

Lesson Plans for Module 03101

INTRODUCTION TO HVACR

Introduction to HVACR (Module 03101) provides a broad introduction to the world of the HVACR technician. The most basic operating principles of HVACR systems are presented along with a review of technician licensing and trade-governing regulations. The final portion of the module describes potential career paths for the well-trained HVACR technician.

Objectives

Learning Objective 1

State the basic principles of heating, ventilation, air conditioning, and refrigeration.

- State the basic principles of heating.
- State the basic principles of ventilation.
- State the basic principles of air conditioning.
- State the basic principles of refrigeration.

Learning Objective 2

Describe the principles that guide HVACR installation and service techniques.

- Identify some common HVACR safety concerns and guidelines.
- Describe the role of HVACR technicians in energy-efficient system operation and state how LEED principles affect green-building design and construction.
- Describe common HVACR contractor and technician licensure requirements.
- Identify important codes and permits.

Learning Objective 3

Identify HVACR career paths available and describe common training processes.

- Identify the personal characteristics needed to be a successful craft professional.
- Describe career opportunities in the various business segments of the HVACR industry.
- Describe how HVACR training is delivered and the general requirements and structure of an apprenticeship program.

Performance Tasks

This is a knowledge-based module. There are no Performance Tasks.

Recommended Teaching Time: 5 hours

Prerequisites

Core

Before You Begin

As you prepare for each Section, allow sufficient time to review the course objectives, content, visual aids (including the *HVACR PowerPoint®* Presentations and/or Dynamic Lecture Presentations), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

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Lesson Plans for Module 03102

TRADE MATHEMATICS

Trade Mathematics (Module 03102) Math is an essential skill required to advance in the HVACR profession. Math is used when cutting and fitting pipe, when sizing and installing ductwork, and when calculating electrical values such as current flow.

Objectives

Learning Objective 1

Convert measurement units from the US standard system to the metric system, and vice versa.

- Identify measurement units in the US standard and metric systems.
- Convert length, area, and volume values.
- Convert weight values.
- Convert pressure and temperature values.

Learning Objective 2

Solve basic algebraic equations.

- Define algebraic terms.
- Demonstrate an understanding of the sequence of operations.
- Solve basic algebraic equations.

Learning Objective 3

Identify and describe geometric figures.

- Describe the characteristics of a circle.
- Identify and describe types of angles.
- Identify and describe types of polygons.
- Calculate various values associated with triangles.

Performance Tasks

This is a knowledge-based module. There are no Performance Tasks.

Recommended Teaching Time: 10 hours

Prerequisites

Core

Before You Begin

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BASIC ELECTRICITY

Basic Electricity (Module 03106) An HVACR system needs an electrical power source to operate. Most of the problems an HVACR technician encounters when faced with a service call involve the electrical system, so an understanding of electrical theory, power and control components, and circuits is essential. Technicians must have a firm foundation in these topics to get started in the craft, allowing them to understand the circuits of complex systems and troubleshoot them when problems arise.

Objectives**Learning Objective 1**

State the fundamentals of power generation and identify common electrical safety practices.

- State how electrical power is generated and distributed and identify the two kinds of current produced.
- Identify general electrical safety practices and state electrical lockout/tagout procedures.
- State OSHA electrical safety requirements and identify common electrical PPE.

Learning Objective 2

Explain basic electrical theory.

- Define common electrical units and apply Ohm's law and the power formula.
- Describe the differences between series and parallel circuits and calculate circuit values for each type.

Learning Objective 3

Identify the electrical measuring instruments used in HVACR work and describe how to use them.

- Describe how voltage is measured.
- Describe how current is measured.
- Describe how resistance is measured and how continuity is determined.

Learning Objective 4

Identify electrical components used in HVACR systems and describe their functions.

- Identify and describe various load devices and explain how they are represented on circuit diagrams.
- Identify and describe various control devices and explain how they are represented on circuit diagrams.
- Identify and describe common electrical diagrams used in HVACR work.

Performance Tasks**Performance Task 1 (Learning Objectives 1, 2, 3 and 4)**

- Draw a connection diagram for a circuit that includes the following components:
 - A power control switch
 - 120VAC/24VAC control transformer
 - A control relay with a 24VAC coil
 - (2) 120VAC lights, controlled by the relay and wired in parallel

Performance Task 2 (Learning Objectives 1, 2, 3 and 4)

- Assemble the circuit based on the connection diagram developed in Performance Task 1, powered by a GFCI-protected power source.

Performance Task 3 (Learning Objective 2, 3 and 4)

- With the circuit de-energized, check circuit components and relay contacts for continuity.

Performance Task 4 (Learning Objective 2, 3 and 4)

- With the circuit de-energized, measure and record the resistance of the transformer windings, relay coil, and lights.

Performance Task 5 (Learning Objectives 2, 3 and 4)

- Energize the circuit, turning on the lights, and measure and record the total circuit current.

Performance Task 6 (Learning Objectives 2, 3 and 4)

- Measure the voltage provided by the power source to the transformer primary.

Performance Task 7 (Learning Objectives 2, 3 and 4)

- De-energize and disable the circuit power source. Verify that power is disabled with a voltmeter.

Recommended Teaching Time: 15 hours

Prerequisites

Core

Lesson Plans for Module 03108

INTRODUCTION TO HEATING

Introduction to Heating (Module 03108) Most homes and businesses need some type of heating system. Installing and servicing furnaces is a big responsibility. Because flames and combustible fuels are often involved, there is always the potential for fire or explosion. A well-trained technician minimizes those hazards, and fossil fuels are consistently used to heat many thousands of buildings safely and reliably. There are practical reasons for choosing one heating system over another. When most heating systems are properly installed according to the manufacturer's instructions and serviced by qualified technicians, they will operate satisfactorily for many years.

Objectives

Learning Objective 1

Explain the fundamental concepts of heating and combustion.

- a. Describe the heat transfer process and how temperature, humidity, and heat are measured.
- b. Describe the combustion process and identify common fuels and their characteristics.

Learning Objective 2

Identify and describe gas furnaces, their components, and their basic installation and maintenance requirements.

- a. Describe various types of gas furnaces.
- b. Identify and describe common gas furnace components and controls.
- c. Describe the basic installation and maintenance requirements of gas furnaces.

Learning Objective 3

Describe hydronic and electric heating systems.

- a. Describe hydronic heating systems and identify common components.
- b. Describe electric heating equipment and identify common components.

Performance Tasks

Performance Task 1 (Learning Objective 2)

1. Identify and describe the function of the primary components in an induced-draft furnace or condensing furnace.

Performance Task 2 (Learning Objective 2)

2. Check and record the temperature rise, manifold gas pressure, and flame quality on an operating gas furnace.

Performance Task 3 (Learning Objective 2)

3. Using the furnace manufacturer's installation instructions, determine if a furnace installation has the required clearances.

Recommended Teaching Time: 15 hours

Prerequisites

Core

Before You Begin

As you prepare for each Section, allow sufficient time to review the course objectives, content, visual aids (including the *HVACR* PowerPoint® Presentations and/or Dynamic Lecture Presentations), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

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Safety Considerations

During the course of this module, trainees may be required to work on or around operational heating equipment and/or fuel gas supplies. Ensure that trainees possess and use the required PPE while performing these tasks.

Lesson Plans for Module 03107

INTRODUCTION TO COOLING

Introduction to Cooling (Module 03107) To service cooling and heat pump systems, you must have a clear understanding of the refrigeration cycle and the function of its primary components. Technicians can apply this knowledge to all refrigerant circuits. Despite the differences in the many possible refrigerants and applications, the basic principles presented here apply to all direct-expansion refrigerant circuits.

Objectives

Learning Objective 1

Explain the fundamental concepts of the refrigeration cycle.

- a. Describe the relationship between heat transfer and the state of substances.
- c. Describe pressure/temperature relationships.
- d. Describe basic refrigerant flow and the changes of state occurring in the refrigeration cycle.
- e. Identify common instruments used to measure pressure and temperature.

Learning Objective 2

Identify common refrigerants and their identifying characteristics.

- a. Identify fluorocarbon refrigerants.
- b. Describe the use of ammonia as a refrigerant.
- c. Identify various refrigerant containers and their safe handling requirements.

Learning Objective 3

Identify the major components of cooling systems and their function.

- a. Identify various types of compressors.
- b. Identify different types of condensers.
- c. Identify different types of evaporators.
- d. Describe devices used to meter refrigerant flow.
- e. Recount basic refrigerant piping concepts.
- f. Identify various accessories used in refrigerant circuits.

Learning Objective 4

Identify the common controls used in cooling systems and how they function.

- a. Identify common primary controls.
- b. Identify common secondary controls.

Performance Tasks

Performance Task 1 (Learning Objective 1)

1. Measure and record the dry bulb and wet bulb temperatures of the supply and return air streams in an operating cooling system.

Performance Task 2 (Learning Objective 1)

2. Connect a refrigerant gauge manifold and properly calculate subcooling and superheat on an operating system.

Performance Task 3 (Learning Objective 2)

3. Identify refrigerants using cylinder color codes.

Performance Task 4 (Learning Objectives 3 and 4)

4. Identify the compressor, condenser, evaporator, metering device, and accessories in a cooling system.

Recommended Teaching Time: 30 hours

Prerequisites

Core

Before You Begin

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Lesson Plans for Module 03109

AIR DISTRIBUTION SYSTEMS

Air Distribution Systems (Module 03109) HVAC systems use ductwork to deliver conditioned air to the spaces being cooled or heated. The ductwork is made of sheet metal, fiberglass ductboard, or fabric. The performance of any HVAC system is closely related to the performance of the air distribution system. The ductwork must be of the proper size and type, and it must be correctly installed and sealed. It is important for an HVAC technician to understand how deficiencies in an air distribution system affect performance and how to recognize these deficiencies as the source of a problem.

Objectives

Learning Objective 1

Describe the factors related to air movement and its measurement in air distribution systems.

- Describe how pressure, velocity, and volume are interrelated in airflow.
- Describe air distribution in a typical residential system.
- Identify common air measurement instruments.

Learning Objective 2

Describe the mechanical equipment and materials used to create air distribution systems.

- Describe various blower types and applications.
- Describe various fan designs and applications.
- Demonstrate an understanding of the fan laws.
- Describe common duct materials and fittings.
- Identify the characteristics of common grilles, registers, and dampers.

Learning Objective 3

Identify the different approaches to air distribution system design and energy conservation.

- Identify various air distribution system layouts.
- Describe heating and cooling air movement resulting from various air distribution system designs.
- Explain how to maximize energy efficiency through the proper sealing and testing of air distribution systems.

Performance Tasks

Performance Task 1 (Learning Objective 1)

- Use a manometer to measure static pressure in a duct.

Performance Task 2 (Learning Objective 1)

- Use a velometer to measure the velocity of airflow at supply diffusers or registers.

Performance Task 3 (Learning Objective 1)

- Use a velometer to calculate the volume of airflow in a duct.

Recommended Teaching Time: 15 hours

Prerequisites

Core

Before You Begin

As you prepare for each Section, allow sufficient time to review the course objectives, content, visual aids (including the *HVACR* PowerPoint® presentations and/or Dynamic Lecture Presentations), and these lesson plans, and to gather the required equipment and materials. Consider time required for demonstrations, laboratories, field trips, and testing.

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Lesson Plans for Module 03103

BASIC COPPER AND PLASTIC PIPING PRACTICES

Basic Copper and Plastic Piping Practices (Module 03103) Copper tubing is used extensively in HVACR work. Copper is the base material for virtually all common refrigerant piping. Plastic piping is also used in heating and cooling systems for a variety of purposes. Plastic piping may be used to carry chilled water for large cooling systems, condenser water for water-cooled mechanical systems, or even to vent high-efficiency gas furnaces. This module will introduce copper and plastic piping materials and explain how these piping systems are applied and assembled.

Objectives

Learning Objective 1

Recognize different types of copper tubing and the related fittings.

- Identify and describe the characteristics of copper tubing products.
- Identify various copper fittings.

Learning Objective 2

Explain how to mechanically join copper tubing.

- Explain how to measure, cut, bend, and swage copper tubing.
- Describe how to join copper tubing using flare and compression joints.
- Describe how to join copper tubing using press-to-connect and push-to-connect fittings.
- Explain how pressure testing on refrigerant lines is conducted.
- Identify common hangers and supports associated with copper tubing installations.

Learning Objective 3

Recognize different types of plastic piping and explain how they are joined.

- Recognize and identify different types of plastic piping.
- Explain how to join various types of plastic piping.

Performance Tasks

Performance Task 1 (Learning Objectives 1 and 2)

- Cut and bend copper tubing.

Performance Task 2 (Learning Objectives 1 and 2)

- Join copper tubing using a flared connection.

Performance Task 3 (Learning Objectives 1 and 2)

- Join copper tubing using a compression fitting and ferrule.

Performance Task 4 (Learning Objectives 1 and 2)

- Assemble press-to-connect joints in copper tubing according to the manufacturer's instructions.

Performance Task 5 (Learning Objective 3)

- Cut and join PVC pipe and fittings.

Recommended Teaching Time: 12.5 hours

Prerequisites

Core

Before You Begin

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SOLDERING AND BRAZING

Soldering and Brazing (Module 03104) Soldering is used primarily to join copper water lines and condensate lines in the HVACR craft. Brazing is used when mechanically strong, pressure-resistant joints are needed for refrigerant lines. Both soldering and brazing demand careful attention to safety due to the hazards associated with flammable gases and open flames. With some practice, HVACR technicians quickly master soldering and brazing techniques.

Objectives

Learning Objective 1

Describe and demonstrate the safe process of soldering copper tubing.

- a. Describe and demonstrate the use of the PPE, tools, and materials needed to solder copper tubing.
- b. Describe and demonstrate the preparation required for soldering.
- c. Describe and demonstrate the soldering process.

Learning Objective 2

Describe and demonstrate the safe process of brazing copper tubing.

- a. Describe and demonstrate the use of the PPE, tools, and materials needed to braze copper tubing.
- b. Describe and demonstrate the preparation used for brazing.
- c. Describe and demonstrate the brazing process.
- d. Describe and demonstrate the process of brazing copper tubing to dissimilar metals.

Performance Tasks

Performance Task 1 (Learning Objective 1)

1. Properly set up and shut down an air-acetylene torch.

Performance Task 2 (Learning Objective 1)

2. Properly prep and safely solder copper tubing in various planes, using various fittings.

Performance Task 3 (Learning Objective 2)

3. Properly set up and shut down oxyacetylene equipment.

Performance Task 4 (Learning Objective 2)

4. Properly prep and safely braze copper tubing in various planes, using various fittings, with a nitrogen purge.

Performance Task 5 (Learning Objective 2)

5. Braze copper tubing to either steel or brass components.

Recommended Teaching Time: 10 hours

Prerequisites

Core

Before You Begin

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Lesson Plans for Module 03105

BASIC CARBON STEEL PIPING PRACTICES

Basic Carbon Steel Piping Practices (Module 03105) Iron and steel pipe are used in many HVACR systems. Steel pipe is used to carry water in hydronic systems and supply gas to furnaces. The ability to properly cut, thread, and join steel pipe is an important skill for an HVACR installer as well as service technicians.

Objectives

Learning Objective 1

Identify and describe the various types of steel pipe and fittings.

- Identify the characteristics and uses of steel pipe.
- Describe the characteristics of pipe threads and how they are measured.
- Identify various types of pipe fittings and describe how they are used.
- Describe how to measure pipe and determine cut lengths.

Learning Objective 2

Describe the tools and methods used to cut and thread steel pipe.

- Identify pipe cutting and reaming tools.
- Identify pipe threading equipment and explain how to thread a pipe.

Learning Objective 3

Describe how to mechanically join and install steel pipe.

- Describe the tools and techniques used to connect threaded pipe.
- Describe pipe grooving methods and techniques.
- Describe how to assemble flanged steel pipe.
- Describe how to correctly install and support steel pipe.

Performance Tasks

Performance Task 1 (Learning Objectives 1 and 2)

- Cut, ream, and thread steel pipe.

Performance Task 2 (Learning Objectives 1 and 3)

- Join threaded pipe or pipe nipples using various fittings.

Recommended Teaching Time: 10 hours

Prerequisites

Core

Before You Begin

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