

KACC-0245 Fundamentals of Gas Heating Blueprint

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Competency and Learning Objectives

1. Explain combustion theory and the purpose of a combustion analysis.
 - Explain the properties of combustion.
 - Explain the importance of a combustion analysis.
2. Identify different gas furnace types and explain the sequence of operation.
 - Identify the different types and applications of furnace installations.
 - Identify the components of a furnace
 - Explain the sequence of operation of various furnaces.
3. Determine the proper sizing of gas piping, flue venting, and combustion air, using international mechanical and gas code books.
 - Determine the sizing of piping used for gas fired appliances.
 - Determine the size of combustion air openings needed for gas fired appliances.
 - Determine the size of the flue for gas pipe venting systems.
4. Identify the sources and causes of carbon monoxide and how to handle it.
 - Explain what causes carbon monoxide. [combustion]
 - Identify sources that generate carbon monoxide.
 - Demonstrate how to check for carbon monoxide.
 - Explain how to respond if carbon monoxide is discovered.
 - Describe the symptoms of carbon monoxide poisoning.
5. Examine the functionality of a furnace and its components.
 - Identify the components of a furnace.
 - Interpret furnace wiring diagram and control sequence.
 - Disassemble, assemble, and rewire components of a furnace.
6. Analyze furnace efficiency.

- Perform combustion analysis.
- Measure furnace for proper air flow and temperature rise.
- Perform deration for different elevation installations.
- Clock gas meter for fuel volume to the furnace.

Orientation to Course

Course Description:

This course introduces the theory and applications of combustion heating systems. Students learn principles of natural gas heating systems and associated mechanical codes and safety; includes COSA carbon monoxide protection.

Using fire to heat with began long ago. But now we don't only need to have the fire, but we also need to make sure it is burning properly and safely. In this course you will explore combustion theory to know how a proper fire burns. You will also explore how modern-day furnaces are installed, controlled and serviced.

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:

- Explain combustion theory and the purpose of a combustion analysis.
- Identify different gas furnace types and explain the sequence of operation.
- Determine the proper sizing of gas piping, flue venting, and combustion air, using international mechanical and gas code books.
- Identify the sources and causes carbon monoxide and how to handle it.
- Explain the functionality of a furnace and its components.
- Analyze furnace efficiency.

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 and manuals 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
- Carbon Monoxide: A Clear and Present Danger handbook, Dwyer, et al., ESCO Press
- Gas Technician Certification Training Study Guide [Borrow from instructor]
- Good Practices for Gas Piping and Appliance Installations [Get from instructor]
- International Fuel Gas Code (IFGC) [Borrow from instructor]

Labs

You will have 14 labs and 13 assignments 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 *(Note: Instructions for learning management system)*

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: Combustion Theory

Combustion Theory Overview

Combustion is the rapid oxidation of any material classified as combustible matter. In our case we are referring to burning gas fuel, whether it is the natural gas of propane or in our furnaces to heat our homes. If the world were a perfect place, then every furnace would have “perfect combustion” when it burned our heating fuel gas. But the world isn’t perfect and we will never accomplish “perfect combustion”. So we have to settle for “complete combustion”. This module will introduce you to what is required to have “complete combustion” and also what happens when we don’t have “complete combustion”. We will discuss the importance of performing proper combustion analysis to make sure our furnace is running at peak efficiency.

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

- Explain the properties of combustion.
- Explain the importance of a combustion analysis.

Combustion Theory Assignments

As you work through this module pay close attention to what makes up complete combustion, including checking gas pressure and temperature rise. Make sure you understand why it is important to perform a combustion analysis as part of a furnace setup and maintenance.

In this module, you will read a section out of the textbook, a section out of the Carbon Monoxide handbook, view a video presentation, and complete 4 lab projects.

Combustion Theory Instructions

1. Read section 30.4.1 Gas Burners on pages 635 and 636 in your Heating and Cooling Essentials Textbook.
2. Read the section entitled "Combustion" in the Carbon Monoxide: A Clear and Present Danger handbook starting on page 55.
3. Check your knowledge: Take the section review quiz.
4. Complete the Lab Projects.

Check Your Knowledge: Combustion

After you have read the section in the Heating and Cooling Essentials textbook and have read the section on Combustion in the Carbon Monoxide textbook take this open book review quiz. This quiz is designed to help you know what you have learned from the textbooks.

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 the **Submit** button. You will be shown your score.

Lab Project: Measuring Manifold Gas Pressure

For a furnace to have complete combustion it must have the proper volume of fuel gas supplied to the manifold and burner orifices. In this lab, you will be measuring and adjusting manifold gas pressures on furnaces in the lab per manufacturer requirements.

Instructions

1. Print out the Manifold Gas Pressure Lab Worksheet.
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.

Lab Project: Gas Meter Clocking

For this lab you will be clocking a gas meter to determine what volume of gas is getting to the furnace and then using the Btu heat content of the fuel gas to calculate the furnace Btu input.

One big problem that occurs with furnaces is that at different altitudes the same furnace will produce a different heat output. A furnace's input and output rating is set for sea level. As the altitude rises the output of the furnace goes down. This is because the heat content of the fuel

gas gets less and less as the altitude goes up. So, the only way to know what the heat output is on a furnace is to know what the heat input is.

To figure this, you need to calculate the volume of gas in ft³/hour getting to the furnace and the heat content of the gas in BTU's. Then using the Btu heat content of the local fuel gas, multiply it by the volume of gas being supplied to the furnace. This will give you the furnace's input in Btu/hr.

Watch this YouTube video on clocking a gas meter before you start your lab.

[Service of the 80% gas furnace. Check the firing rate by clocking the meter part 10](#)

Instructions

1. Print out the Gas Meter Clocking Lab Worksheet.
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.

Lab Project: Combustion Analysis

The only way to know if a furnace is running at its top efficiency is to perform a combustion analysis. This combustion test looks at the temperature of the flue gas, the percent of oxygen (O₂) and carbon dioxide (CO₂). The test also looks for the amount of carbon monoxide (CO) as well. In this lab you will be setting the proper manifold gas pressure, and then performing the combustion analysis on the furnace flue gas.

Instructions

1. Print out the Combustion Analysis lab worksheet.
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.

Combustion Theory Written Progress Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers section 30.4.1 Gas Burners in chapter 30 in the Heating and Cooling Essentials Textbook and the Combustion section in the Carbon Monoxide 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 2: Furnace Types

Furnace Types Overview

Now that you understand what is required to have completed combustion when working with furnaces, we can start looking at the different types of furnaces and their applications. We will also study the sequence of operation of different types of furnaces. Understanding the sequence of operation of a furnace is a must when it comes to troubleshooting a furnace. If you

know that it is supposed to do and it doesn't to it, then you know where to look to get the furnace back running again.

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

- Identify the different types and applications of furnace installations.
- Identify the components of a furnace.
- Explain the sequence of operation of various furnaces.

To begin with let's take a look at a couple of YouTube Videos:

[Types of Furnaces Video](#)

[Basic functions of Gas Furnace components Video](#)

Furnace Types Assignments: Furnace Identification

In this section of the module you need to pay close attention to the direction the air flows through the different furnace types and the furnace efficiency rating.

You will read 2 chapters in the textbook, take a check your knowledge quiz on the chapters and complete 1 lab project.

Furnace Types Instructions

1. Read chapter 29 in the Heating and Cooling Essentials textbook.
2. Complete Check your knowledge: Take the chapter 29 review quiz.
3. Read chapter 30 in the textbook.
4. Complete Check your knowledge: Take the chapter 30 review quiz.
5. Complete the Lab Projects.

Check Your Knowledge: Chapter 29 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 30 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: Furnace Identification

In this lab you will be identifying the different types of furnaces. You will be looking for the direction of the airflow, furnace efficiency, and whether the combustion draft is forced or induced.

Instructions

1. Print out the Furnace Identification lab worksheet.
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.

Module 3: Furnace Types Continued

Furnace Types Assignments: Sequence of Operation

You need to fully understand the sequence of operation of the different types of furnaces. Understanding this is vital to improving your troubleshooting skills. In this section of the module you will be looking at different gas burner ignition setups and operation. This section of the module consists of viewing 5 videos and performing 6 lab projects. Each gas burner ignition system will have 1 or 2 videos and 2 labs.

Furnace Types: Sequence of Operation Instructions

There are a couple of ways you can do these assignments.

1. First watch these videos about the different gas burner ignition systems and then complete the labs that go along with these videos.

OR

2. Come to the classroom, watch a video on a classroom computer and then go do a lab. Then repeat the process for the other labs.

Here are the different gas burner ignition systems you will be looking at:

- Standing Pilot
- Intermittent Pilot/Smart Valve
- Direct Ignition

Watch these *Honeywell videos on the ignition systems you will be working with in this module.

Flame Detection

Standing Pilot

Intermittent Pilot

SmartValve

Direct Burner Ignition

**Note: Instructor uses a series of Honeywell videos that he has permission to stream through the learning management system.*

Lab Project: Honeywell Gas Valve Trainer - Standing Pilot

For this lab you will be working on the standing pilot ignition system. While this ignition system is starting to get used less and less you will still run into HVAC equipment that still use standing pilots. So, you still need to understand how this system works. You will be using the Honeywell Gas Valve Trainer to build a standing pilot ignition system and then test its operation.

Instructions

1. Print out the Honeywell Standing Pilot Lab Worksheet.
2. Ask your Instructor for the Honeywell Gas Valve Trainer Box.
3. Using 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: Ignition Systems, Part 1: Standing Pilot

Now that you have built and tested the standing pilot ignition system with the Honeywell Gas Valve Trainer, you will now work on a real furnace with a standing pilot ignition system.

Instructions

1. Print out the Standing Pilot Lab worksheet.
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.

Lab Project: Honeywell Gas Valve Trainer: Intermittent Pilot and Smart Valve

For this lab you will be working on the intermittent pilot and Smart Valve ignition system. While this ignition system is starting to get used less and less, you will still run into HVAC equipment that still use intermittent pilots. So you still need to understand how this system works. You will be using the Honeywell Gas Valve Trainer to build a intermittent pilot ignition system and a Smart Valve system and then test their operation.

Instructions

1. Print out the intermittent pilot Lab Worksheet.
2. Print out the Smart Valve Lab Worksheet.
3. Ask your Instructor for the Honeywell Gas Valve Trainer Box.
4. Using the worksheet, follow the instructions for the lab.
5. Have your instructor sign off that you have completed the lab.
6. 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: Ignition Systems, Part 2: Intermittent Pilot and Smart Valve

Now that you have built and tested the intermittent pilot and Smart Valve ignition system with the Honeywell Gas Valve Trainer, you will now work on a real furnace with a intermittent pilot ignition system and one with a Smart Valve ignition system.

Instructions

1. Print out the intermittent pilot and Smart Valve Lab Worksheet.
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.

Lab Project: Honeywell Gas Valve Trainer: Hot Surface and Direct Spark Systems

For this lab you will be working on the hot surface and direct spark ignition system. Almost all new gas fired appliances are going to this direct light ignition, so you need to have a very good working knowledge of this style. You will be using the Honeywell Gas Valve Trainer to build a hot surface ignition system and a direct spark ignition system and then test their operation.

Instructions

1. Print out the Hot Surface Lab Worksheet.
2. Print out the Direct Spark Lab Worksheet.
3. Ask your Instructor for the Honeywell Gas Valve Trainer Box.
4. Using the worksheet, follow the instructions for the lab.
5. Have your instructor sign off that you have completed the lab.
6. 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: Ignition Systems, Part 3: Hot Surface and Direct Spark Systems

Now that you have built and tested the hot surface and direct spark ignition system with the Honeywell Gas Valve Trainer, you will now work on a real furnace with a hot surface ignition system and one with a direct spark ignition system.

Instructions

1. Print out the Hot Surface and Direct Spark Lab Worksheet.
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.

Furnace Types Written Progress Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers chapters 29 and 30 in the Heating and Cooling Essentials Textbook and the sequence of operation of gas furnaces. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Furnace Types Lab Practical

As was stated at the beginning of this module:

Now that you understand what is required to have completed combustion when working with furnaces, we can start looking at the different types of furnaces and their applications. We will also study the sequence of operation of different types of furnaces. Understanding the

sequence of operation of a furnace is a must when it comes to troubleshooting a furnace. If you know that it is supposed to do and it doesn't to it, then you know where to look to get the furnace back running again.

For this Lab Practical you will be performing the following:

- Identify the different types and applications of furnace installations.
- Identify the components of a furnace.
- Explain the sequence of operation of various furnaces.

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 4: Installation Codes: Part 1 Gas Piping

Installation Codes Overview

Understanding mechanical and gas codes is very important whether you are working on installing or servicing HVAC equipment. As an installer you need to know the codes so that your installations are installed properly, are safe and will pass inspection. As a service tech knowing the codes will help service HVAC equipment so you can make sure that the equipment will operate at its top efficiency. This module will help to prepare you for KACC 0310, the Rocky Mountain Gas Association (RMGA) certification prep course. In this module you will working on how to properly size gas lines, flue venting, and combustion air openings.

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

- Determine the sizing of gas piping used for gas fired appliances.
- Determine the size of combustion air openings needed for gas fired appliances.
- Determine the size of the flue for gas pipe venting systems.

Note: For this module you will need the following booklets that you can borrow from the instructor:

- A copy of the Questar Gas "Good Practices for Gas Piping and Appliance Installations" hereafter referred to as (QGP). (This is yours to keep.)
- A copy of the RMGA "Gas Technician Certification Training Study Guide" hereafter referred to as (GTC).
- A copy of the "International Fuel Gas Code" hereafter referred to as (IFGC)

Once you have these booklets, most of this module can be done online. You only need to come to class and meet with your instructor to answer any questions you still have before taking your written final exam for this module.

Installation Codes Assignments: Part 1 Gas Piping

As you work through this module, it is vital that you fully understand how to size gas piping, flue vents and combustion air openings. You will be use the blue Good Practices for Gas Piping and Appliance Installations handbook (QGP) and the RMGA's Gas Technician Certification Training Study Guide (GTC). Remember to borrow a copy from your instructor.

For a gas fired appliance to deliver the proper amount of heat, it must be supplied with the proper volume of fuel gas. In this section of the module you will be working on sizing fuel gas lines used for gas-fired appliances so that each appliance is supplied with the proper volume of gas. You will want to become familiar with gas sizing tables 4 and 5 found on pages 55 and 56 of the QGP handbook.

Installation Codes Instructions: Part 1 Gas Piping

1. Read the QGP booklet sections 3.1 to 3.15 pages 33 to 51.
2. Complete the assignment Gas Piping Installation.
3. Check Your Knowledge: Gas Distribution Systems Quiz.
4. Read the QGP booklet sections 3.16 to 3.17 pages 51 to 58.
5. Become familiar with the gas sizing tables 4 & 5 on pages 55 and 56.
6. Read "How to Size Gas Piping Systems" found on page 38 of the GTC.
7. Watch the video that reviews the "How to Size Gas Piping Systems" page you read above.
8. Complete the Lab Assignments Gas Pipe Sizing Part 1 and 2.
9. Complete Check Your Knowledge: Sizing Gas Piping Systems Quiz.

Assignment: Gas Piping Installation

For this assignment you will be entering the answers in Canvas to the questions found on pages 29 to 32 in the GTC. Do not write in the GTC unless you own the study guide.

Check Your Knowledge: Chapter 3 Review Quiz

After you have read the study guide's chapter reading assignments, and have completed the assignment, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the study guide.

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.

Assignment: Gas Pipe Sizing Part 1

For this assignment you will be entering in Canvas the answers to the questions found on pages 39 to 40 in the GTC. Do not write in the GTC unless you own the study guide.

First print off this CFH Requirement Chart.pdf to be used with this assignment.

Assignment: Gas Piping Sizing Part 2

For this assignment you will be entering in Canvas the answers to the questions found on pages 41 to 44 in the GTC. Do not write in the GTC unless you own the study guide.

Check Your Knowledge: Chapter 4 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.

Module 5: Installation Codes Part 2 Combustion Air**Installation Codes Assignments: Part 2 Combustion Air**

Along with having the proper volume of fuel gas being supplied to the appliance you also need to have the proper amount of air for the appliance to mix with the fuel to have complete combustion. That air could be taken from indoors or it might need to be taken from the outdoors. This section of the module will teach you to know if you can use the inside air for combustion or if you need to bring it in from outside through combustion air openings. You will learn how to size these combustion air openings.

Installation Codes Instructions: Part 2 Combustion Air

1. Read Information Sheet 1 - Calculating Area and Volume found on page 52 of the GTC.
2. Complete Exercise 1 and Exercise 2 assignment found on pages 53 and 54 of the GTC.
3. Read the Questar Good Practices booklet section 5, pages 78 to 92.
4. Complete the assignment Combustion Air Part 1.
5. Read Information Sheet 2 - Using the Combustion Air Worksheet found on page 59 of the GTC.
6. Complete the assignment Combustion Air Part 2.
7. Complete Check Your Knowledge: Combustion Air.

Exercise 1: Calculating Area of Combustion Air Ducts and Exercise 2: Calculating Volume

These exercises go along with the Information Sheet 1 - Calculating Area & Volume found on page 52 in the GTC. For these exercises you will be entering in Canvas the answers to the questions found on pages 53 and 54 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Combustion Air Part 1

For this assignment you will be answering questions that deal with code requirements for combustion. You will be entering in Canvas the answers to the questions found on pages 55 to 57 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Combustion Air Part 2

For this assignment make sure you have read over Information Sheet 2 - Using the Combustion Air Worksheet found on page 59 in the GTC. In this assignment you will be answering questions that deal with sizing combustion air for 5 room exercises, found on pages 60, 62, 64, 66, and 68 and then entering them in to Canvas. You can use a Combustion Air Worksheet to help answer your questions for these 5 exercises. Do not write in the GTC unless you own the study guide.

Check Your Knowledge: Chapter 5 Combustion Air 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.

Module 6: Installation Codes Part 3 Venting

Installation Codes Assignments: Part 3 Venting

After the combustion process has happened, we need to get rid of the leftover flue gas. This is done using the flue vents that vent the exhaust gas to the outside. Just like the fuel gas piping and the combustion air openings, flue vents need to be sized properly so you get the proper draft or vent out of these vents. In this section you will be sizing these flue vents using tables found on pages 115-118. Pay close attention to the type of flue pipe you are using so you can use the proper table. You will need the International Fuel Gas Code (IFGC) for this module. You can borrow this code book from the instructor.

Installation Codes: Part 3 Venting Instructions

1. Read Venting Principles found on pages 140-141 of the GTC.
2. Complete assignment Venting Principles.
3. Read Gas Appliances found on pages 143-144 of the GTC.
4. Complete assignment Gas Appliances.
5. Read General Rules found on pages 146-148 of the GTC.
6. Complete assignment General Rules.
7. Read Principles of Venting Sizing found on pages 150-153 of the GTC.
8. Complete assignment Principles of Venting Sizing.
9. Read Single Appliance Sizing Tables found on pages 155-159 of the GTC.
10. Read International Fuel Gas Code (IFGC) 504.1 & 504.2-504.2.16.
11. Complete assignment Single Appliance Venting.
12. Read Multiple Appliance Sizing Tables found on pages 162 to 164 of the GTC.
13. Read International Fuel Gas Code (IFGC) 504.1, and 504.3 through 504.3.28.
14. Complete assignment Multiple Appliance Venting.
15. Complete assignment Sample Problems.
16. Complete Check Your Knowledge: Take chapter review quiz Venting System Sizing.

Assignment: Venting Principle

For this assignment read pages 143 and 144 in the GTC on gas appliances. Then enter in Canvas the answers to the questions found on pages 145 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Gas Appliances

For this assignment read pages 140 and 141 in the GTC on venting principles. Then enter in Canvas the answers to the questions found on pages 142 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: General Rules

For this assignment read pages 146 and 148 in the GTC on general rules. Then enter in Canvas the answers to the questions found on pages 149 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Principles of Venting Sizing

For this assignment read pages 150 and 153 in the GTC on general rules. Then enter in Canvas the answers to the questions found on pages 154 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Single Appliance Venting

For this assignment read pages 155 and 159 in the GTC as well as sections 504.1, 504.2 through 504.2.16 in the IFGC on single appliance venting tables. Then enter in Canvas the answers to the questions found on pages 160 and 161 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Multiple Appliance Venting

For this assignment read over pages 162 to 164 in the GTC as well as sections 504.1, 504.3 through 504.3.28 in the IFGC on single appliance venting tables. Then enter in Canvas the answers to the questions found on pages 160 and 161 in the GTC. Do not write in the GTC unless you own the study guide.

Assignment: Sample Problems

For this assignment you will be calculating the sizing of the vent and connectors for 4 sample problems. On a piece of paper figure out the proper size for the vents and connectors. Turn this paper into your instructor to grade. Then your score will be entered into Canvas.

Check Your Knowledge: Chapter 8 Venting System Sizing

After you have read the reading assignments, 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.

Installation Codes Written Progress 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. As was stated in the beginning of Modules 4:

Understanding mechanical and gas codes is very important whether you are working on installing or servicing HVAC equipment. As an installer you need to know the codes so that your installations are installed properly, are safe and will pass inspection. As a service tech knowing the codes will help you service HVAC equipment so you can make sure that the equipment will operate at its top efficiency. This module will help to prepare you for KACC 0310, the Rocky Mountain Gas Association (RMGA) certification prep course. In this module you will work on how to properly size, gas lines, flue venting, and combustion air openings.

In this written progress exam, you will be looking at 4 example houses. For each example you will need to:

- Determine the sizing of gas piping used for gas fired appliances.
- Determine the size of combustion air openings needed for gas fired appliances.
- Determine the size of the flue for gas pipe venting systems.

Testing Procedures:

1. Print out the copies of the example houses worksheets.
2. You can use the IFGC and the QGP books to figure your answers.
3. Figure out the proper gas piping size for each example.
4. Figure out the proper combustion air opening for each example.
5. Figure out the proper venting size for each example.
6. Click **Take this Quiz**.
7. Record your answers from the worksheets into the quiz.
8. When you have answered all the questions, click **Submit**.

Module 7: Carbon Monoxide Safety

Carbon Monoxide Safety Overview

Carbon Monoxide (CO) is the silent killer. Are you prepared? Are your customers? CO is a gas that is odorless, tasteless and invisible. In this module, you will learn what causes CO and what sources can generate it. You will learn how to check for it, both to protect your customers and yourself. You will also learn what to do when CO is discovered and what the symptoms of CO poisoning are. Understanding CO can save lives, maybe your own.

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

- Explain what causes carbon monoxide.

- Identify sources that generate carbon monoxide.
- Demonstrate how to check for carbon monoxide.
- Explain how to respond if carbon monoxide is discovered.
- Describe the symptoms of carbon monoxide poisoning.

Before we begin, I want you to watch Carbon Monoxide Safety from El Paso County in Colorado. El Paso County and Colorado Springs are probably the number one city and county in the nation when it comes to carbon monoxide awareness.

[Carbon Monoxide Safety](#)

Carbon Monoxide Safety Assignments

In this module you need to pay close attention what causes CO and where to look for it. Also you need to understand the symptoms of CO poisoning and what to do if CO is found in a home.

Checking for CO while in the home is very important for the safety of your customer, but what about you? Are you walking into a building that has a dangerous level of CO already? Checking for CO as you enter the home is a practice you need to get into the habit of following.

You will read 1 chapter in the textbook, take a Check Your Knowledge quiz on the chapter and complete 1 lab project.

Carbon Monoxide Safety Instructions

1. Read the section on Carbon Monoxide Safety in the Carbon Monoxide: A Clear and Present Danger handbook.
2. Watch the Carbon Monoxide Safety PowerPoint Video. **Note:** There is no audio with this video.
3. Complete Check Your Knowledge: Take the Carbon Monoxide Safety review quiz.
4. Complete the Lab Project.

Check your Knowledge: Carbon Monoxide Safety Review Quiz

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

Lab Project: Checking for Carbon Monoxide

In this lab you will be working with carbon monoxide detectors, monitoring for the presence of CO in both the air flow of gas fired appliances and outside the furnace environment. This lab has two parts. For Part 1, you will use a carbon monoxide detector to check for carbon monoxide in the air flow of lab furnaces (not in the flue gases). In Part 2, you will check out a personal carbon monoxide detector. Wear the detector on your person for two days, recording CO levels at different locations throughout your days and nights.

Instructions:

Print out the Lab Worksheets for this part of the lab. You will do this part in the lab.

Part 1

1. Ask your instructor for a carbon monoxide detector.

2. Your instructor will assign you the 5 furnaces you will perform your test for the presence of CO.
3. Show your instructor your test results.

Part 2

You will do this part of the lab outside of class.

1. Check out a personal carbon monoxide detector to be used for this part of the lab.
2. Carry this detector with you for two days. Record the PPM levels in different areas. Use the detector both during the day and at night.
3. On the third day return the detector to your instructor and show them your findings.
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.

Carbon Monoxide Safety Written Progress Exam

This exam will help you and your instructor see how you are progressing in the course. This exam covers the Carbon Monoxide section in the Carbon Monoxide 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 8: Furnace Components and Functionality

Furnace Components and Functionality Overview

In this module we are going to take a closer look at the components and control wiring that make up a gas furnace. And there is no better way to look closely at an item than to take it apart and examine all its parts. So, you are going to do the same to our lab furnaces. Then after you have examined it taken apart, you will put it back together, making sure that it still works.

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

- Identify the components of a furnace.
- Interpret furnace wiring diagram and control sequence.
- Disassemble, assemble, and rewire components of a furnace.

Furnace Components and Functionality Assignments

As was stated before, you will be taking apart furnaces, identifying the components and then putting them back together again. You will also be working with the control circuits and furnace sequence of operation. As you work with the furnaces pay close attention to understanding the sequence of operation of each furnace. Understanding the sequence of operation makes troubleshooting and repair of furnaces much easier.

Furnace Functionality Instructions

1. Review chapter 30 in the Heating and Cooling Essentials textbook again.
2. Complete the Lab Projects.

Lab Project 30: Gas Heat

For this lab you are going to be disassembling and reassembling a gas furnace blower assembly, adjusting a pilot light and thermocouple and drawing several gas furnace control circuits.

1. You will need to remove the lab sheets for Lab 30 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: Furnace Rebuild and Startup

In this lab you will be taking apart different gas furnaces, identifying their components, using the wiring diagrams to list the sequence of operation, and then rebuilding them and starting them up.

Instructions

1. Print out the Lab Worksheet.
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.

Furnace Components and Functionality Lab Practical

As was stated at the beginning of this module:

In this module we are going to take a closer look at the components and control wiring that make up a gas furnace. And there is no better way to look closely at an item than to take it apart and examine all its parts. You are going to do the same to our lab furnaces. Then after you have examined it taken apart, you will put it back together, making sure that it still works.

For this lab practical you will be:

- Identifying the components of a furnace.
- Interpreting furnace wiring diagram and control sequence.
- Disassembling, assembling, and rewiring components of a furnace.

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 9: Operational Efficiency

Operational Efficiency Overview

Being an HVAC service technician means more than just fixing HVAC equipment. You need to be able to look at the big picture. You also need to make sure that the HVAC equipment is working as efficiently as possible. Going green in the HVAC tech's world really means keeping equipment running at its top efficiency. Some of the labs you will be working on are more in-depth labs from earlier in this course.

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

- Perform combustion analysis.
- Measure furnace for proper airflow and temperature rise.
- Perform deration for different elevation installations.
- Clock gas meter for fuel volume to the furnace.

Operational Efficiency Assignments

In this module you are going to want to pay close attention to what it takes to keep a furnace running at its top efficiency and delivering the proper amount of heat for the size of furnace. You are going to see that as furnaces are installed at higher altitudes the amount of heat they produce goes down. Knowing how to make adjustments to furnaces located in higher altitudes is a skill that you need to know so you can make sure they put out the proper amount of heat.

Operational Efficiency Instructions

1. Watch these 4 videos on checking over a residential furnace heating system.
[Gas Furnace Basics: Part 1](#)
[Gas Furnace Basics: Part 2](#)
[Gas Furnace Basics: Part 3](#)
[Gas Furnace Basics: Part 4](#)
2. Perform Lab Project: Furnace Operational Efficiency.

Lab Project: Furnace Operational Efficiency

For this lab you will be conducting furnace efficiency testing using a combustion analyzer, checking for proper manifold gas pressure and temperature rise across the furnace, and clocking the gas meter so you can calculate if the furnace is putting out the proper amount of heat. You will perform these tests on 4 different lab furnaces.

1. Print out 4 copies of the Lab Worksheets.
2. Using the worksheet, follow the instructions for the lab.
3. Have your instructor show you what furnaces to work on.
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.

Final Competency Exam and Practical Assessment

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

- Explain combustion theory and the purpose of a combustion analysis.
- Identify different gas furnace types and explain the sequence of operation.
- Determine the proper sizing of gas piping, flue venting, and combustion air, using international mechanical and gas code books.
- Identify the sources and causes carbon monoxide and how to handle it.
- Explain the functionality of a furnace and its components.
- Troubleshoot and service medium and high efficiency furnaces.
- Analyze furnace 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.

Final Competency Exam Form A *(There is a Form B in case the student does not pass Form A)*

This exam covers chapter 29 and 30 in the Heating and Cooling Essentials Textbook as well as the sections on Carbon Monoxide and Combustion in the Carbon Monoxide: A Clear and Present Danger textbook. The exam also covers the sections in the Questar Good Practices handbook that covered gas piping, venting and combustion air. You may use the Good Practice handbook and calculator for the questions on the exam, but nothing else.

To pass this assessment, you will need a score of 80%. 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.

Fundamentals of Gas Heating Final Lab Practical A *(There is a Form B in case the student does not pass Form A)*

For this final 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.

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.

Lab Practical Furnace Functionality Checklist for Evaluation Student Name: _____

Aspect	Meets Expectations (Proficient) 1 Point	List Proper Sequence of Operation	Draw a Proper Wiring Diagram	Correctly Identify Furnace Components	Properly Rebuild Furnace	Properly Rewire Furnace	Furnaces Works Correctly	Comments
		Score (0-1)						
80% Furnace	Teardown, Identify Components and Rebuild Furnace							
90% Furnace								