Elementary and Intermediate Algebra

A Combined Course

THIRD EDITION

ANNOTATED EDITION



Larson Hostetler

Instructor's Annotated Edition

Elementary and Intermediate Algebra

A Combined Course

Third Edition

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We have included examples and exercises that use real-life data as well as technology output from a variety of software. This would not have been possible without the help of many people and organizations. Our wholehearted thanks go to all for their time and effort.

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A Word from the Authors

Welcome to *Elementary and Intermediate Algebra: A Combined Course*, Third Edition. In this revision, we have continued to focus on developing students' proficiency and conceptual understanding of algebra. We hope you enjoy the Third Edition.

In response to suggestions from elementary and intermediate algebra instructors, we have revised and reorganized the coverage of topics for the Third Edition. We combined the content of the first two chapters of the previous edition and streamlined them into Chapter 1 "The Real Number System" for the Third Edition. To improve the flow of the material, the business applications have been incorporated into Section 3.4 "Ratios and Proportions." "Geometric and Scientific Applications" is now Section 3.5. Compound inequalities and set notation are now introduced in Section 3.6 "Linear Inequalities." And a new section, "Absolute Value Equations and Inequalities," has been added to Chapter 3. In order to be more efficient and to improve the flow of the text, Chapter 4, which previously introduced the coordinate plane and graphs of equations, now includes Section 4.3 "Relations, Functions, and Graphs," Section 4.4 "Slope and Graphs of Linear Equations," Section 4.5 "Equations of Lines," and Section 4.6 "Graphs of Linear Inequalities." "Systems of Equations" has been moved forward to Chapter 7. "Variation" is now covered in Chapter 8 "Rational Expressions, Equations and Functions." And finally, "Graphs of Quadratic Functions" now appears in Chapter 10 "Quadratic Equations and Inequalities."

In order to address the diverse needs and abilities of students, we offer a straightforward approach to the presentation of difficult concepts. In the Third Edition, the emphasis is on helping students learn a variety of techniques—symbolic, numeric, and visual—for solving problems. We are committed to providing students with a successful and meaningful course of study.

Our approach begins with Motivating the Chapter, a new feature that introduces each chapter. These multipart problems are designed to show students the relevance of algebra to the world around them. Each Motivating the Chapter feature is a real-life application that requires students to apply the concepts of the chapter in order to solve each part of the problem. Problem-solving and critical thinking skills are emphasized here and throughout the text in applications that appear in the examples and exercise sets.

To improve the usefulness of the text as a study tool, we added Objectives, which highlight the main concepts that students will learn throughout the section. Each objective is restated in the margin at the point where the concept is introduced, to help keep students focused as they read the section. The Chapter Summary was revised for the Third Edition to make it a more comprehensive and effective study tool. It now highlights the important mathematical vocabulary (Key Terms) and primary concepts (Key Concepts) of the chapter. For easy reference, the Key Terms are correlated to the chapter by page number and the Key Concepts by section number.

As students proceed through each chapter they have many opportunities to assess their understanding. They can check their progress after each section with the Exercise sets (which are correlated to Examples in the section), midway through the chapter with the Mid-Chapter Quiz, and at the end of the chapter with the Review Exercises (which are correlated to the sections) and the Chapter Test. The exercises and test items were carefully chosen and graded in difficulty to allow students to gain confidence as they progress. In addition, students can assess their understanding of previously learned concepts through the Integrated Review exercises that precede the section exercise sets and the Cumulative Tests that follow Chapters 3, 6, 9, and 12.

In the Third Edition, we combined the Technology and Discovery features of the Second Edition. Technology Tips provide point-of-use instructions for using a graphing utility. Technology Discovery features encourage students to explore mathematical concepts with graphing utilities and scientific calculators. Both are highlighted and can easily be omitted without loss of continuity in coverage of material.

To show students the practical uses of algebra, we highlight the connections between the mathematical concepts and the real world in the multitude of applications found throughout the text. We believe that students can overcome their difficulties in mathematics if they are encouraged and supported throughout the learning process. Too often, students become frustrated and lose interest in the material when they cannot follow the text. With this in mind, every effort has been made to write a readable text that can be understood by every student. We hope that your students find our approach engaging and effective.

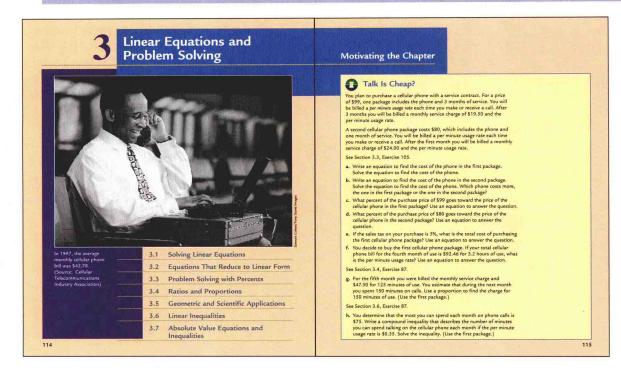
Ron Larson

Robert P. Hostetler

For Larson

Robert & Hosteller

Features



Chapter Opener New

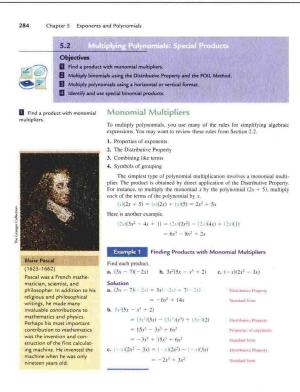
Every chapter opens with *Motivating the Chapter*. Each of these multipart problems incorporates the concepts presented in the chapter in the context of a single real-world application. *Motivating the Chapter* problems are correlated to sections and exercises and can be assigned as students work through the chapter or can be assigned as individual or group projects. The icon the identifies an exercise that relates back to *Motivating the Chapter*.

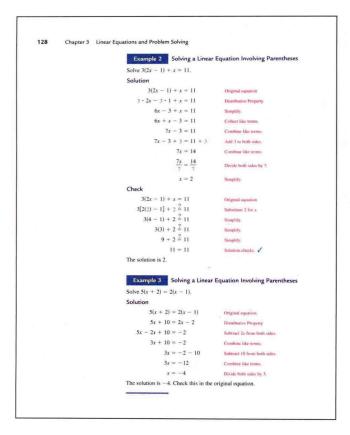
Section Opener New

Every section begins with a list of learning objectives. Each objective is restated in the margin at the point where it is covered.

Historical Note

Historical notes featuring mathematicians or mathematical artifacts are included throughout the text.



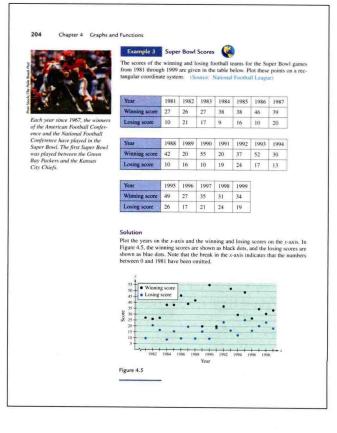


Applications

A wide variety of real-life applications are integrated throughout the text in examples and exercises. These applications demonstrate the relevance of algebra in the real world. Many of the applications use current, real data. The icon indicates an example involving a real-life application.

Examples

Each example was carefully chosen to illustrate a particular mathematical concept or problem-solving technique. The examples cover a wide variety of problems and are titled for easy reference. Many examples include detailed, step-by-step solutions with side comments, which explain the key steps of the solution process.



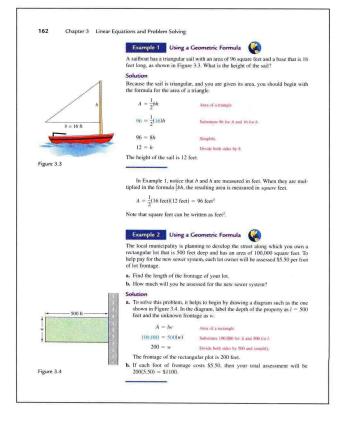


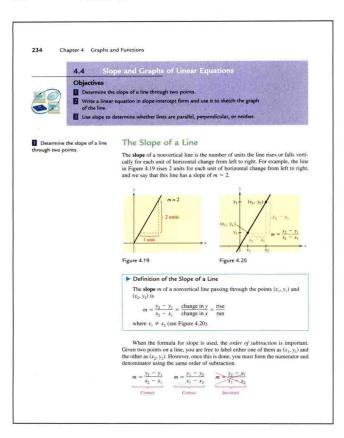
Geometry

Coverage and integration of geometry in examples and exercises have been enhanced throughout the Third Edition.

Problem Solving

This text provides many opportunities for students to sharpen their problem-solving skills. In both the examples and the exercises, students are asked to apply verbal, numerical, analytical, and graphical approaches to problem-solving. In the spirit of the AMATYC and NCTM standards, students are taught a five-step strategy for solving applied problems, which begins with constructing a verbal model and ends with checking the answer.





Definitions and Rules

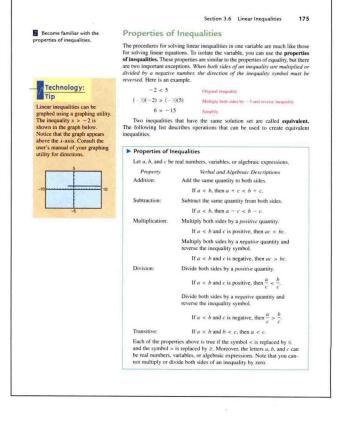
All important definitions, rules, formulas, properties, and summaries of solution methods are highlighted for emphasis. Each of these features is also titled for easy reference.

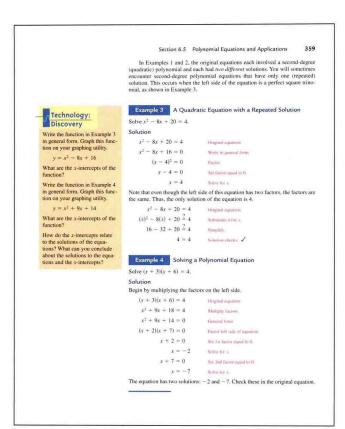
Graphics

Visualization is a critical problem-solving skill. To encourage the development of this skill, students are shown how to use graphs to reinforce algebraic and numeric solutions and to interpret data. The numerous figures in examples and exercises throughout the text were computer generated for accuracy.

Technology Tips

Point-of-use instructions for using graphing utilities appear in the margins. They provide convenient reference for students using graphing technology. In addition, they encourage the use of graphing technology as a tool for visualization of mathematical concepts, for verification of other solution methods, and for facilitation of computations. The *Technology Tips* can easily be omitted without loss of continuity in coverage.





Technology Discovery

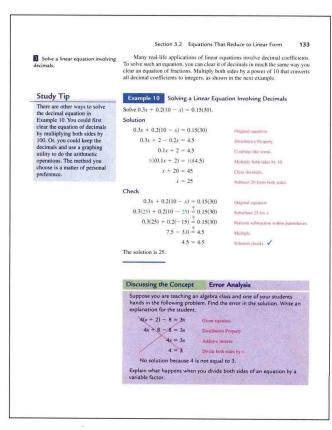
Utilizing the power of technology (scientific calculator and graphing utility), *Technology Discovery* invites students to engage in active exploration of mathematical concepts and discovery of mathematical relationships. These activities encourage students to use their critical thinking skills and help them develop an intuitive understanding of theoretical concepts. *Technology Discovery* features can easily be omitted without loss of continuity in coverage.

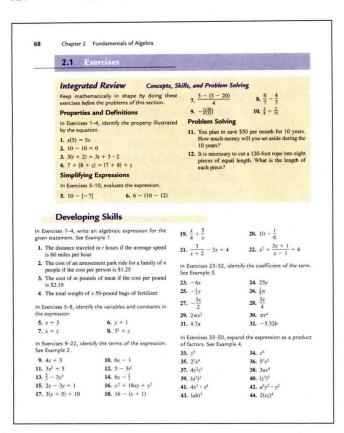
Study Tips

Study Tips offer students specific point-of-use suggestions for studying algebra, as well as pointing out common errors and discussing alternative solution methods. They appear in the margins.

Discussing the Concept

Each section concludes with a *Discussing the Concept* feature. Designed as a section wrap-up activity to give students an opportunity to think, talk, and write about mathematics, each of these activities encourages students to synthesize the mathematical concepts presented in the section. *Discussing the Concept* can be assigned as an independent or collaborative activity or can be used as a basis for a class discussion.





Integrated Review

Each exercise set (except in Chapter 1) is preceded by *Integrated Review* exercises. These exercises are designed to help students keep up with concepts and skills learned in previous chapters. Answers to all *Integrated Review* problems are given in the back of the book.

Exercises

The exercise sets have been reorganized in the Third Edition. Each exercise set is grouped into three categories: *Developing Skills, Solving Problems*, and *Explaining Concepts*. The exercise sets offer a diverse variety of computational, conceptual, and applied problems to accomodate many teaching and learning styles. Designed to build competence, skill, and understanding, each exercise set is graded in difficulty to allow students to gain confidence as they progress. Detailed solutions to all odd-numbered exercises are given in the *Student Solutions Guide*, and answers to all odd-numbered exercises are given in the back of the book.

- 61. Organizing Data With an initial cost of \$5000, a company will produce x units at \$35 per unit. Write an equation that relates the total cost of producing x units to the number of units produced. Plot the cost for producing 100, 150, 200, 250, and 300 units.
- 62. Organizing Data An employee earns \$10 plus \$0.50 for every x units produced per hour. Write an equation that relates the employee's total hourly wage to the number of units produced. Plot the hourly wage for producing 2, 5, 8, 10, and 20 units per hour.
- 63. Organizing Data The table gives the normal temperature y (in degrees Fahrenheit) for Anchorage. Alaska for each month x of the year. The months are numbered 1 through 12, with x = 1 corresponding to January. (Source: National Oceanic and Atmospheric Administration)

x	1	2	3	4	5	6
y	13	18	24	35	46	54
×	7	8	9	10	11	12
y	58	56	48	35	22	14

- (a) Plot the data given in the table.
- (b) Did you use the same scale on both axes? Explain.
- (c) Using the graph, find the three consecutive months when the normal temperature changes the least.
- 64. Organizing Data The table gives the speed of a car x (in kilometers per hour) and the approximate stopping distance y (in meters).

x	50	70	90	110	130
y	20	35	60	95	148

- (a) Plot the data given in the table.
- (b) The x-coordinates increase at equal increments of 20 kilometers per hour. Describe the pattern for the y-coordinates. What are the implications for the driver?
- 65. Graphical Interpretation The table gives the numbers of hours x that a student studied for five different algebra exams and the resulting scores y.

*	3.5	1	8	4.5	0.5
y	72	67	95	81	53

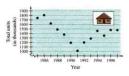
Section 4.1 Ordered Pairs and Graphs

- (a) Plot the data given in the table.
- (b) Use the graph to describe the relationship between the number of hours studied and the resulting exam score.
- Graphical Interpretation The table gives the net income y per share of common stock of the H. J. Heinz Company for the years 1988 through 1997. The year is represented by x. (Source H. J. Heinz Company 1997 Annual Report)

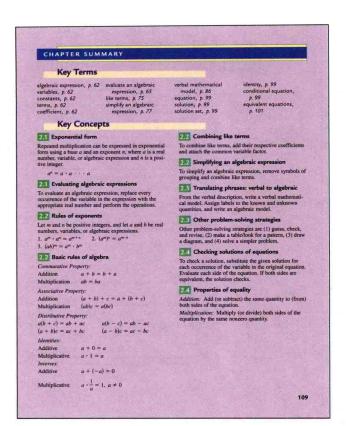
x.	1988	1989	1990	1991	1992
y	\$0.97	\$1.11	\$1.26	\$1.42	\$1.60
x	1993	1994	1995	1996	1997
y	\$1.02	\$1.57	\$1.59	\$1.75	\$0.81

- (a) Plot the data given in the table.
- (b) Use the graph to find the year that had the greatest increase and the year that had the greatest decrease in the income per share.

Graphical Estimation In Exercises 67-70, use the scatter plot showing new privately-owned housing unit starts (in thousands) in the United States from 1985 through 1997. (Source: U.S. Bureau of the Census)



- 67. Estimate the number of new housing starts in 1986.
- 68. Estimate the number of new housing starts in 1991.
- Estimate the increase and the percent increase in housing starts from 1993 to 1994.
- Estimate the decrease and the percent decrease in housing starts from 1994 to 1995.

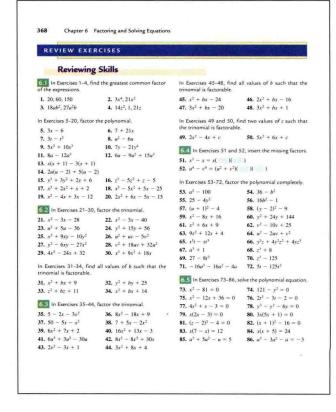


Chapter Summary

The *Chapter Summary* has been completely revised in the Third Edition. Designed to be an effective study tool for students preparing for exams, it highlights the *Key Terms* (referenced by page) and the *Key Concepts* (referenced by section) presented in the chapter.

Review Exercises

The Review Exercises at the end of each chapter have been reorganized in the Third Edition. They are grouped into two categories: Reviewing Skills and Solving Problems. Exercises in Reviewing Skills are correlated to sections in the chapter. The Review Exercises offer students additional practice in preparation for exams. Answers to all odd-numbered exercises are given in the back of the book.



Mid-Chapter Ouiz

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Mid-Chapter Quiz



Take this quiz as you would take a quiz in class. After you are done, check your work against the answers given in the back of the book

- 1. Plot the points (4, -2) and $(-1, -\frac{5}{2})$ on a rectangular coordinate system.
- 2. Determine the quadrants in which the points (x, 5) must be located. (x is a)real number.)
- 3. Decide whether the ordered pairs are solutions of the equation y = 9 |x|. (a) (2, 7) (b) (-3, 12) (c) (-9, 0)
- The scatter plot at the left shows the average number (in millions) of shares traded per day on the New York Stock Exchange for the years 1991 through 1997. Estimate the average number of shares traded per day for each year from 1991 to 1997. (So

8. y = 5 - 2x

12. y = 1 - |x|

In Exercises 5 and 6, find the x- and y-intercepts of the graph of the equation.

5. x - 3y = 12

6. y = 6 - 4x

In Exercises 7-12, graph the equation. 7. y = x - 1

11. y = |x + 3|

13. Does the table below represent y as a function of x? Explain.



14. Does the graph at the left represent v as a function of x? Explain.

In Exercises 15 and 16, evaluate the function at the given values of x and t. **15.** f(x) = 3x - 2 (a) f(-2) (b) f(0) (c) f(5) (d) $f(-\frac{1}{3})$ **16.** $g(t) = 2t^2 - |t|$ (a) g(-2) (b) g(2) (c) g(0) (d) $g(-\frac{1}{2})$

- 17. Find the range of $f(x) = x^2 x$ for the domain $D = \{-2, -1, 0, 1, 2\}$.
- 18. Find the domain for the area of a square with side s. $(A = s^2)$
- **19.** Use a graphing utility to graph $h(x) = 3x^2 4x 7$. Graphically estimate the intercepts of the graph. Explain how to verify your estimates algebraically.
- 20. A new computer system sells for approximately \$3000 and depreciates at the rate of \$500 per year for 4 years. Write the value V of the computer as a function of time t in years. What is the domain of the function? Graph the function over its domain.

Chapter Test

0 1 2 1 0

Take this test as you would take a test in class. After you are done, check your work against the answers given in the back of the book.

- 1. Plot the points (-1, 2), (1, 4), and (2, -1) on a rectangular coordinate stem. Connect the points with line segments to form a right triangle
- 2. Which ordered pairs are solutions of y = |x| + |x 2|?
- (a) (0, -2) (b) (0, 2) (c) (-4, 10) (d) (-2, -2) 3. What is the y-coordinate of any point on the x-axis?
- 4. Find the x- and y-intercepts of the graph of 3x 4y + 12 = 0.
- 5. Does the table at the left represent v as a function of x? Explain your
- 6. Does the graph at the left represent y as a function of x? Explain. 7. Evaluate $f(x) = x^3 - 2x^2$ at the indicated values

(a)
$$f(0)$$
 (b) $f(2)$ (c) $f(-2)$ (d) $f(\frac{1}{2})$

- 8. Find the slope of the line passing through the points (-5, 0) and $(2, \frac{3}{2})$.
- A line with slope m = -2 passes through the point (-3, 4). Find two
 additional points on the line. (The problem has many correct answers.)
- 10. Find the slope of a line perpendicular to the line 3x 5y + 2 = 0.

In Exercises 11-14, graph the equation.

11.
$$x - 2y = 6$$

$$2y = 6$$
 12. $y = \frac{1}{4}$

13.
$$y = |x + 2|$$

14.
$$y = (x - 3)^2$$

15. Find an equation of the line that passes through the point (0, 6) with slope $m = -\frac{3}{8}$

16. Which points are solutions of the inequality $3x + 5y \le 16$? (a) (2, 2) (b) (6, -1) (c) (-2, 4) (d) (7, -1)

In Exercises 17-20, graph the inequality.

17. $y \ge -2$

19. $x \ge 2$ **20.** $y \le 5$

21. The sales y of a product are modeled by y = 230x + 5000, where x is time in years. Interpret the meaning of the slope in this model.

Mid-Chapter Quiz

Each chapter contains a Mid-Chapter Quiz. This feature allows students to perform a selfassessment midway through the chapter. Answers to all questions in the Mid-Chapter Quiz are given in the back of the book.

Chapter Test

Each chapter ends with a Chapter Test. This feature allows students to perform a self-assessment at the end of the chapter. Answers to all questions in the Chapter Test are given in the back of the book.

Cumulative Test

The Cumulative Tests that follow Chapters 3, 6, 9, and 12 provide a comprehensive self-assessment tool that helps students check their mastery of previously covered material. Answers to all questions in the Cumulative Tests are given in the back of the book.

Cumulative Test: Chapters 1-3

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Chapter Test

Cumulative Test: Chapters 1-3

Take this test as you would take a test in class. After you are done, check your work against the answers given in the back of the book.

1. Place the correct symbol (< or >) between the numbers: $-\frac{3}{4}$ $\left| -\frac{2}{4} \right|$

In Exercises 2-7, evaluate the expression.

2.
$$(-200)(2)(-3)$$
 3. $\frac{3}{8} - \frac{5}{6}$ 5. $-(-2)^3$ 6. $3 + 2$

3.
$$\frac{3}{8} - \frac{5}{6}$$

6. $3 + 2(6) - 1$

$$4. \quad -\frac{2}{9} \div \frac{8}{75}$$
6) -1
$$7. \quad 24 + 12 + 3$$

In Exercises 8 and 9, evaluate the expression when x = -2 and y = 3.

8. $2x + y^2$

9.
$$4y - r^3$$

- 10. Use exponential form to write the product $3 \cdot (x + y) \cdot (x + y) \cdot 3 \cdot 3$.
- 11. Use the Distributive Property to expand -2x(x-3).
- 12. Identify the rule of algebra illustrated by 2 + (3 + x) = (2 + 3) + x.

In Exercises 13-15, simplify the expression

13. (3x3)(5x4)

15. $2x^2 - 3x + 5x^2 - (2 + 3x)$

In Exercises 16-18, solve the equation and check your solution.

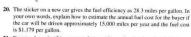
16. 12x - 3 = 7x + 27

17. $2x - \frac{5x}{4} = 13$

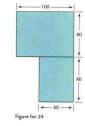
18. 2(x-3)+3=12-x

19. Solve and graph the inequality

$$-1 \le \frac{x+3}{2} < 2.$$



- 21. Express the ratio "24 ounces to 2 pounds" as a fraction in reduced form. 22. The sum of two consecutive even integers is 494. Find the two numbers
- 23. The suggested retail price of a camcorder is \$1150. The camcorder is on sale for "20% off" the list price. Find the sale price.
- 24. The figure at the left shows two pieces of property. The assessed values of the properties are proportional to their areas. The value of the larger piece is \$95,000. What is the value of the smaller piece?



Supplements

Elementary and Intermediate Algebra: A Combined Course, Third Edition, by Larson and Hostetler is accompanied by a comprehensive supplements package, which includes resources for both students and instructors. All items are keyed to the text.

Printed Resources

For the Student

Study and Solutions Guide by Carolyn Neptune, Johnson County Community College, and Gerry C. Fitch, Louisiana State University (0-395-97646-4)

- Detailed, step-by-step solutions to all Integrated Review exercises and to all odd-numbered exercises in the section exercise sets and in the review exercises
- Detailed, step-by-step solutions to all Mid-Chapter Quiz, Chapter Test, and Cumulative Test questions

Graphing Calculator Keystroke Guide by Benjamin N. Levy and Laurel Technical Services (0-395-87777-6)

- Keystroke instructions for the following graphing calculators: (Texas Instruments) *TI-80*, *TI-81*, *TI-82*, *TI-83*, *TI-85*, and *TI-92*; (Casio) *fx-7700GE*, *fx-9700GE*, and *CFX-9800G*; (Hewlett Packard) *HP-38G*; and (Sharp) *EL-9200/9300*
- · Examples with step-by-step solutions
- · Extensive graphics screen output
- · Technology tips

For the Instructor

Instructor's Annotated Edition

(0-395-97644-8)

- Includes entire student edition
- Instructor's answer section, which includes answers to all even-numbered exercises, Technology Discovery boxes, Technology Tip boxes, and Discussing the Concept activities
- Annotations at point of use that offer strategies and suggestions for teaching the course and point out common student errors

Test Item File and Instructor's Resource Guide by Cheryl A. Leech, The Pennsylvania State University, The Behrend College, and Ann R. Kraus, The Pennsylvania State University, The Behrend College (0-395-97643-X)

- Printed test bank with approximately 3300 test items, coded by level of difficulty
- Technology required test items, coded for easy reference
- · Chapter test forms with answer key
- · Two final exams
- · Transparency masters

- Notes to the instructor, which include information on standardized tests such
 as the Texas Academic Skills Program (TASP), the Florida College Level
 Academic Skills Test (CLAST), and the California State University Entry Level
 Mathematics (ELM) Exam. A list of skills covered by the test and the corresponding sections in the text where the topics are covered are also provided.
- · Alternative assessment strategies

Media Resources

For Students and Instructors

Web Site (www.hmco.com)

Contains, but is not limited to, the following student and instructor resources:

- Study guide (for students), which includes section summaries, additional examples with solutions, and starter exercises with answers
- · Chapter projects and additional real-life applications
- · Geometry review
- ACE Algebra Tutor
- · Graphing calculator programs
- · Math Matters and Career Interviews

HM³ Tutor

(Instructor's version Windows: 0-618-04208-3)

This networkable, interactive tutorial software offers the following features:

- Algorithmically generated practice and quiz problems
- A variety of multiple-choice and free-response questions, varying in degree of difficulty
- · Animated examples and interactivity within lessons
- · Hints and full solutions available for every problem
- Integrated classroom management system (for instructors), which includes a syllabus builder and the capability to track and report student performance
- Non-networkable student version (Windows: 0-395-97656-1)

For the Student

Videotape Series by Dana Mosely

(0-395-97659-6)

- · Comprehensive section-by-section coverage
- Detailed explanations of important concepts
- Numerous examples and applications, often illustrated via computer-generated animations
- · Discussion of study skills

For the Instructor

Computerized Test Bank

(Windows: 0-395-97654-5; Macintosh: 0-395-97655-3)

- Test-generating software for IBM and Macintosh computers
- · Approximately 3300 test items
- Also available as a printed test bank

Acknowledgments

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Third Edition Reviewers

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On a personal level, we are grateful to our wives, Deanna Gilbert Larson and Eloise Hostetler, for their love, patience, and support. Also, a special thanks goes to R. Scott O'Neil.

If you have suggestions for improving this text, please feel free to write to us. Over the past two decades we have received many useful comments from both instructors and students, and we value these comments very much.

Ron Larson Robert P. Hostetler

How to Study Algebra

Your success in algebra depends on your active participation both in class and outside of class. Because the material you learn each day builds on the material you learned previously, it is important that you keep up with the course work every day and develop a clear plan of study. To help you learn how to study algebra, we have prepared a set of guidelines that highlight key study strategies.

Preparing for Class

The syllabus your instructor provides is an invaluable resource that outlines the major topics to be covered in the course. Use it to help you prepare. As a general rule, you should set aside two to four hours of study time for each hour spent in class. Being prepared is the first step toward success in algebra. Before class.

- Before class.
 Review your notes from the previous class.
 Read the portion of the text that will be covered in class.
 Use the objectives listed at the beginning of each section to keep you focused on the main ideas of the section.
 Pay special attention to the definitions, rules, and concepts highlighted in boxes. Also, be sure you understand the meanings of mathematical symbols and terms written in boldface type. Keep a vocabulary journal for easy reference.
- ☐ Read through the solved examples. Use the side comments given in the solution steps to help you follow the solution process. Also, read the *Study Tips* given in the margins.
- ☐ Make notes of anything you do not understand as you read through the text. If you still do not understand after your instructor covers the topic in question, ask questions before your instructor moves on to a new topic.
- ☐ If you are using technology in this course, read the *Technology Tips* and try the *Technology Discovery* exercises.

Keeping Up

Another important step toward success in algebra involves your ability to keep up with the work. It is very easy to fall behind, especially if you miss a class. To keep up with the course work, be sure to

- ☐ Attend every class. Bring your text, a notebook, and a pen or pencil. If you miss a class, get the notes from a classmate as soon as possible and review them carefully.
- ☐ Take notes in class. After class, read through your notes and add explanations so that your notes make sense to *you*.
- ☐ Reread the portion of your text that was covered in class. This time, work each example *before* reading through the solution.