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.

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?

Focus on math practices

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

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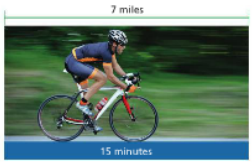
Essential Question Why is it useful to write a ratio of fractions as a unit rate?

EXAMPLE 1 Find a Unit Rate Involving Unit Fractions

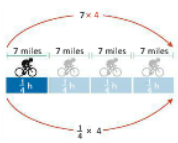
Scan for Multimedia

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

× 4 ↘ ↗ × 4

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	☐	30
Hour	$\frac{1}{4}$	1

÷ ↙ ↘ ÷ 4

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?

EXAMPLE 2 Find and Apply a Unit Rate Involving Fractions

Bronwyn mows the lawn every other weekend. She can mow 12,000 ft^2 in $\frac{2}{3}$ hour. The lawn is 36,000 ft^2.

How long does it take her to mow the entire lawn?

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

$\frac{18{,}000 \times 2}{1 \times 2} = \frac{36{,}000}{2}$ Multiply each term by 2 for the area of the entire lawn.

Bronwyn mows at a rate of 18,000 ft^2 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^2)	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^2 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 $\frac{3}{5}$ mile away. How far is the school from his house?

$\frac{\frac{3}{5} \text{ mi}}{\frac{3}{4} \text{ in.}} = \frac{\frac{3}{5} \times \frac{4}{3}}{\frac{3}{4} \times \frac{4}{3}} = \frac{\frac{4}{5} \text{ mi}}{1 \text{ in.}}$ Divide both terms by $\frac{3}{4}$ to find the unit rate.

$\frac{\frac{4}{5} \text{ mi} \times 2}{1 \text{ in.} \times 2} = \frac{\frac{8}{5} \text{ mi}}{2 \text{ in.}} = \frac{1\frac{3}{5} \text{ mi}}{2 \text{ in.}}$ 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 $\frac{5}{6}$ 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.

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

She skateboards 4 miles per hour.

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

Do You Understand?

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

2. **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

3. **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.

Making a table is another way to show that we are dividing the numerator by the denominator. See question #7 for an example.

Do You Know How?

4. 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?

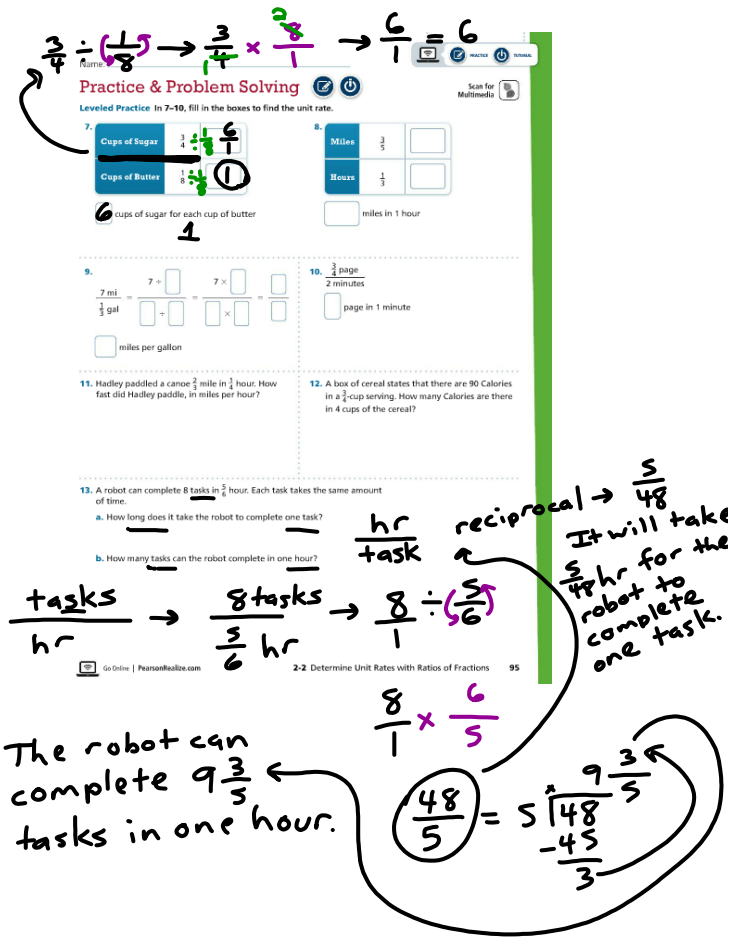
5. Brad buys two packages of mushrooms. Which mushrooms cost less per pound? Explain.

$\$11.25 \div \frac{2}{3} \text{ lb} = \$16.88$ per lb

$\$7.99 \div \frac{1}{2} \text{ lb} = \$15.98$ per lb

The Chanterelle mushrooms are cheaper per lb by $0.90 per lb.

6. 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?



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

$\frac{hr}{task}$ reciprocal $\rightarrow \frac{5}{48}$

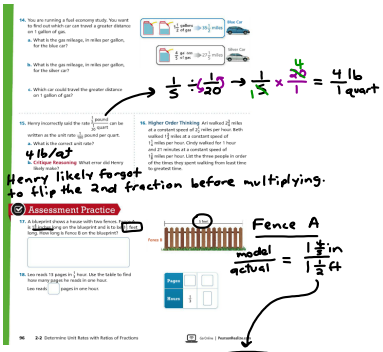
It will take $\frac{5}{48}$ hr for the robot to complete one task.

$\frac{tasks}{hr} \rightarrow \frac{8 tasks}{\frac{5}{6} hr} \rightarrow \frac{8}{1} \div (\frac{5}{6})$

$\frac{8}{1} \times \frac{6}{5}$

$\frac{48}{5} = 5\overline{)48}$ $9\frac{3}{5}$, -45, 3

The robot can complete $9\frac{3}{5}$ tasks in one hour.



$\frac{1\frac{4}{5} in}{1\frac{1}{2} ft} = \frac{? in}{5 ft}$

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

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

$\frac{6}{5} = 5\overline{)6}$ $1\frac{1}{5}$, -5, 1

$\frac{1\frac{1}{5} in \times 5}{1 ft \times 3} = \frac{7 in}{5 ft}$

cross multiply: $\frac{6}{5} = \frac{x}{5}$, $6 \cdot x = 5 \cdot 5$

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

$\frac{6}{15} \times \frac{5}{1}$ cross cancel

$\frac{6}{1} = 6 in$

The fence for B will be 6in on the blueprint.