

KACC-0235 Basic Refrigeration Course Blueprint

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Competencies and Learning Objectives

1. Demonstrate the math and measurement skills needed for the HVAC industry.
 - Calculate volume, length, and area.
 - Calculate invoice pricing.
 - Convert temperatures between Celsius and Fahrenheit.
2. Describe the proper use of tools used in the HVAC trade.
 - Identify basic and specialized hand tools for HVAC.
 - Identify basic and specialized power tools for HVAC. [e.g. specialized= pipe threader, vacuum pump, recovering machine, / basic= drills, saw]
 - Identify basic and specialized test equipment [multi-meters, meggers, micron gauge, manometers, manifold gauges]
3. Explain basic refrigeration theory and characteristics.
 - Define the first and second Laws of Thermodynamics.
 - Describe how heat transfers.
 - Describe the three states of matter and how the change of state effects heat and temperature.
 - Define and calculate British Thermal Unit (BTU), specific heat, latent heat, and sensible heat.
 - Describe superheated vapor and subcooled liquid.
 - Describe temperature and the different temperature scales used to measure it.
 - Describe pressure and the difference between absolute and gauge pressure.
 - Describe the effect pressure and vacuum have on the boiling point of a liquid.
 - Define the Gas Laws.
 - Demonstrate the use of pressure-temperature charts in the operation of refrigeration systems.

4. Demonstrate the operation of the basic components used in a refrigeration system.
 - Describe the process of the basic refrigeration cycle.
 - Describe the basic system components of a basic refrigeration system, their use and the state of the refrigerant in them.
 - Measure pressure and temperature using a manifold gauge set and digital thermometer on a basic refrigerant system.
 - Demonstrate how to check for superheat and subcooling in a basic refrigerant system.
5. Explain the characteristics and applications of different refrigerants and refrigerant oils.
 - Identify different refrigerants.
 - Interpret pressure-temperature (P/T) charts.
 - Describe refrigerant applications within specific temperature ranges.
 - Distinguish between pure component refrigerants and blends.
 - Explain fractionation and temperature glide.
 - Identify the proper oils used for pure refrigerants and blends.
6. Demonstrate the process of refrigerant recovery.
 - Explain ozone depletion and global warming potential.
 - Explain the Montreal Protocol and the Clean Air Act.
 - Identify recovery equipment.
 - Demonstrate the process for refrigerant recovery.
7. Demonstrate refrigerant system evacuation, leak detection, and system recharge.
 - Explain the reason for performing a proper HVAC system evacuation.
 - Describe the different methods of evacuation.
 - Demonstrate the process for evacuating a refrigeration system.
 - Describe the different types of refrigerant leak detection.
 - Perform a refrigeration system leak detection.
 - Explain the different procedures for recharging a HVAC system.
 - Recharge a refrigeration system.

Orientation to Course

Course Description

In Basic Refrigeration you will be exploring the theory of heat transfer and the principles of refrigeration. Because air conditioning and refrigeration systems are made up of copper tubing, you can't see what is going on inside the system. But having an understanding of the principles of heat transfer, thermodynamics, and of the refrigeration system will allow you to know what is going on inside the system without needing to see inside. You will also become familiar with the different types of refrigerants and refrigerant oils. You will also study the importance of proper refrigerant recovery, system evacuation, leak detection, and system recharge. This is an exciting course, that when mastered, will make the rest of your training a lot easier to understand.

Competencies

Upon completion of the course, you will be rated as MC (Mastered Competency) or NM (Not-Mastered Competency) based on your demonstrated ability of the course's established competencies. You will:

- Demonstrate the math and measurement skills needed for the HVAC industry.
- Describe the proper use of tools used in the HVAC trade.
- Explain basic refrigeration theory and characteristics.
- Demonstrate the operation of the basic components used in a refrigeration system.
- Explain the characteristics and applications of different refrigerant and refrigerant oils.
- Describe the process for refrigerant recovery.
- Demonstrate refrigerant system evacuation, leak detection, and system recharge.

Assessment

You will be given a written progress exam and/or a lab practical to see if you are on track in progressing toward the required competencies at the end of each module. You must pass these progress exams with a score of at least 80% before you can move on to the next module.

At the end of the course you will again be given a written exam and final lab practical that you must pass with at least a score of 80% before you will be rated with an MC as your grade for the course.

Syllabus and Textbook *(Note: Books and materials required for this course are listed below.*

Instructor uses instructional materials from this publisher, including presentations, videos, and other learning materials.)

Read the syllabus to understand the expectations for this course. The instructor will go through the syllabus and review the textbook with you on your first day of class.

- Textbook: Heating and Cooling Essentials, ISBN: 978-1-63126-059-9, Crawshaw
- Lab Manual: Heating and Cooling Essentials, ISBN: 978*1-69126*063-6, Crawshaw



Labs

You will have 17 labs as a part of this course. There is a schedule for labs and other opportunities to work with instructors. Sign up ahead of time for labs, about a week before you want to work on a lab. Make sure you come at that time or reschedule it.

Course Navigation

In the left navigation bar is a Course Tools menu. It provides information about what tools you need for the course, and how to navigate in Canvas.

Start the course with the first module below. You can also click on the **Modules** link in the left navigation bar to navigate through the course.

Modules

Module 1: Basic Math and Measurements

Basic Math and Measurements Overview

One of the skills important in HVAC is understanding basic math and how to read and take measurements. You will be using your math skills a lot in this field. Making accurate measurements, properly sizing parts, installing equipment, and completing work orders and timesheets are just a few of the daily duties that require your math skills.

When you have completed this module, you will know how to:

- Calculate volume, length, and area.
- Calculate invoice pricing.
- Convert temperatures between Celsius and Fahrenheit.

Basic Math and Measurements Assignments

In this module you will view a PowerPoint video presentation, read a chapter in the textbook and will have a lab to complete. You will also start using the *Heating and Cooling Essentials* textbook, beginning with chapter 8.

Basic Math & Measurements

1. Read chapter 8 “Mathematics for Technicians” in the *Heating and Cooling Essentials* textbook.
2. View the PowerPoint video presentation “Basic Math & Measurement”. **Note:** There is no audio with this presentation.
3. Check your knowledge: Take the chapter review quiz.
4. Complete Lab Project.

Check Your Knowledge: Chapter 8 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit** button. You will be shown your score.

Lab 8: Mathematics for Technicians

This lab will be done in Canvas, so you do not need to come to the college to perform it. You will be working with basic math and measurement skills.

1. You will need to use the Lab 8 sheets from your lab manual to find the answers.
2. Fill out your lab sheets first and then you will record your answers from your worksheet into the quiz after they have been answered.
3. **Note:** The answers to Activity 8-6: Completing a Work Order/Invoice can be printed on the next assignment page.
4. When you are ready click on Take the Quiz to start your lab.
5. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Basic Math & Measurements Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course.

This exam covers chapter 8 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Basic Math & Measurement Lab Practical

As was stated at the beginning of this module:

One of the skills important in HVAC is understanding basic math and how to read and take measurements. You will be using your math skills a lot in this field. Making accurate measurements, properly sizing parts, installing equipment, and completing work orders and timesheets are just a few of the daily duties that require your math skills.

So for this Lab Practical you will be putting your math skills to the test by:

- Taking linear measurements
- Calculating surface area
- Calculating volume
- Measuring and converting temperatures
- Completing a work order

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

Module 2: Tools in HVAC

Tools Overview

No technician is complete without his tools. This module will introduce you to both basic tools and specialty tools used in the HVAC industry. Having and knowing which tools to use will make you a more productive service technician. Buying the proper tools will be one of your best investments you will make as a HVAC technician.

When you have completed this module, you will know how to:

- Identify basic and specialized hand tools for HVAC.
- Identify basic and specialized power tools for HVAC.
- Identify basic and specialized test equipment for HVAC.

To begin this module, watch this video:

[HVAC tools of the trade](#)

Tools Assignments

In this module you will view a PowerPoint video presentation, read a chapter in the textbook and will have a lab to complete.

Tools

1. Read chapter 2 “Hand Tools” in the *Heating and Cooling Essentials* textbook.
2. View the PowerPoint Video Presentation “Basic Tools”. **Note:** There is no audio with this presentation.
3. Check your knowledge: Take the chapter 2 review quiz.
4. Complete Lab Projects.

Check Your Knowledge: Chapter 2 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook. **Testing Procedures:**

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit**. You will be shown your score.

Lab Project 2: Hand Tools

This lab will be done in Canvas, so you do not need to come to the college to perform it. You will be working with basic math and measurement skills, and will use the Lab 2 sheets from your lab manual to find the answers.

1. Fill out your lab sheets first and then you will record your answers from your worksheet into the quiz after they have been answered.
2. You will not need to do Activity 2-2 or 2-3.
3. When you are ready click on Take the Quiz to start your lab.
4. Answer the questions.
5. Click the **Submit** button when you are finished.

Lab 2a: Specialty Tools

For this lab you will be Identifying some of the specialty tools that are used in the HVAC trade. You will be looking at hand, power, and test equipment.

1. Print out the Lab 2a Worksheets.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the Lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Tools Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapter 2 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Module 3: Fundamentals of Refrigeration

Refrigeration Fundamentals Overview

If asked, most people would say that the process of refrigeration or air conditioning is cooling by adding cold. But, the opposite is true. We don't put cold in. We take heat out. Coldness is just the lack of heat. The definition of refrigeration or air conditioning is simply "Removing heat from an area or product where it is not wanted and releasing it in an area that makes little or no difference". In this module you will be introduced to one of the most important topics in this course.

When you have completed this module, you will know how to:

- Define the first and second Laws of Thermodynamics.
- Describe how heat transfers.
- Describe the three states of matter and how the change of state effects heat and temperature.

- Define and calculate British Thermal Unit (BTU), specific heat, latent heat, and sensible heat.
- Describe superheated vapor and subcooled liquid.
- Describe temperature and the different temperature scales used to measure it.
- Describe pressure and the difference between absolute and gauge pressure.
- Describe the effects pressure and vacuum have on the boiling point of a liquid.
- Define the Gas Laws.
- Demonstrate the use of pressure-temperature charts in the operation of refrigeration systems.

To begin this module, watch these 2 videos:

Heat, Temperature and Energy Transfer (*This is a publisher DVD that the instructor has permission to stream through the learning management system.*)

[Online HVAC Training Video](#)

Refrigeration Fundamentals Assignments

In this module you will view a PowerPoint video presentation, read 2 chapters in the textbook and have 3 labs to complete.

Refrigeration Fundamentals

1. Read chapter 9 “Basic Thermodynamic Principles” in the *Heating and Cooling Essentials* textbook.
2. View the PowerPoint video presentation “Temperature, Pressure & Heat Transfer”.
Note: There is no audio with this presentation.
3. Watch the video “**The Manifold Gaugeset**”. Check your knowledge: Take the chapter 9 review quiz.
4. Read chapter 10 “Temperature and Pressure” in the *Heating and Cooling Essentials* textbook.
5. Check your knowledge: Take the chapter 10 review quiz.
6. Complete Lab Projects.

Check Your Knowledge: Chapter 9 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit**. You will be shown your score.

Check Your Knowledge: Chapter 10 Review Quiz

After you have read the textbook chapter, take the open book chapter review quiz. This quiz is designed to help you see what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit**. You will be shown your score.

Lab 9: Basic Thermodynamic Principles

For this lab you will be expanding your knowledge of thermodynamics and refrigeration theory.

1. This lab will be done in Canvas, so you do not need to come to the college to perform it.
2. You will need to use the Lab 9 sheets from your lab manual.
3. Fill out your lab sheets first and then you will record your answers from your worksheet into the quiz after they have been answered.
4. When you are ready click on Take the Quiz to start your lab.
5. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Lab 10: Temperature and Pressure

For this lab you will be working on better understanding the effects that temperature and pressure have on a refrigeration system.

1. This lab will be done in Canvas, so you do not need to come to the college to perform it.
2. You will need to use the Lab 10 sheets from your lab manual.
3. Fill out your lab sheets first and then you will record your answers from your worksheet into the quiz after they have been answered.
4. When you are ready click on Take the Quiz to start your lab.
5. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Lab Project: Introduction to Refrigeration

For this lab you will be getting familiar with the Amatrol Air Conditioning/Heat Pump trainer. You will learn the different components and how to operate and adjust the trainer. You will also work more with temperature and pressure in this lab.

1. Print out the Lab Worksheet.
2. Ask your instructor for a copy of the Lab Project: Introduction to Refrigeration lab book.
3. Using the lab book and the worksheet; follow the instructions for the lab.
4. Have your instructor sign off that you have completed the lab.

5. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Fundamentals of Refrigeration Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course.

This exam covers chapters 9 and 10 in the Heating and Cooling Essentials Textbook. You will need to print out this worksheet to be used for the last 5 questions on this exam. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Will not have a lab practical with this module.

Module 4: Basic Refrigeration System - Part 1

Basic Refrigeration System Overview

By now you should have a good understanding of the principles of Thermodynamics and refrigeration theory. Now you are going to see how we put these principles to work inside a refrigeration or air conditioning system. While we may not be able to see inside a refrigeration or air-conditioning system, understanding the refrigeration cycle and the job of each one of its components will give us a way of knowing what is going on inside the system. You will also start to work with the tools that will allow you to figure out what is going on inside the system.

When you have completed this module, you will know how to:

- Describe the process of the basic refrigeration cycle.
- Describe the basic system components of a basic refrigeration system, their use and the state of the refrigerant in them.
- Measure pressure and temperature using a manifold gauge set and digital thermometer on a basic refrigerant system.
- Demonstrate how to check for superheat and subcooling in a basic refrigerant system.

To begin this module, watch this video:

Components and Operations *(This is a publisher DVD that the instructor has permission to stream through the learning management system.)*

Basic Refrigeration System Assignments Part 1

In this section of the module you will view a 1 PowerPoint video presentation, read 1 chapter in the textbook and will have 1 lab to complete.

Basic Refrigeration Cycle

1. Read chapter 11 “Basic Refrigeration Cycle” in the *Heating and Cooling Essentials* textbook.
2. View the PowerPoint video Presentation “Intro to Refrigeration Systems”. **Note:** There is no audio with this presentation.
3. Check your knowledge: Take the chapter 11 review quiz.

Check Your Knowledge: Chapter 11 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit**. You will be shown your score.

Lab 11: Basic Refrigeration Cycle

For this lab you will be expanding your knowledge of basic refrigeration cycle.

1. This lab will be done in Canvas, so you do not need to come to the college to perform it.
2. You will need to use the Lab 11 sheets from your lab manual.
3. Fill out your lab sheets first, and then record your answers from your worksheet into the quiz after they have been answered.
4. You will not be doing Activity 11-5 or 11-6 in this lab.
5. When you are ready click on Take the Quiz to start your lab.
6. When you have answered all the questions, click **Submit**. You will be shown your score.

Basic Refrigeration System Assignments Part 2

1. View the PowerPoint video presentation “Compressors” **Note:** There is no audio with this presentation.
2. View the PowerPoint video presentation “Condensers” **Note:** There is no audio with this presentation.
3. Complete Lab Projects.

Lab Project: Compressors

For this lab you will be expanding your knowledge of how compressors are used in the basic refrigeration cycle.

1. Print out the Lab Worksheet.
2. Ask your instructor for a copy of the Lab Project: Compressors lab book.
3. Using the lab book and the worksheet follow the instructions for the lab.
4. Have your instructor sign off that you have completed the lab.
5. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Lab Project: Condensers

For this lab you will be expanding your knowledge of how condensers are used in the basic refrigeration cycle.

1. Print out the Lab Worksheet.
2. Ask your instructor for a copy of the Lab Project: Compressors lab book.
3. Using the lab book and the worksheet follow the instructions for the lab.
4. Have your instructor sign off that you have completed the lab.
5. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Basic Refrigeration System Assignments Part 3

1. View the PowerPoint video presentation “Metering Devices” **Note:** There is no audio with this presentation.
2. View the PowerPoint video presentation “Evaporators” **Note:** There is no audio with this presentation.
3. Complete Lab Project.

Lab Project: Metering Devices and Evaporators

For this lab you will be expanding your knowledge of how metering devices and evaporators are used in the basic refrigeration cycle.

1. Print out the Lab Worksheet.
2. Ask your instructor for a copy of the Lab Project: Compressors lab book.
3. Using the lab book and the worksheet, follow the instructions for the lab.
4. Have your instructor sign off that you have completed the lab.
5. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Module 5: Basic Refrigeration System - Continued

Basic Refrigeration System – Continued

In this module, you will continue to learn about the basic refrigeration system.

When you have completed this module, you will:

- Demonstrate how to check for superheat and subcooling in a basic refrigerant system.

Basic Refrigeration System Assignments Part 4

In this section of the module you will read 1 chapter in the textbook and will have 3 labs to complete.

Other System Components



1. Read chapter 12 “Other System Components” in the *Heating and Cooling Essentials* textbook.
2. Watch this video “Superheat and Subcooling”.
3. Check your knowledge: Take the chapter 12 review quiz. Complete Lab Projects.

Check Your Knowledge: Chapter 12 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit**. You will be shown your score.

Lab 12: Other System Components

For this lab you will be expanding your knowledge of other system components used in the basic refrigeration cycle.

1. You will need to remove the lab sheets for Lab 12 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab Project: Superheat and Subcooling Lab #1

For this lab you will be working on how to measure and calculate superheat and subcooling used in the basic refrigeration cycle.

1. Print out the Lab Worksheets to be used with the lab.
2. Using the worksheet/checklist, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Lab Project: Superheat and Subcooling Lab #2

For this lab you will be expanding your knowledge of why understanding superheat and subcooling is so important when dealing with the basic refrigeration cycle.

1. Print out the Lab Worksheets to be used with the lab.
2. Using the worksheet/checklist, follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.

4. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Basic Refrigeration System Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course.

This exam covers chapters 11 and 12 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Basic Refrigeration System Lab Practical

As stated at the beginning of this module:

"You should have a good understanding of the principles of Thermodynamics and refrigeration theory. Now you are going to see how we put these principles to work inside a refrigeration or air conditioning system. While we may not be able to see inside a refrigeration or air-conditioning system, understanding the refrigeration cycle and the job of each one of its components will give us a way of knowing what is going on inside the system. You will also start to work with the tools that will allow you to figure out what is going on inside the system."

So for this Lab Practical you will show that you understand the components that make up a refrigeration system by working with the Amatrol Thermal Troubleshooting System Trainer. On this trainer you will be:

- Measuring compressor inlet and outlet temperatures and pressures.
- Measuring condenser operation.
- Measuring evaporator operation.
- Measuring and adjusting system superheat.
- Measuring system subcooling.

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab, your instructor will enter your score into Canvas.

Module 6: Refrigerants and Refrigerant Oils

Refrigerants and Refrigerant Oils Overview

Now that you have a good understanding of how the refrigeration cycle works and how the major components function it is time to take a closer look at the refrigerant itself. This module will describe several common refrigerants and their basic properties and applications looking at both pure refrigerants and blends. Different refrigerants operate at different temperatures because of their different boiling points and you will learn how to determine which ones to use

for which temperature ranges. This module will also cover how to select which refrigerant oil to be used with which refrigerant type.

When you have completed this module, you will know how to:

1. Identify different refrigerants.
2. Interpret pressure-temperature (P/T) charts.
3. Describe refrigerant applications within specific temperature ranges.
4. Distinguish between pure component refrigerants and blends.
5. Explain fractionation and temperature glide.
6. Identify the proper oils used for pure refrigerants and blends.

Refrigerants and Refrigerant Oils Assignments

In this module you will read 2 chapters in the textbook and will have 2 labs to complete.

Refrigerants

1. Read chapter 13 “Refrigerants” in the *Heating and Cooling Essentials* textbook.
2. Check your knowledge: Take the chapter 13 review quiz.
3. Read chapter 14 “Zeotropic Blends” in the *Heating and Cooling Essentials* textbook.
4. Check your knowledge: Take the chapter 14 review quiz.
5. Complete Lab Projects.

Check Your Knowledge: Chapter 13 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit** button. You will be shown your score.

Check Your Knowledge: Chapter 14 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit** button. You will be shown your score.

Lab 13 Refrigerants

For this lab you will be identifying different refrigerants and their proper refrigerant oils and what alternative refrigerants could be used to replace the existing refrigerants in HVAC equipment. You will also be working more with figuring superheat and subcooling on refrigerant systems.

1. You will need to remove the lab sheets for Lab 13 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab 14 Zeotropic Blends

For this lab you will be working on how to control evaporator temperature when you retrofit refrigeration and air conditioning systems with new refrigerant.

1. You will need to remove the lab sheets for Lab 14 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Refrigerants and Refrigerant Oils Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapters 13 and 14 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Refrigerants and Refrigerant Oils Lab Practical

As was stated at the beginning of this module:

Now that you have a good understanding of how the refrigeration cycle works and how the major components function it is time to take a closer look at the refrigerant itself. This module will describe several common refrigerants and their basic properties and applications looking at both pure refrigerants and blends. Different refrigerants operate at different temperatures because of their different boiling points and you will learn how to determine which ones to use for which temperature ranges. This module will also cover how to select which refrigerant oil to be used with which refrigerant type.

When you have completed this module, you will know how to:

1. Identify different refrigerants.
2. Interpret pressure-temperature (P/T) charts.

3. Describe refrigerant applications within specific temperature ranges.
4. Distinguish between pure component refrigerants and blends.
5. Explain fractionation and temperature glide.
6. Identify the proper oils used for pure refrigerants and blends.

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

Module 7: Refrigerant Recovery

Refrigerant Recovery Overview

Current refrigerants have one big problem, they are known to destroy the ozone and contribute to global warming. Because of this, very strict rules have been created that prohibits the releasing of refrigerants into the atmosphere. This module will instruct you in the proper way to remove refrigerants from an HVAC system using a recovery machine.

When you have completed this module, you will know how to:

1. Explain ozone depletion and global warming potential.
2. Explain the Montreal Protocol and the Clean Air Act.
3. Identify recovery equipment.
4. Demonstrate the process for refrigerant recovery.

Refrigerant Recovery Assignments

In this module you will read 1 chapter in the textbook and will have 1 lab to complete.

Refrigerants

1. Read chapter 15 “Refrigerant Recovery and Recycling” in the *Heating and Cooling Essentials* textbook.
2. Check your knowledge: Take the chapter 15 review quiz.
3. Complete Lab Project.

Check Your Knowledge: Chapter 15 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz** link.



2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit** button. You will be shown your score.

Lab 15 Refrigerant Recovery and Recycling

For this lab you will be using recovery machines to recover the refrigerant from HVAC equipment.

1. You will need to remove the lab sheets for Lab 15 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Refrigerant Recovery and Recharge Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapter 15 in the Heating and Cooling Essentials Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Just a note that the lab practical for this module will be included with the next module.

Module 8: Evacuation, Leak Detection, and Recharging

Evacuation, Leak Detection, and Recharging Overview

Once the refrigerant has been recovered from an HVAC system and the repairs made the system must be evacuated and recharged. This module will explore the reasons why and the proper way to evacuate and recharge a HVAC system. You will also be learning how to perform leak detection on HVAC systems, when you feel the system has leaked out its' refrigerant.

When you have completed this module, you will know how to:

1. Explain the reason for performing a proper HVAC system evacuation.
2. Describe the different methods of evacuation.
3. Demonstrate the process for evacuating a refrigeration system.
4. Describe the different types of refrigerant leak detection.
5. Perform a refrigeration system leak detection.
6. Explain the different procedures for recharging a HVAC system.
7. Recharge a refrigeration system.

To begin this module, watch these 2 videos:



Evacuation of AC Systems (*These videos are a publisher DVD that the instructor has permission to stream through the learning management system.*)

Charging and Checkout

Evacuation, Leak Detection, and Recharging Assignments

In this module you will read 1 chapter in the textbook and will have 1 lab to complete.

System Evacuation, Leak Detection, and Recharging

1. Read chapter 16 “System Evacuation, Leak Detection, and Recharging” in the *Heating and Cooling Essentials* textbook.
2. Check your knowledge: Take the chapter 16 review quiz.
3. Complete Lab Project.

Check Your Knowledge: Chapter 16 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click **Submit** button. You will be shown your score.

Lab 16 System Evacuation, Leak Detection, and Recharging

For this lab you will be using leak detectors to find refrigerant leaks in an HVAC system. You will also be evacuating and recharging HVAC systems.

1. You will need to remove the lab sheets for Lab 16 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Use the lab manual sheets for the lab.
4. Have your instructor sign off on the front page of your lab sheets that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Refrigerant Recovery and Recharge Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapters 16 in the *Heating and Cooling Essentials* Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Refrigerant Recovery, Evacuation, Leak Detection and Recharge Lab Practical

This Lab Practical is for both Module 7 and Module 8 together.

As was stated at the beginning of this module:

Module 7:

Current refrigerants have one big problem, they are known to destroy the ozone and contribute to global warming. Because of this, very strict rules have been created that prohibits the releasing of refrigerants into the atmosphere. This module will instruct you in the proper way to remove refrigerants from an HVAC system using a recovery machine.

When you have completed this module, you will know how to:

1. Explain ozone depletion and global warming potential.
2. Explain the Montreal Protocol and the Clean Air Act.
3. Identify recovery equipment.
4. Demonstrate the process for refrigerant recovery.

Module 8:

Once the refrigerant has been recovered from an HVAC system and the repairs made the system must be evacuated and recharged. This module will explore the reasons why and the proper way to evacuate and recharge a HVAC system. You will also be learning how to perform leak detection on HVAC systems, when you feel the system has leaked out its' refrigerant.

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% or higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

Final Competency Exam and Practical Assessment

Final Competency Exam and Practical Assessment

As stated at the beginning of this course the Competencies for this course, are to be able to:

- Demonstrate the math and measurement skills needed for the HVAC industry.
- Describe the proper use of tools used in the HVAC trade.
- Explain basic refrigeration theory and characteristics.
- Demonstrate the operation of the basic components used in a refrigeration system.
- Demonstrate how to use pressure-enthalpy charts to determine refrigeration system efficiency.

At the end of each module you should have showed that you have mastered the competency for each module. This Written Exam and Lab Practical are going to make sure that you have fully mastered this course's competencies.

Written Exam Form A *(There is a Form B of this exam in for students who don't pass Form A)*

This written exam covers all chapters that was in this module. That being:

- Chapter 2: Hand Tools
- Chapter 8: Mathematics for Technicians
- Chapter 9: Basic Thermodynamics
- Chapter 10: Temperature and Pressure
- Chapter 11: Basic Refrigeration Cycle
- Chapter 12: Other System Components
- Chapter 13: Refrigerants
- Chapter 14: Zeotropic Blends
- Chapter 15: Refrigerant Recovery and Recycling
- Chapter 16: System Evacuation, Leak Detection, and Recharging

This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

This assessment will measure your knowledge in basic refrigeration. The assessment consists of 40 questions. To pass this assessment, you will need a score of 80% (32 out of 40 points).

If you do not pass on the first attempt, you will have the opportunity to meet with your instructor, study and practice the content further, and retake a different version of the assessment.

Testing Procedures:

1. Click Take this Quiz.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click Submit. You will be shown your score.

Basic Refrigeration Final Lab Practical A *(There is a Form B of this lab in for students who don't pass Form A)*

For final this Lab Practical you will be asked to perform some items similar to those you have completed before. This Lab Practical is going to make sure that you have mastered this course's learning outcomes.

Note: You are going to be tested on these learning outcomes (and others you will master) at different times as you go through the program. This is to make sure that you don't forget and can continue to master the required learning outcomes even after you have passed a course.

You must pass this lab before you will be allowed to move on to the next course.

This lab practical must be performed in the presence of your instructor.

You will need a score of 80% or 24 points to show that you have mastered the outcome.



1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the Checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

Lab Practical 1: Basic Math and Measurements Checklist for Evaluation

Part 1 Linear Measurements

Aspect	Meets Expectations (Proficient) 1 Point	Measure height in inches	Measure width in inches	Measure depth in inches	Convert height to feet and inches	Convert width to feet and inches	Convert depth to feet and inches	Comments
		Score (0-1)						
Rooftop Unit #3	Correctly measure and convert measurements							
Rooftop Unit #3 Curb	Correctly measure and convert measurements							
Rooftop Unit #3 Ductwork	Correctly measure and convert measurements							

Part 2 Calculating Surface Area and Part 3 Calculating Volume

Aspect	Meets Expectations (Proficient) 1 Point	Calculate Approx. Surface Area	Use Proper Method to	Take Measurement	Calculate Volume	Comments
		Score (0-1)				
Building A Hallway	Correctly calculate approx. surface area					
		Score (0-1)				
White Hussman Walk-in Cooler	Correctly calculate volume					
Gray Kamco Walk-in Cooler	Correctly calculate volume					

Aspect	Meets Expectations (Proficient) 1 Point	Calculate Approx. Surface Area	Use Proper Method to		Take Measurement	Calculate Volume	Comments
White Kold-Draft Walk-in Cooler	Correctly calculate volume						

Part 4 Measuring and Converting Temperatures

Aspect	Meets Expectations (Proficient) 1 Point	2 Door Cooler	2 Door Freezer	Large Transformer	Outdoor temperature on	Comments
		Score (0-1)				
Correctly measure temperature						
Correctly convert temperature						

Part 5 Completing a Work Order

Aspect	Meets Expectations (Proficient) 1 Point	Enter Customer Information	Enter Equipment Information	Enter Parts Pricing	Enter Labor Cost	Enter Sales Tax	Comments
		Score (0-1)					



Aspect	Meets Expectations (Proficient) 1 Point	Enter Customer Information	Enter Equipment Information	Enter Parts Pricing	Enter Labor Cost	Enter Sales Tax	Comments
Trane Rooftop #4	Correctly complete a work order						

Lab Practical 2: Basic Refrigeration System Checklist for Evaluation

Part 1: Measure Compressor Inlet and Outlet Temperature and Pressure

Aspect		Meets Expectations (Proficient) 1 Point		Adjust Low Side Pressure Control	Adjust High Side Pressure Control	Setup Trainer Refrigerant Valves	Adjust the Electronic Controller	Adjust Flow Meter	System in Cooling	Comments
		Score (0-1)								
Amatrol Thermal Trainer	Correctly setup trainer for lab									
		Score (0-1)								
Aspect		Meets Expectations (Proficient) 1 Point		Inlet Pressure	Outlet Pressure	Inlet Temperature	Outlet Temperature	Comments		
		Score (0-1)								
Amatrol Thermal Trainer	Correctly take temperature and pressure readings									

Part 2: Measure Condenser Operation and Part 3: Measure Evaporator Operation

Aspect	Meets Expectations (Proficient) 1 Point	Inlet Pressure	Outlet Pressure	Inlet Temperature	Outlet Temperature	Comments
		Score (0-1)				
Amatrol Thermal Trainer	Correctly take condenser temperature and pressure readings					
	Correctly take evaporator temperature and pressure readings					

Part 4: Measuring the Superheat of a system and Part 5: Measuring the Subcooling of a system

Aspect	Meets Expectations (Proficient) 1 Point	Take Temperature readings	Take Pressure readings	Convert Pressure to Temperature	Calculate Superheat/Subcooling	Comments
		Score (0-1)				
Amatrol Thermal Trainer	Correctly measure superheat					
	Correctly measure subcooling					

Part 6: Adjusting the Superheat of the system

Aspect	Meets Expectations (Proficient) 1 Point	Mark Receiver level	Readjust Valves	Record Superheat	Record Subcooling	Adjust TXV	Record Superheat	Record Subcooling	Comments
		Score (0-1)							
Amatrol Thermal Trainer	Correctly adjust superheat								

Lab Practical 3: Pressure-Enthalpy Checklist for Evaluation

Aspect	Meets Expectations (Proficient) 1 Point	Suction Pressure	Liquid Pressure	Suction Line Temperature out of Evaporator	Suction Line Temperature Entering Compressor	Liquid Line Temperature	Comments
		Score (0-1)					
Furnace/AC #8	Correctly Take Temperature and Pressure Reading						
Rooftop #4	Temperature and Pressure Reading						
Superheat/ Subcooling #3	Temperature and Pressure Reading						
Amatrol Thermal Trainer with TXV	Correctly Take Temperature and Pressure Reading						

Aspect	Meets Expectations (Proficient) 1 Point	Plot Evaporator Line	Plot Compressor Line	Plot Condenser Line	Plot Metering Device Line	Comments
		Score (0-1)				
Furnace/AC #8	Correctly Take Temperature and Pressure Reading					
Rooftop #4	Temperature and Pressure Reading					
Superheat/ Subcooling #3	Temperature and Pressure Reading					

Aspect	Meets Expectations (Proficient) 1 Point	Plot Evaporator Line	Plot Compressor Line	Plot Condenser Line	Plot Metering Device Line	Comments
		Score (0-1)				
Amatrol Thermal Trainer with TXV	Correctly Take Temperature and Pressure Reading					

Lab Practical Final Basic Refrigeration Checklist for Evaluation

Competency #1: Demonstrate the math and measurement skills needed for the HVAC industry.

Part 1: Taking and Converting Linear Measurements								
Aspect	Meets Expectations (Proficient) 1 Point	Measure Height	Measure Width	Measure Depth	Convert Height	Convert Width	Convert Depth	Comments
		Score (0-1)						
Rooftop Unit	Correctly measure and convert linear measurements							

Part 2: Calculating Surface Area and Part 3: Calculating Volume						
Aspect	Meets Expectations (Proficient) 1 Point	Measure Desktops	Calculate Surface Area	Measure Cooler or Freezer	Calculate Volume	Comments
		Score (0-1)				
Classroom or Lab Desks	Correctly measure and calculate the surface area					
2 Door Cooler or Freezer	Correctly measure and calculate the volume					

Competency #4: Demonstrate the operation of the basic components used in a refrigeration system.

Part 1: Refrigerant System Components Identification and Part 2: Describing the Refrigeration Cycle Process								
Aspect	Meets Expectations (Proficient) 1 Point	Draw Refrigeration System	Label Components and Tubing	Identify the Refrigeration Condition	Explain the Refrigeration Cycle	Comments		
		Score (0-1)						
Superheat Subcooling Trainer	Correctly draw, label and explain the refrigeration cycle and components							
Part 3: Measuring Pressure and Temperature on a Refrigeration System.								
Aspect	Meets Expectations (Proficient) 1 Point	Measure Suction Pressure	Measure Discharge Pressure	Measure Liquid Line Pressure	Measure Suction Line Temperature	Measure Discharge Line Temperature	Measure Liquid Line Temperature	Comments
		Score (0-1)						
Superheat Subcooling Trainer	Correctly take temperature and pressure readings							

Part 4: Measuring for Superheat and Subcooling of a Refrigeration system				
Aspect	Meets Expectations (Proficient) 1 Point	Calculate Superheat	Calculate Subcooling	Comments
		Score (0-1)		
Superheat Subcooling Trainer	Correctly measure superheat and subcooling			

Competency #5: Explain the characteristics and applications of different refrigerant and refrigerant oils.

Part 1: Obtaining Refrigerant Information														
Aspect	Meets Expectations (Proficient) 1 Point	Identify Temperature Application	Identify System Type	Refrigerant R-number	Chemical formula	Name	Cylinder Color	Amount of Refrigerant	Suction Pressure	Suction Temperature	Superheat	High-side Pressure	Liquid Line Temperature	Subcooling
		Score (0-1)												
LabHVACUnit	Obtaining Refrigerant Information													

Part 2: Controlling Evaporator Temperature When Retrofitting									
Aspect	Meets Expectations (Proficient) 1 Point	Calculate Temperature Glide	Calculate Average Temperature	Calculate Lower Temperature	Converted Pressure	Calculate Higher Temperature	Converted Pressure	Calculate Temperature at Thermal Bulb	Comments
		Score (0-1)							
Evaporator Drawing	Controlling Evaporator Temperature When Retrofitting								

Competency #6: Describe the process for refrigerant recovery.

Competency #7: Demonstrate refrigerant system evacuation, leak detection, and system recharge.

Part 1: Refrigeration System Recover, Evacuation, Leak Detection, and Recharge									
Aspect	Meets Expectations (Proficient) 1 Point	Proper Leak Checking	Proper Recovery Setup	Proper Recovery	Proper Evacuation Setup	Proper Evacuation	Proper Recharge Setup	Proper Recharge	Comments
		Score (0-1)							
Lab HVAC Unit	Refrigeration System Recover, Evacuation, Leak Detection, and Recharge								

Part 2: Refrigeration System Readings and Measurements

Aspect	Meets Expectations (Proficient) 1 Point	Suction Pressure	Suction Line Temperature	Superheat	High-side Pressure	Liquid Line Temperature	Subcooling	Return Air Temperature	Supply Air Temperature	Ambient Temperature	Comments
		Score (0-1)									
LabHVACUnit	Refrigeration System Readings and Measurements										