Lesson 1 - Introduction to Refrigeration and Air Conditioning
Objectives:

- Define refrigeration.
- Identify the basic components of a refrigeration cycle.
- Identify the various gas laws and their importance to a basic knowledge of physics.
- State the date and place of the founding of RSES.
- List six modern-day applications serviced by the refrigeration and air conditioning industry.

Lesson 2 - Basic Physics
Objectives:

- Define the basic structure of matter.
- Describe the fundamental structure of an element, a molecule, and a compound.
- Define and give one example of sensible, latent, and specific heat.
- Explain the methods of measuring the intensity and quantity of heat.
- Identify the physical changes that occur when matter changes state from solid to liquid to gas.
- Calculate the amount of sensible and latent heat added to a solid, a liquid, and a gas.
- List three types of energy (in addition to heat energy) and give an example of each.
- State the latent heat of fusion for ice and the latent heat of vaporization for water.

Lesson 3 - Major Component Functions
Objectives:

- Define *heat* and *cold*.
- State the basic law of heat flow.
- Define the *British thermal unit* (Btu) and the calorie.
- List the three physical states of matter and define each.
- Name the two temperature scales in general use today.
- Using a simple refrigeration system, identify and explain the functions of the four major components in the system.
- Define a *ton of refrigeration*.

Lesson 4 - Gas Laws (Part 1)

- Objectives:
  Name three men who established fundamental gas laws governing the actions and reactions of refrigerants.
- State Boyle's Law and use it to solve problems involving gases.
- State Charles' Law for a constant volume process, and use it to solve problems involving gases.
- State Charles' Law for a constant pressure process, and use it to solve problems involving gases.

Lesson 5 - Gas Laws (Part 2)
Objectives:

- Explain Dalton's Law.
- Describe what is meant by the "density" of a material.
- Define *specific volume*.
- Use the general gas law to determine the temperature, mass, volume, or pressure of a gas.
- Use specific gravity to determine the density of a material.

Lesson 6 - Pressure/Temperature Relationship (Part 1)
Objectives:

- Calculate temperature conversion from Fahrenheit to Celsius and from Celsius to Fahrenheit.
- Define *absolute temperature* and be able to calculate it in either scale.
- Define *pressure*.
- Explain the terms *psig* and *psia*.
- Define *superheat*.
- Define *saturation*.

Lesson 7 - Pressure/Temperature Relationship (Part 2)
Objectives:

- State the effects of pressure and temperature on the boiling point of a liquid.
- Use the saturated refrigerant tables to obtain information.
- Describe the behavior of a superheated gas as it responds to changes in temperature.
- Use the superheated refrigerant tables to obtain information.
- Demonstrate the use of pressure-temperature tables.

Lesson 8
The Compression Refrigeration Cycle (Part 1)
Objectives:

- Explain why a liquid boils and changes to a saturated vapor, and conversely, why a saturated vapor changes to a liquid.
- Describe a refrigeration system.
- Explain the function of a receiver.
- Explain the function of metering devices.
- List three types of metering devices.

Lesson 9 - The Compression Refrigeration Cycle (Part 2)
Objectives:

- Define *net refrigeration effect*.
- State the conditions on which the standard refrigeration ton is based.
- Explain what is meant by the term *volumetric efficiency*.
- Determine *coefficient of performance*.

Lesson 10 - The Compression Refrigeration Cycle (Part 3)
Objectives:

- Calculate displacement and volumetric efficiency.
- Name the factors affecting volumetric efficiency.
- Explain what is meant by the term *compression ratio*.
- Calculate the compression ratio of a compressor.
- Define the term *heat of compression* and *mechanical efficiency*.
- Determine horsepower per ton.

Lesson 11 - Refrigerant Tables
Objectives:

- Use refrigerant tables to:
    - Set controls
    - Compute head pressure for a specific set of operating conditions
    - Adjust superheat settings

- Calculate net refrigeration effect
- Estimate normal discharge temperatures.

Lesson 12 - Refrigerant Properties and Characteristics
Objectives:

- Define the term “refrigerant.”
- Recognize the physical and thermodynamic properties of several common refrigerants.
- Determine compression ratio.
- State the flammability and toxicity levels of commonly used refrigerants.
- Explain the undesirable effect of water in a refrigeration system.
- Determine the correct evaporator/condenser pressures for refrigerants that exhibit temperature glide.
- Explain the relationship between refrigerants and oils.
- Describe the effects of refrigerants on common metals and other materials.
- State the causes and effects of high compression ratios.
- Name several factors that affect the discharge temperature.

Lesson 13 - Refrigerant Designations
Objectives:

- Explain the significance of the ANSI/ASHRAE series designator for refrigerants.
- State the series number for each of the following compound classifications: methane-based, ethane-based,zeotropes, azeotropes, organic, and inorganic.
- Explain the significance of both upper-case and lower-case suffix letters in a designation.
- Interpret ASHRAE safety designations for toxicity and flammability.
- Define *fractionation* and *temperature glide*.
- Explain why only liquid should be used to charge a system with a blend.
- Write a molecular formula from a structural formula for simple compounds.
- Draw a structural formula from a molecular formula for simple compounds.
- Explain the difference between a *recognized* refrigerant and an *approved* refrigerant.
- Distinguish between the terms “substitute” refrigerant and “replacement” refrigerant.

Lesson 14 - Safe Practices and Public Relations
Objectives:

- List the causes and nature of accidents.
- Demonstrate safe practices regarding the use of tools.
- Describe the precautions that should be observed when working around moving machinery.
- Identify electrical and fire hazards, and the steps that should be taken to avoid them.
- Explain how injuries resulting from explosive gases, high pressures, and refrigerant cylinders may be prevented.
- Describe what should be done to promote good customer relations.

Lesson 15 - Compressors
Objectives:

- Distinguish the different types of compressors.
- List the advantages and disadvantages of open-type, semi-hermetic, rotary, screw, and centrifugal compressors.
- Describe the basic functions performed by each type of compressor.
- Define compressor efficiency.

- Explain the effects of high suction and discharge pressure.

Lesson 16 - Open-Type Compressors
Objectives:

- Explain the difference between and open-type compressor and a hermetic compressor.
- Explain how the same compressor can be used for different temperature applications.
- Describe the steps necessary to service the electric motor on an open-type compressor in the field.
- Explain the effect of suction pressure on motor load.
- Describe the installation procedure for a direct-drive-open-type compressor.
- Determine by calculation the motor pulley diameter when the compressor flywheel diameter, the compressor speed, and the motor speed are given.

Lesson 17 - Hermetic and Semi-Hermetic Compressors
Objectives:

- List the five types of compressors used in the mechanical refrigeration system.
- Describe the basic operation of the five types of compressors.
- List the advantages of a hermetically sealed compressor over an open-type compressor.
- Explain the methods used to remove heat from the motors of hermetic and semi-hermetic compressors.
- Describe the procedures involved in replacing a hermetic or semi-hermetic compressor.
- Identify some of the factors that affect compressor capacity.

Lesson 18 - Air-Cooled Condensers
Objectives:

- Explain the function of an air-cooled condenser.
- Describe the effect of non-condensable gasses.
- Identify various types of air-cooled condensers.
- Determine where the condenser should be located.
- Explain the refrigerant piping arrangement for a remote air-cooled condenser.

Lesson 19 - Water-Cooled Condensers
Objectives:

- Describe the function of a shell-and-tube water-cooled condenser.
- Calculate condenser capacity.
- Explain how a tube-in-tube condenser works.
- List the pros and cons of using a water-cooled condenser.
- Describe the operation of a shell-and-coil water-cooled condenser.

Lesson 20 - Refrigeration Evaporators
Objectives:

- Identify various types of evaporators.
- Evaluate evaporator coil performance criteria.
- Select proper fin spacing for a particular application.
- Match the evaporator capacity to the condensing unit.
- Describe the evaporator selection process.
- Identify proper evaporator locations.
- Explain the need for defrosting.

Lesson 21 - Capillary Tubes
Objectives:

- Explain the function of the capillary tube.
- Identify the capillary tube's application characteristics.
- Explain the principles of capillary tube operation.
- Describe what should and should not be done to ensure satisfactory performance in a system that uses a capillary tube.

Lesson 22 - Thermostatic Expansion Valves (Part 1)
Objectives:

- Describe how a thermostatic expansion valve operates.
- Name the three pressures that affect the opening and closing of a TEV.
- Explain when a TEV with a remote charge is normally used.
- Specify where a gas-charged TEV should be installed in relation to the bulb.
- Explain the difference between internal equalizers and external equalizers.
- Discuss the importance of a properly selected TEV to the efficient operation of a refrigeration system.

Lesson 23 - Thermostatic Expansion Valves (Part 2)
Objectives:

- Name the factors that determine the correct type and size of TEV.
- Describe the precautions that you should take when installing a sweat-type TEV.
- Determine the proper location for the remote bulb of a TEV.
- Explain how to adjust superheat.
- Explain the general characteristics of replacement refrigerants and describe their effects of TEVs.

Lesson 24 - Oil in Refrigeration Systems
Objectives:

- List the properties required of a good refrigerant oil.
- Explain the term "solubility" as it relates to refrigerants.
- Describe several oil-related problems that can develop in refrigeration systems.
- Determine the effect on system capacity when oil is present in refrigerant.
- Explain the function of a crankcase heater.
- Explain the phrase "pump-down cycle" and describe how it works.

Lesson 25 - Recover, Recycle, Reclaim
Objectives:

- Define the terms *recover*, *recycle*, and *reclaim*.
- Explain the *de minimis* provision of minor losses when refrigerant is being recovered.
- Determine what portion of a refrigerant cylinder's maximum capacity can be safely filled to prevent hydrostatic bursting.
- Explain why cylinders must be evacuated before being used for recovery, why only refillable cylinders may be used, and why refrigerants must not be mixed.
- Describe the typical routine maintenance items for refrigerant recycling machines in general.

Lesson 26 - Safe Handling of Refrigerants and Cylinders
Objectives:

- Determine how much refrigerant can safely be put in a cylinder.
- Determine the temperature at which a cylinder would be 100% full of liquid, when the refrigerant liquid density and cylinder volume are known.
  Define the term *water capacity*.
- Determine when a cylinder needs to be retested.
- Identify refrigerant cylinders by color coding of the containers.
- List at least five safety procedures to be followed when handling refrigerant cylinders.
- Explain why a non-refillable cylinder must not be reused or converted.

Lesson 27 - Fundamental Concepts of Electricity
Objectives:

- Describe the basic structure of an atom.
- Describe the movement of electrons.
- Define an *electric current*.
- Explain the difference between conductors and insulators.
- Identify at least five materials that are good conductors, and at least five materials that are good insulators.
- Explain what “charged bodies” are.
- Define *static electricity*.
- State Coulomb’s Law
- Explain “electric fields.”
- Define *electromotive force* (EMF).

Lesson 28 - **Fundamental Concepts of Magnetism**
Objectives:

- State the basic laws of magnetism.
- Understand magnetic circuits.
- Describe an electromagnet.
- Understand the difference between “natural” and “artificial” magnets.
- Explain magnetic fields.
- State the two basic theories of magnetism.
- Explain how the earth’s magnetic field works.
- Define the following terms: magnetic shielding, lines of force, magnetic flux, self inductance, mutual induction, and counter electromotive force.
- State Lenz’s Law.

Lesson 29 - Voltage = EMF = Potential Difference
Objectives:

- List and describe each of the basic methods of producing electricity.
- Explain the difference between “cells” and “batteries.”
- Explain the difference between primary cells and secondary cells.
- List the three fundamental requirements for producing a voltage by means of magnetism.
- Define the terms current, ampere, and coulomb.
- Solve problems involving current, charge, and time.

Lesson 30 - Resistors and Resistance
Objectives:

- Describe the differences among various types of resistors.
- Describe the basic structure of resistors.
- Explain how electrons move through a resistor.
- Explain how resistive materials function.
- Find the resistance value of resistors.
- Calculate the wattage requirement of a resistor.
- Calculate the value of resistors in series.
- Calculate the value of resistors in parallel.
- Explain the difference between single-phase ac resistance the three-phase ac resistance.
- Calculate the total current in a resistance network of a three-phase circuit.

Lesson 31 - Conductors
Objectives:

- Explain how conductor sizes are measured.
- Calculate the cross-sectional area of a conductor in square mils and circular mils.
- Define the term ampacity.
- Explain the difference between solid wire and stranded wire.
- Explain the purpose of insulation and describe different types of insulation.
- Discuss the difference between low-voltage control wiring and high-voltage control wiring.

Lesson 32 - Power Supplies
Objectives:

- Describe basic power distribution systems for residential and light commercial applications.
- Explain the difference between three-phase power and single-phase power.
- Explain what a “stinger” leg is, and why it is used.
- Describe how single-phase power can be derived from a three-phase power supply.
- Explain the difference between wye and delta transformers.

Lesson 33 - Circuit Protection Devices
Objectives:

- Discuss the conditions under which circuit protection is needed.
- Describe the different types of fuses.
- List the main components and explain the basic function of circuit a breaker.
- Describe the operation of overload protectors used on compressors and motors.
- Explain the difference between “inherent” overload protection and “external” overload protection.
- Describe the various types of electronic motor protectors.

Lesson 34 - Electricity for the Service Technician (Part 1)
Objectives:

- Define alternating current, direct current, hertz (cycles per second), volts, amperes, and ohms.
- Apply Ohm’s Law to calculate voltage, current, resistance, and power in pure load circuits.
- Describe single-phase and three-phase circuits.
- Explain what the terms grounding, grounded, and ground mean.
- State how, when, and where a voltage check on equipment should be made.

- Explain what causes low voltage.

Lesson 35 - Electricity for the Service Technician (Part 2)
Objectives:

- List the main components of a transformer.
- Describe the basic operation of a transformer.
- Explain the relationship between turns and voltage.
- Calculate primary and secondary voltages.
- Describe how and when transformers are connected in series and in parallel.
- Explain the common applications of control transformers and autotransformers.

Lesson 36 - Electricity for the Service Technician (Part 3)
Objectives:

- Define power.
- Explain the difference between maximum voltage and effective voltage.
- Calculate power factors.
- Explain how a transformer operates.
- Explain the difference between “delta” and “star” connections.
- Troubleshoot motor complaints.