# Intermediate ALGEBRA

## THE LANGUAGE AND SYMBOLISM OF MATHEMATICS

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# Intermediate ALGEBRA

## THE LANGUAGE AND SYMBOLISM OF MATHEMATICS

**James W. Hall**
*Parkland College*

**Brian A. Mercer**
*Parkland College*

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INTERMEDIATE ALGEBRA: THE LANGUAGE AND SYMBOLISM OF MATHEMATICS

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# About the Authors

**JAMES W. HALL** is a retired professor and chair from the mathematics department at Parkland College in Champaign, Illinois. He started teaching mathematics in 1969 at Northern Arizona University and also taught at Clayton State College in Georgia prior to joining Parkland College in 1975. From 1989 to 1990 he taught at Dandenong College in Victoria, Australia. He received a B.S. and an M.A. in mathematics from Eastern Illinois University and an Ed.D. from Oklahoma State University. He was Midwest Regional Vice President of AMATYC (American Mathematical Association of Two-Year Colleges) from 1987 to 1989 and President of IMACC (Illinois Mathematics Association of Community Colleges) from 1995 to 1996. In 1978 he edited the "Report on Microcomputers in the Classroom" for ICTM (Illinois Council of Teachers of Mathematics), and from 1991 to 1995 he was chairperson of the editorial review committee for AMATYC. He also is a writing team chair for Beyond Crossroads. This is his seventeenth mathematics textbook.

**BRIAN A. MERCER** is an associate professor of mathematics at Parkland College in Champaign, Illinois. Before starting at Parkland College in 1998, he taught at Neoga High School from 1994 to 1995 and at Lakeland College from 1997 to 1998. He received a B.S. in mathematics from Eastern Illinois University and an M.S. in mathematics from Southern Illinois University. He is a member of AMATYC, NADE (National Association for Developmental Education), and has served as a board member of IMACC.

# Preface

*The Universe is a grand book which cannot be read until one first learns to comprehend the language and become familiar with the characters in which it is composed. It is written in the language of mathematics.*

*—Galileo*

*Intermediate Algebra: The Language and Symbolism of Mathematics* was written to implement the learning standards of the American Mathematical Association of Two-Year Colleges (AMATYC), as outlined in *Beyond Crossroads.* These standards were used as guiding principles to organize the topics and to give strong support to teachers using the text. The book's organization and pedagogy are designed to work for students with a variety for learning styles and for teachers with varied experiences and backgrounds. As an example of this organization, functions are introduced early, and most of the chapters in the book follow a similar structure, each treating a specific family of functions.

The inclusion of multiple perspectives—verbal, numerical, algebraic, and graphical—has proven popular with a broad cross section of students. Calculator Perspectives help students to visualize mathematics and to see the relationship between algebraic symbols and graphs. The specific instructions provided for the TI-84 Plus calculator also eliminate the need for instructors to create separate keystroke handouts.

## I. TEACHING APPROACH

- Emphasis on the Rule of Four and Multiple Perspectives
  The "rule of four" suggests that concepts should be examined algebraically (symbolically), numerically, graphically, and verbally. Reviewers of the manuscript were very pleased that we integrated multiple perspectives throughout the book. We use multiple perspectives not only in examples and exercises, but also in definitions and exposition. Our experience leads us to believe that students who use the rule of four develop a deeper understanding of the concepts they study. They are less likely to memorize steps, they are more likely to retain the material they understand, and they are more likely to apply mathematics outside the classroom. (See AMATYC Standard for Intellectual Development: Linking Multiple Representations.)

- Technology Is Built-In, Not Added-On
  Topics that once were postponed until many manipulative skills had been developed can now be considered earlier by using technology to focus on concepts instead of computation. The use of a graphing calculator is demonstrated throughout the book. The students' use of technology enables them to examine realistic problems such as producing the payment schedule for a car loan. Together, realistic applications and the use of calculators facilitate the development of modeling skills by the students. Technology is woven throughout the text—it is not simply inserted into a standard presentation. (See AMATYC Standard for Intellectual Development: Using Technology.)

- Functions
  Functions are introduced early in the second chapter, and families of functions are used to outline the topics for most of the chapters in this book. Chapters on polynomial, quadratic, rational, radical, and exponential functions start with a section that covers the properties of the graphs of these functions. For those wanting to apply these functions to realistic data, curve fitting for linear, quadratic, and exponential functions is covered in Sections 2.7, 6.1, and 9.7 respectively. Properties of functions are examined further in Chapter 10 in a preview of college algebra. (See AMATYC Standard for Content: Function)



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- Mathematical Modeling and Word Equations
  The residual value of mathematics—the mathematics that students can still use four or more years after taking a course—is not a collection of tricks or memorized steps. What endures is an understanding that allows students to see mathematics as useful in improving their daily lives. Most people encounter mathematics through words, either orally or in writing, not through equations. Word equations help students bridge the gap between the statement of a word problem and the formation of an algebraic equation that models the problem. Students must model real problems in a course if we expect them to use mathematics on their own. To that end, the text presents many realistic examples and exercises involving data (see the Index of Applications). (See AMATYC Standards for Intellectual Development: Modeling and for Content: Symbolism and Algebra.)

- Factoring
  Factoring is developed gradually with a strong emphasis on the role of the distributive property in establishing the connection between multiplying polynomials and factoring polynomials.

- Using Systems of Equations
  Word problems that involve two unknowns are solved in Chapter 3 using two variables rather than one variable. This approach has been received well by the students who often have more trouble identifying two unknowns using one variable than using a separate variable for each unknown. This approach also received favorable feedback from teachers who class-tested the manuscript. Later in the book we examine alternate approaches that build on creating functional models and the relation of one variable to another.

- Using Discrete Data
  The book includes problems that give the students experience with discrete data. Students will develop a better perspective on mathematical models, especially those who will use Intermediate Algebra as their prerequisite to an Introductory Statistics course. (See AMATYC Standards for Content: Continuous and Discrete Models and Data Analysis, Statistics, and Probability.)

- Using the Language and Symbolism of Mathematics
  Each exercise set starts with a few questions on the language and symbolism of mathematics. One benefit of assigning these exercises that we have noted in our classes is that the students spend more time reading the book before starting the other exercises. (See AMATYC Standards for Intellectual Development: Communicating and for Content: Symbolism and Algebra.)

## II. HIGHLIGHTS

- Geometrical Problems
  Examples and exercises based on geometrical shapes are placed throughout the textbook. Many exercise sets have problems involving perimeter, area, and volume. (See AMATYC Standards for Content: Geometry and Measurement.)

- Design of Exercises
  Many exercises are composed of multiple parts to help the students face common misconceptions about the language and symbolism of mathematics. A few examples are:

| | |
|---|---|
| Exercise 1.4, #21 | **a.** Simplify $(6 + 4)^2$. |
| | **b.** Simplify $6^2 + 4^2$. |
| Exercise 5.4, #29 | **a.** Expand $x(x + 4) + 2(x + 4)$. |
| | **b.** Factor $x(x + 4) + 2(x + 4)$. |
| Exercise 5.7, #55 | **a.** Solve $(5m - 3)(m - 2) = 0$. |
| | **b.** Simplify $(5m - 3)(m - 2)$. |

## SUPPLEMENTS FOR THE INSTRUCTOR

### Instructor's Edition *ISBN-13: 978-0-07-256087-9 (ISBN-10: 0-07-256087-8)*

The Instructor's Edition (IE) contains answers to problems and exercises in the text, including answers to all Language and Symbolism of Mathematics vocabulary questions, all end-of-section exercises, all end-of-chapter review exercises, and all end-of-chapter mastery tests.

### Instructor's Solutions Manual *ISBN-13: 978-0-07-256089-3 (ISBN-10: 0-07-256089-4)*

The Instructor's Solutions Manual, prepared by Mark Smith of College of Lake County, provides comprehensive **worked-out solutions** to exercises in the text.

### Lecture Guide *ISBN-13: 978-0-07-322169-4 (ISBN-10: 0-07-322169-4)*

This supplement, prepared by Kelly Bails of Parkland College, provides instructors with the framework of day-by-day class activities for each section in the book. Each lecture guide can help instructors make more efficient use of class time and can help keep students focused on active learning. Students who use the lecture guides have the framework of well-organized notes that can be completed with the instructor in class.

### Instructor's Testing and Resource CD-ROM *ISBN-13: 978-0-07-256088-6 (ISBN-10: 0-07-256088-6)*

This cross-platform CD-ROM provides a wealth of resources for the instructor. Among the supplements featured on the CD-ROM is a **computerized test bank** utilizing Brownstone Diploma® algorithm-based testing software to quickly create customized exams. This user-friendly program enables instructors to search for questions by topic, format, or difficulty level; to edit existing questions or to add new ones; and to scramble questions and answer keys for multiple versions of a single test. Hundreds of text-specific open-ended and multiple-choice questions are included in the question bank. Sample chapter tests, midterms, and final exams in Microsoft Word® and PDF formats are also provided.

### Video Lectures on Digital Video Disk (DVD) *ISBN-13: 978-0-07-256092-3 (ISBN-10: 0-07-256092-4)*

In the videos, the authors, James Hall and Brian Mercer, work through selected problems from the text book, following the solution methodology employed in the text. The video series is available on DVD or online as an assignable element of MathZone (see next). The DVDs are closed-captioned for the hearing impaired, subtitled in Spanish, and meet the Americans with Disabilities Act Standards for Accessible Design. Instructors may use them as resources in a learning center, for online courses, and/or to provide additional help to students who require extra practice.

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### ALEKS

**ALEKS** (**A**ssessment and **LE**arning in **K**nowledge **S**paces) is an artificial intelligence-based system for mathematics learning, available over the web 24/7. Using unique adaptive questioning, ALEKS accurately assesses what topics each student knows and then determines exactly what each student is ready to learn next. ALEKS interacts with the students much as a skilled human tutor would, moving between explanation and practice as needed, correcting and analyzing errors, defining terms and changing topics on request, and helping them master the course content more quickly and easily. Moreover, the new ALEKS 3.0 now links to text-specific videos, multimedia tutorials, and text book pages in PDF format. ALEKS also offers a robust classroom management system that allows instructors to monitor and direct student progress toward mastery of curricular goals. See www.highed.aleks.com.

## SUPPLEMENTS FOR THE STUDENT

### Student's Solutions Manual *ISBN-13: 978-0-07-283090-3 (ISBN-10: 0-07-283090-5)*

The Student's Solutions Manual, provided by Mark Smith of College of Lake County, provides comprehensive, **worked-out solutions** to odd-numbered exercises. The steps shown in solutions match the style of solved examples in the textbook.

### Lecture Guide *ISBN-13: 978-0-07-322169-4 (ISBN-10: 0-07-322169-4)*

This supplement, prepared by Kelly Bails of Parkland College, provides instructors with the framework of day-by-day class activities for each section in the book. Each lecture guide can help instructors make more efficient use of class time and can help keep students focused on active learning. Students who use the lecture guides have the famework of well-organized notes that can be completed with the instructor in class.

### MathZone—www.mathzone.com

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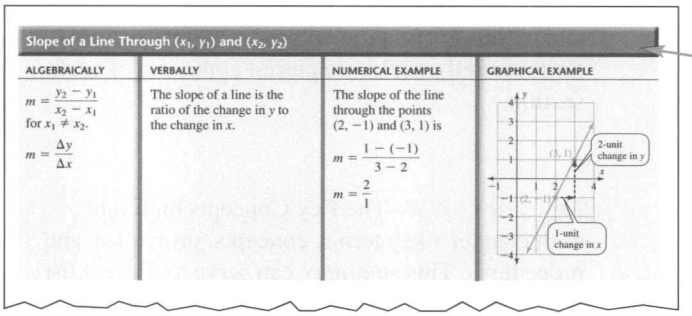
# Walk-Through

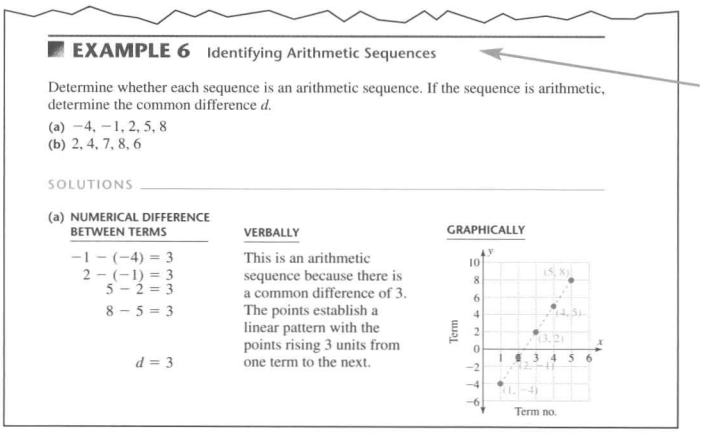


**Slope of a Line Through $(x_1, y_1)$ and $(x_2, y_2)$**

| ALGEBRAICALLY | VERBALLY | NUMERICAL EXAMPLE | GRAPHICAL EXAMPLE |
|---|---|---|---|
| $m = \frac{y_2 - y_1}{x_2 - x_1}$ for $x_1 \neq x_2$. $m = \frac{\Delta y}{\Delta x}$ | The slope of a line is the ratio of the change in $y$ to the change in $x$. | The slope of the line through the points $(2, -1)$ and $(3, 1)$ is $m = \frac{1 - (-1)}{3 - 2}$ $m = \frac{2}{1}$ | 2-unit change in $y$; 1-unit change in $x$ |

## Tools for Learning

**Multiple Perspective boxes**—Demonstrating concepts in multiple perspectives— algebraically (symbolically), numerically, graphically, and verbally—helps students develop a deeper understanding of mathematics.



**EXAMPLE 6** Identifying Arithmetic Sequences

Determine whether each sequence is an arithmetic sequence. If the sequence is arithmetic, determine the common difference $d$.

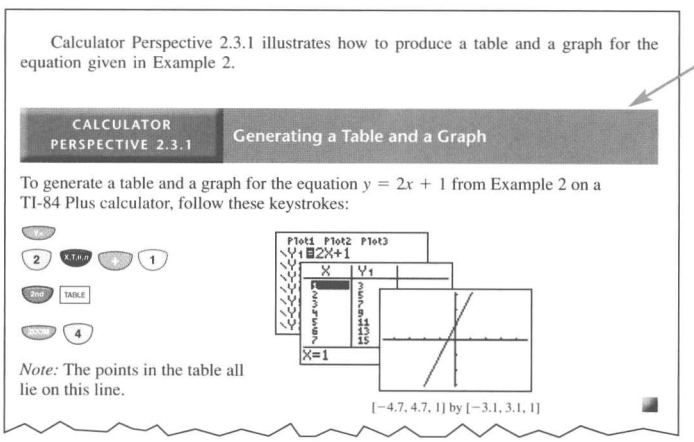
(a) $-4, -1, 2, 5, 8$
(b) $2, 4, 7, 8, 6$

SOLUTIONS

(a)

| NUMERICAL DIFFERENCE BETWEEN TERMS | VERBALLY | GRAPHICALLY |
|---|---|---|
| $-1 - (-4) = 3$ $2 - (-1) = 3$ $5 - 2 = 3$ $8 - 5 = 3$ $d = 3$ | This is an arithmetic sequence because there is a common difference of 3. The points establish a linear pattern with the points rising 3 units from one term to the next. | Term; Term no. |

**Examples**—Each chapter includes many worked examples. These examples advance skills, develop concepts, connect concepts, and show application of concepts. Many examples are presented using multiple perspectives. These problems are worked in the same format students should use and have explanations horizontally aligned with the steps.



Calculator Perspective 2.3.1 illustrates how to produce a table and a graph for the equation given in Example 2.

**CALCULATOR PERSPECTIVE 2.3.1** Generating a Table and a Graph

To generate a table and a graph for the equation $y = 2x + 1$ from Example 2 on a TI-84 Plus calculator, follow these keystrokes:

Y= 2 X,T,θ,n + 1

2nd TABLE

ZOOM 4




[−4.7, 4.7, 1] by [−3.1, 3.1, 1]

*Note:* The points in the table all lie on this line.

**Calculator Perspective boxes**—The TI-84 Plus™ calculator is used to work sample problems as concepts are developed. The location of the Calculator Perspectives within the textbook is not only convenient for the student, it also helps to keep the focus on the mathematical concepts while showing the appropriate use of technology for exploration and for computation.



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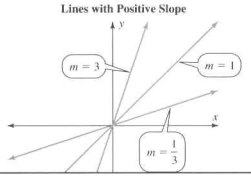
**SELF-CHECK 2.4.2**

The slope of a line is $-\frac{2}{5}$.

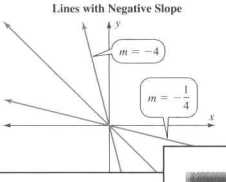
1. How much change in $y$ will a 5-unit increase in $x$ produce?
2. How much change in $y$ will a 1-unit increase in $x$ produce?
3. Graph a line with this slope and a $y$-intercept of (0, 3).

All lines with positive slope go upward to the right since the $x$- and $y$-coordinates increase together. All lines with negative slope go downward to the right since the $y$-coordinate decreases as the $x$-coordinate increases. If we compare two lines graphed on the same coordinate system, the steeper line will have the slope with the larger magnitude.

Lines with Positive Slope




Lines with Negative Slope

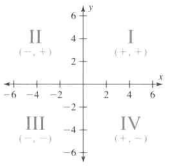



**Self-Checks**—Self-Checks are located in each section to help students to become active learners and monitors of their own progress. The answers for these self-checks are placed at the end of each section.

**Key Concepts**—The Key Concepts highlight each chapter's key terms, concepts, principles, and procedures. This summary can serve as a checklist of key items for students to review.

**KEY CONCEPTS FOR CHAPTER 2**

1. **Cartesian Coordinate System:** The sign pattern for the coordinates in each quadrant of the rectangular coordinate system is shown in the figure.




2. **Scatter Diagram:** A scatter diagram for a set of data points is a graph of these points that can be used to visually examine

- $\Delta x$, read "delta $x$," denotes a change in $x$, and $\Delta y$, read "delta $y$," denotes a change in $y$; $m = \frac{\Delta y}{\Delta x}$.
- The slope of a line gives the change in $y$ for each 1-unit change in $x$.
- A line with positive slope goes upward to the right.
- A line with negative slope goes downward to the right.
- The slope of a horizontal line is 0.
- The slope of a vertical line is undefined.
- The slopes of parallel lines are the same.
- The slopes of perpendicular lines are opposite reciprocals.
- The product of the slopes of perpendicular lines is $-1$.
- The slope of $y = mx + b$ is $m$.
- The slope of $y - y_1 = m(x - x_1)$ is $m$.
- The common difference of an arithmetic sequence is the same as the slope of the line through the points formed by this sequence.
- The grade of a highway refers to the slope of the highway.

7. **Forms of Linear Equations:** A linear equation in $x$ and $y$ is first degree in both $x$ and $y$.
   - Slope-intercept form: $y = mx + b$ or $f(x) = mx + b$ with slope $m$ and $y$-intercept $(0, b)$
   - Vertical line: $x = a$ for a real constant $a$
   - Horizontal line: $y = b$ for a real constant $b$
   - General form: $Ax + By = C$



**GROUP PROJECT FOR CHAPTER 2**

**OSHA Standards for Stair-Step Rise and Run**

This project requires a tape measure, a ruler, or a yardstick.

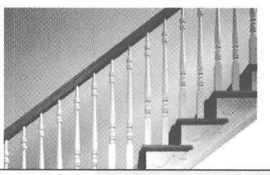
The OSHA standards for stairs for single-family residences vary from the standards for other buildings. The standards for single-family residences set a maximum on the rise of 8 inches and a minimum on the run of 9 inches.

**OSHA* Standard 1910.24**

***Definitions:***

**Rise:** *The vertical distance from the top of a tread to the top of the next higher tread.*

**Run:** *The horizontal distance from the leading edge of a tread to the leading edge of an adjacent tread.*



1. There are 10 steps to the first landing in the stairs of the home of the author, James Hall. Each of these steps has a rise of 8 inches

**Group Project**—Chapters end with a Group Project that encourages collaborative problem-solving while reinforcing connections among mathematical concepts.

## Commentary and Guidance

**Marginal Notes**—The margins of the text are populated with brief hints and explanations of nearby material that will help teachers teach and students learn.

**Mathematical Notes**—These short vignettes describe the origin of some of the symbols and terms used in the text and provide brief glimpses into the lives of some of the men and women of mathematics.

**STEP 1.** Simplify each side of the equation.
- **a.** If the equation contains fractions, simplify by multiplying both sides of the equation by the least common denominator (LCD) of all the fractions.
- **b.** If the equation contains grouping symbols, simplify by using the distributive property to remove the grouping symbols and then combine like terms.

**STEP 2.** Using the addition-subtraction principle of equality, isolate the variable terms on one side of the equation and the constant terms on the other side.

**STEP 3.** Using the multiplication-division principle of equality, solve the equation.

A good rule of thumb to use when solving a linear equation is to try to produce simpler expressions with each step.

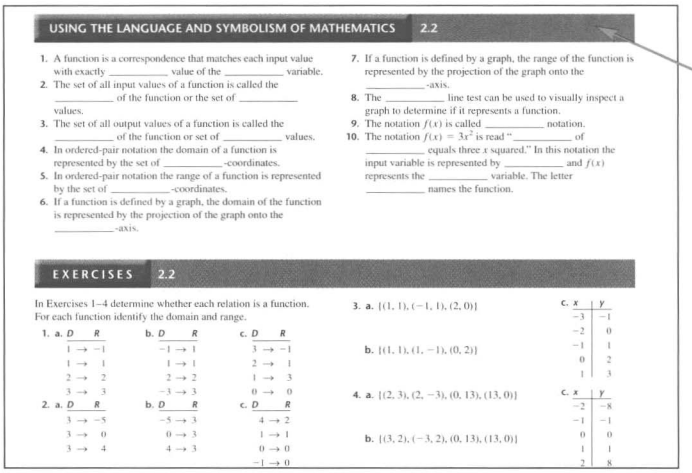
**A Mathematical Note**

$\pi$ is defined as the ratio of the circumference of a circle to its diameter. $\pi \approx 3.14159265$. ($\approx$ means approximately equal to.) However, the decimal form of $\pi$ does not terminate or repeat. In 1897 House Bill #246 was introduced in the Indiana legislature to make 3.2 the value of $\pi$ in that state. Fortunately, better judgment prevailed and this foolish bill was defeated.

SOLUTIONS

| | ADDITIVE INVERSE | |
|---|---|---|
| (a) 7 | $-7$ | Except for zero, the additive inverse of a number is formed by changing the sign of the number. |
| (b) $-3$ | $-(-3) = 3$ | The opposite of negative three is three. |
| (c) 0 | 0 | Zero is its own additive inverse. |
| (d) $-27.89$ | $27.89$ | $-(-27.89) = 27.89$ |
| (e) $\frac{4}{17}$ | $-\frac{4}{17}$ | |
| (f) $\pi$ | $-\pi$ | The opposite of pi is negative pi. |

Graphing calculators can represent both constants and variables. Most of the constants can be entered by using the numeric keys. However, graphing calculators also have a special key to give an approximate value for the constant $\pi$. The TI-84 Plus calculator also has variables that can store different real numbers at different times. This is illustrated in Calculator Perspective 1.2.1.



USING THE LANGUAGE AND SYMBOLISM OF MATHEMATICS 2.2

1. A function is a correspondence that matches each input value with exactly _____ value of the _____ variable.
2. The set of all input values of a function is called the _____ of the function or the set of _____ values.
3. The set of all output values of a function is called the _____ of the function or set of _____ values.
4. In ordered-pair notation the domain of a function is represented by the set of _____-coordinates.
5. In ordered-pair notation the range of a function is represented by the set of _____-coordinates.
6. If a function is defined by a graph, the domain of the function is represented by the projection of the graph onto the _____-axis.
7. If a function is defined by a graph, the range of the function is represented by the projection of the graph onto the _____-axis.
8. The _____ line test can be used to visually inspect a graph to determine if it represents a function.
9. The notation $f(x)$ is called _____ notation.
10. The notation $f(x) = 3x^2$ is read "_____ of _____ equals three $x$ squared." In this notation the input variable is represented by _____ and $f(x)$ represents the _____ variable. The letter _____ names the function.

EXERCISES 2.2

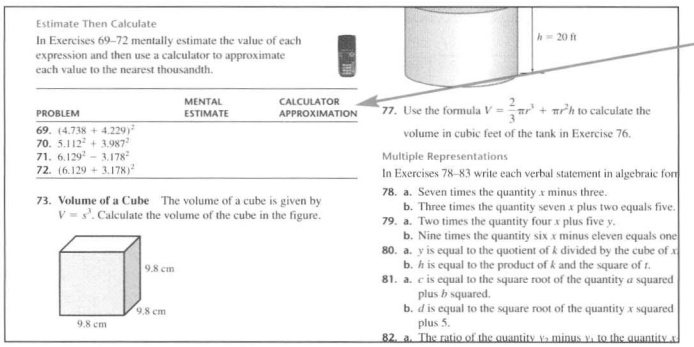
In Exercises 1–4 determine whether each relation is a function. For each function identify the domain and range.

1. a. D R: $1 \to -1$, $1 \to 1$, $2 \to 2$, $3 \to 3$
   b. D R: $-1 \to 1$, $1 \to 1$, $2 \to 2$, $-3 \to 3$
   c. D R: $3 \to -1$, $2 \to 1$, $1 \to 3$, $0 \to 0$
2. a. D R: $3 \to -5$, $3 \to 0$, $3 \to 4$
   b. D R: $-5 \to 3$, $0 \to 3$, $4 \to 3$
   c. D R: $4 \to 2$, $1 \to 1$, $0 \to 0$, $-1 \to 0$
3. a. $\{(1, 1), (-1, 1), (2, 0)\}$
   b. $\{(1, 1), (1, -1), (0, 2)\}$
   c.

| x | y |
|---|---|
| −3 | −1 |
| −2 | 0 |
| −1 | 1 |
| 0 | 2 |
| 1 | 3 |

4. a. $\{(2, 3), (2, -3), (0, 13), (13, 0)\}$
   b. $\{(3, 2), (-3, 2), (0, 13), (13, 0)\}$
   c.

| x | y |
|---|---|
| −2 | −8 |
| −1 | −1 |
| 0 | 0 |
| 1 | 1 |
| 2 | 8 |



Estimate Then Calculate

In Exercises 69–72 mentally estimate the value of each expression and then use a calculator to approximate each value to the nearest thousandth.

| PROBLEM | MENTAL ESTIMATE | CALCULATOR APPROXIMATION |
|---|---|---|
| 69. $(4.738 + 4.229)^2$ | | |
| 70. $5.112^2 + 3.987^2$ | | |
| 71. $6.129^2 - 3.178^2$ | | |
| 72. $(6.129 + 3.178)^2$ | | |

73. **Volume of a Cube** The volume of a cube is given by $V = s^3$. Calculate the volume of the cube in the figure.

9.8 cm, 9.8 cm, 9.8 cm

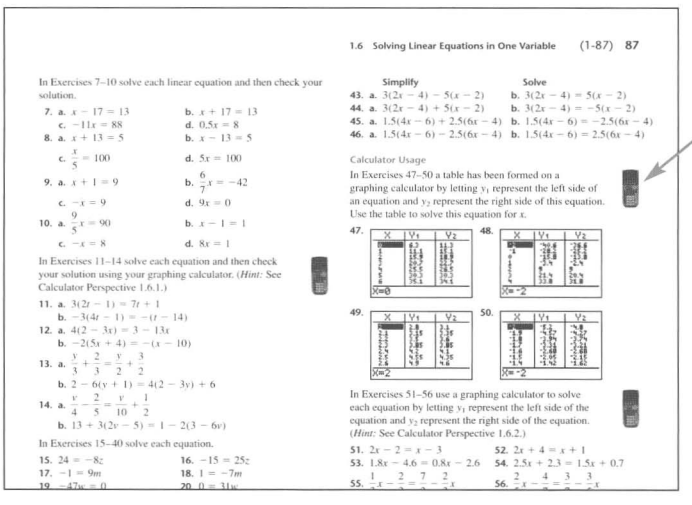
$h = 20$ ft

77. Use the formula $V = \frac{2}{3}\pi r^3 + \pi r^2 h$ to calculate the volume in cubic feet of the tank in Exercise 76.

Multiple Representations

In Exercises 78–83 write each verbal statement in algebraic form.

78. a. Seven times the quantity $x$ minus three.
    b. Three times the quantity seven $x$ plus two equals five.
79. a. Two times the quantity four $x$ plus five $y$.
    b. Nine times the quantity six $x$ minus eleven equals one.
80. a. $y$ is equal to the quotient of $k$ divided by the cube of $x$.
    b. $h$ is equal to the product of $k$ and the square of $t$.
81. a. $c$ is equal to the square root of the quantity $a$ squared plus $b$ squared.
    b. $d$ is equal to the square root of the quantity $x$ squared plus 5.
82. a. The ratio of the quantity $y_2$ minus $y_1$ to the quantity $x$



1.6 Solving Linear Equations in One Variable (1-87) 87

In Exercises 7–10 solve each linear equation and then check your solution.

7. a. $x - 17 = 13$
   b. $x + 17 = 13$
   c. $-11x = 88$
   d. $0.5x = 8$
8. a. $x + 13 = 5$
   b. $x - 13 = 5$
   c. $\frac{x}{5} = 100$
   d. $5x = 100$
9. a. $x + 1 = 9$
   b. $\frac{6}{7}x = -42$
   c. $-x = 9$
   d. $9x = 0$
10. a. $\frac{9}{5}x = 90$
    b. $x - 1 = 1$
    c. $-x = 8$
    d. $8x = 1$

In Exercises 11–14 solve each equation and then check your solution using your graphing calculator. (*Hint:* See Calculator Perspective 1.6.1.)

11. a. $3(2t - 1) = 7t + 1$
    b. $-3(4t - 1) = -(t - 14)$
12. a. $4(2 - 3x) = 3 - 13x$
    b. $-2(5x + 4) = -(x - 10)$
13. a. $\frac{v}{3} + \frac{2}{3} = \frac{v}{2} + \frac{3}{2}$
    b. $2 - 6(v + 1) = 4(2 - 3v) + 6$
14. a. $\frac{v}{4} - \frac{2}{5} = \frac{v}{10} + \frac{1}{2}$
    b. $13 + 3(2v - 5) = 1 - 2(3 - 6v)$

In Exercises 15–40 solve each equation.

15. $24 = -8z$
16. $-15 = 25z$
17. $-1 = 9m$
18. $1 = -7m$
19. $-47w = 0$
20. $0 = 31w$

Simplify

43. a. $3(2x - 4) - 5(x - 2)$
44. a. $3(2x - 4) + 5(x - 2)$
45. a. $1.5(4x - 6) + 2.5(6x - 4)$
46. a. $1.5(4x - 6) - 2.5(6x - 4)$

Solve

b. $3(2x - 4) = 5(x - 2)$
b. $3(2x - 4) = -5(x - 2)$
b. $1.5(4x - 6) = -2.5(6x - 4)$
b. $1.5(4x - 6) = 2.5(6x - 4)$

Calculator Usage

In Exercises 47–50 a table has been formed on a graphing calculator by letting $y_1$ represent the left side of an equation and $y_2$ represent the right side of this equation. Use the table to solve this equation for $x$.

47. 48. 49. 50.

In Exercises 51–56 use a graphing calculator to solve each equation by letting $y_1$ represent the left side of the equation and $y_2$ represent the right side of the equation. (*Hint:* See Calculator Perspective 1.6.2.)

51. $2x - 2 = x - 3$
52. $2x + 4 = x + 1$
53. $1.8x - 4.6 = 0.8x - 2.6$
54. $2.5x + 2.3 = 1.5x + 0.7$
55. $\frac{1}{2}x - \frac{2}{3} = \frac{7}{3} - \frac{2}{3}x$
56. $\frac{2}{3}x - \frac{4}{5} = \frac{3}{5} - \frac{3}{5}x$

# Conceptual Understanding Through Practice

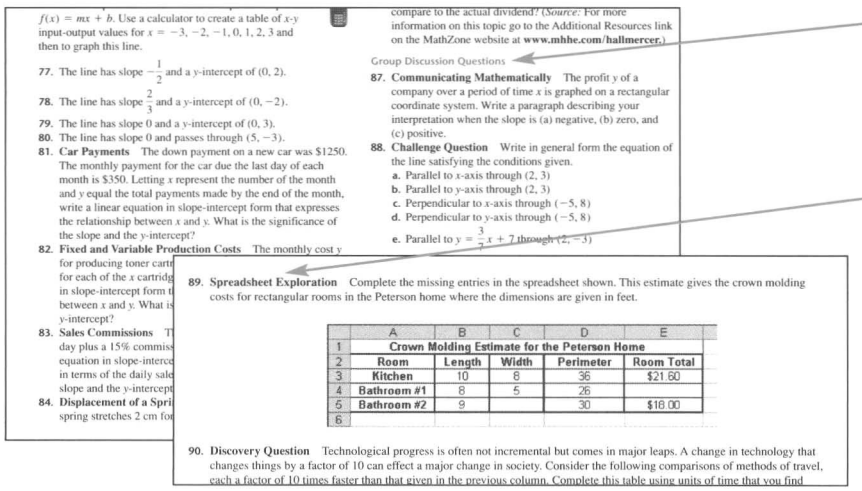
## In every section of the text:

**Using the Language and Symbolism of Mathematics**—Every section includes a series of fill-in-the-blank questions to help students gain fluency in the language and symbolism of mathematics.

**Exercises**—Each end-of-section exercise set is carefully constructed to develop and to reinforce the skills and concepts of algebra, and to provide an appropriate review of the section. Exercise sets include:

**Estimation Skills and Error Analysis Exercises**—Estimation skills, concern for reasonable answers, and the ability to detect calculator errors are critical elements of students' mathematical knowledge. There are examples and exercises in the book specifically designed to help the students develop these skills.

**Calculator Exercises**—When the use of a calculator is appropriate to the solution of an exercise, it is indicated in the text by a calculator icon, right next to the exercise.



$f(x) = mx + b$. Use a calculator to create a table of $x$-$y$ input-output values for $x = -3, -2, -1, 0, 1, 2, 3$ and then to graph this line.

77. The line has slope $-\frac{1}{2}$ and a $y$-intercept of $(0, 2)$.

78. The line has slope $\frac{2}{3}$ and a $y$-intercept of $(0, -2)$.

79. The line has slope 0 and a $y$-intercept of $(0, 3)$.

80. The line has slope 0 and passes through $(5, -3)$.

81. **Car Payments** The down payment on a new car was \$1250. The monthly payment for the car due the last day of each month is \$350. Letting $x$ represent the number of the month and $y$ equal the total payments made by the end of the month, write a linear equation in slope-intercept form that expresses the relationship between $x$ and $y$. What is the significance of the slope and the $y$-intercept?

82. **Fixed and Variable Production Costs** The monthly cost y for producing toner cartr for each of the $x$ cartridg in slope-intercept form t between $x$ and $y$. What is $y$-intercept?

83. **Sales Commissions** T day plus a 15% commis equation in slope-interce in terms of the daily sale slope and the $y$-intercept

84. **Displacement of a Spri** spring stretches 2 cm fo

compare to the actual dividend? (*Source:* For more information on this topic go to the Additional Resources link on the MathZone website at **www.mhhe.com/hallmercer.**)

Group Discussion Questions

87. **Communicating Mathematically** The profit $y$ of a company over a period of time $x$ is graphed on a rectangular coordinate system. Write a paragraph describing your interpretation when the slope is (a) negative, (b) zero, and (c) positive.

88. **Challenge Question** Write in general form the equation of the line satisfying the conditions given.
   a. Parallel to $x$-axis through $(2, 3)$
   b. Parallel to $y$-axis through $(2, 3)$
   c. Perpendicular to $x$-axis through $(-5, 8)$
   d. Perpendicular to $y$-axis through $(-5, 8)$
   e. Parallel to $y = \frac{3}{7}x + 7$ through $(2, -3)$

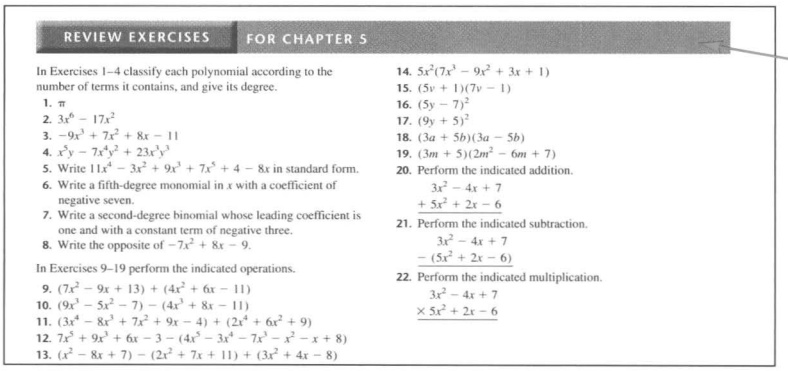
89. **Spreadsheet Exploration** Complete the missing entries in the spreadsheet shown. This estimate gives the crown molding costs for rectangular rooms in the Peterson home where the dimensions are given in feet.

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Crown Molding Estimate for the Peterson Home | | | | |
| 2 | Room | Length | Width | Perimeter | Room Total |
| 3 | Kitchen | 10 | 8 | 36 | $21.60 |
| 4 | Bathroom #1 | 8 | 5 | 26 | |
| 5 | Bathroom #2 | 9 | | 30 | $18.00 |
| 6 | | | | | |

90. **Discovery Question** Technological progress is often not incremental but comes in major leaps. A change in technology that changes things by a factor of 10 can effect a major change in society. Consider the following comparisons of methods of travel, each a factor of 10 times faster than that given in the previous column. Complete this table using units of time that you find

**Group Discussion Questions**—These exercises involve students in interactive and collaborative learning and encourage them to communicate mathematics both orally and in writing.

**Spreadsheet Exploration**—Some sections include spreadsheet exercises. These exercises show how algebra is used to construct spreadsheets and also how spreadsheets can be used to explore algebraic concepts.



**REVIEW EXERCISES** FOR CHAPTER 5

In Exercises 1–4 classify each polynomial according to the number of terms it contains, and give its degree.

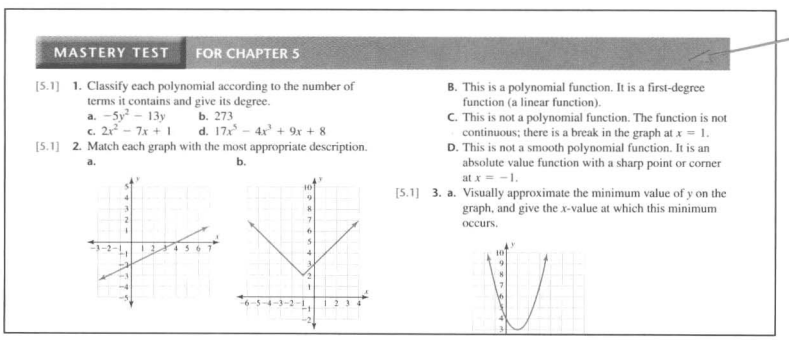
1. $\pi$
2. $3x^6 - 17x^2$
3. $-9x^3 + 7x^2 + 8x - 11$
4. $x^5y - 7x^4y^2 + 23x^3y^3$
5. Write $11x^4 - 3x^2 + 9x^3 + 7x^5 + 4 - 8x$ in standard form.
6. Write a fifth-degree monomial in $x$ with a coefficient of negative seven.
7. Write a second-degree binomial whose leading coefficient is one and with a constant term of negative three.
8. Write the opposite of $-7x^2 + 8x - 9$.

In Exercises 9–19 perform the indicated operations.

9. $(7x^2 - 9x + 13) + (4x^2 + 6x - 11)$
10. $(9x^3 - 5x^2 - 7) - (4x^3 + 8x - 11)$
11. $(3x^4 - 8x^3 + 7x^2 + 9x - 4) + (2x^4 + 6x^2 + 9)$
12. $7x^5 + 9x^3 + 6x - 3 - (4x^5 - 3x^4 - 7x^3 - x^2 - x + 8)$
13. $(x^2 - 8x + 7) - (2x^2 + 7x + 11) + (3x^2 + 4x - 8)$
14. $5x^2(7x^3 - 9x^2 + 3x + 1)$
15. $(5v + 1)(7v - 1)$
16. $(5y - 7)^2$
17. $(9y + 5)^2$
18. $(3a + 5b)(3a - 5b)$
19. $(3m + 5)(2m^2 - 6m + 7)$
20. Perform the indicated addition.
$$\begin{array}{r} 3x^2 - 4x + 7 \\ +\ 5x^2 + 2x - 6 \end{array}$$
21. Perform the indicated subtraction.
$$\begin{array}{r} 3x^2 - 4x + 7 \\ -\ (5x^2 + 2x - 6) \end{array}$$
22. Perform the indicated multiplication.
$$\begin{array}{r} 3x^2 - 4x + 7 \\ \times\ 5x^2 + 2x - 6 \end{array}$$

In every chapter of the text:

**Chapter Review Exercises**—These comprehensive exercise sets provide ample and well-distributed practice on the topics of the chapter.



**MASTERY TEST** FOR CHAPTER 5

[5.1] 1. Classify each polynomial according to the number of terms it contains and give its degree.
   a. $-5y^2 - 13y$  b. 273
   c. $2x^2 - 7x + 1$  d. $17x^5 - 4x^3 + 9x + 8$

[5.1] 2. Match each graph with the most appropriate description.

a.



b.

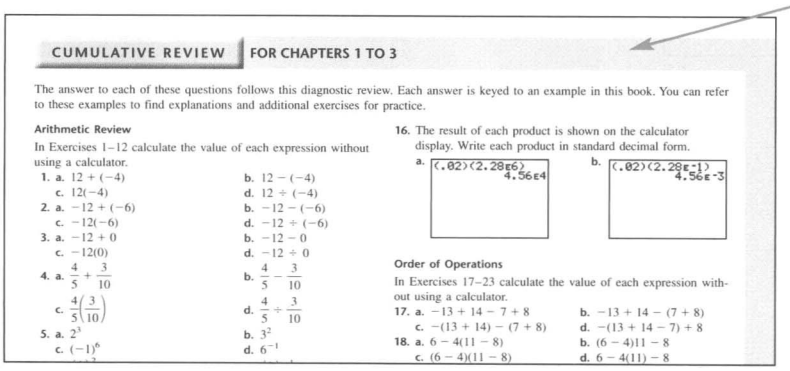


   A. This is a polynomial function. It is a first-degree function (a linear function).
   B. This is a polynomial function. It is a first-degree function (a linear function).
   C. This is not a polynomial function. The function is not continuous; there is a break in the graph at $x = 1$.
   D. This is not a smooth polynomial function. It is an absolute value function with a sharp point or corner at $x = -1$.

[5.1] 3. a. Visually approximate the minimum value of y on the graph, and give the $x$-value at which this minimum occurs.



**Chapter Mastery Test**—These tests are written specifically to cover each objective presented in the chapter.



**CUMULATIVE REVIEW** FOR CHAPTERS 1 TO 3

The answer to each of these questions follows this diagnostic review. Each answer is keyed to an example in this book. You can refer to these examples to find explanations and additional exercises for practice.

**Arithmetic Review**

In Exercises 1–12 calculate the value of each expression without using a calculator.

1. a. $12 + (-4)$  b. $12 - (-4)$
   c. $12(-4)$  d. $12 \div (-4)$
2. a. $-12 + (-6)$  b. $-12 - (-6)$
   c. $-12(-6)$  d. $-12 \div (-6)$
3. a. $-12 + 0$  b. $-12 - 0$
   c. $-12(0)$  d. $-12 \div 0$
4. a. $\frac{4}{5} + \frac{3}{10}$  b. $\frac{4}{5} - \frac{3}{10}$
   c. $\frac{4}{5}\left(\frac{3}{10}\right)$  d. $\frac{4}{5} \div \frac{3}{10}$
5. a. $2^3$  b. $3^2$
   c. $(-1)^6$  d. $6^{-1}$

16. The result of each product is shown on the calculator display. Write each product in standard decimal form.

a. (.02)(2.28E6) 4.56E4

b. (.02)(2.28E-1) 4.56E-3

**Order of Operations**

In Exercises 17–23 calculate the value of each expression without using a calculator.

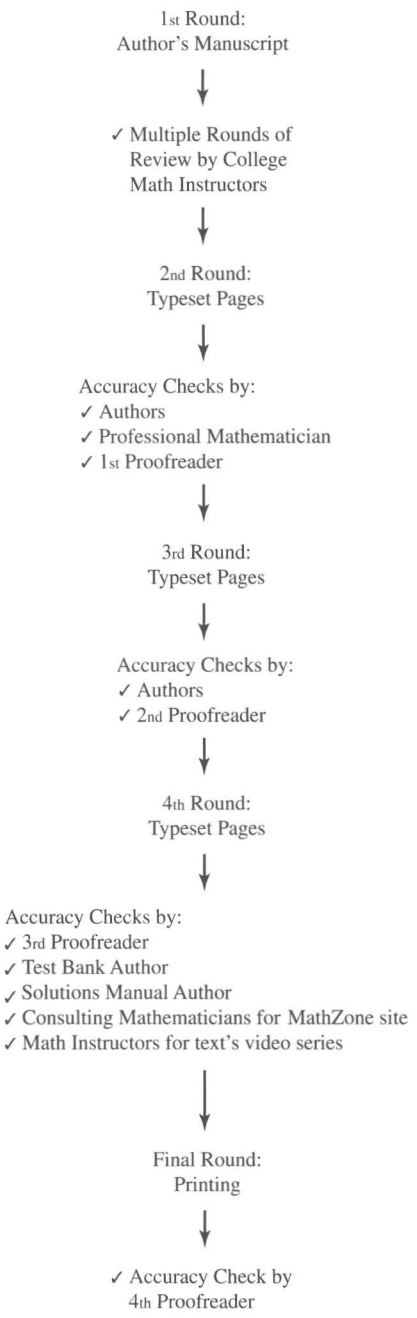
17. a. $-13 + 14 - 7 + 8$  b. $-13 + 14 - (7 + 8)$
   c. $-(13 + 14) - (7 + 8)$  d. $-(13 + 14 - 7) + 8$
18. a. $6 - 4(11 - 8)$  b. $(6 - 4)11 - 8$
   c. $(6 - 4)(11 - 8)$  d. $6 - 4(11) - 8$

**Cumulative Review**—To ensure students have mastered the concepts of the previous chapters, cumulative reviews can be found after Chapters 3, 6, and 9. Direct references to relevant examples placed alongside the answers immediately follow each review.

# Accuracy Statement

## A COMMITMENT TO ACCURACY

You have a right to expect an accurate textbook, and McGraw-Hill invests considerable time and effort to make sure that we deliver one. Listed below are the many steps we take to make sure this happens.




## OUR ACCURACY VERIFICATION PROCESS

### *First Round*

Step 1: Numerous **college math instructors** review the manuscript and report on any errors that they may find, and the authors make these corrections in their final manuscript.

### *Second Round*

Step 2: Once the manuscript has been typeset, the **authors** check their manuscript against the first page proofs to ensure that all illustrations, graphs, examples, exercises, solutions, and answers have been correctly laid out on the pages, and that all notation is correctly used.

Step 3: An outside, **professional mathematician** works through every example and exercise in the page proofs to verify the accuracy of the answers.

Step 4: A **proofreader** adds a triple layer of accuracy assurance in the first pages by hunting for errors, then a second, corrected round of page proofs is produced.

### *Third Round*

Step 5: The **author team** reviews the second round of page proofs for two reasons: 1) to make certain that any previous corrections were properly made, and 2) to look for any errors they might have missed on the first round.

Step 6: A **second proofreader** is added to the project to examine the new round of page proofs to double check the author team's work and to lend a fresh, critical eye to the book before the third round of paging.

### *Fourth Round*

Step 7: A **third proofreader** inspects the third round of page proofs to verify that all previous corrections have been properly made and that there are no new or remaining errors.

Step 8: Meanwhile, in partnership with **independent mathematicians,** the text accuracy is verified from a variety of fresh perspectives:

- The **test bank author** checks for consistency and accuracy as they prepare the computerized test item file.
- The **solutions manual author** works every single exercise and verifies their answers, reporting any errors to the publisher.
- A **consulting group of mathematicians,** who write material for the text's MathZone site, notifies the publisher of any errors they encounter in the page proofs.
- A video production company employing **expert math instructors** for the text's videos will alert the publisher of any errors they might find in the page proofs.

### *Final Round*

Step 9: The **project manager,** who has overseen the book from the beginning, performs a **fourth proofread** of the textbook during the printing process, providing a final accuracy review.

⇒ What results is a mathematics textbook that is as accurate and error-free as is humanly possible, and our authors and publishing staff are confident that our many layers of quality assurance have produced textbooks that are the leaders of the industry for their integrity and correctness.

# Index of Features

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