GLOBAL EDITION

Basic College Mathematics

TWELFTH EDITION

Marvin L. Bittinger • Judith A. Beecher • Barbara L. Johnson

ALWAYS LEARNING

PEARSON

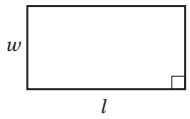
Geometric Formulas

PLANE GEOMETRY

Rectangle

Area: $A = l \cdot w$

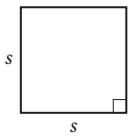
Perimeter: $P = 2 \cdot l + 2 \cdot w$



Square

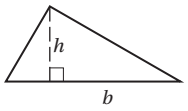
Area: $A = s^2$

Perimeter: $P = 4 \cdot s$



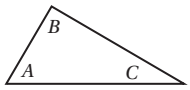
Triangle

Area: $A = \frac{1}{2} \cdot b \cdot h$



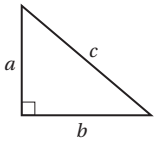
Sum of Angle Measures

$A + B + C = 180°$



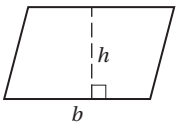
Right Triangle

Pythagorean Theorem:
$a^2 + b^2 = c^2$



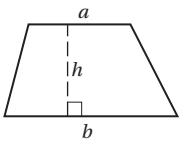
Parallelogram

Area: $A = b \cdot h$



Trapezoid

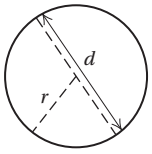
Area: $A = \frac{1}{2} \cdot h \cdot (a + b)$



Circle

Area: $A = \pi \cdot r^2$

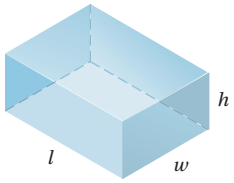
Circumference:
$C = \pi \cdot d = 2 \cdot \pi \cdot r$ ($\frac{22}{7}$ and 3.14 are different approximations for π)



SOLID GEOMETRY

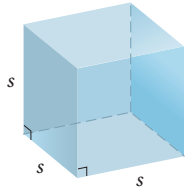
Rectangular Solid

Volume: $V = l \cdot w \cdot h$



Cube

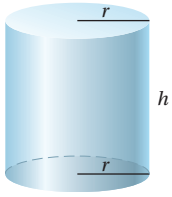
Volume: $V = s^3$



Right Circular Cylinder

Volume: $V = \pi \cdot r^2 \cdot h$

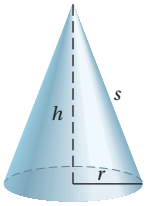
Surface Area:
$S = 2 \cdot \pi \cdot r \cdot h + 2 \cdot \pi \cdot r^2$



Right Circular Cone

Volume: $V = \frac{1}{3} \cdot \pi \cdot r^2 \cdot h$

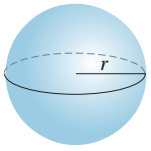
Surface Area:
$S = \pi \cdot r^2 + \pi \cdot r \cdot s$



Sphere

Volume: $V = \frac{4}{3} \cdot \pi \cdot r^3$

Surface Area: $S = 4 \cdot \pi \cdot r^2$



Fraction, Decimal, and Percent Equivalents

Fraction Notation	$\frac{1}{10}$	$\frac{1}{8}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{3}{10}$	$\frac{1}{3}$	$\frac{3}{8}$	$\frac{2}{5}$	$\frac{1}{2}$	$\frac{3}{5}$	$\frac{5}{8}$	$\frac{2}{3}$	$\frac{7}{10}$	$\frac{3}{4}$	$\frac{4}{5}$	$\frac{5}{6}$	$\frac{7}{8}$	$\frac{9}{10}$	$\frac{1}{1}$
Decimal Notation	0.1	0.125	$0.16\overline{6}$	0.2	0.25	0.3	$0.33\overline{3}$	0.375	0.4	0.5	0.6	0.625	$0.66\overline{6}$	0.7	0.75	0.8	$0.83\overline{3}$	0.875	0.9	1
Percent Notation	10%	12.5% or $12\frac{1}{2}\%$	$16.\overline{6}\%$ or $16\frac{2}{3}\%$	20%	25%	30%	$33.\overline{3}\%$ or $33\frac{1}{3}\%$	37.5% or $37\frac{1}{2}\%$	40%	50%	60%	62.5% or $62\frac{1}{2}\%$	$66.\overline{6}\%$ or $66\frac{2}{3}\%$	70%	75%	80%	$83.\overline{3}\%$ or $83\frac{1}{3}\%$	87.5% or $87\frac{1}{2}\%$	90%	100%

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Preface

The Bittinger Program

Math hasn't changed, but students—and the way they learn it—have.

Basic College Mathematics, 12th Edition, continues the Bittinger tradition of objective-based, guided learning, while integrating timely updates to the proven pedagogy. In this edition, there is a greater emphasis on guided learning and helping students get the most out of all of the course resources available with the Bittinger program, including new opportunities for mobile learning.

The program has expanded to include these comprehensive new teaching and learning resources: ***MyMathGuide* workbook**, **To-the-Point Objective Videos**, and enhanced, media-rich **MyMathLab** courses. Feedback from instructors and students motivated these and several other significant improvements: a new design to support guided learning, new figures and photos to help students visualize both concepts and applications, and many new and updated real-data applications to bring the math to life.

With so many resources available in so many formats, the trusted guidance of the Bittinger team on *what to do* and *when* will help today's math students stay on task. Students are encouraged to use ***Your Guide to Success in Math***, a four-step learning path and checklist. The guide will help students identify the resources in the textbook, supplements, and MyMathLab that support *their* learning style, as they develop and retain the skills and conceptual understanding they need to succeed in this and future courses.

In this preface, a look at the key new *and* hallmark resources and features of the *Basic College Mathematics* program—including the textbook/eText, video program, *MyMathGuide* workbook, and MyMathLab—is organized around ***Your Guide to Success in Math***. This will help instructors direct students to the tools and resources that will help them most in a traditional lecture, hybrid, lab-based, or online environment.

NEW AND HALLMARK FEATURES IN RELATION TO Your Guide to Success in Math

STEP 1 Learn the Skills and Concepts

Students have several options for learning, reviewing, and practicing the math concepts and skills.

Textbook/eText

- ☐ **Skill to Review.** At the beginning of nearly every text section, *Skill to Review* offers a just-in-time review of a previously presented skill that relates to the new material in the section. Section and objective references are included for the student's convenience, and two practice exercises are provided for review and reinforcement.
- ☐ **Margin Exercises.** For each objective, problems labeled "Do Exercise . . ." give students frequent opportunities to solve exercises while they learn.
- ☐ ***New!*** **Guided Solutions.** Nearly every section has *Guided Solution* margin exercises with fill-in blanks at key steps in the problem-solving process.

- ☐ ***Enhanced!*** **MyMathLab.** MyMathLab now includes *Active Learning Figures* for directed exploration of concepts; more problem types, including *Reading Checks* and *Guided Solutions*; and new, objective-based videos. (See pp. 16–19 for a detailed description of the features of MyMathLab.)
- ☐ ***New!*** **To-the-Point Objective Videos.** This is a comprehensive new program of objective-based, interactive videos that are incorporated into the Learning Path in MyMathLab and can be used hand-in-hand with the *MyMathGuide* workbook.
  - ☐ ***New!*** **Interactive Your Turn Exercises.** For each objective in the videos, students solve exercises and receive instant feedback on their work.
- ☐ ***New!*** ***MyMathGuide: Notes, Practice, and Video Path.*** This is an objective-based workbook (available in MyMathLab) for guided, hands-on learning. It offers vocabulary, skill, and concept review—along with problem-solving practice—with space to show work and write notes. Incorporated in the Learning Path in MyMathLab, it can be used together with the To-the-Point Objective Video program, instructor lectures, and the textbook.

STEP 2 Check Your Understanding

Throughout the program, students have frequent opportunities to check their work and confirm that they understand each skill and concept before moving on to the next topic.

- ☐ ***New!*** **Reading Checks.** At the beginning of each set of section exercises in the text, students demonstrate their grasp of the skills and concepts.
- ☐ ***New!*** **Active Learning Figures.** In MyMathLab, Active Learning Figures guide students in exploring math concepts and reinforcing their understanding.
- ☐ **Translating for Success.** In the text and in MyMathLab, these activities offer students extra practice with the important first step of the process for solving applied problems.

STEP 3 Do Your Homework

Basic College Mathematics, 12th Edition, has a wealth of proven and updated exercises.

- ☐ **Skill Maintenance.** In each section, these exercises offer a thorough review of the math in the preceding text.
- ☐ **Synthesis Exercises.** To help build critical-thinking skills, these section exercises require students to use what they know and combine learning objectives from the current section with those from previous sections.

STEP 4 Review and Test Your Understanding

Students have a variety of resources to check their skills and understanding along the way and to help them prepare for tests.

- ☐ **Mid-Chapter Review.** Mid-way through each chapter, students work a set of exercises (*Concept Reinforcement, Guided Solutions, Mixed Review,* and *Understanding Through Discussion and Writing*) to confirm that they have grasped the skills and concepts covered in the first half before moving on to new material.
- ☐ **Summary and Review.** This resource provides an in-text opportunity for active learning and review for each chapter. *Vocabulary Reinforcement, Concept Reinforcement,* objective-based *Study Guide* (examples paired with similar exercises), *Review Exercises* (including *Synthesis* problems), and *Understanding Through Discussion and Writing* are included in these comprehensive chapter reviews.

- **Chapter Test.** Chapter Tests offer students the opportunity for comprehensive review and reinforcement prior to taking their instructor's exam. **Chapter Test-Prep Videos** (in MyMathLab and on YouTube) show step-by-step solutions to the Chapter Tests.
- **Cumulative Review.** Following every chapter beginning with Chapter 3, a Cumulative Review revisits skills and concepts from all preceding chapters to help students retain previously learned material.

Study Skills

Developing solid time-management, note-taking, test-taking, and other study skills is key to student success in math courses (as well as professionally and personally). Instructors can direct students to related study skills resources as needed.

- ***New!*** **Studying for Success.** Checklists of study skills—designed to ensure that students develop the skills they need to succeed in math, school, and life—are integrated throughout the text at the beginning of selected sections.
- ***New!*** **Study Skills Modules.** In MyMathLab, interactive modules address common areas of weakness, including time-management, test-taking, and note-taking skills. Additional modules support career-readiness.
- ***New!*** **Student Study Reference. At a Glance**, provided at the end of this book, lists the key information and expressions for quick reference as students work exercises and review for tests.

Learning Math in Context

- ***New!*** **Applications.** Throughout the text in examples and exercises, real-data applications encourage students to see and interpret the mathematics that appears every day in the world around them. Applications that use real data are drawn from business and economics, life and physical sciences, medicine, technology, and areas of general interest such as sports and daily life. New applications include "Fastest-Growing Occupations" (p. 90), "Training Regimens" (p. 210), "Media Usage" (p. 309), and "*The Hobbit: An Unexpected Journey*" (p. 337). For a complete list of applications, please refer to the Index of Applications (p. 7).

BREAKTHROUGH
To improving results

MyMathLab

Ties the Complete Learning Program Together

MyMathLab® Online Course (access code required)

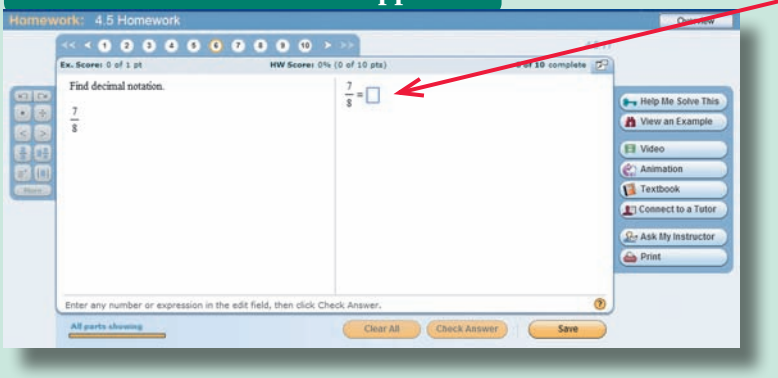
MyMathLab from Pearson is the world's leading online resource in mathematics, integrating interactive homework, assessment, and media in a flexible, easy to use format. MyMathLab delivers **proven results** in helping individual students succeed. It provides **engaging experiences** that personalize, stimulate, and measure learning for each student. And it comes from an **experienced partner** with educational expertise and an eye on the future.

MyMathLab for Developmental Mathematics

Prepared to go wherever you want to take your students.

Personalized Support for Students

Homework with Built-in Support

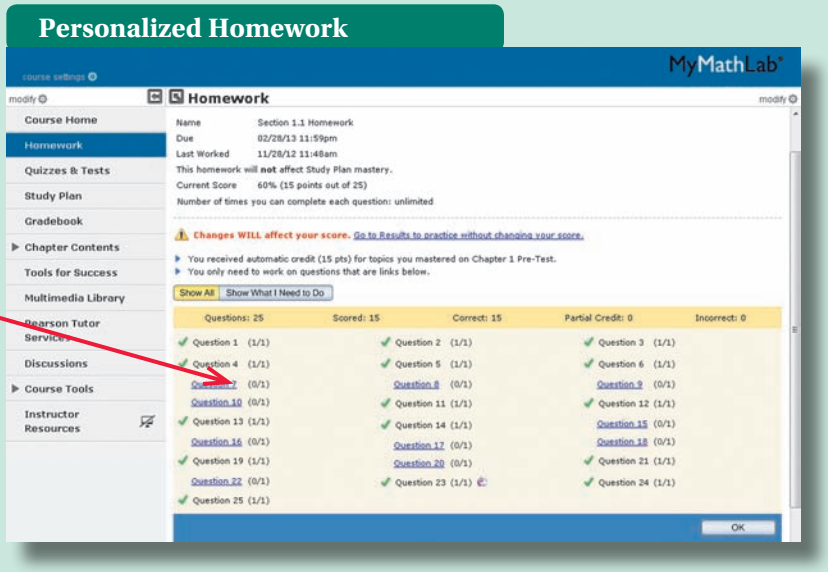


Exercises: The homework and practice exercises in MyMathLab are correlated to the exercises in the textbook, and they regenerate algorithmically to give students unlimited opportunities for practice and mastery. The software offers immediate, helpful feedback when students enter incorrect answers.

Multimedia Learning Aids: Exercises include guided solutions, sample problems, animations, videos, and eText access for extra help at point-of-use.

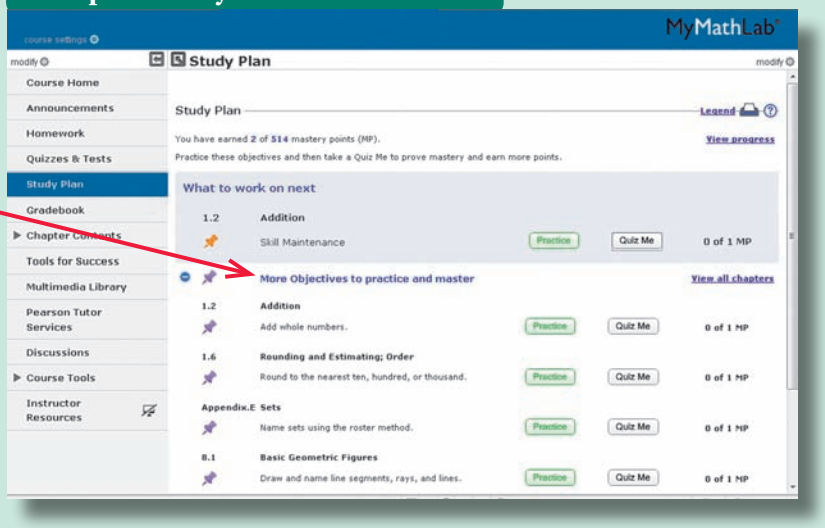
Personalized Homework

To help students achieve mastery, MyMathLab can generate **personalized homework** based on individual performance on tests or quizzes. Personalized homework allows students to focus on topics they have not yet mastered.



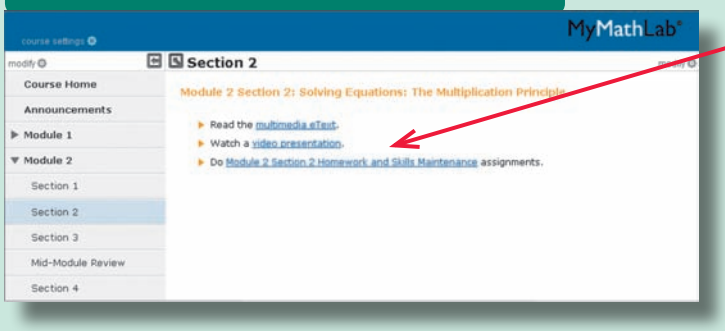
The **Adaptive Study Plan** makes studying more efficient and effective for every student. Performance and activity are assessed continually in real time. The data and analytics are used to provide personalized content—reinforcing concepts that target each student's strengths and weaknesses.

Adaptive Study Plan



Flexible Design, Easy Start-Up, and Results for Instructors

Customized Courses

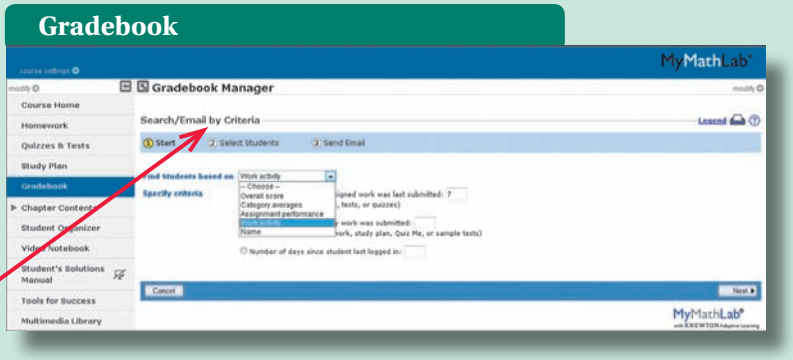


Instructors can modify the site navigation and insert their own directions on course-level landing pages; also, a **custom MyMathLab** course can be built that reorganizes and structures the course material by chapters, modules, units—whatever the need may be.

The **comprehensive online gradebook** automatically tracks students' results on tests, quizzes, and homework and in the study plan. Instructors can use the gradebook to quickly intervene if students have trouble, or to provide positive feedback on a job well done. The data within MyMathLab is easily exported to a variety of spreadsheet programs, such as Microsoft Excel. Instructors can determine which points of data to export and then analyze the results to determine success.

New features, such as **Search/Email by criteria**, make the gradebook a powerful tool for instructors. With this feature, instructors can easily communicate with both at-risk and successful students. They can search by score on specific assignments, non-completion of assignments within a given time frame, last login date, or overall score.

Gradebook



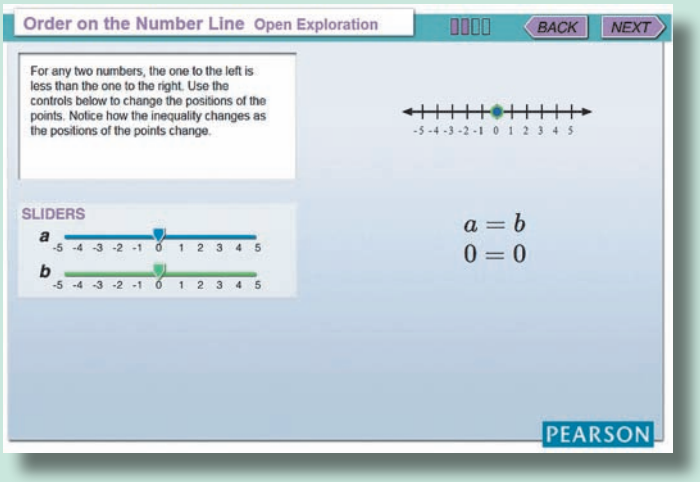
Special Bittinger Resources

in MyMathLab for Students and Instructors

In addition to robust course delivery, MyMathLab offers the full Bittinger eText, additional Bittinger Program features, and the entire set of instructor and student resources in one easy-to-access online location.

New! Active Learning Figures

In MyMathLab, Active Learning Figures guide students in exploring math concepts and reinforcing their understanding. Instructors can use Active Learning Figures in class or as media assignments in MyMathLab to guide students to explore math concepts and reinforce their understanding.



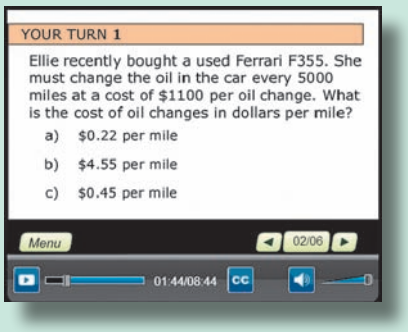
New! Integrated Bittinger Video Program and *MyMathGuide* workbook

Bittinger Video Program*

The Video Program is available in MyMathLab and includes closed captioning and the following video types:

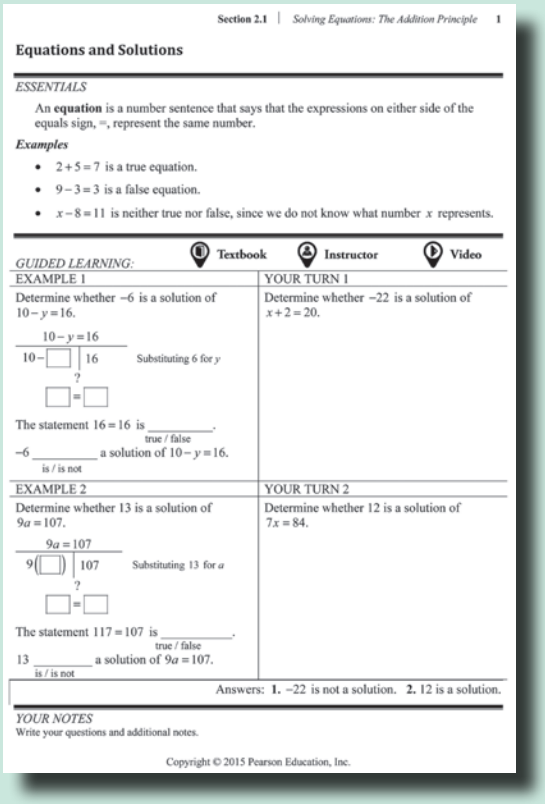
New! To-the-Point Objective Videos. These objective-based, interactive videos are incorporated into the Learning Path in MyMathLab and can be used along with the *MyMathGuide* workbook.

Chapter Test Prep Videos. The Chapter Test Prep Videos let students watch instructors work through step-by-step solutions to all the Chapter Test exercises from the textbook. Chapter Test Prep Videos are also available on YouTube™ (search using author name and book title).



New! *MyMathGuide: Notes, Practice, and Video Path* workbook*

This objective-based workbook for guided, hands-on learning offers vocabulary, skill, and concept review—along with problem-solving practice—with space to show work and write notes. Incorporated in the Learning Path in MyMathLab, *MyMathGuide* can be used together with the To-the-Point Objective Video program, instructor lectures, and the textbook. Instructors can assign To-the-Point Objective Videos in MyMathLab in conjunction with the *MyMathGuide* workbook.



Section 2.1 | *Solving Equations: The Addition Principle* 1

Equations and Solutions

ESSENTIALS

An **equation** is a number sentence that says that the expressions on either side of the equals sign, =, represent the same number.

Examples

- $2+5=7$ is a true equation.
- $9-3=3$ is a false equation.
- $x-8=11$ is neither true nor false, since we do not know what number x represents.

GUIDED LEARNING: Textbook Instructor Video

EXAMPLE 1	YOUR TURN 1
Determine whether -6 is a solution of $10-y=16$. $10-y=16$; $10-\square \mid 16$ Substituting 6 for y; $\overset{?}{\square=\square}$; The statement $16=16$ is _____ (true / false). -6 _____ (is / is not) a solution of $10-y=16$.	Determine whether -22 is a solution of $x+2=20$.
EXAMPLE 2	**YOUR TURN 2**
Determine whether 13 is a solution of $9a=107$. $9a=107$; $9(\square) \mid 107$ Substituting 13 for a; $\overset{?}{\square=\square}$; The statement $117=107$ is _____ (true / false). 13 _____ (is / is not) a solution of $9a=107$.	Determine whether 12 is a solution of $7x=84$.

Answers: **1.** -22 is not a solution. **2.** 12 is a solution.

YOUR NOTES

Write your questions and additional notes.

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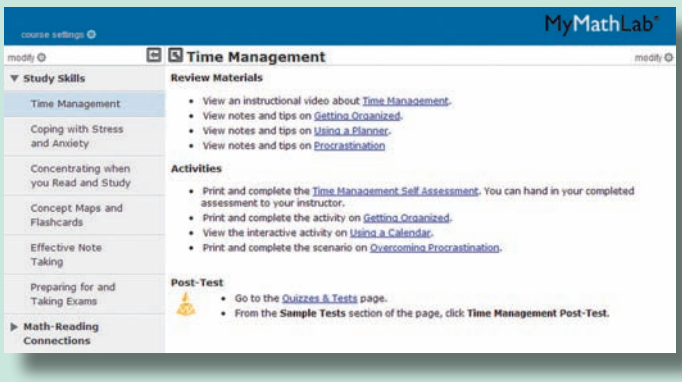

Study Skills Modules

In MyMathLab, interactive modules address common areas of weakness, including time-management, test-taking, and note-taking skills. Additional modules support career-readiness. Instructors can assign module material with a post-quiz.

Additional Resources in MyMathLab

For Students

Student's Solutions Manual*

By Judy Henn

Contains completely worked-out annotated solutions for all the odd-numbered exercises in the text. Also includes fully worked-out annotated solutions for all the exercises (odd- and even-numbered) in the Mid-Chapter Reviews, the Summary and Reviews, the Chapter Tests, and the Cumulative Reviews.

For Instructors

Instructor's Resource Manual with Tests and Mini Lectures**

(download only)
By Laurie Hurley

This manual includes resources designed to help both new and experienced instructors with course preparation and classroom management. This includes chapter-by-chapter teaching tips and support for media supplements. Contains two multiple-choice tests per chapter, six free-response tests per chapter, and eight final exams.

Instructor's Solutions Manual**

(download only)
By Judy Henn

This manual contains detailed, worked-out solutions to all odd-numbered exercises and brief solutions to the even-numbered exercises in the exercise sets.

PowerPoint® Lecture Slides**

(download only)

Present key concepts and definitions from the text.

To learn more about how MyMathLab combines proven learning applications with powerful assessment, visit http://www.mymathlabglobal.com or contact your Pearson representative.

**Also available for download from the Instructor Resource Center (IRC) on http://www.pearsonglobaleditions.com/Bittinger.

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CHAPTER

1

Whole Numbers

1.1 Standard Notation
1.2 Addition
1.3 Subtraction
1.4 Multiplication
1.5 Division

Mid-Chapter Review

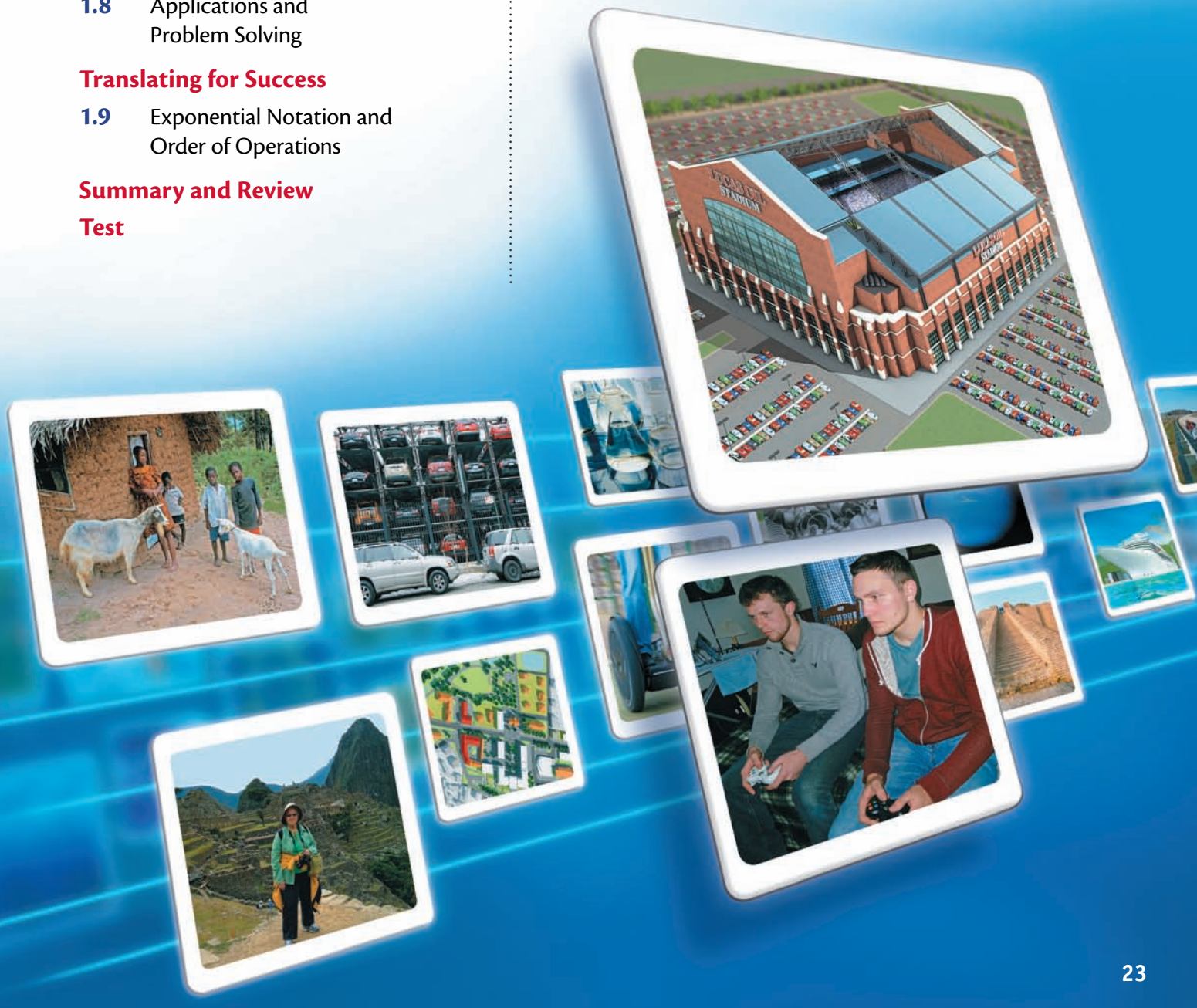
1.6 Rounding and Estimating; Order
1.7 Solving Equations
1.8 Applications and Problem Solving

Translating for Success

1.9 Exponential Notation and Order of Operations

Summary and Review

Test



STUDYING FOR SUCCESS *Getting Off to a Good Start*

- ☐ Your syllabus for this course is extremely important. Read it carefully, noting required texts and materials.
- ☐ If there is an online component for your course, register for it as soon as possible.
- ☐ At the front of the text, you will find a Student Organizer card. This pullout card will help you keep track of important dates and useful contact information.

1.1 Standard Notation

OBJECTIVES

- **a** Give the meaning of digits in standard notation.
- **b** Convert from standard notation to expanded notation.
- **c** Convert between standard notation and word names.

We study mathematics in order to be able to solve problems. In this section, we study how numbers are named. We begin with the concept of place value.

a PLACE VALUE

The numbers of jobs available in 2010 for several professions are shown in the following table.

PROFESSION	NUMBER OF JOBS, 2010
Registered nurses	2,737,400
Radiologic technologists	219,900
Radiation therapists	16,900

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics

A **digit** is a number 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9 that names a place-value location. For large numbers, digits are separated by commas into groups of three, called **periods**. Each period has a name: *ones, thousands, millions, billions, trillions,* and so on. To understand the number of jobs for registered nurses in the table above, we can use a **place-value chart**, as shown below.

PLACE-VALUE CHART

Periods →	Trillions			Billions			Millions			Thousands			Ones		
									2	7	3	7	4	0	0
	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones	Hundreds	Tens	Ones

2 millions 737 thousands 400 ones

EXAMPLES In each of the following numbers, what does the digit 8 mean?

1. 278,342 — 8 thousands
2. 872,342 — 8 hundred thousands
3. 28,343,399,223 — 8 billions
4. 98,413,099 — 8 millions
5. 6328 — 8 ones

Do Margin Exercises 1–6 (in the margin at right). ▶

What does the digit 2 mean in each number?

1. 526,555 **2.** 265,789
3. 42,789,654 **4.** 24,789,654
5. 8924 **6.** 5,643,201

EXAMPLE 6 ***Charitable Organizations.*** Since its founding in 1881 by Clara Barton, the American Red Cross has been the nation's best-known emergency response organization. As part of a worldwide organization, the American Red Cross also aids victims of devastating natural disasters. For the fiscal year ending June 2011, the total revenue of the American Red Cross was $3,452,960,387. What digit names the number of ten millions?

Source: charitynavigator.org

Ten millions

3,452,960,387

The digit 5 is in the ten millions place, so 5 names the number of ten millions.

Do Exercise 7. ▶

7. ***Government Payroll.*** In March 2011, the total payroll for all state employees in the United States was $19,971,861,990. What digit names the number of ten billions?

Source: *2011 Annual Survey of Public Employment and Payroll*

b CONVERTING FROM STANDARD NOTATION TO EXPANDED NOTATION

Heifer International is a charitable organization whose mission is to work with communities to end hunger and poverty and care for the earth by providing farm animals to impoverished families around the world. Consider the data in the following table.

GEOGRAPHICAL AREAS OF NEED	NUMBER OF FAMILIES ASSISTED DIRECTLY AND INDIRECTLY BY HEIFER INTERNATIONAL IN 2011
Africa	220,275
Americas	934,871
Asia, South Pacific	407,640
Central and Eastern Europe	344,945

SOURCE: *Heifer International 2011 Annual Report*

Answers

1. 2 ten thousands **2.** 2 hundred thousands **3.** 2 millions **4.** 2 ten millions **5.** 2 tens **6.** 2 hundreds **7.** 1

The number of families assisted in the Americas was 934,871. This number is expressed in **standard notation**. We write **expanded notation** for 934,871 as follows:

$$934{,}871 = 9 \text{ hundred thousands} + 3 \text{ ten thousands} + 4 \text{ thousands} + 8 \text{ hundreds} + 7 \text{ tens} + 1 \text{ one}.$$

EXAMPLE 7 Write expanded notation for 1815 ft, the height of the CN Tower in Toronto, Canada.

$$1815 = 1 \text{ thousand} + 8 \text{ hundreds} + 1 \text{ ten} + 5 \text{ ones}$$

EXAMPLE 8 Write expanded notation for 407,640, the number of families in Asia and the South Pacific assisted by Heifer International in 2011.

$$407{,}640 = 4 \text{ hundred thousands} + 0 \text{ ten thousands} + 7 \text{ thousands} + 6 \text{ hundreds} + 4 \text{ tens} + 0 \text{ ones}$$

or

$$4 \text{ hundred thousands} + 7 \text{ thousands} + 6 \text{ hundreds} + 4 \text{ tens}$$

Do Exercises 8–11.

Write expanded notation.

8. 2718 mi, the length of the Congo River in Africa

GS

$2718 = 2 \square + 7 \square + \square \text{ ten} + \square \text{ ones}$

9. 344,945, the number of families in Central and Eastern Europe assisted by Heifer International in 2011

10. 1670 ft, the height of the Taipei 101 Tower in Taiwan

11. 104,094 square miles, the area of Colorado

C CONVERTING BETWEEN STANDARD NOTATION AND WORD NAMES

We often use **word names** for numbers. When we pronounce a number, we are speaking its word name. Russia won 82 medals in the 2012 Summer Olympics in London, Great Britain. A word name for 82 is "eighty-two." Word names for some two-digit numbers like 36, 51, and 72 use hyphens. Others like that for 17 use only one word, "seventeen."

2012 Summer Olympics Medal Count

COUNTRY	GOLD	SILVER	BRONZE	TOTAL
United States of America	46	29	29	104
People's Republic of China	38	27	23	88
Russia	24	26	32	82
Great Britain	29	17	19	65
Germany	11	19	14	44

SOURCE: espn.go.com

Answers

8. 2 thousands + 7 hundreds + 1 ten + 8 ones
9. 3 hundred thousands + 4 ten thousands + 4 thousands + 9 hundreds + 4 tens + 5 ones
10. 1 thousand + 6 hundreds + 7 tens + 0 ones, or 1 thousand + 6 hundreds + 7 tens
11. 1 hundred thousand + 0 ten thousands + 4 thousands + 0 hundreds + 9 tens + 4 ones, or 1 hundred thousand + 4 thousands + 9 tens + 4 ones

Guided Solution:
8. thousands, hundreds, 1, 8