

5.3 Solving Rate Problems

Essential Question How can you use rates to help show how a country can save valuable natural resources?

*For want of a nail the shoe was lost.
For want of a shoe the horse was lost.
For want of a horse the rider was lost.
For want of a rider the battle was lost.
For want of a battle the kingdom was lost.
And all for the want of a horseshoe nail.*



1 ACTIVITY: Saving Water

The nursery rhyme above is an example of how a small problem can lead to a big problem.

Work with a partner. Here is an example about a leaky faucet that drips a drop of water every 2 seconds.

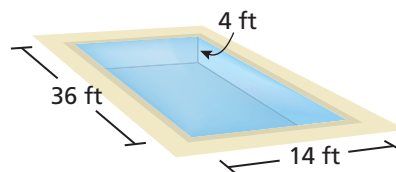
- a. Copy and complete the table showing how many drops of water drip in different amounts of time. Write each entry in the table as a rate in drops per unit of time.

Drops	1					
Time	2 sec	1 min	1 h	1 d	1 wk	1 yr

- b. How many gallons of water are wasted in a year? Show your work.

80 drops = 1 teaspoon
96 teaspoons = 1 pint
8 pints = 1 gallon

- c. There are about 125 million homes and apartments in the United States. Suppose every one of them has a leaky faucet. How many gallons of water will be wasted each year? Explain your reasoning.
- d. The swimming pool shown at the right holds about 15,000 gallons of water. How many times could this pool be filled by the amount of water you found in part (c)?



2 ACTIVITY: Saving Gasoline

Work with a partner.

Drivers in the United States use about 400 million gallons of gasoline each day. There are about 250 million automobiles in the United States. The typical fuel economy of automobiles is about 17 miles per gallon.



- a. How much gasoline does the typical automobile in the United States use each day?

$$\text{Gallons per car per day} = \frac{\text{Number of gallons used}}{\text{Number of cars}}$$

- b. How many miles is a typical automobile in the United States driven each day?

$$\text{Miles per car per day} = \text{Gallons per car per day} \times \text{Fuel economy}$$

- c. How much gasoline can be saved each day by increasing the typical fuel economy in the United States to 25 miles per gallon? Explain your reasoning.

What Is Your Answer?

- IN YOUR OWN WORDS** How can you use rates to help show how a country can save valuable natural resources? Give an example.
- RESEARCH** In Activities 1 and 2, rates are used to show how to save water and gasoline. Think of another example in which rates can be used in efforts to save a natural resource.

Practice

Use what you learned about solving ratio and rate problems to complete Exercises 11–14 on page 206.

Key Idea
Distance, Speed, and Time

Words To find the distance traveled d , multiply the speed r by the time t .

Algebra $d = rt$

Words To find the speed r , divide the distance d by the time t .

Algebra $r = \frac{d}{t}$

Remember

Speed is an example of a rate.

EXAMPLE 1 Finding a Distance

A peregrine falcon can dive at a speed of 80 meters per second. How far can it dive in 4 seconds?

$$d = rt$$

Write the formula for distance.

$$= \frac{80 \text{ meters}}{1 \text{ second}} \times 4 \text{ seconds}$$

Substitute the given values.
The seconds divide out.

$$= 320 \text{ meters}$$

Multiply.

∴ The peregrine falcon can dive 320 meters in 4 seconds.

EXAMPLE 2 Finding a Speed

A great white shark swims 90 feet in 2.5 seconds. What is its speed?

$$r = \frac{d}{t}$$

Write the formula for speed.

$$= \frac{90 \text{ feet}}{2.5 \text{ seconds}}$$

Substitute the given values.

$$= \frac{36 \text{ feet}}{1 \text{ second}}$$

Divide.

∴ Its speed is 36 feet per second.

On Your Own

Now You're Ready
Exercises 3–10

- WHAT IF?** In Example 1, how far can the falcon dive in 7.5 seconds?
- A grizzly bear runs 60 feet in 1.25 seconds. What is its speed?

EXAMPLE 3 Solving a Rate Problem

How high does the hot air balloon rise in 15 seconds?



Rises 9 meters every 3 seconds.

Method 1: Use the formula for distance.

$$\begin{aligned}
 d &= rt && \text{Write the formula for distance.} \\
 &= \frac{9 \text{ meters}}{3 \text{ seconds}} \times 15 \text{ seconds} && \text{Substitute the given values.} \\
 &= 45 \text{ meters} && \text{Multiply.}
 \end{aligned}$$

∴ The balloon rises 45 meters in 15 seconds.

Method 2: Use a unit rate.

$$\frac{9 \text{ meters}}{3 \text{ seconds}} = \frac{3 \text{ meters}}{1 \text{ second}}$$

Find the unit rate.

$$\frac{3 \text{ meters}}{1 \text{ second}} \times 15 \text{ seconds} = 45 \text{ meters}$$

Multiply the unit rate by the time.

∴ The balloon rises 45 meters in 15 seconds.

EXAMPLE 4 Solving a Cost Problem

Four bottles of fruit juice cost \$7. How much do nine bottles cost?

Find a unit rate.

$$\frac{\$7}{4 \text{ bottles}} = \frac{\$1.75}{1 \text{ bottle}}$$

Each bottle costs \$1.75.

$$\frac{\$1.75}{1 \text{ bottle}} \times 9 \text{ bottles} = \$15.75$$

Multiply the unit rate by 9.

∴ Nine bottles cost \$15.75.

On Your Own

- WHAT IF?** In Example 3, how high does the balloon rise in 30 seconds? Solve using both methods.
- Four bottles of water cost \$5. How much do seven bottles cost?

Now You're Ready
Exercises 11–18

Vocabulary and Concept Check

1. **FORMULA** Which is correct?

Distance equals speed times time.

Distance equals speed divided by time.

2. **WRITING** What are the units for the product?

$$\frac{2 \text{ mi}}{1 \text{ h}} \cdot 2.5 \text{ h}$$

Practice and Problem Solving

Find the distance.

- 1 3. $d = \square$, $r = 35 \text{ mi/h}$, $t = 3 \text{ h}$ 4. $d = \square$, $r = 50 \text{ m/sec}$, $t = 25 \text{ sec}$
 5. $d = \square$, $r = 23 \text{ ft/sec}$, $t = 12 \text{ sec}$ 6. $d = \square$, $r = 6 \text{ in./min}$, $t = 53 \text{ min}$

Find the speed.

- 2 7. 425 inches in 85 seconds 8. 900 miles in 18 hours
 9. 870 feet in 15 minutes 10. 3096 meters in 72 seconds

Find how far the object travels in the given amount of time.

- 3 11. 18 hours 12. 24 seconds



Moves 2 meters every 3 hours.



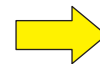
Rises 5 stories every 6 seconds.

13. 40 seconds

14. 20 minutes



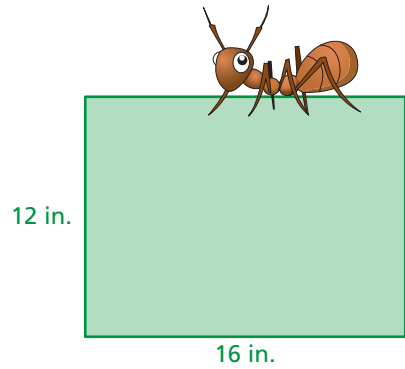
Falls 1810 feet every 10 seconds.



Moves 960 kilometers every 4 minutes.

- 4 15. **YOGURT** Six containers of yogurt cost \$4.50. How much do eight containers cost?
 16. **CEREAL** Three boxes of cereal cost \$9.57. How much do five boxes cost?

17. **WALKING** You walk 5 city blocks in 12 minutes. How many city blocks can you walk in 2 hours?
18. **HAM** Eight ounces of ham cost \$1.92. You bought \$9.60 worth of ham. How many ounces did you buy?
19. **ANT** How fast should an ant run to go around the rectangle in three minutes?



Fruit Punch
8 ounces orange juice
2 ounces lemon juice
6 ounces pineapple juice
6 ounces apple juice
12 ounces lemon-lime soda

20. **FRUIT PUNCH** You are using the recipe to make fruit punch.
- At a party, how many ounces of punch do you think each person will drink?
 - Use your answer to part (a) to estimate how many people this recipe will serve.
 - You invite 60 people to the party. How many punch recipes should you make?

21. **BIKING** You and a friend start biking in opposite directions from the same point. You travel 108 feet every 8 seconds. Your friend travels 63 feet every 6 seconds.
- How far apart are you and your friend after 15 minutes?
 - After 20 minutes, you take a 5-minute rest, but your friend does not. How far apart are you and your friend after 40 minutes? Explain your reasoning.



22. **Critical Thinking** A survey of 120 students had the following results.
- Eighteen are in the concert band.
 - Two out of every nine concert band members are in the jazz band.
 - Every jazz band member is in the concert band.

If you increase the size of the survey to 300 students, how many would you expect to be in the jazz band? Explain your reasoning.



Fair Game Review what you learned in previous grades & lessons

Add.

23. $12 + 16 + 24 + 18 + 16$ 24. $2.6 + 3.5 + 1.7 + 0.8$ 25. $33 + 47 + 25 + 36$

26. **MULTIPLE CHOICE** What is the area of the trapezoid?

- (A) 6 m^2 (B) 36 m^2
 (C) 60 m^2 (D) 210 m^2

