

3.5 Solving Proportions

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

1 ACTIVITY: Solving a Proportion in Science

SCIENCE Scientists use *ratio tables* to determine the amount of a compound (like salt) that is dissolved in a solution. Work with a partner to show how scientists use cross products to determine the unknown quantity in a ratio.

a. Sample: Salt Water

Salt Water	1 L	3 L
Salt	250 g	x g

$$\frac{3\cancel{\text{L}}}{1\cancel{\text{L}}} = \frac{x\cancel{\text{g}}}{250\cancel{\text{g}}}$$

Write proportion.

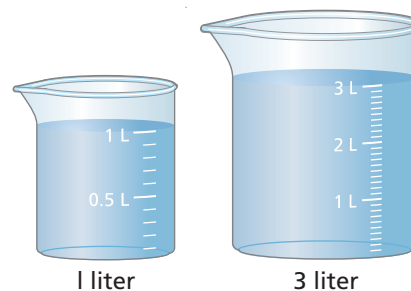
$$3 \cdot 250 = 1 \cdot x$$

Set cross products equal.

$$750 = x$$

Simplify.

So, there are 750 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



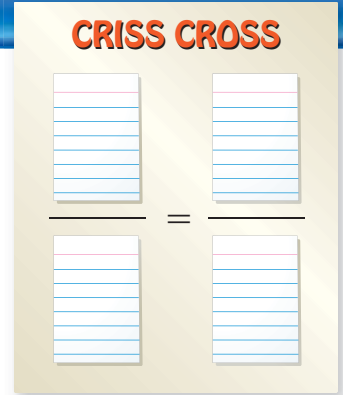
Recipe for SLIME

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 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 in a plastic bag and squeeze the mixture repeatedly to mix it up.

2 ACTIVITY: The Game of Criss Cross

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 8 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, say “Criss Cross” and 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 and 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 in science? 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 126.

Key Idea
Solving Proportions**Method 1** Use mental math. (Section 3.4)**Method 2** Use the Multiplication Property of Equality. (Section 3.5)**Method 3** Use the Cross Products Property. (Section 3.5)**EXAMPLE 1 Solving Proportions Using Multiplication**

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

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

Write the proportion.

$$21 \cdot \frac{5}{7} = 21 \cdot \frac{x}{21}$$

Multiply each side by 21.

$$15 = x$$

Simplify.

The solution is 15.

On Your Own

Solve the proportion using multiplication.

Now You're Ready
Exercises 4–9

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

$$x \cdot 10 = 8 \cdot 7$$

$$10x = 56$$

$$x = 5.6$$

Use the Cross Products Property.

Multiply.

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

Solve the proportion using the Cross Products Property.

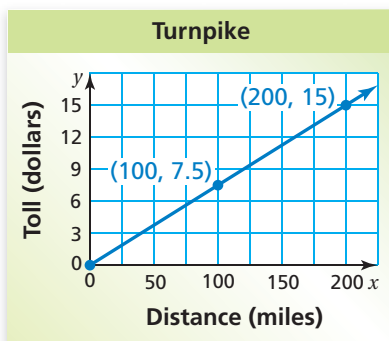
4. $\frac{2}{7} = \frac{x}{28}$

5. $\frac{12}{5} = \frac{6}{y}$

6. $\frac{40}{z+1} = \frac{15}{6}$

EXAMPLE 3 Real-Life Application

The toll due on a turnpike is proportional to the number of miles driven. How much does it cost to drive 150 miles?



Method 1: Interpret the slope as a unit rate.

$$\begin{aligned} \text{slope} &= \frac{\text{change in } y}{\text{change in } x} \\ &= \frac{7.5}{100} && \text{Substitute.} \\ &= 0.075 && \text{Divide.} \end{aligned}$$

The unit rate is \$0.075 per mile. Multiply to find the total cost.

$$150 \text{ mi} \cdot \frac{\$0.075}{1 \text{ mi}} = \$11.25$$

It costs \$11.25 to drive 150 miles on the turnpike.

Method 2: Write and solve a proportion.

$$\begin{aligned} \frac{7.5}{100} &= \frac{x}{150} && \begin{array}{l} \leftarrow \text{dollars} \\ \leftarrow \text{miles} \end{array} && \text{Use } (100, 7.5) \text{ to write a proportion.} \\ 150 \cdot \frac{7.5}{100} &= 150 \cdot \frac{x}{150} && \text{Multiply each side by 150.} \\ 11.25 &= x && \text{Simplify.} \end{aligned}$$

It costs \$11.25 to drive 150 miles on the turnpike.

On Your Own

7. **WHAT IF?** In Example 3, how much does it cost to drive 75 miles on the turnpike?



Vocabulary and Concept Check

- WRITING** What are three ways you can solve a proportion?
- OPEN-ENDED** Which way would you choose to solve $\frac{3}{x} = \frac{6}{14}$? Explain your reasoning.
- 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

Solve the proportion using multiplication.

- | | | | |
|---|-----------------------------------|----------------------------------|----------------------------------|
| 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. $\frac{y}{9} = \frac{44}{54}$ |

Solve the proportion using the Cross Products Property.

- | | | | | |
|---|------------------------------------|------------------------------------|------------------------------------|---------------------------------------|
| 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 $\frac{m}{8} = \frac{15}{24}$.



$$\begin{aligned} \frac{m}{8} &= \frac{15}{24} \\ 8 \cdot m &= 24 \cdot 15 \\ m &= 45 \end{aligned}$$

23. **PENS** Forty-eight pens are packaged in four boxes. How many pens are packaged in nine boxes?
24. **PIZZA PARTY** How much does it cost to buy 10 medium pizzas?



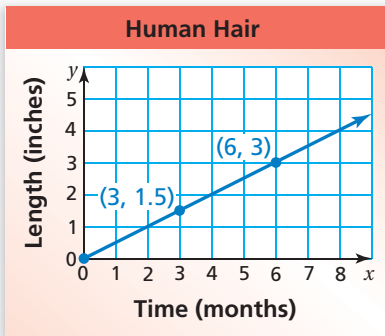
Solve the proportion.

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

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

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

29. **CLASS TRIP** It costs \$95 for 20 students to visit an aquarium. How much does it cost for 162 students?
30. **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?



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

- How long does it take hair to grow 8 inches?
- Use a different method than the one in part (a) to find how long it takes hair to grow 20 inches.

32. **CHEETAH** Cheetahs are the fastest mammals in the world. They can reach speeds of 70 miles per hour.

- At this speed, how long would it take a cheetah to run 17 miles?
- RESEARCH** Use the Internet or library to find how long a cheetah can maintain a speed of 70 miles per hour.

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

34. **LAWN SEED** Three pounds of lawn seed covers 1800 square feet. How many bags are needed to cover 8400 square feet?

35. **Critical Thinking** Consider the proportions $m = \frac{1}{2}$ and $k = \frac{1}{4}$. What is the ratio $\frac{m}{k}$? Explain your reasoning.



Fair Game Review What you learned in previous grades & lessons

Copy and complete. (*Skills Review Handbook*)

36. 530 cm = m

37. 6.4 kg = g

38. 56 oz = lb

39. $1\frac{1}{2}$ mi = ft

40. **MULTIPLE CHOICE** How many cups of milk are shown?

(*Skills Review Handbook*)

(A) $\frac{7}{10}$ c

(B) $\frac{7}{8}$ c

(C) $1\frac{3}{4}$ c

(D) 14 c

