### 3.1 Ratios and Rates

STATE STANDARDS

MA.7.A.1. 4

## 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 ACJIVIJY: 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

Your pay rate for washing cars

The average rainfall rate of Tampa

Your average driving rate from Miami to Key West

The growth rate for the length of a baby alligator

Your running rate in a 100-meter dash

The population growth rate of Naples

The average pay rate for an Orlando Magic player

The fertilization rate for an orange grove

Verbal Rate
inches per month
pounds per acre
meters per second
people per year
dollars per hour
dollars per year
miles per hour
inches per year

Numerical Rate




## 2 ACTIVIJY: 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: $6 \mathrm{~h} \times \frac{\$ 12}{\mathrm{~h}}=6 \mathrm{~h} \times \frac{\$ 12}{\underline{h}} \quad$ Divide out "hours."

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

b. $6 \mathrm{mo} \times \frac{\$ 700}{\mathrm{mo}}$
c. $10 \mathrm{gal} \times \frac{22 \mathrm{mi}}{\mathrm{gal}}$
d. $9 \mathrm{lb} \times \frac{\$ 3}{\mathrm{lb}}$
e. $13 \min \times \frac{60 \mathrm{sec}}{\min }$

## 3 ACTIVIJY: 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.

## Key Vocabulary ${ }^{\text {D }}$ )

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

A ratio is a comparison of two quantities using division.
$\frac{3}{4}, 3$ 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 car on the Miami Metrorail. The Metrorail travels 2.5 miles in 5 minutes.
a. Find the ratio of males to females.
b. Find the speed of the Metrorail.
a. $\frac{\text { males }}{\text { females }}=\frac{45}{60}=\frac{3}{4}$
$\therefore$ - The ratio of males to females is $\frac{3}{4}$.
b. 2.5 miles in 5 minutes $=\frac{2.5 \mathrm{mi}}{5 \mathrm{~min}}=\frac{2.5 \mathrm{mi} \div 5}{5 \mathrm{~min} \div 5}=\frac{0.5 \mathrm{mi}}{1 \mathrm{~min}}$
$\therefore$ The speed is 0.5 mile per minute.

## EXAMPLE

## 2 Finding a Rate from a Jable

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


Use the table to find the unit rate.

$$
\begin{aligned}
\frac{\text { change in money }}{\text { change in distance }} & =\frac{\$ 24}{2 \mathrm{mi}} \quad \text { The money raised increases by } \$ 24 \text { every } 2 \text { miles. } \\
& =\frac{\$ 12}{1 \mathrm{mi}} \quad \text { Simplify. }
\end{aligned}
$$

$\because$ Your unit rate is $\$ 12$ per mile.

## 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

## Sound through Water



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.

$$
\begin{aligned}
\frac{\text { distance traveled }}{\text { elapsed time }} & =\frac{3}{2} \leftarrow \text { kilometers } \\
& =\frac{1.5 \mathrm{~km}}{1 \mathrm{sec}} \quad \text { seconds }
\end{aligned}
$$

$\therefore$ 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


### 3.1 Exercises

## (V) 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. $\$ 74.75$

5. $\$ 1.19$

6. $\$ 2.35$

com

## Practice and Problem Solving

Find the product. List the units.
7. $8 \mathrm{~h} \times \frac{\$ 9}{\mathrm{~h}}$
8. $8 \mathrm{lb} \times \frac{\$ 3.50}{\mathrm{lb}}$
9. $14 \mathrm{sec} \times \frac{60 \mathrm{MB}}{\mathrm{sec}}$
10. $6 \mathrm{~h} \times \frac{19 \mathrm{mi}}{\mathrm{h}}$

## Write the ratio as a fraction in simplest form.

(1)
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 2002, the population of Florida was 16.7 million people. In 2007, it was 18.3 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 <br> 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-Endeak 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.
SECTION 1.6
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 $-\frac{1}{2}$ ?

SECTION 2.1
(A) $-\frac{3}{4}$
(B) $-\frac{7}{12}$
(C) $-\frac{5}{12}$
(D) $-\frac{3}{8}$

