

### Solve & Discuss It!

Allison and her classmates planted bean seeds at the same time as Yuki and her classmates in Tokyo did. Allison is video-chatting with Yuki about their class seedlings. Assume that both plants will continue to grow at the same rate. Who should expect to have the taller plant at the end of the school year?



**Allison's Class**  
2.5 inches  
in 5 days



**Yuki's Class**  
5.5 centimeters  
in 4 days

**Look for Relationships**  
How can you compare the growth rates of the seedlings?

### Lesson 2-2

#### Determine Unit Rates with Ratios of Fractions

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**I can...**  
find unit rates with ratios of fractions and use them to solve problems.

**Focus on math practices**

**Be Precise** What must the students do before they can compare the heights of the plants?

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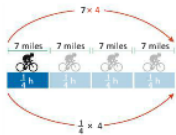
**Essential Question** Why is it useful to write a ratio of fractions as a unit rate?

**EXAMPLE 1** Find a Unit Rate Involving Unit Fractions

Sergio is training for a triathlon. His target speed is 25 miles per hour. Did he achieve his target speed for the first 7 miles of his ride?

**Reasoning** You can use a unit rate to describe Sergio's cycling speed.

You know that 15 minutes is equal to  $\frac{1}{4}$  hour. Draw a diagram to show how the distance Sergio bikes is related to the time he bikes.



Make a table of equivalent ratios to find the unit rate.

Miles	7	28
Hour	$\frac{1}{4}$	1

Sergio bikes  $\frac{28 \text{ miles}}{1 \text{ hour}}$  or 28 miles per hour, so he has achieved, and exceeded, his target speed.

**Try It!**

Sergio increases his target speed to 30 miles per hour. How many more miles does Sergio need to ride in  $\frac{1}{4}$  hour to achieve this target speed?

Miles	<input type="text"/>	30
Hour	$\frac{1}{4}$	1

Sergio must ride  miles in  $\frac{1}{4}$  hour to achieve this target speed, so he needs to ride an additional  mile per  $\frac{1}{4}$  hour.

**Convince Me!** How does the unit rate describe Sergio's cycling speed? How is the unit rate helpful in determining how much farther Sergio must cycle in a given amount of time each time he increases his target speed?

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**EXAMPLE 2** Find and Apply a Unit Rate Involving Fractions

Bronwyn mows the lawn every other weekend. She can mow 12,000 ft<sup>2</sup> in  $\frac{2}{3}$  hour. The lawn is 36,000 ft<sup>2</sup>. How long does it take her to mow the entire lawn?

$$\frac{12,000}{\frac{2}{3}} = \frac{12,000 \times \frac{3}{2}}{1} = \frac{18,000}{1} \text{ ft}^2$$

$$\frac{18,000 \times 2}{1 \times 2} = \frac{36,000}{2}$$

Multiply each term by 2 for the area of the entire lawn.

Bronwyn mows at a rate of 18,000 ft<sup>2</sup> per hour. It takes her 2 hours to mow the entire lawn.

**Look for Relationships** How do the operations used in the table relate to the operations used in the equations at the left?

Area (ft <sup>2</sup> )	12,000	18,000	36,000
Time (h)	$\frac{2}{3}$	$\frac{6}{6}$ or 1	2

**Try It!**

Every other weekend, Bronwyn's brother Daniel mows the lawn. He can mow 15,000 ft<sup>2</sup> in  $\frac{3}{4}$  hour. Who mows the lawn in less time? Explain.

**EXAMPLE 3** Solve Problems Using Unit Rates

Omar knows that his friend Chris lives  $\frac{3}{4}$  mile away. How far is the school from his house?

$$\frac{\frac{3}{4} \text{ mi}}{\frac{3}{4} \text{ in.}} = \frac{\frac{3}{4} \text{ mi} \times \frac{4}{3}}{\frac{3}{4} \text{ in.} \times \frac{4}{3}} = \frac{1 \text{ mi}}{1 \text{ in.}}$$

Divide both terms by  $\frac{3}{4}$  to find the unit rate.

$$\frac{4}{5} \text{ mi} \times 2 = \frac{8}{5} \text{ mi} = 1\frac{3}{5} \text{ mi}$$

$$\frac{1 \text{ in.} \times 2}{2 \text{ in.}} = \frac{2}{2} \text{ in.}$$

Multiply both terms of the unit rate by 2 to find an equivalent rate.

Omar's school is  $1\frac{3}{5}$  miles from his house.



**Try It!**

Sonoma bikes 5 miles to Paige's house. On a map, they measure that distance as  $\frac{5}{8}$  cm. The same map shows that the mall is  $3\frac{1}{2}$  cm from Paige's house. What is the actual distance between Paige's house and the mall?

**KEY CONCEPT**

You can use what you know about equivalent ratios and operations with fractions to write a ratio of fractions as a unit rate.

Tia skateboards  $\frac{2}{3}$  mile for every  $\frac{1}{6}$  hour.

$$\frac{\frac{2}{3}}{\frac{1}{6}} = \frac{\frac{2}{3} \times \frac{6}{6}}{\frac{1}{6} \times \frac{6}{6}} = \frac{4}{1} = 4$$

She skateboards 4 miles per hour.

Miles	$\frac{2}{3}$	4
Hours	$\frac{1}{6}$	1

**Do You Understand?**

- Essential Question** Why is it useful to write a ratio of fractions as a unit rate?
- Use Structure** Jacob mixes  $\frac{1}{3}$  cup of yellow paint for every  $\frac{1}{5}$  cup of blue paint to make green paint. How many cups of yellow paint are needed for 1 cup of blue paint? Complete the table below.

Cups of Yellow Paint	$\frac{1}{3}$	
Cups of Blue Paint	$\frac{1}{5}$	1

- Construct Arguments** How is making a table of equivalent ratios to find the unit rate similar to finding the unit rate by calculating with fractions? Use a specific example to explain your reasoning.

**Do You Know How?**

- Claire boarded an airplane in Richmond, VA, and flew 414 miles directly to Charleston, SC. The total flight time was  $\frac{3}{4}$  hour. How fast did Claire's airplane fly, in miles per hour?

- Brad buys two packages of mushrooms. Which mushrooms cost less per pound? Explain.



- Jed is baking shortbread for a bake sale. The recipe calls for  $1\frac{1}{4}$  cups of flour and  $\frac{1}{2}$  stick of butter. How many cups of flour will Jed need if he uses 3 sticks of butter?

$\frac{3}{4} \div \frac{1}{8} \rightarrow \frac{3}{4} \times \frac{8}{1} \rightarrow \frac{6}{1} = 6$

**Practice & Problem Solving**  
 Leveled Practice In 7-10, find the unit rate.

7. 

Cups of Sugar	3	6
Cups of Butter	1	1

 6 cups of sugar for each cup of butter

8. 

Miles	14	3
Hours	1	3

 $\frac{14}{5} \text{ miles per hour}$

10.  $\frac{3}{5}$  page in 2 minutes  
 page in 1 minute

12. Hadley paddled a canoe  $\frac{2}{3}$  mile in  $\frac{1}{4}$  hour. How fast did Hadley paddle, in miles per hour?  
 see notes

12. A box of cereal states that there are 90 Calories in a  $\frac{3}{4}$ -cup serving. How many Calories are there in 4 cups of the cereal?  
 $5 \overline{) 90} \begin{array}{r} 18 \\ - 90 \\ \hline 0 \end{array}$

13. A robot can complete 8 tasks in  $\frac{5}{6}$  hour. Each task takes the same amount of time.  
 a. How long does it take the robot to complete one task?  
 reciprocal of  $\frac{48}{5} \rightarrow \frac{5}{48}$  hr to complete one task.  
 b. How many tasks can the robot complete in one hour?  
 $\frac{8 \text{ tasks}}{\frac{5}{6} \text{ hr}} \rightarrow 8 \div (\frac{5}{6})$   
 $\frac{8}{1} \times \frac{6}{5}$   
 The robot would take  $\frac{5}{48}$  hr to complete one task.  
 The robot can complete  $9\frac{3}{5}$  tasks per hour.  
 $\frac{48}{5} = 5 \overline{) 48} \begin{array}{r} 9 \\ - 45 \\ \hline 3 \end{array}$

11)  $\frac{\frac{2}{3} \text{ mi}}{\frac{1}{4} \text{ hr}}$  mph?

$\frac{2}{3} \div (\frac{1}{4})$

$\frac{2}{3} \times \frac{4}{1}$

$\frac{8}{3} = 3 \overline{) 8} \begin{array}{r} 2 \\ - 6 \\ \hline 2 \end{array} \frac{2}{3} \text{ mph}$

Hadley paddled  $2\frac{2}{3}$  mph.

14. You are running a fuel economy study. You want to find out which car can travel a greater distance on 1 gallon of gas.
- What is the gas mileage, in miles per gallon, for the blue car?
  - What is the gas mileage, in miles per gallon, for the silver car?
  - Which car could travel the greater distance on 1 gallon of gas?

15. Henry incorrectly said the rate  $\frac{4 \text{ pound}}{20 \text{ quart}}$  can be written as the unit rate  $\frac{1}{5}$  pound per quart.
- What is the correct unit rate?
  - Critique Reasoning** What error did Henry likely make?

4 lb/quart  
Henry likely forgot to flip the second fraction before multiplying.

16. **Higher Order Thinking** Ari walked  $2\frac{1}{2}$  miles at a constant speed of  $2\frac{1}{2}$  miles per hour. Beth walked  $1\frac{1}{2}$  miles at a constant speed of  $1\frac{1}{4}$  miles per hour. Cindy walked for 1 hour and 21 minutes at a constant speed of  $1\frac{1}{8}$  miles per hour. List the three people in order of the times they spent walking from least time to greatest time.

$$\frac{1}{5} \div \left(\frac{1}{20}\right)$$

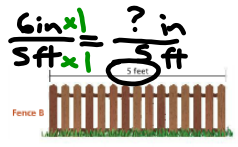
$$\frac{1}{5} \times \frac{20}{1}$$

$$\frac{4 \text{ pound}}{1 \text{ quart}}$$

**Assessment Practice**

17. A blueprint shows a house with two fences. Fence A is  $1\frac{4}{5}$  inches long on the blueprint and is to be  $1\frac{1}{2}$  feet long. How long is Fence B on the blueprint?

see notes



Pages		
Hours	$\frac{1}{3}$	

or  
4 pounds per quart  
or  
4 lb per quart  
or  
4 lb/quart

18. Leo reads 13 pages in  $\frac{1}{3}$  hour. Use the table to find how many pages he reads in one hour. Leo reads  pages in one hour.

Fence B will be  $\frac{6}{5}$  in on the blueprint.

Fence A

17)

$$\frac{1\frac{4}{5} \text{ in}}{1\frac{1}{2} \text{ ft}}$$

$$\frac{1\frac{4}{5}}{1\frac{1}{2}} \div \frac{1\frac{1}{2}}{1\frac{4}{5}}$$

$$\frac{9}{5} \div \left(\frac{3}{2}\right)$$

$$\frac{3 \cdot 9}{5} \times \frac{2}{3}$$

$$\frac{6}{5} \text{ in ft}$$

