4.3 Rates and Unit Rates

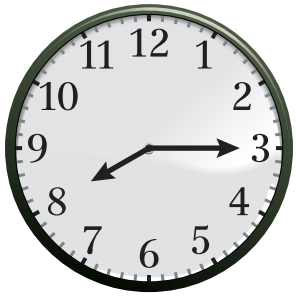
Learning Target: Understand rates involving fractions and use unit rates to solve problems.

Success Criteria:
- I can find unit rates for rates involving fractions.
- I can use unit rates to solve rate problems.

Exploration 1 Writing Rates

Work with a partner.

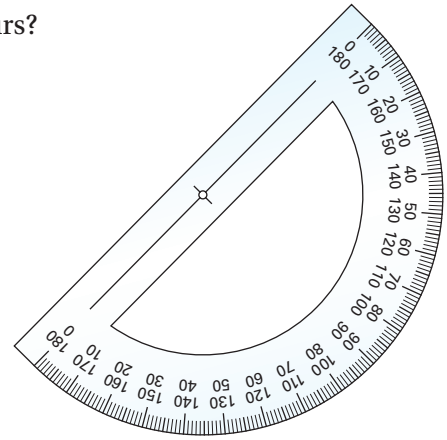
a. How many degrees does the minute hand on a clock move every 15 minutes? Write a rate that compares the number of degrees moved by the minute hand to the number of hours elapsed.



b. Can you use the rate in part (a) to determine how many degrees the minute hand moves in $\frac{1}{2}$ hour? Explain your reasoning.

c. Write a rate that represents the number of degrees moved by the minute hand every hour. How can you use this rate to find the number of degrees moved by the minute hand in $2\frac{1}{2}$ hours?

d. Draw a clock with hour and minute hands. Draw another clock that shows the time after the minute hand moves 900°. How many degrees does the hour hand move in this time? in one hour? Explain your reasoning.



4 MTR COMPARE METHODS

When could you use a protractor to find the number of degrees the minute hand moves? When would you need to use a rate?

Algebraic Reasoning

MA.7.AR.4.4 Given any representation of a proportional relationship, translate the representation to a written description, table or equation.

MA.7.AR.4.5 Solve real-world problems involving proportional relationships.

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4.3 Lesson

Key Vocabulary
rate, *p. 182*
unit rate, *p. 182*
equivalent rates, *p. 182*

Key Ideas

Rates and Unit Rates

Words A **rate** is a ratio of two quantities using different units. A **unit rate** compares a quantity to one unit of another quantity. **Equivalent rates** have the same unit rate.

Numbers You pay \$350 for every $\frac{1}{4}$ ounce of gold.

\$350	\$350	\$350	\$350

Rate: \$350 : $\frac{1}{4}$ oz

$\frac{1}{4}$ oz	$\frac{1}{4}$ oz	$\frac{1}{4}$ oz	$\frac{1}{4}$ oz

Unit Rate: \$1400 : 1 oz

Algebra Rate: a units : b units Unit rate: $\frac{a}{b}$ units : 1 unit

Example 1 Finding Unit Rates

A nutrition label shows that every $\frac{1}{4}$ cup of tuna has $\frac{1}{2}$ gram of fat.

a. How many grams of fat are there for every cup of tuna?

There is $\frac{1}{2}$ gram of fat for every $\frac{1}{4}$ cup of tuna. Find the unit rate.

▶ There are $\frac{\frac{1}{2}}{\frac{1}{4}} = 2$ grams of fat for every cup of tuna.

$\frac{1}{4}$ c	$\frac{1}{4}$ c	$\frac{1}{4}$ c	$\frac{1}{4}$ c
$\frac{1}{2}$ g	$\frac{1}{2}$ g	$\frac{1}{2}$ g	$\frac{1}{2}$ g

b. How many cups of tuna are there for every gram of fat?

There is $\frac{1}{4}$ cup of tuna for every $\frac{1}{2}$ gram of fat. Find the unit rate.

▶ There is $\frac{\frac{1}{4}}{\frac{1}{2}} = \frac{1}{2}$ cup of tuna per gram of fat.

Try It

1. There is $\frac{1}{4}$ gram of fat for every $\frac{1}{3}$ tablespoon of powdered peanut butter. How many grams of fat are there for every tablespoon of the powder?

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Example 2 Using a Unit Rate to Solve a Rate Problem

A scientist estimates that a jet of liquid iron in the Earth's core travels 9 feet every $\frac{1}{2}$ hour. How far does the liquid iron travel in 1 day?

The ratio of feet to hours is $9 : \frac{1}{2}$. Using a ratio table, divide the quantity by $\frac{1}{2}$ to find the unit rate in feet per hour. Then multiply each quantity by 24 to find the distance traveled in 24 hours, or 1 day.

$\times 2$ $\times 24$

Distance (feet)	9	18	432
Time (hours)	$\frac{1}{2}$	1	24

$\times 2$ $\times 24$

▶ So, the liquid iron travels about 432 feet in 1 day.

Try It

2. WHAT IF? The scientist later says that the iron travels 3 feet every 10 minutes. Does this change your answer in Example 2? Explain.

In-Class Practice

1 I don't understand yet. 2 I can do it with help. 3 I can do it on my own. 4 I can teach someone else.

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

4. WRITING Explain why rates are usually written as unit rates.

Find the unit rate.

5. \$1.32 for 12 ounces

6. $\frac{1}{4}$ gallon for every $\frac{3}{10}$ mile

7. FINDING UNIT RATES Find the missing values in the ratio table. Then write the unit rate of grams per cup and the unit rate of cups per gram.

Grams	$\frac{5}{2}$		1	$\frac{15}{4}$	
Cups	$\frac{2}{3}$	$\frac{1}{6}$			4

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Example 3 Modeling Real Life

You hike up a mountain trail at a rate of $\frac{1}{4}$ mile every 10 minutes. You hike 5 miles every 2 hours on the way down the trail. How much farther do you hike in 3 hours on the way down than in 3 hours on the way up?

Because 10 minutes is $\frac{1}{6}$ of an hour, the ratio of miles to hours on the way up is $\frac{1}{4} : \frac{1}{6}$. On the way down, the ratio is 5 : 2. Use ratio tables to find how far you hike in 3 hours at each rate.

Find the unit rate for each part of the hike.

Find the distance you hike in 3 hours on each part of the hike.

Hiking Up	
Distance (miles)	Time (hours)
$\frac{1}{4}$	$\frac{1}{6}$
$\frac{3}{2}$	1
$\frac{9}{2}$	3

Hiking Down	
Distance (miles)	Time (hours)
5	2
$\frac{5}{2}$	1
$\frac{15}{2}$	3

▶ So, you hike $\frac{15}{2} - \frac{9}{2} = \frac{6}{2} = 3$ miles farther in 3 hours on the way down than you hike in 3 hours on the way up.

Check Your rate on the way down is $\frac{5}{2} - \frac{3}{2} = \frac{2}{2} = 1$ mile per hour faster than your rate on the way up. So, you hike 3 miles farther in 3 hours on the way down than you hike in 3 hours on the way up. ✓

In-Class Practice

1 I don't understand yet. 2 I can do it with help. 3 I can do it on my own. 4 I can teach someone else.

8. Two people compete in a five-mile go-kart race. Person A travels $\frac{1}{10}$ mile every 15 seconds. Person B travels $\frac{3}{8}$ mile every 48 seconds. Who wins the race? What is the difference of the finish times of the competitors?

9. **Dig Deeper** A bus travels 0.8 mile east every 45 seconds. A second bus travels 0.55 mile west every 30 seconds. The buses start at the same location. Use two methods to determine how far apart the buses are after 15 minutes. Explain your reasoning.

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4.3 Practice WITH CalcChat® AND CalcView®

Review & Refresh

Represent the ratio relationship using a graph.

1.

Push-Ups	5	10	15
Sit-Ups	10	20	30

2.

Texts Sent	4	8	12
Texts Received	3	6	9

3.

Seeds	15	30	45
Plants	12	24	36

4.

Run (minutes)	6	12	18
Walk (minutes)	2	4	6

Copy and complete the statement using <, >, or =.

5. $\frac{9}{2} \square \frac{8}{3}$ **6.** $-\frac{8}{15} \square \frac{10}{18}$ **7.** $\frac{-6}{24} \square \frac{-2}{8}$

Concepts, Skills, & Problem Solving

WRITING RATES Find the number of degrees moved by the minute hand of a clock in the given amount of time. Explain your reasoning. (See Exploration 1.)

8. $\frac{2}{3}$ hour **9.** $\frac{7}{12}$ hour **10.** $1\frac{1}{4}$ hours

FINDING UNIT RATES Find the unit rate. (See Example 1.)

11. 180 miles in 3 hours

12. 256 miles per 8 gallons

▶ **13.** $\frac{1}{2}$ pound : 5 days

14. 4 grams for every $\frac{3}{4}$ serving

15. \$9.60 for 4 pounds

16. \$4.80 for 6 cans

17. 297 words in 5.5 minutes

18. $\frac{1}{3}$ kilogram : $\frac{2}{3}$ foot

19. $\frac{5}{8}$ ounce per $\frac{1}{4}$ pint

20. $21\frac{3}{4}$ meters in $2\frac{1}{2}$ hours

USING TOOLS Find the missing values in the ratio table. Then write the equivalent ratios.

21.

Calories	25	50		
Servings	$\frac{1}{3}$		1	$\frac{4}{3}$

22.

Oxygen (liters)	4	$\frac{4}{3}$		16
Time (minute)	$\frac{3}{4}$		1	

7 MTR ▶ **23. MODELING REAL LIFE** You can sand $\frac{4}{9}$ square yard of wood in $\frac{1}{2}$ hour. How many square yards can you sand in 3.2 hours? Justify your answer. (See Example 2.)

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24. PROBLEM SOLVING In January 2012, the U.S. population was about 313 million people. In January 2017, it was about 324 million. What was the average rate of population change per year?

REASONING Tell whether the rates are equivalent. Justify your answer.

25. 75 pounds per 1.5 years

38.4 ounces per 0.75 year

26. $7\frac{1}{2}$ miles for every $\frac{3}{4}$ hour

$\frac{1}{2}$ mile for every 3 minutes

27. PROBLEM SOLVING The table shows nutritional information for three beverages.

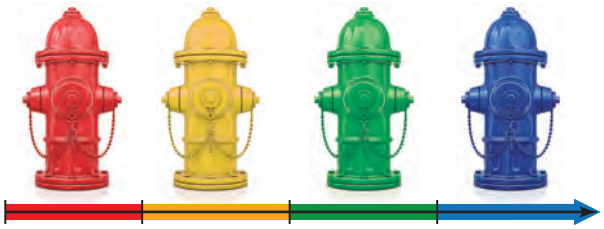
Beverage	Serving Size	Calories	Sodium
Whole milk	1 c	146	98 mg
Orange juice	1 pt	210	10 mg
Apple juice	24 fl oz	351	21 mg

a. Which has the most calories per fluid ounce?

b. Which has the least sodium per fluid ounce?

7 MTR **28. MODELING REAL LIFE** A shuttle leaving Earth's atmosphere travels 15 miles every 2 seconds. When entering Earth's atmosphere, the shuttle travels $2\frac{3}{8}$ miles per $\frac{1}{2}$ second. Find the difference in the distances traveled after 15 seconds when leaving and entering the atmosphere. (See Example 3.)

7 MTR **29. INVESTIGATE** Fire hydrants are one of four different colors to indicate the rate at which water comes from the hydrant.



a. Use the Internet to find the ranges of rates indicated by each color.

b. Research why a firefighter needs to know the rate at which water comes out of a hydrant.

30. Dig Deeper You and a friend start riding bikes toward each other from opposite ends of a 24-mile biking route. You ride $2\frac{1}{6}$ miles every $\frac{1}{4}$ hour. Your friend rides $7\frac{1}{3}$ miles per hour.

a. After how many hours do you meet?

b. When you meet, who has traveled farther? How much farther?