

Refrigeration and Air Conditioning Mechanic (Residential) Level 3

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: A16 Job Coordination and Job Site Management

Level: Three

Duration: 5 hours

Theory: 5 hours

Practical: 0 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of effective job coordinating practices, equipment and material acquisition.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Identify sources of information relevant to job coordinating.	20%
a. Trade related documentation	
b. Related professionals	
c. Customers	
d. Co-workers	
2. Identify information gathering and communication techniques.	20%
a. Questioning	
b. Translating technical information	
c. Using communication	
3. Identify and interpret regulatory requirements.	20%
a. Standards and regulations	
b. Codes and by-laws	
c. Permits	
d. Inspections	
4. Estimate work requirements.	20%
a. Tools and equipment	
b. Components and accessories	
c. Time and costs	
5. Describe the procedures used to coordinate work requirements.	20%
a. Conduct work area inspection	
b. Coordinate work requirements	
c. Maintain customer relations	

- d. Clarify end user problems and concerns
- e. Complete work-related documentation
- f. Generate maintenance documentation
- g. Requisition equipment, components and accessories
- h. Receive equipment, components and accessories
- i. Transfer equipment to designated location

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: A17 Sheet Metal: Simple Layout

Level: Three

Duration: 14 hours

Theory: 7 Hours

Practical: 7 Hours

Overview:

This unit is designed to provide the apprentice with a knowledge of simple layout, its applications and associated calculations and pattern development using simple layout.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Identify types of powder actuated tools and describe their applications.	5%
2. Identify types of shop tools and equipment and describe their applications and procedures for use.	5%
3. Identify types of shop tools and layout tools and equipment and describe their applications and procedures for use.	5%
4. Define and explain terminology associated with simple layout.	5%
5. Describe the types of basic patterns and fittings that require simple layout.	10%
6. Identify calculations used in simple layout and the procedures used to perform them.	10%
7. Describe the procedures used to develop basic patterns and fabricate fittings using simple layout.	10%
a. Determine views	
b. Label lines and points	
c. Prepare pattern	
d. Determine types of seams, joints and edges	
e. Calculate allowances	
f. Determine stretchouts	
g. Confirm pattern accuracy	
h. Cut pattern	
i. Label pieces	
8. Develop patterns using simple layout.	50%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: C2 Building Heat Loss, Heat Gain, Load Calculations

Level: Three

Duration: 30 hours

Theory: 25 hours

Practical: 5 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of performing air conditioning load calculations.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with air conditioning load calculations.	25%
2. Perform heat gain and heat loss calculations for air conditioning systems.	75%
a. Transmission	
• K, C, U and R values	
• Solar load	
b. Air change	
• Infiltration	
• Ventilation	
c. Heat gain/loss	
• Sensible	
• Latent	
d. Miscellaneous	
• Lighting	
• Occupancy	
• Equipment	
e. BTU/hr total	

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: C3 Refrigeration System Design

Level: Three

Duration: 25 hours

Theory: 15 hours

Practical: 10 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of refrigeration system design principles and components and their selection based on design criteria; capacity control; and developing piping and electrical schematics.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with refrigeration system design.	5%
2. Identify and interpret codes and regulation pertaining to refrigeration system design.	5%
3. Explain the fundamental principles of refrigeration system design.	5%
4. Interpret graphs and tables for refrigeration system design.	5%
5. Identify capacity ratings of refrigeration system components.	5%
6. Perform calculations for refrigeration system design.	15%
a. Horsepower per ton	
• Low temperature system	
• Medium temperature system	
• High temperature system	
7. Describe the selection of components and ancillary devices for refrigeration systems based on design criteria.	5%
8. Describe the selection of refrigerant based on design criteria.	5%
9. Describe the factors to consider in the design and layout of refrigeration systems.	5%
10. Describe the importance of balancing system capacity with system load.	5%

11. Describe the factors to consider when sizing pipe for refrigeration piping systems. 5%
12. Describe the procedures used to size pipe for refrigeration piping systems. 5%
13. Develop piping schematics for refrigeration systems. 15%
14. Develop electrical schematics for refrigeration systems. 15%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D2 Air Conditioning Systems

Level: Three

Duration: 25 hours

Theory: 15 hours

Practical: 10 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of residential and commercial air conditioning systems, their components and operation, and the procedures used to install, maintain and troubleshoot residential and commercial air conditioning systems and their components.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with residential and commercial air conditioning systems.	5%
2. Identify types of residential and commercial air conditioning systems and describe their characteristics and applications.	5%
3. Identify types of residential and commercial air conditioning system components and describe their purpose and operation.	10%
4. Describe the procedures used to install residential and commercial air conditioning equipment and their components.	10%
5. Describe the procedures used to maintain and troubleshoot residential and commercial air conditioning equipment and their components.	10%
6. Describe potential residential and commercial air conditioning problems and their causes and remedies.	10%
7. Describe the procedures used to calibrate and adjust air conditioning system components.	10%
8. Describe the procedures used to start-up and shut-down air conditioning systems.	10%
9. Demonstrate the procedures used to install, maintain and troubleshoot residential and commercial air conditioning systems and their components.	30%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D3 Packaged Air Conditioning Units

Level: Three

Duration: 10 hours

Theory: 7 hours

Practical: 3 hours

Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of packaged air conditioning units, their components and operation, and of the procedures used to install, maintain and troubleshoot packaged air conditioning units and their components.

Objectives and Content:	Percent of Unit Mark (%)
1. Define terminology associated with packaged air conditioning units.	7%
2. Identify hazards and describe safe work practices when working with packaged air conditioning units.	7%
3. Identify and interpret codes and regulations pertaining to packaged air conditioning units.	7%
4. Identify types of packaged air conditioning units and describe their characteristics and applications.	7%
5. Identify packaged air conditioning unit components and describe their purpose and operation.	7%
6. Perform calculations for packaged air conditioning units.	7%
7. Identify potential problems and describe their causes and remedies.	7%
8. Describe the procedures used to install packaged air conditioning units and their components.	7%
9. Describe the procedures used to maintain and troubleshoot packaged air conditioning units and their components.	7%
10. Describe the procedures used to start-up and shut-down packaged air conditioning units and their components.	7%
11. Demonstrate the procedures to install, maintain and troubleshoot packaged air conditioning units and their components.	30%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D4 Heat Pump Systems

Level: Three

Duration: 9 hours

Theory: 7 hours

Practical: 2 hours

Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of heat pump systems, their components and operation, and of the procedures used to install, maintain, and troubleshoot heat pump systems and their components.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with heat pump systems.	6%
2. Identify and interpret codes and regulations pertaining to heat pump systems.	6%
3. Describe the operating principles of heat pump systems.	6%
4. Identify types of heat pumps and describe their characteristics and applications.	6%
5. Identify heat pump components and describe their purpose and operation.	6%
6. Describe the operation of the defrost cycle as it relates to heat pumps.	6%
7. Describe the environmental considerations when installing heat pumps.	6%
8. Describe water quality as it relates to open loop systems.	6%
9. Perform calculations for heat pump systems.	6%
10. Describe control sequences for heat pumps.	6%
11. Describe the procedures used to install heat pumps and their components.	6%
12. Describe the procedures used to maintain and troubleshoot heat pumps and their components.	4%
13. Demonstrate the procedures to install, maintain and troubleshoot heat pumps and their components.	30%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D5 Air Conditioning System Design

Level: Three

Duration: 30 hours

Theory: 20 hours

Practical: 10 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of air conditioning system design principles, air volume requirements of air conditioning systems, air conditioning system components and their selection based on design criteria, capacity control, and developing piping and electrical schematics.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with air conditioning system design.	5%
2. Identify and interpret codes and regulations pertaining to air conditioning system design.	5%
3. Explain fundamental principles of air conditioning system design.	5%
4. Interpret graphs and tables for air conditioning system design.	5%
5. Identify capacity ratings of air conditioning system components.	5%
6. Perform calculations for air conditioning system design. a. Air volumes and velocities b. Operating capacity c. Design capacity d. Heating load e. Cooling load f. Peak load g. Transfer rates h. Sizing of humidity control equipment	5%
7. Identify methods of zoning and describe their applications.	5%
8. Identify types of system design and their applications. a. Constant air volume b. Variable air volume	5%

- | | |
|---|------------|
| 9. Describe the selection of components and ancillary devices for air conditioning systems based on design criteria. | 5% |
| 10. Describe the factors to consider in the design and layout of air conditioning systems. | 5% |
| a. Humidification | |
| b. Dehumidification | |
| c. Refrigeration piping | |
| d. Secondary refrigeration piping drainage | |
| e. Condenser water piping | |
| 11. Describe the importance of balancing system capacity with system load. | 5% |
| 12. Describe the procedures used to size pipe for air conditioning piping systems. | 5% |
| 13. Develop piping schematics for air conditioning systems. | 5% |
| 14. Develop electrical schematics for air conditioning systems. | 35% |

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D6 Duct Systems and Design

Level: Three

Duration: 25 hours

Theory: 20 hours

Practical: 5 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of duct system design, duct systems, their components and operation, and the procedures used to install, maintain and troubleshoot duct systems and their components.

Objectives and Content:

**Percent of
Unit Mark (%)**

- | | |
|---|-----|
| 1. Define terminology associated with duct systems. | 5% |
| 2. Identify hazards and describe safe practices pertaining to duct systems. | 5% |
| 3. Identify and interpret codes and regulations pertaining to duct systems. | 10% |
| 4. Identify types of duct systems and describe their characteristics and operation. | 5% |
| 5. Identify duct system components and describe their purpose and operation. | 5% |
| 6. Describe the factors affecting duct system sizing, layout and design. | 10% |
| 7. Identify methods of sizing duct and describe their associated procedures. | 10% |
| 8. Identify types of duct insulation and sealants and describe their applications and procedures for use. | 5% |
| 9. Identify types of duct insulation and sealants and describe their applications. | 10% |
| 10. Identify potential problems in duct systems and design and describe their causes and remedies. | 5% |
| 11. Describe the procedures used to install duct systems and their components. | 5% |
| 12. Describe the procedures used to maintain and troubleshoot duct systems and their components. | 5% |

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D7 Heating Systems

Level: Three

Duration: 18 hours

Theory: 15 hours

Practical: 3 hours

Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of heating systems, their components and operation, and of the procedures used to install, maintain, and troubleshoot heating systems and their components.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with heating systems.	6%
2. Identify hazards and describe safe work practices when working with heating fuels.	6%
3. Describe the physical and chemical properties of heating fuels.	6%
4. Identify and interpret codes and regulations pertaining to heating systems.	6%
a. Jurisdictional certifications	
5. Identify types of heating systems and describe their characteristics and applications.	6%
a. Gas	
b. Oil	
c. Electric	
6. Identify types of heating system components and describe their purpose and operation.	6%
7. Perform calculations for heating systems.	6%
8. Identify potential problems and describe their causes and remedies.	6%
9. Identify specialized tools and equipment and describe their applications and procedures for use.	6%
10. Describe the procedures used to install heating systems and their components.	7%

- | | |
|--|------------|
| 11. Describe the procedures used to maintain and troubleshoot heating systems and their components. | 7% |
| 12. Describe the procedures used to start-up and shut-down heating systems. | 7% |
| 13. Perform the procedures to start-up and shut-down heating systems. | 25% |

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: D8 Air Measuring Instruments and System Air Balancing

Level: Three

Duration: 8 hours

Theory: 5 hours

Practical: 3 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of air measurement and air quality management, the procedures used to measure air flow quantity; air measuring instruments, their applications and procedures for use, and system air balancing procedures.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with air measuring instruments and system air balancing.	5%
2. Identify and interpret codes and regulations pertaining to air measurement and system air balancing.	10%
3. Explain fundamental principles of air movement and air quality management.	10%
4. Identify types of air measurement instruments and describe their applications and procedures for use.	5%
5. Identify types of charts used to monitor and balance air systems and describe their applications and procedures for use.	10%
6. Describe conditions affecting air properties.	5%
7. Perform calculations for system air balancing.	25%
8. Describe the procedures used in system air balancing.	5%
9. Demonstrate the procedures used in system air balancing.	25%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: E9 Fluid Dynamics and Circulating Pumps

Level: Three

Duration: 7 hours

Theory: 7 hours

Practical: 0 hours

Overview:

Upon completion of this unit of instruction the apprentice will demonstrate knowledge of fluid dynamics within piping systems and of circulating pumps, their components and operation.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with fluid dynamics and circulating pumps.	15%
2. Explain principles of fluid dynamics.	15%
3. Identify types of circulating pumps and describe their characteristics and applications.	15%
4. Identify circulating pump components and describe their purpose and operation.	15%
5. Describe the factors to consider when selecting a circulating pump. a. System parameters b. Pump curves c. Circuit configurations	15%
6. Identify potential problems of air in an open or closed system and their causes and remedies.	15%
7. Describe the procedures to purge air from an open or closed system.	10%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: F3 Troubleshooting Refrigeration and Air Conditioning Systems

Level: Three

Duration: 30 hours

Theory: 20 hours

Practical: 10 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of testing tools and equipment, their applications and procedures for use, and the procedures used to troubleshoot electronic components and control boards.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Define terminology associated with electronics.	15%
2. Identify electronic components and describe their purpose and operation.	20%
3. Identify tools and equipment used to test and troubleshoot electronic components and describe their applications and procedures for use.	15%
4. Describe the procedures used to troubleshoot electronic components and control boards.	20%
5. Demonstrate the procedures used to troubleshoot electronic components and control boards.	30%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: F4 Troubleshooting with Schematic Wiring Diagrams

Level: Three

Duration: 19 hours

Theory: 15 hours

Practical: 4 hours

Overview:

This unit is designed to provide the apprentice with the knowledge of advanced schematic wiring diagrams and their use in troubleshooting complex systems.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Interpret advanced schematic wiring diagrams for use in troubleshooting complex systems.	50%
a. Manufacturer's drawings	
b. As-built drawings	
2. Identify troubleshooting techniques using advanced schematic wiring diagrams and describe their associated procedures.	50%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: G3 Gas Code III (includes Propane)

Level: Three

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.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
1. Describe Liquid Petroleum (LP) liquid installation.	10%
2. Describe LP pump, compressors and vaporizers.	10%
3. Describe LP liquid meters, mixing equipment, transport units, trucks, rail, storage facilities, utility systems, pipeline and supply storage, natural gas utility systems, and high and low pressure natural gas and LP gas supply systems.	20%
4. Demonstrate the ability to install and maintain LP, handling equipment, pumps, compressors, vaporizers, and meters.	30%
5. Demonstrate the ability to maintain LP transport equipment and storage facilities, maintain and repair LP utility systems, pipeline and supply storage LP transport equipment and storage facilities, to install, service and maintain high and low pressure natural gas and LP gas supply systems.	30%

Refrigeration and Air Conditioning Mechanic (Residential)

Unit: A18 Pre-Certification Review

Level: Three

Duration: 35 hours

Theory: 35 hours

Practical: 0 hours

Overview:

This unit offers senior apprentices a systematic review of skills and knowledge required to pass the Provincial Examination. It promotes a purposeful personal synthesis between on-the-job learning and the content of in-school technical training. The unit includes information about the significance of Provincial certification and the features of the Provincial Examination.

Objectives and Content:	<u>Percent of Unit Mark (%)</u>
<p>1. Describe the significance, format and general content of Provincial Examinations for the trade of Refrigeration and Air Conditioning Mechanic (Residential).</p> <p>a. Scope and aims of Provincial certification; value of certifications</p> <p>b. Obligations of candidates for Provincial certification</p> <ul style="list-style-type: none"> • Relevance of provincial examinations to current, accepted trade practices; industry-based provincial validation of test items • Supplemental policy (retesting) • Confidentiality of examination content <p>c. Multiple-choice format (four-option) item format, Manitoba standards for acceptable test items</p> <p>d. Government materials relevant to the Provincial examinations for apprentice Refrigeration and Air Conditioning Mechanic (Residential) Technicians</p> <ul style="list-style-type: none"> • Provincial Occupational Analysis (POA); prescribed scope of the skills and knowledge which comprise the trade • POA "Pie-chart" and its relationship to content distribution of Provincial Examination items • Apprenticeship Manitoba Technical Training Package 	<p>5%</p>
<p>2. Identify resources, strategies and other considerations for maximizing successful completion of written examinations.</p> <p>a. Personal preparedness</p> <ul style="list-style-type: none"> • Rest • Nutrition • Personal study regimen • Prior experience in test situations (e.g., Unit tests) 	<p>5%</p>

- b. Self-assessment, consultation and personal study plan
 - Self-assessment of individual strengths/weaknesses in trade related skills and knowledge
 - Approved textbooks
 - Study groups

- 3. **Review program content regarding occupational skills.** **15%**

- 4. **Review program content regarding Trade Mathematics and Science.** **10%**

- 5. **Review program content regarding Refrigeration and Air Cooling Systems.** **15%**

- 6. **Review program content regarding Heating, Ventilation and Air Conditioning Systems.** **10%**

- 7. **Review program content regarding Refrigeration, Heating, Ventilation and Air Conditioning System Components.** **15%**

- 8. **Review program content regarding Control Systems.** **10%**

- 9. **Review program content regarding Gasfitter.** **15%**
