

# 3.1 Ratios and Rates

**Essential Question** How do rates help you describe real-life problems?



## The Meaning of a Word ● Rate

When you rent snorkel gear at the beach, you should pay attention to the rental **rate**. The rental rate is in dollars per hour.



### 1 ACTIVITY: Finding Reasonable Rates

Work with a partner.

- Match each description with a verbal rate.
- Match each verbal rate with a numerical rate.
- Give a reasonable numerical rate for each description. Then give an unreasonable rate.

<i>Description</i>	<i>Verbal Rate</i>	<i>Numerical Rate</i>
Your pay rate for washing cars	inches per month	$\frac{\square}{\text{sec}}$ m
The average rainfall rate in a rain forest	pounds per acre	$\frac{\square}{\text{yr}}$ people
Your average driving rate along an interstate	meters per second	$\frac{\square}{\text{acre}}$ lb
The growth rate for the length of a baby alligator	people per year	$\frac{\square}{\text{h}}$ mi
Your running rate in a 100-meter dash	dollars per hour	$\frac{\square}{\text{yr}}$ in.
The population growth rate of a large city	dollars per year	$\frac{\square}{\text{mo}}$ in.
The average pay rate for a professional athlete	miles per hour	$\frac{\square}{\text{h}}$ \$
The fertilization rate for an apple orchard	inches per year	$\frac{\square}{\text{yr}}$ \$

## 2 ACTIVITY: Unit Analysis

Work with a partner. Some real-life problems involve the product of an amount and a rate. Find each product. List the units.

- a. **Sample:**  $6 \text{ h} \times \frac{\$12}{\text{h}} = 6 \cancel{\text{h}} \times \frac{\$12}{\cancel{\text{h}}}$  Divide out "hours."  
 $= \$72$  Multiply. Answer is in dollars.
- b.  $6 \text{ mo} \times \frac{\$700}{\text{mo}}$
- c.  $10 \text{ gal} \times \frac{22 \text{ mi}}{\text{gal}}$
- d.  $9 \text{ lb} \times \frac{\$3}{\text{lb}}$
- e.  $13 \text{ min} \times \frac{60 \text{ sec}}{\text{min}}$

## 3 ACTIVITY: Writing a Story

Work with a partner.

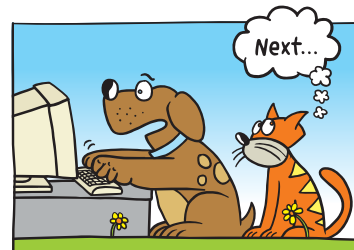
- Think of a story that compares two different rates.
- Write the story.
- Draw pictures for the story.

## What Is Your Answer?

4. **RESEARCH** Use newspapers, the Internet, or magazines to find examples of salaries. Try to find examples of each of the following ways to write salaries.
- a. dollars per hour      b. dollars per month      c. dollars per year
5. **IN YOUR OWN WORDS** How do rates help you describe real-life problems? Give two examples.
6. To estimate the annual salary for a given hourly pay rate, multiply by 2 and insert "000" at the end.

**Sample:** \$10 per hour is about \$20,000 per year.

- a. Explain why this works. Assume the person is working 40 hours a week.
- b. Estimate the annual salary for an hourly pay rate of \$8 per hour.
- c. You earn \$1 million per month. What is your annual salary?
- d. Why is the cartoon funny?



"We had someone apply for the job. He says he would like \$1 million a month, but will settle for \$8 an hour."

### Practice

Use what you discovered about ratios and rates to complete Exercises 7–10 on page 102.

# 3.1 Lesson

## Key Vocabulary

ratio, p. 100  
rate, p. 100  
unit rate, p. 100

A **ratio** is a comparison of two quantities using division.

$$\frac{3}{4}, 3 \text{ to } 4, 3:4$$

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

$$\frac{60 \text{ miles}}{2 \text{ hours}}$$

A rate with a denominator of 1 is called a **unit rate**.

$$\frac{30 \text{ miles}}{1 \text{ hour}}$$

## EXAMPLE 1 Finding Ratios and Rates

There are 45 males and 60 females in a subway car. The subway car travels 2.5 miles in 5 minutes.

- Find the ratio of males to females.
- Find the speed of the subway car.

a.  $\frac{\text{males}}{\text{females}} = \frac{45}{60} = \frac{3}{4}$

∴ The ratio of males to females is  $\frac{3}{4}$ .

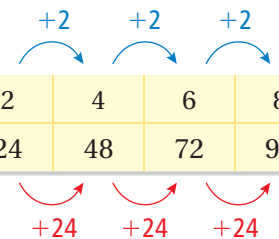
b.  $2.5 \text{ miles in } 5 \text{ minutes} = \frac{2.5 \text{ mi}}{5 \text{ min}} = \frac{2.5 \text{ mi} \div 5}{5 \text{ min} \div 5} = \frac{0.5 \text{ mi}}{1 \text{ min}}$

∴ The speed is 0.5 mile per minute.

## EXAMPLE 2 Finding a Rate from a Table

The table shows the amount of money you can raise by walking for a charity. Find your unit rate in dollars per mile.

Distance (miles)	2	4	6	8
Money (dollars)	24	48	72	96



Use the table to find the unit rate.

$$\begin{aligned} \frac{\text{change in money}}{\text{change in distance}} &= \frac{\$24}{2 \text{ mi}} \\ &= \frac{\$12}{1 \text{ mi}} \end{aligned}$$

The money raised increases by \$24 every 2 miles.

Simplify.

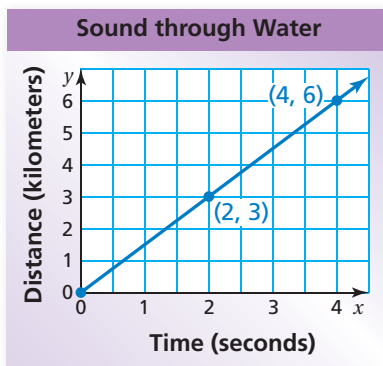
∴ Your unit rate is \$12 per mile.

### On Your Own

- In Example 1, find the ratio of females to males.
- In Example 1, find the ratio of females to total passengers.
- The table shows the distance that the International Space Station travels while orbiting Earth. Find the speed in miles per second.

Time (seconds)	3	6	9	12
Distance (miles)	14.4	28.8	43.2	57.6

### EXAMPLE 3 Finding a Rate from a Line Graph



The graph shows the distance that sound travels through water. Find the speed of sound in kilometers per second.

**Step 1:** Choose a point on the line.

The point (2, 3) shows you that sound travels 3 kilometers in 2 seconds.

**Step 2:** Find the speed.

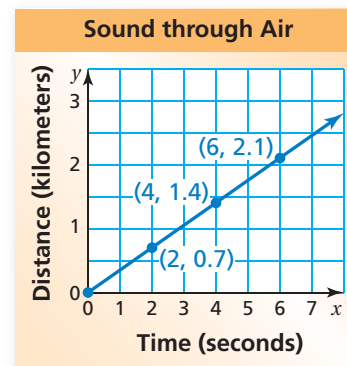
$$\frac{\text{distance traveled}}{\text{elapsed time}} = \frac{3 \text{ kilometers}}{2 \text{ seconds}}$$

$$= \frac{1.5 \text{ km}}{1 \text{ sec}} \quad \text{Simplify.}$$

∴ The speed is 1.5 kilometers per second.

### On Your Own

- WHAT IF?** In Example 3, you use the point (4, 6) to find the speed. Does your answer change? Why or why not?
- The graph shows the distance that sound travels through air. Find the speed of sound in kilometers per second.
- Does sound travel faster in water or in air? Explain.



# 3.1 Exercises

## Vocabulary and Concept Check

- VOCABULARY** How can you tell when a rate is a unit rate?
- WRITING** Why do you think rates are usually written as unit rates?
- OPEN-ENDED** Write a real-life rate that applies to you.

Estimate the unit rate.

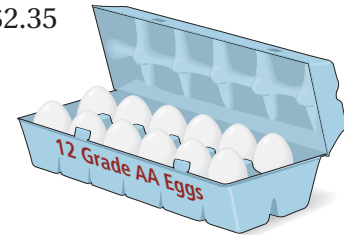
4. \$74.75



5. \$1.19



6. \$2.35



## Practice and Problem Solving

Find the product. List the units.

7.  $8 \text{ h} \times \frac{\$9}{\text{h}}$

8.  $8 \text{ lb} \times \frac{\$3.50}{\text{lb}}$

9.  $14 \text{ sec} \times \frac{60 \text{ MB}}{\text{sec}}$

10.  $6 \text{ h} \times \frac{19 \text{ mi}}{\text{h}}$

Write the ratio as a fraction in simplest form.

11. 25 to 45

12. 63 : 28

13. 35 girls : 15 boys

14. 2 feet : 8 feet

15. 16 dogs to 12 cats

16. 51 correct : 9 incorrect

Find the unit rate.

17. 180 miles in 3 hours

18. 256 miles per 8 gallons

19. \$9.60 for 4 pounds

20. \$4.80 for 6 cans

21. 297 words in 5.5 minutes

22. 54 meters in 2.5 hours

Use the table to find the rate.

23.

Servings	0	1	2	3
Calories	0	90	180	270

24.

Days	0	1	2	3
Liters	0	1.6	3.2	4.8

25.

Packages	3	6	9	12
Servings	13.5	27	40.5	54

26.

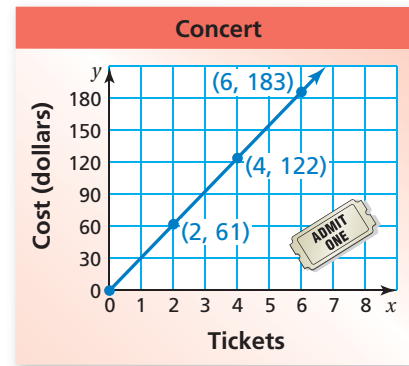
Years	2	6	10	14
Feet	7.2	21.6	36	50.4

27. **DOWNLOAD** At 1 P.M., you have 24 megabytes of a movie. At 1:15 P.M., you have 96 megabytes. What is the download rate in megabytes per minute?

28. **POPULATION** In 2000, the U.S. population was 281 million people. In 2008, it was 305 million. What was the rate of population change per year?

29. **TICKETS** The graph shows the cost of buying tickets to a concert.

- What does the point (4, 122) represent?
- What is the unit rate?
- What is the cost of buying 10 tickets?



30. **CRITICAL THINKING** Are the two statements equivalent? Explain your reasoning.

- The ratio of boys to girls is 2 to 3.
- The ratio of girls to boys is 3 to 2.

31. **TENNIS** A sports store sells three different packs of tennis balls. Which pack is the best buy? Explain.



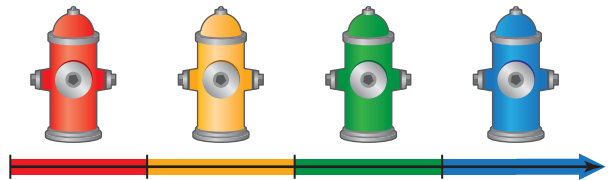
Beverage	Serving Size	Calories	Sodium
Whole milk	1 cup	146	98 mg
Orange juice	1 pt	210	10 mg
Apple juice	24 fl oz	351	21 mg

32. **NUTRITION** The table shows nutritional information for three beverages.

- Which has the most calories per fluid ounce?
- Which has the least sodium per fluid ounce?

33. **Open-Ended** Fire hydrants are painted four different colors to indicate the rate at which water comes from the hydrant.

- RESEARCH** Use the Internet to find the ranges of the rates for each color.
- Research why a firefighter needs to know the rate at which water comes out of the hydrant.



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

Plot the ordered pair in a coordinate plane.

34.  $A(-5, -2)$

35.  $B(-3, 0)$

36.  $C(-1, 2)$

37.  $D(1, 4)$

38. **MULTIPLE CHOICE** Which fraction is greater than  $-\frac{2}{3}$  and less than  $-\frac{1}{2}$ ?

(A)  $-\frac{3}{4}$

(B)  $-\frac{7}{12}$

(C)  $-\frac{5}{12}$

(D)  $-\frac{3}{8}$