

SOLUTIONS MANUAL

Refrigeration & Air Conditioning Technology

SIXTH EDITION

LAB MANUAL

Bill Whitman • Bill Johnson
John Tomczyk • Eugene Silberstein

Instructor's Guide
to Accompany

Refrigeration and Air Conditioning Technology

6th Edition

**Concepts, Procedures, and
Troubleshooting Techniques**

**William C. Whitman
William M. Johnson
John A. Tomczyk
Eugene Silberstein**





**Instructor's Guide to Accompany
Refrigeration & Air Conditioning
Technology, 6E**

**William C. Whitman, William M. Johnson,
John A. Tomczyk, and Eugene Silberstein**

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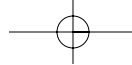
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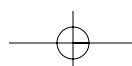
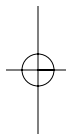
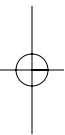
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Contents

Preface	v
PART I Instructor's Guide	1
Unit 1 Heat and Pressure	1
Unit 2 Matter and Energy	3
Unit 3 Refrigeration and Refrigerants	5
Unit 4 General Safety Practices	9
Unit 5 Tools and Equipment	11
Unit 6 Fasteners	13
Unit 7 Tubing and Piping	15
Unit 8 System Evacuation	19
Unit 9 Refrigerant and Oil Chemistry and Management—Recovery, Recycling, Reclaiming, and Retrofitting	21
Unit 10 System Charging	25
Unit 11 Calibrating Instruments	29
Unit 12 Basic Electricity and Magnetism	31
Unit 13 Introduction to Automatic Controls	35
Unit 14 Automatic Control Components and Applications	37
Unit 15 Troubleshooting Basic Controls	41
Unit 16 Advanced Automatic Controls—Direct Digital Controls (DDC) and Pneumatics	43
Unit 17 Types of Electric Motors	45
Unit 18 Application of Motors	47
Unit 19 Motor Controls	49
Unit 20 Troubleshooting Electric Motors	51
Unit 21 Evaporators and the Refrigeration System	53
Unit 22 Condensers	55
Unit 23 Compressors	59
Unit 24 Expansion Devices	63
Unit 25 Special Refrigeration System Components	67
Unit 26 Application of Refrigeration Systems	71
Unit 27 Commercial Ice Machines	73
Unit 28 Special Refrigeration Applications	77
Unit 29 Troubleshooting and Typical Operating Conditions for Commercial Refrigeration	79
Unit 30 Electric Heat	81
Unit 31 Gas Heat	85
Unit 32 Oil Heat	93
Unit 33 Hydronic Heat	97
Unit 34 Indoor Air Quality	101
Unit 35 Comfort and Psychrometrics	103
Unit 36 Refrigeration Applied to Air Conditioning	105
Unit 37 Air Distribution and Balance	107
Unit 38 Installation	109
Unit 39 Controls	113
Unit 40 Typical Operating Conditions	115
Unit 41 Troubleshooting	117
Unit 42 Electric, Gas, and Oil Heat with Electric Air Conditioning	121
Unit 43 Air Source Heat Pumps	123
Unit 44 Geothermal Heat Pumps	129
Unit 45 Domestic Refrigerators	131
Unit 46 Domestic Freezers	135
Unit 47 Room Air Conditioners	137
Unit 48 High-Pressure, Low-Pressure, and Absorption-Chilled Water Systems	139



Unit 49 Cooling Towers and Pumps 141
Unit 50 Operation, Maintenance, and Troubleshooting of Chilled-Water Air-Conditioning Systems. 143
PART II Lecture Outlines 145
PART III Correlation Guide 335



Preface

The text, *Refrigeration and Air Conditioning Technology*, 6th edition, provides coverage of the instructional material in a practical form. Many service tips, procedures, diagnostic charts, and reference materials makes the text a valuable tool even after the students complete their training and become field technicians. This Instructor's Guide was prepared to help the instructor use the text and its supplements package. The guide also helps instructors develop either individual course materials or a complete curriculum.

Part I of the Instructor's Guide follows the unit sequence of the text. The following are included for each unit when appropriate:

- Short description of material covered in text
- Unit Objectives
- Safety Notes
- ARI Competencies that are covered or partially covered in text material
- Recommended Lab Exercises to be completed for the unit
- Diagnoses for Technician Service Calls when not included in the text
- Answers to text Review Questions
- Answers to questions for Review Test in Study Guide/Lab Manual
- Special notes to instructors for Lab Exercises requiring malfunctioning equipment
- Answers to questions in Lab Exercises

Part II contains the Lecture Outlines, Part III contains the Correlation Guide.

Lecture Outlines are both printed and presented in PDF format on the instructor e-resource CD-ROM.

ADDITIONAL SUPPLEMENTS

The Study Guide/Lab Manual

The Study Guide/Lab Manual includes a unit overview, a list of key terms, an objective review test, and lab exercises when appropriate for each unit. Students can be asked to describe verbally or in writing each of the key terms, and the test can be used as an end-of-the-unit test. The lab exercises are designed around equipment that can be found in many typical labs. In addition to the typical labs

that students can work through, there are troubleshooting exercises and situational service ticket exercises in which instructors must place problems in the equipment. A description of each of these problems is included in this guide in the particular unit involved. Instructors may require students to keep a neat manual that can later become a part of a personal portfolio to be used for job interviews.

Online Companion Game Shell

A Game Shell with text questions is available for students online. Each unit of the core text will have games in 3 formats: Hangman, Flashcards, and Concentration. Test questions will be either true/false, multiple choice, or fill-in-the-blank. To locate the Game Shell go to www.delmarlearning.com/companions/ click on Site Map, Online Companions. You can then find the Game Shell by searching by discipline, title, author, or ISBN.

Instructor e.resource

This is an educational resource that creates a truly electronic classroom. It is a CD-ROM containing tools and instructional resources that enrich your classroom and make the instructor's preparation time shorter. The elements of *e.resource* link directly to the text and tie together to provide a unified instructional system. With the e.resource you can spend your time teaching, not preparing to teach.

Features contained in the *e.resource* (Order ISBN: 1-4283-1939-5) include:

- **Teaching Tips:** Teaching hints provide the basis for a lecture outline to present concepts and material. Key points and concepts can be graphically highlighted for student retention.
- **Syllabus:** A summary outline, or guide, for presenting a course on refrigeration and air conditioning using the Refrigeration and Air Conditioning Technology, 6th edition, text.
- **Lecture Outlines:** These are the Lecture Outlines created by unit that are also included in the *Instructor's Guide*. You have the option of using these lecture outlines with your own course information.
- **PowerPoint® Presentation:** These slides provide the basis for a lecture outline that helps you to present concepts and material. Key points and

concepts can be graphically highlighted for student retention.

- **Optical Image Library:** This is a database of full-color key images taken from the text that can be used in lecture presentations, transparencies, tests, and quizzes and to enhance PowerPoint presentations.
- **Computerized Test Bank:** Over 1000 questions of varying levels of difficulty are provided in true/false, multiple choice, fill-in-the-blank, and short answer formats so you can assess student comprehension. This versatile tool enables the instructor to manipulate the data to create original tests.

Video DVD Set

A six-DVD video set addressing over 120 topics covered in the text is available. Each DVD will contain four 20-minute videos. To order the six-DVD set, reference ISBN: 1-4180-7283-4

Audiobook

This is a collection of audio files covering every chapter in Refrigeration and Air Conditioning

Technology, Sixth Edition. The audio files are organized into “A” head groupings (comparable to song), which allow content to be accessed within the chapter. Once downloaded, MP3 audio files can be accessed on portable MP3 players or on PCs with standard Media programs.

Students can listen to the chapter content being read while they follow along and look at the illustrations. References to page numbers are included at the beginning of each chapter. Chapter objectives, boxed features, figure and photo caption, and end-of-chapter elements are included as well (but not end-of-chapter questions). The audio files will not replace the book, since the artwork and photos are essential and must be viewed. ISBN: 1-4283-1942-5

Online Courseware

Online courseware developed from the contents of the core text is available on two platforms, Web CT and Blackboard. Web Tutor on WebCT ISBN: 1-4283-1940-9, Blackboard ISBN: 1-4283-1941-7

PART I Instructor's Guide

Unit

1

Heat and Pressure

This unit covers temperature, methods of measuring heat and transferring heat, and discussions of molecular motion, sensible heat, latent heat, and specific heat. It also discusses atmospheric pressure and equipment including gages used to measure pressure. Some metric measurement terms are included.

There are review questions at the end of the unit in the text that may be assigned as an out-of-class

activity and then used to enhance class discussion. Key terms listed in the Study Guide/Lab Manual may also be used as an assignment and/or basis for discussion. The Review Test in the Study Guide/Lab Manual may be used as an end-of-unit test or for further discussion.

Objectives

After studying this unit, the student should be able to:

- define temperature.
- make conversions between Fahrenheit and Celsius scales.
- describe molecular motion at absolute 0.
- define the British thermal unit.
- describe heat flow between substances of different temperatures.

- explain the transfer of heat by conduction, convection, and radiation.
- discuss sensible heat, latent heat, and specific heat.
- state atmospheric pressure at sea level and explain why it varies at different elevations.
- describe two different types of barometers.
- explain psig and psia as they apply to pressure gages.

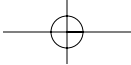
ARI Curriculum Guide Competencies

Background and related information is included in this unit for many of the competencies listed in the following areas of training in the ARI Curriculum Guide:

- PRINCIPLES OF THERMODYNAMICS AND HEAT TRANSFER
- Matter and Heat Behavior
- Fluids and Pressures

Unit 1 Answers to Review Questions (Text)

1. B.
2. At atmospheric pressure of 14.696 psia or 29.92 in Hg.
3. Fahrenheit, Celsius, Rankine, and Kelvin.
4. 0°C.
5. -460°F.
6. 1 pound of water 1°F.
7. D.
8. Heat transfers from molecule to molecule.
9. A.
10. C.
11. It is moved by moving in a medium such as air or water.
12. It is transferred through space without heating the space and heats the first solid object.
13. Substance.
14. 29.92 in Hg, 14.696 psia.
15. A mercury barometer is a standing column of mercury supported by the atmosphere. An aneroid barometer is an enclosed chamber that moves with pressure and registers on a dial.

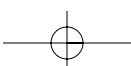
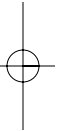
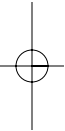


- 16. Straighten.
- 17. 14.696.
- 18. 26.7°C.

- 19. 71.6°F.
- 20. $70 \text{ psig} \times 6.89 = 482.3 \text{ kPa}$.

Unit 1 Answers to Review Test Questions (Study Guide/Lab Manual)

- | | | | |
|-------|--------|--------|--------|
| 1. C. | 6. B. | 11. C. | 16. D. |
| 2. A. | 7. A. | 12. B. | 17. A. |
| 3. A. | 8. A. | 13. D. | 18. B. |
| 4. A. | 9. D. | 14. A. | 19. D. |
| 5. C. | 10. D. | 15. C. | 20. B. |



Unit**2****Matter and Energy**

This unit defines matter, mass, density, specific gravity, and specific volume. Gas laws including Boyle's Law, Charles' Law, General Law of Perfect Gas, and Dalton's Law are stated. The broad term of energy is covered, as well as energy in heat and in magnetism.

The measurement of energy in horsepower, watts, and British thermal units is discussed. Unit review questions, key terms in the Study Guide/Lab Manual, and Study Guide/Lab Manual Review Test questions may be used as discussed in Unit 1.

Objectives

After studying this unit, the student should be able to:

- define matter.
- list the three states in which matter is commonly found.
- define density.
- discuss Boyle's Law.
- state Charles' Law.
- discuss Dalton's Law as it relates to the pressure of different gases.
- define specific gravity and specific volume.
- state two forms of energy important to the air-conditioning (heating and cooling) and refrigeration industry.
- describe work and state the formula used to determine the amount of work in a given task.
- define horsepower.
- convert horsepower to watts.
- convert watts to British thermal units.

Unit 2 Answers to Review Questions (Text)

1. D.
2. Solids, liquid, and vapor.
3. Ice.
4. Down.
5. Downward and outward.
6. D.
7. Weight per unit volume of a substance.
8. The density of a substance compared to the density of water.
9. The volume occupied by one pound of a fluid.
10. The moon has less mass than the earth, thus its gravitational pull is less.
11. Specific volume = $1 \div 1,210 \text{ lb/ft}^3 = .000826 \text{ ft}^3/\text{lb}$.
12. Density = $1 \div (.0018 \text{ ft}^3/\text{lb}) = 555.55$.
13. Specific gravity = $171 \text{ lb/ft}^3 \div 62.4 \text{ lb/ft}^3 = 2.74$.
14. Total volume = 10 ft^3 .
Density is $(4 \text{ lb} \div 10 \text{ ft}^3) = 0.4 \text{ lb/ft}^3$.
Specific gravity is $(0.4 \text{ lb/ft}^3 \div 62.4 \text{ lb/ft}^3) = .0064$.
15. It describes how one gas reacts when mixed with another. For example, natural gas is lighter than air and rises; propane is heavier than air and falls. Specific volume must be considered when determining the size of compressors or vapor pumps.
16. B.
17. It will expand when heated or contract when cooled.
18. Dalton's Law states that the total pressure of a confined mixture of gases is the sum of the pressures of each of the gases in the mixture.
19. Solar and fossil fuels.
20. From decaying animal and vegetable matter compressed below the earth's surface.
21. Power.
22. Force \times distance.
23. $4 \text{ ft} \times 300 \text{ lbs.} = 1,200 \text{ foot pounds}$.
24. An early expression of power or the equivalent of raising 33,000 pounds to a height of 1 foot in one minute. Weight, height, and time.
25. $746 \text{ watts} = 1 \text{ horsepower}$.
26. $(4 \text{ Kw} \times 3,413) = 13,652 \text{ Btu/hr}$.
27. $12,000 \text{ watts} \times 3.413 \text{ Btu/hr} = 40,956 \text{ Btu/hr}$.
28. Kilowatt hour.
29. The temperature is constant so $P_1V_1 = P_2V_2$

$$P_2 = \frac{P_1V_1}{V_2}$$

$$P_2 = \frac{(10 \text{ psig} + 14.696)(30 \text{ ft}^3)}{(25 \text{ ft}^3)} = 29.635 \text{ psia}$$

$$P_2 = (29.635 \text{ psia} - 14.696) = 14.939 \text{ psig}$$

30. The pressure is constant so $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$V_2 = \frac{V_1 T_2}{T_1}$$

$$V_2 = \frac{(3,000 \text{ ft}^3)(55 + 460)^\circ\text{R}}{(75 + 460)^\circ\text{R}} = 2887.8 \text{ ft}^3$$

31. $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$P_2 = \frac{P_1 V_1 T_2}{T_1 V_2}$$

$$P_2 = \frac{(10 \text{ psig} + 14.696)(10.5 \text{ in.}^3)(180^\circ + 460)^\circ\text{R}}{(65 + 460)^\circ\text{R}(1.5 \text{ in.}^3)}$$

$$P_2 = 210.74 \text{ psia}$$

$$P_2 = (210.74 \text{ psia} - 14.696) = 196 \text{ psig}$$

Unit 2 Answers to Review Test Questions (Study Guide/Lab Manual)

1. C.
2. A.
3. B.
4. C.

5. D.
6. A.
7. D.

8. C.
9. C.
10. D.

11. D.
12. D.
13. C.