

5.2 Rates

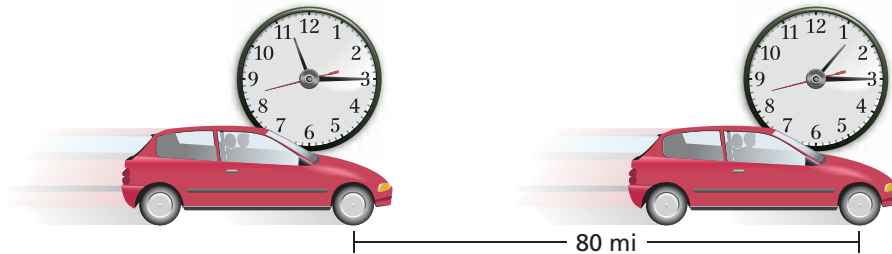
Essential Question How can you use rates to describe changes in real-life problems?

1 ACTIVITY: Stories Without Words

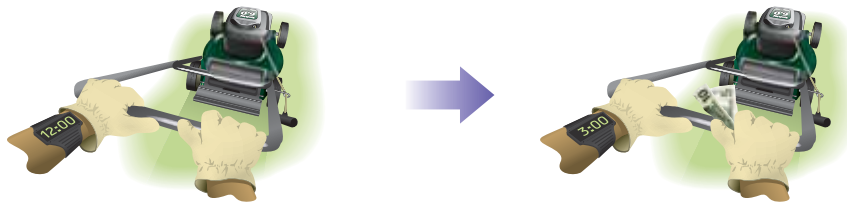
Work with a partner. Each diagram shows a story problem.

- 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*.)

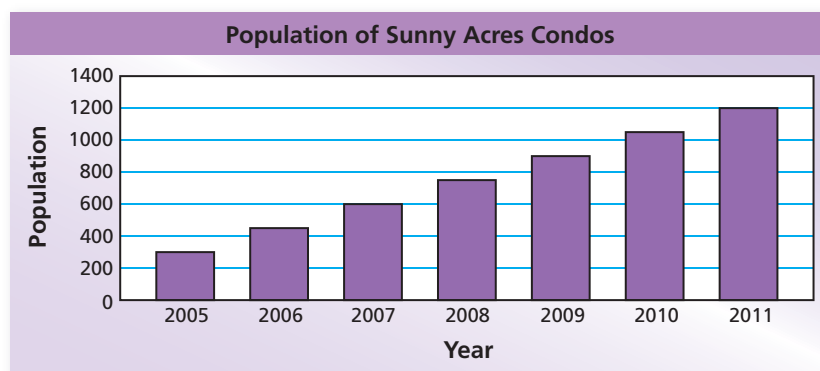
a.



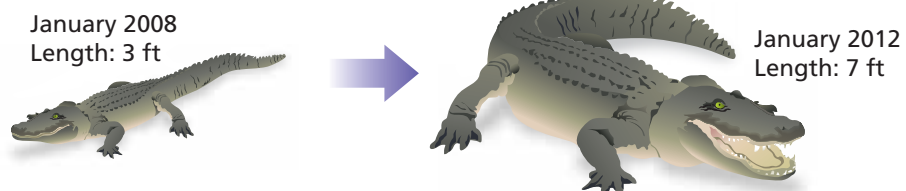
b.



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.

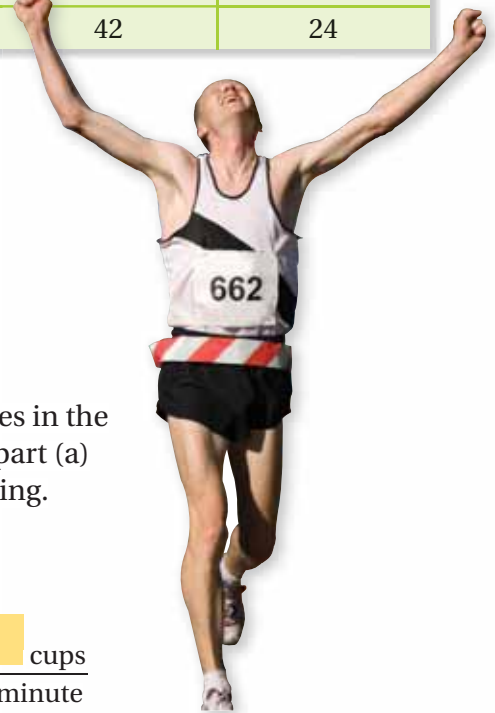
- Find the unit rate $\frac{\text{miles}}{\text{minute}}$.
- Find the unit rate $\frac{\text{minutes}}{\text{mile}}$.
- The runner says, "I averaged 8-minute miles in the marathon." Is he talking about the rate in part (a) or the rate in part (b)? Explain your reasoning.



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