Lesson 1 - Trade Tools
Objectives:

- Explain the importance of using proper tools and test instruments.
- List the various types of wrenches and describe their use.
- Describe the proper procedures for bending, flaring, and swaging tubing.
- Describe the correct use of pinch-off tools.
- Describe the proper techniques for soldering and brazing.
- Identify various types of diagnostic tools and testing instruments.
- Identify various refrigerant charge tools and explain how they are used.
- Explain the reasons for using safety goggles.

Lesson 2 - Refrigeration System Accessories
Objectives:

- Describe the operation, selection, and application of the following accessories:
  - condensing water regulators
  - check valves
  - safety relief devices
  - discharge oil separators
  - liquid level indicators and moisture indicators
  - discharge mufflers
  - compressor lubrication protection controls
  - strainers and filters
  - vibration eliminators
  - suction-line accumulators
  - heat exchangers
  - receivers.

Lesson 3 - Desiccants and Driers
Objectives:

- State the purpose of a desiccant.
- Name and explain the ways in which a desiccant works.
- List three common desiccants used today.
- Describe the properties required of a desiccant.
- Define the terms *mixed desiccants* and *solid-core desiccants*.
- Identify the locations in which a drier can be installed, and explain the advantages and disadvantages of each.
- Describe the differences between a drier and suction-line filter.
- Explain what is meant by the term *hydrophobic behavior of desiccants*.
- State the principle on which all moisture indicators work.

Lesson 4 - Defrosting Methods
Objectives:

- Identify various defrosting methods.
- Describe the basic operation of each method.
- Explain the advantages and disadvantages of each method.

Lesson 5 - Refrigeration System Controls
Objectives:

- Identify typical operating and safety controls.
- Explain the difference between instrument differential and operating differential.
- Describe the operation of a float switch.
- Explain why pilot-operated TEVs are used on large systems.
- Describe the operation of a constant-pressure expansion valve.
- Explain the function of evaporator pressure regulators, suction pressure regulators, and condenser pressure regulators.
- Explain the need for both high-side and low-side float valves.
- Describe the operation of the various types of solenoid valves.
- Explain the function of a refrigerant reversing valve.

Lesson 6 - Refrigeration System Piping (Part 1)
Objectives:

- Determine the maximum pressure drop for commonly used refrigerant piping.
- Describe various methods of ensuring the successful operation of an evaporative condenser.
- Explain the necessity of maintaining a minimum velocity in refrigerant piping.
- Calculate the subcooling necessary to prevent flash gas caused by static head.
- Describe ways in which liquid-line piping can improve the service of equipment.
- Explain how TEVs should be installed when evaporators are interconnected.
- Explain how to install sight glasses in liquid lines.

Lesson 7 - Refrigeration System Piping (Part 2)
Objectives:

- Explain why pressure drop must be minimized in refrigeration piping.
- Lay out a basic piping plan.
- Determine the allowable pressure drop in refrigeration piping.
- Utilize common pipe sizing tables, charts, and graphs.

Lesson 8 - Retrofits and Disposal Requirements
Objectives:

- Explain conversion procedures and describe the components that need to be checked.
- Determine whether a component needs to be replaced or adjusted.
- Adjust controls to their proper settings.
- Explain why the filter-drier is so important.
- Determine when you should contact a component manufacturer for assistance.
- State what records need to be kept and for how long.
- Describe the recovery and disposal process.
- Explain the proper method for disposing of waste oils and refrigerant oil filters.
- Define a “small appliance.”

Lesson 9 - Compressor Replacement and System Evacuation
Objectives:

- Describe the proper procedures for diagnosing compressor problems.
- Distinguish between mechanical failures and compressor burnout.
- Describe the proper procedures for replacing compressors.
- List and observe the necessary safety precautions.

- Explain what “dehydrating the system” means.
- Identify and describe the various methods of evacuation.
- Describe how a high-vacuum pump can be used to evaluate a system adequately.
- Define a *micron*.
- List the instruments used in the field to indicate high-vacuum conditions.
- Explain why the size of the connecting line between the vacuum pump and the system is so important.

Lesson 10 - Motors
Objectives:

- List the basic types of motors used in the HVAC/R industry.
- Describe some of the visual indications that identify defective motors.
- Explain the difference between fractional-horsepower motors and integral-horsepower motors.
- Determine the speed and rotation of a motor.
- Use appropriate test instruments to troubleshoot various types of motors and their associated starting circuits.
- Describe some of the causes of overheating in electric motors.
- Explain what causes *single phasing* in a three-phase motor.
- Calculate voltage and current imbalances in three-phase motors.
- Describe basic motor replacement procedures.
- Read a motor nameplate.
- Use NEMA data to determine motor frame sizes and dimensions.

Lesson 11 - Electric Motors in Refrigeration Systems
Objectives:

- Explain the basic principles of operation of electric motors.
- Calculate motor speed and *slip*.
- Describe the characteristics of various types of single-phase ac motors including split-phase motors, capacitor-start motors, capacitor-start, capacitor-run motors, repulsion-induction motors, and shaded-pole motors.
- Explain the difference between single-phase and three-phase motors.
- List the three main types of three-phase squirrel-cage motors and describe the distinguishing characteristics of each.
- Identify the three main types of dc motors.
- Explain how current-type and voltage-type starting switches operate.

Lesson 12 - Capacitors
Objectives:

- Observe the proper safety precautions when taking capacitance readings.
- Explain the differences between start and run capacitors.
- Discharge a capacitor safely.
- Describe the four main problems or conditions that identify a faulty capacitor.
- Describe the operation of various types of instruments used for testing capacitors.

Lesson 13 - Motor Capacitors
Objectives:

- Identify the two types of capacitors used with electric motors.

- Explain the difference between electrolytic and oil-paper capacitors.
- Explain how capacitors are rated.
- Calculate the capacitance for capacitors connected in series or parallel.
- Describe the operation of starting relays.
- List the main causes of start capacitor failure.

Lesson 14 - Motor Protectors
Objectives:

- Explain the function of a motor protector.
- Describe how an overload relay operates.
- Explain the function of a circuit breaker.
- Describe how external and internal protectors operate.
- Explain how protectors are used with motors.

Lesson 15 - Low-Voltage Thermostats
Objectives:

- Describe the functions performed by low-voltage thermostats.
- Identify the various types of low-voltage thermostats.
- Define the terms *setpoint*, *make point*, *break point*, and *differential* as they apply to low-voltage thermostats.
- Explain how *anticipation* works.
- List the proper guidelines for installing and troubleshooting various types of low-voltage thermostats.

Lesson 16 - Relays, Contactors, and Starters
Objectives:

- List common causes of relay failure.
- Describe the physical indications that identify defective relays and contactors.
- Explain how to test pilot-duty relays and line-duty relays.
- Explain how to test contactors and starters.
- Explain how to test potential relays and current relays.
- Explain how to test time-delay relays.

Lesson 17 - Test Equipment (Part 1)
Objectives:

- Describe the basic operation of the d'Arsonval meter movement.
- Explain the difference between analog and digital measuring instruments.
- Distinguish between voltmeters, ammeters, ohmmeters, and multimeters, and describe the operational principles of each.
- Explain how the *sensitivity* of a voltmeter is calculated.
- Describe how various electrical meters are used to measure resistance, voltage, and current, and to check for continuity.
- Demonstrate how clamp-on ammeters are used.
- Describe the basic operation of a Wheatstone bridge, and explain how it can be configured to act as a resistance bridge or a capacitance bridge.

Lesson 18 - Test Equipment (Part 2)
Objectives:

- Explain the operation of a wattmeter.

- Demonstrate how to read a watt-hour meter.
- Describe how to determine the power factor of a circuit by using a power factor meter.
- Describe how a varmeter can be used in correcting power factor problems.
- Explain the purpose and use of various instrument transformers.
- Explain the operation of megohmmeter.
- Explain the purpose and use of various recording instruments.
- Describe how a compressor analyzer can be used in troubleshooting.

Lesson 19 - Troubleshooting (Part 1)
Objectives:

- Conduct a customer interview.
- Identify the instruments required for performing specific troubleshooting tasks.
- Follow step-by-step procedures in analyzing a problem.
- Describe the most common causes of system malfunctions.

Lesson 20 - Troubleshooting (Part 2)
Objectives:

- Explain the need for following safe procedures when troubleshooting electrical problems.
- Plan and carry out an orderly course of action for diagnosing and correcting electrical problems.
- Describe some of the most common electrical problems encountered in HVAC/R systems.

Lesson 21 - Troubleshooting (Part 3)
Objectives:

- Diagnose compressor malfunctions.
- Evaluate compressor performance by using external testing devices.
- Identify possible causes of compressor failure by performing an internal inspection, where possible.

Lesson 22 - Using Pressure-Enthalpy Diagrams (Part 1)
Objectives:

- List five properties of a refrigerant that must be understood in order to interpret a pressure-enthalpy diagram.
- Explain superheated gases and vapor pressure.
- Define the terms *enthalpy* and *entropy*.
- Determine evaporator pressure and condensing pressure using the pressure-enthalpy diagram.
- Calculate compression ratio, net refrigeration effect, and other values, using the pressure-enthalpy diagram.

Lesson 23 - Using Pressure-Enthalpy Diagrams (Part 2)
Objectives:

- Describe how to use pressure-enthalpy diagrams for estimating energy requirements.
- Explain compressor power.
- Describe the effects of lower condensing temperature, liquid subcooling, and suction vapor superheating.

Lesson 24 - Moisture in Air
Objectives:

- Describe the chemical makeup of dry air and explain what is meant by "wet" air.
- State Dalton's Law and Boyle's Law.
- Define the terms *density* and *specific volume*.
- Explain the difference between *relative humidity* and *absolute humidity*.
- Define the terms *dew point* and *specific humidity*.
- Explain the difference between *sensible heat* and *latent heat*.
- Explain the meaning of "dry-bulb" and "wet-bulb" temperatures.
- Use the appropriate tables to make calculations and solve practical problems relating to the condition and behavior of air.

Lesson 25 - Calculating Cooling Loads
Objectives:

- Define many of the key technical terms used in air conditioning.
- Explain the various factors that determine air conditioning cooling loads.
- Obtain information from a variety of tables and other reference sources and use such data to estimate air conditioning requirements.

Lesson 26 - Psychrometrics
Objectives:

- Define the following terms as they apply to the study of psychrometrics: *sensible heat*, *latent heat*,
- *barometric pressure*, *density*, *dew point*, *relative humidity*, *specific humidity*, *specific volume*, and *enthalpy*.
- Explain how to use psychrometric tables and charts to find various properties of air.

Lesson 27 - Heat Transfer (Part 1)
Objectives:

- Explain the basic principles of heat transfer.
- Name the three methods of heat transfer and give examples of each.
- Describe the factors that affect the rate at which heat is conducted.
- Define the four heat transfer values (the *K*-value, the *C*-value, the *R*-value, and the *U*-value), and explain how they are used.
- Explain the relationship between temperature and density.

Lesson 28 - Heat Transfer (Part 2)
Objectives:

- State the purpose of insulation, and explain the role that insulation plays in conserving energy in refrigeration and air conditioning applications.
- Describe some of the ways in which moisture can infiltrate insulation.
- Describe the effects that moisture has on insulation.
- Explain how partial pressure differences affect the placement of vapor barriers.
- Explain what causes "sweating."
- List some of the characteristics of a good insulation, and describe each.
- Explain how the amount of insulation required for a given application is determined.

Lesson 29 - Estimating the Heat Load (Part 1)
Objectives:

- List the four sources that contribute to the total heat load in any application.
- Explain how to calculate the heat leakage load.
- Use tables to determine the product load.
- Calculate the miscellaneous heat load produced by lights, motors, human occupants, etc., in a refrigerated space.

Lesson 30 - **Estimating the Heat Load (Part 2)**
Objectives:

- Explain the relationships among the various heat transfer factors.
- Explain how *surface film conductance* affects the transmission of heat.
- Interpret outdoor design data for various locations as provided in published tables.
- Describe the effect of the sun's rays on heat loads.
- Identify sources of air infiltration, and compute the rate of infiltration.
- Use published data to determine product loads.
- Define the *latent heat of fusion*.
- Identify supplementary loads and sources.
- Evaluate the selection of a compressor based on hourly load calculations.
- Calculate the total refrigeration load for a refrigerated space.

Lesson 31 - Room Air Conditioners
Objectives:

- Size a room air conditioner properly.
- Estimate cooling loads.
- Select a suitable room air conditioner based on the estimated cooling load.
- Make a thorough pre-installation survey to ensure the compatibility of the selected unit with the customer's electrical system.
- Choose the proper location for the installation of a room air conditioner.
- Diagnose a malfunctioning room air conditioner correctly.
- Test the refrigerant charge of a room air conditioner.

Lesson 32 - Types of Air Conditioning Systems
Objectives:

- Identify the major types of air conditioning systems.
- Explain how single-zone systems differ from multizone systems.
- Describe the basic operation of variable air volume (VAV) systems.
- Explain how induction systems work.
- Describe the various configurations of air-water systems.
- List five kinds of multiple-unit systems

Lesson 33 - Residential Air Conditioning
Objectives:

- Evaluate residential forced-air heating systems for compatibility with add-on cooling.
- Make the necessary calculations to determine whether the blower capacity is sufficient to handle both heating and cooling.
- Check temperature rise and duct static and use the proper graph to determine the flow rate of air through a duct system.

- Describe the factors that must be considered when planning the addition of an air conditioning evaporator coil to a forced-air furnace.
- Locate outdoor condensing units properly.

Lesson 34 - Humidification (Part 1)
Objectives:

- Use the proper terminology in discussing humidification.
- Identify the proper humidity levels for comfort and health.
- Measure humidity levels correctly with instruments.
- Size and select a humidifier.

Lesson 35 - Humidification (Part 2)
Objectives:

- Add moisture to air by various methods.
- Install a humidifier properly.
- Control the humidity level properly.

Lesson 36 - Review of Safety and Codes
Objectives:

- Adhere to personal safety practices and proper equipment safety practices.
- Comply with federal, state, and local safety codes and regulations.