

## 5.2 Rates

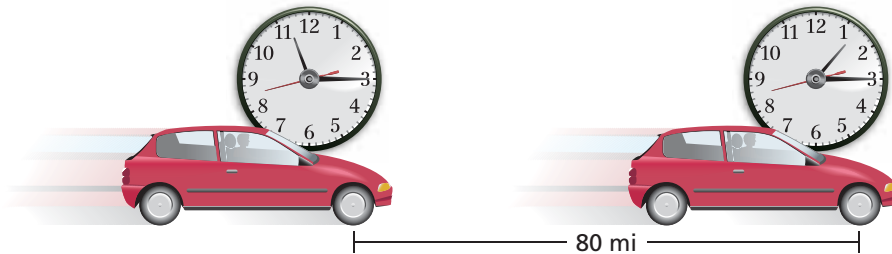
**Essential Question** How can you use rates to describe changes in real-life problems?

### 1 ACTIVITY: Stories Without Words

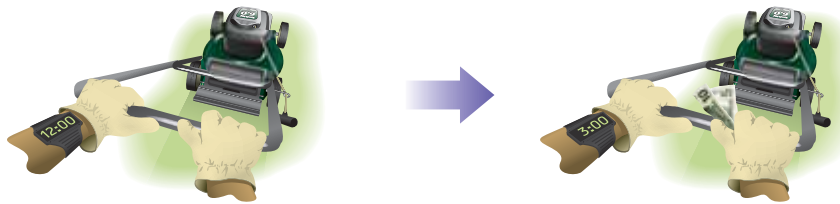
Work with a partner. Each diagram shows a story problem.

- Describe the story problem in your own words.
- Write the rate indicated by the diagram. What are the units?
- Rewrite the rate so that the denominator is 1. (This is called a *unit rate*.)

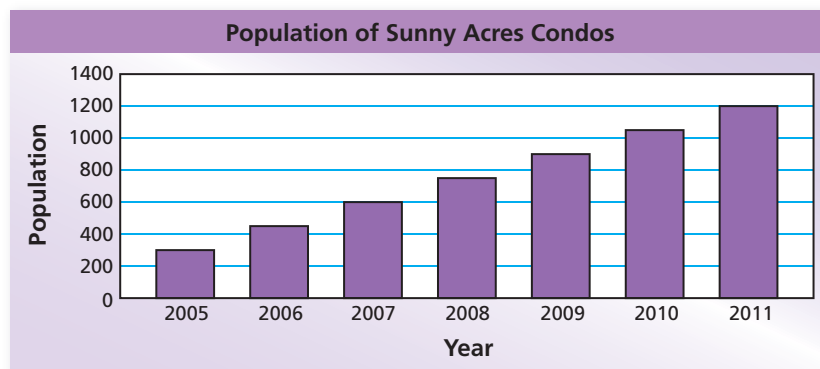
a.



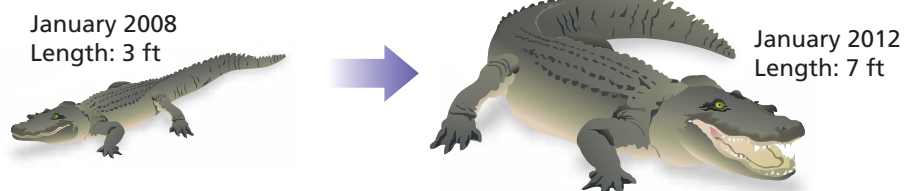
b.



c.



d.



## 2 ACTIVITY: Changing Units in a Rate

Work with a partner.

- Change the units of the rate by multiplying by a “Magic One.” Show your work.
- Write your answer as a unit rate.

<i>Original Rate</i>		<i>Magic One</i>		<i>New Units</i>		<i>Unit Rate</i>
a. Sample:						
$\frac{\$120}{\cancel{h}}$	×	$\frac{\cancel{1} h}{60 \text{ min}}$	=	$\frac{\$120}{60 \text{ min}}$	=	$\frac{\$2}{1 \text{ min}}$
b. $\frac{\$3}{\text{min}}$	×	$\frac{1}{60 \text{ min}}$	=		=	$\frac{\$ \square}{1 \text{ h}}$
c. $\frac{36 \text{ people}}{\text{yr}}$	×	$\frac{1}{12 \text{ mo}}$	=		=	$\frac{\square \text{ people}}{1 \text{ mo}}$
d. $\frac{12 \text{ in.}}{\text{ft}}$	×	$\frac{1}{3 \text{ ft}}$	=		=	$\frac{\square \text{ in.}}{1 \text{ yd}}$
e. $\frac{60 \text{ mi}}{\text{h}}$	×	$\frac{1}{60 \text{ min}}$	=		=	$\frac{\square \text{ mi}}{1 \text{ min}}$
f. $\frac{2 \text{ ft}}{\text{week}}$	×	$\frac{1}{52 \text{ weeks}}$	=		=	$\frac{\square \text{ ft}}{1 \text{ yr}}$

### What Is Your Answer?

- One problem-solving strategy is called *Working Backwards*. What does this mean? How can this strategy be used to find the rates in Activity 2?
- IN YOUR OWN WORDS** How can you use rates to describe changes in real-life problems? Give two examples.

### Practice

Use what you learned about rates to complete Exercises 11–14 on page 200.

### Key Vocabulary

rate, p. 198  
unit rate, p. 198  
unit cost, p. 199

## Key Idea

### Rate and Unit Rate

**Words** A **rate** is a ratio of two quantities using different units.

**Numbers** You pay \$27 for 3 pizzas.

$$\text{rate} = \frac{\$27}{3 \text{ pizzas}}$$

← dollars  
← pizzas

**Words** A **unit rate** compares a quantity to one unit of the other quantity.

**Numbers**

Rate:  $\frac{\$27}{3 \text{ pizzas}}$  }  Unit rate:  $\frac{\$9}{1 \text{ pizza}}$

## EXAMPLE 1 Writing a Rate

In a jalapeño pepper-eating contest, a contestant eats 70 peppers in 3 minutes. Write a rate that represents this situation.

$$\text{rate} = \frac{70 \text{ peppers}}{3 \text{ minutes}}$$

← peppers  
← minutes

∴ A rate is  $\frac{70 \text{ peppers}}{3 \text{ minutes}}$ .

### On Your Own

1. A contestant eats 55 peppers in 4 minutes. Write a rate that represents this situation.

Now You're Ready  
Exercises 3–10

## EXAMPLE 2 Writing a Unit Rate

In orbit, a space shuttle travels 70,000 miles in 4 hours. How far does it travel in 1 hour?

$$\frac{70,000 \text{ miles}}{4 \text{ hours}} = \frac{17,500 \text{ miles}}{1 \text{ hour}}$$

÷ 4  
÷ 4

To get a denominator of 1, divide each number by 4.

∴ The space shuttle travels 17,500 miles in 1 hour.

### Reading

Dollars per hour and miles per gallon are commonly used unit rates.

### EXAMPLE 3 Using a Unit Rate



You earned 150 points for every note you successfully hit in a music video game. How many points did you earn?

$$\begin{array}{c} \text{unit rate} \rightarrow \frac{150 \text{ points}}{1 \text{ note}} = \frac{3750 \text{ points}}{25 \text{ notes}} \\ \begin{array}{c} \times 25 \\ \times 25 \end{array} \end{array}$$

••• You earned 3750 points.

#### On Your Own

Now You're Ready  
Exercises 11–20

- A Japanese bullet train travels 558 miles in 3 hours. How far does the train travel in 1 hour?
- WHAT IF?** In Example 3, you successfully hit 30 notes. How many points did you earn?

A unit rate for cost per unit is a **unit cost**. A unit cost helps compare prices.

### EXAMPLE 4 Comparing Unit Costs

Which bag of dog food is the better buy? Explain.



20-pound bag

$$\begin{array}{c} \div 20 \\ \frac{\$17.20}{20 \text{ pounds}} = \frac{\$0.86}{1 \text{ pound}} \\ \div 20 \end{array}$$

40-pound bag

$$\begin{array}{c} \div 40 \\ \frac{\$33.60}{40 \text{ pounds}} = \frac{\$0.84}{1 \text{ pound}} \\ \div 40 \end{array}$$

••• Because \$0.84 is less than \$0.86, the 40-pound bag is the better buy.

#### On Your Own

Now You're Ready  
Exercises 21 and 22

- A 30-pack of paper towels costs \$48.30. A 32-pack costs \$49.60. Which is the better buy? Explain.

## Vocabulary and Concept Check

- WRITING** Describe a unit rate that you use in real life.
- DIFFERENT WORDS, SAME QUESTION** Which is different? Find “both” answers.

What is the cost per bagel?

What is the unit cost of a bagel?

What is the cost per dozen bagels?

How much does each bagel cost?



## Practice and Problem Solving

Write a rate that represents the situation.

- |   |                                 |                               |
|---|---------------------------------|-------------------------------|
| 1 | 3. 105 words in 35 minutes      | 4. 12 feet in 5 seconds       |
|   | 5. 36 students for 16 computers | 6. \$1.40 for 4 apples        |
|   | 7. 3 baskets in 45 minutes      | 8. 2 inches in 8 years        |
|   | 9. \$48 for 6 tickets           | 10. 150 gallons in 25 minutes |

Write a unit rate for the situation.

- |   |                                  |                                |
|---|----------------------------------|--------------------------------|
| 2 | 11. \$28 saved in 4 weeks        | 12. 18 necklaces in 3 hours    |
|   | 13. 270 miles in 6 hours         | 14. 228 students in 12 classes |
|   | 15. 2520 kilobytes in 18 seconds | 16. 880 calories in 8 servings |
|   | 17. 1080 miles on 15 gallons     | 18. \$12.50 for 5 ounces       |
19. **LIGHTNING** Lightning strikes Earth 100 times per second. What is the rate, in strikes per minute?
20. **HEART RATE** Your heart beats 240 times in 4 minutes. What is your heart rate, in beats per second?
- 3
21. **ENERGY BARS** Which pack of energy bars is the better buy? Explain.
22. **DEBATE** Do you think it is true that the bigger package is always the better buy? Give examples to support your decision.



Decide whether the rates are equivalent.

23.  $\frac{24 \text{ laps}}{6 \text{ minutes}}, \frac{72 \text{ laps}}{18 \text{ minutes}}$

24.  $\frac{126 \text{ points}}{3 \text{ games}}, \frac{210 \text{ points}}{5 \text{ games}}$

25.  $\frac{15 \text{ breaths}}{36 \text{ seconds}}, \frac{90 \text{ breaths}}{3 \text{ minutes}}$

26.  $\frac{\$16}{4 \text{ pounds}}, \frac{\$1}{4 \text{ ounces}}$



27. **FOOD DRIVE** The table shows the amount of food collected by two homerooms. Homeroom A collects 20 additional items of food. How many more items does Homeroom B need to collect to have a higher rate of items per student?

	Homeroom A	Homeroom B
Students	24	16
Canned Food	30	22
Dry Food	42	24

28. **MARATHON** A runner completed his first 26.2-mile marathon in 210 minutes.

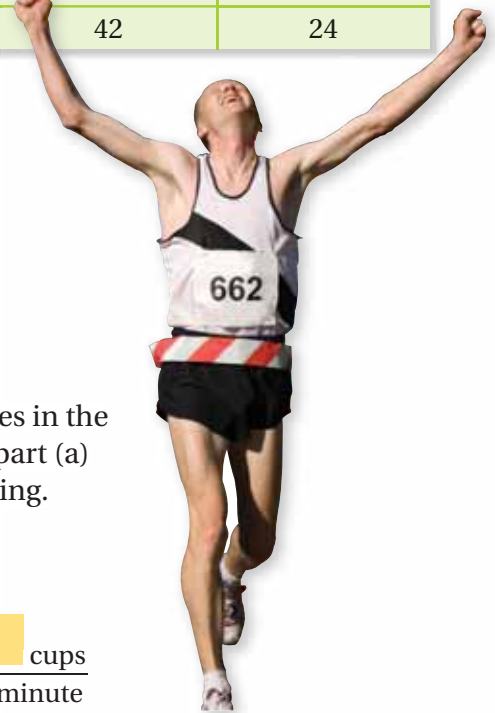
- Find the unit rate  $\frac{\text{miles}}{\text{minute}}$ .
- Find the unit rate  $\frac{\text{minutes}}{\text{mile}}$ .
- The runner says, "I averaged 8-minute miles in the marathon." Is he talking about the rate in part (a) or the rate in part (b)? Explain your reasoning.



Convert the unit rate.

29.  $\frac{45 \text{ miles}}{1 \text{ hour}} = \frac{\square \text{ feet}}{1 \text{ second}}$

30.  $\frac{18 \text{ gallons}}{1 \text{ hour}} = \frac{\square \text{ cups}}{1 \text{ minute}}$



## Fair Game Review what you learned in previous grades & lessons

Write two fractions that are equivalent to the given fraction.

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

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

33.  $\frac{2}{5}$

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

35. **MULTIPLE CHOICE** A handheld video game system that normally costs \$150 is on sale for 35% off. What is the sale price?

(A) \$52.50

(B) \$97.50

(C) \$109.50

(D) \$375