

Fundamentals of Air Conditioning and Refrigeration

Instructional/Task Analysis

**Related Information: What
the Student Should Know**

**Application: What the
Student Should Be Able to Do**

Unit 1: Orientation

- | | |
|--|--|
| 1. Terms and definitions | 12. Find facts on local area companies in the HVACR industry |
| 2. Brief history of heating, ventilation, air conditioning and refrigeration (HVACR) | 13. Find facts on skill and education levels required in HVACR |
| 3. HVACR industry areas | |
| 4. HVACR business levels | |
| 5. ACR manufacturing jobs and their training requirements | |
| 6. ACR wholesaling jobs and their training requirements | |
| 7. HVACR retailing jobs and their training requirements | |
| 8. HVACR building maintenance jobs and their training requirements | |
| 9. Licensing and certification requirements for ACR employment | |
| 10. Working conditions for HVACR employment | |
| 11. Future opportunities for HVACR employment | |

Unit 2: Occupational Safety and First Aid

1. Terms and definitions
2. Dress safely on the job
3. General job and shop safety rules
4. Guidelines for general electrical safety
5. Safety guidelines for using electrical tools
6. Facts about OSHA's role in workplace health and safety

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 2: Occupational Safety and First Aid (continued)

7. Terms associated with fall protection system
8. Fall protection systems (OSHA Standard 29 CFR-1925.502)
9. Terms associated with confined space entry
10. Employer/employee responsibilities concerning confined space entry
11. Respirator requirements
12. What you should know about OSHA's Hazard Communication Standard
13. Storage of hazardous materials
14. How to protect yourself from hazardous substances in the workplace
15. What you should know about OSHA's Bloodborne Pathogen Standard
16. Other items related to the Bloodborne Pathogen Standard
17. Colors of the safety color code and their uses
18. Color coding of safety tags or signs
19. Components of the fire triangle
20. Types of fires and their classifications
21. General types of fire extinguishers and their uses
22. Contributing factors and causes of back injuries
23. Guidelines for lifting and moving items safely
24. Guidelines for preventing slips, trips, and falls
25. Rules for using ladders safely

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 2: Occupational Safety and First Aid (continued)

- | | |
|---|---|
| 26. Safety guidelines for using scaffolds | 29. Complete the student safety pledge form |
| 27. Safety guidelines for using power lifts | 30. Interpret a Material Safety Data Sheet |
| 28. General guidelines for handling an accident | 31. State portable fire extinguisher types, symbols, and operating instructions |
| | 32. Identify and correct safety violations |
| | 33. Operate a fire extinguisher |
| | 34. Lift a heavy object properly |
| | 35. Place and climb a ladder safely |

Unit 3: Hand Tools

- | | |
|--|--|
| 1. Terms and definitions | 14. Identify selected hand tools and describe their uses |
| 2. Types of screwdrivers and their uses | |
| 3. Types of wrenches and their uses | |
| 4. Types of pliers and their uses | |
| 5. Types of hammers and their uses | |
| 6. Punches, chisels, bars, and their uses | |
| 7. Types of files and their uses | |
| 8. Socket sets and their uses | |
| 9. Tubing tools and their uses | |
| 10. Threading tools and their uses | |
| 11. Other hand tools and their uses | |
| 12. Guidelines for using basic hand tools safely | |
| 13. Guidelines for using other hand tools safely | |

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 4: Special Tools

- | | |
|--|--|
| 1. Guidelines for working with drills and power screwdrivers | 9. Grind the head of a chisel or punch |
| 2. Caring for drilling tools | 10. Sharpen a chisel or screwdriver |
| 3. Use and care of grinders, vises, and presses | 11. Lay out, then cut centered circles from metal square |
| 4. Use and care of pullers | |
| 5. Use and care of thermometers | |
| 6. Use and care of hygrometers | |
| 7. Use and care of sheet metal tools in HVACR work | |
| 8. Use of computers in HVACR work | |

Unit 5: HVACR Related Math and Methods of Measuring

1. Terms and definitions
2. Interpretations of symbols used in math problems
3. Place values of whole numbers
4. U.S. conventional units of linear measurement
5. SI Metric units of measurement and associated prefixes
6. Adding whole numbers
7. Subtracting whole numbers
8. Multiplying whole numbers
9. Dividing whole numbers
10. Uses for fractions
11. Distinguishing among types of fractions
12. Reducing fractions to lowest terms
13. Converting mixed numbers and improper fractions
14. Adding fractions

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 5: HVACR Related Math and Methods of Measuring (continued)

- | | |
|---|---|
| 15. Subtracting fractions | 36. Add whole numbers |
| 16. Multiplying fractions | 37. Subtract whole numbers |
| 17. Dividing fractions | 38. Multiply whole numbers |
| 18. Uses for decimals | 39. Divide whole numbers |
| 19. Place values of decimal numbers | 40. Reduce fractions to lowest terms |
| 20. Adding decimal numbers | 41. Convert fractions and mixed numbers |
| 21. Subtracting decimal numbers | 42. Add fractions |
| 22. Multiplying decimal numbers | 43. Subtract fractions |
| 23. Dividing decimal numbers | 44. Multiply fractions |
| 24. Advantages of a decimal equivalent chart | 45. Add decimal numbers |
| 25. Methods of expressing fractions and decimal equivalents | 46. Subtract decimal numbers |
| 26. Rounding numbers | 47. Multiply decimal numbers |
| 27. Degree of accuracy | 48. Divide decimal numbers |
| 28. Percent and its uses | 49. Use the decimal equivalent chart |
| 29. Converting fractions | 50. Convert fractions and percentages |
| 30. Solving percentage problems | 51. Solve percentage problems |
| 31. Terms used in geometry | 52. Calculate area of geometric figures |
| 32. Terms of geometric figures | 53. Use the English-Metric Conversion Chart |
| 33. Calculating perimeter of geometric figures | |
| 34. Calculating area of geometric figures | |
| 35. English-metric conversion charts and how to use them | |

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 6: Measuring

1. Terms and definitions
2. Guidelines for linear measuring (in straight lines)
3. Metrics in the American workplace
4. Interpolating quantities
5. Measuring and converting pressure readings
6. Measuring and converting vacuum readings
7. Measuring and converting temperature readings
8. Measuring and converting weight readings
9. Measuring Btu and Btuh
10. How to read rules and tape measures
11. The architect's scale ruler and its uses
12. Scale ratios found on an architect's scale ruler
13. Steps in using an architect's scale ruler
14. Read the architect's scale at full ratio scale $12'' = 1'-0''$
15. Read the architect's scale at the scale ratio $6'' = 1'-0''$
16. Read the architect's scale at the scale ratio $3'' = 1'-0''$
17. Read the architect's scale at the scale ratio $1\frac{1}{2}'' = 1'-0''$
18. Read the architect's scale at the scale ratio $\frac{1}{4}'' = 1'-0''$
19. Measure lines to the nearest quarter, eighth, and sixteenth of an inch
20. Read a rule
21. Measure selected items with slide calipers
22. Read the architect's scale at full ratio scale $12'' = 1'-0''$
23. Read the architect's scale at the scale ratio $6'' = 1'-0''$
24. Read the architect's scale at the scale ratio $3'' = 1'-0''$
25. Read the architect's scale at the scale ratio $1\frac{1}{2}'' = 1'-0''$
26. Measure lines accurately with various scale ratios on an architect's scale ruler

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 7: Iron, Plastic, and PVC Pipe

- | | |
|---|--|
| 1. Terms and definitions | 15. Identify selected fittings for iron, plastic, and PVC pipe |
| 2. Black iron pipe in HVAC applications | |
| 3. Galvanized pipe in HVAC applications | 16. Cut and ream PVC pipe and join it to a fitting |
| 4. Polybutylene and polyethylene in HVAC applications | 17. Cut, ream, and thread iron pipe |
| 5. Guidelines for using iron pipe fittings | 18. Join flexible plastic pipe with a butt fusion process |
| 6. Guidelines for using PE dielectric unions in HVAC applications | |
| 7. Guidelines for using brass fittings | |
| 8. Guidelines for using flexible plastic fittings | |
| 9. Guidelines for using PVC fittings | |
| 10. Guidelines for working with polybutylene and polyethylene | |
| 11. Guidelines for measuring pipe | |
| 12. Tools for cutting and threading iron pipe | |
| 13. The pipe threading chart | |
| 14. Tools for working with PVC | |

Unit 8: Tubing and Tubing Applications

1. Terms and definitions
2. Kinds of tubing and their applications
3. Advantages of copper tubing in ACR applications
4. Characteristics of Type K copper tubing and its applications
5. Characteristics of Type L copper tubing and its applications
6. Characteristics of Type M copper tubing and its applications
7. Tubing fittings and their characteristics

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 8: Tubing and Tubing Applications (continued)

- | | |
|---|---|
| 8. Flare fittings | 17. Identify selected fittings for copper tubing |
| 9. Flare-to-pipe fittings or half unions | 18. Make a single flare with a compression-type flaring block |
| 10. Compression fittings | 19. Make a single flare with Rol-Air®-type flaring block |
| 11. Sweat fittings | 20. Make a swage joint in copper tubing |
| 12. Quick connect fittings and their applications | 21. Make a 90° bend in copper tubing |
| 13. Guidelines for cutting and reaming tubing | 22. Make a 180° bend in copper tubing |
| 14. Guidelines for flaring tubing | 23. Make a 45° offset bend in copper tubing |
| 15. Guidelines for swaging tubing | |
| 16. Guidelines for bending tubing | |

Unit 9: Soldering and Brazing Equipment

1. Terms and definitions
2. Soldering and brazing parameters
3. Characteristics and components of an air-acetylene torch
4. Modern torch tip design for soldering and brazing
5. Self-lighting torch designs for soldering and brazing
6. Types of fuel gas tanks and their applications
7. Guidelines for lighting, adjusting, and shutting down an air-fuel torch
8. Equipment required for oxyfuel gas torch work
9. Pressure regulating valves and adjusting screws
10. Oxyfuel hoses and their characteristics
11. Parts of an oxyfuel gas torch
12. Oxyfuel gas tips and their uses

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 9: Soldering and Brazing Equipment (continued)

- | | |
|--|--|
| 13. Filler material selection for oxyfuel gas brazing | 20. Light, adjust, and shut down an air-fuel or other gas torch |
| 14. Tip cleaning tools and their uses | 21. Light, adjust, and shut down an air-fuel or other gas torch with a swirl tip |
| 15. Guidelines for cleaning tips | 22. Startup, light, adjust, and shut down an oxyfuel gas torch |
| 16. Steps for setting up oxyfuel gas equipment | |
| 17. Steps for lighting, adjusting, and shutting down an oxyacetylene torch | |
| 18. Safety guidelines for flashback and backfire | |
| 19. Safety rules for oxyfuel gas cylinders and gases | |

Unit 10: Soldering

- | | |
|--|--|
| 1. Terms and definitions | 11. Use an air-fuel gas torch to soft solder copper tubing/swage joints in upright, horizontal, and inverted positions |
| 2. Soldering and brazing processes and their uses | |
| 3. General characteristics of solder | 12. Use an air-fuel gas torch with a swirl tip to solder copper tubing/swage joints in upright, horizontal, and inverted positions |
| 4. The importance of flux in the soldering process | |
| 5. Selecting and applying flux | 13. Use an oxyfuel gas torch to solder copper tubing/swage joints in upright, horizontal, and inverted positions |
| 6. Torch techniques for good soldering | |
| 7. Ways to control heat while soldering | |
| 8. Resistance soldering | |
| 9. Soldering problems and ways to detect them | |
| 10. Soldering safety | |

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 11: Silver Brazing

- | | |
|--|---|
| 1. Terms and definitions | 10. Silver braze upright, inverted, and horizontal swage joints |
| 2. Silver brazing materials and processes | 11. Silver braze a copper-to-steel joint |
| 3. Basic silver brazing alloys | 12. Assemble a copper tubing project |
| 4. Special silver brazing alloys and their characteristics | |
| 5. Prevention of a joint for brazing | |
| 6. Brazing fluxes and their applications | |
| 7. Torch techniques for good brazing | |
| 8. Controlling brazing oxides with nitrogen | |
| 9. Brazing safety | |

Unit 12: Aluminum Soldering, Brazing, and Epoxy Repair

- | | |
|---|--|
| 1. Materials and processes | 7. Soft solder an aluminum tubing/swage joint with an air-fuel torch |
| 2. Special considerations for aluminum repair | 8. Repair a hole in aluminum tubing with brazing and an air-fuel torch |
| 3. Aluminum repairs with epoxy paste | 9. Repair a hole in aluminum tubing with paste epoxy |
| 4. Aluminum repairs with pre-mixed epoxy sticks | 10. Repair a pin-hole leak in aluminum tubing with a pre-mixed, two-part epoxy stick |
| 5. Steps for using aluminum brazing rod | 11. Solder aluminum tubing to copper tubing |
| 6. Steps for using aluminum soft solder | |

Unit 13: Basic Mechanical Refrigeration

1. Terms and definitions
2. Major refrigeration components and their functions
3. How laws of thermodynamics and gases work in a refrigeration cycle
4. Compressor construction types and their applications
5. Reciprocating compressors and their applications

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 13: Basic Mechanical Refrigeration (continued)

- | | |
|--|---|
| 6. Rotary compressors and their applications | 13. Identify components of a basic mechanical refrigeration system and identify conditions in different parts of the system |
| 7. Scroll compressors and their applications | |
| 8. Other compressor types and their applications | 14. Select component functions in a basic refrigeration cycle |
| 9. Types of metering devices and their characteristics | 15. Boil water in a vacuum pump |
| 10. Types of condensers and their characteristics | 16. Observe refrigeration trainer or system and explain superheat and subcooling |
| 11. Types of evaporators and their characteristics | 17. Find and identify basic refrigeration components |
| 12. System design and sensory troubleshooting | 18. Perform sensory evaluation of air conditioning and refrigeration systems |

Unit 14: Refrigeration System Accessories

- | | |
|--|--|
| 1. Terms and definitions | 14. Identify components of a mechanical refrigeration system with accessories and identify conditions in different parts of the system |
| 2. Refrigeration system accessories and their locations | |
| 3. Suction line accumulators and their functions | 15. Select functions for refrigeration system accessories |
| 4. Liquid receivers and their functions | 16. Select operating positions for service valves |
| 5. Oil separators and their functions | |
| 6. Noise and vibration control with large compressors | 17. Find and identify refrigeration system accessories |
| 7. Filter-driers and their applications | |
| 8. Monitoring moisture and liquid refrigerant in a system | |
| 9. Service valves, their operating positions and functions | |
| 10. Service valves and their applications | |
| 11. Shut-off valves and their applications | |
| 12. Access valves and ports and their applications | |
| 13. Pressure controls and their applications | |

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 15: EPA Regulations for Refrigerant Management and Technician Certification

- | | |
|---|---|
| 1. Terms and definitions | 16. Answer Sample certification questions |
| 2. Important historical information about ozone | |
| 3. Ozone depletion and its causes | |
| 4. Human environmental concerns about ozone depletion | |
| 5. Types of global warming and how it is measured | |
| 6. Regulated refrigerants | |
| 7. Ozone depletion potential and what it means | |
| 8. The prohibition on venting | |
| 9. Permitted releases under the "no venting" regulation | |
| 10. Refrigerant leaks and repair requirements | |
| 11. Service requirements | |
| 12. Certification requirements | |
| 13. Certifications procedures | |
| 14. Contents and conduct of certification tests | |
| 15. Training for EPA certification | |

Unit 16: Refrigerants

1. Terms and definitions
2. Types of refrigerants, their composition and identification
3. Refrigerant identification colors and numbers
4. Problems and challenges for an industry in transition
5. The EPA SNAP program and its objectives

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 16: Refrigerants (continued)

- | | |
|--|---|
| 6. Original refrigerants, their applications and possible alternatives | 20. Compute temperature/pressure relationships |
| 7. "Drop-in" and "retrofit" refrigerants | 21. Attach a manifold gauge set to service ports |
| 8. Characteristics of blended refrigerants | 22. Pressure check a refrigeration system |
| 9. Bubble point and dew point and what they mean | 23. Pressure check an air conditioner |
| 10. Gauges, charts, and pressure/temperature relationships | 24. Pressure check a commercial refrigeration system |
| 11. Why pressure/temperature readings and relationships are important | 25. Determine type of refrigerant in a refrigeration or air conditioning system |
| 12. Charging a system with a blend | |
| 13. How to avoid potential problems with refrigerants | |
| 14. Characteristics and applications of ACR lubricants | |
| 15. Guidelines for adding or changing lubricant | |
| 16. Guidelines for working with synthetic oils | |
| 17. Desiccants, their characteristics and uses | |
| 18. The manifold gauges and its applications | |
| 19. How to calibrate gauges on a manifold gauge test | |

Unit 17: Refrigerant Recovery, Recycling and Reclaiming

1. Processing refrigerant
2. Basic recovery processes
3. Basic recovery devices
4. EPA required evacuation practices during recovery
5. Guidelines for effective recovery
6. Improperly mixed refrigerants and how to avoid them

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 17: Refrigerant Recovery, Recycling and Reclaiming (continued)

- | | |
|---|---|
| <ol style="list-style-type: none">7. Recovery system characteristics and applications8. How to make an in-line filter9. Recycling equipment and processes10. Recovery/recycling system characteristics and applications11. Recovery and recycling safety12. The reclaiming process13. Guidelines for using DOT 39 disposable refrigerant cylinders14. Guidelines for using refillable refrigerant cylinders15. Special considerations for disposing of small appliances | <ol style="list-style-type: none">16. Use scales and a calculator to determine how much refrigerant can be added to a refillable refrigerant cylinder17. Use hand-operated pump to recover refrigerant from a small AC or refrigeration system18. Use a recovery machine to recover refrigerant from an AC or refrigeration system19. Use a recovery/recycling machine to recover/recycle refrigerant from an AC or refrigeration system |
|---|---|

Unit 18: Evacuating, Pressurizing, Leak Testing, and Charging

1. Terms and definitions
2. Preparing a refrigeration system for operation
3. Removing refrigerant or other gases
4. Guidelines for assembling components
5. Guidelines for pressurizing a system
6. Leak testing with soap solution
7. Leak testing with a halide torch
8. Leak testing with refrigerant additives
9. Leak testing with electronic leak detectors
10. Why refrigeration systems require evacuation
11. Pressure/temperature requirements for dehydration
12. Use and care of vacuum pumps

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 18: Evacuating, Pressurizing, Leak Testing, and Charging (continued)

- | | |
|--|--|
| 13. Use and care of vacuum measuring equipment | 23. Complete Service Work Order 1 |
| 14. Using/reading a micron gauge | 24. Complete Service Work Order 2 |
| 15. Guidelines for evacuation | 25. Complete Service Work Order 3 |
| 16. Guidelines for charging a system | 26. Install a line tap access valve |
| 17. Charging with a portable charging cylinder | 27. Install a filter-drier on a capillary tube |
| 18. Charging with scales | 28. Pressurize a refrigeration system with refrigerant and dry nitrogen |
| 19. Using a sight glass for charging | 29. Leak check with a halide torch |
| 20. Charging with a superheat charging chart | 30. Evacuate a refrigeration system and verify with a micron vacuum gauge |
| 21. Special considerations for liquid and vapor charging | 31. Filling a charging cylinder |
| 22. Keeping charging records | 32. Vapor charge a refrigeration system from a charging cylinder |
| | 33. Install a thermostatic expansion valve with flare fittings |
| | 34. Install a liquid indicator with flare fittings |
| | 35. Install a filter-drier with flare fittings |
| | 36. Pressurize a refrigeration system with dry nitrogen and leak test |
| | 37. Triple evacuate a refrigeration system |
| | 38. Liquid charge a refrigeration system from a refrigerant cylinder |
| | 39. Check and adjust a thermostatic expansion valve using superheat parameters |
| | 40. Install a core-type access valve |
| | 41. Install a filter-drier with sweat fittings |
| | 42. Leak test a refrigeration system with an electronic leak detector |
| | 43. Liquid charge using a charging cylinder |
| | 44. Vapor charge a refrigeration system from a refrigerant cylinder |
| | 45. Use suction line temperature/pressure parameters to evaluate a system charge |