

Proportional Relationships

Solutions Key

ARE YOU READY?

1. equation 2. evaluate
3. solution 4. rational number

5. Evaluate $x + 5$ for $x = -18$.

$$\begin{array}{r} -18 + 5 \\ -13 \end{array}$$

6. Evaluate $-9y$ for $y = 13$.

$$\begin{array}{r} -9(13) \\ -117 \end{array}$$

7. Evaluate $\frac{z}{-6}$ for $z = 96$.

$$\begin{array}{r} 96 \\ -6 \\ -16 \end{array}$$

8. Evaluate $w - 9$ for $w = -13$.

$$\begin{array}{r} -13 - 9 \\ -22 \end{array}$$

9. Evaluate $-3z + 1$ for $z = 4$.

$$\begin{array}{r} -3(4) + 1 \\ -12 + 1 \\ -11 \end{array}$$

10. Evaluate $3w + 9$ for $w = 7$.

$$\begin{array}{r} 3(7) + 9 \\ 21 + 9 \\ 30 \end{array}$$

11. Evaluate $5 - \frac{y}{3}$ for $y = -3$.

$$\begin{array}{r} 5 - \left(\frac{-3}{3}\right) \\ 5 - (-1) \\ 6 \end{array}$$

12. Evaluate $x^2 + 1$ for $x = -2$.

$$\begin{array}{r} (-2)^2 + 1 \\ 4 + 1 \\ 5 \end{array}$$

13. $y + 14 = -3$

$$\begin{array}{r} -14 \quad -14 \\ y = -17 \end{array}$$

14. $-4y = -72$
 $-4y \div (-4) = -72 \div (-4)$
 $y = 18$

15. $y - 6 = 39$

$$\begin{array}{r} +6 \quad +6 \\ y = 45 \end{array}$$

16. $\frac{y}{3} = -9$

$$\begin{array}{r} \frac{y}{3} \cdot 3 = -9 \cdot 3 \\ y = -27 \end{array}$$

17. $56 = 8y$

$$\begin{array}{r} 56 \div 8 = 8y \div 8 \\ 7 = y \end{array}$$

18. $26 = y + 2$

$$\begin{array}{r} -2 \quad -2 \\ 24 = y \end{array}$$

19. $25 - y = 7$
 $\begin{array}{r} -25 \quad -25 \\ -y = -18 \\ -y(-1) = -18(-1) \\ y = 18 \end{array}$

20. $\frac{121}{y} = 11$
 $\frac{121}{y}(y) = 11(y)$
 $121 = 11y$
 $121 \div 11 = 11y \div 11$
 $11 = y$

21. $-72 = 3y$
 $-72 \div 3 = 3y \div 3$
 $-24 = y$

22. $25 = \frac{150}{y}$
 $25(y) = \frac{150}{y}(y)$
 $25y = 150$
 $25y \div 25 = 150 \div 25$
 $y = 6$

23. $15 + y = 4$
 $\begin{array}{r} -15 \quad -15 \\ y = -11 \end{array}$

24. $-120 = -2y$
 $-120 \div (-2) = -2y \div (-2)$
 $60 = y$

25. To find the next number, add 17.

$$\begin{array}{l} 146 + 17 = 163 \\ 163 + 17 = 180 \\ 180 + 17 = 197 \\ 163, 180, 197 \end{array}$$

26. To find the next two numbers, first subtract 20, then subtract 5.

$$\begin{array}{l} 35 - 20 = 15 \\ 15 - 5 = 10 \\ 10 - 20 = -10 \\ 15, 10, -10 \end{array}$$

27. Numbers repeat in sets of two. To find the next two numbers, multiply by 5.

$$\begin{array}{l} 500 \\ 500 \cdot 5 = 2,500 \\ 500, 2,500, 2,500 \end{array}$$

28. First add 2, then 3, then 4, then 5, etc.

$$\begin{array}{l} 26 + 6 = 32 \\ 32 + 7 = 39 \\ 39 + 8 = 47 \\ 32, 39, 47 \end{array}$$

29. To find the next number, add 2.

$$\begin{array}{l} 7 + 2 = 9 \\ 9 + 2 = 11 \\ 11 + 2 = 13 \\ 9, 11, 13 \end{array}$$

30. To find the next number, add 7.

$$\begin{array}{l} 2 + 7 = 9 \\ 9 + 7 = 16 \\ 16 + 7 = 23 \\ 9, 16, 23 \end{array}$$

31. To find the next number, multiply by -2 .

$$\begin{array}{l} 80 \cdot (-2) = -160 \\ -160 \cdot (-2) = 320 \\ 320 \cdot (-2) = -640 \\ -160, 320, -640 \end{array}$$

32. To find the next two numbers, first subtract 10, then add 5.
- $$-10 - 10 = -20$$
- $$-20 + 5 = -15$$
- $$-15 - 10 = -25$$
- $$-20, -15, -25$$

LESSON 1

Think and Discuss

- Possible answer: A rate whose denominator is 1 represents a unit rate.
- Possible answer: The total price and number of ounces per box must be considered.

Exercises

- $\frac{668 \text{ mL} \div 8}{8 \text{ min} \div 8} = \frac{83.5 \text{ mL}}{1 \text{ min}}$
The faucet leaks 83.5 mL of water per minute.
- $\frac{360 \text{ g} \div 6}{6 \text{ muffins} \div 6} = \frac{60 \text{ g}}{1 \text{ muffin}}$
60 grams of oat flakes are needed per muffin.
- $\frac{2,748 \text{ miles} \div 6}{6 \text{ hours} \div 6} = \frac{458 \text{ miles}}{1 \text{ hour}}$
The airliner travels 458 miles per hour.
- the first station: $\frac{\$18.63 \div 9}{9 \text{ gallons} \div 9} = \frac{\$2.07}{1 \text{ gallon}}$
the second station: $\frac{\$29.54 \div 14}{14 \text{ gallons} \div 14} = \frac{\$2.11}{1 \text{ gallon}}$
the third station: $\frac{\$33.44 \div 16}{16 \text{ gallons} \div 16} = \frac{\$2.09}{1 \text{ gallon}}$
The first station offers the lowest price per gallon.
- $\frac{\$116.25 \div 15}{15 \text{ hours} \div 15} = \frac{\$7.75}{1 \text{ hour}}$
The job pays \$7.75 per hour.
- $\frac{324 \text{ minutes} \div 18}{18 \text{ pounds} \div 18} = \frac{18 \text{ minutes}}{1 \text{ pound}}$
The turkey took 18 minutes per pound to cook.
- $\frac{500 \text{ miles} \div 6.7}{6.7 \text{ hours} \div 6.7} \approx \frac{74.63 \text{ miles}}{1 \text{ hour}}$
The winning car's average speed was about 74.63 miles per hour.
- 32-oz container: $\frac{\$1.99 \div 32}{32 \text{ oz} \div 32} = \frac{\$0.0622}{1 \text{ oz}}$
64-oz container: $\frac{\$3.69 \div 64}{64 \text{ oz} \div 64} = \frac{\$0.0576}{1 \text{ oz}}$
96-oz container: $\frac{\$5.85 \div 96}{96 \text{ oz} \div 96} = \frac{\$0.0609}{1 \text{ oz}}$
The 64-oz container offers the lowest price per fluid ounce.
- $\frac{9 \text{ runs}}{3 \text{ games}} = 3 \text{ runs per game}$
- $\frac{\$207,000}{1,800 \text{ ft}^2} = \115 per ft^2
- $\frac{\$2,010}{6 \text{ months}} = \335 per month
- $\frac{52 \text{ songs}}{4 \text{ CDs}} = 13 \text{ songs per CD}$
- $\frac{226 \text{ mi}}{12 \text{ gal}} = 18.83 \text{ miles per gal}$
- $\frac{324 \text{ words}}{6 \text{ min}} = 54 \text{ words per min}$
- $\frac{\$69}{12 \text{ hr}} = \5.75 per hour
- $\frac{\$12.96}{6 \text{ lb}} = \2.16 per lb
- $\frac{488 \text{ mi}}{4 \text{ trips}} = 122 \text{ mi per trip}$
- $\frac{220 \text{ m}}{20 \text{ s}} = 11 \text{ m per s}$
- $\frac{1.5 \text{ mi}}{39 \text{ min}} = 0.04 \text{ mi per min}$
- $\frac{24,000 \text{ km}}{1.5 \text{ hr}} = 16,000 \text{ km per hour}$
- $\frac{1,026 \text{ students}}{38 \text{ classes}} = 27 \text{ students per class}$
- $\frac{\$49.99}{450 \text{ minutes}} = \0.11 per min
 $\frac{\$62.99}{800 \text{ minutes}} = \0.08 per min
The 800 minutes for \$62.99 is the better buy.
- $\frac{\$2.52}{42 \text{ oz}}$ or $\frac{\$3.64}{52 \text{ oz}}$
 $\frac{\$2.52}{42 \text{ oz}} = \0.06 per oz
 $\frac{\$3.64}{52 \text{ oz}} = \0.07 per oz
42 oz for \$2.52 is the better buy.
- $\frac{\$28.40}{8 \text{ yd}}$ or $\frac{\$55.50}{15 \text{ yd}}$
 $\frac{\$28.40}{8 \text{ yd}} = \3.55 per yd
 $\frac{\$55.50}{15 \text{ yd}} = \3.70 per oz
8 yd for \$28.40 is the better buy.
- $\frac{\$8.28}{0.3 \text{ m}}$ or $\frac{\$13.00}{0.4 \text{ m}}$
 $\frac{\$8.28}{0.3 \text{ m}} = \27.60 per m
 $\frac{\$13.00}{0.4 \text{ m}} = \32.50 per m
0.3 m for \$8.28 is the better buy.
- $\frac{100 \text{ m}}{1,261 \text{ s}}$ or $\frac{200 \text{ m}}{26.38 \text{ s}}$
 $\frac{100 \text{ m}}{1,261 \text{ s}} \approx 7.93 \text{ m/s}$
 $\frac{200 \text{ m}}{26.38 \text{ s}} \approx 7.58 \text{ m/s}$
Justin has the faster average at 7.93 meters per second.
- France: $\frac{60,876,136 \text{ people}}{210,668 \text{ mi}^2} = 289 \text{ people per square mile}$
Germany: $\frac{82,422,299 \text{ people}}{135,236 \text{ mi}^2} = 609 \text{ people per square mile}$
Poland: $\frac{38,536,869 \text{ people}}{117,571 \text{ mi}^2} = 328 \text{ people per square mile}$
France, Poland, Germany
- Possible answer: A package of 6 paper towels costs \$2.49 and a package of 8 paper towels costs \$3.29.

Compare the unit rates of each package to find the best buy.

29. Possible answer: Divide the number of points by the number of games he played to find the points per game.

$$\frac{32,292 \text{ points}}{1,072 \text{ games}} = 30.1 \text{ points per game}$$

30. Mike's unit cost is \$0.0804 per mile.

$$20 \cdot 25 = 500 \text{ miles}; 20 \cdot \$2.01 = \$40.20; \frac{\$40.20}{500 \text{ miles}} \approx \$0.0804$$

Serena's unit cost is approximately \$0.0763 per mile.

$$15 \cdot 30 = 450 \text{ miles}; 15 \cdot \$2.29 = \$34.35; \frac{\$34.35}{450 \text{ miles}} \approx \$0.0763$$

So, Mike gets the better buy.

31. D; \$0.155

$$\frac{\$2.48}{16 \text{ oz}} = \$0.155$$

32. $\frac{3 \text{ min}}{5 \text{ cuts}} = 0.6 \text{ min per cut}$

LESSON 2

Think and Discuss

- Possible answer: The ratios in Example 1B do not simplify to the same ratio. Ratios are proportional if they are the same when written in simplest form.
- Possible answer: A ratio is a relationship between two quantities. When two ratios are proportional, they show the same relationship.
- Possible answer: $\frac{10}{4} = \frac{20}{8}$. The ratios reduce to the same fraction, $\frac{5}{2}$.

Exercises

1. $\frac{2}{3}$ is already in simplest form.

Simplify $\frac{4}{6}$.

$$\frac{4}{6} = \frac{4 \div 2}{6 \div 2} = \frac{2}{3}$$

Since $\frac{2}{3} = \frac{2}{3}$, the ratios are proportional.

2. Simplify $\frac{5}{10}$ and $\frac{8}{18}$.

$$\frac{5}{10} = \frac{5 \div 5}{10 \div 5} = \frac{1}{2}$$

$$\frac{8}{18} = \frac{8 \div 2}{18 \div 2} = \frac{4}{9}$$

Since $\frac{1}{2} \neq \frac{4}{9}$, the ratios are not proportional.

3. Simplify $\frac{9}{12}$ and $\frac{15}{20}$.

$$\frac{9}{12} = \frac{9 \div 3}{12 \div 3} = \frac{3}{4}$$

$$\frac{15}{20} = \frac{15 \div 5}{20 \div 5} = \frac{3}{4}$$

Since $\frac{3}{4} = \frac{3}{4}$, the ratios are proportional.

4. $\frac{3}{4}$ is already in simplest form.

Simplify $\frac{8}{12}$.

$$\frac{8}{12} = \frac{8 \div 4}{12 \div 4} = \frac{2}{3}$$

Since $\frac{3}{4} \neq \frac{2}{3}$, the ratios are not proportional.

5. Write the ratios with a common denominator, such as 36.

$$\frac{10}{12} = \frac{10 \cdot 3}{12 \cdot 3} = \frac{30}{36}$$

$$\frac{15}{18} = \frac{15 \cdot 2}{18 \cdot 2} = \frac{30}{36}$$

Since both ratios are equal to $\frac{30}{36}$, they are proportional.

6. Write the ratios with a common denominator, such as 36.

$$\frac{6}{9} = \frac{6 \cdot 4}{9 \cdot 4} = \frac{24}{36}$$

$$\frac{8}{12} = \frac{8 \cdot 3}{12 \cdot 3} = \frac{24}{36}$$

Since both ratios are equal to $\frac{24}{36}$, they are proportional.

7. Write the ratios with a common denominator, such as 12.

$$\frac{3}{4} = \frac{3 \cdot 3}{4 \cdot 3} = \frac{9}{12}$$

$$\frac{5}{6} = \frac{5 \cdot 2}{6 \cdot 2} = \frac{10}{12}$$

Since $\frac{9}{12} \neq \frac{10}{12}$, the ratios are not proportional.

8. Write the ratios with a common denominator, such as 18.

$$\frac{4}{6} = \frac{4 \cdot 3}{6 \cdot 3} = \frac{12}{18}$$

$$\frac{6}{9} = \frac{6 \cdot 2}{9 \cdot 2} = \frac{12}{18}$$

Since both ratios are equal to $\frac{12}{18}$, they are proportional.

9. Possible answer:

$$\frac{1}{3} = \frac{1 \cdot 2}{3 \cdot 2} = \frac{2}{6}$$

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

10. Possible answer:

$$\frac{9}{21} = \frac{9 \div 3}{21 \div 3} = \frac{3}{7}$$

$$\frac{9}{21} = \frac{3}{7}$$

11. Possible answer:

$$\frac{8}{3} = \frac{8 \cdot 2}{3 \cdot 2} = \frac{16}{6}$$

$$\frac{8}{3} = \frac{16}{6}$$

12. Possible answer:

$$\frac{10}{4} = \frac{10 \div 2}{4 \div 2} = \frac{5}{2}$$

$$\frac{10}{4} = \frac{5}{2}$$

13. $\frac{5}{8}$ is already in simplest form.

Simplify $\frac{7}{14}$.

$$\frac{7}{14} = \frac{7 \div 7}{14 \div 7} = \frac{1}{2}$$

Since $\frac{5}{8} \neq \frac{1}{2}$, the ratios are not proportional.

14. Simplify $\frac{8}{24}$ and $\frac{10}{30}$.

$$\frac{8}{24} = \frac{8 \div 8}{24 \div 8} = \frac{1}{3}$$

$$\frac{10}{30} = \frac{10 \div 10}{30 \div 10} = \frac{1}{3}$$

Since $\frac{1}{3} = \frac{1}{3}$, the ratios are proportional.

15. Simplify $\frac{18}{20}$ and $\frac{81}{180}$.

$$\frac{18}{20} = \frac{18 \div 2}{20 \div 2} = \frac{9}{10}$$

$$\frac{81}{180} = \frac{81 \div 9}{180 \div 9} = \frac{9}{20}$$

Since $\frac{9}{10} \neq \frac{9}{20}$, the ratios are not proportional.

16. $\frac{27}{35}$ is already in simplest form.

Simplify $\frac{15}{20}$.

$$\frac{15}{20} = \frac{15 \div 5}{20 \div 5} = \frac{3}{4}$$

Since $\frac{27}{35} \neq \frac{3}{4}$, the ratios are not proportional.

17. Write the ratios with a common denominator, such as 9.

$$\frac{2}{3} = \frac{2 \cdot 3}{3 \cdot 3} = \frac{6}{9}$$

$$\frac{4}{9} = \frac{4 \cdot 1}{9 \cdot 1} = \frac{4}{9}$$

Since $\frac{6}{9} \neq \frac{4}{9}$, the ratios are not proportional.

18. Write the ratios with a common denominator, such as 60.

$$\frac{18}{12} = \frac{18 \cdot 5}{12 \cdot 5} = \frac{90}{60}$$

$$\frac{15}{10} = \frac{15 \cdot 6}{10 \cdot 6} = \frac{90}{60}$$

Since both ratios are equal to $\frac{90}{60}$, they are proportional.

19. Write the ratios with a common denominator, such as 24.

$$\frac{7}{8} = \frac{7 \cdot 3}{8 \cdot 3} = \frac{21}{24}$$

$$\frac{14}{24} = \frac{14 \cdot 1}{24 \cdot 1} = \frac{14}{24}$$

Since $\frac{21}{24} \neq \frac{14}{24}$, the ratios are not proportional.

20. Write the ratios with a common denominator, such as 3.

$$\frac{18}{54} = \frac{18 \div 18}{54 \div 18} = \frac{1}{3}$$

$$\frac{10}{30} = \frac{10 \div 10}{30 \div 10} = \frac{1}{3}$$

Since both ratios are equal to $\frac{1}{3}$, they are proportional.

21. Possible answer:

$$\frac{5}{9} = \frac{5 \cdot 2}{9 \cdot 2} = \frac{10}{18}$$

$$\frac{5}{9} = \frac{10}{18}$$

22. Possible answer:

$$\frac{27}{60} = \frac{27 \div 3}{60 \div 3} = \frac{9}{20}$$

$$\frac{27}{60} = \frac{9}{20}$$

23. Possible answer:

$$\frac{6}{15} = \frac{6 \div 3}{15 \div 3} = \frac{2}{5}$$

$$\frac{6}{15} = \frac{2}{5}$$

24. Possible answer:

$$\frac{121}{99} = \frac{121 \div 11}{99 \div 11} = \frac{11}{9}$$

$$\frac{121}{99} = \frac{11}{9}$$

25. Possible answer:

$$\frac{11}{13} = \frac{11 \cdot 5}{13 \cdot 5} = \frac{55}{65}$$

$$\frac{11}{13} = \frac{55}{65}$$

26. Possible answer:

$$\frac{5}{22} = \frac{5 \cdot 3}{22 \cdot 3} = \frac{15}{66}$$

$$\frac{5}{22} = \frac{15}{66}$$

27. Possible answer:

$$\frac{78}{104} = \frac{78 \div 2}{104 \div 2} = \frac{39}{52}$$

$$\frac{78}{104} = \frac{39}{52}$$

28. Possible answer:

$$\frac{27}{72} = \frac{27 \div 9}{72 \div 9} = \frac{3}{8}$$

$$\frac{27}{72} = \frac{3}{8}$$

29. Angelfish 4 8 **24** 20

Tigerfish **3** 6 18 **15**

$$\frac{8}{6} = \frac{4}{3} = \frac{24}{18} = \frac{20}{15}$$

30. Squares 2 4 6 8

Circles **8** 16 **24** 32

$$\frac{2}{8} = \frac{4}{16} = \frac{6}{24} = \frac{8}{32}$$

31. Possible answer:

$$\frac{3 \cdot 2}{7 \cdot 2} = \frac{6}{14} \text{ or } 6 \text{ to } 14$$

$$\frac{3 \cdot 3}{7 \cdot 3} = \frac{9}{21} \text{ or } 9 \text{ to } 21$$

32. Possible answer:

$$\frac{6 \div 2}{2 \div 2} = \frac{3}{1} \text{ or } 3 \text{ to } 1$$

$$\frac{3 \cdot 3}{1 \cdot 3} = \frac{9}{3} \text{ or } 9 \text{ to } 3$$

33. Possible answer:

$$\frac{5 \cdot 2}{12 \cdot 2} = \frac{10}{24} \text{ or } 10 \text{ to } 24$$

$$\frac{5 \cdot 3}{12 \cdot 3} = \frac{15}{36} \text{ or } 15 \text{ to } 36$$

34. Possible answer:

$$\frac{8 \div 4}{4 \div 4} = \frac{2}{1} \text{ or } 2 \text{ to } 1$$

$$\frac{8 \div 2}{4 \div 2} = \frac{4}{2} \text{ or } 4 \text{ to } 2$$

35. Possible answer:

$$\frac{6 \div 3}{9 \div 3} = \frac{2}{3} \text{ or } 2 \text{ to } 3$$

$$\frac{6 \cdot 2}{9 \cdot 2} = \frac{12}{18} \text{ or } 12 \text{ to } 18$$

36. Possible answer:

$$\frac{10 \div 10}{50 \div 10} = \frac{1}{5} \text{ or } 1 \text{ to } 5$$

$$\frac{10 \div 5}{50 \div 5} = \frac{2}{10} \text{ or } 2 \text{ to } 10$$

37. Possible answer:

$$\frac{10 \div 2}{4 \div 2} = \frac{5}{2} \text{ or } 5 \text{ to } 2$$

$$\frac{10 \cdot 2}{4 \cdot 2} = \frac{20}{8} \text{ or } 20 \text{ to } 8$$

38. Possible answer:

$$\frac{1 \cdot 2}{10 \cdot 2} = \frac{2}{20} \text{ or } 2 \text{ to } 20$$

$$\frac{1 \cdot 3}{10 \cdot 3} = \frac{3}{30} \text{ or } 3 \text{ to } 30$$

39. a. $\frac{1 \text{ can}}{4 \text{ hours}}$

b. No, $1:4 = x:2,080$; the class recycled 520 cans.

40. No; the driver must drop off the girls and boys in the same ratio of 15:12. If not, the ratio changes.

41. $1:2 = 2:4$, $2:1 = 4:2$, $1:1 = 2:2$, $1:1 = 4:4$, $2:2 = 4:4$

42. Possible answer:

$$\frac{22}{1} = \frac{22 \cdot 10}{1 \cdot 10} = \frac{220}{10}$$

There could be 220 students and 10 teachers at the school.

43. a. 8:5

b. Cypress Pond: $\frac{8}{5}$

$$\text{Mill Pond: } \frac{15}{10} = \frac{15 \div 5}{10 \div 5} = \frac{3}{2}$$

$$\text{Clear Pond: } \frac{3}{2}$$

$$\text{Gill Pond: } \frac{2}{7}$$

Mill Pond and Clear Pond have the same ratio of salamanders to frogs.

44. Marcus: $\frac{230}{40} = 5.75$

$$\text{Phillip: } \frac{192}{32} = 6.00$$

No, Marcus earned \$5.75 per hour and Phillip earned \$6.00 per hour.

45. The student multiplied the numerator by 2 and the denominator by 3. The multipliers should have been the same.

46. Write them with a common denominator or reduce them both to the lowest terms.

47. No; during the first 100 ft, she falls at a rate of

125 ft/s. During the next 400 ft, she falls at a rate of about 174 ft/s.

48. D; $\frac{128}{144}$

$$\frac{32}{48} = \frac{32 \div 16}{48 \div 16} = \frac{2}{3}$$

$$\frac{128}{144} = \frac{128 \div 16}{144 \div 16} = \frac{8}{9}$$

Since $\frac{2}{3} \neq \frac{8}{9}$, the two ratios are not proportional.

The other choices all reduce to a ratio of $\frac{2}{3}$.

49. H; $\frac{70}{84}$

$$\frac{70}{84} = \frac{70 \div 14}{84 \div 14} = \frac{5}{6}$$

The other choices are already in simplest form and none equals the ratio $\frac{5}{6}$.

LESSON 3

Think and Discuss

- Possible answer: For each ratio, draw a line from the first term to the second term of the other ratio. These lines form an "X," which indicates a "cross product."
- Possible answer: The error was in multiplying the first terms and multiplying the second terms rather than cross multiplying the first term of one ratio by the second term of the other.
- Possible answer: To decide whether 6:45 and 2:15 form a proportion, first write both in fraction form, $\frac{6}{45}$ and $\frac{2}{15}$. Then multiply $6 \cdot 15$ and $45 \cdot 2$. Since both equal 90, the ratios form a proportion.

Exercises

1. $\frac{6}{10} = \frac{36}{x}$

$$6 \cdot x = 10 \cdot 36$$

$$6x = 360$$

$$\frac{6x}{6} = \frac{360}{6}$$

$$x = 60$$

2. $\frac{4}{7} = \frac{5}{p}$

$$4 \cdot p = 7 \cdot 5$$

$$4p = 35$$

$$\frac{4p}{4} = \frac{35}{4}$$

$$p = 8.75$$

3. $\frac{12.3}{m} = \frac{75}{100}$

$$12.3 \cdot 100 = m \cdot 75$$

$$1,230 = 75m$$

$$\frac{1,230}{75} = \frac{75m}{75}$$

$$16.4 = m$$

4. $\frac{t}{42} = \frac{1.5}{3}$

$$t \cdot 3 = 42 \cdot 1.5$$

$$3t = 63$$

$$\frac{3t}{3} = \frac{63}{3}$$

$$t = 21$$

5. Let x be the weight of 1,470 one-dollar bills.

$$\frac{2,450 \text{ bills}}{5 \text{ lb}} = \frac{1,470 \text{ bills}}{x}$$

$$\frac{2,450}{5} = \frac{1,470}{x}$$

$$2,450 \cdot x = 5 \cdot 1,470$$

$$2,450x = 7,350$$

$$\frac{2,450x}{2,450} = \frac{7,350}{2,450}$$

$$x = 3$$

A stack of 1,470 one-dollar bills weighs 3 lb.

6. $\frac{4}{36} = \frac{x}{180}$

$$720 = 36x$$

$$20 = x$$

7. $\frac{7}{84} = \frac{12}{h}$

$$7h = 1,008$$

$$h = 144$$

8. $\frac{3}{24} = \frac{r}{52}$

$$156 = 24r$$

$$6\frac{1}{2} = r$$

9. $\frac{5}{140} = \frac{12}{v}$

$$5v = 1,680$$

$$v = 336$$

10. $\frac{45}{x} = \frac{15}{3}$

$$135 = 15x$$

$$9 = x$$

11. $\frac{t}{6} = \frac{96}{16}$

$$16t = 576$$

$$t = 36$$

12. $\frac{2}{5} = \frac{s}{12}$

$$24 = 5s$$

$$\frac{4}{5} = s$$

13. $\frac{14}{n} = \frac{5}{8}$

$$112 = 5n$$

$$22\frac{2}{5} = n$$

14. Let x be the height of 45 coins.

$$\frac{10 \text{ coins}}{21.25 \text{ mm}} = \frac{45 \text{ coins}}{x}$$

$$10x = 956.25$$

$$x = 95.625$$

A stack of 45 coins would be about 95.63 mm tall.

15. Let x be the unknown number of grams.

$$\frac{18.5 \text{ oz}}{524 \text{ g}} = \frac{8 \text{ oz}}{x}$$

$$18.5x = 4,192$$

$$x \approx 226.595$$

Jenna has about 227 g of soup.

16. $\frac{4}{h} = \frac{12}{24}$

$$96 = 12h$$

$$8 = h$$

Possible answer: $\frac{12}{24} = \frac{1}{2}$

17. $\frac{x}{15} = \frac{12}{90}$

$$90x = 180$$

$$x = 2$$

Possible answer: $\frac{12}{90} = \frac{4}{30}$

18. $\frac{39}{4} = \frac{t}{12}$

$$468 = 4t$$

$$117 = t$$

Possible answer: $\frac{39}{4} = \frac{78}{8}$

19. $\frac{5.5}{6} = \frac{16.5}{w}$

$$5.5w = 99$$

$$w = 18$$

Possible answer: $\frac{5.5}{6} = \frac{11}{12}$

20. $\frac{1}{3} = \frac{y}{25.5}$

$$25.5 = 3y$$

$$8.5 = y$$

Possible answer: $\frac{1}{3} = \frac{2}{6}$

21. $\frac{18}{x} = \frac{1}{5}$

$$90 = x$$

$$x = 90$$

Possible answer: $\frac{1}{5} = \frac{2}{10}$

22. $\frac{m}{4} = \frac{175}{20}$

$$20m = 700$$

$$m = 35$$

$$\text{Possible answer: } \frac{35}{4} = \frac{70}{8}$$

$$23. \frac{8.7}{2} = \frac{q}{4}$$

$$34.8 = 2q$$

$$17.4 = q$$

$$\text{Possible answer: } \frac{8.7}{2} = \frac{26.1}{6}$$

$$24. \frac{r}{84} = \frac{32.5}{182}$$

$$182r = 2,730$$

$$r = 15$$

$$\text{Possible answer: } \frac{15}{84} = \frac{30}{168}$$

$$25. \frac{76}{304} = \frac{81}{k}$$

$$76k = 24,624$$

$$k = 324$$

$$\text{Possible answer: } \frac{76}{304} = \frac{1}{4}$$

$$26. \frac{9}{500} = \frac{p}{2,500}$$

$$22,500 = 500p$$

$$45 = p$$

$$\text{Possible answer: } \frac{9}{500} = \frac{18}{1,000}$$

$$27. \frac{5}{j} = \frac{6}{19.8}$$

$$99 = 6j$$

$$16.5 = j$$

$$\text{Possible answer: } \frac{5}{16.5} = \frac{10}{33}$$

28. Let w be the amount of white paint needed.

$$\frac{5}{2} = \frac{8.5}{w}$$

$$5w = 17$$

$$w = 3.4$$

3.4 quarts of white paint should be mixed with the blue paint.

29. Let x be the unknown number of dimes.

$$\frac{18}{40} = \frac{x}{50}$$

$$18 \cdot 50 = 40x$$

$$\frac{900}{40} = x$$

$$22.5 = x$$

23 dimes would balance the weight.

30. Let h be the unknown number of hours.

$$\frac{126.2}{2} = \frac{189.3}{h}$$

$$126.2h = 378.6$$

$$h = 3$$

It would take Sandra 3 hours.

31. $325 - 265 + 215 = 275$, the number of campers in July

Let x be the unknown number of counselors.

$$\frac{325}{26} = \frac{275}{x}$$

$$325x = 7,150$$

$$x = 22$$

The camp would need 22 counselors to have the same camper to counselor ratio as June.

32. 10, 6, 30, 18

$$\text{Possible answer: } \frac{6}{18} = \frac{10}{30}$$

33. 4, 6, 10, 15

$$\text{Possible answer: } \frac{4}{10} = \frac{6}{15}$$

34. 12, 21, 7, 4

$$\text{Possible answer: } \frac{4}{12} = \frac{7}{21}$$

35. 75, 4, 3, 100

$$\text{Possible answer: } \frac{3}{75} = \frac{4}{100}$$

36. 30, 42, 5, 7

$$\text{Possible answer: } \frac{5}{30} = \frac{7}{42}$$

37. 5, 90, 108, 6

$$\text{Possible answer: } \frac{5}{6} = \frac{90}{108}$$

38. a. Within the Tuesday sample of 100 fish in the pond, 4 had been part of the Monday sample.

$$b. \frac{50}{n}$$

$$c. \frac{(\text{Tuesday tagged})}{(\text{Tuesday total})} = \frac{(\text{Pond tagged})}{(\text{Pond total})}$$

$$\frac{4}{100} = \frac{50}{n}$$

$$4n = 5,000$$

$$n = 1,250$$

There are an estimated 1,250 fish in the pond.

39. Let a be the number of unknown oxygen atoms.

$$\frac{1}{7} = \frac{15}{a}$$

$$a = 105$$

15 molecules of citric acid contain 105 oxygen atoms.

40. Let k be the unknown distance.

$$\frac{21}{7} = \frac{9}{k}$$

$$21k = 63$$

$$k = 3$$

The storm is 3 kilometers away.

41. Possible answer: What amount of sautéed fish, in ounces, contains 60 grams of protein?

42. Possible answer: I got 9 out of 12 questions correct on a test. I can find out my score by using the proportion $\frac{9}{12} = \frac{x}{100}$. My score is 75.

43. Multiply both ratios by b and simplify. Then multiply both by d and simplify.

$$\frac{a}{b} \cdot b = \frac{c}{d} \cdot b \text{ or } a = \frac{cb}{d};$$

$$a \cdot d = \frac{cb}{d} \cdot d \text{ or } ad = cb,$$

which shows that the cross products are equal.

$$44. C; \frac{7}{14} = \frac{15}{30}$$

$$7 \cdot 30 = 210$$

$$14 \cdot 15 = 210$$

These ratios are proportional.

$$45. \frac{2}{3} = \frac{?}{?}$$

$$12 \div 2 = 6$$

$$12 \div 3 = 4$$

$$\text{So, } \frac{2}{3} = \frac{4}{6}$$

READY TO GO ON?

- $\frac{\$140}{18 \text{ ft}^2} = \7.78 ft^2
- $\frac{346 \text{ mi}}{22 \text{ gal}} = 15.73 \text{ mi/gal}$
- $\frac{\$2.99}{14 \text{ lb}} = \$0.21/\text{lb}$
- $\frac{621 \text{ miles}}{11.5 \text{ hours}} = 621 \div 11.5 = 54 \text{ mi/hr}$
Shaunti's average speed was 54 mi/hr.
- $\frac{\$1.10}{7 \text{ oz}} \approx \$0.1571/\text{oz}$
 $\frac{\$1.46}{9 \text{ oz}} = \$0.1622/\text{oz}$
The 7-oz bag for \$1.10 has the lower price.
- Possible answer:
 $\frac{10}{16} = \frac{5}{8}$
- Possible answer:
 $\frac{21}{28} = \frac{3}{4}$
- Possible answer:
 $\frac{40}{48} = \frac{10}{12}$
- Ryan: $\frac{\$272}{40 \text{ hr}} = \$6.80/\text{hr}$
Jonathan: $\frac{\$224}{32 \text{ hr}} = \$7.00/\text{hr}$
The rates are not proportional; Ryan earned \$6.80 per hour and Jonathan earned \$7.00 per hour.
- $\frac{1}{0.735} \stackrel{?}{=} \frac{20}{14.70}$
 $0.735 \times 20 \stackrel{?}{=} 1 \times 14.70$
 $14.70 = 14.70$
Yes, the ratios are equivalent.
- $\frac{n}{8} = \frac{15}{4}$
 $n \cdot 4 = 15 \cdot 8$
 $4n = 120$
 $n = 30$
- $\frac{20}{t} = \frac{2.5}{6}$
 $20 \cdot 6 = t \cdot 2.5$
 $120 = 2.5t$
 $48 = t$
- $\frac{6}{11} = \frac{0.12}{z}$
 $6 \cdot z = 0.12 \cdot 11$
 $6z = 1.32$
 $z = 0.22$
- $\frac{15}{24} = \frac{x}{10}$
 $15 \cdot 10 = x \cdot 24$
 $150 = 24x$
 $x = 6.25$
- $\frac{1}{7} = \frac{5.5}{x}$
 $1 \cdot x = 5.5 \cdot 7$
 $x = 38.5$
Cliff's dog is 38.5 years old in human years.

LESSON 4

Think and Discuss

- $\angle J$ corresponds to $\angle U$, $\angle K$ corresponds to $\angle T$, and $\angle L$ corresponds to $\angle S$.
- Possible answer: All rectangles are not similar. For example, a square with side lengths of 5 inches and a rectangle with a length of 10 inches and a width of

4 inches are both rectangles but are different shapes. All the sides on the square are equal, so they could not be proportional to all the sides of the rectangle.

Exercises

- \overline{AB} corresponds to \overline{DE}
 \overline{BC} corresponds to \overline{EF}
 \overline{AC} corresponds to \overline{DF}

$$\frac{AB}{DE} \square \frac{BC}{EF} \square \frac{AC}{DF}$$

$$\frac{9}{3} \square \frac{12}{4} \square \frac{6}{2}$$

$$\frac{3}{1} \square \frac{3}{1} \square \frac{3}{1}$$

Since the ratios of the corresponding sides are equivalent, the triangles are similar.

- \overline{RQ} corresponds to \overline{VT}
 \overline{QS} corresponds to \overline{TW}
 \overline{RS} corresponds to \overline{VW}

$$\frac{RQ}{VT} \square \frac{QS}{TW} \square \frac{RS}{VW}$$

$$\frac{3}{15} \square \frac{5}{20} \square \frac{7}{28}$$

$$\frac{1}{5} \square \frac{1}{4} \square \frac{1}{4}$$

Since the ratios of the corresponding sides are not equivalent, the triangles are not similar.

- The corresponding angles of the figures have equal measures. Determine whether the ratios of the lengths of the corresponding sides are proportional.

$$\frac{50}{45} \square \frac{80}{72} \square \frac{50}{45} \square \frac{80}{72}$$

$$\frac{10}{9} \square \frac{10}{9} \square \frac{10}{9} \square \frac{10}{9}$$

Since the ratios of the corresponding sides are equivalent, the triangles are similar.

- The corresponding angles of the figures have equal measures. Determine whether the ratios of the lengths of the corresponding sides are proportional.

$$\frac{7}{11} \square \frac{3.5}{3.5} \square \frac{11}{15} \square \frac{5}{5}$$

$$\frac{7}{11} \square \frac{1}{1} \square \frac{11}{15} \square \frac{1}{1}$$

Since the ratios of the corresponding sides are not equivalent, the triangles are not similar.

- \overline{JK} corresponds to \overline{PQ}
 \overline{KL} corresponds to \overline{QR}
 \overline{JL} corresponds to \overline{PR}

$$\frac{JK}{PQ} \square \frac{KL}{QR} \square \frac{JL}{PR}$$

$$\frac{18}{4} \square \frac{18}{48} \square \frac{12}{28}$$

$$\frac{3}{8} \square \frac{3}{8} \square \frac{3}{7}$$

Since the ratios of the corresponding sides are not equivalent, the triangles are not similar.

- \overline{CD} corresponds to \overline{JL}
 \overline{DE} corresponds to \overline{KL}
 \overline{CE} corresponds to \overline{JK}

$$\frac{CD}{JL} \square \frac{DE}{KL} \square \frac{CE}{JK}$$

$$\frac{60}{36} \square \frac{40}{24} \square \frac{50}{30}$$

$$\frac{5}{3} \square \frac{5}{3} \square \frac{5}{3}$$

Since the ratios of the corresponding sides are equivalent, the triangles are similar.

7. The corresponding angles of the figures have equal measures. Determine whether the ratios of the lengths of the corresponding sides are proportional.

$$\frac{14}{23} \blacksquare \frac{14}{23} \blacksquare \frac{14}{23} \blacksquare \frac{14}{23}$$

Since the ratios of the corresponding sides are equivalent, the triangles are similar.

8. The corresponding angles of the figures do not have equal measures. The figures are not similar.
 9. The corresponding angles of the figures do not have equal measures. The figures are not similar.
 10. Write the length and width of each size as a ratio and simplify.

$$\frac{3}{5} = \frac{3}{5}$$

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

$$\frac{8}{18} = \frac{4}{9}$$

$$\frac{9}{20} = \frac{9}{20}$$

$$\frac{16}{24} = \frac{2}{3}$$

$$\frac{20}{30} = \frac{2}{3}$$

Select the sizes whose ratios are equivalent.

$$\frac{4}{6} = \frac{16}{24} = \frac{20}{30}$$

Michelle could order the 4 in. \times 6 in. and 16 in. \times 24 in.

11. \overline{AB} corresponds to \overline{LM}
 \overline{AC} corresponds to \overline{LN}
 \overline{BC} corresponds to \overline{MN}

$$\frac{AB}{LM} \blacksquare \frac{AC}{LN} \blacksquare \frac{BC}{MN}$$

$$\frac{9}{6} \blacksquare \frac{18}{12} \blacksquare \frac{12}{8}$$

$$\frac{3}{2} \blacksquare \frac{3}{2} \blacksquare \frac{3}{2}$$

Since the ratios of the corresponding sides are equivalent, the triangles are similar.

12. \overline{CD} corresponds to \overline{FG}
 \overline{CE} corresponds to \overline{FH}
 \overline{ED} corresponds to \overline{HG}

$$\frac{CD}{FG} \blacksquare \frac{CE}{FH} \blacksquare \frac{ED}{HG}$$

$$\frac{28}{32} \blacksquare \frac{18}{24} \blacksquare \frac{32}{42}$$

$$\frac{7}{8} \blacksquare \frac{3}{4} \blacksquare \frac{16}{21}$$

Since the ratios of the corresponding sides are not equivalent, the triangles are not similar.

13. $\frac{4}{12} \blacksquare \frac{5}{15}$
 $60 = 60$
 Yes, they are similar.

14. $\frac{4}{5} \blacksquare \frac{10}{8}$
 $32 \neq 50$
 No, they are not similar.

15. $\frac{12}{8} \blacksquare \frac{15}{10}$
 $120 = 120$

Yes, they are similar.

16. Yes; the side ratios are equivalent because all the sides of a square are all the same and squares all have four right angles.
 17. No; parallelograms do not all have the same angle measures.
 18. No; all rectangles have four right angles, but the ratios of the lengths of corresponding sides are not necessarily proportional.
 19. No; acute angles of a right triangle are not the same in every right triangle.

20. Write an equation.

$$6x = x + 6$$

$$5x = 6$$

$$x = \frac{6}{5} \text{ or } 1\frac{1}{5} \text{ or } 1.2$$

Check:

$$\frac{6}{5} + 6 \blacksquare \frac{6}{5} \cdot 6$$

$$\frac{6}{5} + \frac{30}{5} \blacksquare \frac{36}{5}$$

$$\frac{36}{5} \blacksquare \frac{36}{5}$$

21. Possible answer: To find out whether triangles are similar, determine whether the ratios of their corresponding sides are proportional.

22. Write a proportion using ratios of the

side of a larger triangle
 form, $\frac{\text{side of a larger triangle}}{\text{side of a smaller triangle}}$.

$$\frac{5}{4} = \frac{40}{x}$$

$$5 \cdot x = 40 \cdot 4$$

$$5x = 160$$

$$x = 32$$

The length of the corresponding side of the smaller triangle is 32 feet.

23. C; 14.4 feet

$$\frac{8}{10} = \frac{w}{18}$$

$$8 \cdot 18 = w \cdot 10$$

$$144 = 10w$$

$$14.4 = w$$

24. No; the proportions are not equal.

$$\frac{2.61}{6.14} = \frac{3.61}{7.14}$$

$$2.61 \cdot 7.14 \blacksquare 3.61 \cdot 6.14$$

$$18.6354 \neq 22.1654$$

LESSON 5

Think and Discuss

1. Possible answer: $\frac{16}{56} = \frac{12}{x}$
 2. Possible answer: You could stand next to a tree and measure your shadow and the shadow of the tree to find the height of the tree. You could do the same with a basketball goal.

Exercises

1. $\frac{XZ}{PR} = \frac{YZ}{RQ}$

$$\frac{8}{20} = \frac{9}{a}$$

$$8 \cdot a = 20 \cdot 9$$

$$8a = 180$$

$$a = 22.5$$

RQ is 22.5 centimeters.

b corresponds to $\angle Z$.

$$b = 89^\circ$$

2. $\frac{YX}{QP} = \frac{XZ}{PR}$

$$\frac{48}{30} = \frac{y}{35}$$

$$48 \cdot 35 = y \cdot 30$$

$$1,680 = 30y$$

$$56 = y$$

XZ is 56 meters.

s corresponds to $\angle Q$.

$$s = 58^\circ$$

3. Let w = width of the smaller garden.

$$\frac{54}{36} = \frac{42}{w}$$

$$54 \cdot w = 42 \cdot 36$$

$$54w = 1,512$$

$$w = 28$$

The smaller garden is 28 feet wide.

4. $\frac{x}{9.5} = \frac{21}{8}$

$$\text{Estimate: } 10 \cdot 20 = 8 \cdot x$$

$$x \approx 25$$

The water tower is about 25 feet tall.

5. $\frac{BA}{DE} = \frac{BC}{EF}$

$$\frac{9}{x} = \frac{12}{18}$$

$$9 \cdot 18 = 12 \cdot x$$

$$162 = 12x$$

$$13.5 = x$$

DE is 13.5 inches.

n corresponds to $\angle F$.

$$n = 40^\circ$$

6. $\frac{ED}{BA} = \frac{DF}{AC}$

$$\frac{7.2}{4} = \frac{12.96}{b}$$

$$7.2 \cdot b = 12.96 \cdot 4$$

$$7.2b = 51.84$$

$$b = 7.2$$

AC is 7.2 feet long.

x corresponds to $\angle E$.

$$x = 64^\circ$$

7. Let h = the height of the still.

$$\frac{h}{444 \text{ in.}} = \frac{0.55 \text{ in.}}{0.98 \text{ in.}}$$

$$0.98 \text{ in.} \cdot h = 444 \text{ in.} \cdot 0.55 \text{ in.}$$

$$0.98 \text{ in.} \cdot h = 244.2 \text{ in.}$$

$$h = 249.18 \text{ in.}$$

The still is 249.18 in. tall.

8. Let x = the height of the cactus.

$$\frac{3.5}{5} = \frac{x}{14.5}$$

$$3.5 \cdot 14.5 = x \cdot 5$$

$$50.75 = 5x$$

$$10.15 = x$$

The cactus is about 10 feet tall.

9. Let x = the height of the taller building.

$$\frac{14}{16} = \frac{x}{24}$$

$$14 \cdot 24 = x \cdot 16$$

$$336 = 16x$$

$$21 = x$$

The taller building is 21 meters tall.

10. No; the ratios of the lengths of their sides are not equivalent.

$$\frac{3.5}{6.5} = \frac{4}{9.5}$$

$$3.5 \cdot 9.5 \neq 4 \cdot 6.5$$

$$33.25 \neq 26$$

11. Let o = the height of the Blazing Orange triangle.

$$\frac{12}{7} = \frac{16}{o}$$

$$12 \cdot o = 16 \cdot 7$$

$$12o = 112$$

$$o \approx 9.3$$

The Blazing Orange triangle is about 9.3 inches.

Let p = the length of the Grape Purple triangle.

$$\frac{12}{3} = \frac{16}{p}$$

$$12 \cdot p = 16 \cdot 3$$

$$12p = 48$$

$$p = 4 \text{ in.}$$

The length of the Grape Purple triangle is 4 inches.

Let b = the height of the Dynamite Blue triangle.

$$\frac{12}{15} = \frac{16}{b}$$

$$12 \cdot b = 16 \cdot 15$$

$$12b = 240$$

$$b = 20$$

The height of the Dynamite Blue triangle is

20 inches.

12. Possible answer: A pole casts a shadow that is 4 feet long. At the same time, a tree casts a shadow that is 2 feet long. The tree is 6 feet tall. How tall is the pole?

Let x = the height of the pole.

$$\frac{6}{2} = \frac{x}{4}$$

$$6 \cdot 4 = x \cdot 2$$

$$24 = 2x$$

$$12 = x$$

The pole is 12 feet tall.

13. Possible answer: Write proportions using the lengths of corresponding sides. Solve the proportions for the missing lengths.

14. $\frac{8}{5} = \frac{6}{y}$

$$8 \cdot y = 6 \cdot 5$$

$$8y = 30$$

$$y = 3.75$$

15. B; 12 cm

$$\frac{15}{x} = \frac{11.25}{9}$$

$$15 \cdot 9 = 11.25 \cdot x$$

$$135 = 11.25x$$

$$12 = x$$

16. Let x = the height of the building.

$$\frac{x}{16} = \frac{6}{2.5}$$

$$2.5 \cdot x = 6 \cdot 16$$

$$2.5x = 96$$

$$x = 38.4$$

The building is 38.4 feet tall.

LESSON 6

Think and Discuss

- Possible answer: The model is bigger because its scale factor is greater than 1. A model with a scale factor of 1 is the same size as the original subject, and a model with a scale factor less than 1 is smaller than the original object.
- Possible answer: To find the scale of a drawing, divide the length of the drawing by the actual length of the antenna. The scale factor is $\frac{1}{60}$.

Exercises

$$1. \frac{\text{model height}}{\text{bear height}} = \frac{6}{84}$$

$$= \frac{1}{14}$$

The scale factor is $\frac{1}{14}$.

$$2. \frac{\text{model length}}{\text{moray eel length}} = \frac{1.5}{5}$$

$$= \frac{3}{10}$$

The scale factor is $\frac{3}{10}$.

$$3. \frac{\text{photo}}{\text{sculpture}} = \frac{1}{16}$$

$$\frac{4.2}{l} = \frac{1}{16}$$

$$l = 4.2 \cdot 16$$

$$l = 67.2$$

$$\frac{2.5}{w} = \frac{1}{16}$$

$$w = 2.5 \cdot 16$$

$$w = 40$$

The sculpture is 67.2 cm tall and 40 cm wide.

4. Let d be the actual distance between cities.

$$\frac{1}{48} = \frac{4.3}{d}$$

$$d = 4.3 \cdot 48$$

$$d = 206.4$$

The distance between the cities is 206.4 km.

$$5. \frac{\text{model wingspan}}{\text{eagle wingspan}} = \frac{6}{90}$$

$$= \frac{1}{15}$$

The scale factor is $\frac{1}{15}$.

$$6. \frac{\text{model length}}{\text{dolphin length}} = \frac{13}{260}$$

$$= \frac{1}{20}$$

The scale factor is $\frac{1}{20}$.

$$7. \frac{\text{drawing}}{\text{tree}} = \frac{1}{20}$$

$$\frac{6.75}{t} = \frac{1}{20}$$

$$t = 6.75 \cdot 20$$

$$t = 135$$

The tree is 135 inches tall.

8. Let d be the actual distance between cities.

$$\frac{2}{80} = \frac{7.6}{d}$$

$$2d = 7.6 \cdot 80$$

$$2d = 608$$

$$d = 304 \text{ km}$$

The distance between the cities is 304 km.

$$9. \frac{1}{12} = \frac{4}{h}$$

$$h = 12 \cdot \frac{4}{3}$$

$$h = 16$$

The lamp's height is 16 inches.

$$10. \frac{1}{12} = \frac{h}{32}$$

$$12h = 32$$

$$h = \frac{32}{12} = 2\frac{2}{3}$$

$$\frac{1}{12} = \frac{l}{69}$$

$$12l = 69$$

$$l = \frac{69}{12} = 5\frac{3}{4}$$

The couch's height is $2\frac{2}{3}$ in. and its length is $5\frac{3}{4}$ in.

$$11. \frac{1}{12} = \frac{6.25}{h}$$

$$h = 75$$

$$\frac{1}{12} = \frac{11.75}{w}$$

$$w = 141$$

$$\frac{1}{12} = \frac{20}{l}$$

$$l = 240$$

The table's height is 75 cm, its width is 141 cm, and its length is 240 cm.

$$12. \frac{13 \text{ cm}}{260 \text{ cm}} = \frac{1}{20}$$

$$\text{or } \frac{6 \text{ cm}}{120 \text{ cm}} = \frac{1}{20}$$

The scale factor is $\frac{1}{20}$.

13. The scale factor is $\frac{1 \text{ in.}}{3 \text{ yd.}}$

$$18 \text{ ft} = 6 \text{ yd}$$

$$\frac{1 \text{ in.}}{3 \text{ yd}} = \frac{x}{6} \text{ yd}$$

$$3x = 6$$

$$x = 2$$

The countertop is 2 inches long on the scale drawing.

14. Because the scale is 10 cm: 1 mm and because 10 cm is longer than 1 mm, the drawing will be larger.

$$15. \frac{1}{10} = \frac{2.5}{x}$$

$$x = 25$$

The soldiers marched about 25 miles.

$$16. \frac{1}{10} = \frac{x}{8.1}$$

$$10x = 8.1$$

$$x = 0.81$$

They are 0.81 in., or about $\frac{13}{16}$ in., apart on the map.

17. Leaving 3 in. between the model and the table edge makes the model area 6 in. (0.5 ft) shorter on each side. Therefore, the model area is 2.75 ft by 2.75 ft.

Write ratios of the form: $\frac{\text{model}}{\text{battlefield}}$

$$\frac{2.75 \text{ ft}}{11 \text{ mi}} = 0.25 \text{ ft per mi}$$

$$\frac{2.75 \text{ ft}}{7.5 \text{ mi}} = 0.37 \text{ ft per mi}$$

If 1 mile on the battlefield equals anything greater than 0.25 feet on the model, the 11-mile side will not fit on the table. The largest scale factor he can use is 1 mi : 0.25 ft or 1 ft : 4 mi.

18. Find the scale factor between the original and reduced map.

$$\frac{5}{1.5} = 3\frac{1}{3} = \frac{10}{3}$$

Write a proportion to find the distance on the original map when the distance on the reduced map is 1.75 inches.

$$\frac{10}{3} = \frac{x}{1.75}$$

$$3x = 17.5$$

$$x \approx 5.8$$

The distance on the original map is 5.8 inches.

Since the scale is 1 mile to the inch, the actual distance is 5.8 miles.

19. B; 9 feet

$$\frac{1}{16} = \frac{7}{x}$$

$$x = 112$$

$$112 \text{ in.} \times \frac{1 \text{ ft}}{12 \text{ in.}} = 9 \text{ ft}$$

$$20. \frac{3}{120} = \frac{6.8}{x}$$

$$3x = 816$$

$$x = 272$$

The distance between the actual cities is 272 km.

READY TO GO ON?

- The corresponding angles are equal and the corresponding sides have the same proportions, so the triangles are similar.
- The corresponding sides do not yield the same proportions so the figures are not similar.
- $\frac{10}{z} = \frac{13}{32.5}$
 $13z = 325$
 $z = 25$
 XY is 25 m.
 d corresponds to $\angle Z$.
 $d = 64.5^\circ$
- $\frac{8}{t} = \frac{14}{42}$
 $14t = 336$
 $t = 24$
 YZ is 24 in.
 s corresponds to $\angle B$.
 $s = 85^\circ$
- $\frac{6}{8} = \frac{10}{x}$

$$6x = 80$$

$$x = 13\frac{1}{3}$$

The length of the enlarged design is $13\frac{1}{3}$ in.

$$6. \frac{6}{4} = \frac{x}{20}$$

$$4x = 120$$

$$x = 30$$

The height of the building is about 30 ft.

$$7. \frac{16.8}{6} = 2.8$$

The scale factor is 2.8.

$$8. \frac{1}{24} = \frac{6}{x}$$

$$x = 144$$

The driveway is actually 144 in., or 12 ft long.

$$9. \frac{1}{65} = \frac{x}{260}$$

$$65x = 260$$

$$x = 4$$

On the map, the distance between the cities is 4 in.

STUDY GUIDE: REVIEW

- similar
- rate
- scale factor
- $\frac{540 \text{ ft}}{90 \text{ s}} = 6 \text{ ft per s}$
- $\frac{436 \text{ mi}}{4 \text{ hr}} = 109 \text{ mi per hr}$
- $\frac{\$ 56}{25 \text{ gal}} = \2.24 per gal
 $\frac{\$ 32.05}{15 \text{ gal}} \approx \2.14 per gal
 Since $\$2.24 > \2.14 , 15 gallons for \$32.05 is the better buy.
- $\frac{\$ 160}{5 \text{ g}} = \32 per g
 $\frac{\$ 315}{9 \text{ g}} = \35 per g
 Since $\$35 > \32 , 5 g for \$160 is the better buy.
- $\frac{\$197.50}{25 \text{ h}} = \$7.90/\text{h}$
 Beatriz earned \$7.90/h.
- $\frac{9}{27} = \frac{1}{3}$
 $\frac{6}{20} = \frac{3}{10}$
 Since $\frac{1}{3} \neq \frac{3}{10}$, the ratios are not proportional.
- $\frac{15}{25} = \frac{3}{5}$
 $\frac{20}{30} = \frac{2}{3}$
 Since $\frac{3}{5} \neq \frac{2}{3}$, the ratios are not proportional.
- $\frac{21}{14} = \frac{3}{2}$
 $\frac{18}{12} = \frac{3}{2}$

Since $\frac{3}{2} = \frac{3}{2}$, the ratios are proportional.

12. Possible answer: $\frac{10}{12} = \frac{10 \cdot 3}{12 \cdot 3} = \frac{30}{36}$

13. Possible answer: $\frac{45}{50} = \frac{45 \cdot 2}{50 \cdot 2} = \frac{90}{100}$

14. Possible answer: $\frac{9}{15} = \frac{9 \cdot 3}{15 \cdot 3} = \frac{27}{45}$

15. $\frac{4}{6} = \frac{n}{3}$
 $6n = 12$
 $n = 2$

16. $\frac{2}{a} = \frac{5}{15}$
 $5a = 30$
 $a = 6$

17. $\frac{b}{1.5} = \frac{8}{3}$
 $3b = 12$
 $b = 4$

18. $\frac{16}{11} = \frac{96}{x}$
 $16x = 1,056$
 $x = 66$

19. $\frac{2}{y} = \frac{1}{5}$
 $y = 10$

20. $\frac{7}{2} = \frac{70}{w}$
 $7w = 140$
 $w = 20$

21. $\frac{8}{48} \neq \frac{6}{6} \neq \frac{3}{18} \neq \frac{6}{6}$
 $\frac{1}{6} \neq \frac{1}{1} \neq \frac{1}{6} \neq \frac{1}{1}$

The ratios of the corresponding sides are not equivalent, so the figures are not similar.

22. $\frac{7}{10.5} \neq \frac{5}{7.5} \neq \frac{8}{12}$
 $\frac{7}{10.5} \neq \frac{5}{7.5} \rightarrow 7 \cdot 7.5 \neq 10.5 \cdot 5; 52.5 \neq 52.5$

$\frac{5}{7.5} \neq \frac{8}{12} \rightarrow 5 \cdot 12 \neq 7.5 \cdot 8; 60 \neq 60$

$\frac{7}{10.5} \neq \frac{8}{12} \rightarrow 7 \cdot 12 \neq 10.5 \cdot 8; 84 \neq 84$

When each of the ratios are cross-multiplied, their products are all equal. The ratios of the corresponding sides are equivalent, so the figures are similar.

23. $\frac{DE}{KL} = \frac{DF}{LJ}$
 $\frac{72}{18} = \frac{x}{25}$
 $18x = 1,800$
 $x = 100$ ft

a corresponds to $\angle E$.
 $a = 84^\circ$

24. Let x be the unknown length of the frame.

$\frac{9}{3} = \frac{24}{x}$
 $9 \cdot x = 24 \cdot 3$
 $9x = 72$
 $x = 8$

The length of the frame is 8 cm.

25. $\frac{x}{31} = \frac{2}{8}$
 $8x = 62$
 $x = 7.75$ ft

The tree is about 8 feet tall.

26. $\frac{1}{40} = \frac{x}{484}$
 $40x = 484$
 $x = 12.1$

The model's wingspan is 12.1 inches.

27. $\frac{1}{38} = \frac{4.3}{x}$
 $x = 163.4$

The actual distance is 163.4 miles.

CHAPTER TEST

1. $\frac{576 \text{ tacos}}{48 \text{ hours}} = 12$ tacos per hour

2. $\frac{\$5.25}{5 \text{ lb}} = \1.05 per lb

$\frac{\$9.75}{10 \text{ lb}} = \0.975 per lb

Since $\$1.05 > \0.975 , the 10-lb box for $\$9.75$ is the better buy.

3. $\frac{5}{6}$ is already in simplest form.

Simplify $\frac{12}{15}$.

$\frac{12}{15} = \frac{12 \div 3}{15 \div 3} = \frac{4}{5}$

Since $\frac{5}{6} \neq \frac{4}{5}$, the ratios are not proportional.

4. Simplify $\frac{4}{10}$.

$\frac{4}{10} = \frac{4 \div 2}{10 \div 2} = \frac{2}{5}$

Simplify $\frac{6}{15}$.

$\frac{6}{15} = \frac{6 \div 3}{15 \div 3} = \frac{2}{5}$

Since $\frac{2}{5} = \frac{2}{5}$, the ratios are proportional.

5. $\frac{22}{35}$ is already in simplest form.

Simplify $\frac{110}{175}$.

$\frac{110}{175} = \frac{110 \div 5}{175 \div 5} = \frac{22}{35}$

Since $\frac{22}{35} = \frac{22}{35}$, the ratios are proportional.

6. Simplify $\frac{18}{22}$.

$\frac{18}{22} = \frac{18 \div 2}{22 \div 2} = \frac{9}{11}$

Simplify $\frac{52}{66}$.

$\frac{52}{66} = \frac{52 \div 2}{66 \div 2} = \frac{26}{33}$

Since $\frac{9}{11} \neq \frac{26}{33}$, the ratios are not proportional.

7. Possible answers:

$\frac{22}{30} = \frac{11}{15}$

8. Possible answers:

$\frac{7}{9} = \frac{14}{18}$

9. Possible answers:

$\frac{18}{54} = \frac{1}{3}$

10. Possible answers:

$\frac{10}{17} = \frac{20}{34}$

11. $\frac{9}{12} = \frac{m}{6}$

$12m = 54$
 $m = 4.5$

12. $\frac{x}{2} = \frac{18}{6}$

$6x = 36$
 $x = 6$

13. $\frac{3}{7} = \frac{21}{t}$

$3t = 147$
 $t = 49$

14. $\frac{5}{p} = \frac{10}{2}$

$10p = 10$
 $p = 1$

15. Let x be the unknown amount of tomatoes.

$$\frac{6}{2} = \frac{x}{1.5}$$
$$6 \cdot 1.5 = 2 \cdot x$$
$$9 = 2x$$
$$4.5 = x$$

The recipe requires 4.5 cups of tomatoes.

16. The corresponding angles and the ratios of the corresponding sides are not equal, so the figures are not similar.
17. The corresponding angles and the ratios of the corresponding sides are equal, so the figures are similar.

18. $\frac{MO}{WZ} = \frac{ON}{YZ}$

$$\frac{5}{3} = \frac{n}{4}$$

$$3n = 20$$

$$n = 6\frac{2}{3} \text{ in.}$$

a corresponds to $\angle Z$.

$$a = 116^\circ$$

19. $\frac{YZ}{NO} = \frac{WZ}{MO}$

$$\frac{33}{11} = \frac{x}{10}$$

$$11x = 330$$

$$x = 30 \text{ m}$$

c corresponds to $\angle N$.

$$c = 62^\circ$$

20. $\frac{1 \text{ in.}}{15 \text{ ft}} = \frac{8 \text{ in.}}{l}$

$$l = 120$$

$$\frac{1 \text{ in.}}{15 \text{ ft}} = \frac{12 \text{ in.}}{w}$$

$$l = 180$$

The actual building is 120 ft by 180 ft.

21. $\frac{1\frac{1}{4} \text{ in.}}{25 \text{ mi}} = \frac{x}{75 \text{ mi}}$

$$25x = 75 \cdot \frac{5}{4}$$

$$25x = \frac{375}{4}$$

$$x = \frac{375}{4} \cdot \frac{1}{25}$$

$$x = 3\frac{3}{4}$$

On the map, the distance between the two towns is

$$3\frac{3}{4} \text{ inches.}$$