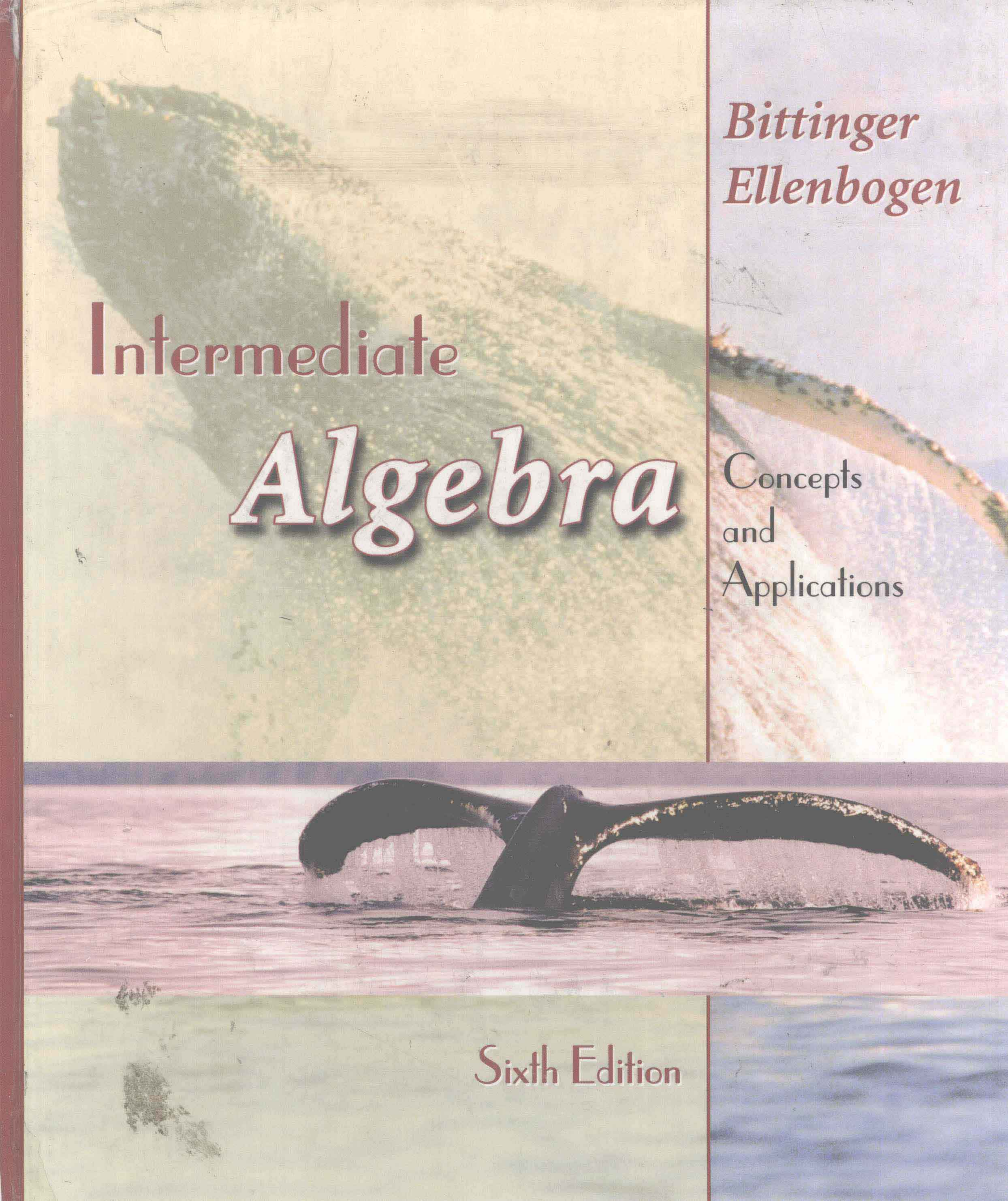
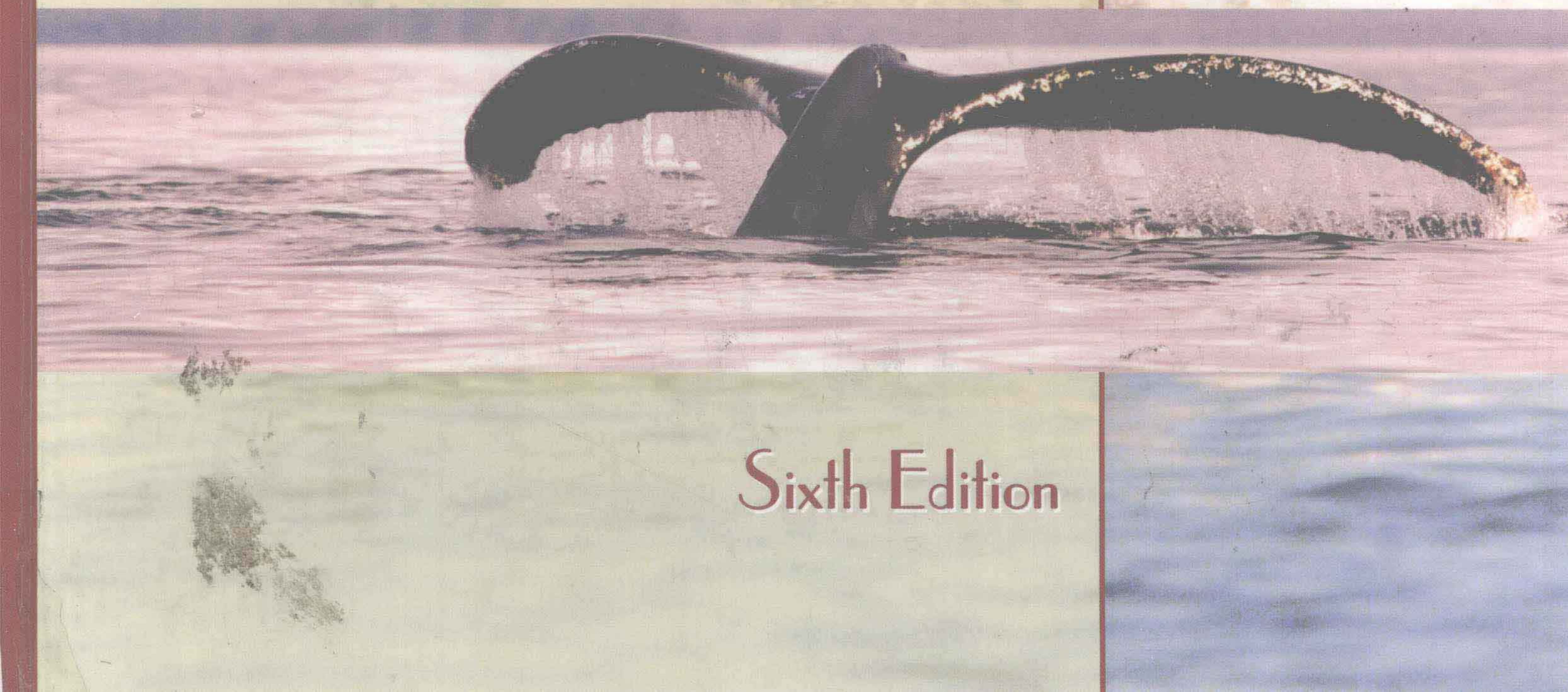




*Bittinger
Ellenbogen*

Intermediate
Algebra

Concepts
and
Applications



Sixth Edition

Intermediate Algebra

CONCEPTS AND APPLICATIONS

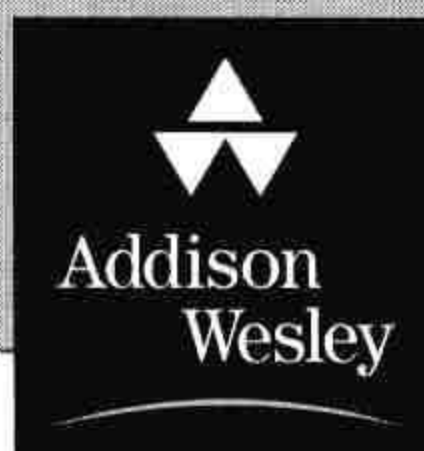
SIXTH EDITION

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Community College of Vermont



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Preface

We are pleased to present the sixth edition of *Intermediate Algebra: Concepts and Applications*. Each time we work on a new edition, it's a balancing act. On the one hand, we want to preserve the features, applications, and explanations that faculty have come to rely on and expect. On the other hand, we want to blend our own ideas for improvement with the many insights that we receive from faculty and students throughout North America. The result is a living document in which new features and applications are developed while successful features and popular applications from previous editions are updated and refined. Our goal, as always, is to present content that is easy to understand and has the depth required for success in this and future courses.

Appropriate for a one-term course in intermediate algebra, this text is intended for those students who have a firm background in elementary algebra. It is one of three texts in an algebra series that also includes *Elementary Algebra: Concepts and Applications*, Sixth Edition, by Bittinger/Ellenbogen and *Elementary and Intermediate Algebra: Concepts and Applications, A Combined Approach*, Third Edition, by Bittinger/Ellenbogen/Johnson.

Approach

Our goal, quite simply, is to help today's students both learn and retain mathematical concepts. To achieve this goal, we feel that we must prepare developmental-mathematics students for the transition from "skills-oriented" elementary and intermediate algebra courses to more "concept-oriented" college-level mathematics courses. This requires that we teach these same students critical thinking skills: to reason mathematically, to communicate mathematically, and to identify and solve mathematical problems. Following are some aspects of our approach that are used in this revision to help meet the challenges we all face teaching developmental mathematics.

Problem Solving

One distinguishing feature of our approach is our treatment of and emphasis on problem solving. We use problem solving and applications to motivate the material wherever possible, and we include real-life applications and problem-solving techniques throughout the text. Problem solving not only encourages students to think about how mathematics can be used, it helps to prepare them for more advanced material in future courses.

- In Chapter 1, we introduce the five-step process for solving problems: (1) Familiarize, (2) Translate, (3) Carry out, (4) Check, and (5) State the answer. These steps are then used consistently throughout the text whenever we encounter a problem-solving situation. Repeated use of this problem-solving strategy gives students a sense that they have a starting point for any type of problem they encounter, and frees them to focus on the mathematics necessary to successfully translate the problem situation. We often use estimation and carefully checked guesses to help with the Familiarize and Check steps (see pp. 33, 166, 373, and 524).

Applications

Interesting applications of mathematics help motivate both students and instructors. Solving applied problems gives students the opportunity to see their conceptual understanding put to use in a real way. In the Sixth Edition of *Intermediate Algebra: Concepts and Applications*, not only have we increased the total number of applications and real-data problems overall, nearly 20 percent of our applications are new, and we have increased the number of source lines to better highlight the real-world data. As in the past, art is integrated into the applications and exercises to aid the student in visualizing the mathematics. (See pp. 119, 128, 351, and 393.)

Pedagogy

New! Connecting the Concepts. To help students understand the “big picture,” Connecting the Concepts subsections within each chapter (and highlighted in the table of contents) relate the concept at hand to previously learned and upcoming concepts. Because students may occasionally “lose sight of the forest because of the trees,” we feel confident that this feature will help them keep better track of their bearings as they encounter new material. (See pp. 25, 172, 249, and 266.)

New! Study Tips. Most plentiful in the first three chapters when students are still establishing their study habits, Study Tips are found in the margins and interspersed throughout the first seven chapters. Our Study Tips range from how to approach assignments, to reminders of the various study aids that are available, to strategies for preparing for a final exam. (See pp. 93, 157, and 212.)

New! Aha! Exercises. Designated by *Aha!*, these exercises can be solved quickly if the student has the proper insight. The *Aha!* designation is used the first time a new insight can be used on a particular type of exercise and indicates to the student that there is a simpler way to complete the exercise that requires less lengthy computation. It's then up to the student to find the simpler approach and, in subsequent exercises, to determine if and when that particular insight can be used again. Occasionally the *Aha!* exercise is easily answered by looking at the preceding odd-numbered exercise. Our hope is that the *Aha!* exercises will discourage rote learning and reward students who “look before they leap” into a problem. (See pp. 122, 240, 285, 301, and 341.)

Technology Connections. Throughout each chapter, optional Technology Connection boxes help students use graphing calculator technology to better visualize a concept that they have just learned. To connect this feature to the exercise sets, certain exercises are marked with a graphing calculator icon and reinforce the use of this optional technology. (See pp. 94, 96, 120, 239, and 269.)

Skill Maintenance Exercises. Retaining mathematical skills is critical to a student's success in future courses. To this end, nearly every exercise set includes six to eight Skill Maintenance exercises that review skills and concepts from preceding chapters of the text. In this edition, not only have the Skill Maintenance exercises been increased by 50 percent, but they are now designed to provide extra practice with the specific skills needed for the very next section of the text. We also now list answers to both odd- and even-numbered Skill Maintenance exercises, along with their section references, in the answers at the back of the book. (See pp. 91, 158, 250, and 316.)

Synthesis Exercises. Following the Skill Maintenance section, each exercise set ends with a group of Synthesis exercises designated by their own heading. These exercises offer opportunities for students to synthesize skills and concepts from earlier sections with the present material, and often provide students with deeper insights into the current topic. Synthesis exercises are generally more challenging than those in the main body of the exercise set. (See pp. 150, 241, 435, and 442.)

Writing Exercises. In this edition, nearly every set of exercises includes at least four writing exercises. Two of these are more basic and appear just before the Skill Maintenance exercises. The other writing exercises are more challenging and appear as Synthesis exercises. All writing exercises are marked with  and require answers that are one or more complete sentences. This type of problem has been found to aid in student comprehension, critical thinking, and conceptualization. Because some instructors may collect answers to writing exercises, and because more than one answer may be correct, answers to writing exercises are not listed at the back of the text. (See pp. 231, 302, 342, and 351.)

Collaborative Corners. In today's professional world, teamwork is essential. We continue to provide optional Collaborative Corner features throughout the text that require students to work in groups to explore and solve mathematical problems. There are one to three Collaborative Corners per chapter, each one appearing after the appropriate exercise set. (See pp. 39, 223, 277, and 423.)

Cumulative Review. After Chapters 3, 6, 9, and 11, we have included a Cumulative Review, which reviews skills and concepts from preceding chapters of the text. (See pp. 207, 405, 615, and 699.)

What's New in the Sixth Edition?

We have rewritten many key topics in response to user and reviewer feedback and have made significant improvements in design, art, pedagogy, and an expanded supplements package. Detailed information about the content changes is available in the form of a conversion guide. Please ask your local Addison-Wesley sales consultant for more information. Following is a list of the major changes in this edition.

New Design

You will see that the page dimension for this edition is larger, which allows for an open look and a typeface that is easier to read. In addition, we continue to pay close attention to the pedagogical use of color to make sure that it is used to present concepts in the clearest possible manner.

Content Changes

A variety of content changes have been made throughout the text. Some of the more significant changes are listed below.

- Chapter 2 now includes a brief introduction to interpolation and extrapolation. The concept of slope is now closely linked with the idea of rate of change, beginning in Section 2.3.
- The topic of variation has been removed from Section 8.6 and moved into Section 6.8. As a result, Chapter 8 has been shortened to 9 sections.
- Chapter 7 has been rewritten so that Section 7.3 is now strictly on multiplying radical expressions. Section 7.4 is now strictly on division of radical expressions. Section 7.5 is now devoted to expressions with two or more radical terms.
- Chapter 9 now begins with Composite and Inverse Functions (formerly Section 9.2) and then moves to Exponential Functions (formerly Section 9.1). This makes for more flow of topics and facilitates coverage of Composite and Inverse Functions as a stand-alone topic if desired.

Supplements for the Instructor

New! Annotated Instructor's Edition

(ISBN 0-201-65873-9)

The *Annotated Instructor's Edition* includes all the answers to the exercise sets, usually right on the page where the exercises appear, and Teaching Tips in the margins that give insights and classroom discussion suggestions that will be especially useful for new instructors. These handy answers and ready Teaching Tips will help both new and experienced instructors save classroom preparation time.

New! MyMathLab

MyMathLab.com is a complete, on-line course for Addison-Wesley mathematics textbooks that integrates interactive, multimedia instruction correlated to the textbook content. MyMathLab can be easily customized to suit the needs of students and instructors and provides a comprehensive and efficient on-line course-management system that allows for diagnosis, assessment, and tracking of students' progress.

MyMathLab features the following:

- Fully interactive multimedia textbooks are built in CourseCompass, a version of Blackboard™ designed specifically for Addison-Wesley.
- Chapter and section folders from the textbook contain a wide range of instructional content: videos, software tools, audio clips, animations, and electronic supplements.
- Hyperlinks take you directly to on-line testing, diagnosis, tutorials, and gradebooks in MathXL—Addison-Wesley's tutorial and testing system for mathematics and statistics.
- Instructors can create, copy, edit, assign, and track all tests for their course as well as track student tutorial and testing performance.
- With push-button ease, instructors can remove, hide, or annotate Addison-Wesley preloaded content, add their own course documents, or change the order in which material is presented.
- Using the communication tools found in MyMathLab, instructors can hold on-line office hours, host a discussion board, create communication groups within their class, send e-mails, and maintain a course calendar.
- Print supplements are available on-line, side by side with their textbooks.

For more information, visit our Web site at www.mymathlab.com or contact your Addison-Wesley sales representative for a live demonstration.

Printed Test Bank/ Instructor's Resource Guide (ISBN 0-201-73490-7)

The Instructor's Resource Guide portion of this supplement contains the following:

- Extra practice problems and answers
- Black-line masters of grids and number lines for transparency masters or test preparation

- A videotape index and section cross-references to our tutorial software packages
- A syllabus conversion guide from the Fifth Edition to the Sixth Edition

The Printed Test Bank portion of this supplement contains the following:

- Six new alternate free-response test forms for each chapter, organized with the same topic order as the chapter tests in the main text. Each form includes synthesis questions, as appropriate, at the end of each test.
- Two new multiple-choice versions of each chapter test
- Eight new alternate test forms for the final examination: Alternate Test Forms A, B, and C of the final examinations are organized by chapter and D, E, and F are organized by problem type.
- Answers to all tests

Instructor's Solutions Manual

(ISBN 0-201-73489-3)

The *Instructor's Solutions Manual* contains fully worked-out solutions to the odd-numbered exercises and brief solutions to the even-numbered exercises in the exercise sets.

Answer Book

(ISBN 0-201-73727-2)

The *Answer Book* includes answers to all even-numbered and odd-numbered exercises.

TestGen-EQ/QuizMaster-EQ

(ISBN 0-201-73732-9)

Available on a dual-platform Windows/Macintosh CD-ROM, this fully networkable software enables instructors to build, edit, print, and administer tests using a computerized test bank of questions organized according to the contents of each chapter. Tests can be printed or saved for on-line testing via a network on the Web, and the software can generate a variety of grading reports for tests and quizzes.

InterAct Math Plus

(ISBN 0-201-72140-6)

Available to Windows users of *Intermediate Algebra: Concepts and Applications*, Sixth Edition, this networkable software provides course management and on-line administration for Addison-Wesley's InterAct Math Tutorial Software (see "Supplements for the Student"). InterAct Math Plus enables instructors to create and administer on-line tests, summarize students' results, and monitor students' progress in the tutorial software, providing an invaluable teaching and tracking resource.

InterAct MathXL: www.mathxl.com

(12-month registration ISBN 0-201-71111-7, stand-alone)

The MathXL Web site provides diagnostic testing and tutorial help, all on-line using InterAct Math[®] tutorial software and TestGen-EQ testing software. Students can take chapter tests correlated to the text, receive individualized study plans based on those test results, work practice problems and receive tutorial instruction for areas in which they need improvement, and take further tests to gauge their progress. Instructors can customize tests and track all student test results, study plans, and practice work.

Supplements for the Student**New! Web Site:** www.MyMathLab.com

Ideal for lecture-based, lab-based, and on-line courses, this state-of-the-art Web site provides students with a centralized point of access to the wide variety of on-line resources available with this text. The pages of the actual book are loaded into MyMathLab.com, and as students work through a section of the on-line text, they can link directly from the pages to supplementary resources (such as tutorial software, interactive animations, and audio and video clips) that provide instruction, exploration, and practice beyond what is offered in the printed book. MyMathLab.com generates personalized study plans for students and allows instructors to track all student work on tutorials, quizzes, and tests. Complete course-management capabilities, including a host of communication tools for course participants, are provided to create a user-friendly and interactive on-line learning environment.

Student's Solutions Manual

(ISBN 0-201-65874-7)

The *Student's Solutions Manual* by Judith A. Penna contains completely worked-out solutions with step-by-step annotations for all the odd-numbered exercises in the text, with the exception of the Writing exercises. This manual also lists, without complete solutions, the answers for even-numbered text exercises.

InterAct Math[®] Tutorial CD-ROM

(ISBN 0-201-74624-7)

This interactive tutorial software provides Windows users with algorithmically generated practice exercises that correlate at the objective level to the odd-numbered exercises in the text. Each practice exercise is accompanied by both an example and a guided solution designed to involve students in the solution process. Selected problems also include a video clip that helps students visualize concepts. The software recognizes common student errors and provides appropriate feedback. Instructors can use InterAct Math Plus course management software to create, administer, and track on-line tests and monitor student performance during practice sessions.

InterAct MathXL www.mathxl.com

(12-month registration ISBN 0-201-71630-5, stand-alone)

The MathXL Web site provides diagnostic testing and tutorial help, all on-line, using InterAct Math[®] tutorial software and TestGen-EQ testing software. Students can take chapter tests correlated to the text, receive individualized study plans based on those test results, work practice problems and receive tutorial instruction for areas in which they need improvement, and take further tests to gauge their progress.

Videotapes (ISBN 0-201-74209-8)

Developed and produced especially for this text, the videotapes feature an engaging team of instructors, including the authors. These instructors present material and concepts by using examples and exercises from every section of the text in a format that stresses student interaction.

Digital Video Tutor

(ISBN 0-201-74641-7, stand-alone)

The videotapes for this text are now available on CD-ROM, making it easy and convenient for students to watch video segments from a computer at home or on campus. The complete digitized video set, now affordable and portable for students, is ideal for distance learning or supplemental instruction.

AW Math Tutor Center

(ISBN 0-201-72170-8, stand-alone)

The AW Math Tutor Center is staffed by qualified mathematics instructors who provide students with tutoring on examples and odd-numbered exercises from the textbook. Tutoring is available via toll-free telephone, fax, or e-mail.

Acknowledgments

No book can be produced without a team of professionals who take pride in their work and are willing to put in long hours. Barbara Johnson, in particular, deserves special thanks for her work as development editor. Barbara's tireless devotion to all aspects of this project and her many fine suggestions have contributed immeasurably to the quality of this text. Laurie A. Hurley also deserves special thanks for her careful accuracy checks, well-thought-out suggestions, and uncanny eye for detail. Judy Penna's outstanding work in organizing and preparing the printed supplements and the indexes amounts to an inspection of the text that goes far beyond the call of duty and for which we will always be extremely grateful. Thanks to Tom Schicker for authoring the *Printed Test Bank*. Dawn Mulheron not only served as an accuracy checker, but was terrifically helpful in posting and double-checking the "catches" found by the checkers. Daphne Bell of Motlow State Community College, Cassidy Ferraro, and Donald Carlson provided enormous help, often in the face of great time pressure, as accuracy checkers. We are also indebted to Chris Burditt and Jann

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Martha Morong, of Quadrata, Inc., provided editorial and production services of the highest quality imaginable—she is simply a joy to work with. Geri Davis, of the Davis Group, Inc., performed superb work as designer, art editor, and photo researcher, and always with a disposition that can brighten an otherwise gray day. Network Graphics generated the graphs, charts, and many of the illustrations. Not only are the people at Network reliable, but they clearly take pride in their work. The many hand-drawn illustrations appear thanks to Jim Bryant, a gifted artist with true mathematical sensibilities. Tom and Pam Hansen, of Copy Ship Fax Plus, consistently went the extra yard in providing the best in copying services.

Our team at Addison-Wesley deserves special thanks. Assistant Editor Greg Erb coordinated all the reviews, tracked down countless pieces of information, and managed many of the day-to-day details—always in a pleasant and reliable manner. Executive Project Manager Kari Heen expertly provided a steadying influence along with gentle prodding at just the right moments. Senior Acquisitions Editor Jenny Crum provided many fine suggestions along with unflagging support. Senior Production Supervisor Kathy Manley exhibited patience when others would have shown frustration. Designer Dennis Schaefer's willingness to listen and then creatively respond resulted in a book that is beautiful to look at. Marketing Manager Dona Kenly skillfully kept us in touch with the needs of faculty; Executive Technology Producer Lorie Reilly provided us with the technological guidance so necessary for our many supplements; and Media Producer Tricia Mescall remains the steady hand responsible for our fine video series. Our publisher, Jason Jordan, deserves credit for assembling this fine team and remaining accessible to us on both a professional and personal level. To all of these people we owe a real debt of gratitude.

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Finally, a special thank you to all those who so generously agreed to discuss their professional use of mathematics in our chapter openers. These dedicated people, none of whom we knew prior to writing this text, all share a desire to make math more meaningful to students. We cannot imagine a finer set of role models.

M.L.B.
D.J.E.

Feature Walkthrough



AN APPLICATION

More and more Americans are making their travel arrangements using the Internet. The number of on-line travel buyers has grown from 48 million in 1999 to approximately 60 million in 2001 (Source: Travel Industry Association of America). Find the rate at which this number is growing.

This problem appears as Example 10 in Section 2.3.

2 Graphs, Functions, and Linear Equations

- 2.1 Graphs
- 2.2 Functions
- 2.3 Linear Functions: Slope, Graphs, and Models
- 2.4 Another Look at Linear Graphs
- 2.5 Other Equations of Lines
 - Connecting the Concepts*
- 2.6 The Algebra of Functions
 - Summary and Review*
 - Test*

I use math in many different ways. Initially, I must estimate the hours and cost of the project for my customer. During development, I use math to create pages, frames, tables, automation objects, and graphics.



TAMMY GROSS
Webmaster
Indianapolis, IN

CHAPTER OPENERS

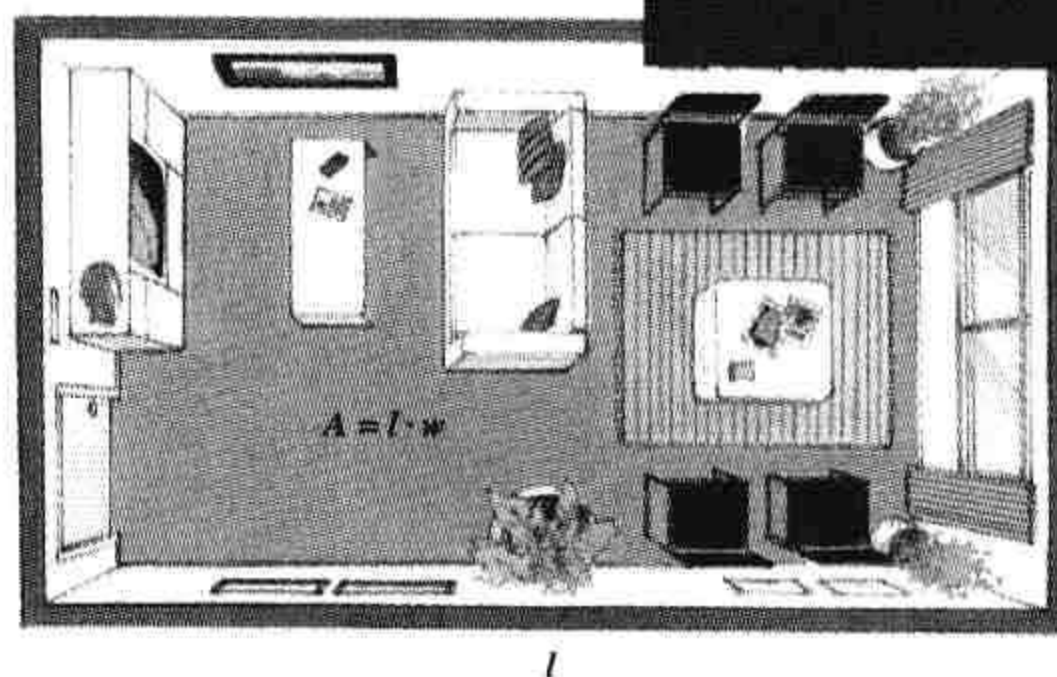
Each chapter opens with a list of the sections covered and a real-life application that includes a testimonial from a person in that field to show how integral mathematics is in problem solving. Real data are often used in these applications, as well as in many other exercises, and in “on the job” examples (like those students might find in the workplace) to increase student interest.

Teaching Tip

If students struggle with solving formulas, you may wish to substitute numbers first. For example, in $A = lw$, if the area is 200 ft² and the width is 10 ft, what is the length?

Solving Formulas

Suppose we remember the area and the width and want to find the length. To do so, we could use the formula (Area = Length · Width) for l , using the same numbers.



ANNOTATED INSTRUCTOR'S EDITION

A new *Annotated Instructor's Edition* provides both new and experienced instructors with helpful, timesaving classroom-preparation tools. In addition to including the answers to the exercise sets right on the page where the exercises appear, this special edition incorporates Teaching Tips that give new content insights and classroom discussion suggestions. These tips will save preparation time for each class and provide guidance for new instructors.

NEW!

STUDY TIPS

Study Tips can be found throughout the first seven chapters of the text to help students develop sound study habits and to remind them to use the extra tutorial resources that are available.

NEW!

Study Tip

The AW Math Tutor Center provides free tutoring to students using this text. Assisted by qualified mathematics instructors via telephone, fax, or e-mail, you can receive live tutoring on examples and exercises. For more information on the AW Math Tutor Center, see the "To the Student" portion of the preface.

Negative Integers as Exponents

Later in this text we will explain what numbers are. Until then, integer exponents will suffice.

To develop a definition for negative exponents, we proceed in two ways. First we proceed as in arithmetic:

$$\begin{aligned}\frac{5^3}{5^7} &= \frac{5 \cdot 5 \cdot 5}{5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5} = \frac{5 \cdot 5 \cdot 5 \cdot 1}{5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5} \\ &= \frac{5 \cdot 5 \cdot 5}{5 \cdot 5 \cdot 5} \cdot \frac{1}{5 \cdot 5 \cdot 5 \cdot 5} \\ &= \frac{1}{5^4}.\end{aligned}$$

Were we to apply the quotient rule, we would have

$$\frac{5^3}{5^7} = 5^{3-7} = 5^{-4}.$$

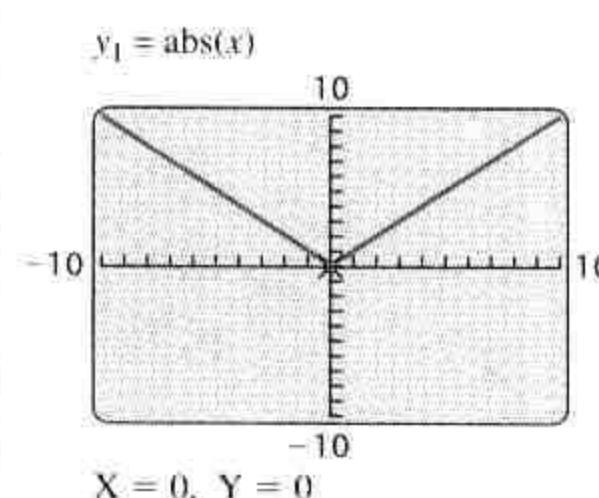
These two expressions for $5^3/5^7$ suggest that

$$5^{-4} = \frac{1}{5^4}.$$

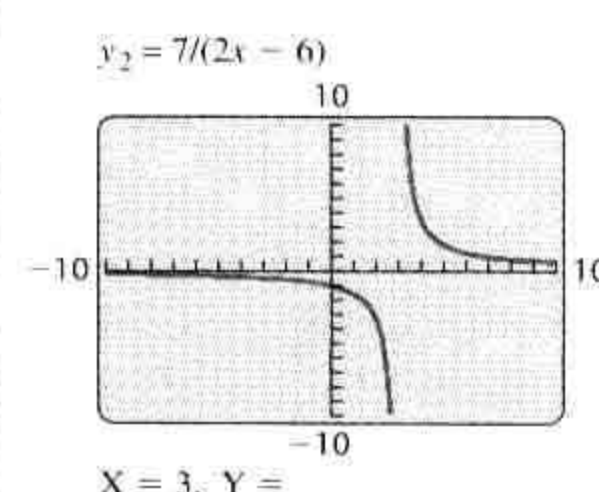
This leads to the definition of negative exponents.



To visualize Example 6, note that the graph of $y_1 = |x|$ (which is entered $y_1 = \text{abs}(x)$, using the NUM option of the MATH menu) appears without interruption for any piece of the x -axis that we examine.



In contrast, the graph of $y_2 = \frac{7}{2x-6}$ has a break at $x = 3$.



a) $f(x) = |x|$

b) $f(x) = \frac{7}{2x-6}$

Solution

a) We ask ourselves, "Is there any number x for which we cannot compute $|x|$?" Since we can find the absolute value of *any* number, the answer is no. Thus the domain of f is $\mathbb{R}$, the set of all real numbers.

b) Is there any number x for which $\frac{7}{2x-6}$ cannot be computed? Since $\frac{7}{2x-6}$ cannot be computed when $2x-6$ is 0, the answer is yes. To determine what x -value causes the denominator to be 0, we solve an equation:

$$\begin{aligned}2x - 6 &= 0 && \text{Setting the denominator equal to 0} \\ 2x &= 6 && \text{Adding 6 to both sides} \\ x &= 3. && \text{Dividing both sides by 2}\end{aligned}$$

Thus, 3 is *not* in the domain of f , whereas all other real numbers are. The domain of f is $\{x \mid x \text{ is a real number and } x \neq 3\}$.

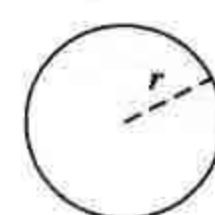
Applications: Interpolation and Extrapolation

Function notation is often used in formulas. For example, the area A of a circle is a function of its radius r , instead of

$$A = \pi r^2,$$

we can write

$$A(r) = \pi r^2.$$



When a function is given as a graph in a problem-solving situation, we are often asked to determine certain quantities on the basis of the graph. Later in this text, we will develop models that can be used for calculations. For now we simply use the graph to estimate the coordinates of an unknown point by using other points with known coordinates. When the unknown point is *between* the known points, this process is called **interpolation**. If the unknown point extends *beyond* the known points, the process is called **extrapolation**.

TECHNOLOGY CONNECTION FEATURE

Optional Technology Connections appear throughout each chapter to help students visualize, through the use of technology, a concept that they have just learned. This feature is reinforced in many exercise sets through exercises marked with a graphing calculator icon.

CORNER

Reduce, Reuse, and Recycle

Focus: Inequalities and problem solving**Time:** 15–20 minutes**Group size:** 2

In the United States, the amount of solid waste (rubbish) being recycled is slowly catching up to the amount being generated. In 1991, each person generated, on average, 4.3 lb of solid waste every day, of which 0.8 lb was recycled. In 2000, each person generated, on average, 4.4 lb of solid waste, of which 1.3 lb was recycled.

(Sources: U.S. Census 2000 and EPA Municipal Solid Waste Factbook)

ACTIVITY

Assume that the amount of solid waste being generated and the amount recycled are both increasing linearly. One group member should find a linear function w for which $w(t)$ represents the number of pounds of waste generated per person per day t years after 1991. The other group member should find a linear function r for which $r(t)$ represents the number of pounds recycled per person per day t years after 1991. Finally, working together, the group should determine those years for which the amount recycled will meet or exceed the amount generated.

COLLABORATIVE CORNER FEATURE

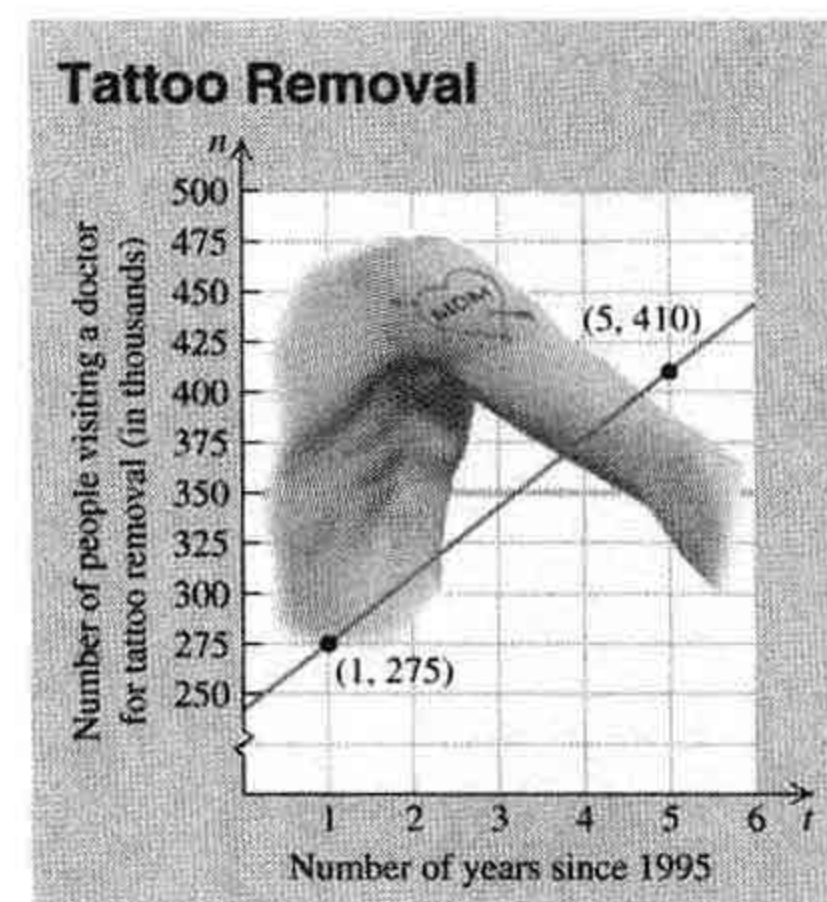
A popular feature from the previous edition, optional Collaborative Corners are inserted throughout the text. Collaborative Corners give students the opportunity to work as a group to solve problems or to perform specially designed activities. There are two or three Collaborative Corners per chapter, each one appearing after the appropriate exercise set.

Example 3

Tattoo removal. In 1996, an estimated 275,000 Americans visited a doctor for tattoo removal. That figure was expected to grow to 410,000 in 2000 (Source: Mike Meyers; staff writer, Star-Tribune Newspaper of the Twin Cities Minneapolis–St. Paul, copyright 2000). Assuming constant growth since 1995, how many people will visit a doctor for tattoo removal in 2005?

Solution

- Familiarize.** Constant growth indicates a constant rate of change, so a linear relationship can be assumed. If we let n represent the number of people, in thousands, who visit a doctor for tattoo removal and t the number of years since 1995, we can form the pairs (1, 275) and (5, 410). After choosing suitable scales on the two axes, we draw the graph. Note that the jagged “break” on the vertical axis is used to avoid including a large portion of unused grid.



- Translate.** To find an equation relating n and t , we first find the slope of the line. This corresponds to the *growth rate*:

$$\begin{aligned} m &= \frac{410 \text{ thousand people} - 275 \text{ thousand people}}{5 \text{ years} - 1 \text{ year}} \\ &= \frac{135 \text{ thousand people}}{4 \text{ years}} \\ &= 33.75 \text{ thousand people per year.} \end{aligned}$$

Next, we use the point-slope equation and solve for n :

$$\begin{aligned} n - 275 &= 33.75(t - 1) && \text{Writing point-slope form} \\ n - 275 &= 33.75t - 33.75 && \text{Using the distributive law} \\ n &= 33.75t + 241.25 && \text{Adding 275 to both sides} \end{aligned}$$

- Carry out.** Using function notation, we have

$$n(t) = 33.75t + 241.25.$$

REAL-DATA APPLICATIONS

Applications have always been a strength of this text, and now the authors bring you even more of a good thing. This edition includes 20% new application and real-data problems, along with an increase in the total number of applications overall.

CONNECTING THE CONCEPTS

Let's briefly summarize our work up to this point in the text: After a review of the basics of algebra and problem solving in Chapter 1, we turned our attention in Chapter 2 to equations in two variables for which graphs are used to represent the solution sets. Graphs also enabled us to visualize the solutions of systems of equations in Chapter 3. In Chapter 4, we continued finding solutions, but this time our work included absolute-value functions and inequalities.

Here in Chapter 5, we will take a break from solving equations and inequalities and concentrate on finding equivalent expressions. Our work with equivalent expressions will ultimately allow us to solve a new type of equation at the end of this chapter.

Chapters 6 and 7 will follow a similar pattern: After learning new ways of writing equivalent expressions, we will learn to solve new types of equations toward the end of each chapter.

NEW!

CONNECTING THE CONCEPTS

This feature highlights the importance of connecting concepts and invites students to pause and check that they understand the “big picture.” This helps assure that students understand how concepts work together in several sections at once. For example, students are alerted to shifts made from solving equations to writing equivalent expressions. The pacing of this feature helps students increase their comprehension and maximize their retention of key concepts.

NEW!

AHA! EXERCISES

In many exercise sets, students will see a new icon, *Aha!*. This icon indicates to students that there is a simpler way to complete the exercise without going through a lengthy computation. It's then up to the student to discover that simpler approach. The *Aha!* icon appears the first time a new insight can be used on a particular type of exercise. After that, it's up to the student to determine if and when that particular insight can be reused.

SYNTHESIS EXERCISES

Synthesis exercises in this new edition guarantee an extensive and wide-ranging variety of problems in every exercise set. The Synthesis exercises allow students to combine concepts from more than one section and provide challenge for even the strongest students. Mixed in with these problems are occasional *Aha!* exercises (described above).

EXERCISES

47. $(2x^3 - 3y^2)^2$ 48. $(3s^2 + 4t^3)^2$
49. $(a^2b^2 + 1)^2$ 50. $(x^2y - xy^2)^2$
51. Let $P(x) = 4x - 1$. Find $P(x) \cdot P(x)$.
52. Let $Q(x) = 3x^2 + 1$. Find $Q(x) \cdot Q(x)$.
53. Let $F(x) = 2x - \frac{1}{3}$. Find $[F(x)]^2$.
54. Let $G(x) = 5x - \frac{1}{2}$. Find $[G(x)]^2$.

Multiply.

55. $(c + 2)(c - 2)$ 56. $(x - 3)(x + 3)$
57. $(4x + 1)(4x - 1)$ 58. $(3 - 2x)(3 + 2x)$
59. $(3m - 2n)(3m + 2n)$ 60. $(3x + 5y)(3x - 5y)$
61. $(x^3 + yz)(x^3 - yz)$
62. $(4a^3 + 5ab)(4a^3 - 5ab)$
63. $(-mn + m^2)(mn + m^2)$
64. $(-3b + a^2)(3b + a^2)$
65. $(x + 1)(x - 1)(x^2 + 1)$
66. $(y - 2)(y + 2)(y^2 + 4)$
67. $(a - b)(a + b)(a^2 - b^2)$
68. $(2x - y)(2x + y)(4x^2 - y^2)$
69. $(a + b + 1)(a + b - 1)$
70. $(m + n + 2)(m + n - 2)$
71. $(2x + 3y + 4)(2x + 3y - 4)$
72. $(3a - 2b + c)(3a - 2b - c)$

73. *Compounding interest.* Suppose that P dollars is invested in a savings account at interest rate i , compounded annually, for 2 yr. The amount A in the account after 2 yr is given by

$$A = P(1 + i)^2.$$

Find an equivalent expression for A .

74. *Compounding interest.* Suppose that P dollars is invested in a savings account at interest rate i , compounded semiannually, for 1 yr. The amount A in the account after 1 yr is given by

$$A = P\left(1 + \frac{i}{2}\right)^2.$$

Find an equivalent expression for A .

75. Given $f(x) = x^2 + 5$, find and simplify.
a) $f(t - 1)$
b) $f(a + h) - f(a)$
c) $f(a) - f(a - h)$

76. Given $f(x) = x^2 + 7$, find and simplify.
a) $f(p + 1)$
b) $f(a + h) - f(a)$
c) $f(a) - f(a - h)$
77. Find two binomials whose product is $x^2 - 25$ and explain how you decided on those two binomials.
78. Find two binomials whose product is $x^2 - 6x + 9$ and explain how you decided on those two binomials.

SKILL MAINTENANCE

Solve.

79. $ab + ac = d$, for a
80. $xy + yz = w$, for y
81. $mn + m = p$, for m
82. $rs + s = t$, for s
83. *Value of coins.* There are 50 dimes in a roll of dimes, 40 nickels in a roll of nickels, and 40 quarters in a roll of quarters. Kacie has 13 rolls of coins, which have a total value of \$89. There are three more rolls of dimes than nickels. How many of each type of roll does she have?
84. *Wages.* Takako worked a total of 17 days last month at her father's restaurant. She earned \$50 a day during the week and \$60 a day during the weekend. Last month Takako earned \$940. How many weekdays did she work?

SYNTHESIS

85. We have seen that $(a - b)(a + b) = a^2 - b^2$. Explain how this result can be used to develop a fast way of multiplying $95 \cdot 105$.
86. A student incorrectly claims that since $2x^2 \cdot 2x^2 = 4x^4$, it follows that $5x^3 \cdot 5x^5 = 25x^{25}$. What mistake is the student making?

Multiply. Assume that variables in exponents represent natural numbers.

87. $[(-x^a y^b)^4]^a$
88. $(z^{m^2} n^3)(z^{4n^3})^{n^2}$
89. $(a^4 b^2)^{\frac{1}{2}} (\frac{1}{2} a^{3x} b)^2$
90. $(a^4 b^y)^{w+z}$
91. $y^3 z^n (y^{3n} z^3 - 4yz^{2n})$

WRITING EXERCISES

Writing exercises, indicated by , provide opportunities for students to answer problems with one or more sentences. Often, these questions have more than one correct response and ask students to explain *why* a certain concept works as it does. In this new edition, two Writing exercises now precede the Skill Maintenance exercises, indicating that they are somewhat less challenging than those that follow the Skill Maintenance exercises. This allows for Writing exercises to be assigned to a wider cross section of the student body.

SKILL MAINTENANCE EXERCISES

As in the past, Skill Maintenance exercises appear in all exercise sets as a means of keeping past concepts fresh and previously covered skills sharp. Two changes to the Skill Maintenance exercises now improve this already popular feature: The number has been increased nearly 50% and they are now designed to provide extra practice with the specific skills needed for the very next section of the text.