

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 1: Fundamentals of Electricity

1. Terms and definitions
2. Electricity
3. Sources of electricity and their characteristics
4. The electron theory
5. The importance of electrical charges
6. How current is caused to flow in a circuit
7. Insulators, semiconductors, and conductors
8. Direct current
9. Alternating current
10. Electrical loads
11. Basic electrical circuits
12. Basic electrical symbols
13. The three types of circuits
14. Circuit grounding
15. Electrical measurements
16. Expressing large numbers
17. Terms and abbreviations used in rules governing electricity
18. The three equations for using Ohm's Law
19. Using Ohm's Law to find unknown values
20. Using Ohm's Law to determine values in a series circuit
21. Using Ohm's Law to determine values in a parallel circuit
22. Using Ohm's Law to determine values in series-parallel circuits
23. Applications of electronics in HVACR control systems
24. Investigate the differences between electrical and electronic
25. Convert electrical measurements to basic units
26. Use Ohm's Law to determine unknown values in resistive circuits

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Unit 2: Tools, Materials, and Test Instruments

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| 1. Terms and definitions | 18. Locate information about test instruments used in HVACR work |
| 2. Tools | 19. Read a voltmeter |
| 3. Electrical wiring | 20. Read an ohmmeter |
| 4. Connecting electrical wires | 21. Read an ammeter |
| 5. Guidelines for splicing wires | 22. Identify start, run and common terminals and draw the windings of a split-phase motor |
| 6. Connecting wires to terminals | 23. Solder terminals onto wires |
| 7. Test instrument characteristics | 24. Splice wires using wire nuts |
| 8. Reading test instruments | 25. Use digital and analog voltmeters to check power sources |
| 9. Using voltmeters and voltage testers | 26. Use digital and analog ohmmeters to check continuity of fuses |
| 10. Using ohmmeters | 27. Use digital and analog ohmmeters to determine resistance of resistors |
| 11. Using an ohmmeter to check motors | 28. Use digital and analog ohmmeters to identify terminals and electrical condition of a hermetic compressor |
| 12. Checking a hermetic compressor motor with an ohmmeter | 29. Use digital and analog ammeters to read start and run amperage of a motor |
| 13. Using ammeters | |
| 14. Using test accessories | |
| 15. Effects of current on the human body | |
| 16. How to avoid electrical accidents | |
| 17. Rescue procedure for electrical accidents | |

Unit 3: Electrical Power

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| 1. Terms and definitions | 12. Locate information about the power supply to your residence |
| 2. Characteristics of electrical power | 13. Use Watt's Law to determine power |
| 3. Transformers | 14. Read an electric watt-hour meter |
| 4. Power distribution | 15. Use wattmeters and ammeters to determine watts |
| 5. Types of power supplies | |
| 6. Delivery systems | |
| 7. Problems with power delivery | |
| 8. Power consumption | |
| 9. Watt's Law | |
| 10. Measuring power consumption | |
| 11. Reading a watt-hour meter | |

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Unit 4: Circuits, Symbols, and Diagrams

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| 1. Terms and definitions | 12. Locate wiring diagrams on equipment at your residence |
| 2. Electrical and electronic circuits | |
| 3. Integrated circuits | 13. Draw pictorials, fabricate working models, and draw ladder schematics for basic series and parallel circuits |
| 4. The language of electricity | |
| 5. Sources and applications of wiring diagrams | 14. Draw pictorials, fabricate working models, and draw ladder schematics for series-parallel circuits |
| 6. Pictorial wiring diagrams | |
| 7. Schematic wiring diagrams | 15. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with varied loads and switching |
| 8. Electronic wiring diagrams | |
| 9. Draw a pictorial diagram | |
| 10. Building a ladder schematic diagram | |
| 11. Using symbols | |

Unit 5: Controls and Protection Devices

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| 1. Terms and definitions | 16. Draw pictorials, fabricate working models, and draw ladder schematics for shunt circuits with one SPST switch |
| 2. Controls and their applications | |
| 3. Types of controls | 17. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with 3-way switches |
| 4. Control systems | |
| 5. Switch configurations and symbols | 18. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with 3-way and 4-way switches |
| 6. Identifying switch symbols | |
| 7. Three and four way switches and their applications | 19. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with safety switches |
| 8. Applications of shunt circuits | |
| 9. Electronic switching | 20. Draw a pictorial, fabricate a working model, and draw a ladder schematic of a basic small refrigeration circuit |
| 10. Protection devices | |
| 11. Overcurrent protection devices | |
| 12. Pressure-actuated protection devices | |
| 13. Motor protection devices | |
| 14. Bimetal protection devices | |
| 15. Protecting electronic circuits | |

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Unit 6: Transformers and Relays

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| 1. Terms and definitions | 16. Identify selected relays |
| 2. How a transformer works | 17. Check current relays with an ohmmeter |
| 3. Control transformer specifications | 18. Check potential relays with an ohmmeter |
| 4. Providing DC power | 19. Check current relays with an ammeter and a voltmeter |
| 5. Relay components and uses | 20. Check a potential relay with an ammeter and a voltmeter |
| 6. Using relay symbols in electrical drawings | 21. Install a solid-state, time-delay relay |
| 7. Control relays and contactors | 22. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with basic relays |
| 8. Control relay and contactor switching arrangements | 23. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with dual relays |
| 9. Types of motor starting relays and their uses | 24. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with special applications |
| 10. Motor starting current relay operations | 25. Draw pictorials, fabricate working models, and draw ladder schematics for circuits with multiple relays |
| 11. Motor starting current relay specifications | |
| 12. Motor starting voltage relay operations | |
| 13. Potential relay specifications | |
| 14. Time delay relays | |
| 15. Electronic controls for timed functions | |

Unit 7: Thermostats

1. Terms and definitions
2. Thermostat types and their applications
3. Temperature sensors
4. Electrical contacts
5. Major components of a heating/cooling thermostat
6. Heating thermostat anticipation
7. Cooling thermostat anticipation
8. Installing heating/cooling thermostats
9. Multistage thermostats
10. Subbase applications

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Unit 7: Thermostats (continued)

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| 11. Basic internal thermostat switching | 16. Install a wall thermostat and determine heat anticipation |
| 12. Programmable thermostat applications | 17. Replace a standard thermostat with an electronic programmable thermostat |
| 13. Electronic thermostat characteristics | 18. Program a programmable thermostat |
| 14. Additional benefits of solid-state thermostats | |
| 15. Special applications of line voltage thermostats | |

Unit 8: Introduction to Electric Motors

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| 1. Terms and definitions | 15. Use manufacturers' catalogues to locate motors and their applications |
| 2. Electric motor applications | 16. Use a pulley selection chart and pulley selection formula |
| 3. Types of electric motors and their applications | 17. Solve electric motor problems |
| 4. Basic DC motor operation | 18. Replace a missing V-belt, adjust tension, and check motor operation. |
| 5. Basic AC motor operation | |
| 6. Single-phase AC motor starting | |
| 7. Basic AC electric motor parts and their functions | |
| 8. Types of motor construction | |
| 9. Types of motor mounts and typical applications | |
| 10. Motor data plates | |
| 11. Pulleys and belts | |
| 12. Pulley selection | |
| 13. Sizing and selecting V-belts | |
| 14. Troubleshooting electric motors | |

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Unit 9: Shaded-Pole Motors

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| 1. Terms and definitions | 8. Wire shaded-pole motors to AC voltage |
| 2. Characteristics and applications of shaded-pole motors | 9. Disassemble, inspect, clean, reassemble and check operation of a shaded-pole motor |
| 3. Shaded-pole motor construction | |
| 4. Controlling shaded-pole motor speed | |
| 5. Shaded-pole motor rotation | |
| 6. Troubleshooting shaded-pole motors | |
| 7. Using power factor for watt/amp amp/watt conversions | |

Unit 10: Split-Phase Motors

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| 1. Terms and definitions | 7. Wire a single-voltage, split-phase motor to an AC power source |
| 2. Characteristics and applications of split-phase motors | 8. Wire a dual-voltage, split-phase motor for 120 VAC |
| 3. Split-phase motor construction | 9. Wire a dual-voltage, split-phase motor for 208/240 VAC |
| 4. Split-phase motor starting mechanisms | 10. Disassemble, inspect, clean, reassemble, and check operation of a split-phase motor |
| 5. Wiring connections for split-phase motors | |
| 6. Troubleshooting split-phase motors | |

Unit 11: Capacitors

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| 1. Terms and definitions | 8. Calculate ratings of grouped capacitors |
| 2. Capacitors in HVACR circuit applications | 9. Check capacitors with an analog ohmmeter |
| 3. Effects of inductive loads on current/voltage relationships | 10. Check capacitors with a capacitor analyzer |
| 4. Capacitor construction and operation | |
| 5. Types of capacitors | |
| 6. Guidelines for capacitor replacement | |
| 7. Grouping capacitors | |

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Unit 12: Capacitor Motors

1. Terms and definitions
2. Applications of capacitors to motors
3. CS motor characteristics and applications
4. PSC motor characteristics and applications
5. CSR motor characteristics and applications
6. Troubleshooting capacitor motors
7. Troubleshooting capacitor motor start components
8. Draw connecting wiring for a CS motor with a start capacitor and a current relay
9. Draw connecting wiring for a PSC motor
10. Draw connecting wiring for a CSR motor
11. Wire a CS compressor with a current relay
12. Wire a PSC motor
13. Wire a CSR compressor motor
14. Disassemble, inspect, clean, reassemble, and check operation of a PSC fan motor
15. Use a hermetic analyzer to start, reverse, and check operation of a PSC compressor motor
16. Install a hard start kit
17. Troubleshoot a CSR compressor with an ammeter

Unit 13: Electronically Commutated Motors

1. Terms and definitions
2. Characteristics and applications of Electronically Commutated Motors (ECM)
3. ECM motor construction and programming
4. Controlling airflow with an ECM motor
5. Benefits and limits of ECM motors
6. Power connections for a typical ECM
7. Modes of communication
8. ECM motors and Electromagnetic Interference (EMI)
9. Installation guidelines to minimize ECM motor generated EMI
10. Service basics for all ECM motors
11. Compare the applications and uses of PSC motors with ECM motors

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Unit 14: Three-Phase Motors

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| <ol style="list-style-type: none">1. Terms and definitions2. Characteristics and applications of three-phase motors3. Three-phase motor construction4. Wiring connections for three-phase motors5. Troubleshooting three-phase motors | <ol style="list-style-type: none">6. Draw connecting wiring for wye wound and delta wound dual-voltage motors7. Wire a dual-voltage, three-phase motor, reverse rotation, and check operation |
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Unit 15: Troubleshooting HVACR System Electrical Circuits

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| <ol style="list-style-type: none">1. Terms and definitions2. Guidelines for troubleshooting HVACR system electrical circuits3. Identifying circuit components and their operations4. Guidelines for test meter selection5. Using a voltmeter6. Applying the hopscotch method for troubleshooting7. Using an ammeter8. Using an ohmmeter9. Check for shorts and grounds10. Using jumpers to troubleshoot11. Troubleshooting techniques | <ol style="list-style-type: none">12. Identify components on HVACR system electrical diagrams13. Identify component operations from HVACR system electrical diagrams14. Select test instruments or procedures for specific HVACR system troubleshooting15. Solve HVACR electrical troubleshooting problems16. Troubleshoot series electrical circuits on selected HVACR equipment17. Troubleshoot parallel electrical circuits on selected HVACR equipment18. Troubleshoot series-parallel electrical circuits on selected HVACR equipment |
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Unit 16: HVACR System Wiring Diagrams

1. Terms and definitions
2. Guidelines for drawing system diagrams
3. HVACR components and their schematic symbols
4. HVACR system switches and their schematic symbols
5. Solid-state components and their schematic symbols
6. Procedure for drawing typical HVACR system wiring diagrams
7. Draw wiring diagrams for a small refrigeration unit with a coil-type current relay
8. Draw wiring diagrams for a small refrigeration unit with a solid-state start relay
9. Draw wiring diagrams for a window air conditioner
10. Draw wiring diagrams for a standard upflow gas furnace
11. Draw wiring diagrams for a standard downflow gas furnace
12. Draw wiring diagrams for a multi-position gas furnace with an integrated control board
13. Draw wiring diagrams for a condensing unit
14. Draw wiring diagrams for an electric furnace
15. Draw wiring diagrams for a condensing unit and an air handler
16. Draw a ladder schematic for a small refrigeration unit
17. Observe a small refrigeration unit and draw a ladder schematic of its electrical circuits
18. Observe a window air conditioner and draw a ladder schematic of its electrical circuits
19. Observe a heating/cooling system with 24V controls and draw a ladder schematic of its electrical circuits
20. Observe a heat pump system and draw a ladder schematic of its electrical circuits