

6

PERCENTS

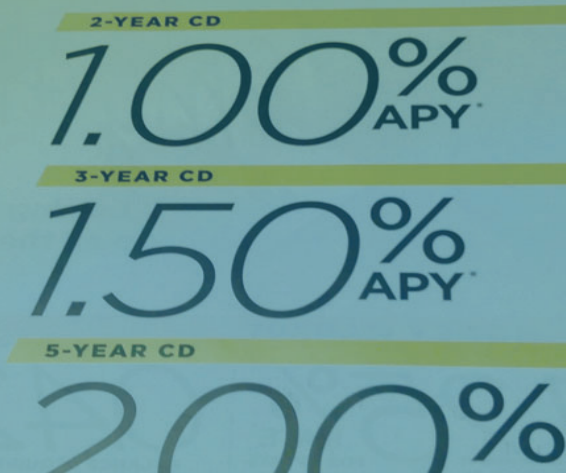


Figure 6.1 Banks provide money for savings and charge money for loans. The interest on savings and loans is usually given as a percent. (credit: Mike Mozart, Flickr)

Chapter Outline

- 6.1 Understand Percent
- 6.2 Solve General Applications of Percent
- 6.3 Solve Sales Tax, Commission, and Discount Applications
- 6.4 Solve Simple Interest Applications
- 6.5 Solve Proportions and their Applications



Introduction

When you deposit money in a savings account at a bank, it earns additional money. Figuring out how your money will grow involves understanding and applying concepts of percents. In this chapter, we will find out what percents are and how we can use them to solve problems.

6.1

Understand Percent

Learning Objectives

By the end of this section, you will be able to:

- › Use the definition of percent
- › Convert percents to fractions and decimals
- › Convert decimals and fractions to percents



BE PREPARED :: 6.1

Before you get started, take this readiness quiz.

Translate “the ratio of 33 to 5” into an algebraic expression.

If you missed this problem, review [Table 2.7](#).



BE PREPARED :: 6.2

Write $\frac{3}{5}$ as a decimal.

If you missed this problem, review [Example 5.28](#).

- ✓ **BE PREPARED :: 6.3** Write 0.62 as a fraction.
If you missed this problem, review [Example 5.4](#).

Use the Definition of Percent

How many cents are in one dollar? There are 100 cents in a dollar. How many years are in a century? There are 100 years in a century. Does this give you a clue about what the word “percent” means? It is really two words, “per cent,” and means per one hundred. A **percent** is a ratio whose denominator is 100. We use the percent symbol %, to show percent.

Percent

A percent is a ratio whose denominator is 100.

According to data from the American Association of Community Colleges (2015), about 57% of community college students are female. This means 57 out of every 100 community college students are female, as [Figure 6.2](#) shows. Out of the 100 squares on the grid, 57 are shaded, which we write as the ratio $\frac{57}{100}$.

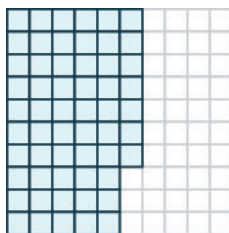


Figure 6.2 Among every 100 community college students, 57 are female.

Similarly, 25% means a ratio of $\frac{25}{100}$, 3% means a ratio of $\frac{3}{100}$ and 100% means a ratio of $\frac{100}{100}$. In words, “one hundred percent” means the total 100% is $\frac{100}{100}$, and since $\frac{100}{100} = 1$, we see that 100% means 1 whole.

EXAMPLE 6.1

According to the Public Policy Institute of California (2010), 44% of parents of public school children would like their youngest child to earn a graduate degree. Write this percent as a ratio.

✓ Solution

The amount we want to convert is 44%. 44%

Write the percent as a ratio. Remember that *percent* means per 100. $\frac{44}{100}$

- > **TRY IT :: 6.1** Write the percent as a ratio.
According to a survey, 89% of college students have a smartphone.
- > **TRY IT :: 6.2** Write the percent as a ratio.
A study found that 72% of U.S. teens send text messages regularly.

EXAMPLE 6.2

In 2007, according to a U.S. Department of Education report, 21 out of every 100 first-time freshmen college students at 4-year public institutions took at least one remedial course. Write this as a ratio and then as a percent.

 **Solution**

The amount we want to convert is 21 out of 100. 21 out of 100

Write as a ratio.	$\frac{21}{100}$
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Convert the 21 per 100 to percent.	21%
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 **TRY IT :: 6.3**

Write as a ratio and then as a percent: The American Association of Community Colleges reported that 62 out of 100 full-time community college students balance their studies with full-time or part time employment.

 **TRY IT :: 6.4**

Write as a ratio and then as a percent: In response to a student survey, 41 out of 100 Santa Ana College students expressed a goal of earning an Associate's degree or transferring to a four-year college.

Convert Percents to Fractions and Decimals

Since percents are ratios, they can easily be expressed as fractions. Remember that percent means per 100, so the denominator of the fraction is 100.

**HOW TO :: CONVERT A PERCENT TO A FRACTION.**

- Step 1. Write the percent as a ratio with the denominator 100.
- Step 2. Simplify the fraction if possible.

EXAMPLE 6.3

Convert each percent to a fraction:

- (a) 36%
- (b) 125%

 **Solution**

(a)

	36%
--	-----

Write as a ratio with denominator 100.	$\frac{36}{100}$
--	------------------

Simplify.	$\frac{9}{25}$
-----------	----------------

ⓑ

	125%
Write as a ratio with denominator 100.	$\frac{125}{100}$
Simplify.	$\frac{5}{4}$

> **TRY IT :: 6.5** Convert each percent to a fraction:

ⓐ 48% ⓑ 110%

> **TRY IT :: 6.6** Convert each percent to a fraction:

ⓐ 64% ⓑ 150%

The previous example shows that a percent can be greater than 1. We saw that 125% means $\frac{125}{100}$, or $\frac{5}{4}$. These are improper fractions, and their values are greater than one.

EXAMPLE 6.4

Convert each percent to a fraction:

ⓐ 24.5% ⓑ $33\frac{1}{3}\%$

✓ **Solution**

ⓐ

	24.5%
Write as a ratio with denominator 100.	$\frac{24.5}{100}$
Clear the decimal by multiplying numerator and denominator by 10.	$\frac{24.5(10)}{100(10)}$
Multiply.	$\frac{245}{1000}$
Rewrite showing common factors.	$\frac{5 \cdot 49}{5 \cdot 200}$
Simplify.	$\frac{49}{200}$

ⓑ

	$33\frac{1}{3}\%$
Write as a ratio with denominator 100.	$\frac{33\frac{1}{3}}{100}$
Write the numerator as an improper fraction.	$\frac{\frac{100}{3}}{100}$
Rewrite as fraction division, replacing 100 with $\frac{100}{1}$.	$\frac{100}{3} \div \frac{100}{1}$
Multiply by the reciprocal.	$\frac{100}{3} \cdot \frac{1}{100}$
Simplify.	$\frac{1}{3}$

> **TRY IT :: 6.7** Convert each percent to a fraction:

- ⓐ 64.4% ⓑ $66\frac{2}{3}\%$

> **TRY IT :: 6.8** Convert each percent to a fraction:

- ⓐ 42.5% ⓑ $8\frac{3}{4}\%$

In **Decimals**, we learned how to convert fractions to decimals. To convert a percent to a decimal, we first convert it to a fraction and then change the fraction to a decimal.



HOW TO :: CONVERT A PERCENT TO A DECIMAL.

- Step 1. Write the percent as a ratio with the denominator 100.
 Step 2. Convert the fraction to a decimal by dividing the numerator by the denominator.

EXAMPLE 6.5

Convert each percent to a decimal:

- ⓐ 6% ⓑ 78%

✓ **Solution**

Because we want to change to a decimal, we will leave the fractions with denominator 100 instead of removing common factors.

(a)

	6%
Write as a ratio with denominator 100.	$\frac{6}{100}$
Change the fraction to a decimal by dividing the numerator by the denominator.	0.06

(b)

	78%
Write as a ratio with denominator 100.	$\frac{78}{100}$
Change the fraction to a decimal by dividing the numerator by the denominator.	0.78

> **TRY IT :: 6.9** Convert each percent to a decimal:

- (a) 9% (b) 87%

> **TRY IT :: 6.10** Convert each percent to a decimal:

- (a) 3% (b) 91%

EXAMPLE 6.6

Convert each percent to a decimal:

- (a) 135% (b) 12.5%

✓ **Solution**

(a)

	135%
Write as a ratio with denominator 100.	$\frac{135}{100}$
Change the fraction to a decimal by dividing the numerator by the denominator.	1.35

(b)

	12.5%
Write as a ratio with denominator 100.	$\frac{12.5}{100}$
Change the fraction to a decimal by dividing the numerator by the denominator.	0.125

> **TRY IT :: 6.11** Convert each percent to a decimal:

- (a) 115% (b) 23.5%

> **TRY IT :: 6.12** Convert each percent to a decimal:

- (a) 123% (b) 16.8%

Let's summarize the results from the previous examples in **Table 6.1**, and look for a pattern we could use to quickly convert a percent number to a decimal number.

Percent	Decimal
6%	0.06
78%	0.78
135%	1.35
12.5%	0.125

Table 6.1

Do you see the pattern?

To convert a percent number to a decimal number, we move the decimal point two places to the left and remove the % sign. (Sometimes the decimal point does not appear in the percent number, but just like we can think of the integer 6 as 6.0, we can think of 6% as 6.0%.) Notice that we may need to add zeros in front of the number when moving the decimal to the left.

Figure 6.3 uses the percents in **Table 6.1** and shows visually how to convert them to decimals by moving the decimal point two places to the left.

Percent	Decimal
006.%	0.06
078.%	0.78
135.%	1.35
012.5%	0.125

Figure 6.3

EXAMPLE 6.7

Among a group of business leaders, 77% believe that poor math and science education in the U.S. will lead to higher unemployment rates.

Convert the percent to: (a) a fraction (b) a decimal

✓ **Solution**

(a)

77%

Write as a ratio with denominator 100. $\frac{77}{100}$

ⓑ

$$\frac{77}{100}$$

Change the fraction to a decimal by dividing the numerator by the denominator. 0.77



TRY IT :: 6.13

Convert the percent to: ⓐ a fraction and ⓑ a decimal

Twitter's share of web traffic jumped 24% when one celebrity tweeted live on air.



TRY IT :: 6.14

Convert the percent to: ⓐ a fraction and ⓑ a decimal

The U.S. Census estimated that in 2013, 44% of the population of Boston age 25 or older have a bachelor's or higher degrees.

EXAMPLE 6.8

There are four suits of cards in a deck of cards—hearts, diamonds, clubs, and spades. The probability of randomly choosing a heart from a shuffled deck of cards is 25%. Convert the percent to:

- ⓐ a fraction ⓑ a decimal



Figure 6.4 (credit: Riles32807, Wikimedia Commons)

✓ Solution

ⓐ

$$25\%$$

Write as a ratio with denominator 100. $\frac{25}{100}$

Simplify. $\frac{1}{4}$

ⓑ

$\frac{1}{4}$

 Change the fraction to a decimal by dividing the numerator by the denominator. 0.25

**TRY IT ::** 6.15

Convert the percent to: ⓐ a fraction, and ⓑ a decimal

The probability that it will rain Monday is 30%.

**TRY IT ::** 6.16

Convert the percent to: ⓐ a fraction, and ⓑ a decimal

The probability of getting heads three times when tossing a coin three times is 12.5%.

Convert Decimals and Fractions to Percents

To convert a decimal to a percent, remember that percent means per hundred. If we change the decimal to a fraction whose denominator is 100, it is easy to change that fraction to a percent.



HOW TO :: CONVERT A DECIMAL TO A PERCENT.

Step 1. Write the decimal as a fraction.

Step 2. If the denominator of the fraction is not 100, rewrite it as an equivalent fraction with denominator 100.

Step 3. Write this ratio as a percent.

EXAMPLE 6.9

Convert each decimal to a percent: ⓐ 0.05 ⓑ 0.83

✓ Solution

ⓐ

0.05

Write as a fraction. The denominator is 100. $\frac{5}{100}$

Write this ratio as a percent. 5%

ⓑ

0.83

The denominator is 100. $\frac{83}{100}$

Write this ratio as a percent. 83%

> **TRY IT :: 6.17** Convert each decimal to a percent: (a) 0.01 (b) 0.17.

> **TRY IT :: 6.18** Convert each decimal to a percent: (a) 0.04 (b) 0.41

To convert a mixed number to a percent, we first write it as an improper fraction.

EXAMPLE 6.10

Convert each decimal to a percent: (a) 1.05 (b) 0.075

✓ Solution

(a)

	0.05
Write as a fraction.	$1\frac{5}{100}$
Write as an improper fraction. The denominator is 100.	$\frac{105}{100}$
Write this ratio as a percent.	105%

Notice that since $1.05 > 1$, the result is more than 100%.

(b)

	0.075
Write as a fraction. The denominator is 1,000.	$\frac{75}{1,000}$
Divide the numerator and denominator by 10, so that the denominator is 100.	$\frac{7.5}{100}$
Write this ratio as a percent.	7.5%

> **TRY IT :: 6.19** Convert each decimal to a percent: (a) 1.75 (b) 0.0825

> **TRY IT :: 6.20** Convert each decimal to a percent: (a) 2.25 (b) 0.0925

Let's summarize the results from the previous examples in [Table 6.2](#) so we can look for a pattern.

Decimal	Percent
0.05	5%
0.83	83%
1.05	105%
0.075	7.5%

Table 6.2

Do you see the pattern? To convert a decimal to a percent, we move the decimal point two places to the right and then add the percent sign.

Figure 6.5 uses the decimal numbers in Table 6.2 and shows visually to convert them to percents by moving the decimal point two places to the right and then writing the % sign.

Percent	Decimal
006.%	0.06
078.%	0.78
135.%	1.35
012.5%	0.125

Figure 6.5

In **Decimals**, we learned how to convert fractions to decimals. Now we also know how to change decimals to percents. So to convert a fraction to a percent, we first change it to a decimal and then convert that decimal to a percent.



HOW TO :: CONVERT A FRACTION TO A PERCENT.

- Step 1. Convert the fraction to a decimal.
- Step 2. Convert the decimal to a percent.

EXAMPLE 6.11

Convert each fraction or mixed number to a percent: (a) $\frac{3}{4}$ (b) $\frac{11}{8}$ (c) $2\frac{1}{5}$

✓ Solution

To convert a fraction to a decimal, divide the numerator by the denominator.

(a)

Change to a decimal.	$\frac{3}{4}$
----------------------	---------------

Write as a percent by moving the decimal two places.	0.75
--	------

75%

ⓑ

Change to a decimal.

$\frac{11}{8}$

Write as a percent by moving the decimal two places.

1.375

137.5%

ⓒ

Write as an improper fraction.

$2\frac{1}{5}$

Change to a decimal.

$\frac{11}{5}$

Write as a percent.

2.20

220%

Notice that we needed to add zeros at the end of the number when moving the decimal two places to the right.

**TRY IT ::** 6.21Convert each fraction or mixed number to a percent: ⓐ $\frac{5}{8}$ ⓑ $\frac{11}{4}$ ⓒ $3\frac{2}{5}$ **TRY IT ::** 6.22Convert each fraction or mixed number to a percent: ⓐ $\frac{7}{8}$ ⓑ $\frac{9}{4}$ ⓒ $1\frac{3}{5}$

Sometimes when changing a fraction to a decimal, the division continues for many decimal places and we will round off the quotient. The number of decimal places we round to will depend on the situation. If the decimal involves money, we round to the hundredths place. For most other cases in this book we will round the number to the nearest thousandth, so the percent will be rounded to the nearest tenth.

EXAMPLE 6.12Convert $\frac{5}{7}$ to a percent. **Solution**

To change a fraction to a decimal, we divide the numerator by the denominator.

$\frac{5}{7}$

Change to a decimal—rounding to the nearest thousandth.

0.714

Write as a percent.

71.4%

**TRY IT ::** 6.23Convert the fraction to a percent: $\frac{3}{7}$ **TRY IT ::** 6.24Convert the fraction to a percent: $\frac{4}{7}$

When we first looked at fractions and decimals, we saw that fractions converted to a repeating decimal. When we converted the fraction $\frac{4}{3}$ to a decimal, we wrote the answer as $1.\bar{3}$. We will use this same notation, as well as fraction notation, when we convert fractions to percents in the next example.

EXAMPLE 6.13

An article in a medical journal claimed that approximately $\frac{1}{3}$ of American adults are obese. Convert the fraction $\frac{1}{3}$ to a percent.

 **Solution**

	$\frac{1}{3}$
	$\frac{0.33\dots}{3 \overline{)1.00}}$
Change to a decimal.	$\frac{9}{10}$ $\frac{9}{1}$
Write as a repeating decimal.	0.333 ...
Write as a percent.	$33\frac{1}{3}\%$

We could also write the percent as $33.\bar{3}\%$.

 **TRY IT :: 6.25**

Convert the fraction to a percent:

According to the U.S. Census Bureau, about $\frac{1}{9}$ of United States housing units have just 1 bedroom.

 **TRY IT :: 6.26**

Convert the fraction to a percent:

According to the U.S. Census Bureau, about $\frac{1}{6}$ of Colorado residents speak a language other than English at home.



6.1 EXERCISES

Practice Makes Perfect

Use the Definition of Percents

In the following exercises, write each percent as a ratio.

- In 2014, the unemployment rate for those with only a high school degree was 6.0%.
- In 2015, among the unemployed, 29% were long-term unemployed.
- The unemployment rate for those with Bachelor's degrees was 3.2% in 2014.
- The unemployment rate in Michigan in 2014 was 7.3%.

In the following exercises, write as

- Ⓐ a ratio and Ⓑ a percent

- 57 out of 100 nursing candidates received their degree at a community college.
- 80 out of 100 firefighters and law enforcement officers were educated at a community college.
- 42 out of 100 first-time freshmen students attend a community college.
- 71 out of 100 full-time community college faculty have a master's degree.

Convert Percents to Fractions and Decimals

In the following exercises, convert each percent to a fraction and simplify all fractions.

- | | | |
|----------------------|----------------------|----------------------|
| 9. 4% | 10. 8% | 11. 17% |
| 12. 19% | 13. 52% | 14. 78% |
| 15. 125% | 16. 135% | 17. 37.5% |
| 18. 42.5% | 19. 18.4% | 20. 46.4% |
| 21. $9\frac{1}{2}\%$ | 22. $8\frac{1}{2}\%$ | 23. $5\frac{1}{3}\%$ |
| 24. $6\frac{2}{3}\%$ | | |

In the following exercises, convert each percent to a decimal.

- | | | |
|-----------|-----------|----------|
| 25. 5% | 26. 9% | 27. 1% |
| 28. 2% | 29. 63% | 30. 71% |
| 31. 40% | 32. 50% | 33. 115% |
| 34. 125% | 35. 150% | 36. 250% |
| 37. 21.4% | 38. 39.3% | 39. 7.8% |
| 40. 6.4% | | |

In the following exercises, convert each percent to

Ⓐ a simplified fraction and Ⓑ a decimal

41. In 2010, 1.5% of home sales had owner financing. (Source: Bloomberg Businessweek, 5/23–29/2011)
42. In 2000, 4.2% of the United States population was of Asian descent. (Source: www.census.gov)
43. According to government data, in 2013 the number of cell phones in India was 70.23% of the population.
44. According to the U.S. Census Bureau, among Americans age 25 or older who had doctorate degrees in 2014, 37.1% are women.
45. A couple plans to have two children. The probability they will have two girls is 25%.
46. Javier will choose one digit at random from 0 through 9. The probability he will choose 3 is 10%.
47. According to the local weather report, the probability of thunderstorms in New York City on July 15 is 60%.
48. A club sells 50 tickets to a raffle. Osbaldo bought one ticket. The probability he will win the raffle is 2%.

Convert Decimals and Fractions to Percents

In the following exercises, convert each decimal to a percent.

49. 0.01
50. 0.03
51. 0.18
52. 0.15
53. 1.35
54. 1.56
55. 3
56. 4
57. 0.009
58. 0.008
59. 0.0875
60. 0.0625
61. 1.5
62. 2.2
63. 2.254
64. 2.317

In the following exercises, convert each fraction to a percent.

65. $\frac{1}{4}$
66. $\frac{1}{5}$
67. $\frac{3}{8}$
68. $\frac{5}{8}$
69. $\frac{7}{4}$
70. $\frac{9}{8}$
71. $6\frac{4}{5}$
72. $5\frac{1}{4}$
73. $\frac{5}{12}$
74. $\frac{11}{12}$
75. $2\frac{2}{3}$
76. $1\frac{2}{3}$
77. $\frac{3}{7}$
78. $\frac{6}{7}$
79. $\frac{5}{9}$
80. $\frac{4}{9}$

In the following exercises, convert each fraction to a percent.

81. $\frac{1}{4}$ of washing machines needed repair. 82. $\frac{1}{5}$ of dishwashers needed repair.

In the following exercises, convert each fraction to a percent.

83. According to the National Center for Health Statistics, in 2012, $\frac{7}{20}$ of American adults were obese. 84. The U.S. Census Bureau estimated that in 2013, 85% of Americans lived in the same house as they did 1 year before.

In the following exercises, complete the table.

85.

Fraction	Decimal	Percent
$\frac{1}{2}$		
	0.45	
		18%
$\frac{1}{3}$		
	0.008	
2		

Table 6.3

86.

Fraction	Decimal	Percent
$\frac{1}{4}$		
	0.65	
		22%
$\frac{2}{3}$		
	0.004	
3		

Table 6.4

Everyday Math

87. Sales tax Felipa says she has an easy way to estimate the sales tax when she makes a purchase. The sales tax in her city is 9.05%. She knows this is a little less than 10%.

- (a) Convert 10% to a fraction.
 (b) Use your answer from (a) to estimate the sales tax Felipa would pay on a \$95 dress.

88. Savings Ryan has 25% of each paycheck automatically deposited in his savings account.

- (a) Write 25% as a fraction.
 (b) Use your answer from (a) to find the amount that goes to savings from Ryan's \$2,400 paycheck.

Amelio is shopping for textbooks online. He found three sellers that are offering a book he needs for the same price, including shipping. To decide which seller to buy from he is comparing their customer satisfaction ratings. The ratings are given in the chart.

Use the chart to answer the following questions

Seller	Rating
A	$\frac{4}{5}$
B	$3\frac{5}{4}$
C	85%

89. Write seller C's rating as a fraction and a decimal. 90. Write seller B's rating as a percent and a decimal.
91. Write seller A's rating as a percent and a decimal. 92. Which seller should Amelio buy from and why?

Writing Exercises

93. Convert 25%, 50%, 75%, and 100% to fractions. Do you notice a pattern? Explain what the pattern is.
94. Convert $\frac{1}{10}$, $\frac{2}{10}$, $\frac{3}{10}$, $\frac{4}{10}$, $\frac{5}{10}$, $\frac{6}{10}$, $\frac{7}{10}$, $\frac{8}{10}$, and $\frac{9}{10}$ to percents. Do you notice a pattern? Explain what the pattern is.
95. When the Szetos sold their home, the selling price was 500% of what they had paid for the house 30 years ago. Explain what 500% means in this context.
96. According to cnn.com, cell phone use in 2008 was 600% of what it had been in 2001. Explain what 600% means in this context.

Self Check

Ⓐ After completing the exercises, use this checklist to evaluate your mastery of the objectives of this section.

I can...	Confidently	With some help	No-I don't get it!
use the definition of percent.			
convert percents to fractions and decimals.			
convert decimals and fractions to percents.			

Ⓑ If most of your checks were:

...confidently. Congratulations! You have achieved the objectives in this section. Reflect on the study skills you used so that you can continue to use them. What did you do to become confident of your ability to do these things? Be specific.

...with some help. This must be addressed quickly because topics you do not master become potholes in your road to success. In math, every topic builds upon previous work. It is important to make sure you have a strong foundation before you move on. Whom can you ask for help? Your fellow classmates and instructor are good resources. Is there a place on campus where math tutors are available? Can your study skills be improved?

...no—I don't get it! This is a warning sign and you must not ignore it. You should get help right away or you will quickly be overwhelmed. See your instructor as soon as you can to discuss your situation. Together you can come up with a plan to get you the help you need.

6.2

Solve General Applications of Percent

Learning Objectives

By the end of this section, you will be able to:

- ▶ Translate and solve basic percent equations
- ▶ Solve applications of percent
- ▶ Find percent increase and percent decrease

**BE PREPARED** :: 6.4

Before you get started, take this readiness quiz.

Translate and solve: $\frac{3}{4}$ of x is 24.If you missed this problem, review [Example 4.105](#).**BE PREPARED** :: 6.5Simplify: $(4.5)(2.38)$.If you missed this problem, review [Example 5.15](#).**BE PREPARED** :: 6.6Solve: $3.5 = 0.7n$.If you missed this problem, review [Example 5.43](#).

Translate and Solve Basic Percent Equations

We will solve percent equations by using the methods we used to solve equations with fractions or decimals. In the past, you may have solved percent problems by setting them up as proportions. That was the best method available when you did not have the tools of algebra. Now as a prealgebra student, you can translate word sentences into algebraic equations, and then solve the equations.

We'll look at a common application of percent—tips to a server at a restaurant—to see how to set up a basic percent application.

When Aolani and her friends ate dinner at a restaurant, the bill came to \$80. They wanted to leave a 20% tip. What amount would the tip be?

To solve this, we want to find what *amount* is 20% of \$80. The \$80 is called the *base*. The amount of the tip would be $0.20(80)$, or \$16 See [Figure 6.6](#). To find the amount of the tip, we multiplied the percent by the base.

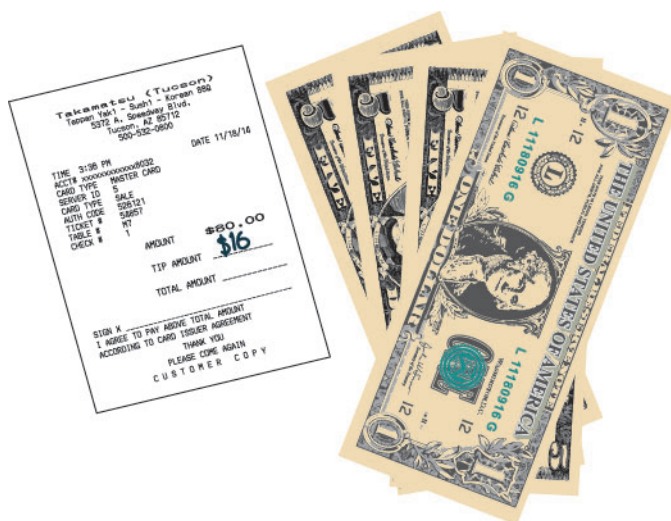


Figure 6.6 A 20% tip for an \$80 restaurant bill comes out to \$16.

In the next examples, we will find the amount. We must be sure to change the given percent to a decimal when we translate the words into an equation.

EXAMPLE 6.14

What number is 35% of 90?

✓ Solution

Translate into algebra. Let n = the number.

$$\underbrace{\text{What number}}_n \text{ is } \underbrace{35\%}_{= 0.35} \text{ of } \underbrace{90}_{. 90}$$

Multiply.

$$n = 31.5$$

31.5 is 35% of 90

> **TRY IT :: 6.27** What number is 45% of 80?

> **TRY IT :: 6.28** What number is 55% of 60?

EXAMPLE 6.15

125% of 28 is what number?

✓ Solution

Translate into algebra. Let a = the number.

$$\underbrace{125\%}_{1.25} \text{ of } \underbrace{28}_{. 28} \text{ is } \underbrace{\text{what number?}}_a$$

Multiply.

$$35 = a$$

125% of 28 is 35.

Remember that a percent over 100 is a number greater than 1. We found that 125% of 28 is 35, which is greater than 28.

> **TRY IT :: 6.29** 150% of 78 is what number?

> **TRY IT :: 6.30** 175% of 72 is what number?

In the next examples, we are asked to find the base.

EXAMPLE 6.16

Translate and solve: 36 is 75% of what number?

Solution

Translate. Let $b =$ the number. $\underbrace{36}_{36}$ $\underbrace{\text{is}}{=}$ $\underbrace{75\%}_{0.75}$ $\underbrace{\text{of}}{.}$ $\underbrace{\text{what number?}}_b$

Divide both sides by 0.75. $\frac{36}{0.75} = \frac{0.75b}{0.75}$

Simplify. $48 = b$
36 is 75% of 48.

> **TRY IT :: 6.31** 17 is 25% of what number?

> **TRY IT :: 6.32** 40 is 62.5% of what number?

EXAMPLE 6.17

6.5% of what number is \$1.17?

Solution

Translate. Let $b =$ the number. $\underbrace{6.5\%}_{0.065}$ $\underbrace{\text{of}}{.}$ $\underbrace{\text{what number}}_b$ $\underbrace{\text{is}}{=}$ $\underbrace{\$1.17?}_{1.17}$

Divide both sides by 0.065. $\frac{0.065n}{0.065} = \frac{1.17}{0.065}$

Simplify. $n = 18$
6.5% of \$18 is \$1.17.

> **TRY IT :: 6.33** 7.5% of what number is \$1.95?

> **TRY IT :: 6.34** 8.5% of what number is \$3.06?

In the next examples, we will solve for the percent.

EXAMPLE 6.18

What percent of 36 is 9?

 **Solution**

Translate into algebra. Let $p =$ the percent.	$\underbrace{\text{What percent}}_p \text{ of } \underbrace{36}_{36} \text{ is } \underbrace{9}_{9}?$
Divide by 36.	$\frac{36p}{36} = \frac{9}{36}$
Simplify.	$p = \frac{1}{4}$
Convert to decimal form.	$p = 0.25$
Convert to percent.	$p = 25\%$ 25% of 36 is 9.

 **TRY IT :: 6.35** What percent of 76 is 57?

 **TRY IT :: 6.36** What percent of 120 is 96?

EXAMPLE 6.19

144 is what percent of 96?

 **Solution**

Translate into algebra. Let $p =$ the percent.	$\frac{144}{144} = \frac{\text{what percent}}{p} \text{ of } \frac{96}{96}?$
Divide by 96.	$\frac{144}{96} = \frac{96p}{96}$
Simplify.	$1.5 = p$
Convert to percent.	$150\% = p$ 144 is 150% of 96.

 **TRY IT :: 6.37** 110 is what percent of 88?

 **TRY IT :: 6.38** 126 is what percent of 72?

Solve Applications of Percent

Many applications of percent occur in our daily lives, such as tips, sales tax, discount, and interest. To solve these applications we'll translate to a basic percent equation, just like those we solved in the previous examples in this section. Once you translate the sentence into a percent equation, you know how to solve it.

We will update the strategy we used in our earlier applications to include equations now. Notice that we will translate a sentence into an equation.

**HOW TO :: SOLVE AN APPLICATION**

- Step 1. Identify what you are asked to find and choose a variable to represent it.
- Step 2. Write a sentence that gives the information to find it.
- Step 3. Translate the sentence into an equation.
- Step 4. Solve the equation using good algebra techniques.
- Step 5. Check the answer in the problem and make sure it makes sense.
- Step 6. Write a complete sentence that answers the question.

Now that we have the strategy to refer to, and have practiced solving basic percent equations, we are ready to solve percent applications. Be sure to ask yourself if your final answer makes sense—since many of the applications we'll solve involve everyday situations, you can rely on your own experience.

EXAMPLE 6.20

Dezohn and his girlfriend enjoyed a dinner at a restaurant, and the bill was \$68.50. They want to leave an 18% tip. If the tip will be 18% of the total bill, how much should the tip be?

Solution

What are you asked to find?	the amount of the tip
Choose a variable to represent it.	Let t = amount of tip.
Write a sentence that give the information to find it.	The tip is 18% of the total bill.
Translate the sentence into an equation.	$\underbrace{\text{The tip}}_t \text{ is } \underbrace{18\%}_{= 0.18} \text{ of } \underbrace{\$68.50}_{\$68.50}.$
Multiply.	$t = 12.33$
Check. Is this answer reasonable?	
If we approximate the bill to \$70 and the percent to 20%, we would have a tip of \$14. So a tip of \$12.33 seems reasonable.	
Write a complete sentence that answers the question.	The couple should leave a tip of \$12.33.

TRY IT :: 6.39

Cierra and her sister enjoyed a special dinner in a restaurant, and the bill was \$81.50. If she wants to leave 18% of the total bill as her tip, how much should she leave?

TRY IT :: 6.40

Kimngoc had lunch at her favorite restaurant. She wants to leave 15% of the total bill as her tip. If her bill was \$14.40, how much will she leave for the tip?

EXAMPLE 6.21

The label on Masao's breakfast cereal said that one serving of cereal provides 85 milligrams (mg) of potassium, which is

2% of the recommended daily amount. What is the total recommended daily amount of potassium?

Nutrition Facts		
Serving Size: 1 cup (47g)		
Servings Per Container: About 7		
Amount Per Serving	Cereal	With Milk
Calories	180	230
Calories from Fat	10	20
% Daily Value*		
Total Fat 1g	2%	2%
Saturated Fat 0g	0%	0%
Trans Fat 0g		
Polyunsaturated Fat 0.5g		
Monounsaturated Fat 0.5g		
Cholesterol 0mg	0%	0%
Sodium 190mg	8%	11%
Potassium 85mg	2%	8%
Total Carbohydrate 40g	13%	15%
Dietary Fiber 1g	4%	4%
Sugars 8g		
Protein 3g		

✓ Solution

What are you asked to find? the total amount of potassium recommended

Choose a variable to represent it. Let a = total amount of potassium.

Write a sentence that gives the information to find it. 85 mg is 2% of the total amount.

Translate the sentence into an equation. $\underbrace{85 \text{ mg}}_{85} \text{ is } \underbrace{2\%}_{0.02} \text{ of } \underbrace{a}_{a}?$

Divide both sides by 0.02. $\frac{85}{0.02} = \frac{0.02a}{0.02}$

Simplify. $4,250 = a$

Check: Is this answer reasonable?

Yes. 2% is a small percent and 85 is a small part of 4,250.

Write a complete sentence that answers the question. The amount of potassium that is recommended is 4250 mg.

> TRY IT :: 6.41

One serving of wheat square cereal has 7 grams of fiber, which is 29% of the recommended daily amount. What is the total recommended daily amount of fiber?

> TRY IT :: 6.42

One serving of rice cereal has 190 mg of sodium, which is 8% of the recommended daily amount. What is the total recommended daily amount of sodium?

EXAMPLE 6.22

Mitzi received some gourmet brownies as a gift. The wrapper said each brownie was 480 calories, and had 240 calories of fat. What percent of the total calories in each brownie comes from fat?

 **Solution**

What are you asked to find?	the percent of the total calories from fat
Choose a variable to represent it.	Let $p =$ percent from fat.
Write a sentence that gives the information to find it.	What percent of 480 is 240?
Translate the sentence into an equation.	$\underbrace{\text{What percent}}_p \text{ of } \underbrace{480}_{480} \text{ is } \underbrace{240}_{240}?$
Divide both sides by 480.	$\frac{p \cdot 480}{480} = \frac{240}{480}$
Simplify.	$p = 0.5$
Convert to percent form.	$p = 50\%$
Check. Is this answer reasonable?	
Yes. 240 is half of 480, so 50% makes sense.	
Write a complete sentence that answers the question.	Of the total calories in each brownie, 50% is fat.

 **TRY IT :: 6.43**

Veronica is planning to make muffins from a mix. The package says each muffin will be 230 calories and 60 calories will be from fat. What percent of the total calories is from fat? (Round to the nearest whole percent.)

 **TRY IT :: 6.44**

The brownie mix Ricardo plans to use says that each brownie will be 190 calories, and 70 calories are from fat. What percent of the total calories are from fat?

Find Percent Increase and Percent Decrease

People in the media often talk about how much an amount has increased or decreased over a certain period of time. They usually express this increase or decrease as a percent.

To find the **percent increase**, first we find the amount of increase, which is the difference between the new amount and the original amount. Then we find what percent the amount of increase is of the original amount.



HOW TO :: FIND PERCENT INCREASE.

Step 1. Find the amount of increase.

- $\text{increase} = \text{new amount} - \text{original amount}$

Step 2. Find the percent increase as a percent of the original amount.

EXAMPLE 6.23

In 2011, the California governor proposed raising community college fees from \$26 per unit to \$36 per unit. Find the percent increase. (Round to the nearest tenth of a percent.)

Solution

What are you asked to find?	the percent increase
Choose a variable to represent it.	Let p = percent.
Find the amount of increase.	$\underbrace{36}_{\text{new amount}} - \underbrace{26}_{\text{original amount}} = \underbrace{10}_{\text{increase}}$
Find the percent increase.	The increase is what percent of the original amount?
Translate to an equation.	$\underbrace{10}_{10} \text{ is } \underbrace{\text{what percent}}_p \text{ of } \underbrace{26}_{26}?$ $\frac{10}{26} = \frac{p}{100}$
Divide both sides by 26.	$\frac{10}{26} = \frac{26p}{26}$
Round to the nearest thousandth.	$0.384 = p$
Convert to percent form.	$38.4\% = p$
Write a complete sentence.	The new fees represent a 38.4% increase over the old fees.

TRY IT :: 6.45

In 2011, the IRS increased the deductible mileage cost to 55.5 cents from 51 cents. Find the percent increase. (Round to the nearest tenth of a percent.)

TRY IT :: 6.46

In 1995, the standard bus fare in Chicago was \$1.50. In 2008, the standard bus fare was \$2.25. Find the percent increase. (Round to the nearest tenth of a percent.)

Finding the **percent decrease** is very similar to finding the percent increase, but now the amount of decrease is the difference between the original amount and the final amount. Then we find what percent the amount of decrease is of the original amount.



HOW TO :: FIND PERCENT DECREASE.

- Step 1. Find the amount of decrease.
 - decrease = original amount – new amount
- Step 2. Find the percent decrease as a percent of the original amount.

EXAMPLE 6.24

The average price of a gallon of gas in one city in June 2014 was \$3.71. The average price in that city in July was \$3.64. Find the percent decrease.

✓ Solution

What are you asked to find?	the percent decrease
Choose a variable to represent it.	Let p = percent.
Find the amount of decrease.	$\underbrace{3.71}_{\text{original amount}} - \underbrace{3.64}_{\text{new amount}} = \underbrace{0.07}_{\text{increase}}$
Find the percent of decrease.	The decrease is what percent of the original amount?
Translate to an equation.	$\underbrace{0.07}_{\text{is}} = \underbrace{\text{what percent}}_p \text{ of } \underbrace{3.71}_{\text{of } 3.71}$
Divide both sides by 3.71.	$\frac{0.07}{3.71} = \frac{3.71p}{3.71}$
Round to the nearest thousandth.	$0.019 = p$
Convert to percent form.	$1.9\% = p$
Write a complete sentence.	The price of gas decreased 1.9%.

> TRY IT :: 6.47

The population of one city was about 672,000 in 2010. The population of the city is projected to be about 630,000 in 2020. Find the percent decrease. (Round to the nearest tenth of a percent.)

> TRY IT :: 6.48

Last year Sheila's salary was \$42,000. Because of furlough days, this year her salary was \$37,800. Find the percent decrease. (Round to the nearest tenth of a percent.)

▶ MEDIA :: ACCESS ADDITIONAL ONLINE RESOURCES

- [Percent Increase and Percent Decrease Visualization \(http://www.openstax.org/l/24percentindec\)](http://www.openstax.org/l/24percentindec)



6.2 EXERCISES

Practice Makes Perfect

Translate and Solve Basic Percent Equations

In the following exercises, translate and solve.

97. What number is 45% of 120?
98. What number is 65% of 100?
99. What number is 24% of 112?
100. What number is 36% of 124?
101. 250% of 65 is what number?
102. 150% of 90 is what number?
103. 800% of 2,250 is what number?
104. 600% of 1,740 is what number?
105. 28 is 25% of what number?
106. 36 is 25% of what number?
107. 81 is 75% of what number?
108. 93 is 75% of what number?
109. 8.2% of what number is \$2.87?
110. 6.4% of what number is \$2.88?
111. 11.5% of what number is \$108.10?
112. 12.3% of what number is \$92.25?
113. What percent of 260 is 78?
114. What percent of 215 is 86?
115. What percent of 1,500 is 540?
116. What percent of 1,800 is 846?
117. 30 is what percent of 20?
118. 50 is what percent of 40?
119. 840 is what percent of 480?
120. 790 is what percent of 395?

Solve Applications of Percents

In the following exercises, solve the applications of percents.

121. Geneva treated her parents to dinner at their favorite restaurant. The bill was \$74.25. She wants to leave 16% of the total bill as a tip. How much should the tip be?
122. When Hiro and his co-workers had lunch at a restaurant the bill was \$90.50. They want to leave 18% of the total bill as a tip. How much should the tip be?
123. Trong has 12% of each paycheck automatically deposited to his savings account. His last paycheck was \$2,165. How much money was deposited to Trong's savings account?
124. Cherise deposits 8% of each paycheck into her retirement account. Her last paycheck was \$1,485. How much did Cherise deposit into her retirement account?
125. One serving of oatmeal has 8 grams of fiber, which is 33% of the recommended daily amount. What is the total recommended daily amount of fiber?
126. One serving of trail mix has 67 grams of carbohydrates, which is 22% of the recommended daily amount. What is the total recommended daily amount of carbohydrates?
127. A bacon cheeseburger at a popular fast food restaurant contains 2,070 milligrams (mg) of sodium, which is 86% of the recommended daily amount. What is the total recommended daily amount of sodium?
128. A grilled chicken salad at a popular fast food restaurant contains 650 milligrams (mg) of sodium, which is 27% of the recommended daily amount. What is the total recommended daily amount of sodium?
129. The nutrition fact sheet at a fast food restaurant says the fish sandwich has 380 calories, and 171 calories are from fat. What percent of the total calories is from fat?

130. The nutrition fact sheet at a fast food restaurant says a small portion of chicken nuggets has 190 calories, and 114 calories are from fat. What percent of the total calories is from fat?

131. Emma gets paid \$3,000 per month. She pays \$750 a month for rent. What percent of her monthly pay goes to rent?

132. Dimple gets paid \$3,200 per month. She pays \$960 a month for rent. What percent of her monthly pay goes to rent?

Find Percent Increase and Percent Decrease

In the following exercises, find the percent increase or percent decrease.

133. Tamanika got a raise in her hourly pay, from \$15.50 to \$17.55. Find the percent increase.

134. Ayodele got a raise in her hourly pay, from \$24.50 to \$25.48. Find the percent increase.

135. Annual student fees at the University of California rose from about \$4,000 in 2000 to about \$9,000 in 2014. Find the percent increase.

136. The price of a share of one stock rose from \$12.50 to \$50. Find the percent increase.

137. According to Time magazine (7/19/2011) annual global seafood consumption rose from 22 pounds per person in 1960 to 38 pounds per person today. Find the percent increase. (Round to the nearest tenth of a percent.)

138. In one month, the median home price in the Northeast rose from \$225,400 to \$241,500. Find the percent increase. (Round to the nearest tenth of a percent.)

139. A grocery store reduced the price of a loaf of bread from \$2.80 to \$2.73. Find the percent decrease.

140. The price of a share of one stock fell from \$8.75 to \$8.54. Find the percent decrease.

141. Hernando's salary was \$49,500 last year. This year his salary was cut to \$44,055. Find the percent decrease.

142. From 2000 to 2010, the population of Detroit fell from about 951,000 to about 714,000. Find the percent decrease. (Round to the nearest tenth of a percent.)

143. In one month, the median home price in the West fell from \$203,400 to \$192,300. Find the percent decrease. (Round to the nearest tenth of a percent.)

144. Sales of video games and consoles fell from \$1,150 million to \$1,030 million in one year. Find the percent decrease. (Round to the nearest tenth of a percent.)

Everyday Math

145. Tipping At the campus coffee cart, a medium coffee costs \$1.65. MaryAnne brings \$2.00 with her when she buys a cup of coffee and leaves the change as a tip. What percent tip does she leave?

146. Late Fees Alison was late paying her credit card bill of \$249. She was charged a 5% late fee. What was the amount of the late fee?

Writing Exercises

147. Without solving the problem “44 is 80% of what number”, think about what the solution might be. Should it be a number that is greater than 44 or less than 44? Explain your reasoning.

148. Without solving the problem “What is 20% of 300?” think about what the solution might be. Should it be a number that is greater than 300 or less than 300? Explain your reasoning.

149. After returning from vacation, Alex said he should have packed 50% fewer shorts and 200% more shirts. Explain what Alex meant.

150. Because of road construction in one city, commuters were advised to plan their Monday morning commute to take 150% of their usual commuting time. Explain what this means.

Self Check

a After completing the exercises, use this checklist to evaluate your mastery of the objectives of this section.

I can...	Confidently	With some help	No-I don't get it!
translate and solve basic percent equations.			
solve applications of percent.			
find percent increase and percent decrease.			

b After reviewing this checklist, what will you do to become confident for all objectives?

6.3

Solve Sales Tax, Commission, and Discount Applications

Learning Objectives

By the end of this section, you will be able to:

- ▶ Solve sales tax applications
- ▶ Solve commission applications
- ▶ Solve discount applications
- ▶ Solve mark-up applications



BE PREPARED :: 6.7

Before you get started, take this readiness quiz.

Solve $0.0875(720)$ through multiplication.

If you missed this problem, review [Example 5.17](#).



BE PREPARED :: 6.8

Solve $12.96 \div 0.04$ through division.

If you missed this problem, review [Example 5.22](#).

Solve Sales Tax Applications

Sales tax and commissions are applications of percent in our everyday lives. To solve these applications, we will follow the same strategy we used in the section on decimal operations. We show it again here for easy reference.



HOW TO ::

Solve an application

- Step 1. Identify what you are asked to find and choose a variable to represent it.
- Step 2. Write a sentence that gives the information to find it.
- Step 3. Translate the sentence into an equation.
- Step 4. Solve the equation using good algebra techniques.
- Step 5. Check the answer in the problem and make sure it makes sense.
- Step 6. Write a complete sentence that answers the question.

Remember that whatever the application, once we write the sentence with the given information (Step 2), we can translate it to a percent equation and then solve it.

Do you pay a tax when you shop in your city or state? In many parts of the United States, sales tax is added to the purchase price of an item. See [Figure 6.7](#). The sales tax is determined by computing a percent of the purchase price.

To find the sales tax multiply the purchase price by the sales tax rate. Remember to convert the sales tax rate from a percent to a decimal number. Once the sales tax is calculated, it is added to the purchase price. The result is the total cost—this is what the customer pays.

BOULEVARD	
ONE MISSION STREET SAN FRANCISCO, CA 94105 (415) 543-8084 DINING ROOM	
5213 KEN	
Tbl 32/1	Chk 5265 Gst 2
Apr 14 '08 08:05PM	
1 D SOUP	13,75
1 D LOBSTER LINGUI	18,75
1 D LAMB	32,00
1 1/2 GL SAUV BLANC	4,25
1 D BANANAS FOSTER	9,50
SUBTOTAL	78,25
Tax (8%)	6,26
Total	84,51
BOULEVARD COOKBOOKS ARE NOW AVAILABLE PLEASE ASK YOUR SERVER THANK YOU FOR DINING WITH US	

Figure 6.7 The sales tax is calculated as a percent of the purchase price.

Sales Tax

The sales tax is a percent of the purchase price.

$$\begin{aligned}\text{Sales Tax} &= \text{Tax Rate} \cdot \text{Purchase Price} \\ \text{Total Cost} &= \text{Purchase Price} + \text{Sales Tax}\end{aligned}$$

EXAMPLE 6.25

Cathy bought a bicycle in Washington, where the sales tax rate was 6.5% of the purchase price. What was

- Ⓐ the sales tax and Ⓑ the total cost of a bicycle if the purchase price of the bicycle was \$392?

✓ Solution

Ⓐ

Identify what you are asked to find.

What is the sales tax?

Choose a variable to represent it.

Let t = sales tax.

Write a sentence that gives the information to find it.

The sales tax is 6.5% of the purchase price.

Translate into an equation. (Remember to change the percent to a decimal).

$$\underbrace{\text{The sales tax}}_t \text{ is } \underbrace{6.5\%}_{0.065} \text{ of } \underbrace{\text{the } \$392 \text{ purchase price.}}_{392}$$

Simplify.

$$t = 25.48$$

Check: Is this answer reasonable?

Yes, because the sales tax amount is less than 10% of the purchase price.

Write a complete sentence that answers the question.

The sales tax is \$25.48.

ⓑ

Identify what you are asked to find.	What is the total cost of the bicycle?
Choose a variable to represent it.	Let c = total cost of bicycle.
Write a sentence that gives the information to find it.	The total cost is the purchase price plus the sales tax.
Translate into an equation.	$\underbrace{\text{The total cost}}_c \text{ is } \underbrace{\$392}_{392} \text{ plus } \underbrace{\$25.48}_{25.48}$ $c = 417.48$
Simplify.	
Check: Is this answer reasonable?	
Yes, because the total cost is a little more than the purchase price.	
Write a complete sentence that answers the question.	The total cost of the bicycle is \$417.48.

> **TRY IT :: 6.49**

Find ⓐ the sales tax and ⓑ the total cost: Alexandra bought a television set for \$724 in Boston, where the sales tax rate was 6.25% of the purchase price.

> **TRY IT :: 6.50**

Find ⓐ the sales tax and ⓑ the total cost: Kim bought a winter coat for \$250 in St. Louis, where the sales tax rate was 8.2% of the purchase price.

EXAMPLE 6.26

Evelyn bought a new smartphone for \$499 plus tax. She was surprised when she got the receipt and saw that the tax was \$42.42. What was the sales tax rate for this purchase?

Solution

Identify what you are asked to find.	What is the sales tax rate?
Choose a variable to represent it.	Let r = sales tax.
Write a sentence that gives the information to find it.	What percent of the price is the sales tax?
Translate into an equation.	$\underbrace{\text{What percent}}_r \underbrace{\text{of}}_{.} \underbrace{\text{the } \$499 \text{ price}}_{499} \underbrace{\text{is}}_{=} \underbrace{\text{the } \$42.42 \text{ tax?}}_{42.42}$
Divide.	$\frac{499r}{499} = \frac{42.42}{499}$
Simplify.	$r = 0.085$
Check. Is this answer reasonable?	
Yes, because 8.5% is close to 10%. 10% of \$500 is \$50, which is close to \$42.42.	
Write a complete sentence that answers the question.	The sales tax rate is 8.5%.

TRY IT :: 6.51

Diego bought a new car for \$26,525. He was surprised that the dealer then added \$2,387.25. What was the sales tax rate for this purchase?

TRY IT :: 6.52

What is the sales tax rate if a \$7,594 purchase will have \$569.55 of sales tax added to it?

Solve Commission Applications

Sales people often receive a **commission**, or percent of total sales, for their sales. Their income may be just the commission they earn, or it may be their commission added to their hourly wages or salary. The commission they earn is calculated as a certain percent of the price of each item they sell. That percent is called the **rate of commission**.

Commission

A commission is a percentage of total sales as determined by the rate of commission.

$$\text{commission} = \text{rate of commission} \cdot \text{total sales}$$

To find the commission on a sale, multiply the rate of commission by the total sales. Just as we did for computing sales tax, remember to first convert the rate of commission from a percent to a decimal.

EXAMPLE 6.27

Helene is a realtor. She receives 3% commission when she sells a house. How much commission will she receive for selling a house that costs \$260,000?

✓ Solution

Identify what you are asked to find.	What is the commission?
Choose a variable to represent it.	Let $c =$ the commission.
Write a sentence that gives the information to find it.	The commission is 3% of the price.
Translate into an equation.	$\underbrace{\text{The commission}}_c \text{ is } \underbrace{3\%}_{= 0.03} \text{ of } \underbrace{\text{the } \$260,000 \text{ price.}}_{260,000}$
Simplify.	$c = 7800$
Check. Is this answer reasonable?	
Yes. 1% of \$260,000 is \$2,600, and \$7,800 is three times \$2,600.	
Write a complete sentence that answers the question.	Helene will receive a commission of \$7,800.

> TRY IT :: 6.53

Bob is a travel agent. He receives 7% commission when he books a cruise for a customer. How much commission will he receive for booking a \$3,900 cruise?

> TRY IT :: 6.54

Fernando receives 18% commission when he makes a computer sale. How much commission will he receive for selling a computer for \$2,190?

EXAMPLE 6.28

Rikki earned \$87 commission when she sold a \$1,450 stove. What rate of commission did she get?

✓ Solution

Identify what you are asked to find.	What is the rate of commission?
Choose a variable to represent it.	Let $r =$ the rate of commission.
Write a sentence that gives the information to find it.	The commission is what percent of the sale?
Translate into an equation.	$\underbrace{\text{The \$87 commission}}_{87} \text{ is } \underbrace{\text{what percent}}_{0.03} \text{ of } \underbrace{\text{the \$1450 sale?}}_{1450}$
Divide.	$\frac{87}{1450} = \frac{1450r}{1450}$
Simplify.	$0.06 = r$
Change to percent form.	$r = 6\%$
Check if this answer is reasonable.	
Yes. A 10% commission would have been \$145. The 6% commission, \$87, is a little more than half of that.	
Write a complete sentence that answers the question.	The commission was 6% of the price of the stove.

> TRY IT :: 6.55

Homer received \$1,140 commission when he sold a car for \$28,500. What rate of commission did he get?

> TRY IT :: 6.56

Bernice earned \$451 commission when she sold an \$8,200 living room set. What rate of commission did she get?

Solve Discount Applications

Applications of discount are very common in retail settings [Figure 6.8](#). When you buy an item on sale, the **original price** of the item has been reduced by some dollar amount. The **discount rate**, usually given as a percent, is used to determine the amount of the discount. To determine the **amount of discount**, we multiply the discount rate by the original price. We summarize the discount model in the box below.



Figure 6.8 Applications of discounts are common in everyday life. (credit: Charleston's TheDigital, Flickr)

Discount

An amount of discount is a percent off the original price.

$$\begin{aligned}\text{amount of discount} &= \text{discount rate} \cdot \text{original price} \\ \text{sale price} &= \text{original price} - \text{discount}\end{aligned}$$

The sale price should always be less than the original price. In some cases, the amount of discount is a fixed dollar amount. Then we just find the sale price by subtracting the amount of discount from the original price.

EXAMPLE 6.29

Jason bought a pair of sunglasses that were on sale for \$10 off. The original price of the sunglasses was \$39. What was the sale price of the sunglasses?

✓ Solution

Identify what you are asked to find.

What is the sale price?

Choose a variable to represent it.

Let $s =$ the sale price.

Write a sentence that gives the information to find it.

The sale price is the original price minus the discount.

Translate into an equation.

$$\underbrace{\text{The sale price}}_s \text{ is } = \underbrace{\text{the original } \$39 \text{ price}}_{39} \text{ minus } - \underbrace{\text{the } \$10 \text{ discount.}}_{10}$$

Simplify.

$$s = 29$$

Check if this answer is reasonable.

Yes. The sale price, \$29, is less than the original price, \$39.

Write a complete sentence that answers the question.

The sale price of the sunglasses was \$29.

> TRY IT :: 6.57

Marta bought a dishwasher that was on sale for \$75 off. The original price of the dishwasher was \$525. What was the sale price of the dishwasher?

> TRY IT :: 6.58

Orlando bought a pair of shoes that was on sale for \$30 off. The original price of the shoes was \$112. What was the sale price of the shoes?

In **Example 6.29**, the amount of discount was a set amount, \$10. In **Example 6.30** the discount is given as a percent of the original price.

EXAMPLE 6.30

Elise bought a dress that was discounted 35% off of the original price of \$140. What was Ⓐ the amount of discount and Ⓑ the sale price of the dress?

✓ Solution

Ⓐ Before beginning, you may find it helpful to organize the information in a list.

Original price = \$140

Discount rate = 35%

Amount of discount = ?

Identify what you are asked to find.	What is the amount of discount?
Choose a variable to represent it.	Let $d =$ the amount of discount.
Write a sentence that gives the information to find it.	The discount is 35% of the original price.
Translate into an equation.	$\underbrace{\text{The discount}}_s \text{ is } = \underbrace{35\%}_{0.35} \text{ of } \underbrace{\text{the \$140 original price.}}_{140}$
Simplify.	$d = 49$
Check if this answer is reasonable.	
Yes. A \$49 discount is reasonable for a \$140 dress.	
Write a complete sentence that answers the question.	The amount of discount was \$49.

ⓑ

Original price = \$140
 Amount of discount = \$49
 Sale price = ?

Identify what you are asked to find.	What is the sale price of the dress?
Choose a variable to represent it.	Let $s =$ the sale price.
Write a sentence that gives the information to find it.	The sale price is the original price minus the discount.
Translate into an equation.	$\underbrace{\text{The sale price}}_s \text{ is } = \underbrace{\text{the \$140}}_{140} \text{ minus } \underbrace{\text{the \$49 discount.}}_{49}$
Simplify.	$s = 91$
Check if this answer is reasonable.	
Yes. The sale price, \$91, is less than the original price, \$140.	
Write a complete sentence that answers the question.	The sale price of the dress was \$91.

> **TRY IT :: 6.59**

Find ⓐ the amount of discount and ⓑ the sale price: Sergio bought a belt that was discounted 40% from an original price of \$29.

> **TRY IT :: 6.60**

Find ⓐ the amount of discount and ⓑ the sale price: Oscar bought a barbecue grill that was discounted 65% from an original price of \$395.

There may be times when you buy something on sale and want to know the discount rate. The next example will show this case.

EXAMPLE 6.31

Jeannette bought a swimsuit at a sale price of \$13.95. The original price of the swimsuit was \$31. Find the (a) amount of discount and (b) discount rate.

✓ **Solution**

(a) Before beginning, you may find it helpful to organize the information in a list.

Original price = \$31
Amount of discount = ?
Sale price = \$13.95

Identify what you are asked to find.	What is the amount of discount?
Choose a variable to represent it.	Let $d =$ the amount of discount.
Write a sentence that gives the information to find it.	The discount is the original price minus the sale price.
Translate into an equation.	$\underbrace{\text{The discount}}_s \text{ is } = \underbrace{\text{the \$31 original price}}_{31} \text{ minus } - \underbrace{\text{the \$13.95 sale price.}}_{13.95}$
Simplify.	$d = 17.05$
Check if this answer is reasonable.	
Yes. The \$17.05 discount is less than the original price.	
Write a complete sentence that answers the question.	The amount of discount was \$17.05.

(b) Before beginning, you may find it helpful to organize the information in a list.

Original price = \$31
Amount of discount = \$17.05
Discount rate = ?

Identify what you are asked to find.	What is the discount rate?
Choose a variable to represent it.	Let $r =$ the discount rate.
Write a sentence that gives the information to find it.	The discount is what percent of the original price?
Translate into an equation.	$\underbrace{\text{The discount of \$17.05}}_s \text{ is } = \underbrace{\text{what percent}}_r \text{ of } \cdot \underbrace{\text{the \$31 original price.}}_{31}$
Divide.	$\frac{17.05}{31} = \frac{r(31)}{31}$
Simplify.	$0.55 = r$
Check if this answer is reasonable.	
The rate of discount was a little more than 50% and the amount of discount is a little more than half of \$31.	
Write a complete sentence that answers the question.	The rate of discount was 55%.

> **TRY IT :: 6.61**

Find (a) the amount of discount and (b) the discount rate: Lena bought a kitchen table at the sale price of \$375.20. The original price of the table was \$560.

> **TRY IT :: 6.62**

Find (a) the amount of discount and (b) the discount rate: Nick bought a multi-room air conditioner at a sale price of \$340. The original price of the air conditioner was \$400.

Solve Mark-up Applications

Applications of mark-up are very common in retail settings. The price a retailer pays for an item is called the **wholesale price**. The retailer then adds a **mark-up** to the wholesale price to get the **list price**, the price he sells the item for. The mark-up is usually calculated as a percent of the wholesale price. The percent is called the **mark-up rate**. To determine the amount of mark-up, multiply the mark-up rate by the wholesale price. We summarize the mark-up model in the box below.

Mark-up

The mark-up is the amount added to the wholesale price.

$$\begin{aligned}\text{amount of mark-up} &= \text{mark-up rate} \cdot \text{wholesale price} \\ \text{list price} &= \text{wholesale price} + \text{mark up}\end{aligned}$$

The list price should always be more than the wholesale price.

EXAMPLE 6.32

Adam's art gallery bought a photograph at the wholesale price of \$250. Adam marked the price up 40%. Find the (a) amount of mark-up and (b) the list price of the photograph.

✓ **Solution**

(a)

Identify what you are asked to find.

What is the amount of mark-up?

Choose a variable to represent it.

Let $m =$ the amount of each mark-up.

Write a sentence that gives the information to find it.

The mark-up is 40% of the wholesale price.

Translate into an equation.

$$\underbrace{\text{The mark-up}}_m \text{ is } \underbrace{40\%}_{0.40} \text{ of } \underbrace{\text{the \$250 wholesale price.}}_{250}$$

Simplify.

$$m = 100$$

Check if this answer is reasonable.

Yes. The markup rate is less than 50% and \$100 is less than half of \$250.

Write a complete sentence that answers the question.

The mark-up on the photograph was \$100.

ⓑ

Identify what you are asked to find.	What is the list price?
Choose a variable to represent it.	Let $p =$ the list price.
Write a sentence that gives the information to find it.	The list price is the wholesale price plus the mark-up.
Translate into an equation.	$\underbrace{\text{The list price}}_p \text{ is } = \underbrace{\text{the \$250 wholesale price}}_{250} \text{ plus } + \underbrace{\text{the \$100 mark-up.}}_{100}$
Simplify.	$p = 350$
Check if this answer is reasonable.	
Yes. The list price, \$350, is more than the wholesale price, \$250.	
Write a complete sentence that answers the question.	The list price of the photograph was \$350.

> **TRY IT :: 6.63**

Jim's music store bought a guitar at wholesale price \$1,200. Jim marked the price up 50%. Find the ⓐ amount of mark-up and ⓑ the list price.

> **TRY IT :: 6.64**

The Auto Resale Store bought Pablo's Toyota for \$8,500. They marked the price up 35%. Find the ⓐ amount of mark-up and ⓑ the list price.



6.3 EXERCISES

Practice Makes Perfect

Solve Sales Tax Applications

In the following exercises, find Ⓐ the sales tax and Ⓑ the total cost.

151. The cost of a pair of boots was \$84. The sales tax rate is 5% of the purchase price.

152. The cost of a refrigerator was \$1,242. The sales tax rate is 8% of the purchase price.

153. The cost of a microwave oven was \$129. The sales tax rate is 7.5% of the purchase price.

154. The cost of a tablet computer is \$350. The sales tax rate is 8.5% of the purchase price.

155. The cost of a file cabinet is \$250. The sales tax rate is 6.85% of the purchase price.

156. The cost of a luggage set \$400. The sales tax rate is 5.75% of the purchase price.

157. The cost of a 6-drawer dresser \$1,199. The sales tax rate is 5.125% of the purchase price.

158. The cost of a sofa is \$1,350. The sales tax rate is 4.225% of the purchase price.

In the following exercises, find the sales tax rate.

159. Shawna bought a mixer for \$300. The sales tax on the purchase was \$19.50.

160. Orphia bought a coffee table for \$400. The sales tax on the purchase was \$38.

161. Bopha bought a bedroom set for \$3,600. The sales tax on the purchase was \$246.60.

162. Ruth bought a washer and dryer set for \$2,100. The sales tax on the purchase was \$152.25.

Solve Commission Applications

In the following exercises, find the commission.

163. Christopher sold his dinette set for \$225 through an online site, which charged him 9% of the selling price as commission. How much was the commission?

164. Michele rented a booth at a craft fair, which charged her 8% commission on her sales. One day her total sales were \$193. How much was the commission?

165. Farrah works in a jewelry store and receives 12% commission when she makes a sale. How much commission will she receive for selling a \$8,125 ring?

166. Jamal works at a car dealership and receives 9% commission when he sells a car. How much commission will he receive for selling a \$32,575 car?

167. Hector receives 17.5% commission when he sells an insurance policy. How much commission will he receive for selling a policy for \$4,910?

168. Denise receives 10.5% commission when she books a tour at the travel agency. How much commission will she receive for booking a tour with total cost \$7,420?

In the following exercises, find the rate of commission.

169. Dontay is a realtor and earned \$11,250 commission on the sale of a \$375,000 house. What is his rate of commission?

170. Nevaeh is a cruise specialist and earned \$364 commission after booking a cruise that cost \$5,200. What is her rate of commission?

171. As a waitress, Emily earned \$420 in tips on sales of \$2,625 last Saturday night. What was her rate of commission?

172. Alejandra earned \$1,393.74 commission on weekly sales of \$15,486 as a salesperson at the computer store. What is her rate of commission?

173. Maureen earned \$7,052.50 commission when she sold a \$45,500 car. What was the rate of commission?

174. Lucas earned \$4,487.50 commission when he brought a \$35,900 job to his office. What was the rate of commission?

Solve Discount Applications

In the following exercises, find the sale price.

175. Perla bought a cellphone that was on sale for \$50 off. The original price of the cellphone was \$189.

176. Sophie saw a dress she liked on sale for \$15 off. The original price of the dress was \$96.

177. Rick wants to buy a tool set with original price \$165. Next week the tool set will be on sale for \$40 off.

178. Angelo's store is having a sale on TV sets. One set, with an original price of \$859, is selling for \$125 off.

In the following exercises, find Ⓐ the amount of discount and Ⓑ the sale price.

179. Janelle bought a beach chair on sale at 60% off. The original price was \$44.95

180. Errol bought a skateboard helmet on sale at 40% off. The original price was \$49.95.

181. Kathy wants to buy a camera that lists for \$389. The camera is on sale with a 33% discount.

182. Colleen bought a suit that was discounted 25% from an original price of \$245.

183. Erys bought a treadmill on sale at 35% off. The original price was \$949.95.

184. Jay bought a guitar on sale at 45% off. The original price was \$514.75.

In the following exercises, find Ⓐ the amount of discount and Ⓑ the discount rate. (Round to the nearest tenth of a percent if needed.)

185. Larry and Donna bought a sofa at the sale price of \$1,344. The original price of the sofa was \$1,920.

186. Hiroshi bought a lawnmower at the sale price of \$240. The original price of the lawnmower is \$300.

187. Patty bought a baby stroller on sale for \$301.75. The original price of the stroller was \$355.

188. Bill found a book he wanted on sale for \$20.80. The original price of the book was \$32.

189. Nikki bought a patio set on sale for \$480. The original price was \$850.

190. Stella bought a dinette set on sale for \$725. The original price was \$1,299.

Solve Mark-up Applications

In the following exercises, find Ⓐ the amount of the mark-up and Ⓑ the list price.

191. Daria bought a bracelet at wholesale cost \$16 to sell in her handicraft store. She marked the price up 45%.

192. Regina bought a handmade quilt at wholesale cost \$120 to sell in her quilt store. She marked the price up 55%.

193. Tom paid \$0.60 a pound for tomatoes to sell at his produce store. He added a 33% mark-up.

194. Flora paid her supplier \$0.74 a stem for roses to sell at her flower shop. She added an 85% mark-up.

195. Alan bought a used bicycle for \$115. After re-conditioning it, he added 225% mark-up and then advertised it for sale.

196. Michael bought a classic car for \$8,500. He restored it, then added 150% mark-up before advertising it for sale.

Everyday Math

197. Coupons Yvonne can use two coupons for the same purchase at her favorite department store. One coupon gives her \$20 off and the other gives her 25% off. She wants to buy a bedspread that sells for \$195.

- (a) Calculate the discount price if Yvonne uses the \$20 coupon first and then takes 25% off.
- (b) Calculate the discount price if Yvonne uses the 25% off coupon first and then uses the 20% coupon.
- (c) In which order should Yvonne use the coupons?

198. Cash Back Jason can buy a bag of dog food for \$35 at two different stores. One store offers 6% cash back on the purchase plus \$5 off his next purchase. The other store offers 20% cash back.

- (a) Calculate the total savings from the first store, including the savings on the next purchase.
- (b) Calculate the total savings from the second store.
- (c) Which store should Jason buy the dog food from? Why?

Writing Exercises

199. Priam bought a jacket that was on sale for 40% off. The original price of the jacket was \$150. While the sales clerk figured the price by calculating the amount of discount and then subtracting that amount from \$150, Priam found the price faster by calculating 60% of \$150.

- (a) Explain why Priam was correct.
- (b) Will Priam's method work for any original price?

200. Roxy bought a scarf on sale for 50% off. The original price of the scarf was \$32.90. Roxy claimed that the price she paid for the scarf was the same as the amount she saved. Was Roxy correct? Explain.

Self Check

(a) After completing the exercises, use this checklist to evaluate your mastery of the objectives of this section.

I can...	Confidently	With some help	No-I don't get it!
solve sales tax applications.			
solve commission applications.			
solve discount applications.			
solve mark-up applications.			

(b) What does this checklist tell you about your mastery of this section? What steps will you take to improve?

6.4

Solve Simple Interest Applications

Learning Objectives

By the end of this section, you will be able to:

- ▶ Use the simple interest formula
- ▶ Solve simple interest applications



BE PREPARED :: 6.9

Before you get started, take this readiness quiz.

Solve $0.6y = 45$.

If you missed this problem, review [Example 5.43](#).



BE PREPARED :: 6.10

Solve $\frac{n}{1.45} = 4.6$.

If you missed this problem, review [Example 5.44](#).

Use the Simple Interest Formula

Do you know that banks pay you to let them keep your money? The money you put in the bank is called the **principal**, P , and the bank pays you **interest**, I . The interest is computed as a certain percent of the principal; called the **rate of interest**, r . The rate of interest is usually expressed as a percent per year, and is calculated by using the decimal equivalent of the percent. The variable for time, t , represents the number of years the money is left in the account.

Simple Interest

If an amount of money, P , the principal, is invested for a period of t years at an annual interest rate r , the amount of interest, I , earned is

$$I = Prt$$

where

$$\begin{aligned} I &= \text{interest} \\ P &= \text{principal} \\ r &= \text{rate} \\ t &= \text{time} \end{aligned}$$

Interest earned according to this formula is called **simple interest**.

The formula we use to calculate simple interest is $I = Prt$. To use the simple interest formula we substitute in the values for variables that are given, and then solve for the unknown variable. It may be helpful to organize the information by listing all four variables and filling in the given information.

EXAMPLE 6.33

Find the simple interest earned after 3 years on \$500 at an interest rate of 6%.

Solution

Organize the given information in a list.

$$\begin{aligned} I &= ? \\ P &= \$500 \\ r &= 6\% \\ t &= 3 \text{ years} \end{aligned}$$

We will use the simple interest formula to find the interest.

Write the formula.	$I = Prt$
Substitute the given information. Remember to write the percent in decimal form.	$I = (500)(0.06)(3)$
Simplify.	$I = 90$
Check your answer. Is \$90 a reasonable interest earned on \$500 in 3 years?	
In 3 years the money earned 18%. If we rounded to 20%, the interest would have been $500(0.20)$ or \$100. Yes, \$90 is reasonable.	
Write a complete sentence that answers the question.	The simple interest is \$90.

> **TRY IT :: 6.65** Find the simple interest earned after 4 years on \$800 at an interest rate of 5%.

> **TRY IT :: 6.66** Find the simple interest earned after 2 years on \$700 at an interest rate of 4%.

In the next example, we will use the simple interest formula to find the principal.

EXAMPLE 6.34

Find the principal invested if \$178 interest was earned in 2 years at an interest rate of 4%.

Solution

Organize the given information in a list.

$$I = \$178$$

$$P = ?$$

$$r = 4\%$$

$$t = 2 \text{ years}$$

We will use the simple interest formula to find the principal.

Write the formula.	$I = Prt$
Substitute the given information.	$178 = P(0.04)(2)$
Divide.	$\frac{178}{0.08} = \frac{0.08P}{0.08}$
Simplify.	$2,225 = P$
Check your answer. Is it reasonable that \$2,225 would earn \$178 in 2 years?	
$I = Prt$	
$178 \stackrel{?}{=} 2,225(0.04)(2)$	
$178 = 178 \checkmark$	
Write a complete sentence that answers the question.	The principal is \$2,225.

> **TRY IT :: 6.67** Find the principal invested if \$495 interest was earned in 3 years at an interest rate of 6%.

> **TRY IT :: 6.68**

Find the principal invested if \$1,246 interest was earned in 5 years at an interest rate of 7%.

Now we will solve for the rate of interest.

EXAMPLE 6.35

Find the rate if a principal of \$8,200 earned \$3,772 interest in 4 years.

✓ **Solution**

Organize the given information.

$$I = \$3,772$$

$$P = \$8,200$$

$$r = ?$$

$$t = 4 \text{ years}$$

We will use the simple interest formula to find the rate.

Write the formula.	$I = Prt$
Substitute the given information.	$3,772 = 8,200r(4)$
Multiply.	$3,772 = 32,800r$
Divide.	$\frac{3,772}{32,800} = \frac{32,800r}{32,800}$
Simplify.	$0.115 = r$
Write as a percent.	$11.5\% = r$
Check your answer. Is 11.5% a reasonable rate if \$3,772 was earned in 4 years?	
$I = Prt$	
$3,772 \stackrel{?}{=} 8,200(0.115)(4)$	
$3,772 = 3,772 \checkmark$	
Write a complete sentence that answers the question.	The rate was 11.5%.

> **TRY IT :: 6.69**

Find the rate if a principal of \$5,000 earned \$1,350 interest in 6 years.

> **TRY IT :: 6.70**

Find the rate if a principal of \$9,000 earned \$1,755 interest in 3 years.

Solve Simple Interest Applications

Applications with simple interest usually involve either investing money or borrowing money. To solve these applications, we continue to use the same strategy for applications that we have used earlier in this chapter. The only difference is that in place of translating to get an equation, we can use the simple interest formula.

We will start by solving a simple interest application to find the interest.

EXAMPLE 6.36

Nathaly deposited \$12,500 in her bank account where it will earn 4% interest. How much interest will Nathaly earn in

5 years?

 **Solution**

We are asked to find the Interest, I .

Organize the given information in a list.

$$I = ?$$

$$P = \$12,500$$

$$r = 4\%$$

$$t = 5 \text{ years}$$

Write the formula.

$$I = Prt$$

Substitute the given information.

$$I = (12,500)(0.04)(5)$$

Simplify.

$$I = 2,500$$

Check your answer. Is \$2,500 a reasonable interest on \$12,500 over 5 years?

At 4% interest per year, in 5 years the interest would be 20% of the principal. Is 20% of \$12,500 equal to \$2,500? Yes.

Write a complete sentence that answers the question.

The interest is \$2,500.

 **TRY IT :: 6.71**

Areli invested a principal of \$950 in her bank account with interest rate 3%. How much interest did she earn in 5 years?

 **TRY IT :: 6.72**

Susana invested a principal of \$36,000 in her bank account with interest rate 6.5%. How much interest did she earn in 3 years?

There may be times when you know the amount of interest earned on a given principal over a certain length of time, but you don't know the rate. For instance, this might happen when family members lend or borrow money among themselves instead of dealing with a bank. In the next example, we'll show how to solve for the rate.

EXAMPLE 6.37

Loren lent his brother \$3,000 to help him buy a car. In 4 years his brother paid him back the \$3,000 plus \$660 in interest. What was the rate of interest?

 **Solution**

We are asked to find the rate of interest, r .

Organize the given information.

$$I = 660$$

$$P = \$3,000$$

$$r = ?$$

$$t = 4 \text{ years}$$

Write the formula.	$I = Prt$
Substitute the given information.	$660 = (3,000)r(4)$
Multiply.	$660 = (12,000)r$
Divide.	$\frac{660}{12,000} = \frac{(12,000)r}{12,000}$
Simplify.	$0.055 = r$
Change to percent form.	$5.5\% = r$
Check your answer. Is 5.5% a reasonable interest rate to pay your brother?	
$I = Prt$	
$660 \stackrel{?}{=} (3,000)(0.055)(4)$	
$660 = 660 \checkmark$	
Write a complete sentence that answers the question.	The rate of interest was 5.5%.

> TRY IT :: 6.73

Jim lent his sister \$5,000 to help her buy a house. In 3 years, she paid him the \$5,000, plus \$900 interest. What was the rate of interest?

> TRY IT :: 6.74

Hang borrowed \$7,500 from her parents to pay her tuition. In 5 years, she paid them \$1,500 interest in addition to the \$7,500 she borrowed. What was the rate of interest?

There may be times when you take a loan for a large purchase and the amount of the principal is not clear. This might happen, for instance, in making a car purchase when the dealer adds the cost of a warranty to the price of the car. In the next example, we will solve a simple interest application for the principal.

EXAMPLE 6.38

Eduardo noticed that his new car loan papers stated that with an interest rate of 7.5%, he would pay \$6,596.25 in interest over 5 years. How much did he borrow to pay for his car?

✓ Solution

We are asked to find the principal, P .

Organize the given information.

$$I = 6,596.25$$

$$P = ?$$

$$r = 7.5\%$$

$$t = 5 \text{ years}$$

Write the formula.	$I = Prt$
Substitute the given information.	$6,596.25 = P(0.075)(5)$
Multiply.	$6,596.25 = 0.375P$
Divide.	$\frac{6,596.25}{0.375} = \frac{0.375P}{0.375}$
Simplify.	$17,590 = P$
Check your answer. Is \$17,590 a reasonable amount to borrow to buy a car?	
$I = Prt$	
$6,596.25 \stackrel{?}{=} (17,590)(0.075)(5)$	
$6,596.25 = 6,596.25 \checkmark$	
Write a complete sentence that answers the question.	The amount borrowed was \$17,590.

> TRY IT :: 6.75

Sean's new car loan statement said he would pay \$4,866.25 in interest from an interest rate of 8.5% over 5 years. How much did he borrow to buy his new car?

> TRY IT :: 6.76

In 5 years, Gloria's bank account earned \$2,400 interest at 5%. How much had she deposited in the account?

In the simple interest formula, the rate of interest is given as an annual rate, the rate for one year. So the units of time must be in years. If the time is given in months, we convert it to years.

EXAMPLE 6.39

Caroline got \$900 as graduation gifts and invested it in a 10-month certificate of deposit that earned 2.1% interest. How much interest did this investment earn?

✓ Solution

We are asked to find the interest, I .

Organize the given information.

$$I = ?$$

$$P = \$900$$

$$r = 2.1\%$$

$$t = 10 \text{ months}$$

Write the formula.

$$I = Prt$$

Substitute the given information, converting 10 months to $\frac{10}{12}$ of a year.

$$I = \$900(0.021)\left(\frac{10}{12}\right)$$

Multiply.

$$I = 15.75$$

Check your answer. Is \$15.75 a reasonable amount of interest?

If Caroline had invested the \$900 for a full year at 2% interest, the amount of interest would have been \$18. Yes, \$15.75 is reasonable.

Write a complete sentence that answers the question.

The interest earned was \$15.75.

> **TRY IT :: 6.77**

Adriana invested \$4,500 for 8 months in an account that paid 1.9% interest. How much interest did she earn?

> **TRY IT :: 6.78**

Milton invested \$2,460 for 20 months in an account that paid 3.5% interest. How much interest did he earn?



6.4 EXERCISES

Practice Makes Perfect

Use the Simple Interest Formula

In the following exercises, use the simple interest formula to fill in the missing information.

201.

Interest	Principal	Rate	Time (years)
	\$1200	3%	5

Table 6.5

202.

Interest	Principal	Rate	Time (years)
	\$1500	2%	4

Table 6.6

203.

Interest	Principal	Rate	Time (years)
\$4410		4.5%	7

Table 6.7

204.

Interest	Principal	Rate	Time (years)
\$2112		3.2%	6

Table 6.8

205.

Interest	Principal	Rate	Time (years)
\$577.08	\$4580		2

Table 6.9

206.

Interest	Principal	Rate	Time (years)
\$528.12	\$3260		3

Table 6.10

In the following exercises, solve the problem using the simple interest formula.

207. Find the simple interest earned after 5 years on \$600 at an interest rate of 3%.

208. Find the simple interest earned after 4 years on \$900 at an interest rate of 6%.

209. Find the simple interest earned after 2 years on \$8,950 at an interest rate of 3.24%.

210. Find the simple interest earned after 3 years on \$6,510 at an interest rate of 2.85%.

211. Find the simple interest earned after 8 years on \$15,500 at an interest rate of 11.425%.

212. Find the simple interest earned after 6 years on \$23,900 at an interest rate of 12.175%.

213. Find the principal invested if \$656 interest was earned in 5 years at an interest rate of 4%.

214. Find the principal invested if \$177 interest was earned in 2 years at an interest rate of 3%.

215. Find the principal invested if \$70.95 interest was earned in 3 years at an interest rate of 2.75%.

216. Find the principal invested if \$636.84 interest was earned in 6 years at an interest rate of 4.35%.

217. Find the principal invested if \$15,222.57 interest was earned in 6 years at an interest rate of 10.28%.

218. Find the principal invested if \$10,953.70 interest was earned in 5 years at an interest rate of 11.04%.

- 219.** Find the rate if a principal of \$5,400 earned \$432 interest in 2 years.
- 220.** Find the rate if a principal of \$2,600 earned \$468 interest in 6 years.
- 221.** Find the rate if a principal of \$11,000 earned \$1,815 interest in 3 years.
- 222.** Find the rate if a principal of \$8,500 earned \$3,230 interest in 4 years.

Solve Simple Interest Applications

In the following exercises, solve the problem using the simple interest formula.

- 223.** Casey deposited \$1,450 in a bank account with interest rate 4%. How much interest was earned in 2 years?
- 224.** Terrence deposited \$5,720 in a bank account with interest rate 6%. How much interest was earned in 4 years?
- 225.** Robin deposited \$31,000 in a bank account with interest rate 5.2%. How much interest was earned in 3 years?
- 226.** Carleen deposited \$16,400 in a bank account with interest rate 3.9%. How much interest was earned in 8 years?
- 227.** Hilaria borrowed \$8,000 from her grandfather to pay for college. Five years later, she paid him back the \$8,000, plus \$1,200 interest. What was the rate of interest?
- 228.** Kenneth lent his niece \$1,200 to buy a computer. Two years later, she paid him back the \$1,200, plus \$96 interest. What was the rate of interest?
- 229.** Lebron lent his daughter \$20,000 to help her buy a condominium. When she sold the condominium four years later, she paid him the \$20,000, plus \$3,000 interest. What was the rate of interest?
- 230.** Pablo borrowed \$50,000 to start a business. Three years later, he repaid the \$50,000, plus \$9,375 interest. What was the rate of interest?
- 231.** In 10 years, a bank account that paid 5.25% earned \$18,375 interest. What was the principal of the account?
- 232.** In 25 years, a bond that paid 4.75% earned \$2,375 interest. What was the principal of the bond?
- 233.** Joshua's computer loan statement said he would pay \$1,244.34 in interest for a 3 year loan at 12.4%. How much did Joshua borrow to buy the computer?
- 234.** Margaret's car loan statement said she would pay \$7,683.20 in interest for a 5 year loan at 9.8%. How much did Margaret borrow to buy the car?
- 235.** Caitlin invested \$8,200 in an 18-month certificate of deposit paying 2.7% interest. How much interest did she earn from this investment?
- 236.** Diego invested \$6,100 in a 9-month certificate of deposit paying 1.8% interest. How much interest did he earn from this investment?
- 237.** Airin borrowed \$3,900 from her parents for the down payment on a car and promised to pay them back in 15 months at a 4% rate of interest. How much interest did she owe her parents?
- 238.** Yuta borrowed \$840 from his brother to pay for his textbooks and promised to pay him back in 5 months at a 6% rate of interest. How much interest did Yuta owe his brother?

Everyday Math

239. Interest on savings Find the interest rate your local bank pays on savings accounts.

- Ⓐ What is the interest rate?
- Ⓑ Calculate the amount of interest you would earn on a principal of \$8,000 for 5 years.

240. Interest on a loan Find the interest rate your local bank charges for a car loan.

- Ⓐ What is the interest rate?
- Ⓑ Calculate the amount of interest you would pay on a loan of \$8,000 for 5 years.

Writing Exercises

241. Why do banks pay interest on money deposited in savings accounts?

242. Why do banks charge interest for lending money?

Self Check

Ⓐ After completing the exercises, use this checklist to evaluate your mastery of the objectives of this section.

I can...	Confidently	With some help	No-I don't get it!
use the simple interest formula.			
solve simple interest applications.			

Ⓑ On a scale of 1–10, how would you rate your mastery of this section in light of your responses on the checklist? How can you improve this?

6.5

Solve Proportions and their Applications

Learning Objectives

By the end of this section, you will be able to:

- ▶ Use the definition of proportion
- ▶ Solve proportions
- ▶ Solve applications using proportions
- ▶ Write percent equations as proportions
- ▶ Translate and solve percent proportions

✓ **BE PREPARED** :: 6.11 Before you get started, take this readiness quiz.

Simplify: $\frac{1}{\frac{3}{4}}$.

If you missed this problem, review [Example 4.44](#).

✓ **BE PREPARED** :: 6.12 Solve: $\frac{x}{4} = 20$.

If you missed this problem, review [Example 4.99](#).

✓ **BE PREPARED** :: 6.13 Write as a rate: Sale rode his bike 24 miles in 2 hours.

If you missed this problem, review [Example 5.63](#).

Use the Definition of Proportion

In the section on Ratios and Rates we saw some ways they are used in our daily lives. When two ratios or rates are equal, the equation relating them is called a **proportion**.

Proportion

A proportion is an equation of the form $\frac{a}{b} = \frac{c}{d}$, where $b \neq 0$, $d \neq 0$.

The proportion states two ratios or rates are equal. The proportion is read “ a is to b , as c is to d ”.

The equation $\frac{1}{2} = \frac{4}{8}$ is a proportion because the two fractions are equal. The proportion $\frac{1}{2} = \frac{4}{8}$ is read “1 is to 2 as 4 is to 8”.

If we compare quantities with units, we have to be sure we are comparing them in the right order. For example, in the proportion $\frac{20 \text{ students}}{1 \text{ teacher}} = \frac{60 \text{ students}}{3 \text{ teachers}}$ we compare the number of students to the number of teachers. We put students in the numerators and teachers in the denominators.

EXAMPLE 6.40

Write each sentence as a proportion:

- Ⓐ 3 is to 7 as 15 is to 35. Ⓑ 5 hits in 8 at bats is the same as 30 hits in 48 at-bats.
- Ⓒ \$1.50 for 6 ounces is equivalent to \$2.25 for 9 ounces.

✓ **Solution**

(a)

3 is to 7 as 15 is to 35.

Write as a proportion. $\frac{3}{7} = \frac{15}{35}$

(b)

5 hits in 8 at-bats is the same as 30 hits in 48 at-bats.

Write each fraction to compare hits to at-bats. $\frac{\text{hits}}{\text{at-bats}} = \frac{\text{hits}}{\text{at-bats}}$

Write as a proportion. $\frac{5}{8} = \frac{30}{48}$

(c)

\$1.50 for 6 ounces is equivalent to \$2.25 for 9 ounces.

Write each fraction to compare dollars to ounces. $\frac{\$}{\text{ounces}} = \frac{\$}{\text{ounces}}$

Write as a proportion. $\frac{1.50}{6} = \frac{2.25}{9}$

> **TRY IT :: 6.79**

Write each sentence as a proportion:

- (a) 5 is to 9 as 20 is to 36. (b) 7 hits in 11 at-bats is the same as 28 hits in 44 at-bats.
 (c) \$2.50 for 8 ounces is equivalent to \$3.75 for 12 ounces.

> **TRY IT :: 6.80**

Write each sentence as a proportion:

- (a) 6 is to 7 as 36 is to 42. (b) 8 adults for 36 children is the same as 12 adults for 54 children.
 (c) \$3.75 for 6 ounces is equivalent to \$2.50 for 4 ounces.

Look at the proportions $\frac{1}{2} = \frac{4}{8}$ and $\frac{2}{3} = \frac{6}{9}$. From our work with equivalent fractions we know these equations are true.

But how do we know if an equation is a proportion with equivalent fractions if it contains fractions with larger numbers?

To determine if a proportion is true, we find the **cross products** of each proportion. To find the cross products, we multiply each denominator with the opposite numerator (diagonally across the equal sign). The results are called a cross products because of the cross formed. The cross products of a proportion are equal.

$$8 \cdot 1 = 8 \quad 2 \cdot 4 = 8 \quad 9 \cdot 2 = 18 \quad 3 \cdot 6 = 18$$

$$\frac{1}{2} \times \frac{4}{8} \qquad \frac{2}{3} \times \frac{6}{9}$$

Cross Products of a Proportion

For any proportion of the form $\frac{a}{b} = \frac{c}{d}$, where $b \neq 0$, $d \neq 0$, its cross products are equal.

$$a \cdot d = b \cdot c$$

$$\frac{a}{b} = \frac{c}{d}$$

Cross products can be used to test whether a proportion is true. To test whether an equation makes a proportion, we find the cross products. If they are the equal, we have a proportion.

EXAMPLE 6.41

Determine whether each equation is a proportion:

$$\textcircled{a} \frac{4}{9} = \frac{12}{28} \quad \textcircled{b} \frac{17.5}{37.5} = \frac{7}{15}$$

Solution

To determine if the equation is a proportion, we find the cross products. If they are equal, the equation is a proportion.

\textcircled{a}

$$\frac{4}{9} = \frac{12}{28}$$

Find the cross products.

$$28 \cdot 4 = 112 \quad 9 \cdot 12 = 108$$

$$\frac{4}{9} \neq \frac{12}{28}$$

Since the cross products are not equal, $28 \cdot 4 \neq 9 \cdot 12$, the equation is not a proportion.

\textcircled{b}

$$\frac{17.5}{37.5} = \frac{7}{15}$$

Find the cross products.

$$15 \cdot 17.5 = 262.5 \quad 37.5 \cdot 7 = 262.5$$

$$\frac{17.5}{37.5} = \frac{7}{15}$$

Since the cross products are equal, $15 \cdot 17.5 = 37.5 \cdot 7$, the equation is a proportion.

TRY IT :: 6.81 Determine whether each equation is a proportion:

$$\textcircled{a} \frac{7}{9} = \frac{54}{72} \quad \textcircled{b} \frac{24.5}{45.5} = \frac{7}{13}$$

TRY IT :: 6.82 Determine whether each equation is a proportion:

$$\textcircled{a} \frac{8}{9} = \frac{56}{73} \quad \textcircled{b} \frac{28.5}{52.5} = \frac{8}{15}$$

Solve Proportions

To solve a proportion containing a variable, we remember that the proportion is an equation. All of the techniques we have used so far to solve equations still apply. In the next example, we will solve a proportion by multiplying by the Least Common Denominator (LCD) using the Multiplication Property of Equality.

EXAMPLE 6.42Solve: $\frac{x}{63} = \frac{4}{7}$. **Solution**

$$\frac{x}{63} = \frac{4}{7}$$

To isolate x , multiply both sides by the LCD, 63.

$$63\left(\frac{x}{63}\right) = 63\left(\frac{4}{7}\right)$$

Simplify.

$$x = \frac{9 \cdot 7 \cdot 4}{7}$$

Divide the common factors.

$$x = 36$$

Check: To check our answer, we substitute into the original proportion.

$$\frac{x}{63} = \frac{4}{7}$$

Substitute $x = 36$

$$\frac{36}{63} \stackrel{?}{=} \frac{4}{7}$$

Show common factors.

$$\frac{4 \cdot 9}{7 \cdot 9} \stackrel{?}{=} \frac{4}{7}$$

Simplify.

$$\frac{4}{7} = \frac{4}{7} \checkmark$$

 **TRY IT :: 6.83** Solve the proportion: $\frac{n}{84} = \frac{11}{12}$. **TRY IT :: 6.84** Solve the proportion: $\frac{y}{96} = \frac{13}{12}$.

When the variable is in a denominator, we'll use the fact that the cross products of a proportion are equal to solve the proportions.

We can find the cross products of the proportion and then set them equal. Then we solve the resulting equation using our familiar techniques.

EXAMPLE 6.43Solve: $\frac{144}{a} = \frac{9}{4}$. **Solution**

Notice that the variable is in the denominator, so we will solve by finding the cross products and setting them equal.

	$\frac{144}{a} \times \frac{9}{4}$
Find the cross products and set them equal.	$4 \cdot 144 = a \cdot 9$
Simplify.	$576 = 9a$
Divide both sides by 9.	$\frac{576}{9} = \frac{9a}{9}$
Simplify.	$64 = a$
Check your answer.	
	$\frac{144}{a} = \frac{9}{4}$
Substitute $a = 64$	$\frac{144}{64} \stackrel{?}{=} \frac{9}{4}$
Show common factors..	$\frac{9 \cdot 16}{4 \cdot 16} \stackrel{?}{=} \frac{9}{4}$
Simplify.	$\frac{9}{4} = \frac{9}{4} \checkmark$

Another method to solve this would be to multiply both sides by the LCD, $4a$. Try it and verify that you get the same solution.

> **TRY IT :: 6.85** Solve the proportion: $\frac{91}{b} = \frac{7}{5}$.

> **TRY IT :: 6.86** Solve the proportion: $\frac{39}{c} = \frac{13}{8}$.

EXAMPLE 6.44

Solve: $\frac{52}{91} = \frac{-4}{y}$.

 **Solution**

Find the cross products and set them equal. $\frac{52}{91} = \frac{-4}{y}$

$$y \cdot 52 = 91(-4)$$

Simplify. $52y = -364$

Divide both sides by 52. $\frac{52y}{52} = \frac{-364}{52}$

Simplify. $y = -7$

Check:

$$\frac{52}{91} = \frac{-4}{y}$$

Substitute $y = -7$ $\frac{52}{91} \stackrel{?}{=} \frac{-4}{-7}$

Show common factors.

Simplify. $\frac{4}{7} = \frac{4}{7} \checkmark$

 **TRY IT :: 6.87** Solve the proportion: $\frac{84}{98} = \frac{-6}{x}$.

 **TRY IT :: 6.88** Solve the proportion: $\frac{-7}{y} = \frac{105}{135}$.

Solve Applications Using Proportions

The strategy for solving applications that we have used earlier in this chapter, also works for proportions, since proportions are equations. When we set up the proportion, we must make sure the units are correct—the units in the numerators match and the units in the denominators match.

EXAMPLE 6.45

When pediatricians prescribe acetaminophen to children, they prescribe 5 milliliters (ml) of acetaminophen for every 25 pounds of the child's weight. If Zoe weighs 80 pounds, how many milliliters of acetaminophen will her doctor prescribe?

 **Solution**

Identify what you are asked to find.	How many ml of acetaminophen the doctor will prescribe
Choose a variable to represent it.	Let $a =$ ml of acetaminophen.
Write a sentence that gives the information to find it.	If 5 ml is prescribed for every 25 pounds, how much will be prescribed for 80 pounds?
Translate into a proportion.	$\frac{\text{ml}}{\text{pounds}} = \frac{\text{ml}}{\text{pounds}}$
Substitute given values—be careful of the units.	$\frac{5}{25} = \frac{a}{80}$
Multiply both sides by 80.	$80 \cdot \frac{5}{25} = 80 \cdot \frac{a}{80}$
Multiply and show common factors.	$\frac{16 \cdot 5 \cdot 5}{5 \cdot 5} = \frac{80a}{80}$
Simplify.	$16 = a$
Check if the answer is reasonable.	
Yes. Since 80 is about 3 times 25, the medicine should be about 3 times 5.	
Write a complete sentence.	The pediatrician would prescribe 16 ml of acetaminophen to Zoe.

You could also solve this proportion by setting the cross products equal.

 **TRY IT :: 6.89**

Pediatricians prescribe 5 milliliters (ml) of acetaminophen for every 25 pounds of a child's weight. How many milliliters of acetaminophen will the doctor prescribe for Emilia, who weighs 60 pounds?

 **TRY IT :: 6.90**

For every 1 kilogram (kg) of a child's weight, pediatricians prescribe 15 milligrams (mg) of a fever reducer. If Isabella weighs 12 kg, how many milligrams of the fever reducer will the pediatrician prescribe?

EXAMPLE 6.46

One brand of microwave popcorn has 120 calories per serving. A whole bag of this popcorn has 3.5 servings. How many calories are in a whole bag of this microwave popcorn?

 **Solution**

Identify what you are asked to find.	How many calories are in a whole bag of microwave popcorn?
Choose a variable to represent it.	Let c = number of calories.
Write a sentence that gives the information to find it.	If there are 120 calories per serving, how many calories are in a whole bag with 3.5 servings?
Translate into a proportion.	$\frac{\text{calories}}{\text{serving}} = \frac{\text{calories}}{\text{serving}}$
Substitute given values.	$\frac{120}{1} = \frac{c}{3.5}$
Multiply both sides by 3.5.	$(3.5)\left(\frac{120}{1}\right) = (3.5)\left(\frac{c}{3.5}\right)$
Multiply.	$420 = c$
Check if the answer is reasonable.	
Yes. Since 3.5 is between 3 and 4, the total calories should be between 360 ($3 \cdot 120$) and 480 ($4 \cdot 120$).	
Write a complete sentence.	The whole bag of microwave popcorn has 420 calories.

 **TRY IT :: 6.91**

Marissa loves the Caramel Macchiato at the coffee shop. The 16 oz. medium size has 240 calories. How many calories will she get if she drinks the large 20 oz. size?

 **TRY IT :: 6.92**

Yaneli loves Starburst candies, but wants to keep her snacks to 100 calories. If the candies have 160 calories for 8 pieces, how many pieces can she have in her snack?

EXAMPLE 6.47

Josiah went to Mexico for spring break and changed \$325 dollars into Mexican pesos. At that time, the exchange rate had \$1 U.S. is equal to 12.54 Mexican pesos. How many Mexican pesos did he get for his trip?

Solution

Identify what you are asked to find.	How many Mexican pesos did Josiah get?
Choose a variable to represent it.	Let p = number of pesos.
Write a sentence that gives the information to find it.	If \$1 U.S. is equal to 12.54 Mexican pesos, then \$325 is how many pesos?
Translate into a proportion.	$\frac{\$}{\text{pesos}} = \frac{\$}{\text{pesos}}$
Substitute given values.	$\frac{1}{12.54} = \frac{325}{p}$
The variable is in the denominator, so find the cross products and set them equal.	$p \cdot 1 = 12.54(325)$
Simplify.	$c = 4,075.5$
Check if the answer is reasonable.	
Yes, \$100 would be \$1,254 pesos. \$325 is a little more than 3 times this amount.	
Write a complete sentence.	Josiah has 4075.5 pesos for his spring break trip.

TRY IT :: 6.93

Yurianna is going to Europe and wants to change \$800 dollars into Euros. At the current exchange rate, \$1 US is equal to 0.738 Euro. How many Euros will she have for her trip?

TRY IT :: 6.94

Corey and Nicole are traveling to Japan and need to exchange \$600 into Japanese yen. If each dollar is 94.1 yen, how many yen will they get?

Write Percent Equations As Proportions

Previously, we solved percent equations by applying the properties of equality we have used to solve equations throughout this text. Some people prefer to solve percent equations by using the proportion method. The proportion method for solving percent problems involves a percent proportion. A **percent proportion** is an equation where a percent is equal to an equivalent ratio.

For example, $60\% = \frac{60}{100}$ and we can simplify $\frac{60}{100} = \frac{3}{5}$. Since the equation $\frac{60}{100} = \frac{3}{5}$ shows a percent equal to an equivalent ratio, we call it a **percent proportion**. Using the vocabulary we used earlier:

$$\frac{\text{amount}}{\text{base}} = \frac{\text{percent}}{100}$$

$$\frac{3}{5} = \frac{60}{100}$$

Percent Proportion

The amount is to the base as the percent is to 100.

$$\frac{\text{amount}}{\text{base}} = \frac{\text{percent}}{100}$$

If we restate the problem in the words of a proportion, it may be easier to set up the proportion:

The amount is to the base as the percent is to one hundred.

We could also say:

The amount out of the base is the same as the percent out of one hundred.

First we will practice translating into a percent proportion. Later, we'll solve the proportion.

EXAMPLE 6.48

Translate to a proportion. What number is 75% of 90?

✓ Solution

If you look for the word "of", it may help you identify the base.

Identify the parts of the percent proportion. $\underbrace{\text{What number}}_{\text{amount}}$ is $\underbrace{75\%}_{\text{percent}}$ of $\underbrace{90?}_{\text{base}}$

Restate as a proportion. What number out of 90 is the same as 75 out of 100?

Set up the proportion. Let $n = \text{number}$. $\frac{n}{90} = \frac{75}{100}$

> **TRY IT :: 6.95** Translate to a proportion: What number is 60% of 105?

> **TRY IT :: 6.96** Translate to a proportion: What number is 40% of 85?

EXAMPLE 6.49

Translate to a proportion. 19 is 25% of what number?

✓ Solution

Identify the parts of the percent proportion. $\underbrace{19}_{\text{amount}}$ is $\underbrace{25\%}_{\text{percent}}$ of $\underbrace{\text{what number?}}_{\text{base}}$

Restate as a proportion. 19 out of what number is the same as 25 out of 100?

Set up the proportion. Let $n = \text{number}$. $\frac{19}{n} = \frac{25}{100}$

> **TRY IT :: 6.97** Translate to a proportion: 36 is 25% of what number?

> **TRY IT :: 6.98** Translate to a proportion: 27 is 36% of what number?

EXAMPLE 6.50

Translate to a proportion. What percent of 27 is 9?

✓ Solution

Identify the parts of the percent proportion. $\underbrace{\text{What percent}}_{\text{percent}}$ $\text{ of } \underbrace{27}_{\text{base}}$ $\text{ is } \underbrace{9?}_{\text{amount}}$

Restate as a proportion. 9 out of 27 is the same as what number out of 100?

Set up the proportion. Let $p = \text{percent}$. $\frac{9}{27} = \frac{p}{100}$

> **TRY IT :: 6.99** Translate to a proportion: What percent of 52 is 39?

> **TRY IT :: 6.100** Translate to a proportion: What percent of 92 is 23?

Translate and Solve Percent Proportions

Now that we have written percent equations as proportions, we are ready to solve the equations.

EXAMPLE 6.51

Translate and solve using proportions: What number is 45% of 80?

✓ Solution

Identify the parts of the percent proportion. $\underbrace{\text{What number}}_{\text{amount}}$ $\text{ is } \underbrace{45\%}_{\text{percent}}$ $\text{ of } \underbrace{80?}_{\text{base}}$

Restate as a proportion. What number out of 80 is the same as 45 out of 100?

Set up the proportion. Let $n = \text{number}$. $\frac{n}{80} = \frac{45}{100}$

Find the cross products and set them equal. $100 \cdot n = 80 \cdot 45$

Simplify. $100n = 3,600$

Divide both sides by 100. $\frac{100n}{100} = \frac{3,600}{100}$

Simplify. $n = 36$

Check if the answer is reasonable.

Yes. 45 is a little less than half of 100 and 36 is a little less than half 80.

Write a complete sentence that answers the question. 36 is 45% of 80.

> **TRY IT :: 6.101** Translate and solve using proportions: What number is 65% of 40?

> **TRY IT :: 6.102** Translate and solve using proportions: What number is 85% of 40?

In the next example, the percent is more than 100, which is more than one whole. So the unknown number will be more than the base.

EXAMPLE 6.52

Translate and solve using proportions: 125% of 25 is what number?

 **Solution**

Identify the parts of the percent proportion.	$\underbrace{125\%}_{\text{percent}} \text{ is } \underbrace{25}_{\text{base}} \text{ of } \underbrace{\text{what number?}}_{\text{amount}}$
Restate as a proportion.	What number out of 25 is the same as 125 out of 100?
Set up the proportion. Let $n =$ number.	$\frac{n}{25} = \frac{125}{100}$
Find the cross products and set them equal.	$100 \cdot n = 25 \cdot 125$
Simplify.	$100n = 3,125$
Divide both sides by 100.	$\frac{100n}{100} = \frac{3,125}{100}$
Simplify.	$n = 31.25$
Check if the answer is reasonable.	
Yes, 125 is more than 100 and 31.25 is more than 25.	
Write a complete sentence that answers the question.	125% of 25 is 31.25.

 **TRY IT :: 6.103** Translate and solve using proportions: 125% of 64 is what number?

 **TRY IT :: 6.104** Translate and solve using proportions: 175% of 84 is what number?

Percents with decimals and money are also used in proportions.

EXAMPLE 6.53

Translate and solve: 6.5% of what number is \$1.56?

 **Solution**

Identify the parts of the percent proportion.	$\underbrace{6.5\%}_{\text{percent}} \text{ of } \underbrace{\text{what number}}_{\text{base}} \text{ is } \underbrace{\$1.56?}_{\text{amount}}$
Restate as a proportion.	\$1.56 out of what number is the same as 6.5 out of 100?
Set up the proportion. Let $n =$ number.	$\frac{1.56}{n} = \frac{6.5}{100}$
Find the cross products and set them equal.	$100(1.56) = n \cdot 6.5$
Simplify.	$156 = 6.5n$
Divide both sides by 6.5 to isolate the variable.	$\frac{156}{6.5} = \frac{6.5n}{6.5}$
Simplify.	$24 = n$
Check if the answer is reasonable.	
Yes. 6.5% is a small amount and \$1.56 is much less than \$24.	
Write a complete sentence that answers the question.	6.5% of \$24 is \$1.56.

 **TRY IT :: 6.105** Translate and solve using proportions: 8.5% of what number is \$3.23?

 **TRY IT :: 6.106** Translate and solve using proportions: 7.25% of what number is \$4.64?

EXAMPLE 6.54

Translate and solve using proportions: What percent of 72 is 9?

✓ **Solution**

Identify the parts of the percent proportion.	$\underbrace{\text{What percent}}_{\text{percent}} \text{ of } \underbrace{72}_{\text{base}} \text{ is } \underbrace{9?}_{\text{amount}}$
Restate as a proportion.	9 out of 72 is the same as what number out of 100?
Set up the proportion. Let $n =$ number.	$\frac{9}{72} = \frac{n}{100}$
Find the cross products and set them equal.	$72 \cdot n = 100 \cdot 9$
Simplify.	$72n = 900$
Divide both sides by 72.	$\frac{72n}{72} = \frac{900}{72}$
Simplify.	$n = 12.5$
Check if the answer is reasonable.	
Yes. 9 is $\frac{1}{8}$ of 72 and $\frac{1}{8}$ is 12.5%.	
Write a complete sentence that answers the question.	12.5% of 72 is 9.

> **TRY IT :: 6.107** Translate and solve using proportions: What percent of 72 is 27?

> **TRY IT :: 6.108** Translate and solve using proportions: What percent of 92 is 23?



6.5 EXERCISES

Practice Makes Perfect

Use the Definition of Proportion

In the following exercises, write each sentence as a proportion.

243. 4 is to 15 as 36 is to 135.

244. 7 is to 9 as 35 is to 45.

245. 12 is to 5 as 96 is to 40.

246. 15 is to 8 as 75 is to 40.

247. 5 wins in 7 games is the same as 115 wins in 161 games.

248. 4 wins in 9 games is the same as 36 wins in 81 games.

249. 8 campers to 1 counselor is the same as 48 campers to 6 counselors.

250. 6 campers to 1 counselor is the same as 48 campers to 8 counselors.

251. \$9.36 for 18 ounces is the same as \$2.60 for 5 ounces.

252. \$3.92 for 8 ounces is the same as \$1.47 for 3 ounces.

253. \$18.04 for 11 pounds is the same as \$4.92 for 3 pounds.

254. \$12.42 for 27 pounds is the same as \$5.52 for 12 pounds.

In the following exercises, determine whether each equation is a proportion.

255. $\frac{7}{15} = \frac{56}{120}$

256. $\frac{5}{12} = \frac{45}{108}$

257. $\frac{11}{6} = \frac{21}{16}$

258. $\frac{9}{4} = \frac{39}{34}$

259. $\frac{12}{18} = \frac{4.99}{7.56}$

260. $\frac{9}{16} = \frac{2.16}{3.89}$

261. $\frac{13.5}{8.5} = \frac{31.05}{19.55}$

262. $\frac{10.1}{8.4} = \frac{3.03}{2.52}$

Solve Proportions

In the following exercises, solve each proportion.

263. $\frac{x}{56} = \frac{7}{8}$

264. $\frac{n}{91} = \frac{8}{13}$

265. $\frac{49}{63} = \frac{z}{9}$

266. $\frac{56}{72} = \frac{y}{9}$

267. $\frac{5}{a} = \frac{65}{117}$

268. $\frac{4}{b} = \frac{64}{144}$

269. $\frac{98}{154} = \frac{-7}{p}$

270. $\frac{72}{156} = \frac{-6}{q}$

271. $\frac{a}{-8} = \frac{-42}{48}$

272. $\frac{b}{-7} = \frac{-30}{42}$

273. $\frac{2.6}{3.9} = \frac{c}{3}$

274. $\frac{2.7}{3.6} = \frac{d}{4}$

275. $\frac{2.7}{j} = \frac{0.9}{0.2}$

276. $\frac{2.8}{k} = \frac{2.1}{1.5}$

277. $\frac{1}{2} = \frac{m}{8}$

278. $\frac{1}{3} = \frac{9}{n}$

Solve Applications Using Proportions

In the following exercises, solve the proportion problem.

- 279.** Pediatricians prescribe 5 milliliters (ml) of acetaminophen for every 25 pounds of a child's weight. How many milliliters of acetaminophen will the doctor prescribe for Jocelyn, who weighs 45 pounds?
- 280.** Brianna, who weighs 6 kg, just received her shots and needs a pain killer. The pain killer is prescribed for children at 15 milligrams (mg) for every 1 kilogram (kg) of the child's weight. How many milligrams will the doctor prescribe?
- 281.** At the gym, Carol takes her pulse for 10 sec and counts 19 beats. How many beats per minute is this? Has Carol met her target heart rate of 140 beats per minute?
- 282.** Kevin wants to keep his heart rate at 160 beats per minute while training. During his workout he counts 27 beats in 10 seconds. How many beats per minute is this? Has Kevin met his target heart rate?
- 283.** A new energy drink advertises 106 calories for 8 ounces. How many calories are in 12 ounces of the drink?
- 284.** One 12 ounce can of soda has 150 calories. If Josiah drinks the big 32 ounce size from the local mini-mart, how many calories does he get?
- 285.** Karen eats $\frac{1}{2}$ cup of oatmeal that counts for 2 points on her weight loss program. Her husband, Joe, can have 3 points of oatmeal for breakfast. How much oatmeal can he have?
- 286.** An oatmeal cookie recipe calls for $\frac{1}{2}$ cup of butter to make 4 dozen cookies. Hilda needs to make 10 dozen cookies for the bake sale. How many cups of butter will she need?
- 287.** Janice is traveling to Canada and will change \$250 US dollars into Canadian dollars. At the current exchange rate, \$1 US is equal to \$1.01 Canadian. How many Canadian dollars will she get for her trip?
- 288.** Todd is traveling to Mexico and needs to exchange \$450 into Mexican pesos. If each dollar is worth 12.29 pesos, how many pesos will he get for his trip?
- 289.** Steve changed \$600 into 480 Euros. How many Euros did he receive per US dollar?
- 290.** Martha changed \$350 US into 385 Australian dollars. How many Australian dollars did she receive per US dollar?
- 291.** At the laundromat, Lucy changed \$12.00 into quarters. How many quarters did she get?
- 292.** When she arrived at a casino, Gerty changed \$20 into nickels. How many nickels did she get?
- 293.** Jesse's car gets 30 miles per gallon of gas. If Las Vegas is 285 miles away, how many gallons of gas are needed to get there and then home? If gas is \$3.09 per gallon, what is the total cost of the gas for the trip?
- 294.** Danny wants to drive to Phoenix to see his grandfather. Phoenix is 370 miles from Danny's home and his car gets 18.5 miles per gallon. How many gallons of gas will Danny need to get to and from Phoenix? If gas is \$3.19 per gallon, what is the total cost for the gas to drive to see his grandfather?
- 295.** Hugh leaves early one morning to drive from his home in Chicago to go to Mount Rushmore, 812 miles away. After 3 hours, he has gone 190 miles. At that rate, how long will the whole drive take?
- 296.** Kelly leaves her home in Seattle to drive to Spokane, a distance of 280 miles. After 2 hours, she has gone 152 miles. At that rate, how long will the whole drive take?

297. Phil wants to fertilize his lawn. Each bag of fertilizer covers about 4,000 square feet of lawn. Phil's lawn is approximately 13,500 square feet. How many bags of fertilizer will he have to buy?

298. April wants to paint the exterior of her house. One gallon of paint covers about 350 square feet, and the exterior of the house measures approximately 2000 square feet. How many gallons of paint will she have to buy?

Write Percent Equations as Proportions

In the following exercises, translate to a proportion.

299. What number is 35% of 250?

300. What number is 75% of 920?

301. What number is 110% of 47?

302. What number is 150% of 64?

303. 45 is 30% of what number?

304. 25 is 80% of what number?

305. 90 is 150% of what number?

306. 77 is 110% of what number?

307. What percent of 85 is 17?

308. What percent of 92 is 46?

309. What percent of 260 is 340?

310. What percent of 180 is 220?

Translate and Solve Percent Proportions

In the following exercises, translate and solve using proportions.

311. What number is 65% of 180?

312. What number is 55% of 300?

313. 18% of 92 is what number?

314. 22% of 74 is what number?

315. 175% of 26 is what number?

316. 250% of 61 is what number?

317. What is 300% of 488?

318. What is 500% of 315?

319. 17% of what number is \$7.65?

320. 19% of what number is \$6.46?

321. \$13.53 is 8.25% of what number?

322. \$18.12 is 7.55% of what number?

323. What percent of 56 is 14?

324. What percent of 80 is 28?

325. What percent of 96 is 12?

326. What percent of 120 is 27?

Everyday Math

327. Mixing a concentrate Sam bought a large bottle of concentrated cleaning solution at the warehouse store. He must mix the concentrate with water to make a solution for washing his windows. The directions tell him to mix 3 ounces of concentrate with 5 ounces of water. If he puts 12 ounces of concentrate in a bucket, how many ounces of water should he add? How many ounces of the solution will he have altogether?

328. Mixing a concentrate Travis is going to wash his car. The directions on the bottle of car wash concentrate say to mix 2 ounces of concentrate with 15 ounces of water. If Travis puts 6 ounces of concentrate in a bucket, how much water must he mix with the concentrate?

Writing Exercises

329. To solve “what number is 45% of 350” do you prefer to use an equation like you did in the section on Decimal Operations or a proportion like you did in this section? Explain your reason.

330. To solve “what percent of 125 is 25” do you prefer to use an equation like you did in the section on Decimal Operations or a proportion like you did in this section? Explain your reason.

Self Check

Ⓐ After completing the exercises, use this checklist to evaluate your mastery of the objectives of this section.

I can...	Confidently	With some help	No-I don't get it!
use definition of proportion.			
solve proportions.			
solve applications using proportions.			
write percent equations as proportions.			
translate and solve percent proportions.			

Ⓑ Overall, after looking at the checklist, do you think you are well-prepared for the next Chapter? Why or why not?

CHAPTER 6 REVIEW

KEY TERMS

commission A commission is a percentage of total sales as determined by the rate of commission.

discount An amount of discount is a percent off the original price, determined by the discount rate.

mark-up The mark-up is the amount added to the wholesale price, determined by the mark-up rate.

percent A percent is a ratio whose denominator is 100.

percent decrease The percent decrease is the percent the amount of decrease is of the original amount.

percent increase The percent increase is the percent the amount of increase is of the original amount.

proportion A proportion is an equation of the form $\frac{a}{b} = \frac{c}{d}$, where $b \neq 0$, $d \neq 0$. The proportion states two ratios or rates are equal. The proportion is read " a is to b , as c is to d ".

sales tax The sales tax is a percent of the purchase price.

simple interest If an amount of money, P , the principal, is invested for a period of t years at an annual interest rate r , the amount of interest, I , earned is $I = Prt$. Interest earned according to this formula is called simple interest.

KEY CONCEPTS

6.1 Understand Percent

- **Convert a percent to a fraction.**
 - Step 1. Write the percent as a ratio with the denominator 100.
 - Step 2. Simplify the fraction if possible.
- **Convert a percent to a decimal.**
 - Step 1. Write the percent as a ratio with the denominator 100.
 - Step 2. Convert the fraction to a decimal by dividing the numerator by the denominator.
- **Convert a decimal to a percent.**
 - Step 1. Write the decimal as a fraction.
 - Step 2. If the denominator of the fraction is not 100, rewrite it as an equivalent fraction with denominator 100.
 - Step 3. Write this ratio as a percent.
- **Convert a fraction to a percent.**
 - Step 1. Convert the fraction to a decimal.
 - Step 2. Convert the decimal to a percent.

6.2 Solve General Applications of Percent

- **Solve an application.**
 - Step 1. Identify what you are asked to find and choose a variable to represent it.
 - Step 2. Write a sentence that gives the information to find it.
 - Step 3. Translate the sentence into an equation.
 - Step 4. Solve the equation using good algebra techniques.
 - Step 5. Write a complete sentence that answers the question.
 - Step 6. Check the answer in the problem and make sure it makes sense.
- **Find percent increase.**
 - Step 1. Find the amount of increase:

$$\text{increase} = \text{new amount} - \text{original amount}$$
 - Step 2. Find the percent increase as a percent of the original amount.
- **Find percent decrease.**

Step 1. Find the amount of decrease.

$$\text{decrease} = \text{original amount} - \text{new amount}$$

Step 2. Find the percent decrease as a percent of the original amount.

6.3 Solve Sales Tax, Commission, and Discount Applications

- **Sales Tax** The sales tax is a percent of the purchase price.
 - $\text{sales tax} = \text{tax rate} \cdot \text{purchase price}$
 - $\text{total cost} = \text{purchase price} + \text{sales tax}$
- **Commission** A commission is a percentage of total sales as determined by the rate of commission.
 - $\text{commission} = \text{rate of commission} \cdot \text{original price}$
- **Discount** An amount of discount is a percent off the original price, determined by the discount rate.
 - $\text{amount of discount} = \text{discount rate} \cdot \text{original price}$
 - $\text{sale price} = \text{original price} - \text{discount}$
- **Mark-up** The mark-up is the amount added to the wholesale price, determined by the mark-up rate.
 - $\text{amount of mark-up} = \text{mark-up rate} \cdot \text{wholesale price}$
 - $\text{list price} = \text{wholesale price} + \text{mark up}$

6.4 Solve Simple Interest Applications

- **Simple interest**
 - If an amount of money, P , the principal, is invested for a period of t years at an annual interest rate r , the amount of interest, I , earned is $I = Prt$
 - Interest earned according to this formula is called **simple interest**.

6.5 Solve Proportions and their Applications

- **Proportion**
 - A proportion is an equation of the form $\frac{a}{b} = \frac{c}{d}$, where $b \neq 0$, $d \neq 0$. The proportion states two ratios or rates are equal. The proportion is read " a is to b , as c is to d ".
- **Cross Products of a Proportion**
 - For any proportion of the form $\frac{a}{b} = \frac{c}{d}$, where $b \neq 0$, its cross products are equal: $a \cdot d = b \cdot c$.
- **Percent Proportion**
 - The amount is to the base as the percent is to 100. $\frac{\text{amount}}{\text{base}} = \frac{\text{percent}}{100}$

REVIEW EXERCISES

6.1 Understand Percent

In the following exercises, write each percent as a ratio.

- 331.** 32% admission rate for the university **332.** 53.3% rate of college students with student loans

In the following exercises, write as a ratio and then as a percent.

- 333.** 13 out of 100 architects are women. **334.** 9 out of every 100 nurses are men.

In the following exercises, convert each percent to a fraction.

335. 48% 336. 175% 337. 64.1%
338. $8\frac{1}{4}\%$

In the following exercises, convert each percent to a decimal.

339. 6% 340. 23% 341. 128%
342. 4.9%

In the following exercises, convert each percent to \textcircled{a} a simplified fraction and \textcircled{b} a decimal.

343. In 2012, 13.5% of the United States population was age 65 or over. (Source: www.census.gov)
344. In 2012, 6.5% of the United States population was under 5 years old. (Source: www.census.gov)
345. When a die is tossed, the probability it will land with an even number of dots on the top side is 50%.
346. A couple plans to have three children. The probability they will all be girls is 12.5%.

In the following exercises, convert each decimal to a percent.

347. 0.04 348. 0.15 349. 2.82
350. 3 351. 0.003 352. 1.395

In the following exercises, convert each fraction to a percent.

353. $\frac{3}{4}$ 354. $\frac{11}{5}$ 355. $3\frac{5}{8}$
356. $\frac{2}{9}$ 357. According to the Centers for Disease Control, $\frac{2}{5}$ of adults do not take a vitamin or supplement.
358. According to the Centers for Disease Control, among adults who do take a vitamin or supplement, $\frac{3}{4}$ take a multivitamin.

In the following exercises, translate and solve.

359. What number is 46% of 350?
360. 120% of 55 is what number?
361. 84 is 35% of what number?
362. 15 is 8% of what number?
363. 200% of what number is 50?
364. 7.9% of what number is \$4.74?
365. What percent of 120 is 81.6?
366. What percent of 340 is 595?

6.2 Solve General Applications of Percents

In the following exercises, solve.

367. When Aurelio and his family ate dinner at a restaurant, the bill was \$83.50. Aurelio wants to leave 20% of the total bill as a tip. How much should the tip be?

370. Elsa gets paid \$4,600 per month. Her car payment is \$253. What percent of her monthly pay goes to her car payment?

In the following exercises, solve.

371. Jorge got a raise in his hourly pay, from \$19.00 to \$19.76. Find the percent increase.

368. One granola bar has 2 grams of fiber, which is 8% of the recommended daily amount. What is the total recommended daily amount of fiber?

372. Last year Bernard bought a new car for \$30,000. This year the car is worth \$24,000. Find the percent decrease.

369. The nutrition label on a package of granola bars says that each granola bar has 190 calories, and 54 calories are from fat. What percent of the total calories is from fat?

6.3 Solve Sales Tax, Commission, and Discount Applications

In the following exercises, find @ the sales tax @ the total cost.

373. The cost of a lawn mower was \$750. The sales tax rate is 6% of the purchase price.

374. The cost of a water heater is \$577. The sales tax rate is 8.75% of the purchase price.

In the following exercises, find the sales tax rate.

375. Andy bought a piano for \$4,600. The sales tax on the purchase was \$333.50.

376. Nahomi bought a purse for \$200. The sales tax on the purchase was \$16.75.

In the following exercises, find the commission.

377. Ginny is a realtor. She receives 3% commission when she sells a house. How much commission will she receive for selling a house for \$380,000?

378. Jackson receives 16.5% commission when he sells a dinette set. How much commission will he receive for selling a dinette set for \$895?

In the following exercises, find the rate of commission.

379. Ruben received \$675 commission when he sold a \$4,500 painting at the art gallery where he works. What was the rate of commission?

380. Tori received \$80.75 for selling a \$950 membership at her gym. What was her rate of commission?

In the following exercises, find the sale price.

381. Aya bought a pair of shoes that was on sale for \$30 off. The original price of the shoes was \$75.

382. Takwanna saw a cookware set she liked on sale for \$145 off. The original price of the cookware was \$312.

In the following exercises, find **a** the amount of discount and **b** the sale price.

- 383.** Nga bought a microwave for her office. The microwave was discounted 30% from an original price of \$84.90.
- 384.** Jarrett bought a tie that was discounted 65% from an original price of \$45.

In the following exercises, find **a** the amount of discount **b** the discount rate. (Round to the nearest tenth of a percent if needed.)

- 385.** Hilda bought a bedspread on sale for \$37. The original price of the bedspread was \$50.
- 386.** Tyler bought a phone on sale for \$49.99. The original price of the phone was \$79.99.

In the following exercises, find

- a** the amount of the mark-up **b** the list price

- 387.** Manny paid \$0.80 a pound for apples. He added 60% mark-up before selling them at his produce stand. What price did he charge for the apples?
- 388.** It cost Noelle \$17.40 for the materials she used to make a purse. She added a 325% mark-up before selling it at her friend's store. What price did she ask for the purse?

6.4 Solve Simple Interest Applications

In the following exercises, solve the simple interest problem.

- 389.** Find the simple interest earned after 4 years on \$2,250 invested at an interest rate of 5%.
- 390.** Find the simple interest earned after 7 years on \$12,000 invested at an interest rate of 8.5%.
- 391.** Find the principal invested if \$660 interest was earned in 5 years at an interest rate of 3%.
- 392.** Find the interest rate if \$2,898 interest was earned from a principal of \$23,000 invested for 3 years.
- 393.** Kazuo deposited \$10,000 in a bank account with interest rate 4.5%. How much interest was earned in 2 years?
- 394.** Brent invested \$23,000 in a friend's business. In 5 years the friend paid him the \$23,000 plus \$9,200 interest. What was the rate of interest?
- 395.** Fresia lent her son \$5,000 for college expenses. Three years later he repaid her the \$5,000 plus \$375 interest. What was the rate of interest?
- 396.** In 6 years, a bond that paid 5.5% earned \$594 interest. What was the principal of the bond?

6.5 Solve Proportions and their Applications

In the following exercises, write each sentence as a proportion.

- 397.** 3 is to 8 as 12 is to 32.
- 398.** 95 miles to 3 gallons is the same as 475 miles to 15 gallons.
- 399.** 1 teacher to 18 students is the same as 23 teachers to 414 students.
- 400.** \$7.35 for 15 ounces is the same as \$2.94 for 6 ounces.

In the following exercises, determine whether each equation is a proportion.

401. $\frac{5}{13} = \frac{30}{78}$

402. $\frac{16}{7} = \frac{48}{23}$

403. $\frac{12}{18} = \frac{6.99}{10.99}$

404. $\frac{11.6}{9.2} = \frac{37.12}{29.44}$

In the following exercises, solve each proportion.

405. $\frac{x}{36} = \frac{5}{9}$

406. $\frac{7}{a} = \frac{-6}{84}$

407. $\frac{1.2}{1.8} = \frac{d}{6}$

408. $\frac{1}{2} = \frac{m}{20}$

In the following exercises, solve the proportion problem.

409. The children's dosage of acetaminophen is 5 milliliters (ml) for every 25 pounds of a child's weight. How many milliliters of acetaminophen will be prescribed for a 60 pound child?

410. After a workout, Dennis takes his pulse for 10 sec and counts 21 beats. How many beats per minute is this?

411. An 8 ounce serving of ice cream has 272 calories. If Lavonne eats 10 ounces of ice cream, how many calories does she get?

412. Alma is going to Europe and wants to exchange \$1,200 into Euros. If each dollar is 0.75 Euros, how many Euros will Alma get?

413. Zack wants to drive from Omaha to Denver, a distance of 494 miles. If his car gets 38 miles to the gallon, how many gallons of gas will Zack need to get to Denver?

414. Teresa is planning a party for 100 people. Each gallon of punch will serve 18 people. How many gallons of punch will she need?

In the following exercises, translate to a proportion.

415. What number is 62% of 395?

416. 42 is 70% of what number?

417. What percent of 1,000 is 15?

418. What percent of 140 is 210?

In the following exercises, translate and solve using proportions.

419. What number is 85% of 900?

420. 6% of what number is \$24?

421. \$3.51 is 4.5% of what number?

422. What percent of 3,100 is 930?

PRACTICE TEST

In the following exercises, convert each percent to **(a)** a decimal **(b)** a simplified fraction.

423. 24%

424. 5%

425. 350%

In the following exercises, convert each fraction to a percent. (Round to 3 decimal places if needed.)

426. $\frac{7}{8}$

427. $\frac{1}{3}$

428. $\frac{11}{12}$

In the following exercises, solve the percent problem.

429. 65 is what percent of 260?

430. What number is 27% of 3,000?

431. 150% of what number is 60?

432. Yuki's monthly paycheck is \$3,825. She pays \$918 for rent. What percent of her paycheck goes to rent?

433. The total number of vehicles on one freeway dropped from 84,000 to 74,000. Find the percent decrease (round to the nearest tenth of a percent).

434. Kyle bought a bicycle in Denver where the sales tax was 7.72% of the purchase price. The purchase price of the bicycle was \$600. What was the total cost?

435. Mara received \$31.80 commission when she sold a \$795 suit. What was her rate of commission?

436. Kiyoshi bought a television set on sale for \$899. The original price was \$1,200. Find:

437. Oxana bought a dresser at a garage sale for \$20. She refinished it, then added a 250% markup before advertising it for sale. What price did she ask for the dresser?

(a) the amount of discount

(b) the discount rate (round to the nearest tenth of a percent)

438. Find the simple interest earned after 5 years on \$3000 invested at an interest rate of 4.2%.

439. Brenda borrowed \$400 from her brother. Two years later, she repaid the \$400 plus \$50 interest. What was the rate of interest?

440. Write as a proportion: 4 gallons to 144 miles is the same as 10 gallons to 360 miles.

441. Solve for a: $\frac{12}{a} = \frac{-15}{65}$

442. Vin read 10 pages of a book in 12 minutes. At that rate, how long will it take him to read 35 pages?

649. \$17.50/hour
 655. \$0.11, \$0.12; 60 tablets for \$6.49
 661. 12
 667. 17
 673. $8b$
 679. $11cd$

651. \$0.42
 657. $\frac{a \text{ adults}}{45 \text{ children}}$
 663. -9
 669. $12 < \sqrt{155} < 13$
 675. $15mn$
 681. 5.5 feet

653. \$1.65
 659. $\frac{19}{3+n}$
 665. not a real number
 671. 7.55
 677. $7y$
 683. 72 mph

Practice Test

685. $1\frac{73}{100}$

691. 0.192
 697. 200
 703. 8.8

709. The unit prices are \$0.172 per ounce for 64 ounces, and \$0.177 per ounce for 48 ounces; 64 ounces is the better buy.

687.
 (a) 16.7 (b) 16.75 (c) 17
 693. -0.08
 699. 1.975
 705. \$26.45

711. $12n$

689. 18.42
 695. 2
 701. -1.2
 707.
 (a) 52.1 (b) 51.5 (c) 55
 713. 15 feet

Chapter 6

Be Prepared

- 6.1. $\frac{33}{5}$
 6.4. 32
 6.7. 63
 6.10. 6.67
 6.13. $\frac{24 \text{ miles}}{2 \text{ hours}}$

- 6.2. 0.6
 6.5. 10.71
 6.8. 324
 6.11. $\frac{1}{12}$

- 6.3. $\frac{31}{50}$
 6.6. 5
 6.9. 75
 6.12. 80

Try It

- 6.1. $\frac{89}{100}$
 6.4. $\frac{41}{100}$, 41%
 6.7.
 (a) $\frac{161}{250}$ (b) $\frac{2}{3}$
 6.10.
 (a) 0.03 (b) 0.91
 6.13.
 (a) $\frac{6}{25}$ (b) 0.24
 6.16.
 (a) $\frac{1}{8}$ (b) 0.125
 6.19.
 (a) 175% (b) 8.25%
 6.22.
 (a) 87.5% (b) 225% (c) 160%

- 6.2. $\frac{72}{100}$
 6.5.
 (a) $\frac{12}{25}$ (b) $\frac{11}{10}$
 6.8.
 (a) $\frac{17}{40}$ (b) $\frac{7}{80}$
 6.11.
 (a) 1.15 (b) 0.235
 6.14.
 (a) $\frac{11}{25}$ (b) 0.44
 6.17.
 (a) 1% (b) 17%
 6.20.
 (a) 225% (b) 9.25%
 6.23. 42.9%

- 6.3. $\frac{62}{100}$, 62%
 6.6.
 (a) $\frac{16}{25}$ (b) $\frac{3}{2}$
 6.9.
 (a) 0.09 (b) 0.87
 6.12.
 (a) 1.23 (b) 0.168
 6.15.
 (a) $\frac{3}{10}$ (b) 0.3
 6.18.
 (a) 4% (b) 41%
 6.21.
 (a) 62.5% (b) 275% (c) 340%
 6.24. 57.1%

6.25. $11.\bar{1}\%$, or $11\frac{1}{9}\%$

6.28. 33

6.31. 68

6.34. \$36

6.37. 125%

6.40. \$2.16

6.43. 26%

6.46. 50%

6.49.

Ⓐ \$45.25 Ⓑ \$769.25

6.52. 7.5%

6.55. 4%

6.58. \$82

6.61.

Ⓐ \$184.80 Ⓑ 33%

6.64.

Ⓐ \$2,975 Ⓑ \$11,475

6.67. \$2,750

6.70. 6.5%

6.73. 6%

6.76. \$9,600

6.79.

Ⓐ $\frac{5}{9} = \frac{20}{36}$ Ⓑ $\frac{7}{11} = \frac{28}{44}$

Ⓒ $\frac{2.50}{8} = \frac{3.75}{12}$

6.82.

Ⓐ no Ⓑ no

6.85. 65

6.88. -9

6.91. 300

6.94. 56,460 yen

6.97. $\frac{36}{n} = \frac{25}{100}$

6.100. $\frac{n}{100} = \frac{23}{92}$

6.103. $\frac{n}{64} = \frac{125}{100}$; $n = 80$

6.106. $\frac{4.64}{n} = \frac{7.25}{100}$; $n = 64$

6.26. $16.\bar{6}\%$, or $16\frac{2}{3}\%$

6.29. 117

6.32. 64

6.35. 75%

6.38. 175%

6.41. 24.1 grams

6.44. 37%

6.47. 6.3%

6.50.

Ⓐ \$20.50 Ⓑ \$270.50

6.53. \$273

6.56. 5.5%

6.59.

Ⓐ \$11.60 Ⓑ \$17.40

6.62.

Ⓐ \$60 Ⓑ 15%

6.65. \$160

6.68. \$3,560

6.71. \$142.50

6.74. 4%

6.77. \$57.00

6.80.

Ⓐ $\frac{6}{7} = \frac{36}{42}$ Ⓑ $\frac{8}{36} = \frac{12}{54}$

Ⓒ $\frac{3.75}{6} = \frac{2.50}{4}$

6.83. 77

6.86. 24

6.89. 12 ml

6.92. 5 pieces

6.95. $\frac{n}{105} = \frac{60}{100}$

6.98. $\frac{27}{n} = \frac{36}{100}$

6.101. $\frac{n}{40} = \frac{65}{100}$; $n = 26$

6.104. $\frac{n}{84} = \frac{175}{100}$; $n = 147$

6.107. $\frac{27}{72} = \frac{n}{100}$; $n = 37.5\%$

6.27. 36

6.30. 126

6.33. \$26

6.36. 80%

6.39. \$14.67

6.42. 2,375 mg

6.45. 8.8%

6.48. 10%

6.51. 9%

6.54. \$394.20

6.57. \$450

6.60.

Ⓐ \$256.75 Ⓑ \$138.25

6.63.

Ⓐ \$600 Ⓑ \$1,800

6.66. \$56

6.69. 4.5%

6.72. \$7,020

6.75. \$11,450

6.78. \$143.50

6.81.

Ⓐ no Ⓑ yes

6.84. 104

6.87. -7

6.90. 180 mg

6.93. 590 Euros

6.96. $\frac{n}{85} = \frac{40}{100}$

6.99. $\frac{n}{100} = \frac{39}{52}$

6.102. $\frac{n}{40} = \frac{85}{100}$; $n = 34$

6.105. $\frac{3.23}{n} = \frac{8.5}{100}$; $n = 38$

6.108. $\frac{23}{92} = \frac{n}{100}$; $n = 25\%$

Section Exercises

1. $\frac{6}{100}$

7.

Ⓐ $\frac{42}{100}$ Ⓑ 42%

13. $\frac{13}{25}$

19. $\frac{23}{125}$

25. 0.05

3. $\frac{32}{1000}$

9. $\frac{1}{25}$

15. $\frac{5}{4}$

21. $\frac{19}{200}$

27. 0.01

5.

Ⓐ $\frac{57}{100}$ Ⓑ 57%

11. $\frac{17}{100}$

17. $\frac{3}{8}$

23. $\frac{4}{75}$

29. 0.63

31. 0.4
37. 0.214

43.
Ⓐ $\frac{7023}{10,000}$ Ⓑ 0.7023

49. 1%
55. 300%
61. 150%
67. 37.5%
73. $41\frac{2}{3}\%$ or $41.\bar{6}\%$

79. $55.\bar{5}\%$

85.

Fraction	Decimal	Percent
$\frac{1}{2}$	0.5	50%
$\frac{9}{20}$	0.45	45%
$\frac{9}{50}$	0.18	18%
$\frac{1}{3}$	0.3	33.3%
$\frac{1}{125}$	0.008	0.8%
2	2.0	200%

91. 80%; 0.8

97. 54
103. 18,000
109. \$35
115. 36%
121. \$11.88
127. 2,407 mg
133. 13.2%
139. 2.5%
145. 21.2%

151.
Ⓐ \$4.20 Ⓑ \$\$88.20

33. 1.15
39. 0.078

45.
Ⓐ $\frac{1}{4}$ Ⓑ 0.25

51. 18%
57. 0.9%
63. 225.4%
69. 175%
75. $266.\bar{6}\%$

81. 25%

87.
Ⓐ $\frac{1}{10}$
Ⓑ approximately \$9.50

93. $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1.

99. 26.88
105. 112
111. \$940
117. 150%
123. \$259.80
129. 45%
135. 125%
141. 11%
147. The original number should be greater than 44. 80% is less than 100%, so when 80% is converted to a decimal and multiplied to the base in the percent equation, the resulting amount of 44 is less. 44 is only the larger number in cases where the percent is greater than 100%.
153.
Ⓐ \$9.68 Ⓑ \$138.68

35. 1.5
41.
Ⓐ $\frac{3}{200}$ Ⓑ 0.015

47.
Ⓐ $\frac{3}{5}$ Ⓑ 0.6

53. 135%
59. 8.75%
65. 25%
71. 680%
77. 42.9%

83. 35%

89. $\frac{17}{20}$, 0.85

95. The Szetos sold their home for five times what they paid 30 years ago.
101. 162.5
107. 108
113. 30%
119. 175%
125. 24.2 grams
131. 25%
137. 72.7%
143. 5.5%
149. Alex should have packed half as many shorts and twice as many shirts.

155.
Ⓐ \$17.13 Ⓑ \$267.13

157.

- (a) \$61.45 (b) \$1,260.45

163. \$20.25

169. 3%

175. \$139

179.

- (a) \$26.97 (b) \$17.98

185.

- (a) \$576 (b) 30%

191.

- (a) \$7.20 (b) \$23.20

197.

- (a) \$131.25 (b) \$126.25

- (c) 25% off first, then \$20 off

203. \$14,000

209. \$579.96

215. \$860

221. 5.5%

227. 3%

233. \$3,345

239. Answers will vary.

245. $\frac{12}{5} = \frac{96}{40}$

251. $\frac{9.36}{18} = \frac{2.60}{5}$

257. no

263. $x = 49$ 269. $p = -11$ 275. $j = 0.6$

281. 114 beats/minute. Carol has not met her target heart rate.

287. \$252.50

293. 19 gallons, \$58.71

299. $\frac{n}{250} = \frac{35}{100}$

305. $\frac{90}{n} = \frac{150}{100}$

311. $\frac{n}{180} = \frac{65}{100}$

317. $\frac{n}{488} = \frac{300}{100}$

323. $\frac{14}{56} = \frac{p}{100}$

329. Answers will vary.

Review Exercises

331. $\frac{32}{100}$

159. 6.5%

165. \$975

171. 16%

176. \$81

181.

- (a) \$128.37 (b) \$260.63

187.

- (a) \$53.25 (b) 15%

193.

- (a) \$0.20 (b) \$0.80

199.

(a) Priam is correct. The original price is 100%. Since the discount rate was 40%, the sale price was 60% of the original price.

- (b) Yes.

205. 6.3%

211. \$14,167

217. \$24,679.91

223. \$116

229. 3.75%

235. \$332.10

241. Answers will vary.

247. $\frac{5}{7} = \frac{115}{161}$

253. $\frac{18.04}{11} = \frac{4.92}{3}$

259. no

265. $z = 7$ 271. $a = 7$ 277. $m = 4$

283. 159 cal

289. 0.8 Euros

295. 12.8 hours

301. $\frac{n}{47} = \frac{110}{100}$

307. $\frac{17}{85} = \frac{p}{100}$

313. $\frac{n}{92} = \frac{18}{100}$

319. $\frac{7.65}{n} = \frac{17}{100}$

325. $\frac{12}{96} = \frac{p}{100}$

161. 6.85%

167. \$859.25

173. 15.5%

177. \$125

183.

- (a) \$332.48 (b) \$617.47

189.

- (a) \$370 (b) 43.5%

195.

- (a) \$258.75 (b) \$373.75

201. \$180

207. \$90

213. \$3,280

219. 4%

225. \$4,836

231. \$35,000

237. \$195.00

243. $\frac{4}{15} = \frac{36}{135}$

249. $\frac{8}{1} = \frac{48}{6}$

255. yes

261. yes

267. $a = 9$ 273. $c = 2$

279. 9 ml

285. $\frac{3}{4}$ cup

291. 48 quarters

297. 4 bags

303. $\frac{45}{n} = \frac{30}{100}$

309. $\frac{340}{260} = \frac{p}{100}$

315. $\frac{n}{26} = \frac{175}{100}$

321. $\frac{13.53}{n} = \frac{8.25}{100}$

327. He must add 20 oz of water to obtain a final solution of 32 oz.

335. $\frac{12}{25}$

337. $\frac{641}{1000}$

343.

(a) $\frac{27}{200}$ (b) 0.135

349. 282%

355. 362.5%

361. 240

367. \$16.70

373.

(a) \$45 (b) \$795

379. 15%

385.

(a) \$13 (b) 26%

391. \$4400

397. $\frac{3}{8} = \frac{12}{32}$

403. no

409. 12 ml

415. $\frac{n}{395} = \frac{62}{100}$

421. $\frac{3.51}{n} = \frac{4.5}{100}$, \$78

339. 0.06

345.

(a) $\frac{1}{2}$ (b) 0.5

351. 0.3%

357. 40%

363. 25

369. 28.4%

375. 7.25%

381. \$45

387.

(a) \$0.48 (b) \$1.28

393. \$900

399. $\frac{1}{18} = \frac{23}{414}$

405. 20

411. 340 calories

417. $\frac{15}{1000} = \frac{p}{100}$

341. 1.28

347. 4%

353. 75%

359. 161

365. 68%

371. 4%

377. \$11,400

383.

(a) \$25.47 (b) \$59.43

389. \$450

395. 2.5%

401. yes

407. 4

413. 13 gallons

419. $\frac{n}{900} = \frac{85}{100}$, 765

Practice Test

423. 0.24, $\frac{6}{25}$

429. 25%

435. 4%

441. -52

425. 3.5, $\frac{7}{2}$

431. 40

437. \$70

427. $33.\bar{3}\%$ or $33\frac{1}{3}\%$

433. 11.9%

439. 6.25%

Chapter 7

Be Prepared

7.1. $\frac{319}{100}$

7.4. $8y + 15$

7.7. 0.75

7.10. 4

7.13. 4, 290

7.2. $0.\overline{45}$

7.5. 12

7.8. 16

7.11. $\frac{2}{5}$

7.14. $\frac{5}{9}$

7.3. 12

7.6. -15

7.9. $12y + 15$

7.12. $\frac{27}{10}$

7.15. $\frac{5}{12}$

Try It

7.1.

(a) $\frac{-24}{1}$ (b) $\frac{357}{100}$

7.4.

(a) rational (b) rational

(c) irrational

7.2.

(a) $\frac{-19}{1}$ (b) $\frac{841}{100}$

7.5.

(a) rational (b) irrational

7.3.

(a) rational (b) rational

(c) irrational

7.6.

(a) irrational (b) rational