

BEGINNING ALGEBRA



JULIE MILLER
MOLLY O'NEILL

BEGINNING ALGEBRA

JULIE MILLER
MOLLY O'NEILL

Daytona Beach Community College



Higher Education

Boston Burr Ridge, IL Dubuque, IA Madison, WI New York San Francisco St. Louis
Bangkok Bogotá Caracas Kuala Lumpur Lisbon London Madrid Mexico City
Milan Montreal New Delhi Santiago Seoul Singapore Sydney Taipei Toronto

BEGINNING ALGEBRA

Published by McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020. Copyright © 2004 by The McGraw-Hill Companies, Inc. All rights reserved. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of The McGraw-Hill Companies, Inc., including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 0 VNH/VNH 0 9 8 7 6 5 4 3

1 2 3 4 5 6 7 8 9 0 VNH/VNH 0 9 8 7 6 5 4 3

ISBN 0-07-236371-1 (Student Edition)

ISBN 0-07-252561-4 (Annotated Instructor's Edition)

Publisher: *William K. Barter*

Senior sponsoring editor: *David Dietz*

Developmental editor: *Erin Brown*

Executive marketing manager: *Marianne C. P. Rutter*

Senior marketing manager: *Mary K. Kittell*

Lead project manager: *Peggy J. Selle*

Production supervisor: *Sherry L. Kane*

Senior media project manager: *Tammy Juran*

Media technology producer: *Jeff Huettman*

Designer: *K. Wayne Harms*

Cover/interior designer: *Rokusek Design*

Cover image: *David Woodfall/Gettyimages*

Lead photo research coordinator: *Carrie K. Burger*

Photo research: *LouAnn K. Wilson*

Supplement producer: *Brenda A. Ernzen*

Compositor: *TechBooks*

Typeface: *10/12 Times Roman*

Printer: *Von Hoffmann Corporation*

Photo Credits

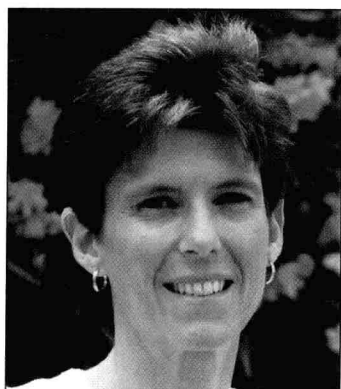
About the Authors: Photo of Julie Miller by Marc Campbell; Photo of Molly O'Neill by Gail Beckwith.
Chapter R: Opener: © Vol. 38/CORBIS; p. 25: © CORBIS website; p. 42: © PhotoDisc website. Chapter 1:
Opener: © Vol. 154/CORBIS; p. 68: © Elena Rooraid/Photo Edit; p. 76: © Vol. 44/CORBIS; p. 88: © CORBIS
website; p. 106: © David Young-Wolff/Photo Edit. Chapter 2: Opener: © CORBIS website; p. 150: © Vol. 44/
CORBIS; p. 159: © Judy Griesedieck/CORBIS; p. 169: © CORBIS website; p. 181: © CORBIS website; p. 195:
© Robert Brenner/Photo Edit; p. 207: © Tony Freeman/Photo Edit. Chapter 3: Opener: © CORBIS website;
p. 254: © Vol. 26/CORBIS; p. 256: © CORBIS website; p. 293: © CORBIS website; p. 308: © CORBIS website.
Chapter 4: Opener: © Vol. 1/PhotoDisc; p. 377: © Michael Newman/Photo Edit; p. 385: © Vol. 4/CORBIS.
Chapter 5: Opener: © Vol. 62/CORBIS; p. 398: © Paul Morris/CORBIS; p. 408: © Vol. 56/CORBIS; p. 415:
© Michael Newman/Photo Edit; p. 434: © EyeWire/Getty Images website; p. 441 (left): © Vol. 117/CORBIS;
p. 441 (right): © Vol. 35/CORBIS; p. 460: © PhotoDisc website. Chapter 6: Opener: © Vol. 188/CORBIS; p. 477:
© EyeWire/Getty website; p. 489: © Vol. 107/CORBIS; p. 500: © EyeWire/Getty website; p. 520: © Susan Van
Etten/Photo Edit. Chapter 7: Opener: © Vol. 247/CORBIS; p. 550: © Vol. 132/CORBIS; p. 560: © Burke/Triolo
Productions/FoodPix/Getty Images; p. 570: © Jeff Greenberg/Photo Edit. Chapter 8: Opener: © Bill Ross/
CORBIS; p. 605: © AP/Wide World Photos; p. 620: © Dennis O'Clair/Stone Images/Getty Images; p. 628:
© CORBIS website; p. 643: © Vol. 101/CORBIS. Chapter 9: Opener: © Vol. 110/PhotoDisc; p. 679: © PhotoDisc
website; p. 697 (left): © Massimo Listri/CORBIS; p. 697 (right): © PhotoDisc/Getty website; p. 719: © Vol. 527/
CORBIS; p. 726: © Frank Whitney/Brand X Pictures/PictureQuest.

DEDICATION

To Geoff and Pam, and Joelle and Bob
—Julie Miller

To my parents, Doris and Richard Krajewski
—Molly O'Neill

ABOUT THE AUTHORS



JULIE MILLER

Julie Miller has been a member of the Mathematics Department at Daytona Beach Community College for 14 years where she has taught developmental and upper level courses. Prior to her work at DBCC, Julie worked as a software engineer for General Electric in the area of flight and radar simulation. Julie earned a bachelor of science degree in applied mathematics from Union College in Schenectady, New York and a master of science in mathematics from the University of Florida. In addition to her textbook, Julie has authored several course supplements for college algebra, trigonometry, and precalculus and several short works of fiction and nonfiction for young readers.



MOLLY O'NEILL

Molly O'Neill is also from Daytona Beach Community College where she has taught for 16 years in the Mathematics Department. She has taught a variety of courses from developmental mathematics to calculus. Before she came to Florida, Molly taught as an adjunct instructor at the University of Michigan—Dearborn, Eastern Michigan University, Wayne State University, and Oakland Community College. Molly earned a bachelor of science degree in mathematics and a master of arts and teaching from Western Michigan University in Kalamazoo, Michigan. Besides her textbook, Molly has authored several course supplements for college algebra, trigonometry, and precalculus and reviewed texts for developmental mathematics.

HELP YOURSELF

To succeed in mathematics, as in any subject, you must be willing to devote some of your time and attention to completing homework assignments and preparing for exams. You must set aside time for yourself on a regular basis to put any classroom notes to use and work through homework exercises. As you study your notes and work on homework, you may find that some concepts are easier to understand than others. For this reason, you may need to have a concept explained more than once or in different ways. Outside of the explanations you may receive in the classroom or from tutors, this textbook and its accompanying products will provide you with additional explanations, worked examples, and exercise sets to help you master concepts and practice what you learn. If you use the resources available to you, with a little self-discipline and patience you should find that you achieve a passing grade in the course and build the groundwork necessary for further studies in mathematics.

SUPPLEMENTS FOR THE STUDENT

The following products were developed in conjunction with your textbook to offer you additional support in your course.

Student Learning Site—Online Learning Center

The Student Learning Site of the Online Learning Center (OLC), located at www.mhhe.com/miller_oneill contains valuable resources that will help you improve your understanding of the topics presented in your course.

The Student Learning Site is passcode-protected. A passcode can be found at the front of your newly purchased text and is *free when you purchase a new text*.

When you enter the Student Learning Site, you will find materials for a Student Portfolio, a downloadable formula card, access to NetTutor™, access to tutorials, and more!

NetTutor

NetTutor is a revolutionary system that enables you to interact with a live tutor over the World Wide Web by using NetTutor's Web-based, graphical chat capabilities. You can also submit questions and receive answers, browse previously answered questions, and view previous live chat sessions. You can access the NetTutor environment from home or school, regardless of the Internet browser or computer you are using, as long as the computer has a modem and a connection to the Internet.

To learn more about NetTutor and to register, visit the Student Learning Site of the Online Learning Center.

Miller/O'Neill Tutorial CD-ROM

The interactive CD-ROM that accompanies *Beginning Algebra* is a self-paced tutorial specifically linked to the text that reinforces topics through unlimited opportunities to review concepts and practice problem solving. The CD-ROM provides section-specific animated lessons with accompanying audio, practice exercises that enable you to work through problems with step-by-step guidance available, concept-matching problems that test vocabulary skills as well as identification of properties and rules, and more. This browser-based CD requires virtually no computer training and will run on both Windows and Macintosh computers. The CD-ROM is available free to students who purchase a *new* text.

Miller/O'Neill Video Series (Videotapes or Video CDs)

The video series is based on problems taken directly from the Practice Exercises. The Practice Exercises contain icons that show which problems from the text appear in the video series. A mathematics instructor presents selected problems and works through them, following the solution methodology employed in the text. The video series is also available on video CDs.

Student's Solutions Manual

The *Student's Solutions Manual* contains comprehensive, worked-out solutions to the odd-numbered exercises in the Practice Exercise sets, the Midchapter Reviews, the end-of-chapter Review Exercises, the Chapter Tests and the Cumulative Review Exercises.

PUTTING IT ALL TOGETHER

This text and its accompanying supplements have been designed to offer you the kind of support that will help you succeed in your course. Here are a few suggestions for using the text and its accompanying materials.

To prepare for exams, rework assigned homework problems to practice. Also, work through the Chapter Tests and compare your answers with those in the back of the text. You can use the Student Portfolio, available on the Student Learning Site of the Online Learning Center, to keep your notes and other class-related papers such as quizzes and tests organized. If you save your tests, you can rework problems from the test in preparation for other exams. You can also use the Vocabulary Worksheets from the Student Portfolio to review terms that might appear on any of your quizzes or exams.

If you are looking for extra help and are not able to get help in school due to conflicting schedules with your instructor or tutoring center, you can use NetTutor. The Student Learning Site of the Online Learning Center contains many other valuable elements such as “e-professors.” The e-professors are tutorials based on topics selected from each section of the text. These tutorials present worked-out solutions to problems, similar to those found in your text. Another valuable source of help is the Video Series. If you cannot attend a class on a particular day or if you would just like more explanation, refer to the selected problems from the Practice Exercises of your text that have a video icon. Once you identify these problems, you can use the videotapes or videos on CD to watch an instructor present the solutions.

The *Student's Solutions Manual* for the text is another way to obtain worked-out solutions for problems in your text if you would like a reminder or a hint as to how various problems are solved.

ACKNOWLEDGMENTS

Preparing a first edition mathematics text is an enormous undertaking that would never have been possible without the creative ideas and constructive feedback offered by many reviewers. We are especially thankful to the following instructors for their valuable feedback and careful review of the manuscript:

Mary Kay Best, *Coastal Bend College*
 Connie Buller, *Metropolitan Community College*
 Gerald F. Busald, *San Antonio College*
 Elizabeth Condon, *Queens Community College*
 Pat C. Cook, *Weatherford College*
 Jacqueline Coomes, *Eastern Washington University*
 Cynthia M. Craig, *Augusta State University*
 Andres Delgado, *Orange County Community College*
 Irene Duranczyk, *Eastern Michigan University*
 Pat Foard, *South Plains College*
 Dr. Paul F. Foutz, *Temple College*
 Jacqueline B. Giles, *Houston County Community College*
 Celeste Hernandez, *Richland College*
 Julie Hess, *Grand Rapids Community College*
 Kayana Hoagland, *South Puget Sound Community College*
 Rosalie Hojegan, *Possaic County Community College*
 Lori Holdren, *Manatee Community College*
 Sarah Jackman, *Richland College*
 Nancy R. Johnson, *Manatee Community College*
 Steven Kahn, *Anne Arundel Community College*
 Jane Keller, *Metropolitan Community College*
 Jeff A. Koleno, *Lorain County Community College*
 Mary M. Leeseberg, *Manatee Community College*
 Deann Leoni, *Edmonds Community College*
 Pamela A. Lipka, *University of Wisconsin*
 J. Robert Malena, *Community College of Allegheny County—South Campus*
 Maria M. Maspons, *Miami Dade Community College*
 Debbie K. Millard, *Florida Community College*
 Jean P. Millen, *Georgia Perimeter College*
 Cameron Neal, Jr., *Temple College*
 Linda Padilla, *Joliet Junior College*
 Bernard J. Pina, *Dona Ana Branch Community College—NMSU*
 Rita Beth Pruitt, *South Plains College*

Nancy C. Ressler, *Oakton Community College*
Reynaldo Rivera, Jr., *Estrella Mountain Community College*
Mary Romans, *Kent State University*
Fred Safier, *City College of San Francisco*
Ned W. Schillow, *Lehigh Carbon Community College*
Mary Lee Seitz, *Erie Community College*
Cindy Shaber, *Boise State University*
Lisa Sheppard, *Lorain County Community College*
Brian Starr, *National University*
Dr. Bryan Stewart, *Tarrant County College*
Alexis Thurman, *County College of Morris*
Dr. Roy N. Tucker, *Palo Alto College*
Sandra Vrem, *College of the Redwoods*
Thomas L. Wolters, *Muskegon Community College*

Special thanks go to Doris McClellan Lewis and Karyn Anderson for preparing the *Instructor's Solutions Manual* and the *Student's Solutions Manual*, to Cynthia Cruz of College of the Canyons for her appearance in and work on the video series, and to Lauri Semarne for performing an accuracy check of the manuscript.

In addition to the assistance provided by the reviewers, we would also like to thank the many people behind the scenes at McGraw-Hill who have made this project possible. Our sincerest thanks to Erin Brown, David Dietz, and Bill Barter for being patient and kind editors, to Peggy Selle for keeping us on track during production, and to Mary Kittell and Marianne Rutter for their creative ideas promoting all of our efforts. We further appreciate the hard work of Wayne Harms, Carrie Burger, Tammy Juran, and Jeff Huettman.

Finally, we give special thanks to all the students and instructors who use *Beginning Algebra* in their classes.

Julie Miller and Molly O'Neill

KEY FEATURES

To get the most use out of your textbook, take a few minutes to familiarize yourself with its features.

Chapter Openers

Each chapter opens with an application relating to topics presented in the chapter. The Chapter Openers also contain website references for **Technology Connections**—Internet activities found in the Student Learning Site of the Online Learning Center—that further the scope of the application.

RADICALS

chapter

8



- 8.1 Introduction to Roots and Radicals
- 8.2 Properties of Radicals
- 8.3 Addition and Subtraction of Radicals
- 8.4 Multiplication of Radicals
- Midchapter Review
- 8.5 Rationalization
- 8.6 Radical Equations
- 8.7 Rational Exponents
- Chapter 8 Summary
- Chapter 8 Review Exercises
- Chapter 8 Test
- Cumulative Review Exercises, Chapters 1–8

The area of a triangle can be found if the length of one side (the base) and the corresponding height of the triangle are known.

$$A = \frac{1}{2}bh$$

However, if the height of a triangle is not known, but the lengths of the three sides, a , b , and, c are given, the area of the triangle can be found using Heron's formula:

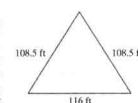
$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

where

$$s = \frac{1}{2}(a + b + c)$$

Heron's formula and other applications of radicals are studied in this chapter.

The Louvre pyramid, designed by architect I. M. Pei, is a glass structure that serves as the entrance to the Louvre Museum in Paris. Each triangular face is made of glass with dimensions as shown.



The area of each face can be found using Heron's formula:

$$s = \frac{1}{2}(108.5 + 108.5 + 116) = 166.5$$

$$A = \sqrt{166.5(166.5 - 108.5)(166.5 - 108.5)(166.5 - 116)} \approx 5318.4$$

The area of each triangular face required approximately 5318.4 ft² of glass.

226 Chapter 3 Polynomials and Properties of Exponents

Concepts

1. Review of Exponential Notation
2. Evaluating Expressions with Exponents
3. Multiplying and Dividing Common Bases
4. Simplifying Expressions with Exponents
5. Applications of Exponents

section

3.1 EXPONENTS: MULTIPLYING AND DIVIDING COMMON BASES

1. Review of Exponential Notation

Recall that an **exponent** is used to show repeated multiplication of the base.

Definition of b^n

Let b represent any real number and n represent a positive integer. Then,

$$b^n = \underbrace{b \cdot b \cdot b \cdot \dots \cdot b}_{n \text{ factors of } b}$$

example 1

Evaluating Expressions with Exponents

For each expression, identify the exponent and base. Then evaluate the expression.

- a. 6^2 b. $\left(-\frac{1}{2}\right)^3$ c. 0.8^4

Solution:

Expression	Base	Exponent	Result
a. 6^2	6	2	$(6)(6) = 36$
b. $\left(-\frac{1}{2}\right)^3$	$-\frac{1}{2}$	3	$\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right) = -\frac{1}{8}$
c. 0.8^4	0.8	4	$(0.8)(0.8)(0.8)(0.8) = 0.4096$

Note that if no exponent is explicitly written for an expression, then the expression has an implied exponent of 1. For example,

$$\begin{aligned} x &= x^1 \\ y &= y^1 \\ 5 &= 5^1 \end{aligned}$$

2. Evaluating Expressions with Exponents

Recall from Section 1.2 that particular care must be taken when evaluating exponential expressions involving negative numbers. An exponential expression with a negative base is written with parentheses around the base, such as $(-3)^2$.

To evaluate $(-3)^2$, we have: $(-3)^2 = (-3)(-3) = 9$

If no parentheses are present, the expression -3^2 is the *opposite* of 3^2 , or equivalently, $-1 \cdot 3^2$.

$$\text{Hence: } -3^2 = -1(3^2) = -1(3)(3) = -9$$

Special Elements

Concepts

A list of important concepts is provided at the beginning of each section. Each concept corresponds to a heading within the section, making it easy to locate topics as you study or work through homework exercises.

example 6**Writing an Equation of a Line Through Two Points**

Write an equation of the line passing through the points $(-3, 0)$ and $(3, -4)$. Write the answer in slope-intercept form.

Solution:

Given two points on a line, the slope can be found with the slope formula.

$$\begin{array}{cc} (-3, 0) & \text{and} & (3, -4) \\ (x_1, y_1) & & (x_2, y_2) \end{array} \quad \text{Label the points.}$$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{(-4) - (0)}{(3) - (-3)} = \frac{-4}{6} = -\frac{2}{3}$$

With the slope $m = -\frac{2}{3}$, the slope-intercept form of the line is $y = -\frac{2}{3}x + b$.

To find b , substitute the values of x and y from *either* ordered pair and then solve the resulting equation for b . We will use the point $(-3, 0)$.

$$y = -\frac{2}{3}x + b$$

$$0 = -\frac{2}{3}(-3) + b$$

$$0 = 2 + b$$

$$-2 = b$$

The slope-intercept form is $y = -\frac{2}{3}x - 2$.

A sketch of the line shows that the line passes through the points $(-3, 0)$ and $(3, -4)$ as desired (Figure 6-25).

7. Writing an Equation of a Line Parallel or Perpendicular to Another Line

example 7**Writing an Equation of a Line Parallel to Another Line**

Write an equation of the line passing through the point $(1, 2)$ and parallel to the line $y = 3x - 4$. Write the answer in slope-intercept form.

Solution:

Figure 6-26 shows the line $y = 3x - 4$ (pictured in black) and a line parallel to it (pictured in blue) that passes through the point $(1, 2)$. The given line, $y = 3x - 4$, is written in slope-intercept form and its slope is easily identified as 3. The line parallel to the given line must also have a slope of 3.

The slope-intercept form of the line we want to find is

$$y = 3x + b$$

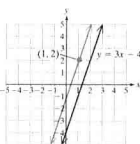


Figure 6-25

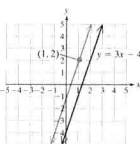


Figure 6-26

Tips

Tip boxes appear throughout the text and offer helpful hints and insight.

4. Use the addition and subtraction properties of equality to collect the constant terms on the other side of the equation.
5. Use the multiplication and division properties of equality to make the coefficient of the variable term equal to 1.
6. Check your answer.

example 3**Solving Linear Equations**

$$\text{a. } \frac{1}{6}x - \frac{2}{3} = \frac{1}{5}x - 1$$

$$\text{b. } \frac{1}{3}(x + 7) - \frac{1}{2}(x + 1) = 4$$

Solution:

$$\text{a. } \frac{1}{6}x - \frac{2}{3} = \frac{1}{5}x - 1$$

The LCD of 6, 3, and 5 is 30.

$$\left(\frac{1}{6}x - \frac{2}{3}\right) \cdot 30 = \left(\frac{1}{5}x - 1\right) \cdot 30$$

Multiply by the LCD, 30.

$$\frac{30}{1} \cdot \frac{1}{6}x - \frac{30}{1} \cdot \frac{2}{3} = \frac{30}{1} \cdot \frac{1}{5}x - \frac{30}{1} \cdot 1$$

Apply the distributive property (recall $30 = \frac{30}{1}$).

$$5x - 20 = 6x - 30$$

Clear fractions.

$$5x - 6x - 20 = 6x - 6x - 30$$

Subtract $6x$ from both sides.

$$-x - 20 = -30$$

$$-x - 20 + 20 = -30 + 20$$

Add 20 to both sides.

$$-x = -10$$

$$\frac{-x}{-1} = \frac{-10}{-1}$$

Divide both sides by -1 .

$$x = 10$$

$$\text{b. } \frac{1}{3}(x + 7) - \frac{1}{2}(x + 1) = 4$$

The LCD of 3 and 2 is 6.

$$\left[\frac{1}{3}(x + 7) - \frac{1}{2}(x + 1)\right] \cdot 6 = 4 \cdot 6$$

Multiply both sides by 6.

$$\frac{6}{1} \left[\frac{1}{3}(x + 7) \right] - \frac{6}{1} \left[\frac{1}{2}(x + 1) \right] = 24$$

Apply the distributive property.

$$2(x + 7) - 3(x + 1) = 24$$

$$2x + 14 - 3x - 3 = 24$$

Clear parentheses.

$$-x + 11 = 24$$

Combine like terms.

Avoiding Mistakes

Through marginal notes labeled Avoiding Mistakes you are alerted to common errors and are shown methods to avoid them.

Avoiding Mistakes

Notice that on the left-hand side of this equation, the product of 6 and $\frac{1}{3}$ is taken first, and then the result of 2 is distributed through the parentheses. Similarly, the product of 6 and $-\frac{1}{2}$ is taken first. The result of -3 is then distributed through the parentheses.

Calculator Connections

Optional Calculator Connections boxes, appear throughout the text. These boxes appear for your reference and may be included as part of your reading assignment, depending on the amount of emphasis your instructor places on the calculator in your course. They are designed for use with a scientific and/or a graphing calculator.

Calculator Connections

Note that parentheses are required to divide 188.4 by the quantity 2π . This guarantees that the calculator follows the implied order of operations. Without parentheses, the calculator would divide 188.4 by 2 and then multiply the result by π .

Scientific Calculator

Enter: $\boxed{1}\boxed{8}\boxed{8}\boxed{.}\boxed{4}\boxed{+}\boxed{(}\boxed{2}\boxed{\times}\boxed{\pi}\boxed{)}\boxed{=}$ **Result:** 29.98479128 correct

Enter: $\boxed{1}\boxed{8}\boxed{8}\boxed{.}\boxed{4}\boxed{\div}\boxed{2}\boxed{\times}\boxed{\pi}\boxed{=}$ **Result:** 295.938028 incorrect

Graphing Calculator

$\boxed{188.4}\boxed{\div}\boxed{(}\boxed{2}\boxed{\pi}\boxed{)}\boxed{=}$ ← Correct

$\boxed{188.4}\boxed{\div}\boxed{2}\boxed{\pi}\boxed{=}$ ← Incorrect

Calculator Exercises

Approximate the expressions with a calculator. Round to three decimal places if necessary.

1. $\frac{880}{2\pi}$ 2. $\frac{1600}{\pi(4)^2}$ 3. $\frac{20}{(-0.05)(5)}$ 4. $\frac{10}{0.5(6+4)}$

section 5.4 PRACTICE EXERCISES

1. For the rational expression

$$\frac{x^2 - 4x - 5}{x^2 - 7x + 10}$$

- a. Find the value of the expression (if possible) when $x = 0, 1, -1, 2$, and 5 .
- b. Factor the denominator and identify the domain. Write the domain in set-builder notation.
- c. Reduce the expression.

2. For the rational expression

For Exercises 7–20, add or subtract the expressions with like denominators as indicated.

7. $\frac{7}{8} + \frac{3}{8}$ 8. $\frac{1}{3} + \frac{7}{3}$

9. $\frac{9}{16} - \frac{3}{16}$ 10. $\frac{14}{15} - \frac{4}{15}$

11. $\frac{5a}{a+2} - \frac{3a-4}{a+2}$ 12. $\frac{2b}{b-3} - \frac{b-9}{b-3}$

13. $\frac{5c}{c+3} + \frac{30}{c+3}$ 14. $\frac{12}{d+1} + \frac{6d}{d+1}$

27. $\frac{6}{a^2 - b^2} - \frac{2a}{a^2 + a^2b}$

28. $\frac{7x}{x^2 + 2xy + y^2} - \frac{3}{x^2 + xy}$

For Exercises 29–44, add or subtract the expressions with unlike denominators as indicated.

29. $\frac{5}{a+1} + \frac{4}{3a+3}$ 30. $\frac{2}{c-4} + \frac{1}{5c-20}$

31. $\frac{k}{k^2 - 9} - \frac{4}{k-3}$ 32. $\frac{7}{h+5} - \frac{2h-3}{h^2 - 25}$

For Exercises 51–54, translate the English phrases into algebraic expressions. Then simplify by combining the rational expressions.

Section 8.1 Introduction to Roots and Radicals 605

119. On a map, the cities Asheville, North Carolina, Roanoke, Virginia, and Greensboro, North Carolina, form a right triangle (see the figure). The distance between Asheville and Roanoke is 300 km. The distance between Roanoke and Greensboro is 134 km. How far is it from Greensboro to Asheville? Round the answer to the nearest kilometer.

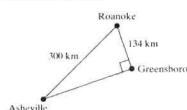


Figure for Exercise 119

120. Jackson, Mississippi, is west of Meridian, Mississippi, a distance of 141 km. Tupelo, Mississippi, is north of Meridian, a distance of 209 km. How far is it from Jackson to Tupelo? Round the answer to the nearest kilometer.

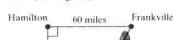


- b. How much tape is needed to tape both diagonals?
- c. How much tape is needed to tape 20 such windows?



EXPANDING YOUR SKILLS

122. For what values of x will \sqrt{x} be a real number?
123. For what values of x will $\sqrt{-x}$ be a real number?
124. A motorist must drive between Frankville and Clayton. Normally the driver takes the route around the mountains by driving through Hamilton (see figure).



Practice Exercises

The Practice Exercises contain a variety of problem types.

- **Applications** are based on real-world facts and figures. Working through these problems will help you improve your problem-solving skills.
- **Exercises Keyed to Video** are labeled with an icon to help you identify those exercises that appear in the video series that accompanies this text.
- **Calculator Exercises** present situations when a calculator can be used to help you perform calculations that might be overly time-consuming if done by hand. They are designed for use with either a scientific or a graphing calculator.
- **Expanding Your Skills**, found near the end of most Practice Exercise sets, are exercises that challenge your knowledge of the concepts presented.

chapter 4 MIDCHAPTER REVIEW: "FACTORIZING STRATEGY"

1. What is meant by a prime factor?
2. What is the first step in factoring any polynomial?
3. When factoring a binomial, what pattern can you look for?
4. When factoring a trinomial what pattern do you look for first before using the grouping method or trial-and-error method?
5. Are factorable polynomials factored completely in one step?

Midchapter Reviews

The Midchapter Reviews are provided to help you strengthen your understanding of concepts learned in the beginning of a chapter before you move on to new ideas presented later in the chapter.

End-of-Chapter Summary and Exercises

The **Summary**, found at the end of each chapter, outlines key concepts and terms for each section, and illustrates concepts with examples. With this list, you can quickly identify important ideas and vocabulary to be reviewed before quizzes or exams. Following the Summary is a set of **Review Exercises** that are organized by section. A **Chapter Test** appears after each set of Review Exercises.

Chapters 2–9 also include a **Cumulative Review** that follows the Chapter Test. These end-of-chapter materials are useful resources that will help you prepare for quizzes or exams.

Summary 651

chapter 8 SUMMARY

SECTION 8.1—INTRODUCTION TO ROOTS AND RADICALS

KEY CONCEPTS:

b is a square root of a if $b^2 = a$.

The expression \sqrt{a} represents the principal square root of a .

b is an n th-root of a if $b^n = a$.

1. If n is a positive even integer and $a > 0$, then $\sqrt[n]{a}$ is the principal (positive) n th-root of a .
2. If n is a positive odd integer, then $\sqrt[n]{a}$ is the n th-root of a .
3. If n is any positive integer, then $\sqrt[n]{0} = 0$.

EXAMPLES:

The square roots of 16 are 4 and -4 because $(4)^2 = 16$ and $(-4)^2 = 16$.

$$\sqrt{16} = 4 \quad \text{Because } 4^2 = 16$$

$$\sqrt[3]{16} = 2 \quad \text{Because } 2^3 = 16$$

$$\sqrt[5]{125} = 5 \quad \text{Because } 5^5 = 125$$

chapter 8

REVIEW EXERCISES

Section 8.1

For Exercises 1–4, state the principal square root and the negative square root.

1. 196
2. 1.44
3. 225
4. 0.64
5. Explain why $\sqrt{-64}$ is not a real number.
6. Explain why $\sqrt[3]{-64}$ is a real number.

For Exercises 7–22, simplify the expressions, if possible.

7. $-\sqrt{144}$
8. $-\sqrt{25}$
9. $-\sqrt{144}$
10. $\sqrt{-25}$
11. $\sqrt{y^2}$
12. $\sqrt[3]{y^3}$
13. $\sqrt[4]{y^4}$
14. $\sqrt[5]{y^5}$
15. $-\sqrt[3]{125}$
16. $-\sqrt[4]{625}$
17. $\sqrt[5]{p^{25}}$
18. $\sqrt[3]{q^{27}}$
19. $\sqrt[4]{\frac{81}{t^8}}$
20. $\sqrt[3]{\frac{-27}{w^3}}$

$$21. \sqrt{-32} \quad 22. \sqrt[3]{-1}$$

For Exercises 23–30, use a calculator to evaluate the radicals. Round the answer to three decimal places.

23. $\sqrt{10}$
24. $\sqrt{31}$
25. $\sqrt[3]{15}$
26. $\sqrt[4]{63}$
27. $\sqrt[5]{8}$
28. $\sqrt[3]{25}$
29. $\sqrt[4]{82}$
30. $\sqrt[5]{100}$

31. The radius, r , of a circle can be found from the area of the circle according to the formula:

$$r = \sqrt{\frac{A}{\pi}}$$

- a. What is the radius of a circular garden whose area is 160 m^2 ? Round to the nearest tenth of a meter.
- b. What is the radius of a circular fountain whose area is 1600 ft^2 ? Round to the nearest tenth of a foot.

chapter 8

TEST

1. State the conditions for a radical expression to be in simplified form.

For Exercises 2–7, simplify the radicals, if possible. Assume all variables represent positive real numbers.

2. $\sqrt{242x^2}$
3. $\sqrt[3]{48y^4}$
4. $\sqrt{-64}$
5. $\sqrt{\frac{5a^6}{81}}$
6. $\frac{9}{\sqrt{6}}$
7. $\frac{2}{\sqrt{5}+6}$

8. Translate the English phrases into algebraic expressions and simplify.

- a. The sum of the square root of twenty-five and the cube of five.
- b. The difference of the square of four and the fourth root of 16.

9. Estimate the value of the following radicals. Then use your calculator to approximate the value to three decimal places.

- a. $\sqrt{38}$
- b. $\sqrt[3]{20}$

10. A baseball player hits the ball at an angle of 30° with an initial velocity of 112 ft/s. The horizontal

CUMULATIVE REVIEW EXERCISES, CHAPTERS 1–8

For Exercises 1–2, simplify completely:

$$1. \frac{|-3 - 12 + 6 + 2|}{\sqrt{5^2 - 4^2}}$$

$$2. \left(\frac{4}{5} + \frac{2}{15} \right)^2 + \frac{1}{6}$$

$$3. \text{Solve for } y: 2 - 5[2y + 4] - (-3y - 1) = -(y + 5)$$

$$4. \text{Solve for } a: 2a + b + c = A$$

5. Solve the inequality. Graph the solution set. Then write the solution in set-builder notation and in interval notation: $2x - 5(x + 1) < -x + 3$

6. The sum of two-thirds of a number and five equals the number. Find the number.

10. Perform the indicated operations:

$$2(x - 3) - (3x + 4)(3x - 4)$$

11. Perform the indicated operations:

$$\left(\frac{1}{2}c + 4 \right)^2$$

12. Divide:

$$\frac{14x^3y - 7x^2y^2 + 28xy^2}{7x^2y^2}$$

In Exercises 13–15, factor completely:

$$13. 6ax + 2bx - 3ay - by$$

$$14. m^4 - 81 \quad 15. 50c^2 + 40c + 8$$

$$16. \text{Solve for } x: 10x^2 = x + 2$$

APPLICATION INDEX

BIOLOGY/HEALTH/ LIFE SCIENCES

Admission to hospice program, 224
Age and systolic blood pressure, 107
AIDS cases in US by race and ethnicity,
158, 541, 586
AIDS cases in US by sex, 541
Average length of hospital stay, 519
Average number of doctor visits per
year, 665
Calories consumed daily, 254
Calories in a piece of cake, 560
Clients admitted to alcohol rehabilitation
program, 100–101
Fat content of ice-cream, 456
Fat content of popcorn, 460
Fat in oatmeal, 222
Height of plant, 643, 660
Height *versus* arm length, 519–520
Human heart pumping blood, 254
Mammography, 517–518
Maximum heart rate *versus* age, 223, 679
Number of times people work out, 570
Percentage of body fat, 201–203
Percentage of women who smoke, 509
Probability of cell mutation of *Escherichia coli*, 257

BUSINESS

Advertising costs, 641–642
Box office revenues for *Titanic* and *Star Wars*, 146–147
Candy/nut mixture, 570
Commission, 155, 159, 160, 218, 310
Converting currency, 220
Cost of mountain bike, 398
Cost of renting office space, 662
Cost of television commercials, 255
Craft shop making napkins, 234
Day care center, 219
Earnings *versus* time, 483–484
Employees at Wal-Mart and USPS, 255
Employees of government, 255
Fixed and variable costs of business, 514,
520–521
Fund-raising by selling calendars, 718
Hot dog concession stand, 220
Income for small company, 109–110
Median selling price of one-family houses,
508–509
Minimum-wage work force, 256

Natural food store selling tea, 570
Net income of Chrysler, 255
Net income of General Motors, 255
Pay for overtime, 476
Popcorn sales at movie theater, 106–107
Printing press, 448
Profit and loss record, 69
Profit of selling chocolate chip cookies, 385
Profit of selling lemonade, 196
Profit of selling sweet bread, 386
Rental car company, 196
Revenue for electric company, 208
Revenue for Hershey Food Corporation, 256
Revenue for IBM, 256
Revenue for Microsoft, 252
Revenue from selling CDs, 207
Sales for electric company, 208
Sales tax, 155–156, 158, 159, 160, 218
Selling pecan and cashew mix, 181
Selling raisin and granola mix, 181
Supply and demand, 589–590
Ticket sales, 172–173, 180, 295–296,
377–378, 729
Top world exporters, 256
Total pay *versus* number of hours
worked, 489
Wealth of Bill Gates, 254
Writing checks, 67, 68

CHEMISTRY

Mixing acid solution, 590, 663
Mixing alcohol solution, 565–566, 588
Mixing antifreeze solution, 569
Mixing disinfectant solution, 569
Mixing fertilizer, 182
Mixing insecticide, 182
Mixing plant food, 449

CONSTRUCTION

Area of glass window, 37
Area of wading pool, 697
Carpeting costs, 37, 406
Circumference of Buckingham
Fountain, 169
Fence, 37, 310
Garden, 449
Golden Gate Bridge, 121
Grass for front yard, 37
Height of building, 183

Height of light pole, 183
Ladder against house, 366, 525, 656
Painting wall, 37
Parking lot, 234
Patio, 219
Pyramid of Khufu, 169
Roof, 612
Sprinkler system, 697

CONSUMER APPLICATIONS

Automobile tire, 718
Baking holiday candy, 14
Bills, 183
Cereal for breakfast, 15
Coffee, 181
Comparison between cost of satellite dish
and cable, 590–591
Cooking oatmeal, 449
Cooking vegetable soup, 461
Cost of gasoline, 220–221
Cost of ice cream, 678
Cost of long distance phone calls, 221
Cost of movie tickets, 568
Cost of popcorn and drinks at movie
theater, 562–563
Cost of rental car, 500, 520, 551
Cost of renting videos and DVDs, 568
Cost of speeding ticket, 510
Cost of storage space rental, 520, 540–541
Cost of suit, 223
Cost of tapes and CDs, 568
Decorative jars for mixed nuts, 14
Depreciation of value of car, 207, 475–476
Depreciation of value of truck, 388
Discount on book, 218
Discount on clothing, 159, 196
Discount on geraniums, 219
Discount on wooden birdhouses, 196
Disposable diapers, 729
Electric bill, 516
Family budget, 25–26
Granola mixture, 181
Guarantee period for air-conditioning
unit, 376
Guarantee period for stereo system, 377
Guarantee period for truck battery, 370–371
Length of skirt, 15
Lottery jackpot, 255
Lottery ticket, 88
M&Ms, 182

Making holiday aprons, 14
 Mixed nuts, 181, 182
 Mortgage payments, 26
 Ordering shrimp, 15
 Phone bill, 500, 520
 Raffle tickets, 149, 180
 Raise, 23
 Sales tax on textbook, 25
 Saving for vacation, 25
 Saving from monthly pay, 14
 Servings of oatmeal per box, 14
 Sewing dress, 15
 Take-home pay, 14
 Tip at restaurant, 23, 25
 Total cost to rent water purification system, 550–551
 TV commercials, 570
 Water bill, 519
 Water in orange juice, 177–178
 Width of bed, 15

DISTANCE/SPEED

Airplane altitude *versus* horizontal ground distance, 293–294
 Distance, 131, 174–176, 214
 Distance a person can see to the horizon, 628
 Distance between Augusta and Nashville, 656
 Distance between Beijing and London, 441
 Distance between boats, 366
 Distance between Frankville and Clayton, 605
 Distance between Greensboro and Asheville, 605
 Distance between Jackson and Tupelo, 605
 Distance between Reno and Salinas, 604
 Distance between Spokane and Portland, 612
 Distance between St. Johns and Gander, 441
 Distance between Washington DC and Louisville, 604
 Distance of runway *versus* speed of plane, 724
 Distance of skydiver falling, 313
 Distance traveled by car and bus, 182, 193
 Distance traveled by car and truck, 656
 Distance traveled by cars, 181, 219
 Distance traveled by kayak, 601
 Distance traveled by plane, 181
 Speed of bikers, 222
 Speed of boat, 182
 Speed of boat and speed of current, 450, 569, 583–584, 588
 Speed of canoe, 182
 Speed of cars, 182, 456–457, 643
 Speed of motorist, 446–447, 450, 460
 Speed of plane, 182, 445–446, 450, 566–567, 569, 570

Speed of train, 450
 Time for bicycle ride, 398
 Time required to commute to work, 520

ENVIRONMENT

Altitude and temperature, 471–472
 Amoco Cadiz tanker disaster, 254
 Area of Greenland, 149
 Average daily temperature in January for cities, 518–519
 Average depth of Gulf of Mexico, 148
 Average temperature, 85
 Death Valley, 76
 Deepest point in Pacific Ocean, 149
 Distance between lightning strike and observer, 488–489
 Elevation of US cities, 52–53
 Hurricane Floyd, 528–529
 Hurricane Irene, 220
 Land area of Asia and Africa, 150
 Land area of Texas, 254
 Longest river in Africa, 148
 Masking tape over windows before hurricane, 605
 Mount Rainier National Park, 433
 Mt. Everest, 76, 150
 Rainfall for Bermuda, 220
 Rainfall in Miami, 195
 Rainfall in Tampa, 15
 Snow depth *versus* time, 465
 Snowfall in Burlington, 196
 Snowfall in Syracuse, 222
 Snowstorm, 310
 Speed of current, 449, 461, 462, 569, 583–584, 588
 Speed of wind, 450, 569, 570
 Temperatures for cities, 61, 68, 72, 76–77, 103–104, 107–108, 116, 117
 Tropical storm in Texas, 224
 Water flowing over Niagara Falls, 308
 Yellowstone National Park, 433

INVESTMENT

Annual rate of return on investment, 647, 650
 Compound interest, 232, 234, 304
 Piggy bank, 183, 387
 Price per share of stock, 104–105, 108–109, 118, 568
 Price per share of stock for Hershey Foods, 1
 Principal, 173–174, 180, 181, 213–214, 219, 222, 224, 563–565, 568–569, 570, 583–584, 588
 Simple interest, 156–157, 159, 173–174, 180, 213–214, 218

POLITICS

Composition of the House of Representatives by political party, 148
 Election, 182, 588
 Incorrectly marked ballots, 182

SCHOOL

Applicants accepted at Union College, 23
 Cost of advertising school play, 514
 Earning A in math class, 193
 Enrollment at community college, 25
 Enrollment in Catholic schools, 207
 Lighting at college, 570
 Memory devices, 63, 170
 Printing out book report, 14
 Ratio of men to women in chemistry class, 445
 Scores in math class, 194
 Scores in science class, 194
 Students earning money from recycling, 207
 Test score as a function of study time, 675–676

SCIENCE

Charles' law, 449
 Dinosaurs, 255
 Distance an object drops, 698
 Distance between Earth and Polaris, 729
 Distance between Earth and Sun, 255
 Distance between Mercury and Sun, 305
 Distance to Mars, 251
 Earth's orbit around the Sun, 305
 Height of ball, 259–260, 265, 288–289, 297, 365, 376, 384
 Height of object, 727
 Height of rock, 308, 372, 375
 Height of rock on Moon, 726
 Height of rocket, 294, 365, 376
 Height of stone, 360, 365
 Height of tree, 178–179, 451
 Object in free fall, 294–295, 678
 Speed of Space Shuttle, 406
 Total resistance, 434
 Velocity of object, 628, 643, 658

SPORTS

Area of volleyball court, 168
 Baskets by Cynthia Cooper, 590
 Baskets by Kareem Abdul-Jabbar, 570
 Baskets by Wilt Chamberlain, 569–570
 Batting average, 477

Concession stand at Arthur Ashe Tennis Center, 718
 Cost of tennis instruction, 520, 540
 Dimensions of tennis court, 386
 Distance between home plate and second base, 604
 Fishing, 730
 Football games, 68
 Golf outfit, 158
 Golf scores, 449, 550
 Height of baseball, 297–298
 Height of football, 678, 719
 Hiking, 661
 Hockey, 150, 222
 Horizontal position of baseball, 656, 659–660
 Horizontal position of golf ball, 619–620
 Horizontal position of long jumper, 620
 Indianapolis 500, 461, 592
 Perimeter of soccer field, 168–169
 Revenue for sports arena, 295–296
 Running back on football team, 67

Ryder Cup, 194
 Salary for baseball players, 217
 Shuffleboard, 71–72, 76
 Ski runs, 478–479
 Super Bowl, 218, 568
 Touchdowns scored by Jerry Rice, 587
 Triathlon, 660
 Velocity of football, 678–679
 Women's freestyle swimming, 529
 Women's golf, 53

STATISTICS/ DEMOGRAPHICS

Average time spent listening to radio, 512–513
 Average time spent reading newspapers, 519
 Average time spent watching TV, 476–477
 Height and age, 119

Median income for females in US, 487
 Median income for males in US, 484
 Mortality rate *versus* median education level, 729
 Number of Americans over 100 years old, 289–290
 Number of crimes *versus* year, 511–512
 Number of drug arrests, 524–525
 Number of female federal and state prisoners, 487
 Number of jail inmates by year, 516
 Number of male federal and state prisoners, 487
 Number of men *versus* women on police force, 560
 Number of property crimes, 527
 Number of robberies, 527
 Population of Alabama, 444
 Population of US colonies, 1700–1770, 107
 Poverty threshold, 107, 118
 Total consumer debt in auto loans, 527–528

TABLE OF CONTENTS

HELP YOURSELF	xi
KEY FEATURES	xv
APPLICATION INDEX	xix

chapter **R**

REFERENCE: FRACTIONS, DECIMALS, PERCENTS, GEOMETRY, AND STUDY SKILLS	1
R.1 Fractions	2
R.2 Decimals and Percents	16
R.3 Introduction to Geometry	26
R.4 Study Tips	41

chapter **1**

SET OF REAL NUMBERS	43
1.1 Sets of Numbers and the Real Number Line	44
1.2 Order of Operations	54
1.3 Addition of Real Numbers	64
1.4 Subtraction of Real Numbers	69
Chapter 1 Midchapter Review	77
1.5 Multiplication and Division of Real Numbers	78
1.6 Properties of Real Numbers and Simplifying Expressions	89
1.7 Connections to Graphing: Rectangular Coordinate System	100
Chapter 1 Summary	110
Chapter 1 Review Exercises	115
Chapter 1 Test	119

chapter **2**

LINEAR EQUATIONS AND INEQUALITIES	121
2.1 Addition, Subtraction, Multiplication, and Division Properties of Equality	122