

6

Percents

6.1 Fractions, Decimals, and Percents

6.2 The Percent Proportion

6.3 The Percent Equation

6.4 Percents of Increase and Decrease

6.5 Discounts and Markups

6.6 Simple Interest

Chapter Learning Target:

Understand fractions, decimals, and percents.

Chapter Success Criteria:

- I can rewrite fractions, decimals, and percents.
- I can compare and order fractions, decimals, and percents.
- I can use the percent proportion or percent equation to find a percent, a part, or a whole.
- I can apply percents to solve real-life problems.



STEAM Video

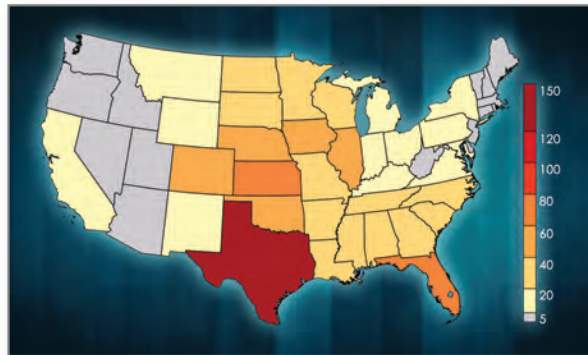


Tornado!

More tornadoes occur each year in the United States than in any other country. How can you use a percent to describe the portion of tornadoes in the United States that occur in your state?

Watch the STEAM Video “Tornado!” Then answer the following questions.

1. The map below shows the average annual number of tornadoes in each state. Which regions have the most tornadoes? the fewest tornadoes?



2. Robert says that only Alaska, Hawaii, and Rhode Island average less than 1 tornado per year. What percent of states average *more* than 1 tornado per year?

Performance Task

Chapter 6 Performance Task (continued)

Tornado Alley

5. Tornadoes are categorized from EF-0 to EF-5, depending on wind speed and level of destruction. EF-0, EF-1, and EF-2 tornadoes are considered weak. One for 25-year period referenced in the table below is the number of tornadoes in the U.S. near Houston. Each for average number of states compares to Oklahoma each year. Round your answer to the nearest whole number. Justify your answer.

4. On average, 1224 tornadoes occur nationwide in the table. What percent of states average more than 1 tornado per year?

3. Your family who lives in Texas. Justify your answer.

Chapter 6 Performance Task

Tornado Alley

In some regions of the country, tornadoes are common, while in other regions, they are very rare. What is Tornado Alley? What states are most frequently hit by tornadoes? How many states are most frequently hit by tornadoes?

1. The table below shows the average number of tornadoes in each state and the average annual number of tornadoes for all of the states in Tornado Alley over a 25-year period. Complete the table. Round your answer for the number of tornadoes in the state to the nearest whole number. Round your answer for the percent of tornadoes in the state to the nearest percent.

State	Average Number of Tornadoes in State	Average Annual Number of Tornadoes in Tornado Alley	Percent of Tornadoes in Tornado Alley
Texas	147	1224	
Kansas	62	1224	
Oklahoma	65	1224	
Nebraska	49	1224	
Arkansas	12	1224	
Colorado	13	1224	

2. To find the average number of tornadoes in Tornado Alley, you can find 20% of the average number of tornadoes in the U.S. Find the average number of tornadoes that occurred in Tornado Alley. Round your answer to the nearest whole number. Justify your answer.

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Big Ideas Math: Modeling Real Life Grade 7
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Tornado Alley

After completing this chapter, you will be able to use the concepts you learned to answer the questions in the *STEAM Video Performance Task*. You will be given information about the average annual numbers of tornadoes in several states over a 25-year period. For example:

Texas: 147

Kansas: 62

Oklahoma: 65

Iowa: 49

You will be asked to solve various percent problems about tornadoes. Why is it helpful to know the percent of tornadoes that occur in each state?

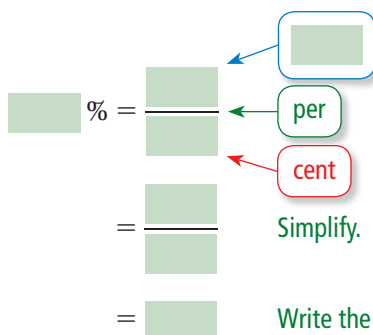
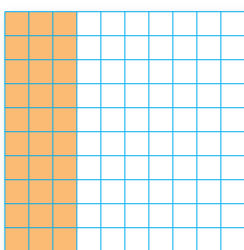
Getting Ready for Chapter

6

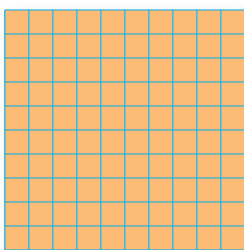
Chapter Exploration

Work with a partner. Write the percent of the model that is shaded. Then write the percent as a decimal.

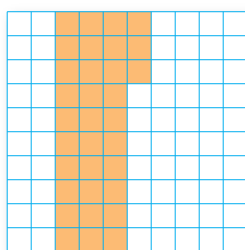
1.



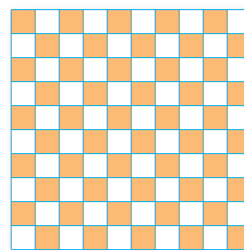
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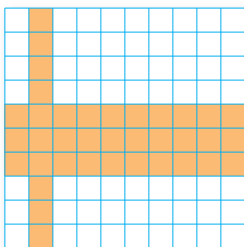
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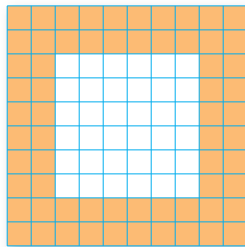
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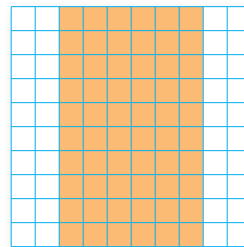
5.



6.



7.



8. **WRITE A PROCEDURE** Work with a partner. Write a procedure for rewriting a percent as a decimal. Use examples to justify your procedure.

Vocabulary

The following vocabulary terms are defined in this chapter. Think about what each term might mean and record your thoughts.

percent of change

percent of decrease

discount

percent of increase

percent error

markup

6.1 Fractions, Decimals, and Percents

Learning Target: Rewrite fractions, decimals, and percents using different representations.

Success Criteria:

- I can write percents as decimals and decimals as percents.
- I can write fractions as decimals and percents.
- I can compare and order fractions, decimals, and percents.

EXPLORATION 1

Comparing Numbers in Different Forms

Work with a partner. Determine which number is greater. Explain your method.

a. 7% sales tax or $\frac{1}{20}$ sales tax



b. 0.37 cup of flour or $\frac{1}{3}$ cup of flour

c. $\frac{5}{8}$ -inch wrench or 0.375-inch wrench



d. $12\frac{3}{5}$ dollars or 12.56 dollars



e. $5\frac{5}{6}$ fluid ounces or 5.6 fluid ounces



EXPLORATION 2

Ordering Fractions, Decimals, and Percents

Work with a partner and follow the steps below.

Math Practice

Make a Plan

Make a plan to order the numbers. How might having a plan help you to order numbers quickly?

- Write five different numbers on individual slips of paper. Include at least one decimal, one fraction, and one percent.
- On a separate sheet of paper, create an answer key that shows your numbers written from least to greatest.
- Exchange slips of paper with another group and race to order the numbers from least to greatest. Then exchange answer keys to check your orders.

6.1 Lesson

Key Ideas

Writing Percents as Decimals

Words Remove the percent symbol. Then divide by 100, which moves the decimal point two places to the left.

Numbers $82\% = 82.\cancel{\%} = 0.82$ $2.\overline{45}\% = 02.\overline{45}\cancel{\%} = 0.02\overline{45}$

Writing Decimals as Percents

Words Multiply by 100, which moves the decimal point two places to the right. Then add a percent symbol.

Numbers $0.47 = 0.\underline{47} = 47\%$ $0.\overline{2} = 0.222\dots = 22.\overline{2}\%$

Remember

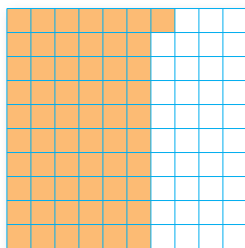
Bar notation indicates one or more repeating digits.



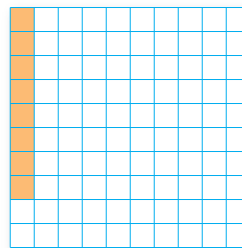
EXAMPLE 1 Converting Between Percents and Decimals

Write each percent as a decimal or each decimal as a percent.
Use a model to represent each number.

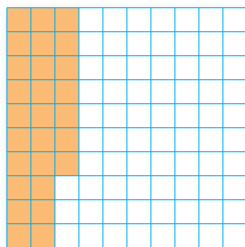
a. $61\% = 61.\cancel{\%} = 0.61$



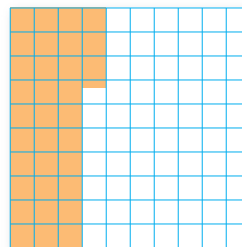
b. $8\% = 08.\cancel{\%} = 0.08$



c. $0.27 = 0.\underline{27} = 27\%$



d. $0.\overline{3} = 0.333\dots = 33.\overline{3}\%$



Try It Write the percent as a decimal or the decimal as a percent.
Use a model to represent the number.

1. 39%

2. $12.\overline{6}\%$

3. 0.05

4. 1.25

EXAMPLE 2**Writing Fractions as Decimals and Percents****Remember**

For a fraction with a denominator of 100, $\frac{n}{100} = n\%$.



Write each fraction as a decimal and a percent.

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

$$\frac{4}{5} = \frac{4 \times 20}{5 \times 20} = \frac{80}{100} = 80\% = 0.8$$

So, $\frac{4}{5}$ can be written as 0.8 or 80%.

b. $\frac{15}{11}$

Use long division to divide 15 by 11.

$$\frac{15}{11} = 1.\overline{36}$$

Write $1.\overline{36}$ as a percent.

$$1.\overline{36} = 1.3636\ldots = 136.\overline{36}\%$$

The remainder repeats. So, it is a repeating decimal.

$$\begin{array}{r} 1.3636 \\ 11 \overline{)15.0000} \\ \underline{-11} \\ 40 \\ \underline{-33} \\ 70 \\ \underline{-66} \\ 40 \\ \underline{-33} \\ 70 \\ \underline{-66} \\ 4 \end{array}$$

So, $\frac{15}{11}$ can be written as $1.\overline{36}$ or $136.\overline{36}\%$.

Try It Write the fraction as a decimal and a percent.

5. $\frac{5}{8}$

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

7. $\frac{11}{3}$

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

**Self-Assessment for Concepts & Skills**

Solve each exercise. Then rate your understanding of the success criteria in your journal.

CONVERTING BETWEEN PERCENTS AND DECIMALS Write the percent as a decimal or the decimal as a percent. Use a model to represent the number.

9. 46%

10. $66.\overline{6}\%$

11. 0.18

12. $2.\overline{3}$

WRITING FRACTIONS AS DECIMALS AND PERCENTS Write the fraction as a decimal and a percent.

13. $\frac{7}{10}$

14. $\frac{5}{9}$

15. $\frac{7}{2000}$

16. $\frac{17}{15}$

EXAMPLE 3

Modeling Real Life



An ice rink is open December through February. The table shows the attendance each month as a portion of the total attendance. How many times more guests visit the ice rink in the busiest month than in the least busy month?

Month	December	January	February
Portion of Guests	0.72	$\frac{3}{25}$	16%

Write $\frac{3}{25}$ and 16% as decimals.

January: $\frac{3}{25} = \frac{12}{100} = 0.12$

February: $16\% = 16\cancel{\%} = 0.16$

The busiest month was December, the second busiest month was February, and the least busy month was January. So, divide 0.72 by 0.12.

$$\begin{array}{r}
 0.12 \overline{)0.72} \longrightarrow 12 \overline{)72} \\
 \underline{-72} \\
 0
 \end{array}$$

Multiply each number by 100.

So, 6 times more guests visit the ice rink in the busiest month than in the least busy month.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.



17. An astronaut spends 53% of the day working, 0.1 of the day eating, $\frac{3}{10}$ of the day sleeping, and the rest of the day exercising. Order the events by duration from least to greatest. Justify your answer.

18. **DIG DEEPER!** A band plays one concert in Arizona, one concert in California, and one concert in Georgia. In California, the band earned $\frac{3}{2}$ the profit that they earned in Arizona. Of the total profit earned by the band, 32% is earned in Arizona. How many times more money did the band earn at the most profitable concert than at the least profitable concert? Justify your answer.

6.1 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Find the missing dimension. Use the scale 1 : 15.

	Item	Model	Actual
1.	Figure skater	Height: in.	Height: 67.5 in.
2.	Pipe	Length: 5 ft	Length: ft

Simplify the expression.

3. $2(3p - 6) + 4p$

4. $5n - 3(4n + 1)$

5. What is the solution of $2n - 4 > -12$?

A. $n < -10$

B. $n < -4$

C. $n > -2$

D. $n > -4$

► Concepts, Skills, & Problem Solving

COMPARING NUMBERS IN DIFFERENT FORMS Determine which number is greater.

Explain your method. (See Exploration 1, p. 235.)

6. $4\frac{2}{5}$ tons or 4.3 tons

7. 82% success rate or $\frac{5}{6}$ success rate

CONVERTING BETWEEN PERCENTS AND DECIMALS Write the percent as a decimal or the decimal as a percent. Use a model to represent the number.

8. 26%

9. 0.63

10. 9%

11. 0.6

12. 44.7%

13. 55%

14. $39.\overline{2}\%$

15. 3.554

16. 123%

17. 0.041

18. 0.122

19. $49.\overline{92}\%$

20. **YOU BE THE TEACHER** Your friend writes $4.\overline{8}\%$ as a decimal. Is your friend correct? Explain your reasoning.

$4.\overline{8}\% = 4.\overline{888} \dots \% = 488.\overline{8}$

WRITING FRACTIONS AS DECIMALS AND PERCENTS Write the fraction as a decimal and a percent.

21. $\frac{29}{100}$

22. $\frac{3}{4}$

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

24. $\frac{2}{3}$

25. $\frac{7}{9}$

26. $\frac{12}{5}$

27. $\frac{9}{2}$

28. $\frac{1}{1000}$

29. $\frac{17}{6}$

30. $\frac{3}{11}$

31. $\frac{1}{750}$

32. $\frac{22}{9}$

MP PRECISION Order the numbers from least to greatest.

33. 66.1% , 0.66 , $\frac{2}{3}$, 0.667

34. $\frac{2}{9}$, 21% , $0.2\overline{1}$, $\frac{11}{50}$

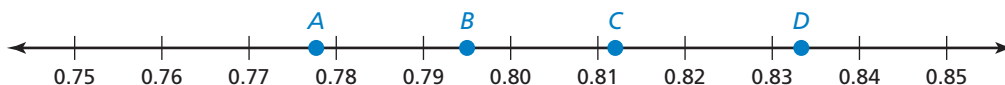
MATCHING Tell which letter shows the graph of the number.

35. $\frac{7}{9}$

36. 0.812

37. $\frac{5}{6}$

38. 79.5%



39. **MP PROBLEM SOLVING** The table shows the portion of students in each grade that participate in School Spirit Week. Order the grades by portion of participation from least to greatest.

Grade	Participation
6	0.64
7	$\frac{3}{5}$
8	65%

40. **MODELING REAL LIFE** The table shows the portion of gold medals that were won by the United States in five summer Olympic games. In what year did the United States win the least portion of gold medals? the greatest portion? Justify your answers.

Year	2000	2004	2008	2012	2016
Portion of Gold Medals Won	12.3%	$\frac{36}{301}$	0.12	$\frac{23}{150}$	$\frac{46}{307}$



41. **MP PROBLEM SOLVING** You, your friend, and your cousin have a basketball competition where each person attempts the same number of shots. You make 70% of your shots, your friend makes $\frac{7}{9}$ of her shots, and your cousin makes $0.7\overline{2}$ of his shots. How many times more shots are made by the first place finisher than the third place finisher?

42. **DIG DEEPER!** Three different mixtures contain small amounts of acetic acid. Mixture A is 0.036 acetic acid, Mixture B is 4.2% acetic acid, and Mixture C is $\frac{1}{22}$ acetic acid. Explain how to use this information to determine which mixture contains the greatest amount of acetic acid.



43. **MODELING REAL LIFE** Over 44% of the 30 students in a class read a book last month. What are the possible numbers of students in the class who read a book last month? Justify your answer.

44. **MP NUMBER SENSE** Fill in the blanks using each of the numbers $0-7$ exactly once, so that the percent, decimal, and fraction below are ordered from least to greatest. Justify your answer.

%

.

6.2 The Percent Proportion

Learning Target: Use the percent proportion to find missing quantities.

Success Criteria:

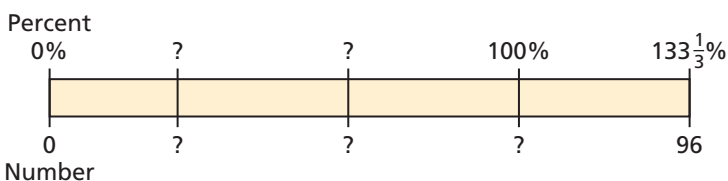
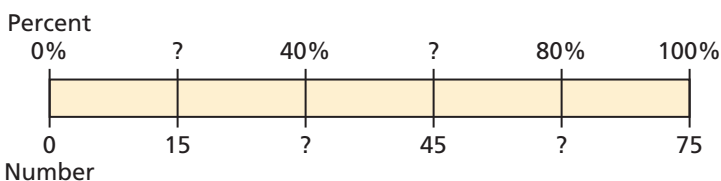
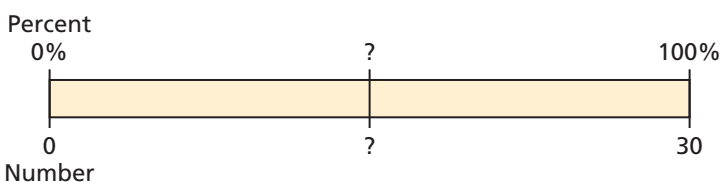
- I can write proportions to represent percent problems.
- I can solve a proportion to find a percent, a part, or a whole.

EXPLORATION 1

Using Percent Models

Work with a partner.

a. Complete each model. Explain what each model represents.



Math Practice

Use a Model

What quantities are given in each model? How can you use these quantities to answer the questions in part (b)?

b. Use the models in part (a) to answer each question.

- What number is 50% of 30?
- 15 is what percent of 75?
- 96 is $133\frac{1}{3}\%$ of what number?

c. How can you use ratio tables to check your answers in part (b)? How can you use proportions? Provide examples to support your reasoning.

d. Write a question different from those in part (b) that can be answered using one of the models in part (a). Trade questions with another group and find the solution.

6.2 Lesson

Key Idea

The Percent Proportion

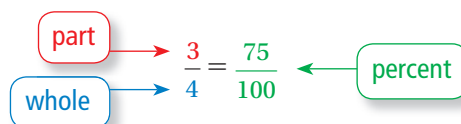
Words You can represent “ a is p percent of w ” with the proportion

$$\frac{a}{w} = \frac{p}{100}$$

where a is part of the whole w , and $p\%$, or $\frac{p}{100}$, is the percent.

Numbers

3 out of 4 is 75%.



In percent problems, the word *of* is usually followed by the whole.

EXAMPLE 1 Finding a Percent

What percent of 15 is 12?

$$\frac{a}{w} = \frac{p}{100}$$

Write the percent proportion.

$$\frac{12}{15} = \frac{p}{100}$$

Substitute 12 for a and 15 for w .

$$100 \cdot \frac{12}{15} = 100 \cdot \frac{p}{100}$$

Multiplication Property of Equality

$$80 = p$$

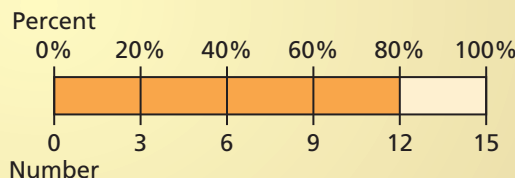
Simplify.

So, 80% of 15 is 12.

You can also use a ratio table to find the percent.

	$\div 3$	$\times 20$	
Part	12	4	80
Whole	15	5	100
	$\div 3$	$\times 20$	

Check Use a model to check your answer.



Try It Write and solve a proportion to answer the question.

- What percent of 5 is 3?
- 24 is what percent of 20?

EXAMPLE 2 Finding a Part

What number is 0.5% of 200?

$$\frac{a}{w} = \frac{p}{100}$$

Write the percent proportion.

$$\frac{a}{200} = \frac{0.5}{100}$$

Substitute 200 for w and 0.5 for p .

$$a = 1$$

Multiply each side by 200.

▶ So, 1 is 0.5% of 200.

Try It Write and solve a proportion to answer the question.

3. What number is 80% of 60? 4. 10% of 40.5 is what number?

EXAMPLE 3 Finding a Whole

150% of what number is 30?

$$\frac{a}{w} = \frac{p}{100}$$

Write the percent proportion.

$$\frac{30}{w} = \frac{150}{100}$$

Substitute 30 for a and 150 for p .

$$3000 = 150w$$

Cross Products Property

$$20 = w$$

Divide each side by 150.

▶ So, 150% of 20 is 30.

Try It Write and solve a proportion to answer the question.

5. 0.1% of what number is 4? 6. $\frac{1}{2}$ is 25% of what number?



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

7. **USING THE PERCENT PROPORTION** Write and solve a proportion to determine what percent of 120 is 54.
8. **MP CHOOSE TOOLS** Use a model to find 60% of 30.
9. **WHICH ONE DOESN'T BELONG?** Which proportion at the left does *not* belong with the other three? Explain your reasoning.

$$\frac{15}{w} = \frac{50}{100}$$

$$\frac{15}{50} = \frac{p}{100}$$

$$\frac{15}{30} = \frac{p}{100}$$

$$\frac{a}{30} = \frac{50}{100}$$

EXAMPLE 4**Modeling Real Life**

Understand
the problem.

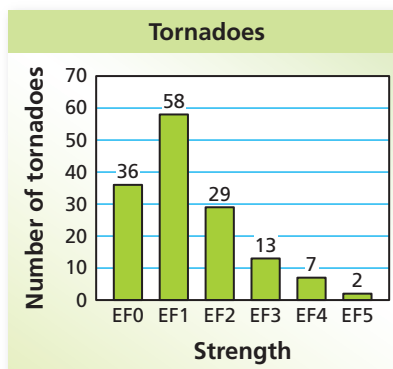
Make a plan.

Solve and
check.

The bar graph shows the strengths of tornadoes that occurred in a state in a recent year. What percent of the tornadoes were EF1s?

You are given a bar graph that shows the number of tornadoes in each strength category. You are asked to find the percent of the tornadoes that were EF1s.

The total number of tornadoes, 145, is the whole, and the number of EF1 tornadoes, 58, is the part. Use the percent proportion to find the percent of the tornadoes that were EF1s.



$$\frac{a}{w} = \frac{p}{100}$$

Write the percent proportion.

$$\frac{58}{145} = \frac{p}{100}$$

Substitute 58 for a and 145 for w .

$$100 \cdot \frac{58}{145} = 100 \cdot \frac{p}{100}$$

Multiplication Property of Equality

$$40 = p$$

Simplify.

So, 40% of the tornadoes were EF1s.

Check Reasonableness

The number of EF1 tornadoes, 58, is less than half the total number of tornadoes, 145. So, the percent of the tornadoes that were EF1s should be less than 50%. Because $40\% < 50\%$, the answer is reasonable. ✓

**Self-Assessment for Problem Solving**

Solve each exercise. Then rate your understanding of the success criteria in your journal.

10. An arctic woolly-bear caterpillar lives for 7 years and spends 90% of its life frozen. How many days of its life is the arctic woolly-bear frozen?

11. **DIG DEEPER!** The table shows the numbers of pictures you upload to a social media website for 5 days in a row. How many total pictures do you upload during the week when 32% of the total pictures are uploaded on Saturday and Sunday?

Day	Pictures Uploaded
Monday	2
Tuesday	2
Wednesday	4
Thursday	1
Friday	8



6.2 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Write the fraction as a decimal and a percent.

1. $\frac{42}{100}$

2. $\frac{7}{1000}$

3. $\frac{13}{9}$

4. $\frac{41}{66}$

Evaluate the expression when $a = -15$ and $b = -5$.

5. $a \div b$

6. $\frac{b+14}{a}$

7. $\frac{b^2}{a+5}$

8. What is the solution of $9x = -1.8$?

A. $x = -5$

B. $x = -0.2$

C. $x = 0.2$

D. $x = 5$

► Concepts, Skills, & Problem Solving

MP CHOOSE TOOLS Use a model to answer the question. Use a proportion to check your answer. (See Exploration 1, p. 241.)

9. What number is 20% of 80?

10. 10 is what percent of 40?

11. 15 is 30% of what number?

12. What number is 120% of 70?

13. 20 is what percent of 50?

14. 48 is 75% of what number?

USING THE PERCENT PROPORTION Write and solve a proportion to answer the question.

15. What percent of 25 is 12?

16. 14 is what percent of 56?

17. 25% of what number is 9?

18. 36 is 0.9% of what number?

19. 75% of 124 is what number?

20. 110% of 90 is what number?

21. What number is 0.4% of 40?

22. 72 is what percent of 45?

$$\begin{array}{l} \frac{a}{w} = \frac{p}{100} \\ \frac{34}{w} = \frac{40}{100} \\ w = 85 \end{array}$$

23. **YOU BE THE TEACHER** Your friend uses the percent proportion to answer the question below. Is your friend correct? Explain your reasoning.

“40% of what number is 34?”

24. **MODELING REAL LIFE** Of 140 seventh-grade students, 15% earn the Presidential Youth Fitness Award. How many students earn the award?

25. **MODELING REAL LIFE** A salesperson receives a 3% commission on sales. The salesperson receives \$180 in commission. What is the amount of sales?



USING THE PERCENT PROPORTION Write and solve a proportion to answer the question.

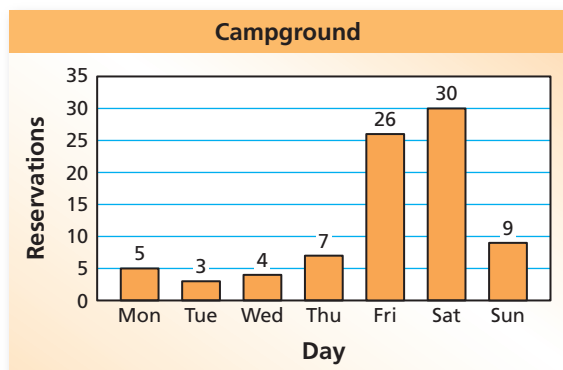
26. 0.5 is what percent of 20?

27. 14.2 is 35.5% of what number?

28. $\frac{3}{4}$ is 60% of what number?

29. What number is 25% of $\frac{7}{8}$?

30. **MODELING REAL LIFE** You are assigned 32 math exercises for homework. You complete 75% of the exercises before dinner. How many exercises do you have left to do after dinner?

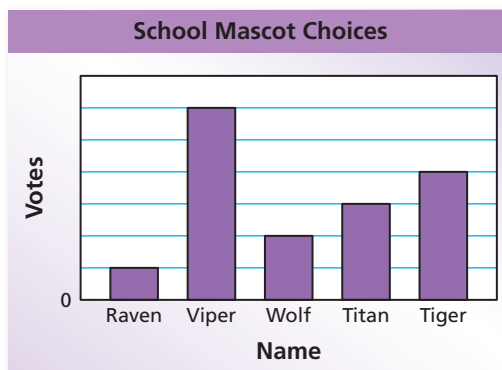


31. **MODELING REAL LIFE** Your friend earns \$10.50 per hour, which is 125% of her hourly wage last year. How much did your friend earn per hour last year?

32. **MODELING REAL LIFE** The bar graph shows the numbers of reserved campsites at a campground for one week. What percent of the reservations were for Friday or Saturday?

33. **MP PROBLEM SOLVING** Your friend displays the results of a survey that asks several people to vote on a new school mascot.

- What is missing from the bar graph?
- What percent of the votes does the least popular mascot receive? Explain your reasoning.
- There are 124 votes total. How many votes does tiger receive?



34. **DIG DEEPER!** A quarterback completes 18 of 33 passes during the first three quarters of a football game. He completes every pass in the fourth quarter and 62.5% of his passes for the entire game. How many passes does the quarterback throw in the fourth quarter? Justify your answer.

35. **MP REASONING** 20% of a number is x . What is 100% of the number? Assume $x > 0$.

36. **MP STRUCTURE** Answer each question. Assume $x > 0$.

- What percent of $8x$ is $5x$?
- What is 65% of $80x$?

6.3 The Percent Equation

Learning Target: Use the percent equation to find missing quantities.

Success Criteria:

- I can write equations to represent percent problems.
- I can use the percent equation to find a percent, a part, or a whole.

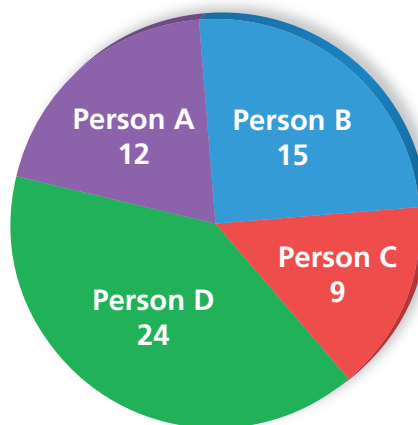
EXPLORATION 1

Using Percent Equations

Work with a partner.

- a. The circle graph shows the number of votes received by each candidate during a school election. So far, only half of the students have voted. Find the percent of students who voted for each candidate. Explain your method.

Votes Received by Each Candidate



Math Practice

Use Equations

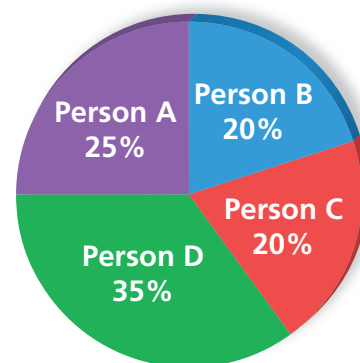
How does the equation you wrote in part (b) compare to the percent proportion? Explain.

- b. You have learned that $\frac{\text{part}}{\text{whole}} = \text{percent}$. Solve the equation for the “part.” Explain your reasoning.

- c. The circle graph shows the final results of the election after every student voted. Use the equation you wrote in part (b) to find the number of students who voted for each candidate.

- d. Use a different method to check your answers in part (c). Which method do you prefer? Explain.

Final Results



6.3 Lesson

Key Idea

The Percent Equation

Words To represent “ a is p percent of w ,” use an equation.

$$a = p\% \cdot w$$

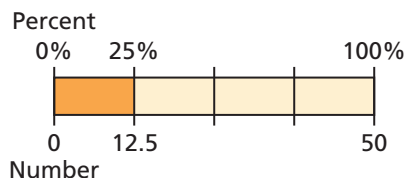
Diagram labels:
 - **percent** points to $p\%$
 - **part of the whole** points to a
 - **whole** points to w

Numbers $15 = 50\% \cdot 30$ $15 = 0.5 \cdot 30$ $15 = \frac{1}{2} \cdot 30$

EXAMPLE 1 Finding a Part of a Number

What number is 24% of 50?

Estimate



Common Error

Remember to convert a percent to a fraction or a decimal when using the percent equation. For Example 1, write 24% as $\frac{24}{100}$.

$$a = p\% \cdot w$$

Write the percent equation.

$$= \frac{24}{100} \cdot 50$$

Substitute $\frac{24}{100}$ for $p\%$ and 50 for w .

$$= 12$$

Simplify.

► So, 12 is 24% of 50.

Reasonable? $12 \approx 12.5$ ✓

Try It Write and solve an equation to answer the question.

- What number is 10% of 20?
- What number is 150% of 40?

EXAMPLE 2 Finding a Percent

9.5 is what percent of 25?

$$a = p\% \cdot w$$

Write the percent equation.

$$9.5 = p\% \cdot 25$$

Substitute 9.5 for a and 25 for w .

$$\frac{9.5}{25} = \frac{p\% \cdot 25}{25}$$

Division Property of Equality

$$0.38 = p\%$$

Simplify.

► Because 0.38 equals 38%, 9.5 is 38% of 25.

Try It Write and solve an equation to answer the question.

3. 3 is what percent of 600?
4. 18 is what percent of 20?

EXAMPLE 3 Finding a Whole

39 is 52% of what number?

Another Method

Use a ratio table.

	$\div 4$	$\times 3$	
Part	52	13	39
Whole	100	25	75

✓

$$a = p\% \cdot w$$

Write the percent equation.

$$39 = 0.52 \cdot w$$

Substitute 39 for a and 0.52 for $p\%$.

$$\frac{39}{0.52} = \frac{0.52 \cdot w}{0.52}$$

Division Property of Equality

$$75 = w$$

Simplify.

So, 39 is 52% of 75.

Try It Write and solve an equation to answer the question.

5. 8 is 80% of what number?
6. 90 is 180% of what number?



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

7. **VOCABULARY** Write the percent equation in words.

USING THE PERCENT EQUATION Write and solve an equation to answer the question.

8. 14 is what percent of 70?
9. What number is 36% of 85?
10. 9 is 12% of what number?
11. 108 is what percent of 72?

12. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find “both” answers.

What number is 20% of 55?

55 is 20% of what number?

20% of 55 is what number?

$0.2 \cdot 55$ is what number?

EXAMPLE 4

Modeling Real Life

8th Street Cafe

DATE: MAY04 12:45PM
TABLE: 29
SERVER: JANE

Food Total 27.50
Tax 1.65
Subtotal 29.15

TIP: _____

TOTAL: _____

Thank You

You are paying for lunch and receive the bill shown.

- a. Find the percent of sales tax on the food total.

Answer the question: \$1.65 is what percent of \$27.50?

$$a = p\% \cdot w$$

Write the percent equation.

$$1.65 = p\% \cdot 27.50$$

Substitute 1.65 for a and 27.50 for w .

$$0.06 = p\%$$

Divide each side by 27.50.

▶ Because 0.06 equals 6%, the percent of sales tax is 6%.

- b. You leave a 16% tip on the food total. Find the total amount you pay for lunch.

Answer the question: What tip amount is 16% of \$27.50?

$$a = p\% \cdot w$$

Write the percent equation.

$$= 0.16 \cdot 27.50$$

Substitute 0.16 for $p\%$ and 27.50 for w .

$$= 4.40$$

Multiply.

The amount of the tip is \$4.40.

▶ So, you pay a total of $\$29.15 + \$4.40 = \$33.55$.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

13. **DIG DEEPER!** A school offers band and chorus classes. The table shows the percents of the 1200 students in the school who are enrolled in band, chorus, or neither class. How many students are enrolled in both classes? Explain.

Class	Enrollment
Band	34%
Chorus	28%
Neither	42%

14. Water Tank A has a capacity of 550 gallons and is 66% full. Water Tank B is 53% full. The ratio of the capacity of Water Tank A to Water Tank B is 11 : 15.
- How much water is in each tank?
 - What percent of the total volume of both tanks is filled with water?



6.3 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Write and solve a proportion to answer the question.

- 30% of what number is 9?
- 42 is what percent of 80?
- What percent of 36 is 20?
- What number is 120% of 80?

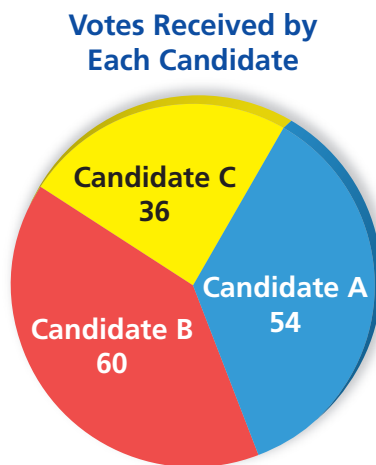
Find the distance between the two numbers on a number line.

- 4 and 10
 - $-\frac{2}{3}$ and $\frac{4}{3}$
 - $-5\frac{2}{5}$ and $-1\frac{3}{10}$
 - 4.3 and 7.5
9. There are 160 people in a grade. The ratio of boys to girls is 3 to 5. Which proportion can you use to find the number x of boys?
- A. $\frac{3}{8} = \frac{x}{160}$ B. $\frac{3}{5} = \frac{x}{160}$ C. $\frac{5}{8} = \frac{x}{160}$ D. $\frac{3}{5} = \frac{160}{x}$

► Concepts, Skills, & Problem Solving

USING PERCENT EQUATIONS The circle graph shows the number of votes received by each candidate during a school election. Find the percent of students who voted for the indicated candidate. (See Exploration 1, p. 247.)

- Candidate A
- Candidate B
- Candidate C



USING THE PERCENT EQUATION Write and solve an equation to answer the question.

- 20% of 150 is what number?
- 45 is what percent of 60?
- 35% of what number is 35?
- 0.8% of 150 is what number?
- 29 is what percent of 20?
- 0.5% of what number is 12?
- What percent of 300 is 51?
- 120% of what number is 102?

YOU BE THE TEACHER Your friend uses the percent equation to answer the question. Is your friend correct? Explain your reasoning.

- What number is 35% of 20?
- 30 is 60% of what number?

$$\begin{aligned} a &= p\% \cdot w \\ &= 0.35 \cdot 20 \\ &= 7 \end{aligned}$$

$$\begin{aligned} a &= p\% \cdot w \\ &= 0.6 \cdot 30 \\ &= 18 \end{aligned}$$

23. **MODELING REAL LIFE** A salesperson receives a 2.5% commission on sales. What commission does the salesperson receive for \$8000 in sales?
24. **MODELING REAL LIFE** Your school raised 125% of its fundraising goal. The school raised \$6750. What was the goal?
25. **MODELING REAL LIFE** The sales tax on the model rocket shown is \$1.92. What is the percent of sales tax?

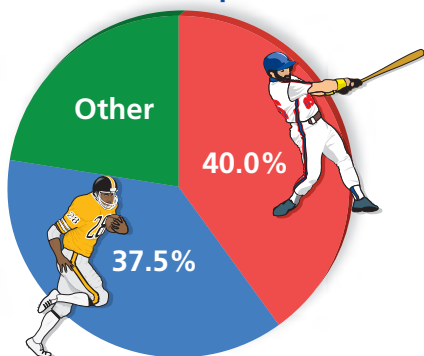


PUZZLE There were n signers of the Declaration of Independence. The youngest was Edward Rutledge, who was x years old. The oldest was Benjamin Franklin, who was y years old.

26. x is 25% of 104. What was Rutledge's age?
27. 7 is 10% of y . What was Franklin's age?
28. n is 80% of y . How many signers were there?



Favorite Sport



29. **MP LOGIC** How can you tell whether a percent of a number will be *greater than*, *less than*, or *equal to* the number? Give examples to support your answer.
30. **MP PROBLEM SOLVING** In a survey, a group of students is asked their favorite sport. Eighteen students choose “other” sports.
- How many students participate in the survey?
 - How many choose football?

31. **TRUE OR FALSE?** Tell whether the statement is *true* or *false*. Explain your reasoning.

If W is 25% of Z , then $Z : W$ is 75 : 25.

32. **DIG DEEPER!** At a restaurant, the amount of your bill before taxes and tip is \$19.83. A 6% sales tax is applied to your bill, and you leave a tip equal to 19% of the original amount. Use mental math to estimate the total amount of money you pay. Explain your reasoning. (*Hint: Use 10% of the original amount.*)

33. **MP REASONING** The table shows your test results in a math class. What score do you need on the last test to earn 90% of the total points on the tests?

Test Score	Point Value
83%	100
91.6%	250
88%	150
?	300

6.4 Percents of Increase and Decrease

Learning Target: Find percents of change in quantities.

Success Criteria:

- I can explain the meaning of percent of change.
- I can find the percent of increase or decrease in a quantity.
- I can find the percent error of a quantity.

EXPLORATION 1

Exploring Percent of Change

Work with a partner.

Each year in the Columbia River Basin, adult salmon swim upriver to streams to lay eggs.

To go up the river, the adult salmon use fish ladders. But to go down the river, the young salmon must pass through several dams.

At one time, there were electric turbines at each of the eight dams on the main stem of the Columbia and Snake Rivers. About 88% of the young salmon pass through a single dam unharmed.



Math Practice

Check Progress

As the number of dams increases, what should be true about the number of young salmon that pass through unharmed?

- One thousand young salmon pass through a dam. How many pass through unharmed?
- One thousand young salmon pass through the river basin. How many pass through all 8 dams unharmed?
- By what percent does the number of young salmon *decrease* when passing through a single dam?
- Describe a similar real-life situation in which a quantity *increases* by a constant percent each time an event occurs.

6.4 Lesson

Key Vocabulary

percent of change,
p. 254
percent of increase,
p. 254
percent of decrease,
p. 254
percent error, p. 256

A **percent of change** is the percent that a quantity changes from the original amount.

$$\text{percent of change} = \frac{\text{amount of change}}{\text{original amount}}$$

Key Idea

Percents of Increase and Decrease

When the original amount increases, the percent of change is called a **percent of increase**.

$$\text{percent of increase} = \frac{\text{new amount} - \text{original amount}}{\text{original amount}}$$

When the original amount decreases, the percent of change is called a **percent of decrease**.

$$\text{percent of decrease} = \frac{\text{original amount} - \text{new amount}}{\text{original amount}}$$

EXAMPLE 1 Finding a Percent of Increase

Day	Hours Online
Saturday	2
Sunday	4.5

The table shows the numbers of hours you spent online last weekend. What is the percent of change in your time spent online from Saturday to Sunday?

The time spent online Sunday is greater than the time spent online Saturday. So, the percent of change is a percent of increase.

$$\begin{aligned}\text{percent of increase} &= \frac{\text{new amount} - \text{original amount}}{\text{original amount}} \\ &= \frac{4.5 - 2}{2} && \text{Substitute.} \\ &= \frac{2.5}{2} && \text{Subtract.} \\ &= 1.25, \text{ or } 125\% && \text{Write as a percent.}\end{aligned}$$

▶ So, your time spent online increased 125% from Saturday to Sunday.

Try It Find the percent of change. Round to the nearest tenth of a percent if necessary.

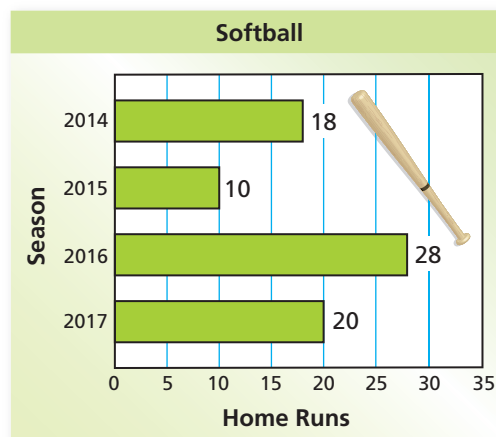
- 10 inches to 25 inches
- 57 people to 65 people



EXAMPLE 2 Finding a Percent of Decrease

The bar graph shows a softball player's home run totals. What was the percent of change from 2016 to 2017?

The number of home runs decreased from 2016 to 2017. So, the percent of change is a percent of decrease.



$$\begin{aligned}\text{percent of decrease} &= \frac{\text{original amount} - \text{new amount}}{\text{original amount}} \\ &= \frac{28 - 20}{28} && \text{Substitute.} \\ &= \frac{8}{28} && \text{Subtract.} \\ &\approx 0.286, \text{ or } 28.6\% && \text{Write as a percent.}\end{aligned}$$

▶ So, the number of home runs decreased about 28.6% from 2016 to 2017.

Try It

3. In Example 2, what was the percent of change from 2014 to 2015?



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

4. **VOCABULARY** What does it mean for a quantity to change by $n\%$?
5. **MP NUMBER SENSE** Without calculating, determine which situation has a greater percent of change. Explain.
 - 5 bonus points added to 50 points
 - 5 bonus points added to 100 points

FINDING A PERCENT OF CHANGE Identify the percent of change as an increase or a decrease. Then find the percent of change.

6. 8 feet to 24 feet
7. 300 miles to 210 miles

Key Idea

The amount of error is always positive.

Percent Error

A **percent error** is the percent that an estimated amount differs from the actual amount.

$$\text{percent error} = \frac{\text{amount of error}}{\text{actual amount}}$$

EXAMPLE 3

Modeling Real Life

You fill bags with about 16 ounces of homemade dog treats. The acceptable percent error when filling a bag is 5%. Tell whether each bag is acceptable.

Find the percent error for each bag.



Bag A: 15 ounces



Bag B: 16.5 ounces

Bag A: The amount of error is
 $16 - 15 = 1$ ounce.

$$\begin{aligned}\text{percent error} &= \frac{\text{amount of error}}{\text{actual amount}} \\ &= \frac{1}{16} \\ &\approx 0.0625, \text{ or } 6.25\%\end{aligned}$$

Bag B: The amount of error is
 $16.5 - 16 = 0.5$ ounce.

$$\begin{aligned}\text{percent error} &= \frac{\text{amount of error}}{\text{actual amount}} \\ &= \frac{0.5}{16} \\ &\approx 0.03125, \text{ or } 3.125\%\end{aligned}$$

Because $6.25\% > 5\%$, Bag A is not acceptable. Because $3.125\% < 5\%$, Bag B is acceptable.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.



- In one round of a game, you are asked how many bones are in a human body. If the percent error of your answer is at most 5%, you earn two points. If the percent error is at most 10%, but greater than 5%, you earn one point. You guess 195 bones. The correct answer is 206 bones. How many points do you earn?
- DIG DEEPER!** The manager of a restaurant offers a 20% decrease in price to tennis teams. A cashier applies a 10% decrease and then another 10% decrease. Is this the same as applying a 20% decrease? Justify your answer.

6.4 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Write and solve an equation to answer the question.

1. What number is 25% of 64?
2. 39.2 is what percent of 112?
3. 5 is 5% of what number?
4. 18 is 32% of what number?

Find the sum. Write fractions in simplest form.

5. $\frac{4}{7} + \left(-\frac{6}{7}\right)$
6. $-4.621 + 3.925$
7. $-\frac{5}{12} + \frac{3}{4}$

► Concepts, Skills, & Problem Solving

EXPLORING PERCENT CHANGE You are given the percent of salmon that pass through a single dam unharmed. By what percent does the number of salmon decrease when passing through a single dam? (See Exploration 1, p. 253.)

8. 75%
9. 80%
10. 62%
11. 94%

FINDING A PERCENT OF CHANGE Identify the percent of change as an *increase* or a *decrease*. Then find the percent of change. Round to the nearest tenth of a percent if necessary.

12. 12 inches to 36 inches
13. 75 people to 25 people
14. 50 pounds to 35 pounds
15. 24 songs to 78 songs
16. 10 gallons to 24 gallons
17. 72 paper clips to 63 paper clips
18. 16 centimeters to 44.2 centimeters
19. 68 miles to 42.5 miles

20. **YOU BE THE TEACHER** Your friend finds the percent increase from 18 to 26. Is your friend correct? Explain your reasoning.

$$\frac{26 - 18}{26} \approx 0.31 = 31\%$$



21. **MODELING REAL LIFE** Last week, you finished Level 2 of a video game in 32 minutes. Today, you finish Level 2 in 28 minutes. What is the percent of change?
22. **MODELING REAL LIFE** You estimate that a baby pig weighs 20 pounds. The actual weight of the baby pig is 16 pounds. Find the percent error.

23. **MP PRECISION** A researcher estimates that a fossil is 3200 years old. Using *carbon-14 dating*, a procedure used to determine the age of an object, the researcher discovers that the fossil is 3600 years old.
- Find the percent error.
 - What other estimate gives the same percent error? Explain your reasoning.



FINDING A PERCENT OF CHANGE Identify the percent of change as an *increase* or a *decrease*. Then find the percent of change. Round to the nearest tenth of a percent if necessary.

24. $\frac{1}{4}$ to $\frac{1}{2}$ 25. $\frac{4}{5}$ to $\frac{3}{5}$ 26. $\frac{3}{8}$ to $\frac{7}{8}$ 27. $\frac{5}{4}$ to $\frac{3}{8}$

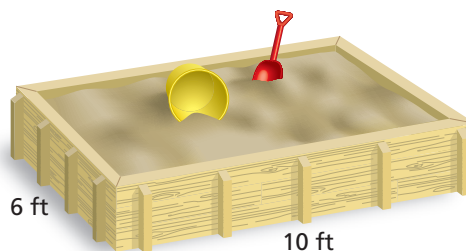
28. **CRITICAL THINKING** Explain why a change from 20 to 40 is a 100% increase, but a change from 40 to 20 is a 50% decrease.

29. **MODELING REAL LIFE** The table shows population data for a community.

Year	Population
2011	118,000
2017	138,000

- What is the percent of change from 2011 to 2017?
- Predict the population in 2023. Explain your reasoning.

30. **GEOMETRY** Suppose the length and the width of the sandbox are doubled.



- Find the percent of change in the perimeter.
- Find the percent of change in the area.

31. **MODELING REAL LIFE** A company fills boxes with about 21 ounces of cereal. The acceptable percent error in filling a box is 2.5%. Box A contains 20.4 ounces of cereal and Box B contains 21.5 ounces of cereal. Tell whether each box is an acceptable weight.



32. **MP PRECISION** Find the percent of change from June to September in the mile-run times shown.

33. **CRITICAL THINKING** A number increases by 10% and then decreases by 10%. Will the result be *greater than*, *less than*, or *equal to* the original number? Explain.

34. **MP PROBLEM SOLVING** You want to reduce your daily calorie consumption by about 9%. You currently consume about 2100 calories per day. Use mental math to estimate the number of calories you should consume in one week to meet your goal. Explain.

35. **DIG DEEPER!** Donations to an annual fundraiser are 15% greater this year than last year. Last year, donations were 10% greater than the year before. The amount raised this year is \$10,120. How much was raised two years ago?

36. **MP REASONING** Forty students are in the science club. Of those, 45% are girls. This percent increases to 56% after more girls join the club. How many more girls join?

6.5 Discounts and Markups

Learning Target: Solve percent problems involving discounts and markups.

Success Criteria:

- I can use percent models to solve problems involving discounts and markups.
- I can write and solve equations to solve problems involving discounts and markups.

EXPLORATION 1

Comparing Discounts

Work with a partner.



- a. The same pair of earrings is on sale at three stores. Which store has the best price? Use the percent models to justify your answer.

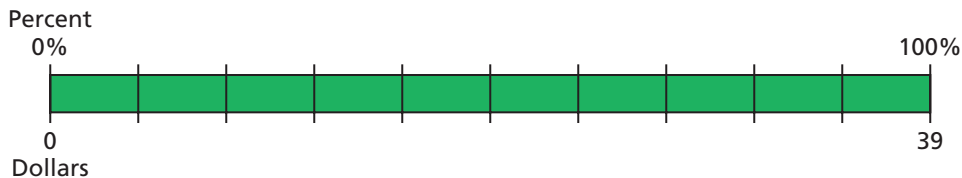
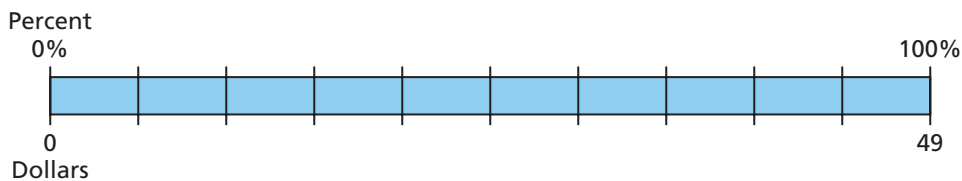
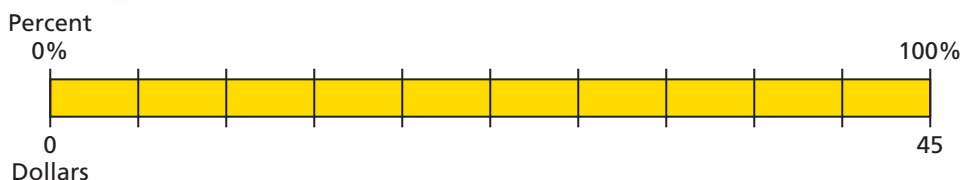
Store A:
Regular price: \$45



Store B:
Regular price: \$49



Store C:
Regular price: \$39

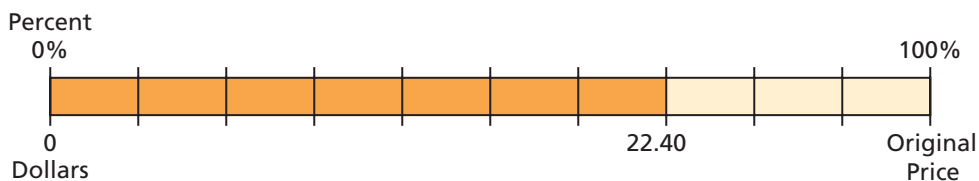


Math Practice

Communicate Precisely

Explain to your partner why 30% of the original price in part (b) is not the same as 30% of what you paid.

- b. You buy the earrings on sale for 30% off at a different store. You pay \$22.40. What was the original price of the earrings? Use the percent model to justify your answer.



- c. You sell the earrings in part (b) to a friend for 60% more than what you paid. What is the selling price? Use a percent model to justify your answer.

6.5 Lesson

Key Vocabulary

discount, p. 260

markup, p. 260

Key Ideas

Discounts

A **discount** is a decrease in the original price of an item.

Markups

To make a profit, stores charge more than what they pay. The increase from what the store pays to the selling price is called a **markup**.

EXAMPLE 1 Finding a Sale Price



The original price of a video game is \$35. What is the sale price?

Method 1: First, find the discount. The discount is 25% of \$35.

$$a = p\% \cdot w \quad \text{Write the percent equation.}$$

$$= 0.25 \cdot 35 \quad \text{Substitute 0.25 for } p\% \text{ and 35 for } w.$$

$$= 8.75 \quad \text{Multiply.}$$

Next, find the sale price.

Sale price	=	Original price	−	Discount
	=	35	−	8.75
	=	26.25		

So, the sale price is \$26.25.

Method 2: Use the fact that the sale price is $100\% - 25\% = 75\%$ of the original price.

Find the sale price.

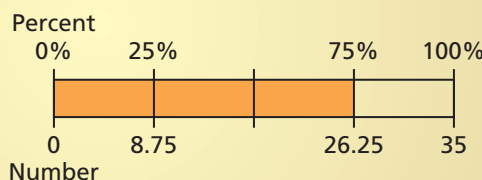
$$\text{Sale price} = 75\% \text{ of } \$35$$

$$= 0.75 \cdot 35$$

$$= 26.25$$

So, the sale price is \$26.25.

Check



For an item with an original price of p , the price after a 25% discount is $p - 0.25p$, or $0.75p$. So, a 25% discount is the same as paying 75% of the original price.

Try It

1. The original price of a skateboard is \$50. The skateboard is on sale for 20% off. What is the sale price?

EXAMPLE 2**Finding an Original Price****What is the original price of the cleats?**

The sale price is $100\% - 40\% = 60\%$ of the original price.

Answer the question:

33 is 60% of what number?

$$a = p\% \cdot w$$

Write the percent equation.

$$33 = 0.6 \cdot w$$

Substitute 33 for a and 0.6 for $p\%$.

$$55 = w$$

Divide each side by 0.6.

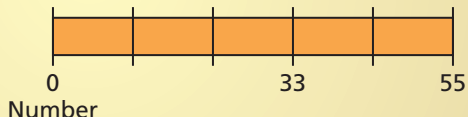


So, the original price of the cleats is \$55.

Check

Percent

0% 60% 100%

**Try It**

- The discount on a DVD is 50%. It is on sale for \$10. What is the original price of the DVD?

**Self-Assessment for Concepts & Skills**

Solve each exercise. Then rate your understanding of the success criteria in your journal.

- WRITING** Describe how to find the sale price of an item that has a 15% discount.

FINDING A SALE PRICE Find the sale price. Use a percent model to check your answer.

- A portable table tennis set costs \$30 before a 30% discount.
- The original price of an easel is \$70. The easel is on sale for 20% off.

FINDING AN ORIGINAL PRICE Find the original price. Use a percent model to check your answer.

- A bracelet costs \$36 after a 25% discount.
- The discount on a toy robot is 40%. The toy robot is on sale for \$54.



EXAMPLE 3**Modeling Real Life**

A store pays \$70 for a bicycle. What is the selling price when the markup is 20%?

Method 1: First, find the markup.
The markup is 20% of \$70.

$$\begin{aligned} a &= p\% \cdot w \\ &= 0.20 \cdot 70 \\ &= 14 \end{aligned}$$

Next, find the selling price.

$$\begin{aligned} \text{Selling price} &= \text{Cost to store} + \text{Markup} \\ &= 70 + 14 \\ &= 84 \end{aligned}$$

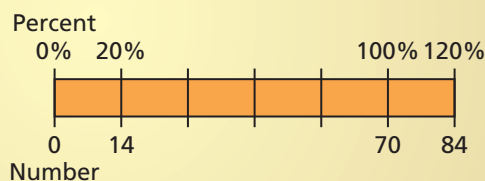
So, the selling price is \$84.

Method 2: Use a ratio table.
The selling price is 120% of the cost to the store.

Percent	Dollars
100%	\$70
20%	\$14
120%	\$84

Diagram showing the relationship between the rows: 100% to 20% is $\div 5$, 20% to 120% is $\times 6$, and 100% to 120% is $\div 5$ and $\times 6$.

So, the selling price is \$84.

Check**Self-Assessment for Problem Solving**

Solve each exercise. Then rate your understanding of the success criteria in your journal.

8. **DIG DEEPER!** You have two coupons for a store. The first coupon applies a \$15 discount to a single purchase, and the second coupon applies a 10% discount to a single purchase. You can only use one coupon on a purchase. When should you use each coupon? Explain.
9. A store sells memory cards for \$25 each.
 - a. The markup for each memory card is 25%. How much did the store pay for 50 memory cards?
 - b. The store offers a discount when a customer buys two or more memory cards. A customer pays \$47.50 for two memory cards. What is the percent of discount?
 - c. How much does a customer pay for three memory cards if the store increases the percent of discount in part (b) by 2%?



6.5 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Identify the percent of change as an *increase* or a *decrease*. Then find the percent of change. Round to the nearest tenth of a percent if necessary.

1. 16 meters to 20 meters
2. 9 points to 4 points
3. 15 ounces to 5 ounces
4. 38 staples to 55 staples

Find the product. Write fractions in simplest form.

5. $\frac{4}{7} \left(-\frac{1}{6} \right)$
6. $-1.58(6.02)$
7. $-3 \left(-2\frac{1}{8} \right)$

► Concepts, Skills, & Problem Solving

COMPARING DISCOUNTS The same item is on sale at two stores. Which one is the better price? Use percent models to justify your answer. (See Exploration 1, p. 259.)

8. 60% off \$60 or 55% off \$50
9. 85% off \$90 or 70% off \$65

USING TOOLS Copy and complete the table.

	Original Price	Percent of Discount	Sale Price
10.	\$80	20%	
11.	\$42	15%	
12.	\$120	80%	
13.	\$112	32%	
14.	\$69.80	60%	
15.		25%	\$40
16.		5%	\$57
17.		80%	\$90
18.		64%	\$72
19.		15%	\$146.54
20.	\$60		\$45
21.	\$82		\$65.60
22.	\$95		\$61.75



FINDING A SELLING PRICE Find the selling price.

23. Cost to store: \$50
Markup: 10%
24. Cost to store: \$80
Markup: 60%
25. Cost to store: \$140
Markup: 25%

26. **YOU BE THE TEACHER** A store pays \$60 for an item. Your friend finds the selling price when the markup is 20%. Is your friend correct? Explain your reasoning.

$$0.2(\$60) = \$12$$

So, the selling price is \$12.



27. **MP STRUCTURE** The scooter is being sold at a 10% discount. The original price is shown. Which methods can you use to find the new sale price? Which method do you prefer? Explain.

Multiply \$42.00 by 0.9.

Multiply \$42.00 by 0.1, then subtract from \$42.00.

Multiply \$42.00 by 0.9, then add to \$42.00.

Multiply \$42.00 by 0.9, then subtract from \$42.00.

28. **MP NUMBER SENSE** The original price of an item is p dollars. Is the price of the item with an 18% markup the same as multiplying the original price by 1.18? Use two expressions to justify your answer.

29. **MP PROBLEM SOLVING** You are shopping for a video game system.

- At which store should you buy the system?
- Store A has a weekend sale. What discount must Store A offer for you to buy the system there?

Store	Cost to Store	Markup
A	\$162	40%
B	\$155	30%
C	\$160	25%

30. **DIG DEEPER!** A pool manager balances the pH level of a pool. The price of a bucket of chlorine tablets is \$90, and the price of a pH test kit is \$11. The manager uses a coupon that applies a 40% discount to the total cost of the two items. How much money does the pool manager pay for each item?

31. **MP PRECISION** You buy a pair of jeans at a department store.
- What is the percent of discount to the nearest percent?
 - What is the percent of sales tax to the nearest tenth of a percent?
 - The price of the jeans includes a 60% markup. After the discount, what is the percent of markup to the nearest percent?

Department Store

Jeans	39.99
Discount	-10.00
Subtotal	29.99
Sales Tax	1.95
Total	31.94

Thank You

32. **CRITICAL THINKING** You buy a bicycle helmet for \$22.26, which includes 6% sales tax. The helmet is discounted 30% off the selling price. What is the original price?



33. **MP REASONING** A drone that costs \$129.50 is discounted 40%. The next month, the sale price is discounted an additional 60%. Is the drone now “free”? If so, explain. If not, find the sale price.

6.6 Simple Interest

Learning Target: Understand and apply the simple interest formula.

Success Criteria:

- I can explain the meaning of simple interest.
- I can use the simple interest formula to solve problems.

EXPLORATION 1

Understanding Simple Interest

Work with a partner. You deposit \$150 in an account that earns 6% *simple interest per year*. You do not make any other deposits or withdrawals. The table shows the balance of the account at the end of each year.

Years	Balance
0	\$150
1	\$159
2	\$168
3	\$177
4	\$186
5	\$195
6	\$204

- Describe any patterns you see in the account balance.
- How is the amount of interest determined each year?
- How can you find the amount of simple interest earned when you are given an initial amount, an interest rate, and a period of time?
- You deposit \$150 in a different account that earns simple interest. The table shows the balance of the account each year. What is the interest rate of the account? What is the balance after 10 years?

Math Practice

Look for Patterns

How does the pattern in the balances help you find the simple interest rate?

Years	0	1	2	3
Balance	\$150	\$165	\$180	\$195

6.6 Lesson

Key Vocabulary

interest, p. 266

principal, p. 266

simple interest, p. 266

Interest is money paid or earned for using or lending money. The **principal** is the amount of money borrowed or deposited.

Key Idea

Simple Interest

Words **Simple interest** is money paid or earned only on the principal.

Algebra

Simple interest

Annual interest rate
(in decimal form)

$$I = Prt$$

Principal

Time (in years)

Reading

An interest rate per year is also called an annual interest rate.

EXAMPLE 1 Finding a Balance

You deposit \$500 in a savings account. The account earns 3% simple interest per year. What is the balance after 3 years?

To find the balance, calculate the interest and add it to the principal.

$$I = Prt$$

Write the simple interest formula.

$$= 500(0.03)(3)$$

Substitute 500 for P , 0.03 for r , and 3 for t .

$$= 45$$

Multiply.

The interest earned is \$45 after 3 years.

▶ So, the balance is $\$500 + \$45 = \$545$ after 3 years.

Try It

1. What is the balance of the account after 9 months?

EXAMPLE 2 Finding an Annual Interest Rate

You deposit \$1000 in an account. The account earns \$100 simple interest in 4 years. What is the annual interest rate?

$$I = Prt$$

Write the simple interest formula.

$$100 = 1000(r)(4)$$

Substitute 100 for I , 1000 for P , and 4 for t .

$$100 = 4000r$$

Simplify.

$$0.025 = r$$

Divide each side by 4000.

▶ So, the annual interest rate of the account is 0.025, or 2.5%.

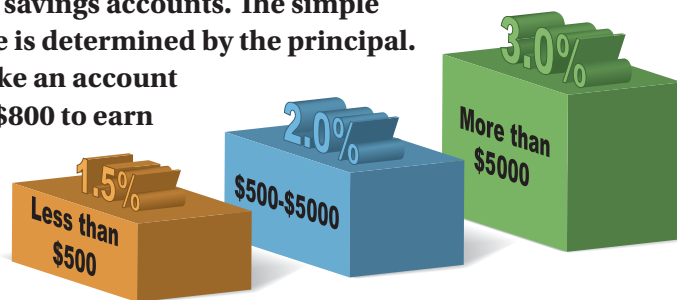
Try It

2. You deposit \$350 in an account. The account earns \$17.50 simple interest in 2.5 years. What is the annual interest rate?

EXAMPLE 3

Finding an Amount of Time

A bank offers three savings accounts. The simple annual interest rate is determined by the principal. How long does it take an account with a principal of \$800 to earn \$100 in interest?



The diagram shows that the interest rate for a principal of \$800 is 2%.

$$I = Prt$$

Write the simple interest formula.

$$100 = 800(0.02)(t)$$

Substitute 100 for I , 800 for P , and 0.02 for r .

$$100 = 16t$$

Simplify.

$$6.25 = t$$

Divide each side by 16.

▶ So, the account earns \$100 in interest in 6.25 years.

Try It

3. In Example 3, how long does it take an account with a principal of \$10,000 to earn \$750 in interest?



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

4. **VOCABULARY** Explain the meaning of simple interest.

USING THE SIMPLE INTEREST FORMULA Use the simple interest formula.

5. You deposit \$20 in a savings account. The account earns 4% simple interest per year. What is the balance after 4 years?
6. You deposit \$800 in an account. The account earns \$360 simple interest in 3 years. What is the annual interest rate?
7. You deposit \$650 in a savings account. How long does it take an account with an annual interest rate of 5% to earn \$178.25 in interest?

EXAMPLE 4**Modeling Real Life**

You borrow \$600 to buy a violin. The simple annual interest rate is 15%. You pay off the loan after 2 years of equal monthly payments. How much is each payment?

Understand
the problem.

You are given the amount and simple annual interest rate of a loan that you pay back in 2 years. You are asked to find the monthly payment.

Make a plan.

Use the simple interest formula to find the interest you pay on the loan. Then divide the total amount you pay by the number of months in 2 years.

Solve and
check.

$$I = Prt$$

Write the simple interest formula.

$$= 600(0.15)(2)$$

Substitute 600 for P , 0.15 for r , and 2 for t .

$$= 180$$

Multiply.

You pay $\$600 + \$180 = \$780$ for the loan.

So, each monthly payment is $\frac{780}{24} = \$32.50$.

Look Back When you substitute 600 for P and 0.15 for r , you obtain $I = 90t$. This indicates that you pay \$90 in interest each year. So, in 2 years you pay $2(90) = \$180$ in interest. ✓



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

8. You want to deposit \$1000 in a savings account for 3 years. One bank adds a \$100 bonus to your principal and offers a 2% simple annual interest rate. Another bank does not add a bonus, but offers 6% simple interest per year. Which bank should you choose? Explain.
9. Your cousin borrows \$1125 to repair her car. The simple annual interest rate is 10%. She makes equal monthly payments of \$25. How many years will it take to pay off the loan?
10. **DIG DEEPER!** You borrow \$900 to buy a laptop. You plan to pay off the loan after 5 years of equal monthly payments. After 10 payments, you have \$1200 left to pay. What is the simple annual interest rate of your loan?

6.6 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Find the selling price.

1. A store pays \$8 for a pool noodle. The markup is 20%.
2. A store pays \$3 for a magazine. The markup is 5%.

Solve the inequality. Graph the solution.

3. $x + 5 < 2$
4. $b - 2 \geq -1$
5. $w + 6 \leq -3$

► Concepts, Skills, & Problem Solving

UNDERSTANDING SIMPLE INTEREST The table shows the balance of an account each year. What is the interest rate of the account? What is the balance after 10 years?

(See Exploration 1, p. 265.)

6.

Years	Balance
0	\$40
1	\$42
2	\$44
3	\$46

7.

Years	Balance
0	\$175
1	\$189
2	\$203
3	\$217

FINDING INTEREST EARNED An account earns simple annual interest.

(a) Find the interest earned. (b) Find the balance of the account.

8. \$600 at 5% for 2 years
9. \$1500 at 4% for 5 years
10. \$350 at 3% for 10 years
11. \$1800 at 6.5% for 30 months
12. \$925 at 2.3% for 2.4 years
13. \$5200 at 7.36% for 54 months

14. **YOU BE THE TEACHER** Your friend finds the simple interest earned on \$500 at 6% for 18 months. Is your friend correct? Explain your reasoning.

$$I = (500)(0.06)(18)$$

$$= \$540$$

FINDING AN ANNUAL INTEREST RATE Find the annual interest rate.

15. $I = \$24$, $P = \$400$, $t = 2$ years
16. $I = \$562.50$, $P = \$1500$, $t = 5$ years
17. $I = \$54$, $P = \$900$, $t = 18$ months
18. $I = \$160$, $P = \$2000$, $t = 8$ months

FINDING AN AMOUNT OF TIME Find the amount of time.

19. $I = \$30$, $P = \$500$, $r = 3\%$
20. $I = \$720$, $P = \$1000$, $r = 9\%$
21. $I = \$54$, $P = \$800$, $r = 4.5\%$
22. $I = \$450$, $P = \$2400$, $r = 7.5\%$

23. **FINDING AN ACCOUNT BALANCE** A savings account earns 5% simple interest per year. The principal is \$1200. What is the balance after 4 years?
24. **FINDING AN ANNUAL INTEREST RATE** You deposit \$400 in an account. The account earns \$18 simple interest in 9 months. What is the annual interest rate?
25. **FINDING AN AMOUNT OF TIME** You deposit \$3000 in a CD (certificate of deposit) that earns 5.6% simple annual interest. How long will it take to earn \$336 in interest?

FINDING AN AMOUNT PAID Find the amount paid for the loan.

26. \$1500 at 9% for 2 years 27. \$2000 at 12% for 3 years
28. \$2400 at 10.5% for 5 years 29. \$4800 at 9.9% for 4 years

USING THE SIMPLE INTEREST FORMULA Copy and complete the table.

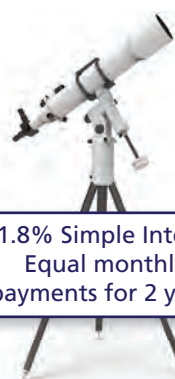
	Principal	Annual Interest Rate	Time	Simple Interest
30.	\$12,000	4.25%	5 years	
31.		6.5%	18 months	\$828.75
32.	\$15,500	8.75%		\$5425.00
33.	\$18,000		54 months	\$4252.50

34. **MODELING REAL LIFE** A family borrows money for a rainforest tour. The simple annual interest rate is 12%. The loan is paid after 3 months. What is the total amount paid for the tour?
35. **MODELING REAL LIFE** You deposit \$5000 in an account earning 7.5% simple interest per year. How long will it take for the balance of the account to be \$6500?



Rainforest Tour

<i>Tickets</i>	\$ 940
<i>Food</i>	\$ 170
<i>Supplies</i>	\$ 120



11.8% Simple Interest
Equal monthly
payments for 2 years

36. **MODELING REAL LIFE** You borrow \$1300 to buy a telescope. What is the monthly payment?
37. **MP REASONING** How many years will it take for \$2000 to double at a simple annual interest rate of 8%? Explain how you found your answer.
38. **DIG DEEPER!** You take out two loans. After 2 years, the total interest for the loans is \$138. On the first loan, you pay 7.5% simple annual interest on a principal of \$800. On the second loan, you pay 3% simple annual interest. What is the principal for the second loan?
39. **MP REPEATED REASONING** You deposit \$500 in an account that earns 4% simple annual interest. The interest earned each year is added to the principal to create a new principal. Find the total amount in your account after each year for 3 years.
40. **MP NUMBER SENSE** An account earns $r\%$ simple interest per year. Does doubling the initial principal have the same effect on the total interest earned as doubling the amount of time? Justify your answer.

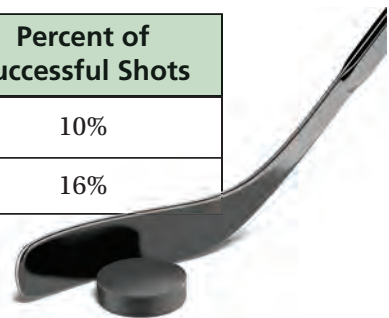
6

Connecting Concepts

► Using the Problem-Solving Plan

- The table shows the percent of successful shots for each team in a hockey game. A total of 55 shots are taken in the game. The ratio of shots taken by the Blazers to shots taken by the Hawks is 6 : 5. How many goals does each team score?

Team	Percent of Successful Shots
Blazers	10%
Hawks	16%



Understand the problem.

You know that 55 shots are taken in a hockey game and that the Blazers take 6 shots for every 5 shots taken by the Hawks. You also know the percent of successful shots for each team.

Make a plan.

Use a ratio table to determine the number of shots taken by each team. Then use the percent equation to determine the number of successful shots for each team.

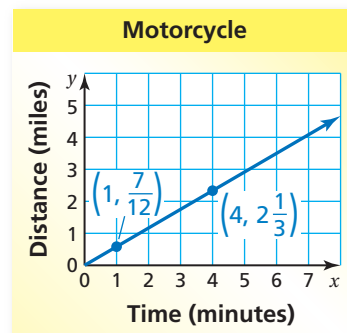
Solve and check.

Use the plan to solve the problem. Then check your solution.

- Fill in the blanks with positive numbers so that the sum of the fractions is 37.5% of the first fraction. Justify your answer.

$$\frac{\text{yellow square}}{5} + \left(-\frac{\text{yellow square}}{4} \right)$$

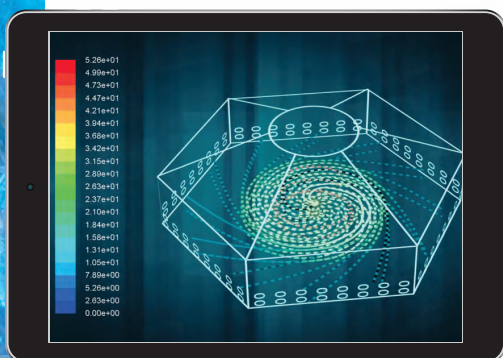
- The graph shows the distance traveled by a motorcycle on a dirt road. After turning onto a paved road, the motorcycle travels $\frac{1}{5}$ mile every $\frac{1}{4}$ minute. Find the percent of change in the speed of the motorcycle. Round to the nearest tenth of a percent if necessary.



Performance Task

Tornado Alley

At the beginning of this chapter, you watched a STEAM Video called "Tornado!" You are now ready to complete the performance task related to this video, available at BigIdeasMath.com. Be sure to use the problem-solving plan as you work through the performance task.





► Review Vocabulary

Write the definition and give an example of each vocabulary term.

percent of change, p. 254

percent of increase, p. 254

percent of decrease, p. 254

percent error, p. 256

discount, p. 260

markup, p. 260

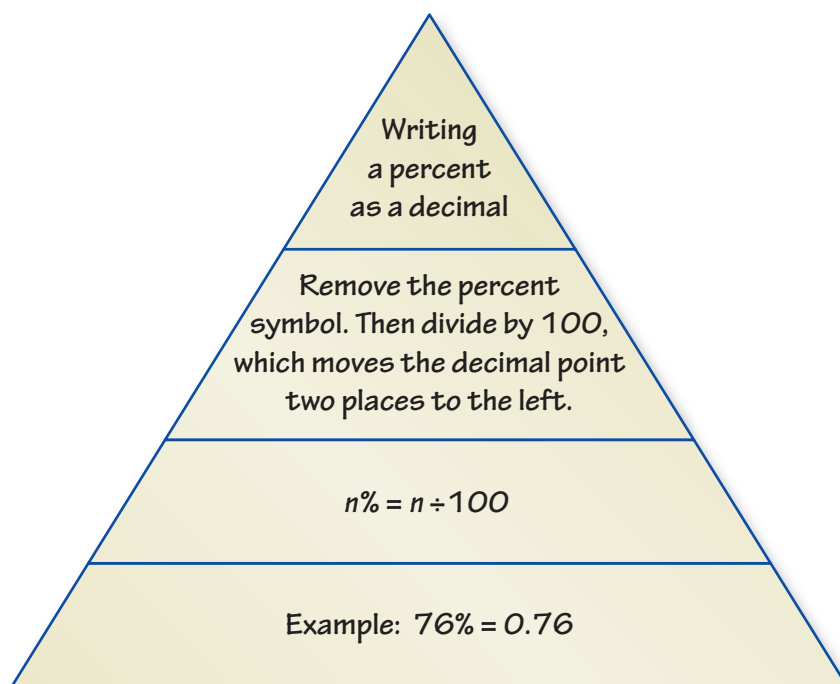
interest, p. 266

principal, p. 266

simple interest, p. 266

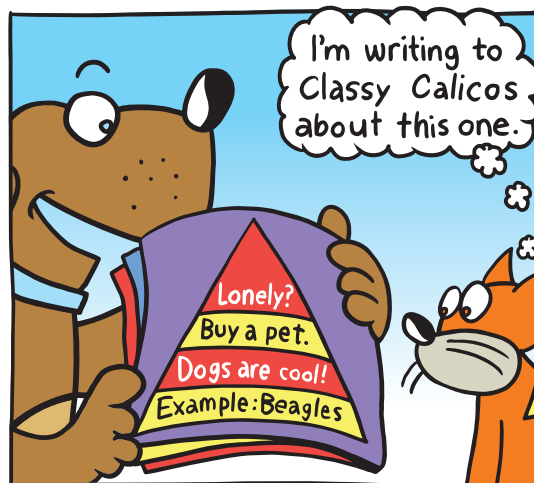
► Graphic Organizers

You can use a **Summary Triangle** to explain a concept. Here is an example of a Summary Triangle for *writing a percent as a decimal*.



Choose and complete a graphic organizer to help you study the concept.

1. writing a decimal as a percent
2. comparing and ordering fractions, decimals, and percents
3. the percent proportion
4. the percent equation
5. percent of change
6. discount
7. markup



"I found this great **Summary Triangle** in my *Beautiful Beagle Magazine*."

► Chapter Self-Assessment

As you complete the exercises, use the scale below to rate your understanding of the success criteria in your journal.



6.1 Fractions, Decimals, and Percents (pp. 235–240)

Learning Target: Rewrite fractions, decimals, and percents using different representations.

Write the percent as a decimal or the decimal as a percent. Use a model to represent the number.

- | | | |
|---------|----------------|----------|
| 1. 74% | 2. 2% | 3. 221% |
| 4. 0.17 | 5. $4.\bar{3}$ | 6. 0.079 |

Write the fraction as a decimal and a percent.

- | | | |
|--------------------|------------------|-------------------|
| 7. $\frac{17}{20}$ | 8. $\frac{3}{8}$ | 9. $\frac{14}{9}$ |
|--------------------|------------------|-------------------|

10. For school spirit day, 11.875% of your class wears orange shirts, $\frac{5}{8}$ of your class wears blue shirts, 0.15625 of your class wears white shirts, and the rest of your class wears gold shirts. Order the portions of shirts of each color from least to greatest. Justify your answer.



6.2 The Percent Proportion (pp. 241–246)

Learning Target: Use the percent proportion to find missing quantities.

Write and solve a proportion to answer the question.

- What percent of 60 is 18?
- 40 is what percent of 32?
- What number is 70% of 70?
- $\frac{3}{4}$ is 75% of what number?
- About 29% of the Earth's surface is covered by land. The total surface area of the Earth is about 510 million square kilometers. What is the area of the Earth's surface covered by land?





6.3 The Percent Equation (pp. 247–252)

Learning Target: Use the percent equation to find missing quantities.

Write and solve an equation to answer the question.

16. What number is 24% of 25?
17. 9 is what percent of 20?
18. 60.8 is what percent of 32?
19. 91 is 130% of what number?
20. 85% of what number is 10.2?
21. 83% of 20 is what number?
22. 15% of the parking spaces at a school are handicap spaces. The school has 18 handicap spaces. How many parking spaces are there in total?
23. Of the 25 students on a field trip, 16 bring cameras. What percent of the students bring cameras?



6.4 Percents of Increase and Decrease (pp. 253–258)

Learning Target: Find percents of change in quantities.

Identify the percent of change as an *increase* or a *decrease*. Then find the percent of change. Round to the nearest tenth of a percent if necessary.

24. 6 yards to 36 yards
25. 120 meals to 52 meals
26. You estimate that a jar contains 68 marbles. The actual number of marbles is 60. Find the percent error.

27. The table shows the numbers of skim boarders at a beach on Saturday and Sunday. What was the percent of change in boarders from Saturday to Sunday?

Day	Number of Skim Boarders
Saturday	12
Sunday	9





6.5 Discounts and Markups (pp. 259–264)

Learning Target: Solve percent problems involving discounts and markups.

Find the sale price or original price.

28. Original price: \$50
Discount: 15%
Sale price: ?
29. Original price: ?
Discount: 20%
Sale price: \$75
30. What is the original price of the tennis racquet?
31. A store pays \$50 for a pair of shoes. The markup is 25%.
a. What is the selling price for the shoes?
b. What is the total cost for a person to buy the shoes including a 6% sales tax?



6.6 Simple Interest (pp. 265–270)

Learning Target: Understand and apply the simple interest formula.

An account earns simple interest. (a) Find the interest earned. (b) Find the balance of the account.

32. \$300 at 4% for 3 years
33. \$2000 at 3.5% for 4 years
34. $I = \$17$, $P = \$500$, $t = 2$ years
35. $I = \$426$, $P = \$1200$, $t = 5$ years

Find the annual interest rate.

Find the amount of time.

36. $I = \$60$, $P = \$400$, $r = 5\%$
37. $I = \$237.90$, $P = \$1525$, $r = 2.6\%$
38. You deposit \$100 in an account. The account earns \$2 simple interest in 6 months. What is the annual interest rate?

39. Bank A is offering a loan with a simple interest rate of 8% for 2 years. Bank B is offering a loan with a simple interest rate of 6.5% for 3 years.

- a. Assuming the monthly payments are equal, what is the monthly payment for the four wheeler from Bank A? from Bank B?
- b. Give reasons for why a person might choose Bank A and why a person might choose Bank B for a loan to buy the four wheeler. Explain your reasoning.



6

Practice Test

Write the percent as a decimal, or the decimal as a percent. Use a model to represent the number.

1. 0.96%
2. 3%
3. $25.\overline{5}\%$
4. $0.\overline{6}$
5. 7.88
6. 0.58

Order the numbers from least to greatest.

7. 86%, $\frac{15}{18}$, 0.84, $\frac{8}{9}$, $0.8\overline{6}$
8. 91.6%, 0.91, $\frac{11}{12}$, 0.917, 9.2%

Write and solve a proportion or equation to answer the question.

9. What percent of 28 is 21?
10. 64 is what percent of 40?
11. What number is 80% of 45?
12. 0.8% of what number is 6?

Identify the percent of change as an *increase* or a *decrease*. Then find the percent of change. Round to the nearest tenth of a percent if necessary.

13. 4 strikeouts to 10 strikeouts
14. \$24 to \$18

Find the sale price or selling price.

15. Original price: \$15
Discount: 5%
Sale price: ?
16. Cost to store: \$5.50
Markup: 75%
Selling price: ?

An account earns simple interest. Find the interest earned or the principal.

17. Interest earned: ?
Principal: \$450
Interest rate: 6%
Time: 8 years
18. Interest earned: \$27
Principal: ?
Interest rate: 1.5%
Time: 2 years

19. You spend 8 hours each weekday at school. (a) Write the portion of a weekday spent at school as a fraction, a decimal, and a percent. (b) What percent of a week is spent at school if you go to school 4 days that week? Round to the nearest tenth.
20. Research indicates that 90% of the volume of an iceberg is below water. The volume of the iceberg above the water is 160,000 cubic feet. What is the volume of the iceberg below water?
21. You estimate that there are 66 cars in a parking lot. The actual number of cars is 75.
 - a. Find the percent error.
 - b. What other estimate gives the same percent error? Explain your reasoning.



6

Cumulative Practice

1. A movie theater offers 30% off the price of a movie ticket to students from your school. The regular price of a movie ticket is \$8.50. What is the discounted price that you pay for a ticket?

A. \$2.55 B. \$5.50
C. \$5.95 D. \$8.20



2. What is the least value of x for which the inequality is true?

$$16 \geq -2x$$

3. You are building a scale model of a park that is planned for a city. The model uses the scale 1 centimeter = 2 meters. The park will have a rectangular reflecting pool with a length of 20 meters and a width of 12 meters. In your scale model, what will be the area of the reflecting pool?

F. 60 cm^2 G. 120 cm^2
H. 480 cm^2 I. 960 cm^2

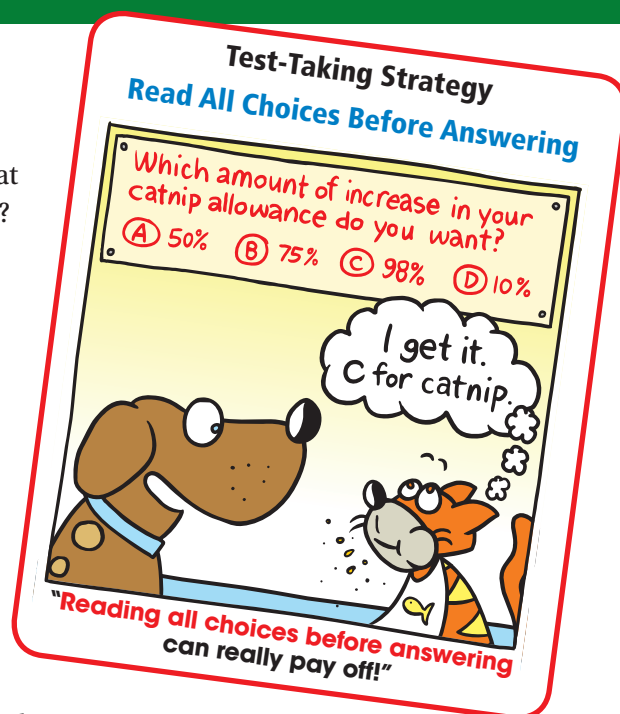
4. Which proportion represents the problem?

"17% of a number is 43. What is the number?"

A. $\frac{17}{43} = \frac{n}{100}$ B. $\frac{n}{17} = \frac{43}{100}$
C. $\frac{n}{43} = \frac{17}{100}$ D. $\frac{43}{n} = \frac{17}{100}$

5. Which list of numbers is in order from least to greatest?

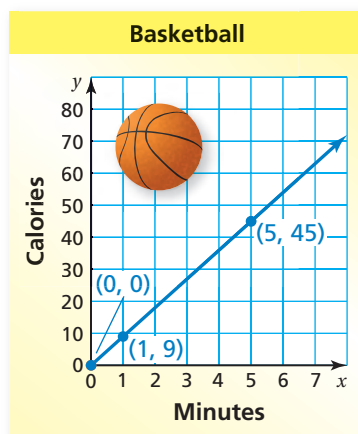
F. $0.8, \frac{5}{8}, 70\%, 0.09$ G. $0.09, \frac{5}{8}, 0.8, 70\%$
H. $\frac{5}{8}, 70\%, 0.8, 0.09$ I. $0.09, \frac{5}{8}, 70\%, 0.8$



6. What is the value of $\frac{9}{8} \div \left(-\frac{11}{4}\right)$?



7. The number of calories you burn by playing basketball is proportional to the number of minutes you play. Which of the following is a valid interpretation of the graph?



- A. The unit rate is $\frac{1}{9}$ calorie per minute.
- B. You burn 5 calories by playing basketball for 45 minutes.
- C. You do not burn any calories if you do not play basketball for at least 1 minute.
- D. You burn an additional 9 calories for each minute of basketball you play.
8. A softball team is ordering uniforms. Each player receives one of each of the items shown in the table.

Item	Jersey	Pants	Hat	Socks
Price (dollars)	x	15.99	4.88	3.99

Which expression represents the total cost (in dollars) when there are 15 players on the team?

- F. $x + 24.86$
- G. $15x + 372.90$
- H. $x + 372.90$
- I. $x + 387.90$

9. Your friend solves the equation. What should your friend do to correct the error that he made?

$$-3(2 + w) = -45$$

$$2 + w = -15$$

$$w = -17$$

- A. Multiply -45 by -3 .
- B. Add 3 to -45 .
- C. Add 2 to -15 .
- D. Divide -45 by -3 .
10. You are comparing the costs of a certain model of ladder at a hardware store and at an online store.



Part A What is the total cost of buying the ladder at each of the stores? Show your work and explain your reasoning.

Part B Suppose that the hardware store is offering 10% off the price of the ladder and that the online store is offering free shipping and handling. Which store offers the lower total cost for the ladder? by how much? Show your work and explain your reasoning.

11. Which graph represents the inequality $-5 - 3x \geq -11$.

