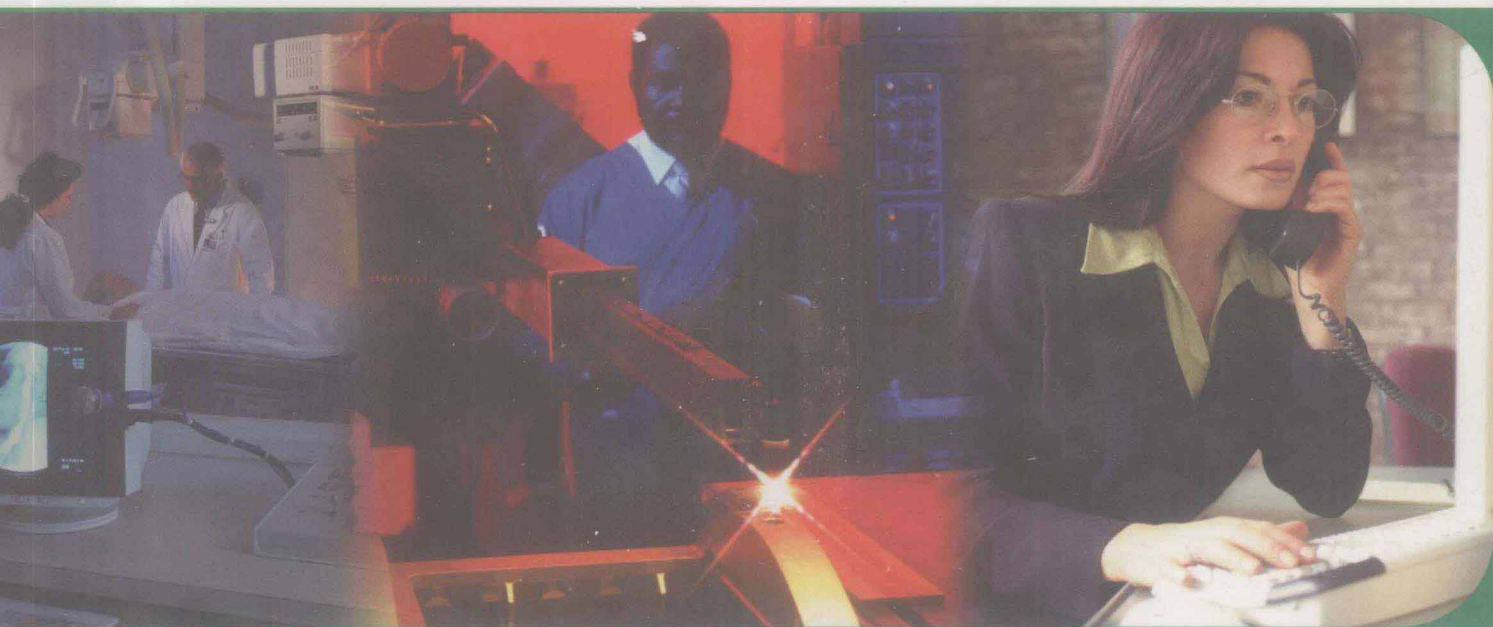


BASIC MATH, ALGEBRA, AND GEOMETRY WITH APPLICATIONS



CHERYL CLEAVES & MARGIE HOBBS



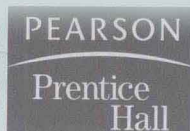
Basic Math, Algebra, and Geometry with Applications

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To Charles and Allen
The loves of our lives and our best friends

Preface

In *Basic Math, Algebra, and Geometry with Applications*, we have replicated the features that made our other texts appropriate for a comprehensive study of mathematics. We use real-life situations as a context for applied problems.

Our goal is to present a systematic framework for successful learning in mathematics that will strengthen students' *mathematical sense* and give students a greater appreciation for the utility of mathematics in everyday life and in the workplace. The text is designed to provide the mathematics required in developmental mathematics or general education. Many of the explanations are enhanced with carefully constructed visualizations.

Commitment to Improving Mathematics Education

The authors have been and continue to be active in the development, revision, and implementation of the standards (*Crossroads*) of the American Mathematical Association of Two-Year Colleges (AMATYC). We enthusiastically promote the standards and guidelines encouraged by AMATYC, NCTM, MAA, and the SCANS document. The Instructor's Resource Manual gives suggestions and activities for implementing the standards.

Calculator Usage

Calculator tips appropriate for both scientific and graphing calculators are periodically included. These generic tips guide students to use critical thinking to determine how their calculator operates without referring to a user's manual.

We emphasize the calculator as a tool that *facilitates* learning and understanding. We include assessment strategies throughout the text and supplementary materials that enable students to test their understanding of a concept independently of their calculator.

Study Strategies and Reference Features

In our experiences as instructors, we are all too aware of the need for students to develop good study habits and good independent learning skills. Students find a good reference text invaluable as they need to review mathematical concepts. Many students have praised the usefulness of our text as a reference standard. For a detailed description of the features of the text and our suggestions for students, refer to the *To the Student* portion of the preface.

Additional Resources

Several additional resources are available with the adoption of the text. These resources include the Instructor's Resource Manual, a Test Item File and a computerized test item file (TestGen), a Student Solutions Manual, a "How to Study Mathematics" booklet, StudyWizard software (packaged with the text), a Companion Website, a Premium Website, and online course material for WebCT, Blackboard, and CourseCompass. Go to www.prenhall.com/cleaves or contact your Prentice Hall representative for more information.

Acknowledgments

A project such as this does not come together without help from many people. Our first avenue for input is through our students and fellow instructors at the Southwest Tennessee Community College and The University of Mississippi. We also receive input from faculty at other colleges and from our many AMATYC colleagues. Their comments and suggestions have been invaluable. In addition, we appreciate the assistance we received in ensuring the accuracy of the text. We thank Julie Anderson and Emily Atchley who spent many hours working every problem in the text and Kim Denley who worked many of the problems. However, we take full responsibility for any misprints or errors that may remain.

Supplements for any text are a vital part of the educational support provided to teachers and students. We thank Jimmy Van Alphen who prepared the Test Item File, Jim and Renee Smith who organized the Student Solutions Manual and the solutions for the Instructor's Resource Manual and Marcus Rasco who adapted the contents of the Premium and Companion websites.

We wish to express thanks to all the people who helped make this text a reality. In particular, we thank Gary Bauer, Senior Acquisitions Editor, and Steve Helba, Editor in Chief, whose belief in our work and support of our ideas have been a major factor in our success. We thank Louise Sette, Prentice Hall production editor. We also thank Monica Ohlinger and Megan Becker of Ohlinger Publishing Services and Emily Autumn of Carlisle Publishers Services.

The teaching of mathematics over time produces a wealth of knowledge about instructional strategies and specific content. We are grateful for the many valuable suggestions that we received in these areas. We wish to thank the following individuals:

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Cheryl Cleaves
Margie Hobbs

To the Student

The mathematics you learn from this book will serve you well and will help you advance your career goals. We have given much thought to the best way to teach mathematics and have done extensive research on how students learn. We have provided a wide variety of features and resources so that you can customize your study to your needs and circumstances. The following features are key to helping you learn the mathematics in this text.

Learning Outcome

Tip box

Learning Strategy

Example with explanatory comments

3 Find the Absolute Value of Integers.

The distance between each pair of consecutive integers is the same for all integers located on the number line. This concept of *distance between numbers* on the number line is related to the concept of *absolute value*. The absolute value of a number is often described as the number of units of distance the number is from zero. The symbol for absolute value is $|\cdot|$; $|3|$ is read “the absolute value of 3.”

Distance is a physical property, and it cannot have a negative value. Thus, the absolute value of a number is always a nonnegative value. If a number is positive, then the absolute value of the number is the number itself. In symbols, if $a > 0$, then $|a| = a$. The absolute value of a negative number is the opposite of that number. In symbols, if $a < 0$, then $|a| = -a$.

The absolute value of zero is zero. In symbols, $|0| = 0$. Examine the following examples of absolute values.

$$|-5| = 5 \quad |27| = 27 \quad |0| = 0$$



What Does Nonnegative Mean?

Are positive numbers also nonnegative? Yes, every positive number is nonnegative. Are there any nonnegative numbers that are not positive?

Yes, zero is *nonnegative and nonpositive*. Therefore, when we say *nonnegative*, we mean positive or zero. Similarly, *nonpositive* is negative or zero.



Learning Strategy Write Facts Symbolically.

Positive numbers are represented symbolically as $a > 0$, where a is any number greater than zero. Negative numbers are represented by $a < 0$, which states that a is any number less than zero. Nonnegative numbers (positives and zero) can be written symbolically as $a \geq 0$. The symbol \geq means “is greater than or equal to.”

Practice reading symbolic statements in words.

$a > 0$	Positive	$a \geq 0$	Nonnegative
$a < 0$	Negative	$a \leq 0$	Nonpositive

Then, the definition of the absolute value of a number can be written symbolically and read in words.

$ a = a$, for $a > 0$	The absolute value of a positive number is equal to itself.
$ a = -a$, for $a < 0$	The absolute value of a negative number is equal to its opposite.
$ 0 = 0$	The absolute value of zero is zero.

EXAMPLE Give the absolute value of the following quantities: (a) $|9|$ (b) $|-4|$ (c) $|0|$

- (a) $|9| = 9$ 9 is positive. Its absolute value is the number itself.
(b) $|-4| = 4$ -4 is negative. Its absolute value is the opposite of -4.
(c) $|0| = 0$ 0 is unsigned. Its absolute value is still zero.

Table of Contents. The table of contents is your “roadmap” to this text. Study it carefully to determine how the topics are arranged. This will aid you in relating topics to each other.

Glossary/Index. An extensive glossary/index is an important part of every mathematics book. Use the index to cross-reference topics and to locate other topics that relate to the topic you are studying.

Learning Outcomes. A learning outcome is what you should be able to do when you master a concept. These outcomes can guide you through your study plan. The chapter opening page lists the learning outcomes for the chapter. Each section begins with a statement of learning outcomes that shows you what you should look for and learn in that section. If you read and think about these outcomes before you begin the section, you will know what to look for as you work through the section. Self-Study Exercises are organized by learning outcomes and the Chapter Summary lists the learning outcomes for your review.

Six-Step Approach to Problem Solving. Successful problem solvers use a systematic, logical approach. We use a six-step approach to problem solving. This approach gives you a system for solving a variety of math problems. You will learn how to organize the information given and how to develop a logical plan for solving the problem. You are asked to analyze and compare and to estimate as you solve problems. Estimation helps you decide whether your answer is reasonable. You will learn

Example with explanatory comments

Calculator tip

Learning Outcome

Procedure box

EXAMPLE Find the area to the nearest hundredth of the top of a circular tank with a diameter of 12 ft 8 in.

If we are using a calculator, we can calculate the area using continuous steps as shown in the tip following this example.

$$A = \pi r^2$$

$$A = (\pi) \left(\frac{12 + \frac{8}{12}}{2} \right)^2$$

Follow the order of operations. 8 in. = $\frac{8}{12}$ ft.
The diameter, $12 + \frac{8}{12}$, divided by 2 is the radius.

$$A = 126.012772 \text{ ft}^2$$

Calculator result

$$A = 126.01 \text{ ft}^2 \text{ (rounded)}$$

Area is a square measure.

The area of the top of the tank is 126.01 ft² or 125.95 ft² (basic calculator using $\pi = 3.14$).



Develop Your Calculator Proficiency.

It is important to know how your calculator performs continuous operations.

Let's try a problem we have already worked so we know what the correct answer should be. We will rework the preceding example.

Option 1 using the π key and $\frac{\square}{\square}$ key:

$$12 \square 8 \square 12 \square \square 2 \square \square \pi \square \square \square \Rightarrow 126.012772$$

Option 2 using the general power key \wedge and the $\frac{\square}{\square}$ key:

$$12 \square 8 \square 12 \square \square 2 \square \wedge \square 2 \square \square \pi \square \square \square \Rightarrow 126.0127721$$

An alternative sequence of keystrokes is required if the parentheses keys are used. Experiment with your calculator to find other sequences that work.

Option 3 using parentheses:

$$\pi \square \square \square \square 12 + 8 \div 12 \square \square 2 \square \square \square \square \square \Rightarrow 126.0127721$$

Work several problems both continuously and by recording and reentering intermediate calculations to learn how your calculator works and to develop your skills and confidence.

3 Find the Perimeter and Area of Composite Figures.

As we look about us, we see geometric shapes that are not squares, rectangles, parallelograms, trapezoids, triangles, or circles. Yet our work may require us to calculate the perimeter and area of these shapes. In such cases, we can use what we already know to find both perimeter and area. These shapes are called *composite* figures; that is, figures made up of two or more geometric figures.



To find a missing dimension of a composite shape:

1. Determine how the missing dimension is related to known dimensions.
2. Make a calculation of known dimensions according to the relationship found in Step 1.

to interpret the results of your calculations within the problem's context, a skill you will use on your job.

Tip Boxes. These boxes give helpful hints for doing mathematics, and they draw your attention to important observations and connections that you may have missed in an example.

Learning Strategies. Strategies that help you build a framework for successful learning are found in each chapter. The strategies show ways to manage your learning of mathematics that you may not have thought of before. Many of the strategies have to do with your *mathematical sense* and give you a greater appreciation for the power of mathematics in your workplace and your life. Many of these strategies are also useful in other areas of study.

Using Your Calculator. Calculators are useful in all levels of mathematics. Some tips introduce easy-to-follow calculator strategies. The tips show you how to analyze the procedure and set up a problem for a calculator solution; a sample series of keystrokes is often included. In addition, the tips help you determine how your type of calculator operates for various mathematical processes.

Use of Color in the Text. As you read the text and work through the examples, notice the items shaded with color or gray. These will help you follow the logic of

Six-Step Problem Solving Example

Tip box

Use of color

EXAMPLE A truck travels 102 mi on 6 gal of gasoline. How far will it travel on 30 gal of gasoline?

Known facts Pair 1: 102 mi uses 6 gal of gasoline.

Unknown facts Pair 2: m mi uses 30 gal of gasoline.

Estimation $30 \text{ gal} \div 6 \text{ gal} = 5$. Then, approximately 5 times 100 miles can be driven. More than 102 miles can be traveled on 30 gal.

Calculations

$\frac{102 \text{ mi}}{m \text{ mi}} = \frac{6 \text{ gal}}{30 \text{ gal}}$	Dimension Analysis
	$\frac{\text{distance}_1}{\text{distance}_2} = \frac{\text{gasoline}_1}{\text{gasoline}_2}$ Pair 1
	$\frac{102}{m} = \frac{6}{30}$ $\frac{\text{mi}}{\text{mi}} \cdot \frac{\text{gal}}{\text{gal}}$
$102(30) = 6m$	Cross multiply: $\text{mi}(\text{gal}) = \text{gal}(\text{mi})$.
$\frac{3,060}{6} = \frac{6m}{6}$	Divide by gal. Reduce: $\frac{\text{mi}(\cancel{\text{gal}})}{\cancel{\text{gal}}} = \frac{\text{gal}(\cancel{\text{mi}})}{\cancel{\text{gal}}}$.
$510 = m$	m is expressed in miles.

Interpretation The truck will travel 510 mi on 30 gal of gasoline.



Analyze Dimensions.

Even though we often remove the written dimensions from an equation, we should analyze the dimensions to be sure we use the correct units in the solution.

EXAMPLE If a metal rod tapers 1 in. for every 24 in. of length, what is the amount of taper of a 30-in. piece of rod? (See Fig. 9-3.)

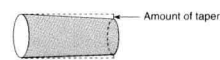


Figure 9-3

Known facts Pair 1: 1-in taper for 24-in. length

Unknown facts Pair 2: x -in taper for 30-in length

Estimation A 30-in. rod will taper more than 1 in.

Calculations

$\frac{1\text{-in. taper}}{x\text{-in. taper}} = \frac{24\text{-in. length}}{30\text{-in. length}}$	Pair 1
	Pair 2

$$\frac{1}{x} = \frac{24}{30}$$

Cross multiply.

$$1(30) = 24x$$

$$30 = 24x$$

Divide.

working through the example. Color also highlights important items and boxed features such as the Tips, Learning Strategies, and rules, procedures, and formulas.

Self-Study Exercises. These practice sets are keyed to the learning outcomes and appear at the end of each section. Use these exercises to check your understanding of the section. The answers to every exercise are at the end of the text, so you can get immediate feedback on whether you understand the concepts.

Assignment Exercises. An extensive set of exercises appears at the end of each chapter, so you can review all the learning outcomes presented in the chapter. These exercises, organized by section, may be assigned as homework, or you may want to work them on your own for additional practice. Challenge problems are at the end of the Assignment Exercises. Answers to the odd-numbered exercises are given at the end of the text, and worked-out solutions appear in a separate Student Solutions Manual available for purchase. Your instructor has the solutions to the even-numbered exercises in the Instructor's Resource Manual.

Concepts Analysis. Too often we focus on the *how to* and overlook the *why* of mathematical concepts. The Concepts Analysis questions further your understanding of a concept and help you see the connections between concepts. Some concepts questions present incorrect solutions to exercises to give you practice in analyzing and correcting errors. Error analysis also reinforces your understanding of concepts. As an added bonus, these exercises strengthen your writing skills. Suggested responses (answers) are found in the Instructor's Resource Manual.

Challenge Problems

Concepts Analysis

Chapter Summary

CHALLENGE PROBLEMS

137. The temperature at 8:00 A.M. is recorded as -3°C . Calculate the temperature at each hour as recorded by the increases (inc), decreases (dec), and no change (n.c.).
- | | |
|-------------------------------|-------------------------------|
| 9:00 A.M.: (inc) 2° | 2:00 P.M.: (inc) 3° |
| 10:00 A.M.: (inc) 1° | 3:00 P.M.: (dec) 4° |
| 11:00 A.M.: (inc) 0° | 4:00 P.M.: (dec) 7° |
| 12:00 P.M.: (inc) 1° | 5:00 P.M.: (dec) 8° |
| 1:00 P.M.: (n.c.) | 6:00 P.M.: (dec) 12° |
138. How many automobile license plates can be formed if the pattern is 3 digits and 3 letters, and both letters and numbers can be repeated? 6 letters and all letters can be repeated?

CONCEPTS ANALYSIS

- What two operations for integers use similar rules for handling the signs? Explain the rules for these operations.
- What operation with 0 is not defined?
- Write a statement using the symbol for "is greater than."
- Explain how to find the sign of a power if the base is a negative integer. Give an example for an even exponent and for an odd exponent.
- Draw a number line that shows positive and negative integers and zero, and place the following integers on the number line: $-3, 8, -2, 0, 3, 5$.
- Explain what is meant by "the absolute value of a number." Give an example.
- Describe the process of adding two integers that have different signs.
- Describe the correct order for operations with integers in words.
- Give an example of multiplying two negative integers, and give the product.
- Find and correct the mistakes in the following problem.

$$\begin{aligned} (-8)^2 &= 3(2) \\ 16 &= 3(2) \\ 13(2) & \\ 26 & \end{aligned}$$

CHAPTER SUMMARY

Learning Outcomes

Section 2-1

- Relate integers to natural numbers and whole numbers (pp. 72-73).
- Compare integers (p. 73).
- Find the absolute value of integers (pp. 74-75).
- Find the opposite of integers (p. 75).
- Locate points on a rectangular coordinate system (pp. 75-78).

What to Remember with Examples

Positive numbers are to the right of zero and negative numbers are to the left of zero on the number line.

Arrange from smallest to largest: $5, -3, 0, 8, -5$
 $-5, -3, 0, 5, 8$

The "greater than" symbol is $>$.
 The "less than" symbol is $<$.

Use $>$ or $<$ to make a true statement: $5 ? -3; 5 > -3$

The absolute value of a number is its *distance* from zero without regard to direction.

Evaluate the following absolute values: $|-3|, |5|$
 $|-3| = 3, |5| = 5$

Opposites are numbers that have the same absolute value but opposite signs.

Give the opposite of the following: $8, -4, -2, +4$
 $-8, 4, 2, -4$

To plot a point on the rectangular coordinate system: 1. Start at the origin. 2. Count to the left or right (horizontally) the number of units of the first signed number. 3. Start at the ending point found in Step 2, and count up or down (vertically) the number of units of the second signed number.

Chapter Summary

101

Chapter Summary. Each chapter includes a summary in the form of a two-column chart. The first column lists the learning outcomes of the chapter. The second column gives the procedures and examples for each outcome. Page references are included to facilitate your preview or review of the chapter.

Trial Test. The trial test at the end of each chapter lets you check your understanding of the chapter learning outcomes. You should be able to work each problem without referring to any examples in your text or your notes. Take this test before you take the class test to check and verify your understanding of the chapter material. Answers to the odd-numbered exercises appear at the end of the text, and their solutions appear in a separate Student Solutions Manual. Your instructor has the solutions to the even-numbered exercises in the Instructor's Resource Manual.

Student Solutions Manual. This manual can be purchased at your college bookstore or from online bookstores. It gives you extra *learning insurance* to help you master learning outcomes in the text. The manual contains worked-out solutions to the odd-numbered exercises in the Assignment Exercises and the Chapter Trial Test for each chapter of the text. Answers to these exercises appear in the back of your text, but using the manual to study the worked-out solutions reinforces your problem-solving skills and your understanding of the concepts.

How to Study Mathematics. Your instructor can obtain free copies of this booklet, which describes various learning techniques you can use to learn mathematics.

StudyWizard Software. This software, which is packaged with the text, provides additional practice with the math concepts presented in the text. Each question contains a reference to the section and outcome in the text where the concept appears, making it easier to find those sections that you want to review. Immediate feedback is provided for all questions, allowing you to strengthen your skills and test your knowledge of the concepts. The glossary included on the software allows you to review the terms and concepts presented in the text.

Companion Website. This free website, available at www.prenhall.com/cleaves, provides even more practice with the math concepts presented in the form of short quizzes for each section of the text. These quizzes are immediately graded, and you have the opportunity to send the results to your instructor via email.

Online Course Material. Passcodes for WebCT, Blackboard, and CourseCompass, as well as the Premium Website, are available for purchase. The system you use will depend on the software available at your school. These online resources provide numerous multiple-choice questions, including practice and chapter tests to review and check your comprehension. Short-answer quizzes, discussion questions, and review material complete the online packages.

We wish you much success in your study of mathematics. Many of the improvements for this book were suggested by students such as yourself. If you have suggestions for improving the presentation, please give them to your instructor or email the authors at ccleaves@bellsouth.net or mhobbs@watervalley.net.

Cheryl Cleaves
Margie Hobbs

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Whole Numbers and Decimals

1

1–1 Whole Numbers, Decimals, and the Place-Value System

- 1 Identify place values in whole numbers.
- 2 Read and write whole numbers in words, standard notation, and expanded notation.
- 3 Compare whole numbers.
- 4 Identify place values in decimal numbers.
- 5 Read and write decimal numbers.
- 6 Write fractions with power-of-10 denominators as decimal numbers.
- 7 Compare decimal numbers.
- 8 Round a whole number or a decimal number to a place value.
- 9 Round a whole number or a decimal number to a number with one nonzero digit.

1–2 Adding Whole Numbers and Decimals

- 1 Add whole numbers.
- 2 Add decimal numbers.
- 3 Estimate and check addition.

1–3 Subtracting Whole Numbers and Decimals

- 1 Subtract whole numbers.
- 2 Subtract decimal numbers.
- 3 Estimate and check subtraction.

1–4 Multiplying Whole Numbers and Decimals

- 1 Multiply whole-number factors.
- 2 Multiply decimal factors.
- 3 Apply the distributive property.
- 4 Estimate and check multiplication.