

**STATE SKILL STANDARDS
HEATING, VENTILATION,
AIR CONDITIONING,
AND REFRIGERATION**

Career & Technical Education

Skills for Employment & Lifelong Learning



Prepared by:

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Introduction

The Department of Education has undertaken an ambitious effort to develop statewide career and technical education skill standards. The standards in this document are for Heating, Ventilation, Air Conditioning and Refrigeration (HVAC&R) programs and are designed to clearly state what the student should know and be able to do upon completion of an advanced high-school program.

The writing team determined that any statewide skill standards for programs that teach HVAC&R should be patterned as closely as possible to existing, national standards. The standards are also closely aligned and sequenced with postsecondary HVAC&R programs.

These exit-level standards are designed for students completing an advanced program. Students at the appropriate level of instruction will be expected to demonstrate competence for all performance indicators in the “meets standard” domains for each performance standard.

The standards are organized as follows:

Content Standards are general statements that identify major areas of knowledge, understanding, and skills students are expected to learn in key subject and career areas by the end of the program.

Following each Content Standard are a number of **Performance Standards**. Performance Standards identify the more specific components of each content standard and define the expected abilities of students within each content standard.

Each Performance Standard is analyzed into specific **Performance Indicators**. Performance Indicators are very specific criteria statements for determining whether a student exceeds the standard, meets the standard, or whose performance approaches the standard. Performance Indicators may also be used as learning outcomes which teachers can identify as they plan their program learning objectives.

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Content and Performance Standards

General Safety

Content Standard 1.0: The student will demonstrate safe work practices while performing operations in the HVAC&R lab and/or internship program.

Performance Standard 1.1 The student will adhere to general safety rules and practices including but not limited to those in the following performance indicators.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Obtain CPR rating and First Aid Certification.◆ Design a safety improvement plan.
MEETS STANDARD	<ul style="list-style-type: none">1.1.1 Practice common safety rules and procedures.1.1.2 Demonstrate knowledge of general safety by passing a test.1.1.3 Understand OSHA standards and relate them to HVAC&R safety rule standards.1.1.4 Demonstrate proper procedures during a fire drill.1.1.5 Portray safe behaviors/attitudes while in the working environment.1.1.6 Describe the use of fire extinguishers and blankets.1.1.7 Describe the differences between common classes of fires (A, B, C & D) and their common causes.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify safe behaviors and attitudes.◆ List regulatory agencies that govern jobsite safety.◆ List the common classes of fires.

Content and Performance Standards

Content Standard 1.0: The student will demonstrate safe work practices while performing operations in the HVAC&R lab and/or internship program.

Performance Standard 1.2 The student will demonstrate personal safety and work habits.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Participate in skid car training.◆ Maintain 0 points on driving record.◆ Pass a safe driving course.◆ Obtain CareerSafe certification.
MEETS STANDARD	<ul style="list-style-type: none">1.2.1 Wear appropriate clothing and safety gear.1.2.2 Review OSHA standards sections on personal safety.1.2.3 Explain the effects of substance abuse on safety.1.2.4 Review safe driving practices.1.2.5 Demonstrate proper lifting procedures.1.2.6 Demonstrate proper ladder safety and usage.1.2.7 Maintain a safe, clean, and organized work area.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Explain the proper clothing and the proper use of safety equipment as it pertains to personal safety.◆ Describe good housekeeping practices in the lab.

Content and Performance Standards

Content Standard 1.0: The student will demonstrate safe work practices while performing operations in the HVAC&R lab and/or internship program.

Performance Standard 1.3 The student will demonstrate safety in handling pressurized fluids.	
EXCEEDS STANDARD	♦ Student assembles a MSDS manual for the lab.
MEETS STANDARD	1.3.1 Explain application of pressure relief devices. 1.3.2 Explain proper storage and handling of refrigerants. 1.3.3 Explain effect of temperature and hydraulic expansion. 1.3.4 Explain proper storage and handling of oxygen, nitrogen and acetylene bottles. 1.3.5 Explain the effects of mixing oxygen and oil. 1.3.6 Follow procedures specified on the Material Safety Data Sheet (MSDS). 1.3.7 Store and dispose of hazardous material according to EPA specifications. 1.3.8 Explain ASHRAE Refrigerant Safety Classification of Refrigerants for Toxicity and Flammability. 1.3.9 Explain the safety and handling procedures for R410a and the differences as related to the current family of EPA refrigerants.
APPROACHES STANDARD	♦ Understand and plot the refrigerant pressure and temperature utilizing the T/P chart.

Nevada Academic Standards Correlation: Science (P.12.A.1, P.12.A.5, P.12.A.6, P.12.A.7)

Content and Performance Standards

Content Standard 1.0: The student will demonstrate safe work practices while performing operations in the HVAC&R lab and/or internship program.

Performance Standard 1.4 The student will demonstrate and practice the safe handling of hazardous substances.	
EXCEEDS STANDARD	♦ Demonstrate the proper use of various types of fire extinguishers.
MEETS STANDARD	1.4.1 Explain the differences between hazardous materials, substances and wastes. 1.4.2 Explain use of hazardous material manifest. 1.4.3 List the four classifications of fires.
APPROACHES STANDARD	♦ Explain the meaning of the hazardous material markers. ♦ Explain the fire triangle.

Content and Performance Standards

Content Standard 1.0: The student will demonstrate safe work practices while performing operations in the HVAC&R lab and/or internship program.

Performance Standard 1.5 The student will demonstrate electrical safety practices.	
EXCEEDS STANDARD	♦ Identify and label all the breakers in a panel.
MEETS STANDARD	1.5.1 Explain the importance of ground fault circuit interrupters. 1.5.2 Demonstrate the safe use of power tools and accessories. 1.5.3 Demonstrate safe electrical work habits. 1.5.4 Explain environmental safety practices. 1.5.5 Demonstrate proper procedures when working with hands on live equipment. 1.5.6 Demonstrate proper procedures for the use of tag out and lockout practices. 1.5.7 Demonstrate the safe use of electrical meters.
APPROACHES STANDARD	♦ Describe the electrical current chart and the importance to personal safety.

Content and Performance Standards

Introduction to Air Conditioning and Refrigeration Technology

Content Standard 2.0: The student will demonstrate knowledge of the history of air conditioning and refrigeration and explore related career paths.

Performance Standard 2.1 The student will understand the basics of the refrigeration cycle and its components.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Design a mock model of an air conditioning system.◆ Design a mock model of a refrigeration system.
MEETS STANDARD	<ul style="list-style-type: none">2.1.1 Explain the history of air conditioning and refrigeration.2.1.2 Define air conditioning as it relates to human comfort.2.1.3 Explain the differences between air conditioning and refrigeration.2.1.4 Explain why ventilation is often inadequate.2.1.5 Demonstrate a working knowledge of the four basic components of the refrigeration cycle.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Describe career opportunities in the air conditioning and refrigeration industry.◆ Draw a piping schematic of the four basic compression cycle components.

Content and Performance Standards

Content Standard 2.0: The student will demonstrate knowledge of the history of air conditioning and refrigeration and explore related career paths.

Performance Standard 2.2 The student will demonstrate knowledge of the development of air conditioning as a part of the refrigeration process.	
EXCEEDS STANDARD	♦ Write a research paper on the history of air conditioning and refrigeration.
MEETS STANDARD	2.2.1 Explain the historical development of air conditioning. 2.2.2 Explain the differences between air conditioning and heating. 2.2.3 Describe the various systems of air conditioning. 2.2.4 Explain the differences between air conditioning and refrigeration.
APPROACHES STANDARD	♦ List examples of the different air conditioning and refrigeration systems.

Nevada Academic Standards Correlation: Science (P.12.C.5)

Content and Performance Standards

Content Standard 2.0: The student will demonstrate knowledge of the history of air conditioning and refrigeration and explore related career paths.

Performance Standard 2.3 The student will understand the various heating systems.	
EXCEEDS STANDARD	♦ Explain examples of the various fuels, the efficiencies, and the cost differences of heating.
MEETS STANDARD	2.3.1 Define "heating" as it pertains to human comfort. 2.3.2 Differentiate the various heating systems.
APPROACHES STANDARD	♦ List the various materials used for heating.

Content and Performance Standards

Principles of Thermodynamics and Heat Transfer

Content Standard 3.0: The student will understand thermodynamic properties and heat transfer principles and interpret their significance in air conditioning and refrigeration technology.

Performance Standard 3.1 The student will be introduced to the science of refrigeration and heating.	
EXCEEDS STANDARD	♦ Plot a mock unit on an enthalpy chart and determine the net refrigeration effect.
MEETS STANDARD	3.1.1 Define matter and heat. 3.1.2 Explain the direction and rate of heat flow. 3.1.3 Describe the three methods of heat transfer. 3.1.4 Identify the reference points of temperature. 3.1.5 Explain the difference between heat and temperature. 3.1.6 Explain the difference between latent and sensible heat. 3.1.7 Explain the change of state of matter. 3.1.8 Explain heat/cool storage. 3.1.9 Define specific heat. 3.1.10 Define sensible heat. 3.1.11 Define latent heat of fusion. 3.1.12 Define latent heat of vaporization. 3.1.13 Define enthalpy. 3.1.14 Define saturation temperature (dew point temperature). 3.1.15 Define water vapor pressure. 3.1.16 Explain the direction and rate of moisture transfer. 3.1.17 Calculate the BTUs required to change ice to steam.
APPROACHES STANDARD	♦ Draw the BTU chart and label all the components from ice to steam.

Nevada Academic Standards Correlation: Science (P.12.A.1, P.12.C.2, P.12.C.5); Math (1.12.1, 2.12.4, 3.12.1)

Content and Performance Standards

Content Standard 3.0: The student will understand thermodynamic properties and heat transfer principles and interpret their significance in air conditioning and refrigeration technology.

Performance Standard 3.2 The student will explore the science of fluids and pressures as they relate to air conditioning and refrigeration.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate the value of using inches of mercury or microns when using a vacuum pump.
MEETS STANDARD	3.2.1 Explain the relationship of pressures and fluids at saturation temperatures. 3.2.2 Use the P/T Chart to determine the difference between temperature and pressure. 3.2.3 Define pressure. 3.2.4 Explain atmospheric pressure. 3.2.5 Explain the purpose of compound gauges. 3.2.6 Explain the purpose of bourdon tubes. 3.2.7 Explain barometric pressure. 3.2.8 Explain absolute pressure. 3.2.9 Explain gauge pressure. 3.2.10 Explain inches of mercury absolute. 3.2.11 Explain micron.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify the components on a compound manifold. ◆ Read a compound gauge.

Nevada Academic Standards Correlation: Science (P.12.A.1, E.12.A.2); Math (2.12.5)

Content and Performance Standards

Content Standard 3.0: The student will understand thermodynamic properties and heat transfer principles and interpret their significance in air conditioning and refrigeration technology.

Performance Standard 3.3 The student will understand the relationship of the components of the refrigeration cycle.	
EXCEEDS STANDARD	♦ Draw the complete compression refrigeration system, identifying various pressures, temperatures and change of states, and plot them at various locations throughout the system.
MEETS STANDARD	3.3.1 Identify the four major components and their types within the vapor compression refrigeration system. 3.3.2 Describe the state and conditions of the refrigerant during a cycle. 3.3.3 Explain the importance of superheat and sub-cooling. 3.3.4 Explain the functions of the four major components of a refrigeration system. 3.3.5 List the components that separate the high side from the low side of the system. 3.3.6 Use the temperature/enthalpy (T-H) chart to determine the state of the refrigerant within the mechanical system.
APPROACHES STANDARD	♦ Draw and label the four basic components of the compression cycle.

Nevada Academic Standards Correlation: Science (P.12.A.1); Math (2.12.5)

Content and Performance Standards

Content Standard 3.0: The student will understand thermodynamic properties and heat transfer principles and interpret their significance in air conditioning and refrigeration technology.

Performance Standard 3.4 The student will be able to use different methods of measurement systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Compile a list of conversion factors for air conditioning and refrigeration.◆ Draw the complete compression refrigeration system, identifying various pressures, temperatures and change of states and plots them at various locations throughout the system calculated in the metric system.
MEETS STANDARD	<ul style="list-style-type: none">3.4.1 Explain units of heat, power, velocity, mass, volume and length.3.4.2 Convert from U.S. to metric units according to air conditioning and refrigeration industry standards.3.4.3 Convert from pounds to ounces.3.4.4 Convert from tons of refrigeration to kilowatts.3.4.5 Convert from BTU/H to kilowatts.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Read and convert a given temperature to centigrade and plot over a period of time.◆ Identify U.S. and SI standard units.

Nevada Academic Standards Correlation: Science (P.12.C.2, P.12.C.5); Math (2.12.4, 3.12.1)

Content and Performance Standards

Hand Tools and Equipment

Content Standard 4.0: The student will demonstrate proper use of hand tools and equipment common to the air conditioning and refrigeration industry.

Performance Standard 4.1 The student will be able to identify and demonstrate the proper use of air conditioning and refrigeration related tools and equipment.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Construct and pressurize a piping project to a given set of specifications using hand tools, power tools, and pipe and tubing tools.
MEETS STANDARD	<ul style="list-style-type: none">4.1.1 Properly use basic air conditioning and refrigeration related tools.4.1.2 Properly use power tools used in air conditioning and refrigeration.4.1.3 Properly use pipe and tubing tools.4.1.4 Describe lubrication methods using different types of applicators.4.1.5 Use of pipe cutter to safely and accurately cut pipe.4.1.6 Use a pipe threader to safely and accurately thread pipe.4.1.7 Properly use a flared tubing joint.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify common fasteners and hardware.◆ Identify basic air conditioning and refrigeration related tools.◆ Identify power tools used in air conditioning and refrigeration.◆ Identify pipe and tubing tools.

Content and Performance Standards

Content Standard 4.0: The student will demonstrate proper use of hand tools and equipment common to the air conditioning and refrigeration industry.

Performance Standard 4.2 The student will demonstrate the proper use of electrical meters.	
EXCEEDS STANDARDS	<ul style="list-style-type: none">◆ Write a comparative cost analysis of the different meters available.
MEETS STANDARD	<ul style="list-style-type: none">4.2.1 Describe the safe use of electrical meters.4.2.2 Demonstrate understanding of the basic types of electrical measurement.4.2.3 Determine electrical measurements using an analog meter.4.2.4 Determine electrical measurements using a digital meter.4.2.5 Determine electrical measurements using a megohm meter.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Define amps, volts, ohms, and watts.◆ Identify the different electrical meters.

Content and Performance Standards

Content Standard 4.0: The student will demonstrate proper use of hand tools and equipment common to the air conditioning and refrigeration industry.

Performance Standard 4.3 The student will demonstrate the proper use of refrigeration test instruments.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Perform a leak check, identify the leak, repair the leak and recharge the unit.
MEETS STANDARD	4.3.1 Measure pressures with the refrigeration gauge manifold. 4.3.2 Evacuate systems with a two-stage vacuum pump. 4.3.3 Measure vacuums with a thermistor vacuum gauge. 4.3.4 Measure temperatures with electronic thermometers. 4.3.5 Measure temperatures with bimetal, thermocouple, or infrared thermometers. 4.3.6 Charge a system with an electronic charging scale. 4.3.7 Check for leaks with electronic leak detector and halide torch. 4.3.8 Use nitrogen with trace R-22 for leak detection. 4.3.9 Compare readings to manufacturers' specification. 4.3.10 Determine refrigerant amount and type. 4.3.11 Charge a system to manufacturers' specification.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Describe the various types of refrigeration pressure measuring gauges. ◆ Describe various temperature measuring systems. ◆ Describe various gases for testing refrigeration systems. ◆ Describe various weight measurement systems.

Nevada Academic Standards Correlation: Science (P.12.A.1); Math (3.12.2)

Content and Performance Standards

Content Standard 4.0: The student will demonstrate proper use of hand tools and equipment common to the air conditioning and refrigeration industry.

Performance Standard 4.4 The student will demonstrate proper use of fossil fuel heating system measurement devices.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate a conversion from a free-standing pilot to an electronic ignition. ◆ Explain flame rectification.
MEETS STANDARD	<p>4.4.1 Use measurement devices to determine burner efficiencies.</p> <p>4.4.2 Use measurement devices to determine relative humidity.</p> <p>4.4.3 Measure chimney draft with a gauge.</p> <p>4.4.4 Perform an efficiency test on an oil-gas burner.</p> <p>4.4.5 Determine effectiveness of an oil pump using a vacuum gauge and pressure gauge.</p> <p>4.4.6 Measure gas pressure with the following equipment: U-tube manometer and pressure gauge.</p> <p>4.4.7 Calculate proper size of chimney for both 80 and 90+ furnaces.</p> <p>4.4.8 Check wall thermostat and anticipator.</p> <p>4.4.9 Check electronic pilot system.</p> <p>4.4.10 Check and adjust blower system.</p> <p>4.4.11 Check and adjust fan control.</p> <p>4.4.12 Check limit and safety controls.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify the test equipment used in fossil fuel heating equipment service. ◆ List the various types of fossil fuels used for domestic applications. ◆ Identify the various ignition systems.

Nevada Academic Standards Correlation: Math (3.12.2, 1.12.1, 2.12.2)

Content and Performance Standards

Content Standard 4.0: The student will demonstrate proper use of hand tools and equipment common to the air conditioning and refrigeration industry.

Performance Standard 4.5 The student will demonstrate the use of the instruments necessary to determine proper airflow.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Determine the static pressure across the evaporator coil. ◆ Utilize a manufacturer's airflow data sheet to determine the proper static pressure and cubic feet per minute for an indoor blower system.
MEETS STANDARD	<p>4.5.1 Perform airflow measurement using the following devices: Pitot tube; hot wire; inclined manometer; electronic velometer; and magnahelic gauge.</p> <p>4.5.2 Determine air velocity within a duct via: Pitot tube; incline manometer; electronic velometer; U-tube manometer.</p> <p>4.5.3 Determine air velocity at grilles and diffusers.</p> <p>4.5.4 Determine cubic feet per minute air flow.</p> <p>4.5.6 Measure pressure drop with a magnahelic gauge.</p> <p>4.5.7 Use manufacturer's airflow data sheet.</p> <p>4.5.8 Solve problems using a friction loss chart.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify the instruments necessary to measure airflow. ◆ Determine whether or not an airflow problem exists.

Nevada Academic Standards Correlation: Math (3.12.2, 1.12.1, 2.12.5)

Content and Performance Standards

Piping and Piping Practices

Content Standard 5.0: The student will demonstrate various brazing techniques to prepare and install piping.

Performance Standard 5.1 The student will demonstrate an understanding of the proper tubing and piping requirements for air conditioning systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Construct a closed piping model displaying flared, swag, and soldered connections that will hold pressure.
MEETS STANDARD	<ul style="list-style-type: none">5.1.1 Describe the differences and uses of soldering and brazing alloys used in air conditioning and refrigeration technology.5.1.2 Explain common applications of soldering and brazing alloys and fluxes.5.1.3 Describe heat exchange techniques.5.1.4 Describe the applications and installation of vibration eliminators.5.1.5 Construct a flared copper connection.5.1.6 Construct a swag copper connection.5.1.7 Determine capacities of refrigerant lines.5.1.8 Explain the effects of refrigerant velocity in various line sizes.5.1.9 Explain the use of P-traps in vapor risers.5.1.10 Calculate the amount of refrigerant needed in a given system.5.1.11 Size piping using manufacturer installation instructions.5.1.12 Demonstrate the proper slope of refrigerant lines to aid oil return.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify common types of fittings.◆ Identify types of pipe and tubing used in air conditioning and refrigeration work.◆ Describe methods of insulating pipe and tubing.◆ Identify types of torches.◆ Describe heat sink methods.

Nevada Academic Standards Correlation: Science (P.12.A.5); Math (2.12.5, 3.12.5, 1.12.1, 3.12.2)

Content and Performance Standards

Electricity

Content Standard 6.0: The student will demonstrate knowledge of electrical theory, measurement, circuitry and controls.

Performance Standard 6.1 The student will demonstrate a thorough understanding of basic electricity.	
EXCEEDS STANDARD	♦ Construct and explain how electricity flows in a series circuit, parallel circuit and series-parallel circuit.
MEETS STANDARD	6.1.1 Use Ohm's law to calculate watts, ohms, volts and amps. 6.1.2 Draw and plot the Ohm's law wheel. 6.1.3 Define and compare and contrast single- and three-phase voltage and current. 6.1.4 Identify types of electrical loads (i.e., capacitive, inductive and resistive). 6.1.5 Use Ohm's law to solve circuit problems and calculate circuit loads. 6.1.6 Construct a circuit to demonstrate the electrical characteristics of both series and parallel circuits.
APPROACHES STANDARD	♦ Analyze applications of magnetism in electricity. ♦ Apply magnetic principles to electrical theory. ♦ Compare conducting and insulating materials.

Nevada Academic Standards Correlation: Science (P.12.B.2, P.12.B.3, P.12.C.6); Math (1.12.1, 2.12.3, 2.12.4, 3.12.2)

Content and Performance Standards

Content Standard 6.0: The student will demonstrate knowledge of electrical theory, measurement, circuitry and controls.

Performance Standard 6.2 The student will describe how electricity is generated and distributed.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Research the National Electric Code (NEC) to determine correct wire and conduit size for a connected load.
MEETS STANDARD	<ul style="list-style-type: none">6.2.1 Demonstrate how a basic generator functions.6.2.2 Explain how electricity is produced and distributed.6.2.3 Define Wye (Y) and Delta (Δ) distribution systems.6.2.4 Determine correct wire size and voltage drops for electrical circuits.6.2.5 Determine whether an existing load center is adequate to supply load addition.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify power transformer types.◆ Use electrical meters to test and identify voltages in both single- and three-phase systems.

Nevada Academic Standards Correlation: Science (P.12.B.2, P.12.B.3, P.12.C.6); Math (1.12.1)

Content and Performance Standards

Content Standard 6.0: The student will demonstrate knowledge of electrical theory, measurement, circuitry and controls.

Performance Standard 6.3 The student will identify and use specialty controls used in the air conditioning and refrigeration systems.	
EXCEEDS STANDARD	◆ Perform a test on at least eight different controls utilizing appropriate test equipment and procedures.
MEETS STANDARD	6.3.1 Define magnetic theory. 6.3.2 Install and explain the operation of common relays. 6.3.3 Install and explain the operation of common timers. 6.3.4 Install and explain the operation of common contactors. 6.3.5 Install and explain the operation of common pressure controls.
APPROACHES STANDARD	◆ Identify at least ten different air conditioning and refrigeration controls.

Nevada Academic Standards Correlation: Science (P.12.B.2, P.12.B.3, P.12.C.6)

Content and Performance Standards

Refrigerant System Components

Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

Performance Standard 7.1 The student will explain the functions and uses of metering devices.	
EXCEEDS STANDARD	♦ Perform a superheat and sub-cooling calculation to a manufacturer's specification.
MEETS STANDARD	7.1.1 Describe how various types of metering devices function. 7.1.2 Explain how to size expansion valves. 7.1.3 Explain how to size a thermal expansion valve. 7.1.4 Explain how to size an automatic expansion valve.
APPROACHES STANDARD	♦ Identify types of metering devices.

Content and Performance Standards

Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

Performance Standard 7.2 The student will understand how various types of evaporators function.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Size and select an evaporator based on compressor capacities.◆ Explain how to install a residential evaporator according to local building codes.
MEETS STANDARD	<p>7.2.1 Demonstrate the use of various types of evaporators, (i.e., bare-tube, finned, plate, tube in shell, tube in tube).</p> <p>7.2.2 Adjust an evaporator for proper coil air flow.</p> <p>7.2.3 Check the coil performance in an evaporator.</p>
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify the various types of evaporators (i.e., bare-tube, finned, plate, tube in shell, tube in tube).◆ Identify evaporator locations for correct installation.

Nevada Academic Standards Correlation: Math (1.12.1, 3.12.2)

Content and Performance Standards

Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

Performance Standard 7.3 The student will understand how various types of compressors function.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Size and select a compressor for a specific heat load.
MEETS STANDARD	<p>7.3.1. Explain the advantages and disadvantages of the three types of compressors.</p> <p>7.3.2. Explain the differences between the various methods of compression.</p> <p>7.3.3 Explain methods of capacity control.</p>
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify the types of compressors.◆ Identify methods of compression.

Content and Performance Standards

Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

Performance Standard 7.4 The student will understand how various types of condensers function.	
EXCEEDS STANDARD	♦ Demonstrate knowledge of manufacturer requirements and building codes for proper placement of a condenser.
MEETS STANDARD	7.4.1 Demonstrate the use of the various types of condensers. 7.4.2 Describe common maintenance procedures to service a condenser. 7.4.3 Explain the operation and performance of a condenser.
APPROACHES STANDARD	♦ Identify three types of condensers.

Content and Performance Standards

Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

Performance Standard 7.5 The student will identify and describe the function of air conditioning and refrigeration system accessories.	
EXCEEDS STANDARD	♦ Draw, label and identify the complete compression in a refrigeration cycle utilizing as many of the proper accessories possible.
MEETS STANDARD	7.5.1 Describe the use, function and the proper location of various specialty air conditioning and refrigeration accessories. 7.5.2 Determine the appropriate accessories for systems application. 7.5.3 Replace a drier/filter. 7.5.4 Adjust a crankcase pressure-regulating valve.
APPROACHES STANDARD	♦ Identify the accessories as used in air conditioning.

Content and Performance Standards

Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

Performance Standard 7.6 The student will demonstrate understanding of the function and operation of various access fittings.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate system pump-down procedures according to EPA standards, utilizing front and back seat valves.
MEETS STANDARD	<p>7.6.1 Demonstrate the use of front and back seat positions on the compressor service valves.</p> <p>7.6.2 Demonstrate the use, application and operation of the king valve at the outlet of the receiver.</p> <p>7.6.3 Demonstrate the use, application and operation of the queen valve where present, near the receiver.</p> <p>7.6.4 Demonstrate the use of the small system high side and low side service ports.</p> <p>7.6.5 Demonstrate the use and application of front seating and Schrader valves, and the differences of OEM and field-installed.</p> <p>7.6.6 Install and use clamp on valves.</p> <p>7.6.7 Install and use solder (in) or (on) stem valves.</p> <p>7.6.8 Use quick-disconnects with Schrader-based valves.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Explain the three positions of a king valve.

Content and Performance Standards

Gas Controls

Content Standard 8.0: The student will demonstrate knowledge of the operation and diagnosis of gas control valves, regulators and fossil-fuel heating systems.

Performance Standard 8.1 The student will demonstrate the operation and function of various gas control valves.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Compare and contrast a standard efficient unit to a 90% efficient unit.◆ Perform and analyze a combustion fuel performance efficiency test.
MEETS STANDARD	<ul style="list-style-type: none">8.1.1 Describe the various types of gas control valves.8.1.2 Explain the operation of solenoid valves used to control gas flow.8.1.3 Describe the function and application of various regulators.8.1.4 Describe the function of various pilot/burner ignitions.8.1.5 Describe methods of fan control for the three categories of gas furnaces.8.1.6 Describe the sequence of operation for 78-80% efficient gas furnaces.8.1.7 Describe the function of the components used in the three categories of gas furnaces.8.1.8 Explain the operation of a redundant gas valve.8.1.9 Check the proper gas valve operation.8.1.10 Check the proper sensing current of a flame-sensing device.8.1.11 Check and adjust the inlet and outlet pressure of a gas valve.8.1.12 Check the operation of an induced draft blower by blocking the flue outlet.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify the common types of gas valves.◆ Identify the components used in fossil-fuel heating systems.

Nevada Academic Standards Correlation: Math (1.12.1, 3.12.2)

Content and Performance Standards

Content Standard 8.0: The student will demonstrate knowledge of the operation and diagnosis of gas control valves, regulators and fossil-fuel heating systems.

Performance Standard 8.2 The student will understand the operation of fuel control systems.	
EXCEEDS STANDARD	♦ Summarize the difference between free-standing pilot ignition devices and 90% efficient ignition devices.
MEETS STANDARD	8.2.1 Explain the operation of various ignition and pilot proving devices. 8.2.2 Test and change a thermocouple flame sensor. 8.2.3 Test spark ignition modules. 8.2.4 Perform safety lockout procedures for burners.
APPROACHES STANDARD	♦ Identify various pilot assemblies.

Nevada Academic Standards Correlation: Science (P.12.C.2)

Content and Performance Standards

Content Standard 8.0: The student will demonstrate knowledge of the operation and diagnosis of gas control valves, regulators and fossil-fuel heating systems.

Performance Standard 8.3 The student will install and operate residential control systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Perform a field conversion from a free-standing pilot system to a hot-surfaced ignition system.
MEETS STANDARD	<p>8.3.1 Explain heat and cooling thermostat operation and anticipators.</p> <p>8.3.2 Install and test a fan/limit control to identify set point of control.</p> <p>8.3.3 Wire a complete heating system - line and low voltage.</p> <p>8.3.4 Wire a humidistat into electrical circuit.</p> <p>8.3.5 Wire an electronic air cleaner into an electrical circuit.</p> <p>8.3.6 Program a programmable thermostat for heating, cooling and heat pump operation, including set-up and set-back.</p> <p>8.3.7 Set heat anticipator on a system thermostat.</p> <p>8.3.8 Install residential heating and cooling analog thermostats.</p> <p>8.3.9 Install residential heating and cooling digital thermostats.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify residential heating and cooling thermostats. ◆ Identify controls for heating and cooling.

Nevada Academic Standards Correlation: Math (1.12.1)

Content and Performance Standards

Fossil Heating Systems

Content Standard 9.0: The student will demonstrate competency in the operation and maintenance of unitary and split fossil fuel fired heating systems.

Performance Standard 9.1 The student will service and operate a forced air heating system.	
EXCEEDS STANDARD	♦ Perform a heat-exchanger inspection and CO test.
MEETS STANDARD	9.1.1 Adjust the burner flame for the proper fuel/air ratio. 9.1.2 Check for proper temperature rise through the furnace. 9.1.3 Test all safety controls. 9.1.4 Remove, install and adjust the blower motor and/or belt. 9.1.5 Clean the pilot assembly. 9.1.6 Oil motor(s) and bearings. 9.1.7 Use orifice sizing charts to determine capacities. 9.1.8 Test induced draft pressure switches. 9.1.9 Check all safety controls. 9.1.10 Check sequence of operation.
APPROACHES STANDARD	♦ Identify the types of forced air furnaces.

Nevada Academic Standards Correlation Science (P.12.A.5, P.12.A.6, P.12.A.7); Math (1.12.1)

Content and Performance Standards

Content Standard 9.0: The student will demonstrate competency in the operation and maintenance of unitary and split fossil fuel fired heating systems.

Performance Standard 9.2 The student will test and balance heating systems.	
EXCEEDS STANDARD	◆ Perform a complete diagnostic system check on a fossil-fueled fired unit.
MEETS STANDARD	9.2.1 Perform pressure checks on air distribution systems. 9.2.2 Perform pressure checks on fuel systems. 9.2.3 Perform an efficiency test and adjust fuel burners to manufacturer's recommended rate of CO ₂ , O ₂ , and CO. 9.2.4 Perform a balance method for an air distribution system.
APPROACHES STANDARD	◆ Identify the hazards of deadly gases and products of combustion. ◆ Explain why heating systems must be tested and balanced.

Nevada Academic Standards Correlation: Math (1.12.1, 3.12.2); Science (P.12.A.5, P.12.A.6, P.12.A.7)

Content and Performance Standards

Content Standard 9.0: The student will demonstrate competency in the operation and maintenance of unitary and split fossil fuel fired heating systems.

Performance Standard 9.3 The student will understand the function of humidity for air conditioning comfort systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Determine relative humidity using a psychrometer.◆ Determine dew point using a psychrometer.
MEETS STANDARD	<ul style="list-style-type: none">9.3.1 Explain the importance of humidification.9.3.2 Describe different types of humidifiers.9.3.3 Explain factors affecting humidity in commercial buildings and residences.9.3.4 Select proper humidification equipment.9.3.5 Check operation of humidification equipment.9.3.6 Perform maintenance on humidification equipment.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify the needs of humidity control for air conditioning comfort.

Content and Performance Standards

Air Conditioning Systems

Content Standard 10.0: The student will understand the process of heat transfer and the properties of air as applied in air conditioning applications.

Performance Standard 10.1 The student will understand the relationship between temperature and humidity as they affect comfort.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Plot and interpret heating and cooling processes using the psychrometric chart.
MEETS STANDARD	<ul style="list-style-type: none">10.1.1 Explain the various quantity values obtained from the psychrometric chart such as: dry bulb line (DB), wet bulb line (WB), and enthalpy (h).10.1.2 Calculate sensible, latent and total heat using the psychrometric chart.10.1.3 Determine relative humidity using a sling psychrometer.10.1.4 Determine dew point and grains of moisture.10.1.5 Calculate sensible and latent heat ratio.10.1.6 Plot key points on the psychrometric chart.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify the various plot lines used on the psychrometric chart.◆ Explain sensible and latent heat.

Nevada Academic Standards Correlation: Science (N.12.A.1, N.12.A.2); Math (1.12.1, 2.12.4, 2.12.6, 3.12.2)

Content and Performance Standards

Content Standard 10.0: The student will understand the process of heat transfer and the properties of air as applied in air conditioning applications.

Performance Standard 10.2 The student will understand the operation of cooling systems as part of the refrigeration process.	
EXCEEDS STANDARD	♦ Plot and interpret the changes in air properties to troubleshoot the performance of a heating and cooling system.
MEETS STANDARD	10.2.1 Describe the sequence of the basic refrigeration cycle and operation of the various types of air conditioning systems. 10.2.2 Use and read various tools and instrumentation needed for checking, testing and operating air conditioning systems.
APPROACHES STANDARD	♦ Identify the changes in the air properties during heating and cooling operations.

Nevada Academic Standards Correlation: Math (3.12.2)

Content and Performance Standards

Content Standard 10.0: The student will understand the process of heat transfer and the properties of air as applied in air conditioning applications.

Performance Standard 10.3 The student will troubleshoot an air conditioning system to determine and correct electrical and mechanical cooling problems.	
EXCEEDS STANDARD	<ul style="list-style-type: none">♦ Analyze air conditioning systems and appropriately diagnose the electrical and/or mechanical problems.
MEETS STANDARD	10.3.1 Explain the causes of electrical problems. 10.3.2 Explain the causes of mechanical problems. 10.3.3 Troubleshoot and correct various electrical faults. 10.3.4 Troubleshoot and correct various mechanical faults.
APPROACHES STANDARD	<ul style="list-style-type: none">♦ Identify a mechanical cooling problem.♦ Identify an electrical cooling problem.

Content and Performance Standards

Air Handling

Content Standard 11.0: The student will understand the principles and effect of airflow and duct design on air conditioning system operations.

Performance Standard 11.1 The student will understand the requirements of supplying air to an area to be environmentally controlled.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Use a duct calculator to determine duct size; trunk size; branch ducts; velocity; cubic feet per minute (cfm); total available static pressure and friction loss.◆ Calculate airflow factors for heating and cooling and size registers, grilles and diffusers.
MEETS STANDARD	11.1.1 Describe how to control airflow in duct work. 11.1.2 Calculate and design ducts for proper airflow. 11.1.3 Calculate equivalent length of trunk and branch ducts. 11.1.4 Calculate total effective length of duct runs.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Draw layout of return and supply duct runs.

Nevada Academic Standards Correlation: Math (1.12.1, 3.12.2, 3.12.5)

Content and Performance Standards

Content Standard 11.0: The student will understand the principles and effect of airflow and duct design on air conditioning system operations.

Performance Standard 11.2 The student will install and service air-filtering systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none">♦ Calculate the required quantity of electrostatic filters needed based on the cubic volume of air exchange in an occupied space.
MEETS STANDARD	<p>11.2.1 Describe the various types of mechanical air filters (i.e., disposable, high efficiency, and electrostatic).</p> <p>11.2.2 Describe the operation of electronic air cleaners.</p> <p>11.2.3 Install an electrostatic air cleaner system into existing ductwork.</p> <p>11.2.4 Install an electronic air cleaner system into existing ductwork.</p> <p>11.2.5 Remove and clean pre-filters and cells, and inspect ionizer wires and power packs.</p>
APPROACHES STANDARD	<ul style="list-style-type: none">♦ Describe the operation of an electrostatic air filter.♦ List the common types of air filters

Nevada Academic Standards Correlation: Science (P.12.A.3, P.12.B.2)

Content and Performance Standards

Content Standard 11.0: The student will understand the principles and effect of airflow and duct design on air conditioning system operations.

Performance Standard 11.3 The student will understand how various types of fan/blower systems operate.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Interpret the fans/blowers curve.◆ Select the fans/blowers via the curve.◆ Check fans/blowers performance via curves.
MEETS STANDARD	<p>11.3.1 Define the different types of fans/blowers. 11.3.2 Define the types of centrifugal fans/blowers. 11.3.3 Check for proper rotation. 11.3.4 Check and measure voltage and amperage draws.</p>
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Adjust the pulley to vary amperage draw.

Content and Performance Standards

Electric Motors

Content Standard 12.0: The student will understand the various types of electrical motors used in air conditioning systems.

Performance Standard 12.1 The student will understand the function, operation and service of motors used in air conditioning systems.	
EXCEEDS STANDARD	♦ Demonstrate the proper use of test equipment for electric motor service and maintenance.
MEETS STANDARD	12.1.1 Demonstrate electric motor theory and design while utilizing magnetism and electromotive force. 12.1.2 Explain how motor windings affect rotation. 12.1.3 Explain how the number of poles affects the speed and rotation of motors.
APPROACHES STANDARD	♦ Demonstrate oil-clean, preventative maintenance as pertains to electric motor service.

Nevada Academic Standards Correlation: Science (P.12.B.2)

Content and Performance Standards

Content Standard 12.0: The student will understand the various types of electrical motors used in air conditioning systems.

Performance Standard 12.2 The student will understand the various types of motors and motor components used in air conditioning systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Explain the significance of power factor. ◆ Explain the use of Back Electromotive Force as it pertains to the operation of the electric motors.
MEETS STANDARD	<p>12.2.1 Demonstrate electric motor theory design incorporating various frames, horsepower and mounting techniques.</p> <p>12.2.2 Describe different types of motor design.</p> <p>12.2.3 Explain the function of capacitors in motor circuits.</p> <p>12.2.4 Determine the equivalent capacitance in parallel and series circuits.</p> <p>12.2.5 Compute total Micro Farad (MFD) and voltage ratings in parallel or series circuits.</p> <p>12.2.6 Explain operation and application of various types of motors including but not limited to: capacitor, multi-speed, various phase motors.</p> <p>12.2.7 Describe starting components associated with single-phase motors.</p> <p>12.2.8 Build a basic motor using a piece of wood, copper wire and a coat hanger.</p> <p>12.2.9 Draw and explain the starting and run circuit for a single-phase CSIR compressor using a current type starting relay.</p> <p>12.2.10 Draw and explain the starting and run circuit for a single-phase CSCR compressor using a potential starting relay.</p> <p>12.2.11 Draw and explain the circuit for a PSC compressor.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Determine physical conditions of motor bearings and rotors. ◆ Determine the differences of the run and start capacitors ◆ Determine the uses of the run and start capacitors.

Nevada Academic Standards Correlation: Science (P.12.B.2); Math (1.12.1)

Content and Performance Standards

Content Standard 12.0: The student will understand the various types of electrical motors used in air conditioning systems.

Performance Standard 12.3 The student will understand the operation of three-phase motors.	
EXCEEDS STANDARD	♦ Summarize the advantages and disadvantages of using single-phase versus three-phase motors.
MEETS STANDARD	12.3.1 Explain the operation and application of three-phase motors. 12.3.2. Describe various protection devices associated with three-phase motors. 12.3.3. Describe part winding start of a three-phase motor. 12.3.4. Draw a Delta and Wye schematic for three-phase applications. 12.3.5. Adjust the amperage on a mag-starter for three-phase motors.
APPROACHES STANDARD	♦ Demonstrate how to reverse rotation on three-phase motors.

Nevada Academic Standards Correlation: Science (P.12.C.2)

Content and Performance Standards

Electric Heating Systems

Content Standard 13.0: The student will demonstrate competency in the operation and maintenance of unitary and electrical heating systems.

Performance Standard 13.1 The student will operate and test an electric heating system.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Wire high and low voltage for electric heat sequences.
MEETS STANDARD	<ul style="list-style-type: none">13.1.1 Explain the use of sequencers in electric furnaces.13.1.2 Explain the effects of airflow on temperature rise.13.1.3 Inspect heating elements and insulators.13.1.4 Test thermal fuses.13.1.5 Inspect all electrical connections.13.1.6 Check for proper temperature.13.1.8 Test the electrical sequence of operation of electric furnaces.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Identify the appropriate applications for the use of electric heat.◆ Identify electric heating system components.

Content and Performance Standards

Heat Pump Systems

Content Standard 14.0: The student will demonstrate a working knowledge of reverse cycle heating systems and emergency heat applications.

Performance Standard 14.1 The student will understand the operation of heat pumps.	
EXCEEDS STANDARD	♦ Calculate both economic and thermal balance points.
MEETS STANDARD	14.1.1 Explain the basic theory of various types of heat pump systems. 14.1.2 Explain the function of the electrical and mechanical components of the heat pump systems. 14.1.3 Analyze and explain the refrigerant cycle in cooling, heating and defrosting, identifying the pressure and state of the refrigerant at any point in the circuit. 14.1.4 Explain the different types of defrost methods. 14.1.5 Describe the operations and functions of the timing circuits in defrost controls. 14.1.6 Demonstrate multi-stage heating thermostat operations. 14.1.7 Check reversing valves for proper temperatures. 14.1.8 Calculate temperature settings for multiple outdoor thermostats. 14.1.9 Check the refrigerant charge using a charging chart. 14.1.10 Check the sequence of operation of an air-to-air split system heat pump for cooling, heating and defrost modes.
APPROACHES STANDARD	♦ Explain the history of heat pumps. ♦ Explain terms typically used for heat pumps, including but not limited to: Seasonal Energy Efficiency Ratio (SEER), Coefficient of Performance (COP), Balance Points and Outdoor Design Temperature (ODT). ♦ Identify which three components of a heat pump system are controlled directly during a defrost cycle.

Nevada Academic Standards Correlation: Math (1.12.1)

Content and Performance Standards

Content Standard 14.0: The student will demonstrate a working knowledge of reverse cycle heating systems and emergency heat applications.

Performance Standard 14.2 The student will understand the various applications for the heat pump.	
EXCEEDS STANDARD	♦ Analyze and compare the operation and performance of the different types of heat pump systems.
MEETS STANDARD	14.2.1 Compare and contrast different types of heat pump systems: air-cooled, water-cooled and geothermal. 14.2.2 Explain the integration and operation of the air-to-air heat pump with electric resistance heat. 14.2.3 Explain the integration and operation of the water-to-air heat pump with electric resistance heat. 14.2.4 Explain applications for open- versus closed-loop geothermal heat pump systems 14.2.3 Mechanically and electrically connect and inspect air and water source heat pumps.
APPROACHES STANDARD	♦ Describe the operation of a basic heat pump with an auxiliary heat source.

Nevada Academic Standards Correlation: Science (E.12.A.4, E.12.C.4)

Content and Performance Standards

Content Standard 14.0: The student will demonstrate a working knowledge of reverse cycle heating systems and emergency heat applications.

Performance Standard 14.3 The student will describe the functions of heat pump systems controls and install basic heat pump controls.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Perform tests on reversing valves to determine mechanical or electrical failure.
MEETS STANDARD	<ul style="list-style-type: none"> 14.3.1 Explain the operation and function of a reversing valve. 14.3.2 Explain the operation of each type of defrost control. 14.3.3 Explain the operation of flow and safety controls for a geothermal system. 14.3.4 Describe the purpose and function of outdoor thermostats. 14.3.5 Describe the sequence and purpose of emergency heat controls. 14.3.6 Explain the operation of check valves in heat pumps. 14.3.7 Describe the sequence between the first stage and second stage of a multiple stage thermostat. 14.3.8 Describe the function of auxiliary heat devices and controls. 14.3.9 Select and install appropriate system thermostat. 14.3.10 Wire the control circuit of a heat pump system. 14.3.11 Install or replace a heat-sequencing relay.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify the main types of defrost controls.

Nevada Academic Standards Correlation: Science (E.12.A.4, P.12.C.6)

Content and Performance Standards

Commercial Refrigeration

Content Standard 15.0: The student will apply acquired knowledge of refrigeration systems to food service applications, medical industries and transportation refrigeration.

Performance Standard 15.1 The student will understand the aspects of commercial refrigeration.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Describe the differences in compressor displacement between the various temperature ranges. ◆ Determine compressor capacity using the compressor's curve. ◆ Determine the correct operating amps using the compressors curve.
MEETS STANDARD	<p>15.1.1 Explain basic low- and high-pressure control theory and operation.</p> <p>15.1.2 Explain the operation and components used for the pump-down cycle.</p> <p>15.1.3 Explain the evaporator and the condenser side of a system.</p> <p>15.1.4 Describe the methods used for cycling the compressor on and off.</p> <p>15.1.5 Explain methods of defrost.</p> <p>15.1.6 Explain methods of head pressure control systems.</p> <p>15.1.7 Determine the terminal identification of a single-phase compressor.</p> <p>15.1.8 Define and compute compression ratio and the effect suction and discharge pressure have on compression ratio.</p> <p>15.1.9 Explain the requirements of food preservation in both medium and low temperature applications.</p> <p>15.1.10 Check the operation of a compressor in a particular system.</p> <p>15.1.11 Check system charge, superheat and sub-cooling.</p> <p>15.1.12 Set cut-in and cut-out for a special product.</p> <p>15.1.13 Draw the wiring diagrams for an across-the-line start and a part-winding start.</p> <p>15.1.14 Draw a ladder diagram of a system equipped with a pump-down cycle.</p> <p>15.1.15 Draw the schematic of a single-phase and a three-phase compressor motor.</p> <p>15.1.16 Measure the compressor windings and determine if they are correct.</p>

	15.1.17 Measure the operating amps and determine if they are correct. 15.1.18 Check the operation of the defrost cycle and adjust the time clock. 15.1.19 Adjust head pressure controls for proper operation. 15.1.20 Check operation of equipment equipped for automatic pump down.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Describe the different types and design of compressors used in commercial refrigeration (i.e., hermetic, semi-hermetic, open, scroll and screw).

Nevada Academic Standards Correlation: Science (P.12.B.2, P.12.B.3, P.12.C.6); Math (1.12.1, 3.12.5)

Content and Performance Standards

Content Standard 15.0: The student will apply acquired knowledge of refrigeration systems to food service applications, medical industries and transportation refrigeration.

Performance Standard 15.2 The student will understand the use of multiple evaporators on a single system.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Layout a piping diagram of a multiple evaporator system showing the placement of required low side components (TXVs, EPRs, CK valves, etc.) and required high side components.
MEETS STANDARD	<p>15.2.1 Describe the advantages and disadvantages of parallel and one-on-one rack systems.</p> <p>15.2.2 Describe how compressors are connected.</p> <p>15.2.3 Describe the physical construction of a common rack system.</p> <p>15.2.4 Describe the advantages of controlling capacity using the parallel system.</p> <p>15.2.5 Explain the problems associated with parallel rack systems (i.e., oil level control and contamination due to a compressor burnout).</p> <p>15.2.6 Explain the advantages of multiple evaporator systems.</p> <p>15.2.7 Explain the difference in compressor requirements for a primary/secondary system.</p> <p>15.2.8 Explain the difference between even and uneven parallel systems.</p> <p>15.2.9 Explain the operation of the defrost cycle.</p> <p>15.2.10 Check the staging of compressors with changes in system loads.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Layout a piping diagram of a single compressor system with primary/secondary evaporators.

Content and Performance Standards

Content Standard 15.0: The student will apply acquired knowledge of refrigeration systems to food service applications, medical industries and transportation refrigeration.

Performance Standard 15.3 The student will inspect and service commercial ice makers.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Perform a production capacity test and show the actual weight of ice produced in a 24-hour time period.
MEETS STANDARD	<ul style="list-style-type: none"> 15.3.1 Explain the operation of ice making for both cubed and flaked ice. 15.3.2 Explain water spray system for ice making. 15.3.3 Describe the styles of ice makers and explain the sequence of operation of each. 15.3.4 Follow manufacturer's instructions for cleaning the evaporator. 15.3.5 Follow manufacturer's instructions for cleaning the condenser. 15.3.6 Check the harvest cycle. 15.3.7 Adjust cube size. 15.3.8 Clean ice storage bin. 15.3.9 Inspect and clean drains as necessary. 15.3.10 Replace bearings and seals in flaker-type machine. 15.3.11 Replace auger motor in a flaker-type machine. 15.3.12 Check and adjust water pressure. 15.3.13 Level the machine. 15.3.14 Check water pump. 15.3.15 Describe different types of water filtration systems. 15.3.16 Adjust float valve assembly. 15.3.17 Change float valve assembly. 15.3.18 Check production capacity of a given ice machine.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Describe the three common types of ice makers: cubed, crushed and flaked.

Content and Performance Standards

Content Standard 15.0: The student will apply acquired knowledge of refrigeration systems to food service applications, medical industries and transportation refrigeration.

Performance Standard 15.4 The student will describe the operation of dispensing freezers.	
EXCEEDS STANDARD	♦ Explain the importance of product overrun.
MEETS STANDARD	15.4.1 Describe the application of dispensing freezers. 15.4.2 Describe the types of dispensing freezers. 15.4.3 Describe the design and construction of dispensing freezers. 15.4.4 Describe the maintenance requirements of a dispensing freezer including sanitary requirements. 15.4.5 Check the operation of a dispensing freezer.
APPROACHES STANDARD	♦ Clean and set-up a dispensing freezer.

Nevada Academic Standards Correlation: Science (L.12.C.1)

Content and Performance Standards

Content Standard 15.0: The student will apply acquired knowledge of refrigeration systems to food service applications, medical industries and transportation refrigeration.

Performance Standard 15.5 The student will inspect and service a commercial refrigeration system.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Describe the electrical/mechanical sequence from electrical schematic.
MEETS STANDARD	<ul style="list-style-type: none"> 15.5.1 Explain the operation of low ambient head pressure control systems (fan cycling, dampers and flooding of condenser). 15.5.2 Explain the function operation of oil separation and return to the compressor crankcase. 15.5.3 Explain the oil level (balance) of multi-parallel compressor applications. 15.5.4 Explain the defrost cycle. 15.5.5 Establish the pressure control settings. 15.5.6 Inspect the suction stop valve. 15.5.7 Inspect the system for proper refrigerant charge. 15.5.8 Charge the system with refrigerant on liquid side and suction side. 15.5.9 Test and adjust all operating and safety controls. 15.5.10 Replace filter driers. 15.5.11 Check the compressor oil. 15.5.12 Change the oil in a compressor crankcase. 15.5.13 Inspect and repair electrical circuits for defective connections. 15.5.14 Troubleshoot a problem from an electrical schematic. 15.5.15 Check the oil separator operation and return. 15.5.16 Draw a ladder diagram for various commercial refrigeration systems.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Check for and repair refrigerant leaks.

Content and Performance Standards

System Load Calculations

Content Standard 16.0: The student will calculate the cooling and heating requirements for an environmental living space.

Performance Standard 16.1 The student will calculate heat loss and gains through various insulating materials.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Determine the total resistance to heat flow utilizing R and U heat factors.
MEETS STANDARD	16.1.1 Calculate "U" value: (Btu/hr ft ² F). 16.1.2 Calculate "K" value: (Btu/hr ft ² F). 16.1.3 Calculate "C" value: (Btu/hr ft ² F). 16.1.4 Calculate "R" value: (hr ft ² F/Btu). 16.1.5 Interpret the heat transfer tables ("U," "K," "C," "R"). 16.1.6 Explain various heat transfer through sources such as: conduction, infiltration (sensible and latent), product, radiation and miscellaneous loads (i.e., people, motors, equipment, sensible and latent). 16.1.7 Explain the purpose of vapor barriers. 16.1.8 Interpret tables of specific heat values, latent heat and heat of respiration. 16.1.9 Calculate total heating transfer value of any surface (R) – (U).
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Determine the thickness of various R series insulations.

Nevada Academic Standards Correlation: Math (1.12.1, 2.12.3); Science (P.12.C.2, P.12.C.5, E.12.A.4)

Content and Performance Standards

Content Standard 16.0: The student will calculate the cooling and heating requirements for an environmental living space.

Performance Standard 16.2 The student will calculate heat loss through various construction materials.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Calculate and determine the heating system required for a given structure design. ◆ Make recommendations to reduce heat loss through a structure design.
MEETS STANDARD	<p>16.2.1 Determine the total resistance to heat flow in a structure design.</p> <p>16.2.2 Calculate the size of rooms, wall height, area of walls contacting outside air and wall openings from building prints.</p> <p>16.2.3 Calculate the conduction gained through walls, roofs, floors, and windows.</p> <p>16.2.4 Calculate the infiltration for doors, windows and ventilation systems.</p> <p>16.2.5 Calculate ventilation loads.</p> <p>16.2.6 Calculate the effects of bath and/or kitchen exhaust systems.</p> <p>16.2.7 Calculate the effects of power roof ventilators.</p> <p>16.2.8 Calculate total heating loads.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Calculate the R and U value of an external wall.

Nevada Academic Standards Correlation: Science (P.12.C.5, E.12.A.4); Math (1.12.1, 3.12.5)

Content and Performance Standards

Content Standard 16.0: The student will calculate the cooling and heating requirements for an environmental living space.

Performance Standard 16.3 The student will calculate heat gains through various construction materials.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Calculate cooling system requirements for a structure design. ◆ Make recommendations to reduce heat gains through a structure design.
MEETS STANDARD	<p>16.3.1 Calculate the Cooling Load Temperature Difference (CLTD).</p> <p>16.3.2 Calculate conduction loads gained through doors, walls, windows and floors.</p> <p>16.3.3 Calculate equipment loads from appliances, such as washers, dryers and ranges.</p> <p>16.3.4 Calculate infiltration and ventilation loads.</p> <p>16.3.5 Calculate refrigeration sensible heat ratios.</p> <p>16.3.6 Calculate storage factors.</p> <p>16.3.7 Calculate effects of bath and kitchen exhaust systems.</p> <p>16.3.8 Calculate effects of power roof ventilators.</p> <p>16.3.9 Calculate total cooling load for both sensible and latent heat.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Calculate the R and U value of windows for the structure design.

Nevada Academic Standards Correlation: Science (E.12.A.4); Math (1.12.1, 3.12.5)

Content and Performance Standards

System Installation and Start-Up

Content Standard 17.0: The student will perform system installation and start-ups.

Performance Standard 17.1 The student will inspect and perform check-out procedures to safely start and operate various gas-heating systems.	
EXCEEDS STANDARD	♦ Create a checklist of start-up standard procedures.
MEETS STANDARD	<ul style="list-style-type: none">17.1.1 Explain the importance of manufacturer's installation and start-up guide.17.1.2 Demonstrate the use of tools and instruments for start-up and check-out of heating systems.17.1.3 Determine system electrical, mechanical and code requirements.17.1.4 Verify the equipment airflow and distribution requirements.17.1.5 Check the operation of all electrical control components.17.1.6 Check the operation of gas train components and measurements.17.1.7 Check the ignition systems.17.1.8 Evaluate the fuel supply systems.17.1.9 Test for proper combustion.17.1.10 Check the electrical components for operation and wiring connections.17.1.11 Check for correct heating input and adjust to manufacturer's specifications.
APPROACHES STANDARD	♦ Check for proper line duty and pilot duty voltage.

Content and Performance Standards

Content Standard 17.0: The student will perform system installation and start-ups.

Performance Standard 17.2 The student will inspect and perform check-out procedures to safely start and operate reverse-cycle heating systems.	
EXCEEDS STANDARD	♦ Create a checklist of start-up standard procedures for heat pumps.
MEETS STANDARD	17.2.1 Interpret manufacturer's installation and operation requirements. 17.2.2 Demonstrate the proper use of tools and test equipment common to heat pump systems. 17.2.3 Determine equipment electrical requirements. 17.2.4 Verify equipment airflow and distribution. 17.2.5 Check the operation of all electrical and mechanical components. 17.2.6 Check the supplementary and emergency heat.
APPROACHES STANDARD	♦ Check the system operation in the heating, cooling and defrosting modes.

Content and Performance Standards

Content Standard 17.0: The student will perform system installation and start-ups.

Performance Standard 17.3 The student will inspect and perform check-out procedures to safely start and operate cooling-only systems.	
EXCEEDS STANDARD	♦ Create a checklist of start-up standard procedures for cooling-only systems.
MEETS STANDARD	17.3.1 Understand the importance of manufacturer's installation and operation requirements. 17.3.2 Demonstrate the proper use of tools and test equipment. 17.3.3 Determine the equipment electrical requirements. 17.3.4 Verify the equipment airflow and distribution requirements. 17.3.5 Check the operation of all electrical and mechanical components. 17.3.6 Check the system operation while following all safety procedures.
APPROACHES STANDARD	♦ Mount and wire a cooling-only thermostat and check for proper operation.

Content and Performance Standards

System Servicing and Troubleshooting

Content Standard 18.0: The student will use acquired knowledge to perform system servicing and troubleshooting procedures.

Performance Standard 18.1 The student will troubleshoot and service mechanical system problems.	
EXCEEDS STANDARD	♦ Demonstrate a systematic approach to diagnosing mechanical system problems and determining corrective measures.
MEETS STANDARD	18.1.1 Demonstrate the proper use of tools and test equipment. 18.1.2 Record system data for the mechanical system operation. 18.1.3 Verify the mechanical system operation is acceptable. 18.1.4 Determine the cause of failure in system components. 18.1.5 Determine the actual system airflow using the appropriate test equipment. 18.1.6 Determine system airflow requirements.
APPROACHES STANDARD	♦ Identify and describe possible causes of failure and how to eliminate causes.

Content and Performance Standards

Content Standard 18.0: The student will use acquired knowledge to perform system servicing and troubleshooting procedures.

Performance Standard 18.2 The student will troubleshoot and service electrical system problems.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate a systematic approach to diagnosing electrical system problems and determining corrective measures.
MEETS STANDARD	<ul style="list-style-type: none"> 18.2.1 Outline electrical diagrams into a sequence of operations. 18.2.2 Interpret and electrical-mechanical sequence from an electrical schematic. 18.2.3 Describe the electrical performance of each component throughout the system. 18.2.4 Wire a complete air conditioner, heat pump and/or furnace. 18.2.5 Use electrical test instruments to diagnose electrical problems and correct electrical system performance. 18.2.6 Troubleshoot a faulty compressor overload protector. 18.2.7 Change a schematic diagram to a "ladder" diagram in a drawing.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Record electrical system data.

Nevada Academic Standards Correlation: Science (P.12.C.6)

Content and Performance Standards

Content Standard 18.0: The student will use acquired knowledge to perform system servicing and troubleshooting procedures.

Performance Standard 18.3 The student will troubleshoot and service gas heating system problems.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate a systematic approach to diagnosing gas heating system problems and determining corrective measures.
MEETS STANDARD	<ul style="list-style-type: none"> 18.3.1 Explain the combustion theory for various gasses used in heating systems. 18.3.2 Describe possible causes and corrections of gas component failures in heating systems. 18.3.3 Determine and measure combustion air, ventilation air and unit/system air requirements. 18.3.4 Determine the cause of failure in a heating system. 18.3.5 Explain a heat exchanger inspection. 18.3.6 Check and clean heat exchangers. 18.3.7 Check airflow from the furnace of an air handler.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Record data and verify system operation.

Nevada Academic Standards Correlation: Science (P.12.A.1, P.12.C.2); Math (1.12.1, 3.12.2)

Content and Performance Standards

Content Standard 18.0: The student will use acquired knowledge to perform system servicing and troubleshooting procedures.

Performance Standard 18.4 The student will troubleshoot and service problems in a reverse-cycle heating system.	
EXCEEDS STANDARD	♦ Test and evaluate the operation of the refrigeration cycle in cooling modes, heating modes and defrost cycle.
MEETS STANDARD	18.4.1 Test the operation of the supplementary heat component(s). 18.4.2 Test the operation of the emergency heat status for the heat pump system. 18.4.3 Record the appropriate data to evaluate complete system operation. 18.4.4 Test the proper operation of the reversing valve. 18.4.5 Check the operation of defrost controls.
APPROACHES STANDARD	♦ Inspect the system wiring and tighten connections.

Nevada Academic Standards Correlation: Science (N.12.A.1)

Content and Performance Standards

Content Standard 18.0: The student will use acquired knowledge to perform system servicing and troubleshooting procedures.

Performance Standard 18.5 The student will troubleshoot and service problems in cooling-only systems.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate a systematic approach to diagnosing cooling-only system problems and determining corrective measures. ◆ Analyze system performance according to manufacturer's specifications.
MEETS STANDARD	<p>18.5.1 Explain the required performance checks.</p> <p>18.5.2 Explain the method of measuring superheat, sub-cooling, evaporator and condenser splits.</p> <p>18.5.3 Explain the effects of overcharge and undercharge of refrigerant.</p> <p>18.5.4 Explain the effects of improper airflow.</p> <p>18.5.5 Check for the proper refrigerant charge.</p> <p>18.5.6 Check for proper thermostat and electrical controls.</p> <p>18.5.7 Check and replace filter/driers.</p> <p>18.5.8 Check available voltage and install high and low side manifold gauges.</p> <p>18.5.9 Measure superheat and sub-cooling.</p> <p>18.5.10 Check evaporator splits.</p> <p>18.5.11 Check amperage of each motor.</p> <p>18.5.12 Check electrical component operation.</p> <p>18.5.13 Troubleshoot A/C systems from electrical schematics.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Check system for system leaks. ◆ Inspect electrical connections.

Nevada Academic Standards Correlation: Math (1.12.1, 3.12.2); Science (P.12.C.6)

Content and Performance Standards

Preventative Maintenance

Content Standard 19.0: The student will demonstrate knowledge of the various maintenance requirements and how to implement manufacturer's recommendations.

Performance Standard 19.1 The student will demonstrate maintenance requirements and implement manufacturer's recommendations.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ The student will develop a preventative maintenance checklist for unitary and split systems.
MEETS STANDARD	<ul style="list-style-type: none">19.1.1 Explain the broad tasks and timelines for a quality maintenance program.19.1.2 Explain why each step of the preventative maintenance program is necessary.19.1.3 Explain the performance benefits associated with proper equipment maintenance.19.1.4 Demonstrate various maintenance tasks on major system components.
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Explain the various types of maintenance programs.◆ Develop a list of tools needed to perform the preventative maintenance program.

Content and Performance Standards

Refrigerant Recovery

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.1 The student will demonstrate knowledge of the regulations that affect ozone depletion.	
EXCEEDS STANDARD	♦ Summarize the federal Clean Air Act.
MEETS STANDARD	20.1.1 Explain the significance of the Montreal Protocol. 20.1.2 Explain the significance of the Clean Air Act. 20.1.3 Explain the EPA requirements for technician certification. 20.1.4 Explain the EPA requirements for refrigerant recovery, recycling and reclamation. 20.1.5 Explain the EPA requirements for disposal of systems. 20.1.6 Explain the EPA requirements for labeling. 20.1.7 Explain the EPA requirements for shipping. 20.1.8 Explain the EPA requirements for leak detection. 20.1.9 Explain the EPA requirements of the Significant New Alternatives Policy Program (SNAP). 20.1.10 Explain the EPA requirements for recordkeeping. 20.1.11 Explain Department of Transportation (DOT) requirements for the transportation of refrigerants. 20.1.12 Determine if a refrigerant container is DOT-approved and if the container needs to be retested. 20.1.13 Determine if recovery/recycle equipment is certified and meets requirements. 20.1.14 Properly dispose of empty non-refillable cylinders. 20.1.15 Use recovery equipment and prepare a system for disposal.
APPROACHES STANDARD	♦ Explain refrigerants affect ozone depletion.

Nevada Academic Standards Correlation: Science (E.12.A.2, E.12.A.3, E.12.A.4, E.12.C.4)

Content and Performance Standards

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.2 The student will demonstrate refrigerant handling safety techniques while complying with EPA regulations.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Explain the interactions of refrigerants in the stratosphere as compared to the chemicals emitted in volcanic eruptions.
MEETS STANDARD	20.2.1 Describe the problems associated with mixing refrigerants. 20.2.2 Describe the methods of determining when a recovery cylinder is full. 20.2.3 Describe the problems associated with component isolation where unsafe hydrostatic pressures can occur. 20.2.4 Describe the problems associated with contaminants left in a refrigerant system after recovery. 20.2.5 Explain the impact of state and local codes on system application and retrofit. 20.2.6 Explain proper disposal of oil, components and other materials. 20.2.7 Explain state and local licensing requirements. 20.2.8 Explain the MSDS sheets for individual refrigerants.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Explain global warming and its effects on the environment.

Nevada Academic Standards Correlation: Science (E.12.C.4)

Content and Performance Standards

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.3 The student will demonstrate a thorough understanding of the methods of refrigerant recovery, recycling and reclamation.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate the use of recovery equipment, using system dependent, self-contained and push-pull methods of refrigerant recovery.
MEETS STANDARD	20.3.1 Describe how to manually pump down a system. 20.3.2 Describe how to isolate system components. 20.3.3 Describe the dependent recovery method. 20.3.4 Describe self-contained recovery equipment and methods of recovery. 20.3.5 Describe the push-pull recovery method. 20.3.6 Describe differences between recovered, recycled and reclaimed refrigerants. 20.3.7 Describe the advantages, disadvantages, and applications of liquid and vapor refrigerant recovery.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ List methods for decreasing recovery time.

Nevada Academic Standards Correlation: Science (E.12.C.4)

Content and Performance Standards

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.4 The student will demonstrate a thorough understanding of the use of equipment for refrigerant recovery, recycling and reclamation.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Demonstrate the use of recovery equipment, using system dependent, self-contained and push-pull methods of refrigerant recovery.
MEETS STANDARD	<p>20.4.1 Describe procedures for recovering multiple refrigerants with the same recovery unit.</p> <p>20.4.2 Describe maintenance and efficiency testing procedures for recovery units.</p> <p>20.4.3 Describe maintenance and testing for refrigerant recovery cylinders.</p> <p>20.4.4 Explain when to change filter-driers in recycling equipment.</p> <p>20.4.5 Explain methods of purging non-condensables when utilizing recycling equipment.</p> <p>20.4.6 Demonstrate the method of identifying a type of refrigerant in a given recovery cylinder.</p> <p>20.4.7 Perform procedures for recovery of a refrigerant.</p> <p>20.4.8 Perform procedures for recycling of a refrigerant.</p> <p>20.4.9 Perform maintenance on a recovery or recycling machine.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify proper equipment for a particular recovery, recycling and reclamation job. ◆ Identify recovery cylinders.

Nevada Academic Standards Correlation: Science (E.12.C.4)

Content and Performance Standards

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.5 The student will determine if an alternative refrigerant is applicable for retrofitting a specific system.	
EXCEEDS STANDARD	◆ Procure the Manufacturer's Changeover Guidelines and follow the retrofit procedures.
MEETS STANDARD	20.5.1 Determine if the alternative refrigerant and/or lubricant is on the EPA SNAP list. 20.5.2 Determine if the alternative refrigerant and/or lubricant is U.L. listed. 20.5.3 Determine if the alternative refrigerant and/or lubricant meets the equipment manufacturer's approval. 20.5.4 Determine the lubricant required for the alternate refrigerants.
APPROACHES STANDARD	◆ Measure the residual mineral oil in a system being changed from a CFC to an HFC refrigerant.

Nevada Academic Standards Correlation: Science (E.12.C.4)

Content and Performance Standards

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.6 The student will explain the different classes of refrigerants.	
EXCEEDS STANDARD	♦ Identify when saturation pressure and temperature do not match the refrigerant.
MEETS STANDARD	<p>20.6.1 Compare and contrast the following classes of refrigerants: CFC Refrigerants, HCFC Refrigerants, HFC Refrigerants and HC Refrigerants.</p> <p>20.6.2 Explain the chemical characteristics of Azeotropic mixtures (ASHRAE 500 series).</p> <p>20.6.3 Explain the chemical characteristics of Zeotropic blends (ASHRAE 400 series).</p> <p>20.6.4 Explain physical and chemical properties as it pertains to flammability, toxicity, miscibility and oil return.</p> <p>20.6.5 Define pure refrigerants and azeotropic mixtures.</p> <p>20.6.6 Define zeotropic mixtures.</p> <p>20.6.7 Define zeotropic blends.</p> <p>20.6.8 Explain fractionization of blends.</p> <p>20.6.9 Look up and use the saturation pressure and temperature for a single element refrigerant and azeotropic, zeotropic and blends.</p> <p>20.6.10 Calculate superheat and subcooling.</p> <p>20.6.11 Calculate superheat and subcooling glide.</p> <p>20.6.12 Explain the function of lubricants in systems.</p> <p>20.6.13 Explain the different types and applications of lubricants.</p> <p>20.6.14 Explain properties of lubricants (i.e., materials compatibility, miscibility, viscosity, flash point, and hydroscopic).</p> <p>20.6.15 Describe proper oil disposal.</p> <p>20.6.16 Draw an oil sample from system and perform acid test.</p> <p>20.6.17 Demonstrate proper handling of POEs.</p>
APPROACHES STANDARD	♦ Identify the color and classification of refrigerants by Pantone Matching System (PMS) color number.

Nevada Academic Standards Correlation: Science (E.12.A.2, E.12.A.3, E.12.C.4, P.12.A.1);
Math (1.12.1, 3.12.2)

Content and Performance Standards

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

Performance Standard 20.7 The student will complete the EPA certification test standard 608.	
EXCEEDS STANDARDS	♦ Obtain the EPA certification for Universal type.
MEETS STANDARD	20.7.1 Obtain the EPA 608 CORE and one of the three types of technician certification.
APPROACHES STANDARD	♦ Pass the EPA 608 CORE exam.

Content and Performance Standards

Employability Skills

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.1 Students will demonstrate problem-solving skills.	
EXCEEDS STANDARD	♦ Create an action plan based upon a solution to a work-related problem.
MEETS STANDARD	21.1.1 Solve a work-related problem using the appropriate steps in the problem-solving process. 21.1.2 Demonstrate brainstorming techniques. 21.1.3 Examine and explain the advantages and disadvantages of alternative solutions to one or more problems.
APPROACHES STANDARD	♦ Identify the benefits of solving a work-related problem.

Nevada Academic Standards Correlation: English (10.12.2, 10.12.3)

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.2 Students will demonstrate critical-thinking skills.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Explain the difference between reliable and unreliable observations and statements of facts.
MEETS STANDARD	21.2.1 Identify and explain the essential elements of the critical-thinking process. 21.2.2 Demonstrate critical-thinking skills necessary in the workplace. 21.2.3 Explain how emotional thinking and logical thinking affect decision making in the workplace. 21.2.4 Explain the difference between reliable and unreliable observations and statements of facts. 21.2.5 Recognize patterns or relationships through observation and discovery.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Recognize patterns or relationships through observation and discovery.

Nevada Academic Standards Correlation: English (10.12.1)

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.3 Students will demonstrate the ability to speak, write and listen effectively.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Organize information into the appropriate format in accordance with standard practices, which includes prewriting, drafting, proofreading, editing/revising, and preparing final copy.
MEETS STANDARD	<ul style="list-style-type: none"> 21.3.1 Explain the benefits of effective communication skills in the workplace. 21.3.2 Effectively interpret and respond to verbal and nonverbal messages. 21.3.3 Demonstrate proper telephone etiquette. 21.3.4 Effectively communicate thoughts, ideas and information in writing. 21.3.5 Organize ideas and communicate orally: is able to effectively demonstrate job skills to others. 21.3.6 Locate, understand and interpret written information in documents such as manuals, graphs and schedules. 21.3.7 Select and utilize an appropriate medium for conveying messages with dignity and respect. 21.3.8 Demonstrate sensitivity to cultural diversity in communication.
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify common communication barriers and methods for improving communication.

Nevada Academic Standards Correlation: English (4.12.6, 6.12.5, 7.12.1, 7.12.3, 7.12.4, 7.12.5)

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.4 Students will demonstrate the ability to select, apply and maintain appropriate trade tools and instruments.	
EXCEEDS STANDARD	<ul style="list-style-type: none">◆ Investigate and explain the use, benefits, and costs of technological developments in workplace and school.◆ Identify and demonstrate the appropriate use of technology to enhance the efficiency of the workplace and school.
MEETS STANDARD	<ul style="list-style-type: none">21.4.1 Demonstrate ability to utilize basic hand tools of the trade.21.4.2 Demonstrate ability to utilize electrical meters and pressure gauges.21.4.3 Demonstrate ability to utilize various electronic research methods.21.4.4 Demonstrate knowledge of the basic technology systems currently available and how they apply to your field (i.e., word processing, spreadsheets, multimedia applications and database).
APPROACHES STANDARD	<ul style="list-style-type: none">◆ Demonstrate routine maintenance and repair of trade tools and equipment.

Nevada Academic Standards Correlation: Math (3.12.4)

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.5 Students will demonstrate leadership and teamwork skills.	
EXCEEDS STANDARD	◆ Demonstrate the qualities of an effective leader and team member.
MEETS STANDARD	21.5.1 Work cooperatively with others when given a group project. 21.5.2 Explain traits necessary to effectively lead and influence individuals and groups. 21.5.3 Demonstrate appropriate attitudes and behaviors for effective leadership. 21.5.4 Demonstrate respect for team members, team processes, and team goals. 21.5.5 Participate in the implementation of a group's decision and evaluate the results.
APPROACHES STANDARD	◆ Describe the importance of company dress codes.

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development and lifelong learning.

Performance Standard 21.6 Students will demonstrate sound workplace ethics.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Incorporate ethical responsibilities related to individual performance, safety and customer satisfaction. ◆ Integrate personal and professional ethics into the workplace. ◆ Attend a class or workshop on professional ethics and/or workplace ethics.
MEETS STANDARD	<p>21.6.1 Develop personal work ethics through work experience.</p> <p>21.6.2 Describe the importance of ethics practiced in the workplace.</p> <p>21.6.3 Demonstrate regular attendance, promptness, and the willingness to follow instructions and complete an assigned task.</p> <p>21.6.4 Demonstrate appropriate personal and professional attitudes and behaviors.</p> <p>21.6.5 Demonstrate awareness of legal responsibilities related to individual performance, safety and customer satisfaction.</p> <p>21.6.6 Demonstrate knowledge of various types of harassment.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Explain the importance of regular attendance, promptness, and the willingness to follow instructions and complete an assigned task.

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.7 Students will demonstrate the ability to effectively manage resources in high performance workplaces.	
EXCEEDS STANDARD	◆ Develop a time schedule and prioritized task list to complete multiple-dispatched job assignments.
MEETS STANDARD	21.7.1 Identify and organize the human resources needed to complete a job assignment. 21.7.2 Identify and organize the material resources and space requirements needed to complete a job assignment. 21.7.3 Effectively use technology at its highest level to complete a job assignment. 21.7.4 Demonstrate cooperation and leadership in a team at school or in a workplace setting. 21.7.5 Recognize the need for management skills in the workplace with regard to stress, anger management and substance abuse. 21.7.6 Estimate costs and prepare a detailed work order.
APPROACHES STANDARD	◆ Use the basic components of effective time management.

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.8 Students will demonstrate career planning and development skills.	
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Establish long-term career goals. ◆ Outline progressive path to achieve career advancement. ◆ Attend local and/or regional trade associations and educational meetings.
MEETS STANDARD	<p>21.8.1 Prepare a job application.</p> <p>21.8.2 Prepare a personal resume.</p> <p>21.8.3 Complete a personal aptitude and interest inventory.</p> <p>21.8.4 Participate in a job interview.</p> <p>21.8.5 Establish short-term career goals.</p> <p>21.8.6 Use the Nevada Career Information System (NCIS) or a similar computer-based program to research careers in a chosen field.</p> <p>21.8.7 Participate in an organized job-shadowing activity.</p> <p>21.8.8 Participate in a community service project.</p> <p>21.8.9 Construct a career portfolio.</p> <p>21.8.10 Describe the role of trade associations, workforce development and community enrichment.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Outline processes for obtaining a job. ◆ Differentiate between long- and short-term career goals.

Nevada Academic Standards Correlation: English (5.12.5, 6.12.5, 7.12.1, 7.12.3, 7.12.4, 7.12.5, 9.12.1)

Content and Performance Standards

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

Performance Standard 21.9	Students will demonstrate job retention and lifelong learning skills.
EXCEEDS STANDARD	<ul style="list-style-type: none"> ◆ Develop long-term career-planning strategies. ◆ Cope with personal life situations while maintaining work/school performance. ◆ Explain the elements of a successful job interview.
MEETS STANDARD	<p>21.9.1 Maintain an employment/career portfolio.</p> <p>21.9.2 Identify and explain strategies for balancing work and family roles.</p> <p>21.9.3 Demonstrate understanding of the need for lifelong learning in a rapidly changing job market.</p> <p>21.9.4 Explain various strategies to maintain employment in the face of job reductions.</p> <p>21.9.5 Demonstrate interpersonal skills needed for job retention.</p> <p>21.9.6 Identify and model sound workplace ethics, such as loyalty, punctuality and initiative.</p> <p>21.9.7 Practice continuous self-assessment and goal modification for personal and professional growth.</p>
APPROACHES STANDARD	<ul style="list-style-type: none"> ◆ Identify sources of employment within the community. ◆ Identify interpersonal skills needed for job retention. ◆ Identify various educational options needed for job advancement.

CROSSWALK OF HVAC&R STANDARDS AND ACADEMIC STANDARDS

Content Standard 1.0: The student will demonstrate safe work practices while performing operations in the HVAC&R lab and/or internship program.

Performance Indicators	Academic Standards
1.3.3	<u>Science</u> P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S P.12.A.5 Students know chemical reactions can take place at different rates, depending on a variety of factors (i.e. temperature, concentration, surface area, and agitation). E/S P.12.A.7. Students know that, in chemical reactions, elements combine in predictable ratios, and the numbers of atoms of each element do not change. I/S
1.3.5	<u>Science</u> P.12.A.5 Students know chemical reactions can take place at different rates, depending on a variety of factors (i.e. temperature, concentration, surface area, and agitation). E/S P.12.A.6 Students know chemical reactions either release or absorb energy. E/S P.12.A.7 Students know that, in chemical reactions, elements combine in predictable ratios, and the numbers of atoms of each element do not change. I/S

Content Standard 2.0: The student will demonstrate knowledge of the history of air conditioning and refrigeration and explore related career paths.

2.2.2	<u>Science</u> P.12.C.5. Students know the relationship between heat and temperature. I/S
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Content Standard 3.0: The student will understand thermodynamic properties and heat transfer principles and interpret their significance in air conditioning and refrigeration technology.

3.1.1	<u>Science</u> P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S P.12.C.2 Students know energy forms can be converted. E/S
3.1.7	<u>Science</u> P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S
3.1.9, 3.1.10, 3.1.11, 3.1.12	<u>Science</u> P.12.C.5 Students know the relationship between heat and temperature. I/S
3.1.16	<u>Science</u> P.12.C.5 Students know the relationship between heat and temperature. I/S

3.1.17	Science P.12.C.5 Students know the relationship between heat and temperature. I/S
3.1.17	Math 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 2.12.4 Add, subtract, multiply, and factor (1 st and 2 nd degree) polynomials, describing each step in the process and the connection between the algebraic process and the arithmetic process; use simple quadratic equations with integer roots to solve practical and mathematical problems. 3.12.1 Convert between customary and metric systems; convert among monetary systems.
3.2.1, 3.2.2	Science P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S P.12.C.5 Students know the relationship between heat and temperature. I/S
3.2.2	Math 2.12.5 Model practical problems from everyday situations with a variety of models that includes matrices, translating among tabular, symbolic and graphical representations of functions, with and without technology.
3.2.4, 3.2.7, 3.2.8	Science E.12.A.2 Students know the composition of Earth's atmosphere has changed in the past and is changing today. I/S
3.3.2, 3.3.6	Science P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S
3.3.6	Math 2.12.5 Model practical problems from everyday situations with a variety of models that includes matrices, translating among tabular, symbolic and graphical representations of functions, with and without technology.
3.4.1	Science P.12.C.2 Students know energy forms can be converted. E/S P.12.C.5 Students know the relationship between heat and temperature. I/S
3.4.2, 3.4.4, 3.4.5	Math 2.12.4 Add, subtract, multiply, and factor (1 st and 2 nd degree) polynomials, describing each step in the process and the connection between the algebraic process and the arithmetic process; use simple quadratic equations with integer roots to solve practical and mathematical problems. 3.12.1 Convert between customary and metric systems; convert among monetary systems.

Content Standard 4.0: The student will demonstrate proper use of hand tools and equipment common to the air conditioning and refrigeration industry.

4.3.8, 4.3.10	Science P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S
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4.3.1, 4.3.3, 4.3.4, 4.3.5, 4.3.11	<u>Math</u> 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.
4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5, 4.4.6, 4.4.8	<u>Math</u> 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.
4.4.7	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 2.12.2 Represent and solve problems using discrete structures including graphs and matrices, with and without technology. 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.
4.5.1, 4.5.2, 4.5.3, 4.5.4, 4.5.5, 4.5.6	<u>Math</u> 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.
4.5.7, 4.5.8	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 2.12.5 Model practical problems from everyday situations with a variety of models that includes matrices, translating among tabular, symbolic and graphical representations of functions, with and without technology.

Content Standard 5.0: The student will demonstrate various brazing techniques to prepare and install piping.

5.1.1	<u>Science</u> P.12.A.5 Students know chemical reactions can take place at different rates, depending on a variety of factors (i.e. temperature, concentration, surface area, and agitation). E/S
5.1.7	<u>Math</u> 2.12.5 Model practical problems from everyday situations with a variety of models that includes matrices, translating among tabular, symbolic and graphical representations of functions, with and without technology. 3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems.
5.1.10	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass. 3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems.

5.1.11	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems</p>
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Content Standard 6.0: The student will demonstrate knowledge of electrical theory, measurement, circuitry and controls.

6.1.1, 6.1.2, 6.1.3, 6.1.4, 6.1.5, 6.1.6	<p><u>Science</u></p> <p>P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S</p> <p>P.12.B.3 Students know the strength of the electric force between two objects increases with charge and decreases with distance. I/S</p> <p>P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S</p>
6.1.1	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>2.12.3 Create and use different forms of a variety of equations, proportions, and/or formulas (e.g., $I=PRT$ or $R=I/PT$), solving for the needed variable as necessary in given situations.</p> <p>2.12.4 Add, subtract, multiply, and factor (1st and 2nd degree) polynomials, describing each step in the process and the connection between the algebraic process and the arithmetic process; use simple quadratic equations with integer roots to solve practical and mathematical problems.</p>
6.1.5	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>2.12.3 Create and use different forms of a variety of equations, proportions, and/or formulas (e.g., $I=PRT$ or $R=I/PT$), solving for the needed variable as necessary in given situations.</p> <p>2.12.4 Add, subtract, multiply, and factor (1st and 2nd degree) polynomials, describing each step in the process and the connection between the algebraic process and the arithmetic process; use simple quadratic equations with integer roots to solve practical and mathematical problems.</p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>
6.2.1, 6.2.2, 6.2.3, 6.2.4, 6.2.5	<p><u>Science</u></p> <p>P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S</p> <p>P.12.B.3 Students know the strength of the electric force between two objects increases with charge and decreases with distance. I/S</p> <p>P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S</p>
6.2.5	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p>
6.3.1, 6.3.2, 6.3.3, 6.3.4,	<p><u>Science</u></p>

6.3.5	<p>P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S</p> <p>P.12.B.3 Students know the strength of the electric force between two objects increases with charge and decreases with distance. I/S</p> <p>P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S</p>
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Content Standard 7.0: The student will understand the purposes and uses of refrigeration cycle components to include metering devices; evaporators; compressors; condensers; accessories and access fittings.

7.2.2, 7.2.3	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>
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Content Standard 8.0: The student will demonstrate knowledge of operation and diagnosis of gas control valves, regulators and fossil-fuel heating systems.

8.1.11, 8.1.12	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>
8.2.2	<p><u>Science</u></p> <p>P.12.C.2 Students know energy forms can be converted. E/S</p>
8.3.6, 8.3.7	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p>

Content Standard 9.0: The student will demonstrate competency in the operation and maintenance of unitary and split fossil fuel fired heating systems.

9.1.1	<p><u>Science</u></p> <p>P.12.A.5 Students know chemical reactions can take place at different rates, depending on a variety of factors (i.e. temperature, concentration, surface area, and agitation). E/S</p> <p>P.12.A.6 Students know chemical reactions either release or absorb energy. E/S</p> <p>P.12.A.7 Students know that, in chemical reactions, elements combine in predictable ratios, and the numbers of atoms of each element do not change. I/S</p>
9.1.1, 9.1.2	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p>

9.2.1, 9.2.2, 9.2.3, 9.2.4	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>
9.2.3	<p><u>Science</u></p> <p>P.12.A.5 Students know chemical reactions can take place at different rates, depending on a variety of factors (i.e. temperature, concentration, surface area, and agitation). E/S</p> <p>P.12.A.6 Students know chemical reactions either release or absorb energy. E/S</p> <p>P.12.A.7 Students know that, in chemical reactions, elements combine in predictable ratios, and the numbers of atoms of each element do not change. I/S</p>

Content Standard 10.0: The student will understand the process of heat transfer and the properties of air as applied in air conditioning applications.

10.1.1, 10.1.2, 10.1.3, 10.1.4, 10.1.5, 10.1.6	<p><u>Science</u></p> <p>N.12.A.1 Students know tables, charts, illustrations and graphs can be used in making arguments and claims in oral and written presentations. E/S</p> <p>N.12.A.2 Students know scientists maintain a permanent record of procedures, data, analyses, decisions, and understandings of scientific investigations. I/S</p>
10.1.1, 10.1.2, 10.1.3, 10.1.4, 10.1.5, 10.1.6	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>2.12.4 Add, subtract, multiply, and factor (1st and 2nd degree) polynomials, describing each step in the process and the connection between the algebraic process and the arithmetic process; use simple quadratic equations with integer roots to solve practical and mathematical problems.</p> <p>2.12.6 Determine the domain and range of linear relations given a graph or a set of ordered pairs; explain their importance in problem solving situations.</p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>
10.2.2	<p><u>Math</u></p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>

Content Standard 11.0: The student will understand the principles and effect of airflow and duct design on air conditioning systems operations.

11.1.2, 11.1.3, 11.1.4	<p><u>Math</u></p> <p>1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.</p> <p>3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.</p>
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	3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems.
11.2.1, 11.2.2, 11.2.3, 11.2.4	<u>Science</u> P.12.A.3 Students know the strength of the electric force between two objects increases with charge and decreases with distance. I/S P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S

Content Standard 12.0: The student will understand the various types of electrical motors used in air conditioning systems.

12.1.1, 12.1.2, 12.1.3	<u>Science</u> P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S
12.2.1, 12.2.2, 12.2.3, 12.2.4, 12.2.5, 12.2.6, 12.2.7, 12.2.8	<u>Science</u> P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S
12.2.4, 12.2.5	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.
12.3.1	<u>Science</u> P.12.C.2 Students know energy forms can be converted. E/S

Content Standard 14.0: The student will demonstrate a working knowledge of reverse cycle heating systems and emergency heat applications

14.1.8	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms.
14.2.4	<u>Science</u> E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S
14.3.3	<u>Science</u> E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S
14.3.10, 14.3.11	<u>Science</u> P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S

Content Standard 15.0: The student will apply acquired knowledge of refrigeration systems to food service applications, medical industries and transportation refrigeration.

15.1.7, 15.1.13, 15.1.14, 15.1.15, 15.1.16, 15.1.17	<u>Science</u> P.12.B.2 Students know magnetic forces and electric forces can be thought of as different aspects of electromagnetic force. I/S P.12.B.3 Students know the strength of the electric force between two
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	objects increases with charge and decreases with distance. I/S P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S
15.1.8	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems.
15.4.4	<u>Science</u> L.12.C.1 Students know relationships of organisms and their physical environment E/S

Content Standard 16.0: The student will calculate the cooling and heating requirements for an environmental living space.

16.1.1, 16.1.2, 16.1.3, 16.1.4, 16.1.9	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 2.12.3 Create and use different forms of a variety of equations, proportions, and/or formulas (e.g., $I=PRT$ or $R=I/PT$), solving for the needed variable as necessary in given situations.
16.1.1, 16.1.2, 16.1.3, 16.1.4, 16.1.5, 16.1.6, 16.1.8, 16.1.9	<u>Science</u> P.12.C.2 Students know energy forms can be converted. E/S P.12.C.5 Students know the relationship between heat and temperature. I/S E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S
16.2.1, 16.2.3, 16.2.4	<u>Science</u> P.12.C.5 Students know the relationship between heat and temperature. I/S E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S
16.2.1, 16.2.2, 16.2.3, 16.2.4, 16.2.5, 16.2.6, 16.2.7, 16.2.8	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems.
16.2.8	<u>Science</u> E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S
16.3.1, 16.3.2, 16.3.3, 16.3.4, 16.3.5, 16.3.6, 16.3.7, 16.3.8, 16.3.9	<u>Science</u> E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S
16.3.1, 16.3.2, 16.3.3, 16.3.4, 16.3.5, 16.3.6, 16.3.7, 16.3.8, 16.3.9	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.5 Use relationships (e.g., proportions) and formulas (indirect measurement) to determine the measurement of unknown dimensions, angles, areas, and volumes to solve problems.

Content Standard 18.0: The student will use acquired knowledge to perform system servicing and troubleshooting procedures.

18.2.1, 18.2.2, 18.2.3, 18.2.4, 18.2.5, 18.2.6, 18.2.7	<u>Science</u> P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S
18.3.1	<u>Science</u> P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S P.12.C.2 Students know energy forms can be converted. E/S
18.3.3	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass..
18.4.3.	<u>Science</u> N.12.A.1 Students know tables, charts, illustrations and graphs can be used in making arguments and claims in oral and written presentations. E/S
18.5.9	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.
18.5.11, 18.5.12, 18.5.13	<u>Science</u> P.12.C.6 Students know electricity is transferred from generating sources for consumption and practical uses. I/S

Content Standard 20.0: The student will demonstrate a thorough understanding of the guidelines and standards set forth by the U.S. Environmental Protection Agency that govern refrigerant recovery.

20.1.1, 20.1.2, 20.1.3, 20.1.4, 20.1.5,	<u>Science</u> E.12.A.2 Students know the composition of Earth's atmosphere has changed in the past and is changing today. I/S E.12.A.3 Students understand the role of the atmosphere in Earth's greenhouse effect. E/S E.12.A.4 Students know convection and radiation play important roles in moving heat energy in the Earth system. E/S E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S
20.2.2, 20.2.5, 20.2.6	<u>Science</u> E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S
20.3.1, 20.3.2, 20.3.3, 20.3.4, 20.3.5, 20.3.6, 20.3.7	<u>Science</u> E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S
20.4.1, 20.4.2, 20.4.3,	<u>Science</u>

20.4.4, 20.4.5, 20.04.6, 20.4.7, 20.4.8, 20.4.9	E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S
20.5.1, 20.5.2, 20.5.3, 20.5.4	<u>Science</u> E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S
20.6.1, 20.6.2, 20.6.3, 20.6.4, 20.6.5, 20.6.6, 20.6.7	<u>Science</u> E.12.A.2 Students know the composition of Earth's atmosphere has changed in the past and is changing today. I/S E.12.A.3 Students understand the role of the atmosphere in Earth's greenhouse effect. E/S E.12.C.4 Student knows processes of obtaining, using, and recycling of renewable and non-renewable resources. E/S P.12.A.1 Students know different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases. E/S
20.6.10, 20.6.11	<u>Math</u> 1.12.1 Calculate and estimate sums, differences, products, quotients, powers, and roots using mental math, formulas, and algorithms. 3.12.2 Select and use measurement tools, techniques, and formulas to calculate and compare rates, cost, distances, interest, temperatures, and weight/mass.

Content Standard 21.0: Students will achieve competence in workplace readiness, career development, and lifelong learning.

21.1.1, 21.1.2	<u>English</u> 10.12.2 Negotiate to arrive at consensus by proposing and examining possible options. 10.12.3 Identify and practice techniques such as setting time limits for speakers and deadlines for decision making to improve productivity of group discussion.
21.2.2	<u>English</u> 10.12.1 Participate in problem-solving conversations or group discussions by identifying, synthesizing, and evaluating data.
21.3.6	<u>English</u> 4.12.6 Read and apply multi-step directions in order to perform complex procedures and tasks.
21.3.8	<u>English</u> 6.12.5 Edit for use of standard English. 7.12.1 Apply the rules of usage, grammar, and capitalization with few significant errors; use modifiers, parallel structure, and subordination correctly in writing. 7.12.3 Use rules of punctuation; manipulate conventions for emphasis in writing. 7.12.4 Use rules of capitalization. 7.12.5 Demonstrate conventional spelling.
21.4.4	<u>Math</u> 3.12.4 Use and interpret consumer data (e.g., amortization tables, tax tables, and compound interest charts) to make informed financial decisions related to practical applications such as budget.

21.8.1, 21.8.2	<p><u>English</u> 6.12.5 Edit for use of standard English. 7.12.1 Apply the rules of usage, grammar, and capitalization with few significant errors; use modifiers, parallel structure, and subordination correctly in writing. 7.12.3 Use rules of punctuation; manipulate conventions for emphasis in writing. 7.12.5 Demonstrate conventional spelling. 9.12.1 Use specific and varied vocabulary and apply standard English to communicate ideas.</p>
21.8.3	<p><u>English</u> 5.12.5 Write summaries or abstracts that distill large amounts of information into clear, concise prose. 7.12.4 Use rules of capitalization.</p>
21.8.4	<p><u>English</u> 7.12.5 Demonstrate conventional spelling. 9.12.1 Use specific and varied vocabulary and apply standard English to communicate ideas.</p>
21.8.5, 21.8.6	<p><u>English</u> 7.12.3 Use rules of punctuation; manipulate conventions for emphasis in writing. 7.12.5 Demonstrate conventional spelling. 9.12.1 Use specific and varied vocabulary and apply standard English to communicate ideas.</p>