5.4 Solving Proportions

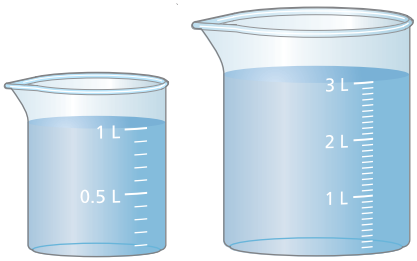
Essential Question How can you use ratio tables and cross products to solve proportions?

1 ACTIVITY: Solving a Proportion in Science

Work with a partner. You can use ratio tables to determine the amount of a compound (like salt) that is dissolved in a solution. Determine the unknown quantity. Explain your procedure.

a. Salt Water

Salt Water	1 L	3 L
Salt	250 g	x g



1 liter 3 liters

$\frac{1\text{ L}}{\square} = \frac{\square}{\square}$ Write proportion.

$1 \cdot \square = \square \cdot \square$ Set cross products equal.

$\square = \square$ Simplify.

∴ There are ☐ grams of salt in the 3-liter solution.

b. White Glue Solution

Water	$\frac{1}{2}$ cup	1 cup
White Glue	$\frac{1}{2}$ cup	x cups

c. Borax Solution

Borax	1 tsp	2 tsp
Water	1 cup	x cups

d. Slime (See recipe.)

Borax Solution	$\frac{1}{2}$ cup	1 cup
White Glue Solution	y cups	x cups

Recipe for SLIME

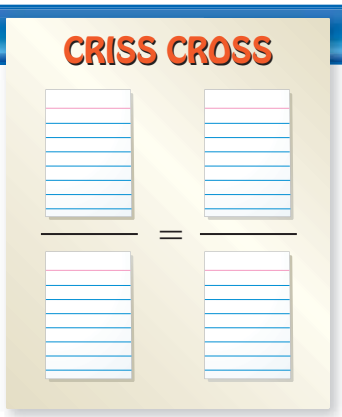
1. Add $\frac{1}{2}$ cup of water and $\frac{1}{2}$ cup white glue. Mix thoroughly. This is your white glue solution.
2. Add a couple drops of food coloring to the white glue solution. Mix thoroughly.
3. Add 1 teaspoon of borax to 1 cup of water. Mix thoroughly. This is your borax solution (about 1 cup).
4. Pour the borax solution and the glue solution into a separate bowl.
5. Place the slime that forms into a plastic bag. Squeeze the mixture repeatedly to mix it up.

Proportions

In this lesson, you will

- solve proportions using multiplication or the Cross Products Property.
- use a point on a graph to write and solve proportions.

2 ACTIVITY: The Game of Criss Cross



Math Practice

Use Operations

How can you use the name of the game to determine which operation to use?

Preparation:

- Cut index cards to make 48 playing cards.
- Write each number on a card.

  1, 1, 1, 2, 2, 2, 3, 3, 3, 4, 4, 4, 5, 5, 5, 6, 6, 6, 7, 7, 7, 8, 8, 8, 9, 9, 9, 10, 10, 10, 12, 12, 12, 13, 13, 13, 14, 14, 14, 15, 15, 15, 16, 16, 16, 18, 20, 25
- Make a copy of the game board.

To Play:

- Play with a partner.
- Deal eight cards to each player.
- Begin by drawing a card from the remaining cards. Use four of your cards to try to form a proportion.
- Lay the four cards on the game board. If you form a proportion, then say "Criss Cross." You earn 4 points. Place the four cards in a discard pile. Now it is your partner's turn.
- If you cannot form a proportion, then it is your partner's turn.
- When the original pile of cards is empty, shuffle the cards in the discard pile. Start again.
- The first player to reach 20 points wins.

What Is Your Answer?

3. **IN YOUR OWN WORDS** How can you use ratio tables and cross products to solve proportions? Give an example.

4. **PUZZLE** Use each number once to form three proportions.

1	2	10	4	12	20
15	5	16	6	8	3

Practice Use what you discovered about solving proportions to complete Exercises 10–13 on page 190.

5.4 Lesson

Check It Out
Lesson Tutorials
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Key Idea

Solving Proportions

Method 1 Use mental math. *(Section 5.3)*

Method 2 Use the Multiplication Property of Equality. *(Section 5.4)*

Method 3 Use the Cross Products Property. *(Section 5.4)*

EXAMPLE 1 Solving Proportions Using Multiplication

Solve $\frac{5}{7} = \frac{x}{21}$.

$\frac{5}{7} = \frac{x}{21}$ Write the proportion.

$21 \cdot \frac{5}{7} = 21 \cdot \frac{x}{21}$ Multiplication Property of Equality

$15 = x$ Simplify.

∴ The solution is 15.

On Your Own

Now You're Ready
Exercises 4–9

Use multiplication to solve the proportion.

1. $\frac{w}{6} = \frac{6}{9}$
2. $\frac{12}{10} = \frac{a}{15}$
3. $\frac{y}{6} = \frac{2}{4}$

EXAMPLE 2 Solving Proportions Using the Cross Products Property

Solve each proportion.

a. $\frac{x}{8} = \frac{7}{10}$

$x \cdot 10 = 8 \cdot 7$ Cross Products Property

$10x = 56$ Multiply.

$x = 5.6$ Divide.

∴ The solution is 5.6.

b. $\frac{9}{y} = \frac{3}{17}$

$9 \cdot 17 = y \cdot 3$

$153 = 3y$

$51 = y$

∴ The solution is 51.

On Your Own

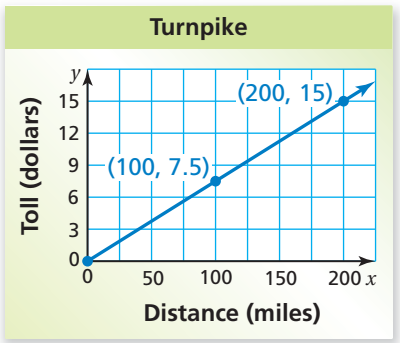
Now You're Ready
Exercises 10–21

Use the Cross Products Property to solve the proportion.

4. $\frac{2}{7} = \frac{x}{28}$ **5.** $\frac{12}{5} = \frac{6}{y}$ **6.** $\frac{40}{z+1} = \frac{15}{6}$

EXAMPLE 3 Real-Life Application

The graph shows the toll y due on a turnpike for driving x miles. Your toll is \$7.50. How many *kilometers* did you drive?



The point (100, 7.5) on the graph shows that the toll is \$7.50 for driving 100 miles. Convert 100 miles to kilometers.

Method 1: Convert using a ratio.

1 mi ≈ 1.61 km

$$100 \text{ mi} \times \frac{1.61 \text{ km}}{1 \text{ mi}} = 161 \text{ km}$$

∴ So, you drove about 161 kilometers.

Method 2: Convert using a proportion.

Let x be the number of kilometers equivalent to 100 miles.

kilometers, miles, kilometers, miles

$$\frac{1.61}{1} = \frac{x}{100}$$

Write a proportion. Use 1.61 km ≈ 1 mi.

$$1.61 \cdot 100 = 1 \cdot x$$

Cross Products Property

$$161 = x$$

Simplify.

∴ So, you drove about 161 kilometers.

On Your Own

Now You're Ready
Exercises 28–30

Write and solve a proportion to complete the statement. Round to the nearest hundredth, if necessary.

7. 7.5 in. ≈ ____ cm **8.** 100 g ≈ ____ oz

9. 2 L ≈ ____ qt **10.** 4 m ≈ ____ ft

5.4 Exercises

Check It Out
Help with Homework
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Vocabulary and Concept Check

1. **WRITING** What are three ways you can solve a proportion?
2. **OPEN-ENDED** Which way would you choose to solve $\frac{3}{x} = \frac{6}{14}$? Explain your reasoning.
3. **NUMBER SENSE** Does $\frac{x}{4} = \frac{15}{3}$ have the same solution as $\frac{x}{15} = \frac{4}{3}$? Use the Cross Products Property to explain your answer.

Practice and Problem Solving

Use multiplication to solve the proportion.

1 4. $\frac{9}{5} = \frac{z}{20}$ 5. $\frac{h}{15} = \frac{16}{3}$ 6. $\frac{w}{4} = \frac{42}{24}$

7. $\frac{35}{28} = \frac{n}{12}$ 8. $\frac{7}{16} = \frac{x}{4}$ 9. $\frac{y}{9} = \frac{44}{54}$

Use the Cross Products Property to solve the proportion.

2 10. $\frac{a}{6} = \frac{15}{2}$ 11. $\frac{10}{7} = \frac{8}{k}$ 12. $\frac{3}{4} = \frac{v}{14}$ 13. $\frac{5}{n} = \frac{16}{32}$

14. $\frac{36}{42} = \frac{24}{r}$ 15. $\frac{9}{10} = \frac{d}{6.4}$ 16. $\frac{x}{8} = \frac{3}{12}$ 17. $\frac{8}{m} = \frac{6}{15}$

18. $\frac{4}{24} = \frac{c}{36}$ 19. $\frac{20}{16} = \frac{d}{12}$ 20. $\frac{30}{20} = \frac{w}{14}$ 21. $\frac{2.4}{1.8} = \frac{7.2}{k}$

22. **ERROR ANALYSIS** Describe and correct the error in solving the proportion $\frac{m}{8} = \frac{15}{24}$.

✗
$$\frac{m}{8} = \frac{15}{24}$$
$$8 \cdot m = 24 \cdot 15$$
$$m = 45$$

23. **PENS** Forty-eight pens are packaged in 4 boxes. How many pens are packaged in 9 boxes?

24. **PIZZA PARTY** How much does it cost to buy 10 medium pizzas?

Solve the proportion.

25. $\frac{2x}{5} = \frac{9}{15}$ 26. $\frac{5}{2} = \frac{d-2}{4}$ 27. $\frac{4}{k+3} = \frac{8}{14}$

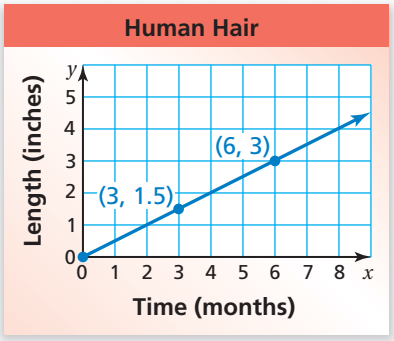
Write and solve a proportion to complete the statement. Round to the nearest hundredth if necessary.

28. 6 km ≈ ____ mi **29.** 2.5 L ≈ ____ gal **30.** 90 lb ≈ ____ kg

31. TRUE OR FALSE? Tell whether the statement is *true* or *false*. Explain.

If $\frac{a}{b} = \frac{2}{3}$, then $\frac{3}{2} = \frac{b}{a}$.

32. CLASS TRIP It costs $95 for 20 students to visit an aquarium. How much does it cost for 162 students?



33. GRAVITY A person who weighs 120 pounds on Earth weighs 20 pounds on the Moon. How much does a 93-pound person weigh on the Moon?

34. HAIR The length of human hair is proportional to the number of months it has grown.

a. What is the hair length in *centimeters* after 6 months?

b. How long does it take hair to grow 8 inches?

c. Use a different method than the one in part (b) to find how long it takes hair to grow 20 inches.

35. SWING SET It takes 6 hours for 2 people to build a swing set. Can you use the proportion $\frac{2}{6} = \frac{5}{h}$ to determine the number of hours h it will take 5 people to build the swing set? Explain.

36. REASONING There are 144 people in an audience. The ratio of adults to children is 5 to 3. How many are adults?

37. PROBLEM SOLVING Three pounds of lawn seed covers 1800 square feet. How many bags are needed to cover 8400 square feet?

38. Critical Thinking Consider the proportions $\frac{m}{n} = \frac{1}{2}$ and $\frac{n}{k} = \frac{2}{5}$. What is the ratio $\frac{m}{k}$? Explain your reasoning.

Fair Game Review What you learned in previous grades & lessons

Plot the ordered pair in a coordinate plane. *(Skills Review Handbook)*

39. $A(-5, -2)$ **40.** $B(-3, 0)$ **41.** $C(-1, 2)$ **42.** $D(1, 4)$

43. MULTIPLE CHOICE Which expression is equivalent to $(3w - 8) - 4(2w + 3)$? *(Section 3.2)*

Ⓐ $11w + 4$ Ⓑ $-5w - 5$ Ⓒ $-5w + 4$ Ⓓ $-5w - 20$