

TENTH EDITION

COLLEGE MATHEMATICS

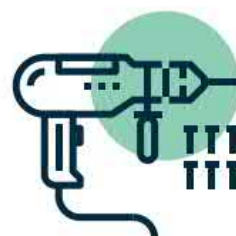
FOR **TRADES** AND **TECHNOLOGIES**



DRAFTING



CONSTRUCTION



CARPENTRY



ALLIED HEALTH



AUTOMOTIVE



AVIATION



AGRICULTURE &
LANDSCAPING



ELECTRONICS
TECHNOLOGY



BUSINESS &
FINANCE



CHERYL **CLEAVES**
MARGIE **HOBBS**

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Conversion Factors

U.S. Customary	To Change		Multiply By
	From	To	
Length or Distance			
12 inches (in.) =	feet	inches	12
1 foot (ft)	inches	feet	0.0833333
3 feet (ft) =	feet	yards	0.333333
1 yard (yd)	yards	feet	3
36 inches (in.) =	yards	inches	36
1 yard (yd)	inches	yards	0.027778
5,280 feet (ft) =	miles	feet	5,280
1 mile (mi)	feet	miles	0.000189
Weight or Mass			
16 ounces (oz) =	pounds	ounces	16
1 pound (lb)	ounces	pounds	0.0625
2,000 pounds (lb) =	tons	pounds	2,000
1 ton (T)	pounds	tons	0.0005
Liquid Capacity or Volume			
3 teaspoons (t) =	tablespoon	teaspoon	3
1 tablespoon (T)	teaspoon	tablespoon	0.333333
2 tablespoons (T) =	ounce	tablespoon	2
1 ounce (oz)	tablespoon	ounce	0.5
8 ounces (oz) =	cups	ounces	8
1 cup (c)	ounces	cups	0.125
2 cups (c) =	pints	cups	2
1 pint (pt)	cups	pints	0.5
2 pints (pt) =	quarts	pints	2
1 quart (qt)	pints	quarts	0.5
4 quarts (qt) =	gallons	quarts	4
1 gallon (gal)	quarts	gallons	0.25

Units of Time	To Change		Multiply By
	From	To	
1 minute =	minutes	seconds	60
60 seconds	seconds	minutes	0.016667
1 hour =	hours	minutes	60
60 minutes	minutes	hours	0.016667
1 day = 24 hours	days	hours	24
	hours	days	0.041667
1 week = 7 days	weeks	days	7
	days	weeks	0.142857
1 fortnight =	fortnights	weeks	2
2 weeks	weeks	fortnights	0.5
1 month = 30 days (ordinary time)	months	days	30
	days	months	0.033333
1 leap month = 29 days	leap months	days	29
	days	leap months	0.034483
1 year = 12 months	years	months	12
	months	years	0.083333
1 year = 365 days	years	days	365
	days	years	0.002740
1 decade = 10 years	decades	years	10
	years	decades	0.1
1 century = 100 years	centuries	years	100
	years	centuries	0.01

Metric System	To Change		Multiply By
	From	To	
Length or Distance			
1 kilometer (km) =	kilometers	meters	1,000
1,000 meters (m)	meters	kilometers	0.001
1 hectometer (hm) =	hectometers	meters	100
100 meters	meters	hectometers	0.01
1 dekameter (dkm)	dekameters	meters	10
or da) = 10 meters	meters	dekameters	0.1
1 decimeter (dm) =	decimeters	meters	0.1
0.1 meter	meters	decimeters	10
1 centimeter (cm) =	centimeters	meters	0.01
0.01 meter	meters	centimeters	100
1 millimeter (mm) =	millimeters	meters	0.001
0.001 meter	meters	millimeters	1,000
Weight			
1 kilogram (kg) =	kilograms	grams	1,000
1,000 grams (g)	grams	kilograms	0.001
1 hectogram (hg) =	hectograms	grams	100
100 grams	grams	hectograms	0.01
1 dekagram (dkg) =	dekagrams	grams	10
10 grams	grams	dekagrams	0.1
1 decigram (dg) =	decigrams	grams	0.1
0.1 gram	grams	decigrams	10
1 centigram (cg) =	centigrams	grams	0.01
0.01 gram	grams	centigrams	100
1 milligram (mg) =	milligrams	grams	0.001
0.001 gram	grams	milligrams	1,000
Capacity			
1 kiloliter (kL) =	kiloliters	liters	1,000
1,000 liters (L)	liters	kiloliters	0.001
1 hectoliter (hL) =	hectoliters	liters	100
100 liters	liters	hectoliters	0.01
1 dekaliter (dkL) =	dekaliters	liters	10
10 liters	liters	dekaliters	0.1
1 deciliter (dL) =	deciliters	liters	0.1
0.1 liter	liters	deciliters	10
1 centiliter (cL) =	centiliters	liters	0.01
0.01 liter	liters	centiliters	100
1 milliliter (mL) =	milliliters	liters	0.001
0.001 liter	liters	milliliters	1,000

Units of Area	To Change		Multiply By
	From	To	
1 square foot =	square feet	square inches	144
144 square inches	square inches	square feet	0.006944
1 square yard =	square yards	square feet	9
9 square feet	square feet	square yards	0.111111
1 square mile =	square miles	square kilometers	2.5887
2.5887 square kilometers	square kilometers	square miles	0.386294

Changing Temperature between Fahrenheit and Celsius

Fahrenheit to Celsius: Subtract 32 then multiply by $\frac{5}{9}$

$$C = \frac{5}{9}(F - 32) \text{ or } C = \frac{F - 32}{1.8}$$

Celsius to Fahrenheit: Multiply by $\frac{9}{5}$ then add 32

$$F = \frac{9}{5}C + 32 \text{ or } F = 1.8C + 32$$

U.S. Customary and Metric Comparisons	To Change		Multiply By
	From	To	
Length			
1 meter =	meters	inches	39.37
39.37 inches	inches	meters	0.0254
1 meter =	meters	feet	3.2808
3.2808 feet	feet	meters	0.3048
1 meter =	meters	yards	1.0936
1.0936 yards	yards	meters	0.9144
1 centimeter =	centimeters	inches	0.3937
0.3937 inch	inches	centimeters	2.54
1 millimeter =	millimeters	inches	0.03937
0.03937 inch	inches	millimeters	25.4
1 kilometer =	kilometers	miles	0.6214
0.6214 mile	miles	kilometers	1.6093
Weight or Mass			
1 gram =	grams	ounces	0.0353
0.0353 ounce	ounces	grams	28.3286
1 kilogram =	kilograms	pounds	2.2046
2.2046 pounds	pounds	kilograms	0.4536
Liquid Capacity			
1 liter =	liters	quarts	1.0567
1.0567 quarts	quarts	liters	0.9463
Capacity or Volume			
1 cubic inch =	cubic inches	cubic centimeters	16.387
16.387 cubic centimeters	cubic centimeters	cubic inches	0.0610
1 cubic inch =	cubic inches	liters	0.01639
0.01639 liters	liters	cubic inches	61.0128
1 cubic foot =	cubic feet	cubic meters	0.0283
0.0283 cubic meter	cubic meters	cubic feet	35.3357
1 teaspoon =	teaspoons	milliliters	4.93
4.93 milliliters	milliliters	teaspoons	0.2028
1 tablespoon =	tablespoons	milliliters	14.97
14.97 milliliters	milliliters	tablespoons	0.0668
1 fluid ounce =	fluid ounces	milliliters	29.57
29.57 milliliters	milliliters	fluid ounces	0.0338
1 cup = 0.24 liters	cups	liters	0.24
	liters	cups	4.1667
1 pint = 0.47 liters	pints	liters	0.47
	liters	pints	2.1277
1 gallon =	gallons	cubic meters	0.00379
0.00379 cubic meters	cubic meters	gallons	263.85

Symbols

+	Add
-	Subtract
$\times, \cdot, *, ()$	Multiply
$\div, \bar{), /, \text{—}}$	Divide
=	Equal to
≈	Approximately equal to
≠	Not equal to
%	Percent
>	Greater than
<	Less than
≥	Greater than or equal to
≤	Less than or equal to
$\sqrt{\quad}$	Radical sign or square root
$(), [], \{ }, \text{—}$	Grouping symbols
$ $	Absolute value
$f(x)$	Function notation, read "f of x"
\overleftrightarrow{AB}	Line AB
\overline{AB}	Line segment AB
\overrightarrow{AB}	Ray AB
≅, ≐	Congruent to
~	Similar to (geometric figures)
∠	Angle
	Parallel
⊥	Perpendicular
△	Triangle
○	Circle
⊓	Right angle
Δ	Delta, change, used with slope
$\{ \dots \}$	Such that, used with set notation
Σ	Summation
x_1	Subscript (1)
$\{ \}, \emptyset$	Empty or null set
∈	Is an element of
∪	Union (of sets)
∩	Intersection (of sets)
π	Constant—Pi (ratio of diameter to circumference of circle, approximately 3.141592654)
e	Constant—natural exponential; from $\left(1 + \frac{1}{n}\right)^n$ where $n \rightarrow \infty$, approximately 2.718281828
i	The square root of -1; $\sqrt{-1}$
∞	Infinity
∴	Therefore
∃	There exists
∀	For every

Special Algebra Patterns for Factoring

$$a^2 + 2ab + b^2 = (a + b)^2$$

$$a^2 - b^2 = (a + b)(a - b)$$

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

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COLLEGE MATHEMATICS

FOR TRADES AND TECHNOLOGIES

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Preface

In *College Mathematics for Trades and Technologies*, Tenth Edition, we have preserved all the features in previous editions that have made this one of the most appropriate texts on the market for a comprehensive study of mathematics in general education and in career programs. We continue to use real-life situations as a context for applied problems.

What's New

The tenth edition retains the writing style and pedagogy that has made the first nine editions successful, while incorporating new features and new material to keep abreast of the curriculum and technology changes that are occurring globally.

New Features:

- ▶ Stop and Check exercises reinforce new concepts and appear in the margins opposite the examples. The answers are located directly beneath to allow students to check their understanding, and worked-out solutions can be found online in MyLab Math.
- ▶ Examples are coded to specific exercises in the Section Exercises to facilitate the mastery of the concepts.
- ▶ Definitions are featured in the margin as they are introduced. These definitions are also included in the Glossary/Index.
- ▶ Learning Catalytics is an interactive student response tool that uses students' own devices to engage them in the learning process. Learning Catalytics is accessible through MyLab Math, where instructors can generate class discussion, promote peer-to-peer learning, and use real-time data to adjust instructional strategy. As an introduction to this exciting new tool we have provided pre-made Learning Catalytics questions that cover pre-requisite skills at the start of each section to check students' preparedness for the new section. Each question is tagged for searching **CleavesCol#**, where **#** is the chapter number. For example, search **CleavesCol8** for all questions from Chapter 8. Learn more about Learning Catalytics in the Instructor Resources tab in MyLab Math.

New Material:

- ▶ Trigonometric functions of cosecant, secant, and cotangent are introduced.
Four online appendices are available in MyLab Math, now with accompanying assignable exercises:
- ▶ Appendix A: Measuring Instruments (calipers, micrometers, uniform and non-uniform scales, and gauges)
- ▶ Appendix B: Number Systems (decimal, binary, octal, and hexadecimal)
- ▶ Appendix C: Matrices and Determinants (including solving systems of equations using Cramer's rule)
- ▶ Appendix D Conic Sections (parabolas, ellipses, circles, and hyperbolas)

Career Coding:

- Examples, section exercises, and chapter review exercises have been coded using 15 different career categories. This will strengthen students' ability to make connections between mathematical concepts and career applications. An index of applications by career code can be found at the end of the book.

AG/H	Agriculture/Horticulture/ Landscaping	Agriculture, Horticulture, Landscaping
AUTO	Auto/Diesel Technology	Automobile and Diesel Mechanics
AVIA	Aviation Technology	Aviation, Geographical Information Systems
BUS	Business/Accounting/ Real Estate	Business Administration, Accounting, Real Estate
CAD/ARC	CAD/Drafting/ Architecture/Surveying	CAD, Drafting, Architecture, Graphic Communication, Surveying
COMP	Computer Technologies	Computer Tech, Information Systems, Information Technology, Network Technology
CON	Construction Trades	Construction, Carpentry, Electrical, Plumbing, HVAC, Pipe Fitting
ELEC	Electronics Technology	Electronics Technology, Computer Electronics
HELPP	Helping Professionals/ Education/Criminal Justice/ Fire Fighting	Criminal Justice, Fire Science, Counseling, Education
HLTH/N	Allied Health/ Nursing/EMS	Healthcare, Nursing, Nutrition, EMS
HOSP	Hospitality/Culinary/ Food Technology	Hotel and Restaurant Management, Culinary Arts, Food Technology
INDTEC	Industrial Technology/ Manufacturing/Machine Technology/Engineering Technology	Manufacturing, Industrial, Machine, Engineering Technologies
INDTR	Industrial Trades/Welding/ Machine Tool/Industrial Maintenance	Welding, Machine Tools, Industrial Maintenance
PFIN	Personal Finance	Home Loans, Credit Cards, Making Purchases, Best Buys
TELE	Telecommunications	Telecommunication Technology

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 power of mathematics in everyday life and in the workplace. The new material in this edition has been added to broaden the usefulness of the text. Many of the explanations have been enhanced with carefully constructed visualizations. Exercises have been updated and new ones added.

Commitment to Improving Mathematics Education

The author continues to be active in the standards and other initiatives 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.

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. In addition, specific instructions for the TI-84 calculator are given.

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

To the Student

The mathematics you learn from this book will help you advance on your career path. 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.

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.

In Great Company. Each chapter opens with an interesting article that gives a situation that resulted from errors made in mathematics. These articles are intended to motivate you to learn from your own errors.

In Great
Company

The image shows a page from a textbook. At the top left, there is a large green box with the number '1' inside. Below this, the title 'Review of Basic Concepts' is displayed in green. To the left of the main content, there is a sidebar with three items: 'Basic Operations with Real Numbers and Complex Numbers', 'Exponents, Roots, and Powers of 10', and 'Order of Operations and Problem Solving'. The main content area features a photograph of a young woman with glasses sitting at a desk with an open book, looking thoughtful. Below the photo, the 'In Great Company' section is titled 'Math: Nobody's Perfect' and contains text about learning from mistakes in mathematics.

3-2 Percentage Problems

LEARNING OUTCOMES

- 1 Identify the portion, base, and rate in percent problems.
- 2 Solve percent problems using the percentage formula.
- 3 Solve percent problems using the percentage proportion.
- 4 Solve business and consumer problems involving percents.

LEARNING CATALYTICS

- Perform the operations.
1. $0.3(900)$
 2. $\frac{80}{0.3}$
 3. $\frac{60}{240}$

STOP AND CHECK

- Identify the P , B , and R for each example.
1. What number is 30% of 80?
 2. 45 is what percent of 90?
 3. 25% of what number is 35?

- Answers:
1. P is missing. $B = 80$. $R = 30\%$.
 2. $P = 45$. $B = 90$. R is missing.
 3. $P = 35$. B is missing. $R = 25\%$.

Formula: a symbolic statement of words or letters that expresses a relationship among quantities

Percentage formula: Portion = Rate \times Base, or $P = RB$

Base: the number (B) that represents the original or total amount

Portion: the number (P) that represents a part or portion of the base. Also called percentage

Rate: the rate (R) is a percent that tells us how the base and portion are related

Percentage: in a problem involving percent, the number (P) that represents a portion of the base. Also called portion; alternate definition is a fraction or ratio with 100 understood as the denominator

1 Identify the Portion, Base, and Rate in Percent Problems. A **formula** expresses a relationship among quantities. When you use the six-step problem-solving approach, the third step, the Solution Plan, is often a formula written in words and letters.

The **percentage formula**, Portion = Rate \times Base, can be written as $P = RB$. The letters or words represent numbers.

In the formula $P = RB$, the **base** (B) represents the original number or one entire quantity. The **portion** (P) represents a part of the base. The **rate** (R) is a percent that tells us how the base and portion are related. In the statement "50 is 20% of 250," 250 is the base (the entire quantity), 50 is the portion (part), and 20% is the rate (percent).

To identify the rate, base, and portion:

1. Identify the rate. *Rate* is usually written as a percent, but it may be a decimal or fraction.
2. Identify the base. *Base* is the total amount, original amount, or entire amount. The base often follows the preposition *of*.
3. Identify the portion. *Portion* can refer to the part, partial amount, amount of increase or decrease, or amount of change. It is a portion of the *base*. The portion often follows a form of the verb *is*.

EXAMPLE 1

Identify the given and missing elements for each example.

- (a) 20% of 75 is what number?
- (b) What percent of 50 is 30?
- (c) Eight is 10% of what number?

R B P
 Percent Total Part

- (a) 20% of 75 is what number?

Use the identifying key words for rate (percent or %), base (total, original, associated with the word *of*), and portion (part, associated with the word *is*).

R B P
 Percent Total Part

- (b) What percent of 50 is 30?

P R B
 Part Percent Total

- (c) Eight is 10% of what number?

See Exercises 1–12.

Did You Know? **Portion can be called percentage.** In a standard dictionary you will see **percentage** defined as "a fraction or ratio with 100 understood as the denominator," as "the result obtained by multiplying a quantity by a percent," and as "a portion or share in relation to a whole; a part." That is, the word *percentage* can refer to both the rate and the portion. This causes many to confuse the words *percent* and *percentage*. Because in written reports the word *percentage* is often used to identify the *percent* or *rate* instead of the portion, we will only use the word *portion* when referring to a *part of the base*.

Learning Outcomes

Learning Catalytics

Stop and Check

Key Vocabulary Terms

Procedures box

Tip Box

Learning Outcomes. A learning outcome is what you should be able to do when you master a concept. These outcome statements can guide you through your study plan. 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. Section Exercises are organized by learning outcomes, and the Chapter Review of Key Concepts give procedures to review and a worked example for each learning outcome.

Learning Catalytics. These questions in the text are featured in Learning Catalytics available through MyLab Math. This interactive student response tool uses students' own devices to engage them in the learning process. Instructors can generate class discussion, promote peer-to-peer learning, and use real-time data to adjust instructional strategy. The questions we have provided test pre-requisite skills at the start of each section to check students' preparedness for the new section. Learn more about Learning Catalytics in the Instructor Resources tab in MyLab Math.

Procedures Boxes. Each learning outcome has one or more procedures boxes. These boxes provide rules or procedures presented as numbered steps. A procedures box may also present a mathematical property, formula, or fact.

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.

Stop and Check Exercises. These extra exercises located in the margin give students immediate practice with answers as new concepts are introduced, so they can master every outcome.

Key Terms. These important vocabulary words are highlighted in bold in the text and called out in the margin with their definitions.

Career coding
in examples

Six-Step
Problem
Solving
Example with
Explanatory
Comments

SECTION 1-3 Order of Operations and Problem Solving 43

More than one relationship may be needed to find the unknown facts. When this is the case, you usually need to read the problem several times to find all the relationships and plan your solution strategy.

EXAMPLE 13

BUS Carlee Anne McAnally needs to ship 78 crystal vases. With standard packing to prevent damage, 5 vases fit in each available box. How many boxes are required to pack the vases?

Unknown fact
Number of boxes required to pack the vases

Known facts
total vases to be shipped = 78
number of vases per box = 5

Relationships
total boxes needed = total number of vases ÷ number per box
total boxes needed = $78 \div 5$

Estimation
 $70 \div 5 = 14$ Round down the dividend.
 $80 \div 5 = 16$ Round up the dividend.
Since 78 is between 70 and 80, the number of boxes needed is between 14 and 16.

Calculation
 $78 \div 5 = 15 \text{ R}3$

Interpretation
16 boxes are needed; 15 boxes will contain 5 vases each, and 1 box will contain 3 vases. The box with 3 vases will need extra packing material. See Exercise 71.

TIP Using Guessing and Checking to Solve Problems An effective strategy for solving problems involves guessing. Make a guess that you think may be reasonable, and check to see if the answer is correct. If your guess is not correct, decide if it is too high or too low. Make another guess based on what you learned from your first guess. Continue until you find the correct answer.

Let's try guessing in the previous example. We found that we could pack 70 vases in 14 boxes and 80 vases in 16 boxes. Since we need to pack 78 vases, how many vases can we pack with 15 boxes? $15(5) = 75$. Still not enough. Therefore, we will need 16 boxes, but the last box will not be full.

You can probably think of other ways to solve this problem. Some plans will be more efficient than others, but you develop your problem-solving skills by pursuing a variety of strategies.

1-3 EXERCISES **MyLab Math** For additional practice go to your study plan in MyLab Math.

1 Use the order of operations to evaluate each problem. See Example 1.

1. $5^2 + 4 - 3$	2. $a^2 + b - 4$	3. $4(3) - 9 + 3$
4. $5 \cdot 2.9 - 4 + 2$	5. $25 - 5 \cdot 4.8$	6. $64 \div 4(2)$
7. $48 \div 8 \cdot 3$	8. $15 - 2 \cdot 3$	9. $a^2 - (4)(3) + 6$

Career-Coded Examples and Exercises. Applied problems focus on a wide variety of careers available as a course of study at your community college, technology center, or university. These careers are grouped into 14 categories, and the examples and exercises are coded to these categories as appropriate. There is also a category for personal finance which is appropriate for all career choices. An index of applications is provided in the back of the book for your convenience.

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

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

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

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 key-strokes is often included. In addition, the tips help you determine how your type of calculator operates for various mathematical processes.

Section Exercises with Reference to Examples

Chapter Review of Key Concepts

See Example 8.

14. Five defective pens were accidentally placed in a box of 139 good pens, making a box of 144 pens. What is the probability of finding a defective pen on the second try if the first try resulted in finding a defective pen?

See Example 9.

16. A company has seven employees. Their ages are 25, 27, 32, 47, 56, 63, and 67, respectively.

What is the probability of selecting an employee for an assignment that is at least 21 years old?

See Example 10.

18. What are the odds against selecting a female employee from a group of 18 female and 6 male employees?

15. A drawing will be held to award door prizes. If the names of 24 people (no repeated names) are in the pool for the drawing, what is the probability that David's name will be pulled at random for the first prize? If his name is pulled and not replaced, what is the probability that Gaynell's name will be pulled next?

17. Playing cards have red or black faces. What is the probability of drawing a card with a green face from a deck of playing cards?

19. An employer has 18 female and 6 male employees who do the same work. What are the odds for selecting a female employee from this group for a special assignment?

6

CHAPTER REVIEW OF KEY CONCEPTS

LEARNING OUTCOMES

Section 6-1

1. Read circle graphs [p. 265].

KEY CONCEPTS AND EXAMPLES

Read a circle, bar, or line graph: 1. Examine the title of the graph to find out what information is shown. 2. Examine the parts to see how they relate to one another and to the whole. 3. Examine the labels for each part of the graph and any explanatory remarks that may be given. 4. Use the given parts to calculate additional amounts or percents.

A circle graph compares parts to a whole.

If the total monthly revenue at a used car dealership is \$75,000, what is the revenue from trucks? (See Fig. 6-22.)

$$35\% \text{ of } 75,000 = \\ 0.35 \times 75,000 = \$26,250$$

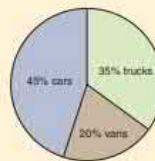


FIGURE 6-22

Section 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. Each example in the section has at least one exercise that is referenced to that example.

Chapter Review of Key Concepts. 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 procedures and examples for each outcome. Page references are included to facilitate your preview or review of the chapter.

4 CHAPTER REVIEW EXERCISES

Section 4-1 MyLab Math For additional practice go to your study plan in MyLab Math.

Write two unit ratios that relate the given pair of measures.

- Feet and inches
- Hours and days
- Pounds and tons
- Yards and miles

Using unit ratios or conversion factors, convert the given measures to the new units.

- How many ounces are in 5 lb?
- HELPP** A fire suit weighing $57\frac{1}{2}$ lb weighs how many ounces?
- Find the number of pounds in 680 oz.
- HOSF** A can of fruit weighs 22.4 oz. How many pounds is this?
- AG/H** How many feet of wire are needed to fence a property line $1\frac{1}{4}$ mi long?
- AVIA** The tail height of a B 737-200 aircraft is 36 ft 6 in. How many inches is the tail height?

Express the measures in standard notation.

- 1 ft 19 in.
- 1 mi 5,375 ft
- 12 lb $17\frac{1}{2}$ oz.
- 2 gal 7 qt

Add or subtract. Write answers in standard notation.

- $$\begin{array}{r} 5 \text{ gal } 3 \text{ qt} \\ + 2 \text{ gal } 3 \text{ qt} \\ \hline \end{array}$$
- $$\begin{array}{r} 7 \text{ ft } 9 \text{ in.} \\ - 4 \text{ ft } 6 \text{ in.} \\ \hline \end{array}$$
- $$\begin{array}{r} 4 \text{ lb } 9 \text{ oz} \\ - 3 \text{ lb } 11 \text{ oz} \\ \hline \end{array}$$
- AVIA** Two packages to be sent air express weigh 5 lb 4 oz each. What is the shipping weight of the two packages?
- AUTO** A water hose purchased for an RV was 2 ft long. What was its length after 7 in. were cut off?

Multiply and write answers for mixed measures in standard notation.

- $$\begin{array}{r} 8 \text{ lb } 3 \text{ oz} \\ \times 9 \\ \hline \end{array}$$
- $$\begin{array}{r} 9 \text{ in.} \\ \times 7 \text{ in.} \\ \hline \end{array}$$
- $$\begin{array}{r} 10 \text{ gal } 3 \text{ qt} \\ \times 7 \\ \hline \end{array}$$

Divide.

- $20 \text{ yd } 2 \text{ ft } 6 \text{ in.} \div 2$
- HELPP** If 18 lb of flame retardant are divided equally into four boxes, express the weight of the contents of each box in pounds and ounces.
- $14 \text{ ft} \div 4 \text{ ft}$
- $5 \frac{\text{mi}}{\text{min}} = \frac{\text{mi}}{\text{h}}$
- HOSP** How many quarts of milk are needed for a recipe that calls for 3 pt of milk?
- $5 \text{ gal } 3 \text{ qt } 2 \text{ pt} \div 6$
- CON** If 32 equal lengths of pipe are needed for a job and each length is to be 2 ft 8 in., how many feet of pipe are needed for the job?
- $2 \text{ mi } 120 \text{ ft} \div 15 \text{ ft}$
- $2,520 \frac{\text{gal}}{\text{h}} = \frac{\text{qt}}{\text{h}}$
- HOSP** How many $\frac{1}{2}$ -oz servings of jelly can be made from a $1\frac{1}{2}$ -lb container of jelly?

Section 4-2

Give the prefix that relates each number to the standard unit in the metric system.

- 1,000 times
- $\frac{1}{10}$ of
- $\frac{1}{1,000}$ of
- 10 times

Chapter Review 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. **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.

Team Problem-Solving Exercises. Employers value an employee's ability to interact with others in a team environment. These exercises will allow you to develop and refine your team-interaction skills.

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.

Write as a fraction in lowest terms.

229. $0.12\frac{1}{2}$

230. $0.37\frac{1}{2}$

Perform the calculations using a calculator.

231. $\frac{7}{8} + \frac{1}{2}$
 $\frac{2}{4}$

232. $\frac{5}{3}$
 $\frac{5}{6} - \frac{1}{3}$

233. $\frac{5}{16} - \frac{1}{8}$
 $\frac{11}{32} + \frac{1}{4}$

Team Problem-Solving Exercises

2 TEAM PROBLEM-SOLVING EXERCISES

Your team is preparing a report that is to be printed on both sides of the paper. It is customary to put odd-numbered pages on the front and even-numbered pages on the back. A new chapter is started on the front of a sheet of paper, even if this creates a preceding blank page. Assign page numbers to the document based on these guidelines.

Chap. 1, 15 pages Chap. 2, 17 pages
Chap. 3, 24 pages Chap. 4, 15 pages

1. What page number will start Chapter 2?
2. How many pages are in the document?
3. How many blank pages are in the document?

Concepts Analysis

2 CONCEPTS ANALYSIS

1. What two operations require a common denominator?
2. Explain how to find the reciprocal of a fraction.
3. What steps must be followed to find the reciprocal of a mixed number?
4. What number can be written as any fraction that has the same numerator and denominator? Explain why.
5. What operation requires the use of the reciprocal of a fraction?
6. Name the operation that has each of the following for an answer: sum, difference, product, quotient.
7. What operation must be used to solve an applied problem if the total and one of the two parts are given?
8. What does the denominator of a fraction indicate?
9. What does the numerator of a fraction indicate?
10. What kind of fraction has a value less than 1?

Find, explain, and correct the mistakes in these problems.

11. $\frac{5}{8} + \frac{1}{8} = \frac{6}{16} = \frac{3}{8}$

12. $\frac{12}{7} - \frac{3}{4}$
 $\frac{3}{4}$

13. $\frac{3}{5} \times 2\frac{1}{5} = 2\frac{3}{25}$

14. $\frac{5}{8} + 4 = \frac{5}{8} \times \frac{4}{1} = \frac{5}{2} = 2\frac{1}{2}$

15. $12\frac{3}{4} = 12\frac{6}{8} = 11\frac{16}{8}$
 $-4\frac{7}{8} = -4\frac{7}{8} = -4\frac{7}{8}$
 $\frac{9}{8} = 7 + 1\frac{1}{8} = 8\frac{1}{8}$

Practice Test

2 PRACTICE TEST

Represent as fractions.

1. 3 out of 4 people in a survey

Write as whole or mixed numbers.

2. $7 \div 9$

3. $\frac{9}{3}$

4. $\frac{14}{9}$

Practice Test. The practice 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.

Cumulative Practice Tests. Practice tests for a group of chapters are included after Chapters 3, 6, 10, 15, 18, and 20. These tests will help you prepare for mid-course or end-of-course exams. Periodically reviewing previously learned material will help you retain the concepts for a longer period of time. **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.

Resources for Success

Get the Most Out of MyLab Math for *College*

Mathematics for Trades and Technologies, Tenth Edition

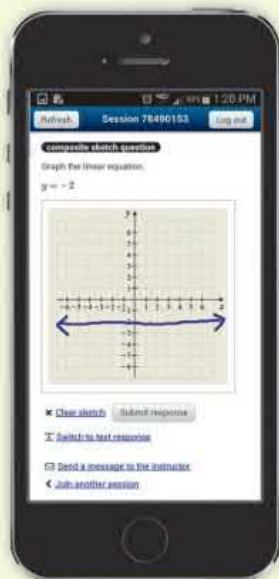
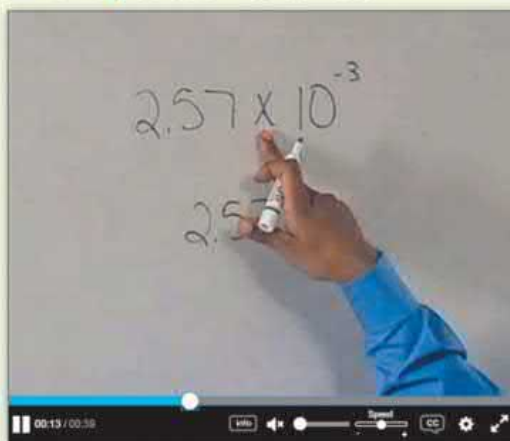
by Cheryl Cleaves and Margie Hobbs

College Mathematics for Trades and Technologies 10th edition offers market-leading content written by author-educators, tightly integrated with the #1 choice in digital learning—MyLab Math. MyLab Math courses can be tailored to the needs of instructors and students, while weaving the author team’s voice and unique approach into all elements of the course. With *College Mathematics*, learning mathematical concepts through real-world trade applications comes through from the text to the MyLab course seamlessly.

Take advantage of the following resources to get the most out of your MyLab Math course.

Motivate and Support Students with Updated Resources

Updated video program provides example-based videos for each section of the text. These videos are short enough that students will actually watch them, and walk students through the solution process of types of problems. The mobile-ready player allows videos to be played on any device-support students no matter where they are.



NEW! Learning Catalytics is an interactive student response tool that uses students’ smartphones, tablets, or laptops to engage them in more sophisticated tasks and thinking. Available through the MyLab Math course, pre-made questions specific to *College Mathematics* are available to use with students. Margin references in the text indicate where an existing Learning Catalytics question would be applicable to use. To find these questions in Learning Catalytics, search for “CleavesCol#” where # is the chapter number.



Resources for Success

Motivate and Support Students with Updated Resources

NEW! A trade application question library provides a wide range of exercises available to assign to work for any instructor's class dynamics. Available in the MyLab Math Assignment Manager, this library of exercises now allows instructors to pull in additional application questions from particular trades or industries.

Expanded MyLab exercise coverage now includes coverage of all online appendices, giving students the chance to practice and reinforce skills from all content areas.

Score: 0 of 1 pt | 15 of 16 (0 complete) | HW Score: 0%, 0 of 16 pts

4.2.B-27 | Question Help

The base of the flange shown in the drawing is actually 6 in. Its drawing width is 5 in.

(a) What will be the actual dimension A if A is 3.75 in. on the drawing?
(b) Find the scale factor of the drawing.

(a) The actual dimension of A is in. (Type a whole number or a decimal.)
(b) The scale factor of the drawing is . (Type a whole number or a simplified fraction.)

Resources for Instructors

The following resources can be downloaded from the Instructor's Resource Center on www.pearson.com, or in the MyLab Math course.

Instructor's Resource Manual

This resource includes teaching tips and activity ideas for each chapter, which can be used for individual or group work, as well as solutions to even-numbered exercises for Chapter Reviews, Practice Tests, Cumulative Practice Tests, and solutions to all Concept Analysis exercises.

UPDATED! TestGen

TestGen® (www.pearsoned.com/testgen) enables instructors to build, edit, print, and administer tests using a computerized bank of questions developed to cover all the objectives of the text. Updated for the 10th edition, TestGen is now algorithmically based, allowing instructors to create multiple but equivalent versions of the same question or test with the click of a button. Instructors can also modify test bank questions or add new questions.

Resources for Students

Student Solutions Manual

This manual contains completely worked-out solutions for all the odd-numbered exercises in the Chapter Reviews, Practice Tests, and Cumulative Practice Test in the text.

Acknowledgments

A project such as this does not come together without help from many people. My first avenue for input is through students and faculty who use the text. Their comments and suggestions have been invaluable.

I wish to express thanks to all the people who helped make this edition a reality, especially team leaders Matt Summers and Tamela Ambush, and project manager Amy Kopperude at iEnergizer Aptara®, Ltd.

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

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Finally, I want to dedicate this book to Margie Hobbs. Margie and I began working together at State Technical Institute at Memphis in 1975 and published our first textbook in 1979. Through the years we were more than just best friends, we were family. Margie had a unique set of qualities that truly set her apart: her attention to detail, her passion and persistence, and her willingness to see the job through made the people around her better—made me better. Her commitment to her family, to the profession of teaching, to her students, to her colleagues, and to this project was unquestioned. She was a dedicated professional to the end, but somehow she managed to always put the needs of others first—which is a truly remarkable thing. Her legacy will live on not only in this textbook, but in our hearts. Thank you for everything you did for us, Margie, and for making me part of your family.

Cheryl Cleaves



Dr. Margie Johnson Hobbs
June 13, 1943–March 16,
2016

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1

Review of Basic Concepts

1-1 Basic Operations with Whole Numbers and Decimals

1-2 Exponents, Roots, and Powers of 10

1-3 Order of Operations and Problem Solving



Ximagination/123RF

In Great Company

Math: Nobody's Perfect

Some people hate to do math because they get frustrated when they make a mistake. Even the most expert mathematician can spend hours working through a problem only to have a teensy-tiny mistake turn the whole thing into useless trash. If you think math demands absolute perfection or if you think your work is wrong if it isn't perfect in every way, then you will be defeated before you even begin to do math.

So, in mathematics, the first step to success is simple: recognize that no one can always get it perfect every time.

The second step to success is also simple: try to do it anyway.

That is all there is to math. If you like succeeding when challenged, you will love math.

A huge part of doing well in math involves learning to separate your ego from your results. When—not if, but when—you get a math problem wrong,

that wrong answer does not mean you are stupid. All it means, is you got that one wrong. Everyone gets math wrong, some of the time. Look at all the *great company* you have!

Steve Kellmeyer, Math Instructor
Art Institute of Dallas

Scientists Can't Add (November 9, 1993)

In 1987, U.S. physicists convinced Congress that the United States was falling behind in high-energy particle physics. We must leap ahead of the competition! We must build a machine capable of carrying out such high-energy work by the next century! The physicists, the mathematicians, the Nobel laureates had it all worked out. They wanted to build what was called a Superconducting Super Collider (SSC). And they could build it, they said, for the low, low price of just \$4.4 billion. Chicken feed, really.

The U.S. government bought into the idea, and Congress approved the funds. In 1991, construction began in a little town just south of Dallas, Texas, the town of Waxahachie. The workers drilled 200 feet down and then began boring a circular tunnel through the bedrock. But even before construction began, prices had begun to rise. Worse, international collaboration, which was supposed to bring in an additional \$2 billion in funding, never actually happened.

By 1993, cost estimates for the project rose from the original \$4.4 billion to over \$12 billion. Prices had already tripled, but only 14 miles of the 54 miles (25%) of underground tunnels had been dug. Equipment still hadn't been bought. Worse, the International Space Station was competing for the same funds the SSC was supposed to get. It was too much. Congress threw in the towel on October 21, 1993, and officially canceled the SSC.

So, what did the United States get for its \$2 billion investment? A big hole in the ground in Texas, topped by a lot of empty buildings, the whole thing surrounded by rusting cyclone fences.

The mathematicians and the Department of Energy officials who oversaw the project apparently couldn't add very well. They kept miscalculating costs and failed to foresee basic difficulties. How can the American public have faith in mathematical models put forward by mathematicians who cannot add up a few dollars to arrive at realistic costs?

Remember this the next time you make a basic addition or subtraction mistake. You aren't the first to do it. You won't be the last. And it isn't nearly as humiliating for you to make such a mistake as it was for all the engineers, mathematicians, physicists, and government employees involved with the SSC. After all, they made essentially the same error, and their mistakes were splashed across the front pages of newspapers across the nation.

Decimal-number system: the system of numbers that uses 10 individual symbols called digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) and place values of powers of 10

Digit: one of the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Place value: the value of a digit based on its position in a number

1-1

Basic Operations with Whole Numbers and Decimals

LEARNING OUTCOMES

- 1 Compare whole numbers.
- 2 Write fractions with power-of-10 denominators as decimal numbers.
- 3 Compare decimal numbers.

Our system of numbers, the **decimal-number system**, uses 10 symbols called **digits**: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. A number can be represented with one or more digits. When a number contains two or more digits, each digit must be in the correct place for the number to have the value we intend it to have. Each place in the system has a specific **place value**.

The numbering system is made up of many different types of numbers. The first two types of numbers that we review are natural numbers and whole numbers. The

- 4 Round a whole number or a decimal number to a specified place value.
- 5 Add and subtract whole numbers and decimals.
- 6 Multiply and divide whole numbers and decimals.

LC LEARNING CATALYTICS

Perform the indicated operations.

1. $1 - 0.03$
2. $0.2(0.03)$
3. $1.5 \div 0.3$

Natural numbers: the set of counting numbers beginning with 1, 2, 3, and continuing indefinitely; also called counting numbers

Ellipsis (...): a notation to show that the pattern established before the ellipsis continues

Counting numbers: same as natural numbers

Whole numbers: the set of natural numbers and the number 0; numbers made up of one or more digits

Periods: groups of three place values—ones, tens, hundreds—for periods such as units, thousands, millions, billions, and trillions

Units: period formed by up to three digits on the right end of a whole number

Thousands: period formed by up to three digits to the left of the units period

Millions: period formed by up to three digits to the left of the thousands period

Billions: period formed by up to three digits to the left of the millions period

Trillions: period formed by up to three digits to the left of the billions period

Number line: visual representation of the relationship of numbers by size

Infinity (∞): a concept that numbers continue without end

Inequality: a mathematical statement showing two numbers that are not equal. Inequality symbols are $<$ and $>$

Less than ($<$): a symbol placed between two numbers showing the left number is smaller than the right number

Greater than ($>$): a symbol placed between two numbers showing the left number is larger than the right number

natural numbers begin with the number 1 and continue indefinitely (1, 2, 3, 4, 5, . . . , 101, 102, 103, . . .). Three periods that follow a list of numbers are called an **ellipsis** and mean that the pattern established before the ellipsis continues. The natural numbers are also called **counting numbers**. The set of **whole numbers** includes all the natural numbers and the number 0. Other types of numbers will be introduced as appropriate.

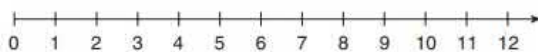
The whole-number place values are arranged in **periods**, or groups of three (Fig. 1-1) reading from right to left. The first period of three is called **units**, the second period of three is called **thousands**, the third period is called **millions**, the fourth period is called **billions**, and the fifth period is called **trillions**. Commas are used to separate these periods. The commas make larger numbers easier to read because we can locate specific place values and interpret numbers more easily. Each group of three digits has a hundreds place, a tens place, and a ones place.

Trillions Period			Billions Period			Millions Period			Thousands Period			Units Period		
Hundred trillions (100,000,000,000,000s)	Ten trillions (10,000,000,000,000s)	Trillions (1,000,000,000,000s)	Hundred billions (100,000,000,000s)	Ten billions (10,000,000,000s)	Billions (1,000,000,000s)	Hundred millions (100,000,000s)	Ten millions (10,000,000s)	Millions (1,000,000s)	Hundred thousands (100,000s)	Ten thousands (10,000s)	Thousands (1,000s)	Hundreds (100s)	Tens (10s)	Ones (1s)

FIGURE 1-1 Whole-number place values and periods.

Did You Know? In four-digit numbers, the comma separating the units period from the thousands period is optional. Thus, 4,575 and 4575 are both acceptable.

- 1 **Compare Whole Numbers.** Whole numbers can be arranged on a **number line** to show a visual representation of the relationship of numbers by size. The most common arrangement is to begin with zero and place numbers on the line from left to right as they get larger.



All numbers have a place on the number line and the numbers continue indefinitely without end. A term that is often used to describe this concept is **infinity** and the symbol is ∞ .

Whole numbers can be compared by size by determining which of the two numbers is larger or smaller. If two numbers are positioned on a number line, the smaller number is positioned to the left of the larger number. The order relationship can be written in a mathematical statement called an **inequality**. An inequality shows that two numbers are not equal; that is, one is larger than the other. Symbols for showing inequalities are the **less than** symbol $<$ and the **greater than** symbol $>$.

$5 < 7$ Five is less than seven.

$7 > 5$ Seven is greater than five.

Cardinal number: a number that shows *how many*

Ordinal number: a number that shows *order* or position

Fraction: a number that is a part of a whole number

Fraction notation: writing the numerator and denominator of a fraction separated by a horizontal bar or slash

Denominator: the denominator of a fraction is the number of parts one unit has been divided into. It is the bottom number of a fraction or the divisor of the indicated division

STOP AND CHECK

- Write two inequalities comparing the numbers 203 and 230.

Answer:

- $203 < 230$ and $230 > 203$

Numerator: the numerator of a fraction is the number of the parts being considered. It is the top number of a fraction or the dividend of the indicated division

Decimal fraction: a fraction whose denominator is always 10 or some power of 10; a fractional notation that uses the decimal point and the place values to its right to represent a fraction whose denominator is 10 or some power of 10, such as 100, 1,000, and so on. A decimal fraction is also referred to as a decimal, a decimal number, or a number using decimal notation

Power of ten: a number whose only nonzero digit is 1: 10, 100, and 1,000 are examples of powers of 10

Decimal number: an alternate name for decimal

Decimal: a fractional notation based on place values for fractions with a denominator of 10 or a power of 10

Decimal notation: a notation for writing a fraction as an equivalent decimal

Decimal point: the symbol (period) placed between the ones place and the tenths place to identify the place value of each digit

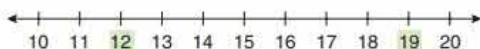
Did You Know? The inequality symbols $<$ and $>$ always point to the smaller number.

To compare whole numbers:

- Mentally position the numbers on a number line.
- Select the number that is farther to the left to be the smaller number.
- Write an inequality using the *less than* symbol. smaller number $<$ larger number
or
Write an inequality using the *greater than* symbol. larger number $>$ smaller number

EXAMPLE 1

Write two inequalities comparing the numbers 12 and 19:



Mentally position the numbers on the line.

12 is the smaller number.

12 is to the left of 19.

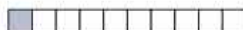
$12 < 19$ or $19 > 12$

Use appropriate inequality symbol.

See Exercises 1–10.

Numbers are used to show *how many* and to show *order*. **Cardinal numbers** show *how many* and **ordinal numbers** show *order* or position (such as first, second, third, fourth, etc.). For example, in the statement “three students are doing a presentation,” three is a cardinal number (showing how many). In the statement “Margaret is the third tallest student in the class,” third is an ordinal number (showing order).

2 Write Fractions with Power-of-10 Denominators as Decimal Numbers. A fraction is a number that is a part of a whole number. A notation for writing numbers that are parts of a whole number is called **fraction notation**. In fraction notation, we write one number over another number.



1 of 10 parts

$\frac{1}{10}$ numerator
denominator

The bottom number, the **denominator**, represents the number of parts that a whole unit contains. The top number, the **numerator**, represents the number of parts being considered.

A special type of fraction is called a **decimal fraction**. Other types of fractions are covered in Chapter 2.

A decimal fraction is a fraction whose denominator is 10 or some power of 10. A **power of 10** is a whole number whose only nonzero digit is 1 (10, 100, 1,000, 10,000, and so on). Often the terms decimal fraction, **decimal number**, and **decimal** are used interchangeably. In fraction notation, 3 out of 10 parts is written as $\frac{3}{10}$. In **decimal notation**, the denominator 10 is not written but is implied by position on the place-value chart (Fig. 1–2). A **decimal point** (.) separates whole-number amounts on the

left and fractional parts on the right. The fraction $\frac{3}{10}$ can be written in decimal notation as 0.3.

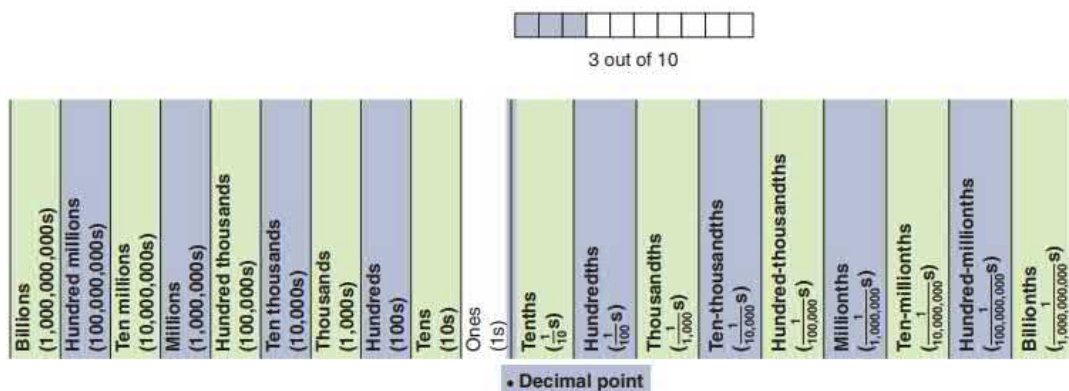


FIGURE 1-2 Place-value chart for whole numbers and decimals.

To extend the place-value chart to include parts of whole amounts, we place a decimal point (.) after the ones place. The place on the right of the ones place is called the *tenths* place. A decimal point is placed between the ones place and the tenths place to distinguish between whole amounts and fractional amounts.

A number that has both a whole-number part and a fraction or decimal part is called a **mixed number**. 3.6 is a mixed number.

Mixed number: a number that has both a whole-number part and a fraction or decimal part

TIP Informal Use of the Word Point Informally, the decimal point is sometimes read as “point.” 3.6 is read “three and six tenths” or “three point six.”

0.0162 is read as “one hundred sixty-two ten-thousandths,” or “point zero one six two,” or “zero point zero one six two.” This informal process is often used in verbal communication to ensure that numbers are not miscommunicated.

Unwritten Decimal Points

When we write whole numbers, we usually omit the decimal point; the decimal point is understood to be at the right end of the whole number. Therefore, any whole number, such as 32, can be written without a decimal (32) or with a decimal (32.).

Fractions like $\frac{1}{10}$ and $\frac{75}{100}$ have denominators that are powers of 10. Any fraction whose denominator is 10, 100, 1,000, 10,000, and so on, can be written as a decimal number without performing any calculations.

To write a fraction that has a denominator of 10, 100, 1,000, 10,000, and so on, as a decimal:

- Use the denominator to find the number of decimal places.

10 → 1 place	Write $\frac{17}{1,000}$ as a decimal.
100 → 2 places	0.____ Three decimal places are needed.
1,000 → 3 places	
10,000 → 4 places	
- Place the numerator so that the last digit is in the farthest place on the right.

0. _ 1 7

- Fill in any blank spaces with zeros.

0.017

STOP AND CHECK

Write as decimal numbers.

- $\frac{9}{10}$
- $\frac{27}{100}$
- $\frac{307}{1,000}$
- $\frac{43}{1,000}$

Answers:

1. 0.9 2. 0.27 3. 0.307 4. 0.043

EXAMPLE 2Write $\frac{3}{10}$, $\frac{25}{100}$, $\frac{425}{100}$, and $\frac{3}{1,000}$ as decimal numbers. $\frac{3}{10}$ is written **0.3**.

One decimal place

 $\frac{25}{100}$ is written **0.25**.

Two decimal places

 $\frac{425}{100}$ is written **4.25**.

Two decimal places

 $\frac{3}{1,000}$ is written **0.003**.

Three decimal places

See Exercises 11–16.

TIP **Do Ending Zeros Change the Value of a Decimal Number?** When we attach zeros on the *right* end of a decimal number, we do not change the value of the number.

$$0.5 = 0.50 = 0.500 \qquad \frac{5}{10} = \frac{50}{100} = \frac{500}{1,000}$$

See equivalent fractions on page 69.

3 Compare Decimal Numbers. As with whole numbers, we often need to compare decimals by size. To make valid comparisons, we must compare like amounts. Whole numbers compare with whole numbers, tenths compare with tenths, thousandths compare with thousandths, and so on.

To compare decimal numbers:

- Compare whole-number parts.
- If the whole-number parts are equal, compare digits place by place, starting at the tenths place and moving to the right.
- Stop when two digits in the same place are different.
- The digit that is larger determines the larger decimal number.

STOP AND CHECK

- Which is larger, 3.51 or 3.508?
- Arrange in order from smallest to largest: 24.6, 24, and 24.55

Answers:

1. 3.51 2. 24, 24.55, 24.6

EXAMPLE 3

(a) Which is larger, 32.47 or 32.48?

~~32.47~~

Look at the whole-number parts. They are the same.

~~32.48~~

Look at the tenths place for each number. Both numbers have a 4 in the tenths place.

Look at the hundredths place. They are different and 8 is larger than 7.

32.48 is the larger number.

(b) Arrange the numbers in order from the smallest to the largest. Use appropriate inequality symbols. 4.1, 4.05, and 4

All three numbers have a whole-number part of 4.

4 has no decimal part so it is the smallest.

4.1 has a one in the tenths place and 4.05 has a zero in the tenths place. 4.05 is smaller.

The numbers in order are 4, 4.05, and 4.1.

 $4 < 4.05 < 4.1$

See Exercises 17–29.

TIP Common Denominators in Decimals The denominator of a decimal fraction is determined by the number of decimal places in the number. Decimal fractions have a common denominator if they have the same number of digits to the right of the decimal point. See common denominators of fractions on page 78.

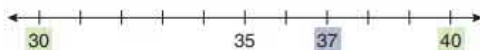
Approximate number: another name for a rounded amount

Round or rounding: to express a number as an approximation

Exact number: a number that is not rounded

4 Round a Whole Number or a Decimal Number to a Specified Place Value. In many situations, an approximate number is used in place of an exact number. An **approximate number** is a rounded amount.

Rounding a number means finding the closest approximate number to a given number. For example, if 37 is rounded to the nearest ten, is 37 closer to 30 or 40? Locate 37 on the number line.



37 is closer to 40 than 30. Thus, 40 is the approximation to the nearest ten for 37. Another way to say this is that 37 rounded to the nearest ten is 40. In this situation, 37 is the exact number and 40 is the approximate number. An **exact number** is a number that is not rounded.

When rounding a number to a certain place value, we must make sure that we are as accurate as the specific situation requires. Generally, the size of the number and its use dictate the decimal place to which it should be rounded.

To round a whole or decimal number to a given place value:

1. Locate the digit that occupies the rounding place. Then examine the digit to the immediate right.
2. If the digit to the right of the rounding place is 0, 1, 2, 3, or 4, do not change the digit in the rounding place. If the digit to the right of the rounding place is 5, 6, 7, 8, or 9, add 1 to the digit in the rounding place.
3. Replace all digits to the *right* of the digit in the rounding place with zeros if they are to the left of the decimal point. Drop digits that are to the right of the digit in the rounding place *and also* to the right of the decimal point.

STOP AND CHECK

1. In making a presentation about the population of Wisconsin, what is a reasonable approximate number for a population of 5,686,986?

Answer:

1. 6,000,000 and 5,700,000 are both reasonable approximations.

EXAMPLE 4

AG/H Oregon has a land area of 96,187 square miles. What would be a reasonable approximate number for this land area?

96,187 rounds to the following approximate numbers:

96,190 to the nearest ten

96,200 to the nearest hundred

96,000 to the nearest thousand

100,000 to the nearest ten thousand

Deciding to which place to round a number is a judgment depending on what use you will make of the rounded or approximate number.

Both 96,000 and 100,000 are reasonable approximations.

See Exercises 30–31.