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Heating and Cooling Essentials

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Heating and Cooling Essentials: Lesson Plan

Instructor: *Date:*
Course: *Unit:*

Chapter 1: Careers in Heating, Ventilation, Air Conditioning, and Refrigeration

Learning Outcomes

- (1.1) Recognize the employment outlook of the HVACR industry and some of the different HVACR career options.
  - 1.1 HVACR as a Career
- (1.2) List the physical, mental, communication, and technical skills needed to be successful in HVACR.
  - 1.2 Job Skills
- (1.3) Explain how to begin a career in the HVACR industry and how to complete the job application process by preparing a résumé, cover letter, and for a job interview.
  - 1.3 Starting a Successful Career in the HVACR Industry

Instructional Resources

- Textbook/eBook: Chapter 1
- Instructor Resources: Chapter 1 Instructor's Presentation for PowerPoint
- Instructor Resources: Chapter 1 Answer Key

Resources for Practice and Application

- Digital Companion: E-Flash Cards, Matching Activity, and Vocabulary Game
- Textbook/eBook: Chapter 1 Review and Assessment, Know and Understand
- Textbook/eBook: Chapter 1 Review and Assessment, Apply and Analyze
- Textbook/eBook: Chapter 1 Review and Assessment, Critical Thinking
- Lab Workbook: Chapter 1–Chapter Review
- Lab Workbook: Lab Activity 1A—Writing a Cover Letter
- Lab Workbook: Lab Activity 1B—Writing a Résumé

Assessment

- Assessment Suite
  - Chapter 1 Pretest
  - Chapter 1 Posttest
  - Chapter 1 Exam

1

Careers in Heating, Ventilation, Air Conditioning, and Refrigeration

HVACR Careers

- Installer
- Service technician
- Counter sales representative
- Energy auditor
- Sheet metal fabricator
- Controls technician
- Building engineer

Lesson Plans, Assessments, and Answer Keys

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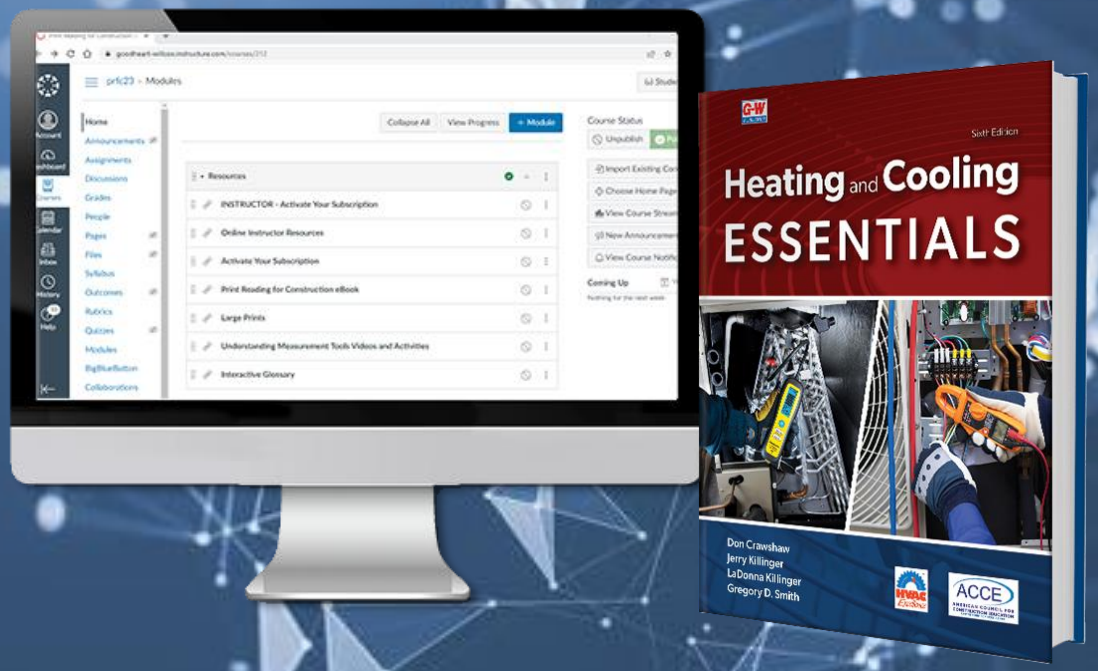

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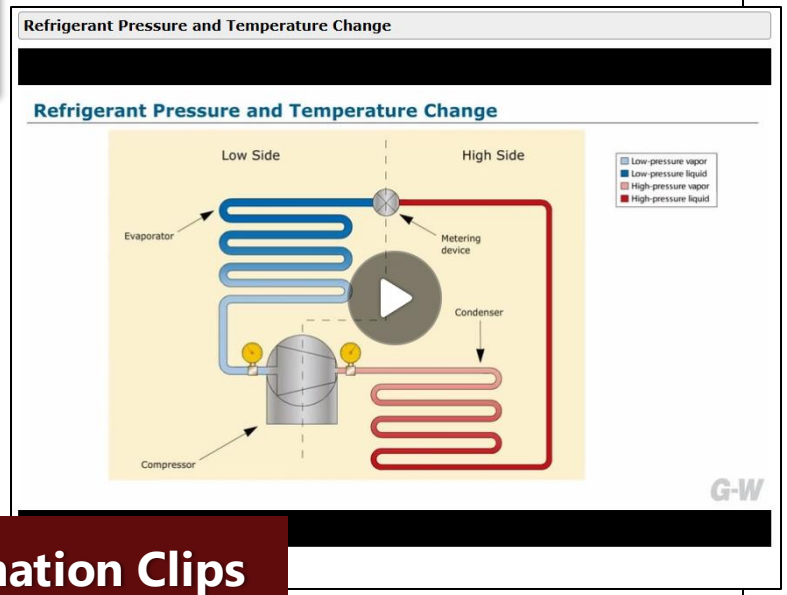

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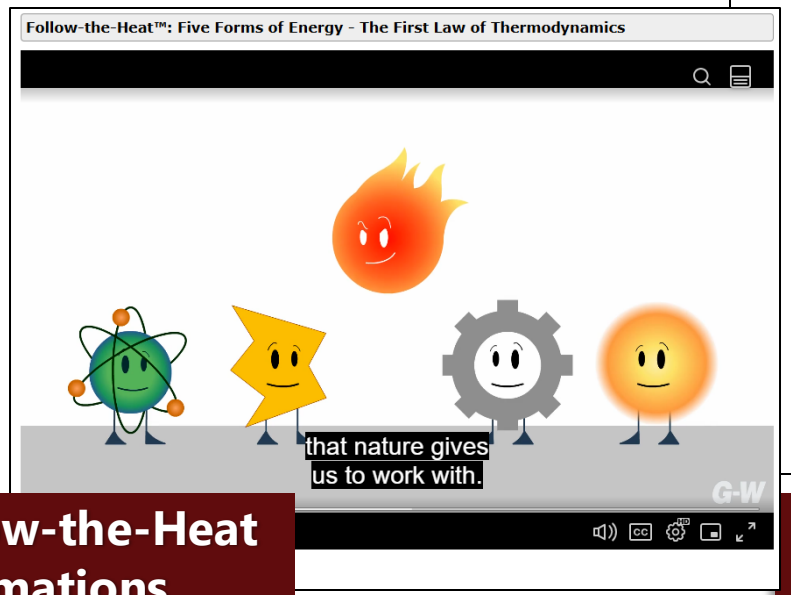

57 Follow-the-Heat Animations

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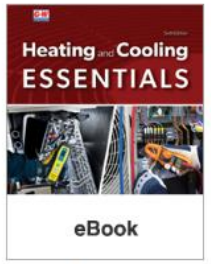
Heating and Cooling Essentials 6e, Online Textbook



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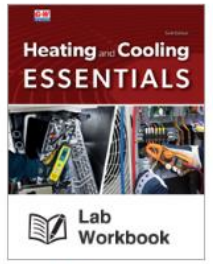

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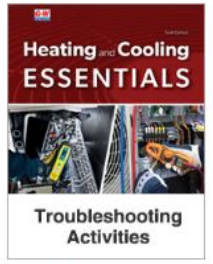

Heating and Cooling Essentials 6e, Troubleshooting Activities

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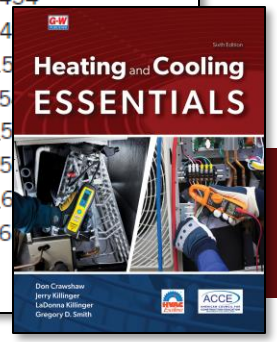
Brief Contents



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Student Textbook

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All workers have the right to:

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- Participate (or have your representative participate) in an OSHA inspection and speak in private to the inspector.
- File a complaint with OSHA within 30 days (by phone, online or by mail) if you have been retaliated against for using your rights.
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Employers must:

- Provide employees a workplace free from recognized hazards. It is illegal to retaliate against an employee for using any of their rights under the law, including raising a health and safety concern with you or with OSHA, or reporting a work-related injury or illness.
- Comply with all applicable OSHA standards.
- Notify OSHA within 8 hours of a workplace fatality or within 24 hours of any work-related inpatient hospitalization, amputation, or loss of an eye.
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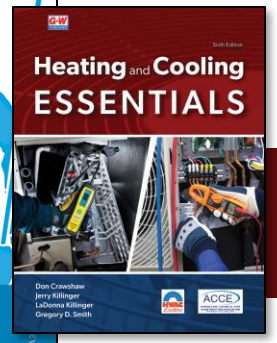
PRO TIP

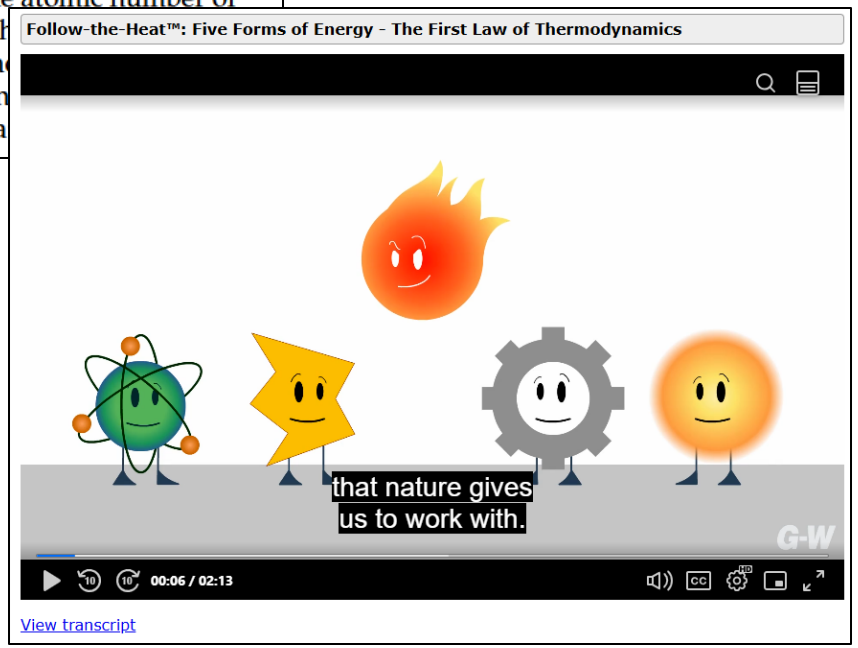
Propane Refrigerant

Propane (R-290) refrigerant is not the standard propane used in gas grills and portable heaters. Standard propane is generally 65%–95% pure propane, with other contaminants and moisture present. Refrigerant-grade propane must be at least 98.5% pure propane and has limits on the amount of moisture that can be present. Never use "standard" propane as a refrigerant.

Inorganic Refrigerants

The 700-series of numbers is assigned to *inorganic refrigerants*, such as ammonia or carbon dioxide, Figure 15-4. The last two numerals represent the atomic number of the substance. For example, the atomic number of ammonia is 17, so the refrigerant number is R-717. Th carbon dioxide is 44, so the number is R-744. Most in are considered "expendable," meaning the vapor is n reuse. The liquid is vaporized and released into the a





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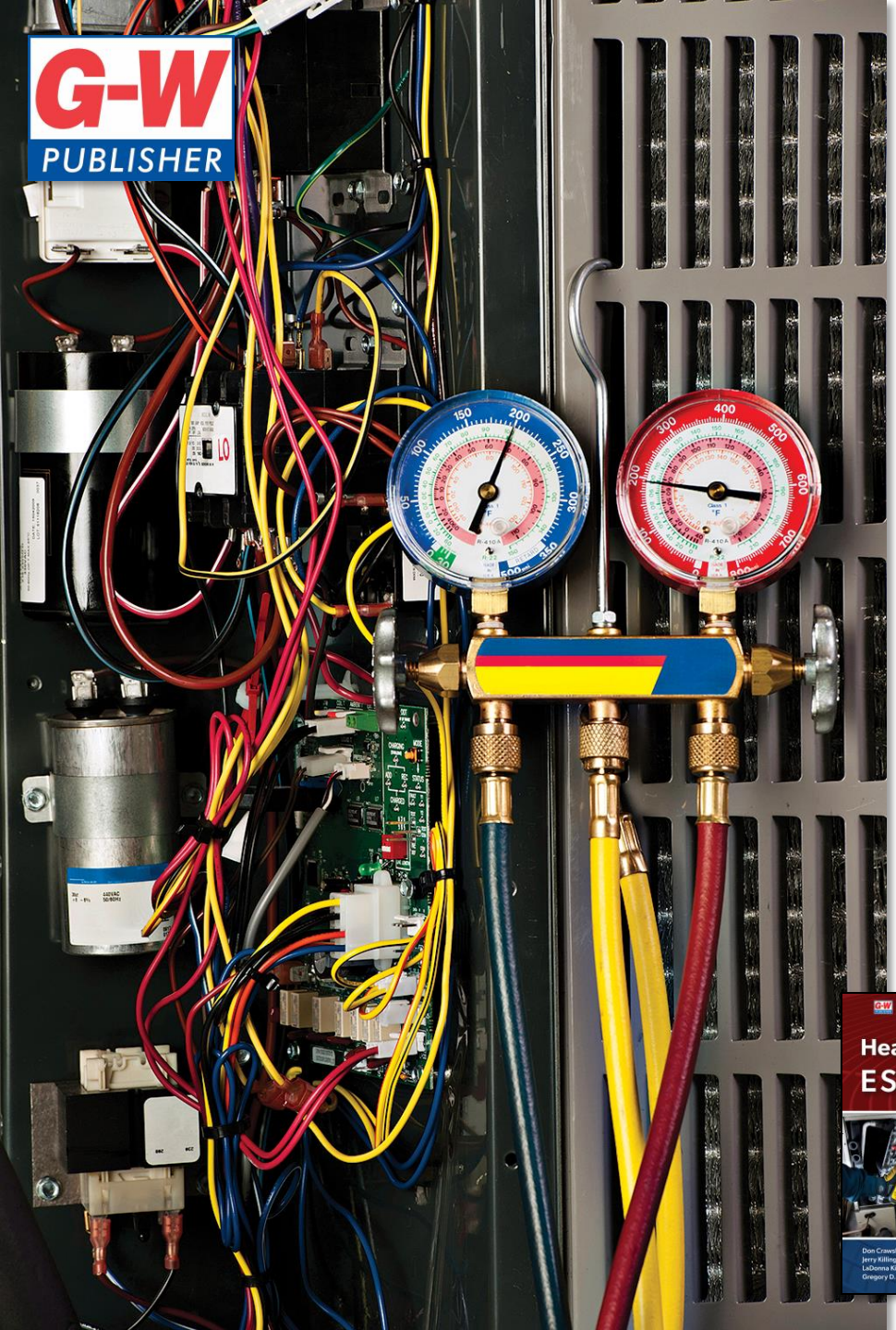


CHAPTER 3 LEARNING OUTCOMES

After studying this chapter, you will be able to:

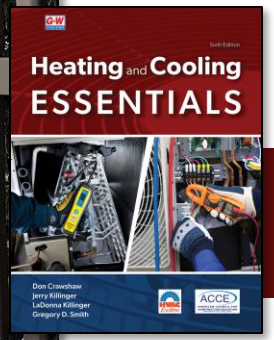
- **3.1** Explain the purpose of OSHA.
- **3.2** Explain the importance of PPE.
- **3.3** Recognize electrical hazards and how to perform a lockout/tagout (LOTO) procedure.
- **3.4** Demonstrate safe ladder use.
- **3.5** Describe general tool safety rules.
- **3.6** Explain how to safely handle various chemicals and pressure-related equipment.
- **3.7** Identify the different classes
- **3.8** Identify best practices when
- **3.9** Practice safe conduct while

CHAPTER 3 TECHNICAL TERMS

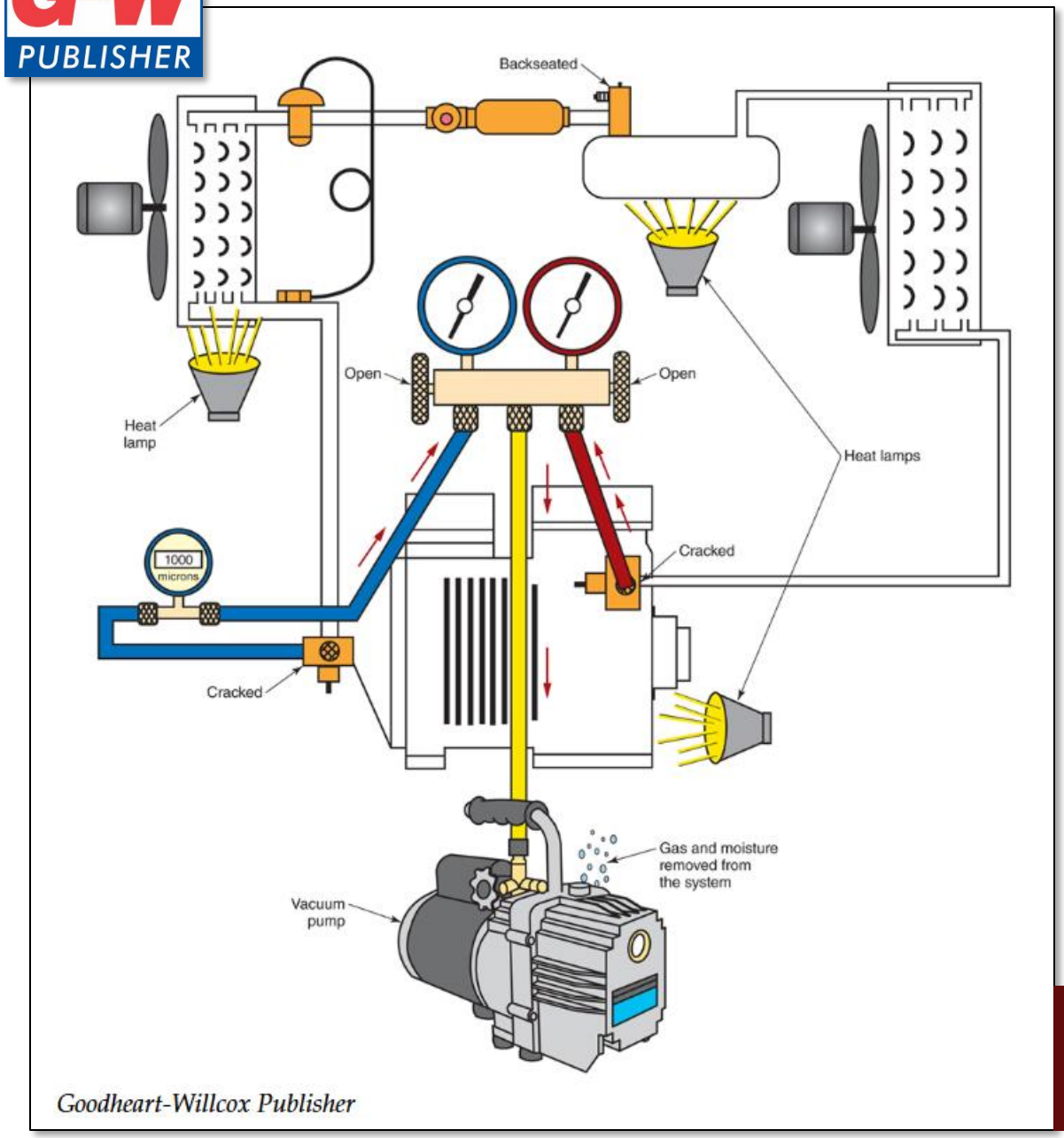
- electric shock
- hazard
- heat stress
- lockout/tagout (LOTO)
- Occupational Safety and Health Administration (OSHA)
- personal protective equipment (PPE)
- safety data sheet (SDS)

Chapter 3 Introduction

A properly trained service technician puts safety first. Being aware of potential hazards can help keep yourself and others safe. Following proper procedures, planning ahead, and wearing protective equipment can also ensure safety when working with a potential hazard. A *hazard* is a potentially harmful situation or substance. This chapter identifies some of the hazards associated with the HVACR industry and how to properly handle working with these hazards.



Chapter-Opening Materials



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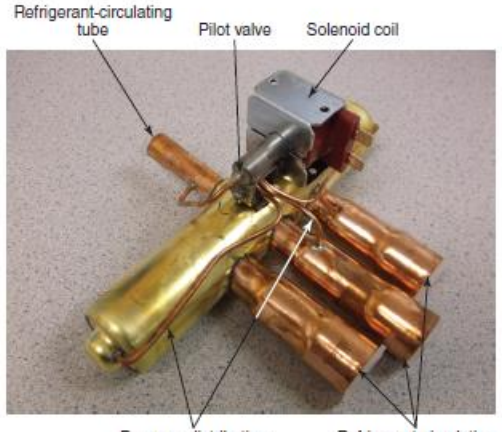

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Figure 30-3. A reversing valve makes it possible to alternate a heat pump's heating and cooling modes by reversing the flow of refrigerant. The valves are available in sizes to match the different heat pump capacities.

exerted, which determines piston position and the refrigerant pathways through the reversing valve. Generally, three refrigerant-circulating tube connections are on one side of the valve body, and a single tube connection is on the opposite side.

As shown in **Figure 30-4**, the compressor discharges into the inlet tube. The middle tube on the *opposite* side of the reversing valve is connected to the compressor suction. Note that refrigerant flow through the compressor is always the *same*; it does *not* reverse. The remaining two tubes on the reversing valve are connected to the indoor coil and the outdoor coil.

The position of the piston-operated slide valve inside the reversing valve determines the direction of refrigerant flow to and from each coil. Flow

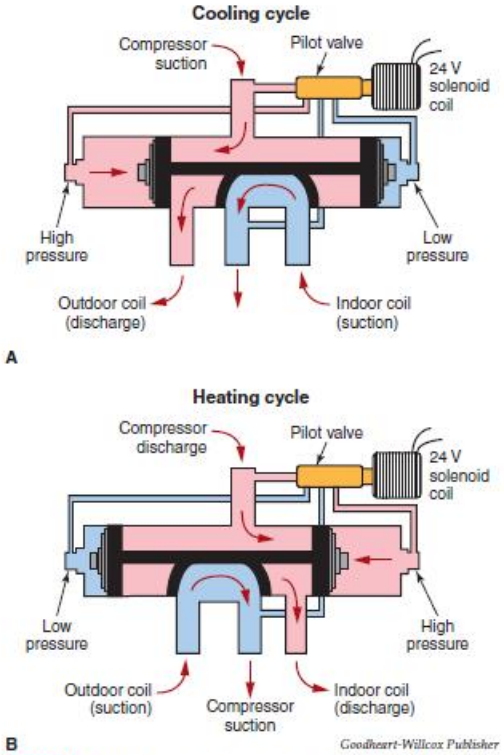

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Figure 30-4. Reversing valve operation. A—In the cooling cycle, high-pressure refrigerant is directed to the outdoor coil. B—In the heating cycle, high-pressure refrigerant is directed to the indoor coil.

the ends of the reversing valve body. Another tube is connected to the suction line where it leaves the reversing valve body. The final tube connects to the compressor discharge line. Note that there is a great pressure difference between a compressor's suction and discharge lines.

Visual Elements Reinforce Content

SAFETY NOTE

Tin-Lead Solders

Tin-lead solders were formerly used by plumbers on copper water lines, but they are no longer permitted in drinking water applications. Lead-free alloys that do not present a human health hazard must be substituted. Tin-lead solders are still used in other plumbing and HVACR applications.

Tin-lead solders may contain small amounts of other metals to produce special properties. Metals commonly added to solders include antimony, bismuth, and silver. Antimony increases the strength of a solder. Where a stronger joint is desired for copper tubing, or where a lead solder is not permissible, a 95/5 tin-antimony alloy is often chosen. This solder has a melting point of 452°F (233°C) and a flow point of 464°F (240°C).

Tin-Antimony Solders

Tin-antimony solder is higher in strength and *elongation* (stretch factor) than tin-lead solders, but like tin-lead it has proven unsatisfactory for applications involving stress and vibration. Another disadvantage is that this alloy tends to powder over time.

CAUTION

Tin-Antimony Use

The 95/5 tin-antimony alloy should not be used on brass or galvanized (zinc-coated) metal. When antimony is in a molten state, it will absorb zinc from the brass or the galvanizing, resulting in a brittle joint.

Bismuth and silver are added to improve the *tinning* (spreading action) of solder. Bismuth is used for lower-temperature solders, while silver is used for higher-temperature solders.

Tin-Silver Solders

Another major group of solders are the tin-silver alloys. These silver-bearing solders are widely used because of the strong connections they form. Also, their low working temperatures eliminate the weakening of base metals caused by annealing (from high-soldering temperatures). Oxide scale formed in high temperatures is also eliminated.

The silver-bearing alloys have the ability to bond with both *ferrous* (containing iron) and nonferrous metals. These solders work well to join dissimilar metals, such as iron to copper. Furthermore, silver-bearing alloys have good elongation (stretch factor) when vibration is a concern. Melting points for these alloys range from 430°F to 535°F (221°C to 279°C).

PRO TIP

Soldering for Stress and Vibration

For applications in the HVACR industry involving stress or vibration, the tin-silver alloys are superior to both tin-lead and tin-antimony alloys.

Solder Fluxes

Flux is a multipurpose chemical used to treat the clean surface of base metals, to remove oxides from filler metal, to prevent reoxidation of material, and to aid the capillary flow of filler alloy. See Figure 8-4. In some instances, the appearance of the flux may indicate temperature. Flux as a temperature guide is explained later in this chapter.

Choosing the proper flux is important to the quality of a soldered connection. There is no universal flux suitable for all applications. Therefore, when selecting a flux for a particular alloy, it is wise to follow the manufacturer's recommendation.

Using Fluxes

Thoroughly cleaning base metal joining surfaces is vital to making strong, leakproof, long-lasting joints. The fittings and tubing must be free of oil, grease, rust, or oxides that would prevent the alloy from penetrating the base metal surfaces. Cleaning is done with a wire brush, fine sandpaper, or emery cloth, Figure 8-5. The joint must be cleaned well; otherwise, the alloy cannot properly flow and penetrate the base metals.

Flux maintains a chemically clean surface during the soldering operation. Its initial purpose is not to clean the metal but to keep the joint oxide-free. Flux dissolves the oxides that form when oxygen contacts the molten alloy or the hot base metals. It is important that the flux remains in place until soldering is completed and that it is not

filler metal alloy that contains phosphorus, which acts as a fluxing agent. However, when brazing dissimilar metals, such as copper to brass or copper to steel, use of the phosphorus-bearing alloy will result in a brittle joint. For this reason, a different alloy is used, and a flux *is* required.

CAUTION

Brazing Fluxes

Brazing fluxes cause metal salts to form. Methyl alcohol (used as an antifreeze) can react with aluminum and cause corrosion. Moreover, poor brazing practice can introduce flux (acid) into the system.

Flowing Nitrogen When Brazing

After brazing a copper joint and allowing it to cool down, small black flakes can be rubbed off the copper pipe. This is oxidation. If there is oxidation on the outside of the joint, it will also be on the inside. Every brazed joint can develop these oxidation flakes that could plug components in the system. A liquid line filter-drier will catch some of these flakes, but it may not catch all of them.

When installing an air-conditioning or refrigeration system, the goal should be to have a system

PROCEDURE

Brazing a Metal Joint

Even heating of the base metal pieces is important so the alloy will flow equally well on both metal surfaces and completely fill the joint. Follow these steps for even heating during the brazing process:

1. Adjust the torch for a neutral flame. The flame size should be large enough to envelop as much of the connection as possible.
2. Begin heating the tubing about 1/2" to 1" (1.25 cm to 2.5 cm) away from the fitting.
3. After the tubing is heated, shift the flame to the fitting. Once the fitting is heated, move the flame steadily back and forth from the tubing to the fitting. Do not hold the flame in one spot, as this causes localized overheating. Continue heating until the assembly reaches the alloy melting temperature.
4. When the assembly reaches the proper temperature, pull the flame back a little. Apply the filler alloy firmly against the tubing at the connection. If the assembly has been properly heated, the alloy will melt and completely penetrate and fill the joint. The alloy will always flow toward the hottest area.
5. After the joint has been completed, make one final pass of the flame around the connection to ensure proper flow and penetration of the alloy.

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Features Enhance Chapter Content and Extend Learning

Chapter 15 Review

Summary

15.1 The continual development of more efficient and environmentally safe refrigerants and advancements in technology have led to the refrigeration and air-conditioning systems seen today.

15.2 Section 608 of the Clean Air Act gives the EPA authority to set guidelines on proper refrigerant safety and handling. The EPA has targeted refrigerants with high ODPs and GWPs for phaseout to reduce the impact of HVACR systems on the environment.

15.3 The general classifications for refrigerants include halide refrigerants (CFCs, HCFCs, HFCs, and HFOs), hydrocarbon (HC) refrigerants, and inorganic refrigerants (ammonia and carbon dioxide).

15.3 Refrigerants are identified by the letter "R" and a number using the DuPont numbering system format. Refrigerants are also identified by their safety classification and the refrigerant cylinder they are manufactured in.

15.4 A pure refrigerant is composed of a single-component fluid that does not change composition when boiling or condensing. An

Know and Understand

1. The first practical compression-cycle refrigeration system was built in _____. (15.1)
   A. 1834
   B. 1850
   C. 1873
   D. 1900

Apply and Analyze

1. Explain why a refrigerant with a high ODP and high GWP is harmful to the environment. (15.2)
2. What is the basic composition of a halide refrigerant? (15.3)
3. Using the ASHRAE and DuPont numbering standard, list the chemical breakdown (number of fluorine, hydrogen, and carbon atoms) and safety classification of R-290. (15.3)
4. Explain the differences between azeotropic and zeotropic refrigerants. (15.4)
5. List some of the qualities that engineers consider when selecting a refrigerant. (15.5)
6. How can a service technician use a P/T chart be used to determine that a noncondensable is in the HVACR system? (15.5)
7. Give one example of each type of application: high-temperature, medium-temperature, and low-temperature. (15.6)

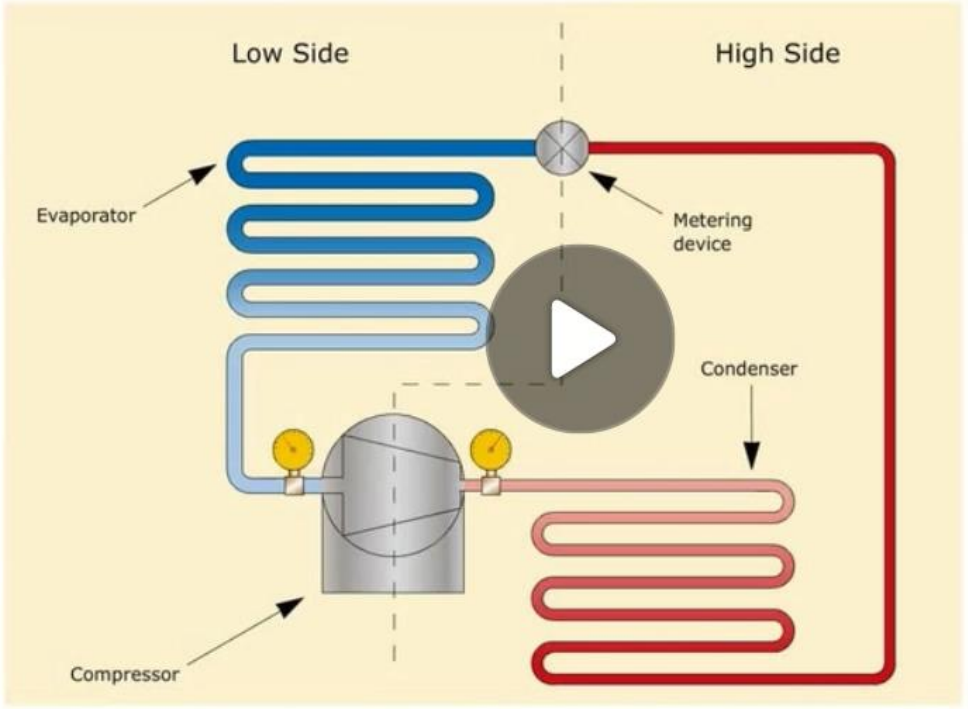
Critical Thinking

1. Review the brief history of refrigerants outlined in the text. Analyze the trends throughout history and speculate on what changes you think will occur in the future of refrigerants used in the HVACR industry. (15.1)
2. Refer to the P/T chart in Figure 15-16 and determine the gauge pressures for R-22, R-134a, and R-410A at 20°F and for R-1234yf and R-600a at 10°F. (15.5)

End-of-Chapter Material

Refrigerant Pressure and Temperature Change

Refrigerant Pressure and Temperature Change



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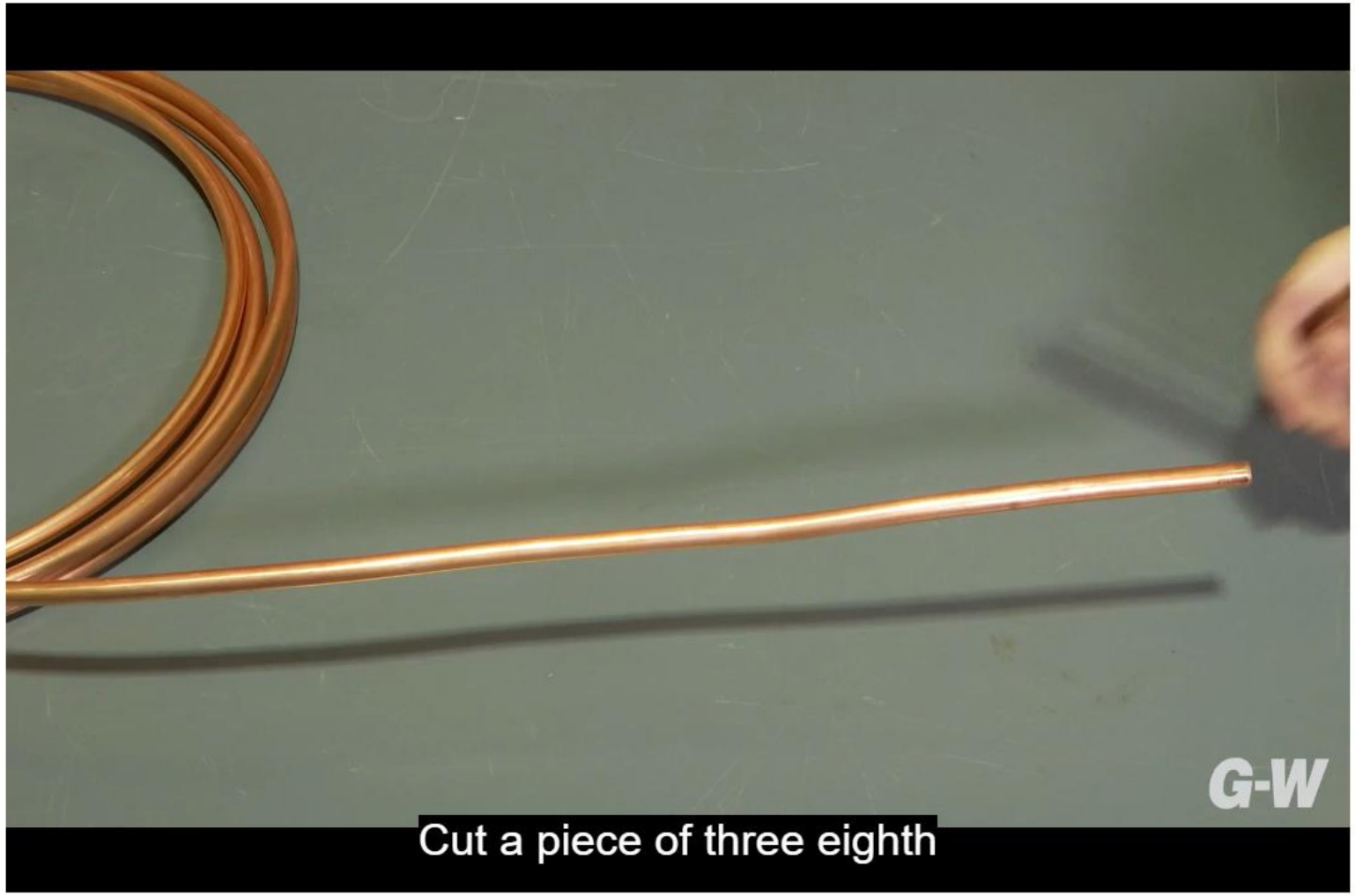
Animations

Bending Copper Tubing



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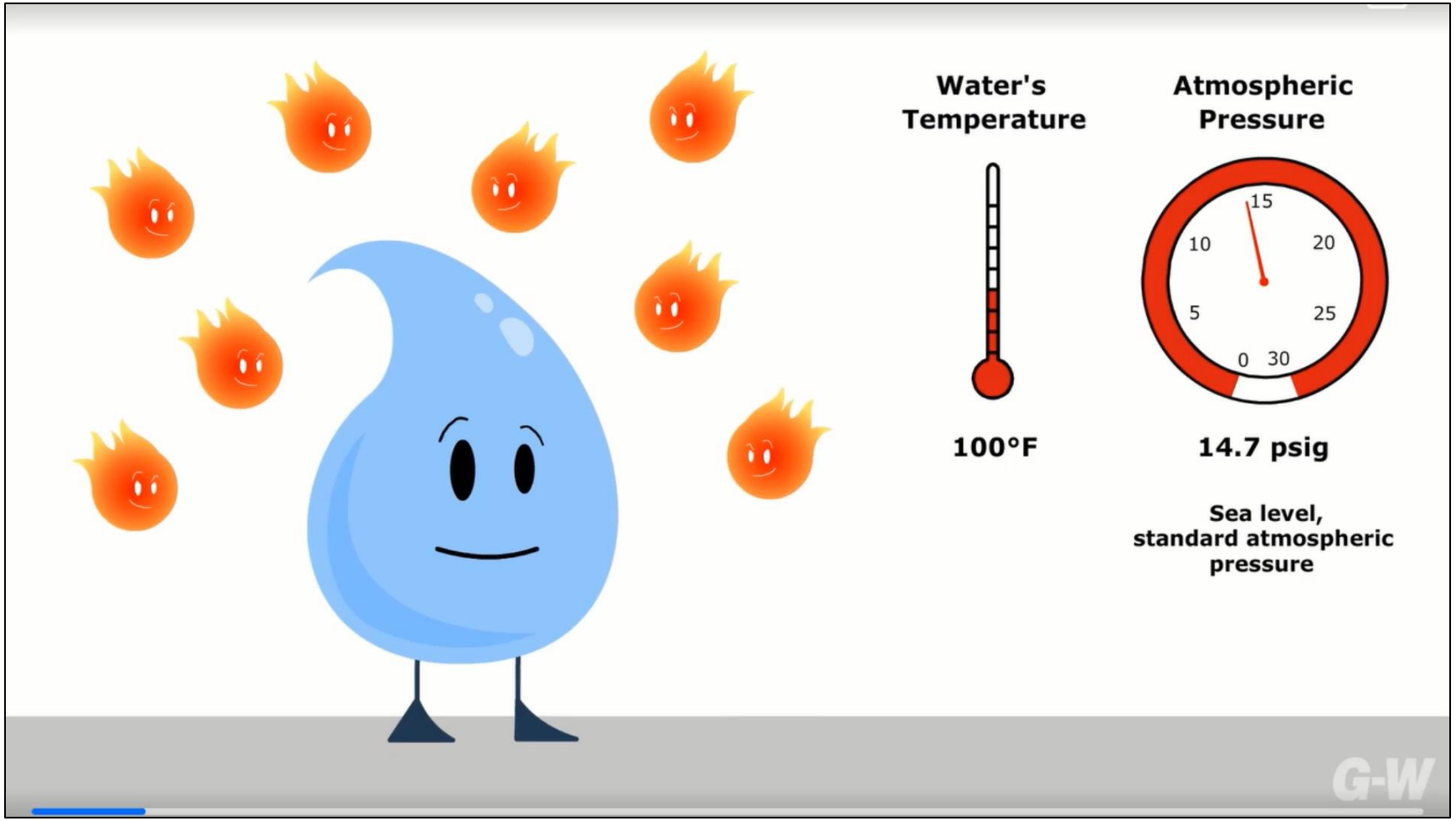
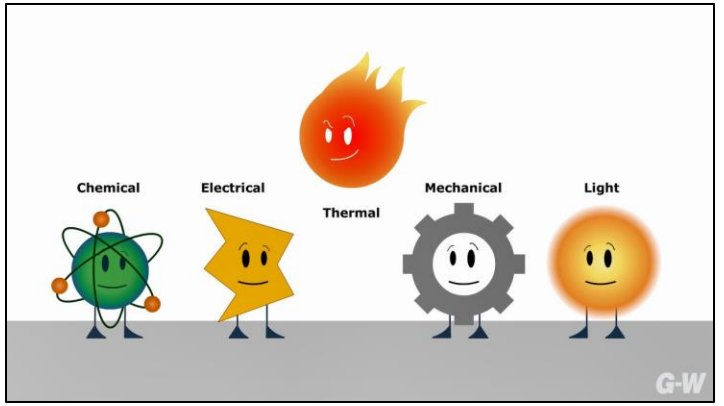
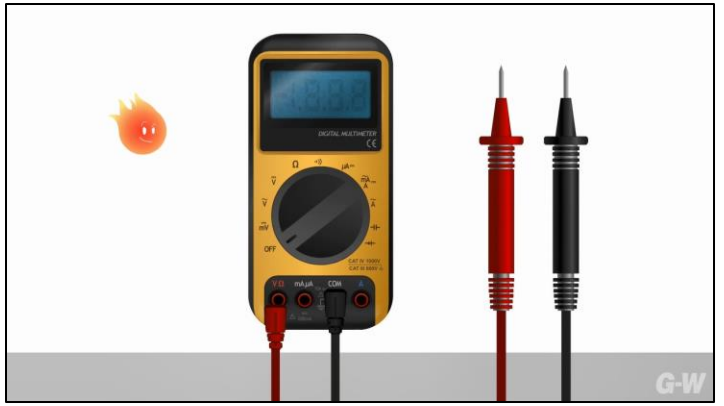






FOLLOW THE HEAT™

Follow-the-Heat Animations

Customer Interview

Troubleshoot Activities

Name:
Date:
Class:

Chapter 7: Working with Pipe

Carefully study the chapter and then answer the following questions.

1. Of the steel pipes used in the HVACR trade, which one is usually specified for water and drain lines?

A. Black iron pipe
B. Aluminum pipe
C. Galvanized pipe
D. Stainless steel pipe

Answer:

2. The International Fuel and Gas Code (IFGC) states that steel pipe used for gas lines needs to be at least _____.

A. Schedule 4
B. Schedule 6
C. Schedule 8
D. Schedule 10

Answer:

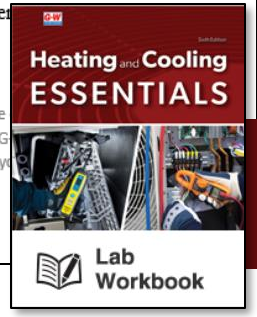
3. Steel and plastic pipe are measured by their _____.

A. outside diameter
B. inside diameter
C. wall thickness
D. weight

Answer:

4. *True or False?* Pipe threads and bolt threads are the same thread patter

Answer:



5. Which of the following is *false* about pipe wrenches?

A. Pipe wrenches are only manufactured in large sizes.
B. Strap-type pipe wrenches can be used on black pipe to eliminate tooth marks.
C. Pipe wrenches can bite on the pipe from any direction they are placed on the pipe.
D. Pipe wrenches are often used in pairs. One for the pipe and one for the fitting.

Answer:

6. *True or False?* Pipe dies come in one size fits all.

Answer:

7. Why does thread cutting oil get applied to the steel pipe when a pipe is being threaded?

A. To keep the cutting blades well lubricated so they do not rust.
B. To keep the die from getting too hot, which can damage the cutting edges.
C. To keep the pipe oiled so the newly threaded area of the pipe does not rust.
D. The cutting oil serves as a sealant for the connection to the next pipe or fitting.

Answer:

Match the following steel pipe tools shown with their respective names.

A

The Ridge Tool Company

Files are provided in DOCX format

Lab Workbook

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