RECPT. #2 PH LEADS
1007 FILTER
120 VAC CONTROL POWER
SIGNAL OUT
SIGNAL IN
ENSIGN GCS #2 6314-139
RECEPTACLE INTERLOCK
MACHINE GROUND


51-1
50 G
CLOSE
OPEN
GROUND MONITOR
DIRECT RELAYING
RESISTOR
CONTROL BREAKER
50 : 5


TAP PLUG
TIME DIAL
TAP SELECTOR BLOCK
INSTANTANEOUS UNIT ADJUSTABLE CORE
CONTROL SPRING ADJUSTING RING
INSTANTANEOUS UNIT
DISK
TIME
GENERAL ELECTRIC
TIME OVERCURRENT RELAY
MODEL 12IAC53B801A TYPE IAC
VERY INVERSE TIME .5/4. AMPERES 50/60 CYCLES
INSTRUCTIONS GEK-34054 PARTS BULLETIN GEF-4373
INSTANTANEOUS UNIT .5/4 AMPERES
PHILADELPHIA, PA.

MINE POWER CABLES

AMPACITY, OVERCURRENT, AND SHORT CIRCUIT PROTECTION

2001 - 8000 VOLTS

WIRE SIZE	75 DEGREE - C	85 DEGREE - C	90DEGREE - C
2	170 X 1.25=212	182 X 1.25=227	188 X 1.25=235
1	196 X 1.25=245	210 X 1.25=262	217 X 1.25=271
1/0	226 X 1.25=282	242 X 1.25=302	249 X 1.25=311
2/0	260 X 1.25=325	278 X 1.25=347	287 X 1.25=359
3/0	299 X 1.25=373	320 X 1.25=400	329 X 1.25=411
4/0	343 X 1.25=428	367 X 1.25=458	379 X 1.25=474

8001 - 15000 VOLTS

	75 DEGREE - C	85 DEGREE - C	90 DEGREE - C
2	168 X 1.25=210	187 X 1.25=234	194 X 1.25=242
1	192 X 1.25=240	215 X 1.25=268	221 X 1.25=276
1/0	221 X 1.25=276	247 X 1.25=308	254 X 1.25=318
2/0	253 X 1.25=316	282 X 1.25=352	290 X 1.25=362
3/0	290 X 1.25=362	324 X 1.25=405	334 X 1.25=418
4/0	333 X 1.25=416	372 X 1.25=465	384 X 1.25=480

SHORT CIRCUIT PROTECTION
FUSE - 3 X AMPACITY AND CIRCUIT BREAKER 6 X AMPACITY

OVERCURRENT RELAY

4160 volt system phase to phase
2/0 AWG cable 5 KV rating at 90 degree insulation
Cable rated for 287 amps X 125% = 359 amps
Current transformer ratio 80:1
Tap bar range 2.0 to 16
80:1 X tap 4 = 320 amps

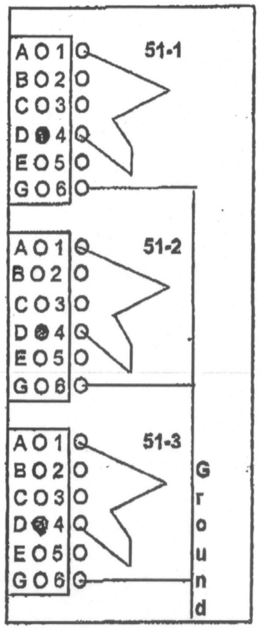
SHORT CIRCUIT

Using a breaker, the short circuit is set no greater than 600% X cable ampacity of 287 amps. (287 X 6 = 1722 amps)
This setting is achieved by adjusting the instantaneous unit adjustable core screw.

GROUND FAULT

4160 volts phase to phase
2400 volts phase to neutral
25 amp grounding resistor 96 ohms
Tap bar range 0.5 to 2.0
Ground fault current is set at no more than 50% of the amp rating of the resistor
Current transformer ratio is 10:1
Current transformer ratio 10:1 set on tap 1.2 (10 X 1.2 = 12 amps) which is less than 50% of the 25 amp grounding resistor.

4160 volt system phase to phase
2/0 AWG cable 5KV volt rating 90c insulation
Current Transformer 80:1 ratio
25 amp grounding resistor rated at 96 ohms
Current tap block 2 - 16 amps.
Instantaneous unit adjustable from 20-40 amps



TAPS	RATIO
BC	10/1
AB	20/1
AC	30/1
DE	40/1
CD	50/1
BD	60/1
AD	80/1
CE	90/1
BE	100/1
AE	120/1

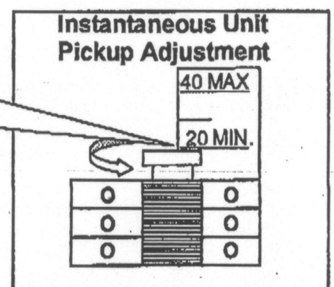
2001 - 8000 VOLTS			
AWG	75c	85c	90c
2	170	182	188
X125%	213	228	235
X600%	1020	1092	1128
1	196	210	217
X125%	245	263	271
X600%	1176	1260	1302
1/0	226	242	249
X125%	283	303	311
X600%	1356	1452	1494
2/0	260	278	287
X125%	325	348	359
X600%	1560	1668	1722
3/0	299	320	329
X125%	374	400	411
X600%	1794	1920	1974
4/0	343	367	379
X125%	429	459	474
X600%	2058	2202	2274

8001 - 15000 VOLTS			
AWG	75c	85c	90c
2	168	187	194
X125%	210	234	243
X600%	1008	1122	1164
1	192	215	221
X125%	240	268	276
X600%	1152	1290	1326
1/0	221	247	254
X125%	276	309	318
X600%	1326	1482	1524
2/0	253	282	290
X125%	316	353	363
X600%	1518	1692	1740
3/0	290	324	334
X125%	363	405	418
X600%	1740	1944	2004
4/0	333	372	384
X125%	416	465	480
X600%	1998	2232	2304

TIME OVERCURRENT RELAY
MODEL 000000000000 TYPE IAC
INVERSE TIME 2 - 16 AMPERES 60 CYCLES
INSTRUCTIONS 00000000 PARTS BULLETIN
INSTANTANEOUS UNIT 20 - 40 AMPERES

Current Tap Block										
O	O	O	O	O	O	O	O	O	O	O
2	3	4	5	6	7	8	10	12	14	16

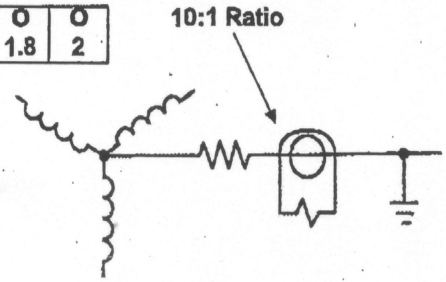
Cable Ampacity
287 X 6 = 1722 Max.SC
1722 Divided by 80:1 CT
Ratio = 21.5 Amps Max.



OVERCURRENT & SHORT CIRCUIT PROTECTION

Cable ampacity 287 amps X 125% = 359. Set the taps on A and D on the multi-tap CT to obtain a 80:1 ratio.
Which tap on the multi-tap block would be used to obtain the highest allowable setting for the 2/0 AWG cable? 4 What is the actual ampacity set at? 320
Set the short circuit instantaneous unit on the maximum allowable 1722 amps.
Set the instantaneous unit core at 21.5 amps. (1722 Divided by 80:1 CT Ratio - 21.5)

Ground Fault Tap Block										
O	O	O	O	O	O	O	O	O	O	O
0.5	0.6	0.7	0.8	0.9	1	1.2	1.4	1.6	1.8	2



Which tap on the multi-tap block would be used to obtain the highest allowable setting? 1.2

What is the actual setting? 12 amps.

_____ volt system phase to phase
____ AWG cable __ volt rating __c insulation
Current Transformer ________ ratio
___ amp grounding resistor rated at __ ohms
Current tap block ________ amps.
Instantaneous unit adjustable from ____ amps

2001 - 8000 VOLTS			
AWG	**75c**	**85c**	**90c**
2	170	182	188
X125%	213	228	235
X600%	1020	1092	1128
1	196	210	217
X125%	245	263	271
X600%	1176	1260	1302
1/0	226	242	249
X125%	283	303	311
X600%	1356	1452	1494
2/0	260	278	287
X125%	325	348	359
X600%	1560	1668	1722
3/0	299	320	329
X125%	374	400	411
X600%	1794	1920	1974
4/0	343	367	379
X125%	429	459	474
X600%	2058	2202	2274

8001 - 15000 VOLTS			
AWG	**75c**	**85c**	**90c**
2	168	187	194
X125%	210	234	243
X600%	1008	1122	1164
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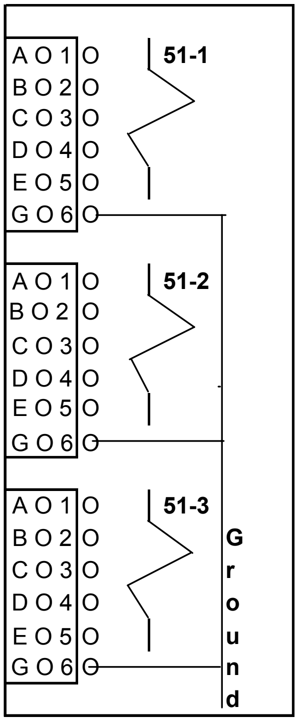
X125%	240	268	276
X600%	1152	1290	1326
1/0	221	247	254
X125%	276	309	318
X600%	1326	1482	1524
2/0	253	282	290
X125%	316	353	363
X600%	1518	1692	1740
3/0	290	324	334
X125%	363	405	418
X600%	1740	1944	2004
4/0	333	372	384
X125%	416	465	480
X600%	1998	2232	2304

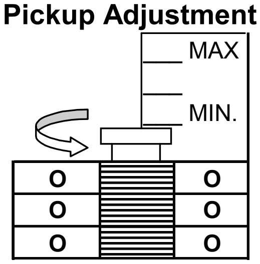


TAPS	**RATIO**
BC	10/1
AB	20/1
AC	30/1
DE	40/1
CD	50/1
BD	60/1
AD	80/1
CE	90/1
BE	100/1
AE	120/1

TIME OVERCURRENT RELAY			
MODEL 000000000000		**TYPE** I A C	
INVERSE **TIME**	**AMPERES** 60 **CYCLES**		
INSTRUCTIONS 00000000	**PARTS BULLETIN**		
INSTANTANEOUS UNIT		**AMPERES**	

Current Tap Block										
O	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**

Instantaneous Unit Pickup Adjustment



OVERCURRENT & SHORT CIRCUIT PROTECTION

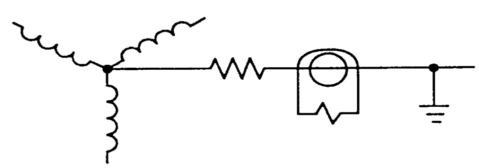
Cable ampacity________amps X 125%=________. Set the taps on _____and_____on the multi-tap CT to obtain a _____ ratio.
Which tap on the mult- tap block would be used to obtain the highest allowable setting for the ____AWG cable?_____What is the actual ampacity set at?_________
Set the short circuit instantaneous unit on the maximum allowable _______amps.
Set the instantaneous unit core at_____ amps.(____amps Divided by_____CT Ratio_____amps)

GROUND FAULT PROTECTION

Ground Fault Tap Block										
O	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**

_______**CT RATIO**

Which tap on the multi-tap block would be used to obtain the highest allowable setting?__________
What is the actual setting? _______amps.



Company					
Mine		**I D Number**			
Date		**HV Underground Feeder Cable**			
Fence Gate Shunted & Locked	Yes	**Cable Size**	2/0		
Fence: Grounded	Yes	**Cable Temp. Rating**	90c		
Danger HV Signs Posted	Yes	**Cable KV Rating**	5		
Fence: Height	6'	**Cable Ampacity**	287		
Metal Structures Grounded	Yes	**Overcurrent Relays**			
Insulated Mats	Yes	**Cable Ampacity**	287	**X125%**	359
Metal Grids Grounded	Yes	**Relays**	**51/1**	**51/2**	**51/3**
Voltage In	12,470	**CT Ratio**	80:1	80:1	80:1
Voltage Out	4,160	**OL Tap Bar Range**	2-16	2-16	2-16
Lightning Arrestors Primary	Yes	**Tap Set On**	4	4	4
Lightning Arrestors Secondary	Yes	**Setting Actual Amps**	320	320	320
Disconnects: Incoming Power	Yes	**Max. Allow. Tap set.**	4	4	4
Visual Disc. 100' Of Portal	Yes	**Time Dial Setting**	1	1	1
Primary Fuse Size	30	**Short Circuit**			
Transformer Connection	D / Y	**Cable Ampacity**	287	**X600%**	1,722
Neutral: Direct or Derived	Direct	**CT Ratio**		80:1	
Transformer KVA or Amps	5,000	**Core Setting Range**		20 - 40	
HV OCB / Vac Bkr. Identified	Yes	**Core Set On**		21.5	
OCB Amp Rating	600	**Setting Actual Amps**		1,722	
OCB Voltage Rating	15 KV	**Max Allow. Core Set. Amps**		21.5	
Vacuum Bkr. Amp Rating	N/A	**Ground Fault Relay 51 - G**			
Vacuum Bkr. Voltage Rating	N/A	**Phase to Neutral Voltage**		2,400	
Grounding Resistor Amps	25	**CT Ratio**		50:5	
Grounding Resistor Ohms	96	**Grounding Resistor Amps**		25	
Neutral GND Resistance Ohms	2	**50% Resistor Rated Amps**		12.5	
Station GND Resistance Ohms	3	**Tap Bar Range**		0.5-2	
Control Voltage	120	**Tap Set On**		1.2	
Monitor Amps	1	**Setting Actual Amps**		12	
Capacitors Primary	No	**Max Allowable Tap Setting**		1.2	
Capacitors Secondary	No	**Time Dial Setting**		0.5	

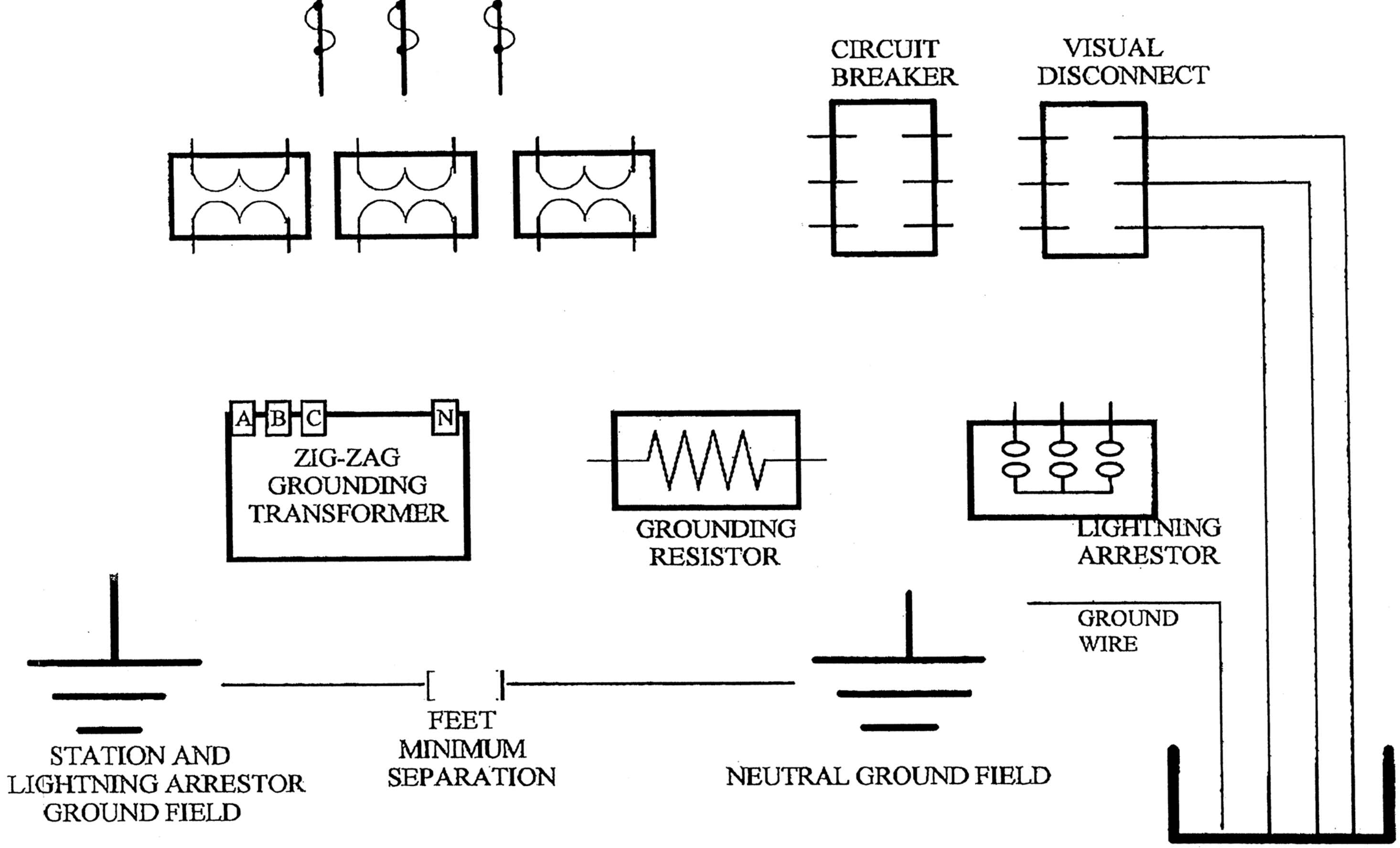
Company					
Mine			I D Number		
Date		HV Underground Feeder Cable			
Fence Gate Shunted & Locked		Cable Size			
Fence: Grounded		Cable Temp. Rating			
Danger HV Signs Posted		Cable KV Rating			
Fence: Height		Cable Ampacity			
Metal Structures Grounded		Overcurrent Relays			
Insulated Mats		Cable Ampacity	X125%		
Metal Grids Grounded		Relays	51/1	51/2	51/3
Voltage In		CT Ratio			
Voltage Out		OL Tap Bar Range			
Lightning Arrestors Primary		Tap Set On			
Lightning Arrestors Secondary		Setting Actual Amps			
Disconnects: Incoming Power		Max. Allow. Tap set.			
Visual Disc. 100' Of Portal		Time Dial Setting			
Primary Fuse Size		Short Circuit			
Transformer Connection		Cable Ampacity	X 600%		
Neutral: Direct or Derived		CT Ratio			
Transformer KVA or Amps		Core Setting Range			
HV OCB / Vac Bkr. Identified		Core Set On			
OCB Amp Rating		Setting Actual Amps			
OCB Voltage Rating		Max Allow. Core Set. Amps			
Vacuum Bkr. Amp Rating		Ground Fault Relay 51 - G			
Vacuum Bkr. Voltage Rating		Phase to Neutral Voltage			
Grounding Resistor Amps		CT Ratio			
Grounding Resistor Ohms		Grounding Resistor Amps			
Neutral GND Resistance Ohms		50% Resistor Rated Amps			
Station GND Resistance Ohms		Tap Bar Range			
Control Voltage		Tap Set On			
Monitor Amps		Setting Actual Amps			
Capacitors Primary		Max Allowable Tap Setting			
Capacitors Secondary		Time Dial Setting			

NAME________________________

DATE________________________

COAL MINE BOREHOLE DRAWING

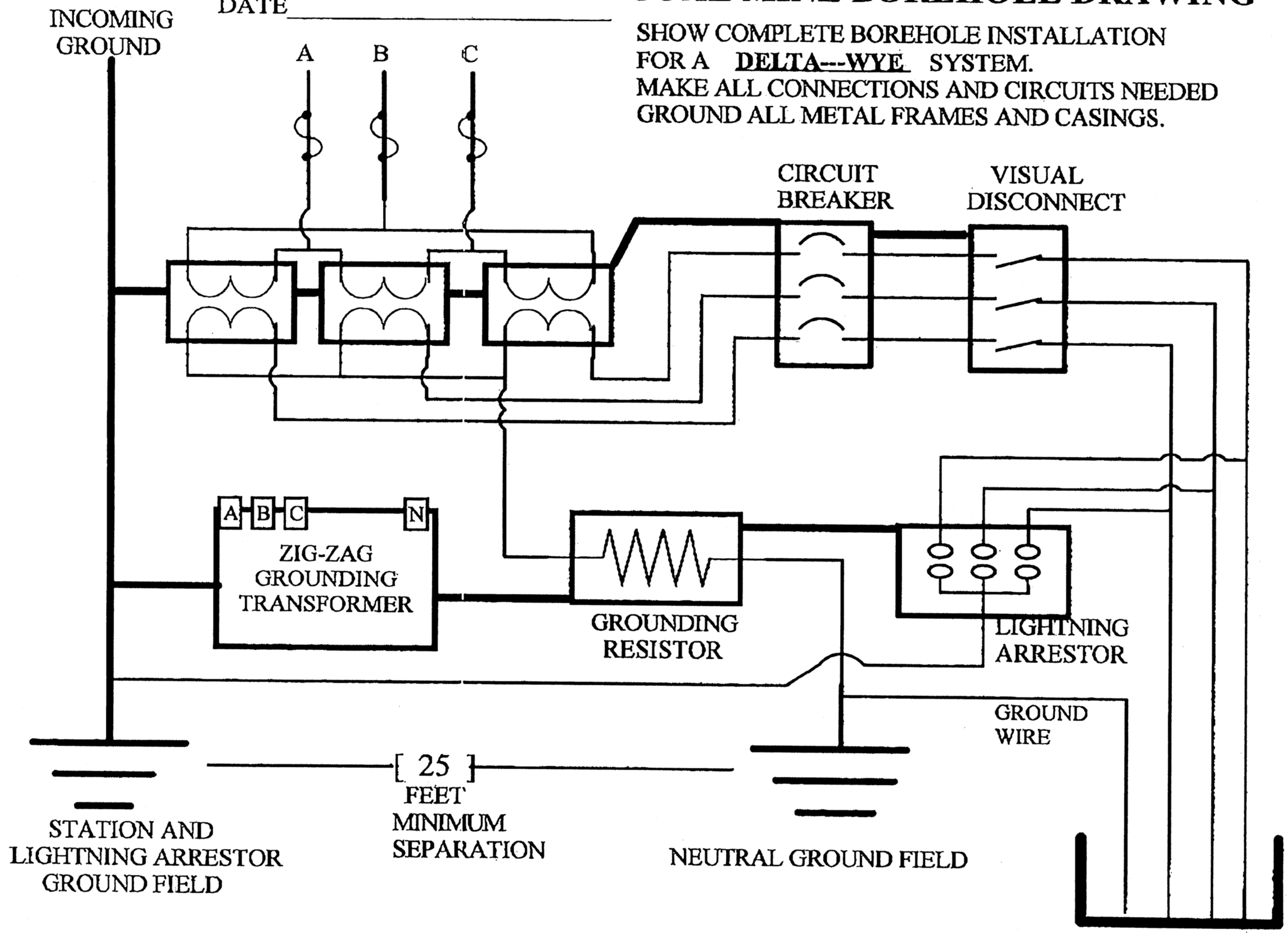
SHOW COMPLETE BOREHOLE INSTALLATION
FOR A ___________---___________SYSTEM.
MAKE ALL CONNECTIONS AND CIRCUITS NEEDED
GROUND ALL METAL FRAMES AND CASINGS.



NAME______________________
DATE______________________

COAL MINE BOREHOLE DRAWING

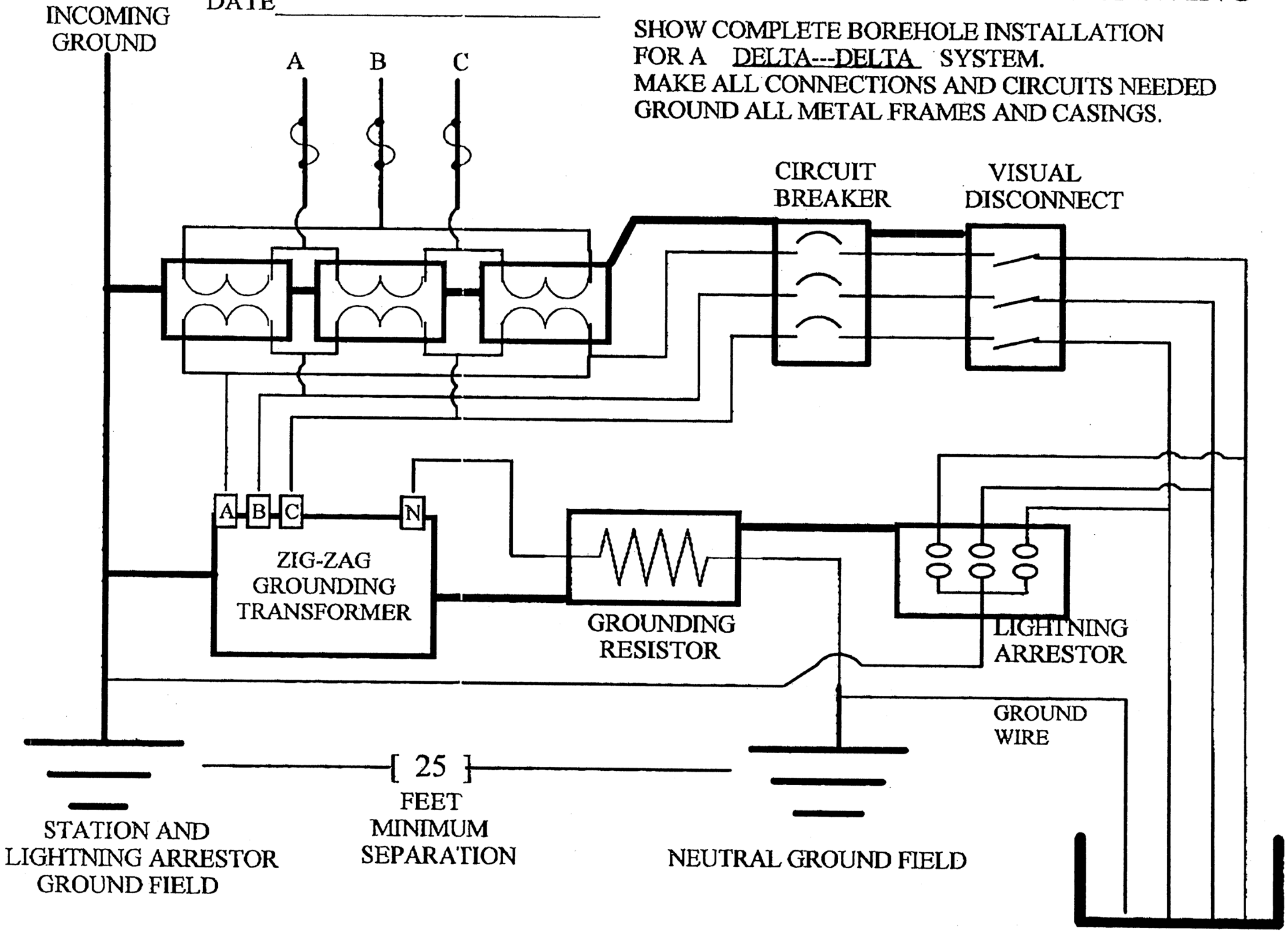
SHOW COMPLETE BOREHOLE INSTALLATION
FOR A **DELTA---WYE** SYSTEM.
MAKE ALL CONNECTIONS AND CIRCUITS NEEDED
GROUND ALL METAL FRAMES AND CASINGS.



NAME____________________________
DATE____________________________

COAL MINE BOREHOLE DRAWING

SHOW COMPLETE BOREHOLE INSTALLATION
FOR A <u>DELTA---DELTA</u> SYSTEM.
MAKE ALL CONNECTIONS AND CIRCUITS NEEDED
GROUND ALL METAL FRAMES AND CASINGS.



DEFINITIONS

VOLTS
Operating voltage.

MOTOR HORSEPOWER
Horsepower of the motor.

MOTOR FLC
Full-load current of the motor.

FLC X 125%
Motor full-load current x 125% to determine required cable size and overload protection. (Some manufacturers have the 125% already calculated into their heater charts).

CABLE SIZES
Power cables are rated at different temperatures. Normally the mining industry uses 75 and 90 degree insulation ratings. Underground mining cables listed have been calculated for the underground ambient temperature factors. The surface charts utilize the standardization of the National Electrical Code for jacketed-cables or enclosed in conduit.

CIRCUIT BREAKER AND FUSE SIZE
Standard Listings 15-20-25-30-35-40-45-50-60-70-80-90-100-110-125-150-175-200-225-250-300 350-400-450-500-600-700-800-1000-1200-1600-2000-2500-3000-4000-5000 and 6000.

FULL-LOAD CURRENT X 250%
Motor full-load current X 250% to determine low setting for short circuit protection if thermal circuit breaker or fuses are used.

FULL-LOAD CURRENT X 400%
Motor full-load current X 400% to determine maximum allowable short circuit protection if thermal circuit breaker or fuses are used.

FULL-LOAD CURRENT x 700%
To determine low setting for short circuit protection using a magnetic CB.

FULL-LOAD CURRENT X 1300%
To determine short circuit protection using a magnetic circuit breaker, try to start at 700% of motor full-load current. If motor will not start, keep increasing but do not exceed 1300% of motor full-load current.

BREAKER TRIP RANGE
The variable adjustable short circuit protection of a circuit breaker.

TRIP RANGE SET ON
From 700% to 1300% of motor full-load current (For a magnetic CB).

HEATER SIZE
No greater than 125% of motor full load current.

HEATER AMPS
Set point of heaters which will open the circuit.

CT RATIO
Current transformer used in conjunction with thermal overloads to provide motor overload protection.

STARTER SIZE
Minimum size starter.

SINGLE MOTOR EXAMPLE

	SURFACE	UNDERGROUND
(**SURFACE**) This example utilizes a thermal circuit breaker or fuses although a thermal magnetic circuit breaker is acceptable. (**UNDERGROUND**) This example utilizes a magnetic circuit breaker.		
VOLTS	460	460
Operating voltage.		
HORSEPOWER	25	25
Rated motor horsepower.		
MOTOR FLC	34	34
Motor full-load current.		
FLC X 125%	43	43
Motor full-load current X 125% = 43 amps.		
CABLE SIZE	8	8
No. 8 AWG copper rated for 50 amps surface or No.8 copper rated for 70 amps underground.		
CABLE AMPACITY	50	70
No. 8 copper rated for 50 amps surface and 70 amps underground.		
FLC X 250%	85	
FLC 34 amps X 250% = 85 amps low setting for short circuit protection (thermal circuit breaker or fuses).		
FLC X 400 %	136	
FLC 34 amps X 400% = 136 amps Maximum setting for short circuit protection (thermal circuit breaker or fuses).		

THERMAL BK OR FUSE SIZE	90	
FLC X 250% = 85 amps (a standard size 90 amp thermal CB or fuse is acceptable).		
FLC X 700%		238
FLC X 700% = 238 amps is low setting for short circuit protection (magnetic CB).		
FLC X 1300%		442
FLC X 1300% = 442 amps is maximum setting for short circuit protection (magnetic CB).		
BREAKER TRIP RANGE		150 480
Magnetic CB with adjustable trip range between 150 to 480 amps.		
TRIP RANGE SETTING		250
CB with 150 to 480 trip range and 13 settings set on No.4 (250 amps) would be acceptable.		
CT RATIO		
Normally not used in motors below 100 HP.		
HEATER SIZE	FH56	FH56
FH 56 rated for 41.5 amps. Rating not to exceed 125% of motor FLC.		
HEATER AMPS	41.5	41.5
FH 56 will open circuit if amperage reaches 41.5 amps.		
STARTER SIZE	2	2
Minimum size starter.		

MULTI-MOTOR EXAMPLE

VOLTS		**460**	
System operating voltage.			
MOTOR FLC		**180**	
Motor full-load current.			
FLC X 125%		**225**	
Motor FLC x 125% = 225 amps.			
FLC + (FLC X 125%)		**405**	
To determine required size feeder conductor in a multi-motor installation. The largest HP FLC X 125% + FLC of other motors connected to the feeder circuit. EXAMPLE: Installation Contains two (2) 460 volt, 150 HP, 180 amp motors. Multiply (180 amps by 125% = 225 amps + 180 amps = 405 amps).			
FEEDER SIZE		**600**	
A 600 MCM copper cable would be the minimum size for surface installation. If this Circuit were to be installed underground, referring to the underground cable ampacity chart 0-2K volts, a 300 MCM 90 degree cable rated at 421 Amps would be acceptable.			
FEEDER AMPACITY		**420**	
Rated ampacity of cable from power Source to beginning of branch circuits.			
TRIP RANGE		**15-3**	
Thermal magnetic CB with adjustable trip range. Low setting 1500 high 3000 amps.			
TRIP RANGE SETTING		**1500**	
150 HP 180 amps 180 X 700% = 1260, set trip range on low (1500 amps).			
FUSE & THERMAL CB SZ		**450**	
Fuse or (thermal CB only) for short circuit protection of feeder cable, try to start at 250%. If motors will not start, increase up to 400% max.			

MOTOR HORSEPOWER	**150**		**150**
Rated motor horsepower.			
MOTOR FLC	**180**		**180**
Motor full-load current.			
FLC X 125%	**225**		**225**
Motor FLC 180 X 125% = 225 amps.			
BRANCH CIR CABLE SIZE	**4/0**		**4/0**
Minimum size cable for motors receiving power from feeder circuit 125% of motor FLC.			
BR. CIR CABLE AMPAC.	**230**		**230**
Rated ampacity of branch circuit cable.			
FLC X 250%	**450**		**450**
FLC 180 X 250% = 450, low setting for short Circuit protection (fuses or thermal CB).			
FLC X 400%	**720**		**720**
FLC 180 X 400% = 720, maximum setting for short circuit protection (fuses or thermal CB).			
FLC X 700%	**1260**		**1260**
FLC of motor X 700% low setting for magnetic CB.			
FLC X 1300%	**2340**		**2340**
FLC of motor X 1300% maximum setting for magnetic CB.			
CT RATIO	**300/5**		**300/5**
A 300/5 CT=60/1 (300 divided by 5 = 60/1) A motor operating at 60 amps, the secondary output would be 1 amp.			
HEATER SIZE	**FH 30**		**FH 30**
Multiply CT ratio (60/1) by FH-30 (3.73 amps) = 224 amps. This is 1 amp under 225-amp max.			
HEATER AMPS	**3.73**		**3.73**
Rated amperage for heater strips will open Circuit if overload condition occurs.			
STARTER SIZE	**5**		**5**
Minimum size starter.			

CT RATIO HEATER SIZE FOR MOTOR PROTECTION

460V	100 HP	125 HP	**150 HP**	200 HP	250 HP
FLC X 125%	155	195	**225**	300	378
100/5 = 20/1	FH-37	FH-40	FH-41	FH-45	FH-47
150/5 = 30/1	FH-33	FH-36	FH-37	FH-40	FH-43
200/5 = 40/1	FH-30	FH-33	FH-34	FH-37	FH-40
250/5 = 50/1	FH-27	FH-30	FH-32	FH-35	FH-37
300/5 = 60/1	FH-26	FH-28	**FH-30**	FH-33	FH-35
350/5 = 70/1	FH-24	FH-26	FH-28	FH-31	FH-34
400/5 = 80/1	FH-22	FH-25	FH-26	FH-30	FH-32
450/5 = 90/1	FH-21	FH-24	FH-25	FH-28	FH-31
500/5 = 100/1	FH-20	FH-23	FH-24	FH-27	FH-30
600/5 = 120/1	FH-18	FH-21	FH-22	FH-25	FH-28

Normally motors over 100 horsepower use current transformers (CT) to provide overload protection.

Overload protection shall not be greater than 125% of the motor rated full-load current.

EXAMPLE: A 300/5 CT=60/1 (300 divided by 5=60). If a motor is operating at 60 amps, the secondary amperage of the CT would be 1 amp.

The chart above has been calculated to determine the maximum overload heater size for proper overload protection not to exceed 125% of motor full-load operating current.

EXAMPLE: A 150 horsepower, 460 volt motor operates at 180 amps full-load current. 180 amps X 125% = 225 amps. Overload protection shall not exceed 225 amps.

The heater size FH-30 is rated for 3.73 amps. Multiply CT ratio (60/1) by FH-30 (3.73 amps) = 224 amps. This is one amp under the 225 amp maximum.

If FH series heaters are not used, this chart can be used to cross reference amperage rating of other heaters.

HP 460	FLC	125%	250%	400%	700%	1300%	HT SZ	ST SZ
0.5	1.1	1.3	2.75	4.4	7.7	14.3	FH 18	0
0.75	1.6	2	4	6.4	11.2	21	FH 23	0
1	2.1	2.6	5.25	8.4	14.7	27	FH 26	0
1.5	3	3.75	7.5	12	21	39	FH 30	0
2	3.4	4.25	8.5	13.6	23.8	44	FH 31	0
3	4.8	6	12	19.2	33.6	62	FH 35	0
5	7.6	9.5	19	30.4	53.2	99	FH 40	0
7.5	11	14	27.5	44	77	143	FH 44	1
10	14	17.5	35	56	98	182	FH 47	1
15	21	26.3	52.5	84	147	273	FH 50	2
20	27	34	67.5	108	189	351	FH 53	2
25	34	43	85	136	238	442	FH 56	2
30	40	50	100	160	280	520	FH 81	3
40	52	65	130	208	364	676	FH 83	3
50	65	81	163	260	455	845	FH 86	3
60	77	96	193	308	539	1001	FH 88	4
75	96	120	240	384	672	1248	FH 90	4
100	124	155	310	496	868	1612	FH 93	4
125	156	195	390	624	1092	2028		5
150	180	225	450	720	1260	2340		5
200	240	300	600	960	1680	3120		5
250	302	378	755	1208	2114	3926		6
300	361	451	902	1444	2527	4693		6
350	414	517	1035	1656	2898	5382		6
400	477	596	1192	1908	3339	6201		6
450	515	644	1287	2060	3605	6695		7
500	590	738	1475	2360	4130	7670		7

HP 575	FLC	125%	250%	400%	700%	1300%	HT SZ	ST SZ
0.5	0.9	1.2	2.25	3.6	6.3	11.7	FH17	0
0.75	1.3	1.62	3.25	5.2	9.1	16.9	FH 21	0
1	1.7	2.12	4.25	6.8	11.9	22.1	FH 23	0
1.5	2.4	3	6	9.6	16.8	31.2	FH 27	0
2	2.7	3.3	6.7	10.8	18.9	35.1	FH 28	0
3	3.9	4.8	9.75	15.6	27.3	50.7	FH 32	0
5	6.1	7.6	15	24.4	42.7	79.3	FH 37	0
7.5	9	11.2	22.5	36	63	117	FH 41	1
10	11	13.75	27.5	44	77	143	FH 44	1
15	17	21.25	42	68	119	221	FH 48	2
20	22	27.5	55	88	154	286	FH 51	2
25	27	33.7	67	108	189	351	FH 53	2
30	32	40	80	128	224	416	FH 78	3
40	41	51	102	164	287	533	FH 79	3
50	52	65	130	208	364	676	FH 83	3
60	62	77	155	248	434	806	FH 85	4
75	77	96	192	308	539	1001	FH 88	4
100	99	124	247	396	693	1287	FH 91	4
125	125	156	312	500	875	1625		5
150	144	180	360	576	1008	1872		5
200	192	240	480	768	1344	2496		5
250	242	302	605	968	1694	3146		6
300	289	361	722	1156	2023	3756		6
350	336	420	840	1344	2352	4368		6
400	382	477	955	1528	2674	4966		6
450	412	515	1030	1648	2884	5356		7
500	472	590	1180	1888	3304	6136		7

MAGNETIC TRIP RANGE								
	150	**300**	**500**	**750**	**800**	**1500**	**2000**	**2500**
	480	**700**	**1000**	**1500**	**1600**	**3000**	**4000**	**5000**
LO	150	300	500	750	800	1500	2000	2500
1	191	350	562	844	900	1688	2250	2812
2	232	400	625	938	1000	1875	2500	3125
3	274	450	687	1031	1100	2063	2750	3437
4	315	500	750	1125	1200	2250	3000	3750
5	356	550	812	1219	1300	2438	3250	4062
6	397	600	875	1313	1400	2625	3500	4375
7	439	650	937	1407	1500	2813	3750	4687
HI	480	700	1000	1500	1600	3000	4000	5000
	50	**66**	**150**					
	150	**190**	**480**	**UNDERGROUND COND.**				
LO	50	66	150		**0-2000V**		**2 TO**	**8 K**
1	58	75	175	**AWG**	**75C**	**90C**	**75C**	**90C**
2	65	85	200	**14**	17	17		
3	73	94	225	**12**	22	22		
4	80	104	250	**10**	28	28		
5	88	113	275	**8**	63	70		
6	95	123	300	**6**	81	93	99	110
7	103	132	325	**4**	106	123	130	144
8	111	142	350	**3**	125	142		
9	118	151	375	**2**	144	163	170	188
10	126	161	400	**1**	163	190	196	217
11	134	170	425	**1/0**	181	219	226	249
HI	142	180	450	**2/0**	213	254	260	287
				3/0	244	294	299	329
SC TRAIL. CABLES				**4/0**	275	329	343	379
10	150	**1**	1000	**250**	306	378	379	419
8	200	**1/0**	1250	**300**	344	421	423	470
6	300	**2/0**	1500	**350**	381	465	465	513
4	500	**3/O**	2000	**400**	406	507	500	555
3	600	**4/0**	2500	**500**	469	575	571	632
2	800							

SURFACE CONDUCTORS		
AWG	COPPER	ALUMINUM
	75C	75C
14	20+	
12	25+	20+
10	35+	30+
8	50	40
6	65	50
4	85	65
3	100	75
2	115	90
1	130	100
1/0	150	120
2/0	175	135
3/0	200	155
4/0	230	180
250	255	205
300	285	230
350	310	250
400	335	270
500	380	310
600	420	340
700	460	375
750	475	385
800	490	395
900	520	425
1000	545	445
1250	590	485
1500	625	520
1750	650	554
2000	665	560

HEATER SIZE					
FH-3	0.27	FH-26	2.58	FH-49	21.7
FH-4	0.31	FH-27	2.83	FH-50	23.9
FH-5	0.34	FH-28	3.11	FH-51	26.2
FH-6	0.38	FH-29	3.42	FH-52	28.7
FH-7	0.42	FH-30	3.73	FH-53	31.4
FH-8	0.46	FH-31	4.07	FH-54	34.5
FH-9	0.5	FH-32	4.39	FH-55	37.9
FH-10	0.55	FH-33	4.87	FH 56	41.5
FH-11	0.62	FH-34	5.3	FH 78	37.5
FH-12	0.68	FH-35	5.9	FH-79	41.5
FH-13	0.75	FH-36	6.4	FH-80	46.3
FH-14	0.83	FH-37	7.1	FH-81	50
FH-15	0.91	FH-38	7.8	FH-82	55
FH-16	1	FH-39	8.5	FH-83	61
FH-17	1.11	FH-40	9.4	FH-84	66
FH-18	1.22	FH-41	10.3	FH-85	73
FH-19	1.34	FH-42	11.3	FH-86	78
FH-20	1.47	FH-43	12.4	FH-87	84
FH-21	1.62	FH-44	13.5	FH-88	92
FH-22	1.78	FH-45	14.9	FH-89	101
FH-23	1.95	FH-46	16.3	FH-90	110
FH-24	2.15	FH-47	18	FH-91	122
FH-25	2.35	FH-48	19.8	FH-92	129
				FH-93	133

100/5=20/1	FH-37	FH-40	FH-41	FH-45	FH-47
150/5=30/1	FH-33	FH-36	FH-37	FH-40	FH-43
200/5=40/1	FH-30	FH-33	FH-34	FH-37	FH-40
250/5=50/1	FH-27	FH-30	FH-32	FH-35	FH-37
300/5=60/1	FH-26	FH-28	FH-30	FH-33	FH-35
350/5=70/1	FH-24	FH-26	FH-28	FH-31	FH-34
400/5=80/1	FH-22	FH-25	FH-26	FH-30	FH-32
450/5=90/1	FH-21	FH-24	FH-25	FH-28	FH-31
500/5=100/1	FH-20	FH-23	FH-24	FH-27	FH-30
600/5=120/1	FH-18	FH-21	FH-22	FH-25	FH-28
CT RATIO HEATER SIZE FOR MOTOR PROT.					
575 V	**100HP**	**125HP**	**150HP**	**200HP**	**250HP**
FLC X 125%	**124**	**156**	**180**	**240**	**302**
100/5=20/1	FH-35	FH-38	FH-39	FH-42	FH-45
150/5=30/1	FH-31	FH-33	FH-35	FH-38	FH-40
200/5=40/1	FH-27	FH-30	FH-32	FH-35	FH-37
250/5=50/1	FH-25	FH-28	FH-29	FH-32	FH-35
300/5=60/1	FH-23	FH-26	FH-27	FH-30	FH-33
350/5=70/1	FH-21	FH-24	FH-25	FH-29	FH-31
400/5=80/1	FH-20	FH-23	FH-24	FH-27	FH-30
450/5=90/1	FH-19	FH-21	FH-23	FH-26	FH-28
500/5=100/1	FH-18	FH-20	FH-22	FH-25	FH-27
600/5=120/1	FH-16	FH-18	FH-20	FH-23	FH-25
STANDARD FUSE AND THERMAL BREAKER SZ					
15	50	125	350	1000	5000
20	60	150	400	1200	6000
25	70	175	450	1600	
30	80	200	500	2000	
35	90	225	600	2500	
40	100	250	700	3000	
45	110	300	800	4000	

LOCATION		
VOLTS		
HORSEPOWER		
MOTOR FLC		
FLC X 125%		
CABLE SIZE		
CABLE AMPACITY		
FLC X 250 %		
FLC X 400 %		
THERM. BKR OR FUSE SZ		
FLC X 700 %		
FLC X 1300 %		
BKR TRIP RANGE		
TRIP RANGE SETTING		
CT RATIO		
HEATER SIZE		
HEATER AMPS		
STARTER SIZE		

LOCATION		
VOLTS		
HORSEPOWER		
MOTOR FLC		
FLC X 125%		
CABLE SIZE		
CABLE AMPACITY		
FLC X 250 %		
FLC X 400 %		
THERM. BKR OR FUSE SZ		
FLC X 700 %		
FLC X 1300 %		
BKR TRIP RANGE		
TRIP RANGE SETTING		
CT RATIO		
HEATER SIZE		
HEATER AMPS		
STARTER SIZE		

LOCATION		
VOLTS		
HORSEPOWER		
MOTOR FLC		
FLC X 125%		
CABLE SIZE		
CABLE AMPACITY		
FLC X 250 %		
FLC X 400 %		
THERM BKR OR FUSE SZ		
FLC X 700 %		
FLC X 1300 %		
BKR TRIP RANGE		
TRIP RANGE SETTING		
CT RATIO		
HEATER SIZE		
HEATER AMPS		
STARTER SIZE		

LOCATION		
VOLTS		
HORSEPOWER		
MOTOR FLC		
FLC X 125%		
CABLE SIZE		
CABLE AMPACITY		
FLC X 250 %		
FLC X 400 %		
THERM BKR OR FUSE SZ		
FLC X 700 %		
FLC X 1300 %		
BKR TRIP RANGE		
TRIP RANGE SETTING		
CT RATIO		
HEATER SIZE		
HEATER AMPS		
STARTER SIZE		

LOCATION			
VOLTS			
MOTOR FLC			
MOTOR FLC X 125%			
FLC + (FLC X 125%)			
FEEDER SIZE			
FEEDER AMPACITY			
TRIP RANGE			
TRIP RANGE SETTING			
FUSE OR TH BKR SZ			
HORSEPOWER			
MOTOR FLC			
MOTOR FLC X 125%			
BR CIR CABLE SZ			
BR CIR CABLE AMP.			
FLC X 250%			
FLC X 400%			
FLC X 700%			
FLC X 1300%			
CT RATIO			
HEATER SIZE			
HEATER AMPS			
STARTER SIZE			

LOCATION			
VOLTS			
MOTOR FLC			
MOTOR FLC X 125%			
FLC + (FLC X 125%)			
FEEDER SIZE			
FEEDER AMPACITY			
TRIP RANGE			
TRIP RANGE SETTING			
FUSE OR TH BKR SZ			
HORSEPOWER			
MOTOR FLC			
MOTOR FLC X 125%			
BR CIR CABLE SZ			
BR CIR CABLE AMP.			
FLC X 250%			
FLC X 400%			
FLC X 700%			
FLC X 1300%			
CT RATIO			
HEATER SIZE			
HEATER AMPS			
STARTER SIZE			

LOCATION			
VOLTS			
MOTOR FLC			
MOTOR FLC X 125%			
FLC + (FLC X 125%)			
FEEDER SIZE			
FEEDER AMPACITY			
TRIP RANGE			
TRIP RANGE SETTING			
FUSE OR TH BKR SZ			
HORSEPOWER			
MOTOR FLC			
MOTOR FLC X 125%			
BR CIR CABLE SZ			
BR CIR CABLE AMP.			
FLC X 250%			
FLC X 400%			
FLC X 700%			
FLC X 1300%			
CT RATIO			
HEATER SIZE			
HEATER AMPS			
STARTER SIZE			

LOCATION			
VOLTS			
MOTOR FLC			
MOTOR FLC X 125%			
FLC + (FLC X 125%)			
FEEDER SIZE			
FEEDER AMPACITY			
TRIP RANGE			
TRIP RANGE SETTING			
FUSE OR TH BKR SZ			
HORSEPOWER			
MOTOR FLC			
MOTOR FLC X 125%			
BR CIR CABLE SZ			
BR CIR CABLE AMP.			
FLC X 250%			
FLC X 400%			
FLC X 700%			
FLC X 1300%			
CT RATIO			
HEATER SIZE			
HEATER AMPS			
STARTER SIZE			

WEST VIRGINIA MINE ELECTRICIANS CERTIFICATION PROGRAM

BIBLIOGRAPHY

RECOMMENTDED STUDY MATERIALS FOR THE WEST VIRGINIA MINE ELECTRICIAN CERTIFICATION EXAMINATION

These books are basic reference for Mine Electricians and were and were the source for the questions on the West Virginia Mine Electrician Certification Examination. The first three books (30 CFR, WV code, and N.E.C.) are the legal references and you should use the latest editions at work or when studying for the exam.

Code of Federal Regulations, Title 30 - Mineral resources (U.S. Government). Washington, D.C.: U.S. Government Printing Office. (For sale by the Superintendent of Documents, U.S. Government Printing Office) -- Key sections in Chapter 1 - Mine Health & Safety Administration, U.S. Department of Labor include: Subchapter D - Part 18 - Electrical motor driven mine equipment and accessories; Subchapter 0 - Part 75 - Mandatory safety standards - underground coal mines, especially subparts F, G, H, I, J, and K; and part 77 - Mandatory safety standards - surface coal mines and surface work areas of underground coal mines, especially subparts F, G, H, I, J, and S.

State of West Virginia - Mining Laws for the Underground. Charleston. Available from the West Virginia Office of Miners' Health, Safety and Training -- Key parts of Chapter 22 - Coal mine Safety Laws Underground - include: Sections 22-1-1 Definitions; 22-2-3 Fans; 22-2-6 Movement of Equipment; 22-2-36 Hoisting; 22-2-37 & 38 Transportation; 22-2-40 through 22-2-47 Electricity; 22-2-51 Housekeeping; 22-2-55 Protective equipment and clothing; 22-2-58 Fire protection; 22-2-59 First aid equipment; and 22-2-62 Thermal coal dryers and plants. (See also Underground Mining Laws of West Virginia - WVU Mining Extension service Study Guide No.1

National Electrical Code - 1983. Boston: National Fire Protection Association, 1983. (For sale by the National Fire Protection Association) -- The N.E.C. covers certification requirements with respect to surface mines and surface areas of underground mines. It consists of mine chapters, all containing some information important to mine electricians. Since one part of the WV Mine Electrician Exam is on the N.E.C., reviewing Chapter nine is an excellent way to prepare for this section of the exam.

West Virginia Mine Electricians Study Guide/Reference Book by Joseph Dorton and Ralph Cole. Morgantown: West Virginia University Mining Extension services, 1981. Gerry E. Barton, Randy Smith, Bennie Comer, John Scott and Shelia Propst: West Virginia Office of Miners' Health, Safety & Training. (Available from the West Virginia Office of Miners' Health, Safety and Training, and the WVU Bookstore) --

Electrical Hazards (NMHSA-CE-005). Beckley, WV: National Mine Health and Safety Academy, 1976. (Singles copies available free from the Department of Continuing Education, National Mine Health and Safety Academy, or the MSHA Training Center in Beckley -- Pocket-sized booklet covering basic electricity, electrical accidents, and the effects of electricity on the body. It describes electrical systems in surface and underground mines, including protection electrical circuits and lockout procedures.

Federal Mine Electrical Certification - Surface and Underground (National School of Mines). Forest Grove, OR: M/A Press, 1979. -- A comprehensive test on surface and underground mine electricity designed to prepare you for the Federal (MSHA) Mine Electrician Certification Examination. Covers most of the topics on the WV exam.

First Aid (NMHSA-CE-006. Beckley, WV: National Mine Health and Safety Academy, 1977. (Single copies available free of charge from the Department of Continuing Education, National Mine Health & Safety Academy) -- This programmed workbook covers the basics of mine gases, including gas detection, detection devices, dangerous areas, and gas accumulation.

Mine Gases (Safety manual No. 2) by Michael G. Zabetakas. Washington, D.C.: U.S. Government Printing Office, 1976. (Single copies available free from the National Mine Health & Safety Academy or the MSHA Training Center in Beckley) -- Pocket-sized booklet covering the basics of mine gases, including their sources and properties, and how they are identified, detected and controlled.

Permissibility - Electric Face Equipment (Safety manual No. 16) by Mac A. Carnes. Washington, D.C.: U.S. Government Printing Office, 1978. (Single copies available free from the National Mine Health & Safety Academy or the MSHA Training Center in Beckley) -- A pocket-sized booklet listing definitions, mandatory requirements as published in 30 CFR Part 18 (Schedule 2G) and Part 75. This booklet contains much of the information for the permissibility portion of the exam.

Underground Mining Laws of West Virginia (Study guide No. 1). Morgantown, West Virginia University Mining Extension Service, 1978. (For sale through the WVU Bookstore) -- Contains Chapter 11 of the Code of West Virginia. Each line is numbered for easy location and it features key reference words and phrases in the right margin. It includes space for notes and an alphabetized index. (See also State of West Virginia Mining Laws for the Underground).

The following are reference materials that you may find useful either in preparing for the exam or in your work.

Alternating Current for Mining Machinery (Joy). Franklin, PA: Joy Manufacturing. -- Developed as a training aid for AC equipment, this manual covers the phasing of AC circuits and shows the practical applications of AC circuits to mining machinery.

Common Sense Electrical Safety. Electrical Hazards/Reference Text, Morgantown: WV Mining Extension Service. January 1984. It handles electricity and electrical hazards in common sense way in mines.

Direct Current for Mining Machinery (Joy). Franklin, PA: Joy Manufacturing. -- Developed as a maintenance training aid for DC equipment and as a reference guide for those preparing to take State or Federal certification exams.

Electrical Applications Guidebook by John E. Traister, 1979. A non-mining book which presents a handy reference containing the rules, equations, wiring tables, electrical diagrams and installation procedures that are most often needed by electricians, foremen, superintendents, designers and so on.

Electrical Engineering Pocket Handbook (Electrical Apparatus Service Association). St. Louis: Electrical Apparatus Service Association. -- Pocket-sized manual contains engineering reference information (tables, formulas, charts, etc.)

Electrical Qualification Supplement (series). A self-instructional training course comprised of twelve underground modules. Each module consists of a set of slides, an audiotape, and w workbook. The series reviews many of the topics covered on the WV Electrician Certification Exam.

Electricity One - Seven, edited by Harry Mileaf, 1978. A non-mining textbook covering basic electricity.

Electric Motor Control by Walter N. Alerich, 1975. A non-mining textbook covering electrical motors control.

Electric Motor Control Fundamentals by McIntyre, R. L., 1974. A non-mining textbook presenting the technical subject of electric motor controls and their application in language as non-technical as possible.

First Aid for Coal Miners (Study Guide No. 10) Morgantown: WVU Mining Extension Service (for sale through the WVU Bookstore). Part of the mine foreman study guide series, this booklet contains a series of questions and answers on mine first aid, including anatomy, respiration, control bleeding, physical shock, wounds and burns, dislocation and fractures, and transportation of the injured. Review many of the topics covered on WV Mine Electrician Certification Exam.

National Electric Safety Code (American National Standards Institute). New York: Institute of Electrical and Electronic Engineers, Inc., 1977. -- Covers basic procedures for protecting individuals from electrical hazards that arise when installing, operating, or maintaining major electrical equipment and supply lines.

Materials available through the National Mine Health and Safety Academy, Beckley, West Virginia.

The following reference materials were identified through a computer search of the Educational Materials Search System (EMSS), to identify education and training aids for mine electricians work. EMSS is a joint project of the Mine Safety and Health Administration, the National Mine Health and Safety Academy, the Bureau of Mines, the West Virginia Office of Miners' Health, Safety and Training, and West Virginia University. For more information on EMSS or these titles, contact the EMSS Office of the Academy or West Virginia University.

A shocking Story, National Safety Council Coal Preparation (Surface: Inexperienced; MSHA 0241), Mine Safety and Health Administration, 1980.

Contact, Electrical Utilities Safety Association Crane Contacts with Overhead Power, National Safety Council Down to Earth, BNA Communications, Inc., 1961.

Electrical Lockout Procedures, Mine Safety and Health Administration, 1976.

Electrical Qualifications Supplement (Surface), The Workshop, Inc., 1983.

Electrical Qualifications Supplement (Underground), The Workshop, Inc., 1983.