# 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.

Snorkel Rentals
$8.75 per hour

Snorkel Rentals
$7.25 per hour

### 1  ACTIVITY: Finding Reasonable Rates

**Work with a partner.**

a. Match each description with a verbal rate.

b. Match each verbal rate with a numerical rate.

c. Give a reasonable numerical rate for each description. Then give an unreasonable rate.

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

## 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:** $6 \text{ h} \times \dfrac{\$12}{\text{h}} = 6\cancel{h} \times \dfrac{\$12}{\cancel{h}}$     Divide out "hours."

$$= \$72 \qquad \text{Multiply. Answer is in dollars.}$$

b. $6 \text{ mo} \times \dfrac{\$700}{\text{mo}}$          c. $10 \text{ gal} \times \dfrac{22 \text{ mi}}{\text{gal}}$

d. $9 \text{ lb} \times \dfrac{\$3}{\text{lb}}$          e. $13 \text{ min} \times \dfrac{60 \text{ sec}}{\text{min}}$

## 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."

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

**Practice**

## 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.**

**a. Find the ratio of males to females.**

**b. Find the speed of the subway car.**

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

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

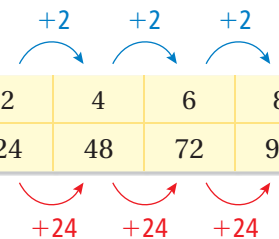**b.** $2.5 \text{ miles in 5 minutes} = \dfrac{2.5 \text{ mi}}{5 \text{ min}} = \dfrac{2.5 \text{ mi} \div 5}{5 \text{ min} \div 5} = \dfrac{0.5 \text{ mi}}{1 \text{ min}}$

∴ 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.**

|  | +2 | +2 | +2 |  |
|---|---|---|---|---|
| **Distance (miles)** | 2 | 4 | 6 | 8 |
| **Money (dollars)** | 24 | 48 | 72 | 96 |
|  | +24 | +24 | +24 |  |

Use the table to find the unit rate.

$\dfrac{\text{change in money}}{\text{change in distance}} = \dfrac{\$24}{2 \text{ mi}}$   The money raised increases by \$24 every 2 miles.

$\phantom{\dfrac{\text{change in money}}{\text{change in distance}}} = \dfrac{\$12}{1 \text{ mi}}$   Simplify.

∴ Your unit rate is \$12 per mile.

Multi-Language Glossary at BigIdeasMath.com.

## On Your Own

**1.** In Example 1, find the ratio of females to males.

**2.** In Example 1, find the ratio of females to total passengers.

**3.** 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**
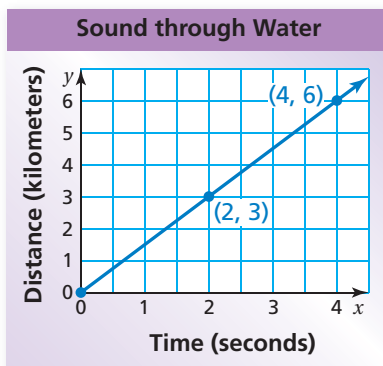
**The graph shows the distance that sound travels through water. Find the speed of sound in kilometers per second.**

**Sound through Water**



**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.

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

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

∴ The speed is 1.5 kilometers per second.

## On Your Own

**4.** **WHAT IF?** In Example 3, you use the point (4, 6) to find the speed. Does your answer change? Why or why not?

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

**6.** Does sound travel faster in water or in air? Explain.

**Sound through Air**
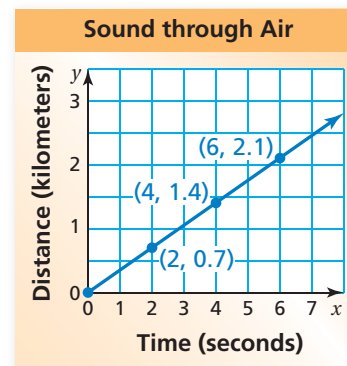
### ✓ Vocabulary and Concept Check

1. **VOCABULARY** How can you tell when a rate is a unit rate?

2. **WRITING** Why do you think rates are usually written as unit rates?

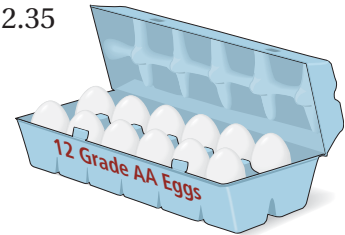3. **OPEN-ENDED** Write a real-life rate that applies to you.

**Estimate the unit rate.**

4. $74.75

Gloss White
PAINT
5 gal

5. $1.19

GRAPE JUICE
12 fl oz

6. $2.35

12 Grade AA Eggs

### Practice and Problem Solving

**Find the product. List the units.**

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

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

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

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

**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.

  **a.** What does the point (4, 122) represent?

  **b.** What is the unit rate?

  **c.** What is the cost of buying 10 tickets?
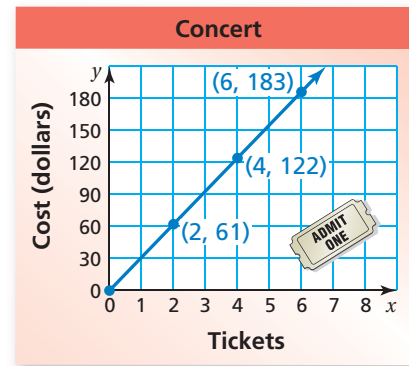
**30.** **CRITICAL THINKING** Are the two statements equivalent? Explain your reasoning.

  • 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.

  **a.** Which has the most calories per fluid ounce?

  **b.** 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.

  **a.** **RESEARCH** Use the Internet to find the ranges of the rates for each color.

  **b.** Research why a firefighter needs to know the rate at which water comes out of the hydrant.
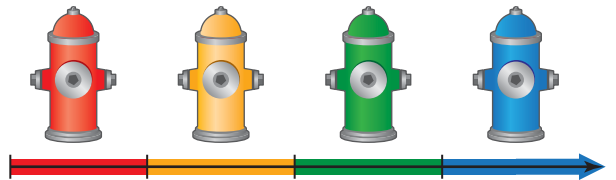
**Fair Game Review** What you learned in previous grades & lessons

**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 $-\frac{1}{2}$?

     Ⓐ $-\frac{3}{4}$          Ⓑ $-\frac{7}{12}$          Ⓒ $-\frac{5}{12}$          Ⓓ $-\frac{3}{8}$