

Refrigeration and Air Conditioning Mechanic Level 3

Refrigeration and Air Conditioning Mechanic

Unit: C1 HVAC Estimation and Coordination

Level: Three

Duration: 21 hours

Theory: 11 hours

Practical: 10 hours

Overview:

This unit is designed to provide the apprentice with the knowledge and skills of heating, ventilation, and air conditioning (HVAC) estimation and coordination. Beginning with terminology, apprentices will interpret codes, blueprints, drawings and specifications, equipment and service documents pertaining to estimation and coordination. Apprentices will apply this knowledge by performing both a residential and commercial HVAC job estimate using technical and working documents. Finally, apprentices will interpret technical and working drawings to develop a plan to coordinate the performance of an HVAC project.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Review terminology associated with HVAC estimation and coordination.	10%
2. Identify safety documentation and describe safe work practices associated with HVAC estimation and coordination.	5%
3. Interpret codes and specifications pertaining to HVAC estimation and coordination.	10%
4. Review technical and working documents. a. Equipment and service documents b. Drawings, blueprints and specifications	25%
5. Demonstrate and perform an HVAC job estimate using technical and working documents. a. Residential b. Commercial	30%
6. Interpret technical and working drawings and develop a plan to coordinate the performance of an HVAC project. a. Materials b. Equipment c. Site considerations d. Installation e. Commissioning f. Labour	20%

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Unit: C2 HVAC Systems Installation

Level: Three

Duration: 63 hours

Theory: 43 hours

Practical: 20 hours

Overview:

This unit is designed to provide the apprentice with knowledge and skills of HVAC systems installation. Beginning with terminology, hazards, and safe work practices, the unit will include jurisdictional codes and manufactures' specifications pertaining to HVAC systems installation. Topics include: HVAC concepts and processes, system components and their characteristics and applications. Apprentices will identify and describe circulating pumps and fluid dynamics. Apprentices will also describe and demonstrate HVAC systems installation procedures. Finally, apprentices will perform HVAC systems installation procedures.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Review terminology associated with HVAC systems installation.	5%
2. Identify hazards and describe safe work practices for equipment pertaining to HVAC systems installation.	5%
3. Interpret jurisdictional codes and manufacturers' specifications pertaining to HVAC systems installation.	5%
4. Identify and describe HVAC concepts and processes.	15%
a. Psychrometric processes	
• Cooling	
• Evaporative cooling	
• Humidification	
• Heating and humidification	
• Heating	
• Heating and dehumidification	
• Dehumidification	
• Cooling and dehumidification	
b. Air quality, air circulation and ventilation	
c. Heating systems	
• Electric	
• Gas	
• Hydronic	

- 5. Identify and describe HVAC system components and their characteristics and applications. 15%**
- a. Compressors
 - Reciprocating
 - Scroll
 - Rotary
 - b. Air movement components
 - Fans (axial, radial)
 - Mechanical drives (belt, direct)
- 6. Identify and describe circulating pumps and fluid dynamics. 15%**
- a. Terminology
 - b. Types of circulating pumps
 - c. Circulating pump components
 - d. Circulating pump selection
 - System parameters
 - Pump curves
 - Circuit configurations
 - e. Circuit troubleshooting
 - Potential problems of air in system
 - Procedures to purge air from an open or closed system
- 7. Describe and demonstrate HVAC systems installation procedures. 15%**
- a. Determine HVAC system parameters
 - b. Determine HVAC loads
 - Calculations
 - c. Determine HVAC heat gain and heat loss
 - Calculations
- 8. Perform installation of HVAC systems. 25%**
- a. Verify system parameters and requirements
 - b. Material take-off
 - c. Place equipment
 - Components
 - Accessories

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Unit: C3 Control Systems Installation II

Level: Three

Duration: 38 hours

Theory: 25 hours

Practical: 13 hours

Overview:

This unit is designed to provide the apprentice with knowledge and skills of control systems installation. Beginning with terminology, hazards, and safe work practices, the unit will include interpreting codes and regulations pertaining to control systems installation. Apprentices will identify and describe control systems and their characteristics and applications. Apprentices will also describe and demonstrate installation of control systems and their components. Finally, apprentices will perform installation of control systems and components.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with control systems installation.	10%
2. Identify hazards and safe work practices pertaining to control systems installation.	5%
3. Interpret codes and regulations pertaining to control systems installation. a. Control systems b. Accessories c. Components	10%
4. Identify and describe control systems and their characteristics and applications. a. Control systems • Electrical • Mechanical • Electronic • Integrated control circuits b. Devices c. Components	20%
5. Describe and demonstrate installation of control systems and their components.	30%
6. Perform installation of control systems and their components. a. Install wiring on control boards b. Test controls and wiring on control boards c. Troubleshoot controls and wiring on control boards	25%

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Unit: C4 HVAC Systems Service

Level: Three

Duration: 56 hours

Theory: 23 hours

Practical: 33 hours

Overview:

This unit is designed to provide the apprentice with knowledge and skills of HVAC systems service. Beginning with terminology, hazards and safe work practices, the unit will interpret codes, regulations and information pertaining to HVAC systems service. Topics include: HVAC systems, components, accessories and their characteristics and applications. Apprentices will identify and describe tools and equipment used for checking and completing HVAC system charge and their applications and procedures for use. Apprentices will also describe and demonstrate HVAC systems service procedures. Finally, apprentices will perform HVAC systems service on various types of HVAC equipment.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with HVAC systems Service.	5%
2. Identify hazards and safe work practices pertaining to HVAC systems service.	5%
3. Interpret codes, regulations and information pertaining to HVAC systems service.	10%
a. Drawings	
b. Wiring diagrams	
c. Manufacturers' literature	
d. Schematic diagrams	
4. Identify and describe HVAC systems, components, accessories and describe their characteristics and applications.	10%
a. Electrical components	
b. Heat pump systems	
c. Air movement/indoor air quality (IAQ)	
5. Identify and describe tools and equipment used for checking and completing HVAC system charge and their applications and procedures for use.	20%
a. HVAC system equipment	
b. HVAC components	
c. HVAC accessories	
6. Describe and demonstrate HVAC systems service procedures.	30%
a. Pre-start-up checks	
• Sequence of operation	

- b. Start-up
 - Phasing
 - Voltage imbalance and amperage
 - Refrigerant charge adjustments
 - Oil levels
 - Operating pressures and temperatures
 - System control adjustments
 - Manufacturers' recommendations
 - Liquid or air requirements
- c. Complete system charge
 - Measuring superheat and sub-cooling
 - Weighing critical charge
 - Interpreting charge charts
 - Checking sight glass
- d. Set up primary and secondary system components
- e. Test and adjust components
 - Blowers
 - Fans
 - Pumps
 - Compressors
 - Motors
 - Dampers
 - Temperature/pressure controls
 - Valves
- f. Commission
 - Documentation
- g. Troubleshoot
- h. Repair

7. Perform HVAC systems service on various types of HVAC equipment.

20%

- a. Pre-start-up check
- b. Start-up
- c. Complete system charge
- d. Primary and secondary component set up
- e. Commission
- f. Troubleshoot
- g. Repair

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Unit: C5 Control Systems Service II

Level: Three
35 hours

Duration:
Theory: 25 hours
Practical: 10 hours

Overview:

This unit is designed to provide the apprentice with knowledge and skills of control systems service. Beginning with terminology, hazards, and safe work practices and procedures, the unit will interpret codes and regulations pertaining to control systems service. Topics include: electrical circuit review, tools and equipment used to troubleshoot and perform maintenance and repair on control systems and their components. Apprentices will interpret HVAC/R control systems service information sourced from drawings, specifications and service manuals. Apprentices will also describe and demonstrate the procedures to service control systems. Finally, apprentices will perform service of control systems.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with control systems service.	5%
2. Identify hazards and safe work practices pertaining to control systems service.	5%
3. Interpret codes and regulations pertaining to control systems service. a. HVAC/R control systems b. Verifying and setting safety parameters	10%
4. Review electrical circuits. a. Series b. Parallel c. Series parallel combination d. Conductor ampacity ratings	10%
5. Identify and describe tools and equipment used to troubleshoot and perform maintenance and repair on control systems and their components. a. Start-up b. Setting operating parameters	10%
6. Interpret HVAC/R control systems service information sourced from drawings, specifications and service manuals.	10%
7. Describe and demonstrate the procedures to service control systems. a. Control circuit systems and components	30%

- Verify basic electrical using schematic wiring diagrams
- b. Control systems
 - Sequence of operation
 - Start up with digital technology
 - Verify and set operating parameters
 - Commission
- c. Calibrate components and adjust parameter set points
 - Electronic controls
 - Control systems
 - Operating and safety controls
- d. Maintenance
- e. Basic diagnosis
 - Electronic controls
 - Inspection
- f. Control system failures
 - Causes
 - Sources
- g. Lock out
 - Isolate
 - De-energise
- h. Repair
 - Control systems
 - Components

8. Perform service of control systems.

20%

- a. Start-up checks
- b. Set operating parameters.

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Unit: C6 Motors II

Level: Three

Duration: 21 hours

Theory: 15 hours

Practical: 6 hours

Overview:

This unit is designed to provide the apprentice with advanced knowledge and skills of motors. Beginning with terminology, hazards, and safe work practices, the unit will interpret codes and manufactures' specifications pertaining to motors. Topics include: motors and their characteristics and applications. Apprentices will describe the procedures to install, maintain and troubleshoot motors components and controls. Apprentices will also identify and describe motor failures, causes and repairs. Finally, apprentices will demonstrate and perform the installation, maintenance and troubleshooting of both single and multi-phase motors, controls and components.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with motors.	10%
2. Identify hazards and safe work practices pertaining to duct systems.	5%
3. Interpret codes and manufacturers' specifications pertaining to motors.	5%
4. Identify and describe motors and their characteristics and applications.	20%
a. Types	
• Single-phase motors	
• Three-phase motors	
• Variable frequency drives (VFD)	
• Electrically-communicated motors (ECM)	
b. Motor controls	
c. Motor nameplates	
d. Capacitors	
e. Components	
f. Starting devices	
• Wiring configuration	
• Operation	
g. Methods to change speed and rotation	
5. Describe the procedures to install, maintain and troubleshoot motors, components and motor controls.	20%
a. Single-phase motors	
b. Three-phase motors	
c. Variable frequency drives (VFD)	

- d. Electrically-communicated motors (ECM)

- 6. Identify and describe motor failures and describe their causes and repairs. 20%**
 - a. Electrical
 - b. Mechanical

- 7. Demonstrate and perform the installation, maintenance and troubleshooting of single and multi-phase motors, controls and components. 20%**
 - a. Wire multi-voltage motors
 - b. Wire start/stop motor latching relay

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Unit: C7 Duct Systems

Level: Three

Duration: 28 hours

Theory: 16 hours

Practical: 12 hours

Overview:

This unit is designed to provide the apprentice with knowledge and skills of duct systems. Beginning with terminology, hazards, and safe work practices, the unit will interpret codes and regulations pertaining to duct systems. Topics include: duct system tools, equipment, components, their applications and procedures for use. Apprentices will identify and describe duct system design principles, considerations and techniques. Apprentices will also describe and demonstrate duct system procedures for HVAC equipment, components and accessories. Finally, apprentices will perform the procedures to plan, install, maintain and troubleshoot duct systems and their components, develop patterns using simple layouts, and to balance air systems.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with duct systems.	5%
a. Duct systems	
b. Air measurement and system balancing	
c. Duct system design	
d. Simple layout	
2. Identify hazards and safe work practices pertaining to duct systems.	5%
3. Interpret codes and regulations pertaining to duct systems.	5%
4. Identify and describe duct system tools, equipment components and their applications and procedures for use.	15%
a. Types of tools	
• Layout	
• Fabrication	
• Installation	
• Monitoring and air measurement	
b. Duct systems	
• Basic patterns	
c. Components	
• Fittings	
• Transitions	

5. **Identify and describe duct system design principles, considerations and techniques.** **15%**
- a. Air movement and air quality management
 - Conditions affecting air properties
 - b. Duct systems factors
 - Design
 - Sizing
 - Layout
6. **Describe and demonstrate duct system procedures for HVAC equipment, components and accessories.** **35%**
- a. Plan
 - Develop simple layout patterns
 - b. Duct system calculations
 - Simple layout
 - System air balancing
 - c. Fabricate
 - Basic Fittings
 - d. Install
 - Balance air systems
 - e. Maintain and adjust
 - f. Troubleshoot
 - Potential Problems
 - Potential causes
 - g. Repair
7. **Perform the procedures to plan, install, maintain and troubleshoot duct systems and their components, develop patterns using simple layout, and to balance air systems.** **20%**

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Unit: C8 HVAC Heat Pump Retrofit

Level: Three

Duration: 28 hours

Theory: 21 hours

Practical: 7 hours

Overview:

This unit is designed to provide the apprentice with the knowledge and skills for retrofitting existing HVAC equipment with heat pump technologies. Beginning with terminology, hazards and safe work practices, the unit will include interpreting manufactures' equipment specifications to meet various HVAC applications. Topics will include analyzing existing HVAC systems to identify energy efficiencies of a new HVAC heat pump system. Apprentices will describe and demonstrate the procedures to install new energy efficient HVAC equipment and controls for heat pump systems as well as retrofit and commission the system. Finally, apprentices will perform the procedures to analyze existing equipment and identify energy efficiencies with heat pump retrofits so the correct equipment can be matched with the customer application.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with HVAC heat pump retrofit. a. Heat pump technology <ul style="list-style-type: none"> • Air to air • Liquid to air • Liquid to liquid • Air to liquid 	5%
2. Identify hazards and safe work practices pertaining to HVAC heat pump retrofit. a. Environmental b. Modification and removal of existing systems	5%
3. Interpret jurisdictional codes and manufactures' specifications pertaining to HVAC heat pump retrofit. a. Electrical requirements b. Heat pump equipment requirements c. Cold climate heat pump applications	5%
4. Identify and analyze existing HVAC systems to determine energy efficiencies of a new HVAC heat pump system. a. Existing system challenges b. Opportunities for energy efficiency c. Federal and provincial grants d. Emerging HVAC heat pump technology e. Whole system replacement	15%

- f. Targeted matched unit replacement
 - g. Supplementing existing equipment
 - h. Equipment selection and application considerations
- 5. Describe the procedures to install new energy efficient HVAC equipment and controls for heat pump systems. 35%**
- a. Replace or adapt fossil-fuel equipment to heat pumps
 - b. Add heat pumps to supplement existing systems
 - Centrally ducted
 - Unitary product (wall units)
 - c. Adapt ductwork for heat pump systems
 - Determine airflow limitations and restrictions in existing ducting systems
 - Calculate new requirements for ductwork to match heat pump air flow
 - Possible equipment re-location
 - d. Optimize controls for high-efficiency heat pump systems
 - Advance control settings / thermostats
 - Select equipment parameters and adjust set points
- 6. Describe and demonstrate the procedures to retrofit and commission HVAC heat pump systems. 20%**
- a. Commission heat pump retrofits
 - Equipment
 - Components
 - Accessories
 - b. Post-installation maintenance on high-efficiency heat pump systems
- 7. Perform the procedures to analyze existing equipment and identify energy efficiencies with heat pump retrofits. 15%**
- a. Determine existing energy efficiency
 - b. Provide a customer recommendation
 - c. Add heat pumps to supplement existing systems
 - d. Adapt ductwork for heat pump systems
 - e. Optimize controls for high-efficiency heat pump systems
 - f. Commission heat pump retrofit

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Unit: C9 Gas Code III

Level: Three

Duration: 25 hours

Theory: 20 hours

Practical: 5 hours

Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of Gasfitter requirements, including propane. This unit is a review and continuation of *B9 Gas Code II* in Level Two.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe propane code B149.2.	35%
2. Describe propane fundamentals.	10%
3. Describe propane fundamentals as applied.	25%
4. Describe B149.1 section 7.	20%
5. Describe Manitoba gas notices.	10%
