

# Refrigeration and Air Conditioning Mechanic (Residential) Level 2

## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** A10 Pipe Threading and Assembly

**Level:** Two

**Duration:** 20 hours

Theory: 4 hours

Practical: 16 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the procedures for selecting, using, and maintaining tools and equipment in a variety of gas-fitting project settings with an emphasis on iron pipe utilization. This unit also delivers training in safe skills required to properly assemble a variety of fundamental gas pipe designs. The principles and practical methods introduced in this unit are pursued in greater depth and complexity in later units of the program.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Describe use, selection, and maintenance of safety gear, personal protective equipment and safe practices used by gasfitters.	5%
2. Demonstrate basic techniques for use, selection, and maintenance of safety gear, personal protective equipment and safe practices used by gasfitters.	5%
3. Describe use, selection, and maintenance of hand tools by gasfitters.	10%
4. Demonstrate basic techniques for hand-tool selection, use, and maintenance by gasfitters.	5%
5. Describe the selection, use, and maintenance of power tools/equipment by gasfitters.	5%
6. Demonstrate basic techniques for the selection, use, and maintenance of power tools/equipment by gasfitters.	10%
7. Demonstrate basic safety and working techniques for assembling/fastening simple piping layouts utilizing proper offset techniques, thread allowance, as published in trade manuals and basic hanger installation.	20%
8. Describe the selection, use, and maintenance of technical instruments, testers, and other tools and equipment as specified by the instructor.	10%
9. Demonstrate basic techniques for the selection, use, and maintenance of technical instruments, testers, and other tools and equipment as specified by the instructor.	10%

- 10. Describe the selection, use, and maintenance of steel welding tools and equipment as they pertain to assisting a gas welder. 10%**
- 11. Demonstrate the basic techniques for the selection, use, and maintenance of steel welding tools and equipment as they pertain to assisting a gas welder. 10%**

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** A15 Pressure Enthalpy Diagrams

**Level:** Two

**Duration:** 15 hours

Theory: 15 hours

Practical: 0 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of pressure enthalpy diagrams and their use in troubleshooting refrigeration systems.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with pressure enthalpy diagrams and system analysis.	10%
2. Locate and interpret information found on pressure enthalpy diagrams.	10%
3. Describe the factors affecting system capacity.	10%
a. Saturated discharge temperature	
b. Saturated suction temperature	
c. Liquid sub-cooling	
d. Suction superheat	
e. Suction to liquid heat exchanger	
f. High and low side pressure drops	
4. Plot a refrigeration cycle using a pressure enthalpy diagram and perform associated calculations.	10%
5. Describe theoretical horsepower and brake horsepower.	10%
6. Describe the effects of pressure loss in refrigeration piping.	10%
7. Describe the concept of system equilibrium and the factors that determine system balance.	10%
8. Describe the effect of an unbalanced system on system performance.	10%
9. Apply cycle diagrams to assist with system troubleshooting.	20%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** B3 Science II

**Level:** Two

**Duration:** 16 hours

Theory: 16 hours

Practical: 0 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the science concepts of combustion and fuels.

### Objectives and Content:

**Percent of  
Unit Mark (%)**

**1. Review science concepts of combustion and fuels.**

**100%**

- a. Combustion
- b. Fuels and heating values
- c. Combustion air
- d. Flames
- e. Products of combustion
- f. Combustion efficiency
- g. Electrical energy
- h. Electrical energy production
- i. electricity

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** C1 Refrigeration and Air Conditioning Installation

**Level:** Two

**Duration:** 29 hours

Theory: 15 hours

Practical: 14 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the procedures used to prepare for and install refrigeration systems and their components, and refrigeration components of air conditioning systems.

<b>Objectives and Content:</b>	<b>Percent of Unit Mark (%)</b>
<b>1. Identify and interpret codes, regulations and manufacturers' specifications pertaining to refrigeration and air conditioning installations.</b>	<b>9%</b>
<b>2. Describe the procedures used to prepare for refrigeration and air conditioning system installations.</b>	<b>9%</b>
a. Select tools and equipment	
b. Select components	
c. Select piping and fittings	
d. Select ancillary devices	
e. Use electrical diagrams	
f. Use piping schematic diagrams	
<b>3. Describe the procedures used to install refrigeration and air conditioning systems.</b>	<b>9%</b>
a. Piping	
b. Wiring	
c. Leak testing	
d. Evacuation	
e. Charging	
<b>4. Describe the factors to consider when performing a system start-up.</b>	<b>9%</b>
a. Phasing, voltage imbalance and amperage	
b. Refrigerant charge adjustments	
c. Oil levels	
d. Operating pressures and temperatures	
e. System control adjustments	
f. Manufacturers' recommendations	

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| <b>5. Describe documentation requirements for system installation, start-up and commissioning.</b> | <b>9%</b>  |
| <b>6. Demonstrate installation of refrigeration systems and their components.</b>                  | <b>30%</b> |
| <b>7. Demonstrate installation of refrigeration components of air conditioning systems.</b>        | <b>25%</b> |

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** D1 Air Conditioning Fundamentals

**Level:** Two

**Duration:** 35 hours

Theory: 30 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of air conditioning fundamentals; air conditioning systems, their components and operation.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with air conditioning.	12%
2. Identify the factors that affect human comfort with respect to air quality.	12%
3. Identify types of air conditioning systems and describe their components and operation.	12%
4. Explain air circulation and ventilation.	12%
5. Identify tools and instruments used to determine air quality.	13%
6. Describe indoor and outdoor design conditions.	14%
7. Demonstrate the installation of air circulation, ventilation, and air conditioning equipment.	25%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** E3 Compressors II

**Level:** Two

**Duration:** 25 hours

Theory: 15 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the procedures used to install, maintain and troubleshoot hermetic and semi-hermetic compressors and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with hermetic and semi-hermetic compressors.	7%
2. Identify hazards and describe safe work practices pertaining to hermetic and semi-hermetic compressors.	7%
3. Identify and interpret codes and regulations pertaining to hermetic and semi-hermetic compressors.	7%
4. Describe compressor classifications according to temperature ranges and displacement.	7%
5. Explain compressor efficiency and how it is determined.	7%
6. Describe the procedures used to install hermetic and semi-hermetic compressors and their components.	7%
7. Describe the procedures used to maintain and troubleshoot hermetic and semi-hermetic compressors and their components.	6%
8. Describe control strategies for compressor protection and liquid refrigerant control.	6%
a. Solenoid drop	
b. Pump out cycle	
c. Pump down cycle	
9. Identify compressor failures and describe their causes and remedies.	6%
a. Mechanical	
b. electrical	

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|---|------------|
| <b>10. Describe the procedures used to start-up and shut-down hermetic and semi-hermetic compressors.</b> | <b>5%</b>  |
| <b>11. Install and troubleshoot hermetic and semi-hermetic compressors and their components.</b>          | <b>35%</b> |

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** E4 Motors I

**Level:** Two

**Duration:** 30 hours

Theory: 20 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of motors and motor controls, their components and operation.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with single-phase motors and motor controls.	7%
2. Explain the principles of single-phase motor operation.	7%
3. Identify types of motors and describe their characteristics, components and operation.	7%
a. Single-phase	
b. Three-phase	
c. Electrically commutated motors (ECM)	
4. Identify and interpret information found on motor nameplates.	7%
5. Identify types of capacitors and describe their characteristics and applications.	7%
6. Describe the procedures used to test capacitors.	7%
7. Identify types of starting devices for single-phase motors and describe their characteristics, wiring configuration and operation.	7%
8. Describe the effects of load and voltage changes on motor operation.	8%
9. Describe methods used to change speed and rotation of single-phase motors.	8%
10. Calculate voltage, resistance and current in motor circuits.	35%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** E5 Metering Devices

**Level:** Two

**Duration:** 20 hours

Theory: 10 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of metering devices and their operation and procedures used to install, maintain and troubleshoot them.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with metering devices.	5%
2. Describe the purpose and operation of metering devices.	5%
3. Identify types of metering devices and describe their characteristics and applications. a. Dry expansion b. Flooded	10%
4. Identify metering device components and describe their purpose and operation.	5%
5. Describe the procedures used to install metering devices.	5%
6. Describe the procedures used to maintain and troubleshoot metering devices.	10%
7. Identify metering device failures and describe their causes and remedies.	10%
8. Demonstrate operation, installation, maintenance and troubleshooting metering devices.	50%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** E6 Fans, Mechanical Drives, Air Filters and Air Cleaners

**Level:** Two

**Duration:** 20 hours

Theory: 15 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of fans, mechanical drives, air filters and air cleaners, and procedures for their components and operation, installation, maintenance and troubleshooting.

<b>Objectives and Content:</b>	<b>Percent of Unit Mark (%)</b>
1. Define terminology associated with fans, mechanical drives and air filters.	7%
2. Identify types of fans and describe their characteristics and applications.	7%
3. Identify fan components and describe their purpose and operation.	7%
4. Identify and interpret information found on fan performance curve charts.	7%
5. Describe factors that affect fan performance.	7%
6. Identify types of mechanical drives and describe their characteristics and applications.	7%
7. Identify types of mechanical drive components and describe their purpose and operation.	6%
8. Identify types of air filters and air cleaners and describe their characteristics and applications.	6%
9. Describe the procedures used to install fans, mechanical drives, air filters and air cleaners, and their components.	6%
10. Describe the procedures used to maintain and troubleshoot fans, mechanical drives, air filters and air cleaners, and their components.	5%

11. **Demonstrate the procedures for operation, installation, maintenance and troubleshooting of fans, mechanical drives, air filters and air cleaners and their components.**

**35%**

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** E7 Condensers

**Level:** Two

**Duration:** 15 hours

Theory: 5 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of condensers and the procedures for their operation, installation, maintenance and troubleshooting.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with condensers.	4%
2. Describe the purpose of condensers.	4%
3. Identify types of condensers and describe their characteristics and applications. a. Air-cooled b. Water-cooled c. Evaporative	4%
4. Identify condenser components and describe their purpose and operation.	4%
5. Describe heat reclaim procedures.	4%
6. Describe head pressure control procedures. a. Air-cooled b. Water-cooled c. Evaporative	4%
7. Describe the factors/conditions that determine condenser capacity and efficiency.	4%
8. Describe the procedures used to size condensers.	4%
9. Describe the procedures used to install condensers and their components.	4%
10. Describe the procedures used to maintain and troubleshoot condensers and their components.	4%

11. Demonstrate procedures for operation, installation, maintenance and troubleshooting of condensers and their components.

60%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** E8 Evaporators

**Level:** Two

**Duration:** 15 hours

Theory: 5 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the procedures for the operation, installation, maintenance and troubleshooting of evaporators and their components.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with evaporators.	2%
2. Describe the purpose and operation of evaporators.	3%
3. Identify types of evaporators and describe their characteristics and applications.	5%
a. Counter, cross and parallel flow	
b. Direct expansion, flooded and liquid overfeed	
c. Forced and induced	
d. Plate or eutectic	
e. Brazed plate/plate and frame	
f. Primary and secondary surface	
g. Chiller barrel (fluid cooler)	
4. Identify evaporator system components and describe their purpose and operation.	5%
a. Drain pan heaters	
b. Evaporator fans and controls	
c. Drain lines	
d. Flow switches	
5. Identify defrost methods and describe electrical and piping considerations.	5%
6. Describe the factors/conditions that determine evaporator capacity and efficiency.	5%
7. Describe the procedures used to size evaporators.	5%
8. Describe the procedures used to install evaporators and their components.	5%

- 9. Describe the procedures used to maintain and troubleshoot evaporators and their components. 5%
- 10. Demonstrate the procedures for the operation, installation, maintenance and troubleshooting of evaporators and their components. 60%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** F1 Control Fundamentals

**Level:** Two

**Duration:** 20 hours

Theory: 15 hours

Practical: 5 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of control fundamentals and their applications; and of system controls, their components and operation.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with system control.	10%
2. Identify types of control systems and describe their components and operation.	10%
3. Identify types of control circuits and describe their applications, components and operation.	
4. Identify types of control devices and describe their applications and operation.	15%
5. Explain open and closed loop control.	10%
6. Describe control and control actions with respect to loads, switches and circuits.	10%
7. Identify types of monitoring controls and describe their applications and operation.	10%
a. Flow	
b. Humidity	
c. Liquid level	
d. Pressure	
e. Temperature	
8. Demonstrate procedures used for the operation of system controls and their components.	20%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** F2 Control Circuits and Wiring Diagrams

**Level:** Two

**Duration:** 30 hours

Theory: 20 hours

Practical: 10 hours

### Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of the procedures used to install, maintain, and troubleshoot control circuits; and of wiring diagrams and their use.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Define terminology associated with control circuits and wiring diagrams.	7%
2. Describe the operating principles of control systems.	7%
3. Describe the operation of a control circuit and its wiring configuration within system design.	7%
4. Identify types of controls and describe their applications.	7%
a. Operating	
b. Safety	
c. Defrost	
5. Identify types of wiring diagrams and describe their characteristics and applications.	7%
a. Pictorial	
b. Schematic	
6. Identify and interpret information and symbols found on schematic diagrams.	7%
7. Sketch a schematic wiring diagram based on a written sequence of control events.	7%
8. Sketch a schematic wiring diagram from a pictorial diagram.	7%
9. Sketch a pictorial diagram from a schematic wiring diagram.	7%
10. Describe the procedures used to install control circuits.	6%
11. Describe the procedures used to maintain and troubleshoot control circuits.	6%

12. Demonstrate the procedures used to install, maintain and troubleshoot control circuits.

25%

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## Refrigeration and Air Conditioning Mechanic (Residential)

**Unit:** G1 Gas Code II (includes Propane)

**Level:** Two

**Duration:** 25 hours

Theory: 20 hours

Practical: 5 hours

**Overview:**

RACM (Residential) apprentices require a good, practical grasp of the Gas Code, including Propane. This unit of instruction is the program gateway to further gas and propane learning skills.

<b>Objectives and Content:</b>	<b><u>Percent of Unit Mark (%)</u></b>
1. Reads and interprets Canadian Gas Codes and the Manitoba Regulation.	100%

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