

1-1 Variables and Expressions

Write a verbal expression for each algebraic expression.

1. $2m$

SOLUTION:

Because the 2 and the m are written next to each other, they are being multiplied. So, the verbal expression *the product of 2 and m* can be used to describe the algebraic expression $2m$.

2. $\frac{2}{3}r^4$

SOLUTION:

The expression shows the product of the factors $\frac{2}{3}$ and r^4 . The factor r^4 represents a number raised to the fourth power. So, the verbal expression *two thirds times r raised to the fourth power* can be used to describe the algebraic expression $\frac{2}{3}r^4$.

3. $a^2 - 18b$

SOLUTION:

The expression shows the difference of two terms. The term a^2 represents a squared. The term $18b$ represents 18 times b . So, the verbal expression *a squared minus 18 times b* can be used to describe the algebraic expression $a^2 - 18b$.

Write an algebraic expression for each verbal expression.

4. the sum of a number and 14

SOLUTION:

Let n represent a number. The word *sum* suggests addition. So, the verbal expression *the sum of a number and 14* can be represented by the algebraic expression $n + 14$.

5. 6 less a number t

SOLUTION:

The word *less* suggests subtraction. So, the verbal expression *6 less a number t* can be represented by the algebraic expression $6 - t$.

6. 7 more than 11 times a number

SOLUTION:

Let n represent a number. The words *more than* suggest addition and the word *times* suggests multiplication. So, the verbal expression *7 more than 11 times a number* can be represented by the algebraic expression $11n + 7$.

7. 1 minus the quotient of r and 7

SOLUTION:

The word *minus* suggests subtraction and the word *quotient* suggests division. So, the verbal expression *1 minus the quotient of r and 7* can be represented by the algebraic expression $1 - \frac{r}{7}$.

8. two fifths of a number j squared

SOLUTION:

The words *two-fifths of a number* suggest multiplication. The *squared* means to raise to the second power. So, the verbal expression *two-fifths of a number j squared* can be represented by the algebraic expression $\frac{2}{5}j^2$.

9. n cubed increased by 5

SOLUTION:

The word *cubed* means to raise to the third power. The words *increased by* suggest addition. So, the verbal expression *n cubed increased by 5* can be represented by the algebraic expression $n^3 + 5$.

10. **GROCERIES** Mr. Bailey purchased some groceries that cost d dollars. He paid with a \$50 bill. Write an expression for the amount of change he will receive.

SOLUTION:

To find the amount of change Mr. Bailey will receive, subtract the cost of the groceries, d , from \$50. So, Mr. Bailey will receive $50 - d$ in change.

1-1 Variables and Expressions

Write a verbal expression for each algebraic expression.

11. $4q$

SOLUTION:

Because 4 and q are written next to each other, they are being multiplied. So, the verbal expression *four times a number q* can be used to describe the algebraic expression $4q$.

12. $\frac{1}{8}y$

SOLUTION:

Because $\frac{1}{8}$ and y are written next to each other, they are being multiplied. So, the verbal expression *one eighth of a number y* can be used to describe the algebraic expression $\frac{1}{8}y$.

13. $15 + r$

SOLUTION:

The expression shows the sum of two terms. So, the verbal expression *15 plus r* can be used to describe the algebraic expression $15 + r$.

14. $w - 24$

SOLUTION:

The expression shows the difference of two terms. So, the verbal expression *w minus 24* can be used to describe the algebraic expression $w - 24$.

15. $3x^2$

SOLUTION:

The expression shows the product of the factors 3 and x^2 . The factor x^2 represents a number raised to the second power. So, the verbal expression *3 times x squared* can be used to describe the algebraic expression $3x^2$.

16. $\frac{r^4}{9}$

SOLUTION:

The expression shows the quotient of two terms. The term r^4 represents a number raised to the fourth power. So, the verbal expression *r to the fourth power divided by 9* can be used to describe the algebraic expression $\frac{r^4}{9}$.

17. $2a + 6$

SOLUTION:

The expression shows the sum of two terms. The term $2a$ represents the product of 2 and a . So, the verbal expression *6 more than the product 2 times a* can be used to describe the algebraic expression $2a + 6$.

18. $r^4 \cdot t^3$

SOLUTION:

The expression shows the product of two factors. The factor r^4 represents a number raised to the fourth power. The factor t^3 represents a number raised to the third power. So, the verbal expression *the product of a number r raised to the fourth power and a number t cubed* can be used to describe the algebraic expression $r^4 \cdot t^3$.

Write an algebraic expression for each verbal expression.

19. x more than 7

SOLUTION:

The words *more than* suggest addition. So, the verbal expression *x more than 7* can be represented by the algebraic expression $7 + x$.

20. a number less 35

SOLUTION:

Let n represent a number. The word *less* suggests subtraction. So, the verbal expression *a number less 35* can be represented by the algebraic expression $n - 35$.

1-1 Variables and Expressions

21. 5 times a number

SOLUTION:

Let n represent a number. The word *times* suggests multiplication. So, the verbal expression *5 times a number* can be represented by the algebraic expression $5n$.

22. one third of a number

SOLUTION:

Let n represent a number. The words *one third of a number* suggest multiplication. So, the verbal expression *one third of a number* can be represented by the algebraic expression $\frac{1}{3}n$.

23. f divided by 10

SOLUTION:

The words *divided by* suggest division. So, the verbal expression *f divided by 10* can be represented by the algebraic expression $\frac{f}{10}$.

24. the quotient of 45 and r

SOLUTION:

The word *quotient* suggests division. So, the verbal expression *the quotient of 45 and r* can be represented by the algebraic expression $\frac{45}{r}$.

25. three times a number plus 16

SOLUTION:

Let n represent a number. The word *times* suggests multiplication, and the word *plus* suggests addition. So, the verbal expression *three times a number plus 16* can be represented by the algebraic expression $3n + 16$.

26. 18 decreased by 3 times d

SOLUTION:

The word *decreased* suggests subtraction, and the word *times* suggests multiplication. So, the verbal expression *18 decreased by 3 times d* can be represented by the algebraic expression $18 - 3d$.

27. k squared minus 11

SOLUTION:

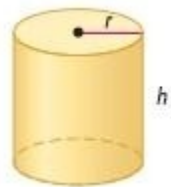
The word *squared* means a number raised to the second power. The word *minus* suggests subtraction. So, the verbal expression *k squared minus 11* can be represented by the algebraic expression $k^2 - 11$.

28. 20 divided by t to the fifth power

SOLUTION:

The words *divided by* suggest division. So, the verbal expression *20 divided by t to the fifth power* can be represented by the algebraic expression $\frac{20}{t^5}$.

29. **GEOMETRY** The volume of a cylinder is π times the radius r squared multiplied by the height. Write an expression for the volume.



SOLUTION:

The words *times* and *multiplied by* suggest multiplication. So, the volume of a cylinder can be written as the algebraic expression $\pi r^2 h$.

30. **FINANCIAL LITERACY** Jocelyn makes x dollars per hour working at the grocery store and n dollars per hour babysitting. Write an expression that describes her earnings if she babysat for 25 hours and worked at the grocery store for 15 hours.

SOLUTION:

To write an expression for how much Jocelyn made babysitting, multiply the number of hours she babysat, 25, by her hourly rate, n . This can be represented by the algebraic expression $25n$.

To write an expression for how much Jocelyn made working at the grocery store, multiply the number of hours she worked, 15, by her hourly rate, x . This can be represented by the algebraic expression $15x$.

To write an expression for her total earnings, find the sum of the amount she earned babysitting and the amount she earned working at the grocery store. This can be written as the expression $25n + 15x$.

1-1 Variables and Expressions

Write a verbal expression for each algebraic expression.

31. $25 + 6x^2$

SOLUTION:

The expression shows the sum of two terms. The term $6x^2$ means six times the square of a number.

So, the algebraic expression $25 + 6x^2$ can be described by the verbal expression *twenty-five plus six times a number squared*.

32. $6f^2 + 5f$

SOLUTION:

The expression shows the sum of two terms. The term $6f^2$ means six times the square of a number.

The term $5f$ means five times a number. So, the algebraic expression $6f^2 + 5f$ can be described by the verbal expression *six times a number squared plus five times the number*.

33. $\frac{3a^5}{2}$

SOLUTION:

The expression shows the quotient of two terms. The term $3a^5$ means three times a number that has been raised to the fifth power. So, the algebraic expression can be described by the verbal expression *three times a number raised to the fifth power divided by two*.

34. **CCSS SENSE-MAKING** A certain smartphone family plan costs \$55 per month plus additional usage costs. If x is the number of cell phone minutes used above the plan amount and y is the number of megabytes of data used above the plan amount, interpret the following expressions.

a. $0.25x$

b. $2y$

c. $0.25x + 2y + 55$

SOLUTION:

a. Since x is the number of cell phone minutes, then $0.25x$ would be the cost of extra minutes at \$0.25 per minute.

b. Since y is the number of megabytes of data used above the plan amount, then $2y$ would be the cost of extra data used at \$2 per megabyte.

c. The expression $0.25x + 2y + 55$ represents the extra minute charges and the extra data usage charge plus the monthly family plan cost of \$55. The expression represents the total monthly cost for the family.

1-1 Variables and Expressions

35. **DREAMS** It is believed that about $\frac{3}{4}$ of our dreams involve people that we know.

a. Write an expression to describe the number of dreams that feature people you know if you have d dreams.

b. Use the expression you wrote to predict the number of dreams that include people you know out of 28 dreams.

SOLUTION:

a. To write an expression to describe the number of dreams that feature people you know if you have d dreams, multiply $\frac{3}{4}$ by d or $\frac{3}{4}d$.

b. To predict the number of dreams that include people you know out of 28 dreams, replace d with 28 in the expression $\frac{3}{4}d$.

$$\begin{aligned}\frac{3}{4}d &= \frac{3}{4}(28) \\ &= 21\end{aligned}$$

So, you would predict having 21 dreams that include people you know.

36. **SPORTS** In football, a touchdown is awarded 6 points and the team can then try for a point after a touchdown.

a. Write an expression that describes the number of points scored on touchdowns and points after touchdowns by one team in a game.

b. If a team wins a football game 27–0, write an equation to represent the possible number of touchdowns and points after touchdowns by the winning team.

c. If a team wins a football game 21–7, how many possible number of touchdowns and points after touchdowns were scored during the game by both teams?

SOLUTION:

a. Let T be the number of touchdowns and p be the number of points scored after touchdowns. So, the expression $6T + p$, describes the number of points scored on touchdowns and points after touchdowns by one team in a game.

b. If a team scores 27 points in a game, then $6T + p = 27$ represents the possible number of touchdowns and points after touchdowns by the winning team.

c. If a team wins a football game 21–7, then $6T + p = 28$ represents the possible number of touchdowns and points after touchdowns that were scored during the game by both teams.

Let $T = 4$ and $p = 4$.

$$\begin{aligned}6T + p &= 6(4) + 4 \\ &= 24 + 4 \\ &= 28\end{aligned}$$

So, it is possible that 4 touchdowns and 4 points after touchdowns were scored during the game by both teams.

1-1 Variables and Expressions

37. **MULTIPLE REPRESENTATIONS** In this problem, you will explore the multiplication of powers with like bases.

a. **TABULAR** Copy and complete the table.

10^2	\times	10^1	$=$	$10 \times 10 \times 10$	$=$	10^3
10^2	\times	10^2	$=$	$10 \times 10 \times 10 \times 10$	$=$	10^4
10^2	\times	10^3	$=$	$10 \times 10 \times 10 \times 10 \times 10$	$=$?
10^2	\times	10^4	$=$?	$=$?

b. **ALGEBRAIC** Write an equation for the pattern in the table.

c. **VERBAL** Make a conjecture about the exponent of the product of two powers with like bases.

SOLUTION:

a.

10^2	\times	10^1	$=$	$10 \times 10 \times 10$	$=$	10^3
10^2	\times	10^2	$=$	$10 \times 10 \times 10 \times 10$	$=$	10^4
10^2	\times	10^3	$=$	$10 \times 10 \times 10 \times 10 \times 10$	$=$?
10^2	\times	10^4	$=$?	$=$?

$10 \times 10 \times 10 \times 10 \times 10 \times 10$

b. The exponent of the product is the sum of the exponents of the factors. So, the algebraic equation $10^2 \times 10^x = 10^{(2+x)}$ represents the pattern.

c. The exponent of the product of two powers is the sum of the exponents of the powers with the same bases.

38. **REASONING** Explain the differences between an algebraic expression and a verbal expression.

SOLUTION:

Algebraic expressions include variables, numbers, and symbols. Verbal expressions contain words. For example, “three more than a double a number” is a verbal expression. The expression $2x + 3$ is the algebraic expression that represents the verbal expression “three more than a double a number”.

39. **OPEN ENDED** Define a variable to represent a real-life quantity, such as time in minutes or distance in feet. Then use the variable to write an algebraic expression to represent one of your daily activities. Describe in words what your expression represents, and explain your reasoning.

SOLUTION:

Sample answer: x is the number of minutes it takes to walk between my house and school. $2x + 15$ represents the amount of time in minutes I spend walking each day since I walk to and from school and I take my dog on a 15 minute walk.

40. **CCSS CRITIQUE** Consuelo and James are writing an algebraic expression for the verbal expression *three times the sum of n squared and 3*. Is either of them correct? Explain your reasoning.

Consuelo

$$3(n^2 + 3)$$

James

$$3n^2 + 3$$

SOLUTION:

Consuelo is correct. The verbal expression says that the sum of n squared and 3 is multiplied by 3. So, parentheses are necessary. James left out the parentheses around $n^2 + 3$.

1-1 Variables and Expressions

41. **CHALLENGE** For the cube, x represents a positive whole number. Find the value of x such that the volume of the cube and 6 times the area of one of its faces have the same value.



SOLUTION:

The volume of a cube can be found by multiplying the length times the width times the height. Because the sides of a cube all have the same length, $V = x \cdot x \cdot x$, or x^3 . The area of one of the faces of the cube can be found by multiplying the length times the width. So, $A = x \cdot x$, or x^2 .

To find the value of x such that the volume of the cube and 6 times the area of one of its faces have the same value, find a value for x such that $x^3 = 6x^2$.

x	$x^3 = 6x^2$	Yes/No
4	$x^3 = 6x^2$ $4^3 \stackrel{?}{=} 6(4^2)$ $64 \neq 96$	No
6	$x^3 = 6x^2$ $6^3 \stackrel{?}{=} 6(6^2)$ $216 = 216$	Yes

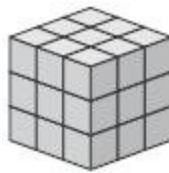
So, the sides must have a length of 6 for the volume of the cube and 6 times the area of one of its faces to have the same value.

42. **WRITING IN MATH** Describe how to write an algebraic expression from a real-world situation. Include a definition of algebraic expression in your own words.

SOLUTION:

Sample answer: An algebraic expression is a math phrase that contains one or more numbers or variables. To write an algebraic expression from real world situation, first assign variables. Then determine the arithmetic operations done on the variables. Finally, put the terms in order.

43. Which expression best represents the volume of the cube?



- A the product of three and five
- B three to the fifth power
- C three squared
- D three cubed

SOLUTION:

The volume of a cube can be found by multiplying the length times the width times the height. Because the sides of a cube all have the same length, $V = x \cdot x \cdot x$, or x^3 . Because the length of each side is 3 units, the expression *three cubed* best represents the volume of the cube.

So, Choice D is the correct answer.

44. Which expression best represents the perimeter of the rectangle?



- F $2lw$
- G $l + w$
- H $2l + 2w$
- J $4(l + w)$

SOLUTION:

To find the perimeter of a rectangle, find the sum of twice the length and twice the width. The expression $2l + 2w$ best represents the perimeter of the rectangle.

Choice H is the correct answer.

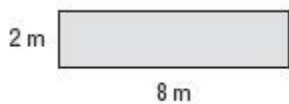
1-1 Variables and Expressions

45. **SHORT RESPONSE** The yards of fabric needed to make curtains is 3 times the length of a window in inches, divided by 36. Write an expression that represents the yards of fabric needed in terms of the length of the window l .

SOLUTION:

The word *times* suggests multiplication and the words *divided by* suggest division. So, $\frac{3l}{36}$ represents the yards of fabric needed in terms of the length of the window l .

46. **GEOMETRY** Find the area of the rectangle.



- A 14 square meters
- B 16 square meters
- C 50 square meters
- D 60 square meters

SOLUTION:

$$\begin{aligned} A &= lw \\ &= 8 \cdot 2 \\ &= 16 \end{aligned}$$

So, the area of the rectangle is 16 square meters.

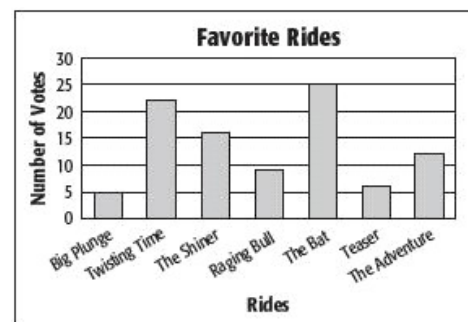
Choice B is the correct answer.

47. **AMUSEMENT PARKS** A roller coaster enthusiast club took a poll to see what each member's favorite ride was. Make a bar graph of the results.

Our Favorite Rides	
Ride	Number of Votes
Big Plunge	5
Twisting Time	22
The Shiner	16
Raging Bull	9
The Bat	25
Teaser	6
The Adventure	12

SOLUTION:

Draw a bar to represent each roller coaster. The vertical scale is the number of members who voted for each rollercoaster. The horizontal scale identifies the roller coaster chosen.



48. **SPORTS** The results for an annual 5K race are shown below. Make a box-and-whisker plot for the data. Write a sentence describing what the length of the box-and-whisker plot tells about the times for the race.

1-1 Variables and Expressions

Annual 5-K Race Results			
Joe	14:48	Carissa	19:58
Jessica	19:27	Jordan	14:58
Lupe	15:06	Taylor	20:47
Dante	20:39	Mi-Ling	15:48
Tia	15:54	Winona	21:35
Amber	20:49	Angel	16:10
Amanda	16:30	Catalina	20:21

SOLUTION:

Order the data from least to greatest. The times in order from least to greatest are 14:48, 14:58, 15:06, 15:48, 15:54, 16:10, 16:30, 19:27, 19:58, 20:21, 20:39, 20:47, 20:49, 21:35.

The times are given in minutes and seconds. Rewrite the times so that they are in seconds by multiplying the number of minutes by 60 and then adding the seconds.

Time in Min:Sec	Time in Seconds
14:48	888
14:58	898
15:06	906
15:48	948
15:54	954
16:10	970
16:30	990
19:27	1167
19:58	1198
20:21	1221
20:39	1239
20:47	1247
20:49	1249
21:35	1295

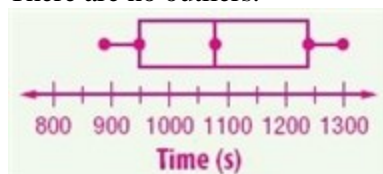
Then determine the quartiles.

$$Q_1 = 948$$

$$Q_2 = 1078.5$$

$$Q_3 = 1239$$

There are no outliers.



Find the mean, median, and mode for each set of data.

49. $\{7, 6, 5, 7, 4, 8, 2, 2, 7, 8\}$

SOLUTION:

$$\frac{7+6+5+7+4+8+2+2+7+8}{10} = \frac{56}{10} = 5.6$$

So, the mean is 5.6.

Order the data from least to greatest.

$$\{2, 2, 4, 5, 6, 7, 7, 7, 8, 8\}.$$

Because there is an even number of data, the median is the mean of 6 and 7.

$$\frac{6+7}{2} = \frac{13}{2} = 6.5$$

So, the median is 6.5.

The number 7 appears most often, so the mode is 7.

50. $\{-1, 0, 5, 2, -2, 0, -1, 2, -1, 0\}$

SOLUTION:

$$\frac{-1+0+5+2+(-2)+0+(-1)+2+(-1)+0}{10} = \frac{4}{10} = 0.4$$

So, the mean is 0.4.

Order the data from least to greatest.

$$\{-2, -1, -1, -1, 0, 0, 0, 2, 2, 5\}$$

Because there is an even number of data, the median is the mean of 0 and 0.

$$\frac{0+0}{2} = \frac{0}{2} = 0$$

So, the median is 0.

The numbers 0 and -1 both occur most often, so the modes are 0 and -1 .

1-1 Variables and Expressions

51. {17, 24, 16, 3, 12, 11, 24, 15}

SOLUTION:

$$\frac{17 + 24 + 16 + 3 + 11 + 24 + 15}{8} = \frac{122}{8} \\ = 15.25$$

So, the mean is 15.25.

Order the data from least to greatest.

{3, 11, 12, 15, 16, 17, 24, 24}.

Because there is an even number of data, the median is the mean of 15 and 16.

$$\frac{15 + 16}{2} = \frac{31}{2} \\ = 15.5$$

So, the median is 15.5.

The number 24 appears most often, so the mode is 24.

52. **SPORTS** Lisa has a rectangular trampoline that is 6 feet long and 12 feet wide. What is the area of her trampoline in square feet?

SOLUTION:

$$A = \ell w \\ = 12 \cdot 6 \\ = 72$$

The area of Lisa's trampoline is 72 square feet.

Find each product or quotient.

53. $\frac{3}{5} \cdot \frac{7}{11}$

SOLUTION:

Multiply the numerators and denominators.

$$\frac{3}{5} \cdot \frac{7}{11} = \frac{3 \cdot 7}{5 \cdot 11} \quad \text{Multiply.} \\ = \frac{21}{55} \quad \text{Simplify.}$$

54. $\frac{4}{3} \div \frac{7}{6}$

SOLUTION:

$$\frac{4}{3} \div \frac{7}{6} = \frac{4}{\cancel{3}} \cdot \frac{\cancel{6}^2}{7} \quad \text{Divide by the GCF, 3.} \\ = \frac{4 \cdot 2}{1 \cdot 7} \quad \text{Multiply.} \\ = \frac{8}{7} \quad \text{Simplify.}$$

55. $\frac{5}{6} \cdot \frac{8}{3}$

SOLUTION:

$$\frac{5}{6} \cdot \frac{8}{3} = \frac{5}{\cancel{6}_3} \cdot \frac{\cancel{8}^4}{3} \quad \text{Divide by the GCF, 3.} \\ = \frac{5 \cdot 4}{3 \cdot 3} \quad \text{Multiply.} \\ = \frac{20}{9} \quad \text{Simplify.}$$

Evaluate each expression.

56. $\frac{3}{5} + \frac{4}{9}$

SOLUTION:

The LCD for 5 and 9 is 45. Rewrite each fraction with denominators of 45 then add the numerators.

$$\frac{3}{5} + \frac{4}{9} = \frac{27}{45} + \frac{20}{45} \\ = \frac{47}{45} \quad \text{Add.}$$

57. $5.67 - 4.21$

SOLUTION:

$$5.67 - 4.21 = 1.46$$

1-1 Variables and Expressions

58. $\frac{5}{6} - \frac{8}{3}$

SOLUTION:

The LCD for 3 and 6 is 6. Rewrite each fraction with a common denominator of 6.

$$\begin{aligned}\frac{5}{6} - \frac{8}{3} &= \frac{5}{6} - \frac{16}{6} \\ &= -\frac{11}{6} \text{ or } -1\frac{5}{6} \quad \text{Subtract.}\end{aligned}$$

59. $10.34 + 14.27$

SOLUTION:

$$10.34 + 14.27 = 24.61$$

60. $\frac{11}{12} + \frac{5}{36}$

SOLUTION:

The LCD for 12 and 36 is 36. Rewrite the fractions with a common denominator of 36.

$$\begin{aligned}\frac{11}{12} + \frac{5}{36} &= \frac{33}{36} + \frac{5}{36} \\ &= \frac{38}{36} \quad \text{Add.} \\ &= \frac{19}{18} \quad \text{Simplify.}\end{aligned}$$

61. $37.02 - 15.86$

SOLUTION:

$$37.02 - 15.86 = 21.16$$

1-2 Order of Operations

Evaluate each expression.

1. 9^2

SOLUTION:

$$\begin{aligned} 9^2 &= 9 \cdot 9 && \text{Use 9 as a factor 2 times.} \\ &= 81 && \text{Multiply.} \end{aligned}$$

2. 4^4

SOLUTION:

$$\begin{aligned} 4^4 &= 4 \cdot 4 \cdot 4 \cdot 4 && \text{Use 4 as a factor 4 times.} \\ &= 256 && \text{Multiply.} \end{aligned}$$

3. 3^5

SOLUTION:

$$\begin{aligned} 3^5 &= 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 && \text{Use 3 as a factor 5 times.} \\ &= 243 && \text{Multiply.} \end{aligned}$$

4. $30 - 14 \div 2$

SOLUTION:

$$\begin{aligned} 30 - 14 \div 2 &= 30 - 7 && \text{Divide 14 by 2.} \\ &= 23 && \text{Subtract 7 from 30.} \end{aligned}$$

5. $5 \cdot 5 - 1 \cdot 3$

SOLUTION:

$$\begin{aligned} 5 \cdot 5 - 1 \cdot 3 &= 25 - 3 && \text{Multiply 5 by 5 and 1 by 3.} \\ &= 22 && \text{Subtract 3 from 25.} \end{aligned}$$

6. $(2 + 5)4$

SOLUTION:

$$\begin{aligned} (2 + 5)4 &= (7)4 && \text{Add 2 and 5.} \\ &= 28 && \text{Multiply 7 by 4.} \end{aligned}$$

7. $[8(2) - 4^2] + 7(4)$

SOLUTION:

$$\begin{aligned} [8(2) - 4^2] + 7(4) &&& \text{Original Expression} \\ &= [8(2) - 16] + 7(4) && \text{Evaluate powers.} \\ &= [16 - 16] + 7(4) && \text{Multiply 8 by 2.} \\ &= [0] + 28 && \text{Subtract 16 from 16.} \\ &= 28 && \text{Multiply 7 by 4.} \end{aligned}$$

8. $\frac{11-8}{1+7 \cdot 2}$

SOLUTION:

$$\begin{aligned} \frac{11-8}{1+7 \cdot 2} &= \frac{11-8}{1+14} && \text{Multiply 7 by 2.} \\ &= \frac{3}{15} && \text{Subtract 8 from 11, add 1 and 14.} \\ &= \frac{1}{5} && \text{Simplify.} \end{aligned}$$

9. $\frac{(4 \cdot 3)^2}{9+3}$

SOLUTION:

$$\begin{aligned} \frac{(4 \cdot 3)^2}{9+3} &= \frac{(12)^2}{9+3} && \text{Multiply.} \\ &= \frac{144}{9+3} && \text{Evaluate the power.} \\ &= \frac{144}{12} && \text{Add.} \\ &= 12 && \text{Divide.} \end{aligned}$$

Evaluate each expression if $a = 4$, $b = 6$, and $c = 8$.

10. $8b - a$

SOLUTION:

Replace b with 6 and a with 4.

$$\begin{aligned} 8b - a &= 8(6) - 4 && \text{Substitute.} \\ &= 48 - 4 && \text{Multiply 8 by 6.} \\ &= 44 && \text{Subtract 4 from 48.} \end{aligned}$$

11. $2a + (b^2 \div 3)$

SOLUTION:

Replace a with 4 and b with 6.

$$\begin{aligned} 2a + (b^2 \div 3) & \\ &= 2(4) + (6^2 \div 3) && \text{Substitute.} \\ &= 2(4) + (36 \div 3) && \text{Evaluate powers.} \\ &= 8 + 12 && \text{Divide 36 by 3.} \\ &= 20 && \text{Add 8 and 12.} \end{aligned}$$

1-2 Order of Operations

12. $\frac{b(9-c)}{a^2}$

SOLUTION:

Replace a with 4 and b with 6.

$$\begin{aligned}\frac{b(9-c)}{a^2} &= \frac{6(9-8)}{4^2} && \text{Substitute.} \\ &= \frac{6(9-8)}{16} && \text{Evaluate powers.} \\ &= \frac{6(1)}{16} && \text{Subtract 8 from 9.} \\ &= \frac{6}{16} && \text{Multiply 6 by 1.} \\ &= \frac{3}{8} && \text{Simplify.}\end{aligned}$$

13. **BOOKS** Akira bought one new book for \$20 and three used books for \$4.95 each. Write and evaluate an expression to find how much money the books cost.

SOLUTION:

To find the cost of the used books, multiply the price by how many Akira purchased. The expression for the total cost is $20 + 3 \times 4.95$.

$$\begin{aligned}20 + 3 \times 4.95 &= 20 + 14.85 \\ &= 34.85\end{aligned}$$

So, the total cost is \$34.85.

14. **CCSS REASONING** Koto purchased food for herself and her friends. She bought 4 cheeseburgers for \$2.25 each, 3 French fries for \$1.25 each, and 4 drinks for \$4.00. Write and evaluate an expression to find how much the food cost.

SOLUTION:

To find the cost of each food item, the number of items purchased must be multiplied by the cost of each item. The expression for the total cost of the food is $4 \times 2.25 + 3 \times 1.25 + 4$. Note that the \$4 cost for the drinks is for all of the drinks *combined*.

$$4 \times 2.25 + 3 \times 1.25 + 4.00 = 9 + 3.75 + 4 = 16.75$$

So, Koto spent \$16.75 on food.

Evaluate each expression.

15. 7^2

SOLUTION:

$$\begin{aligned}7^2 &= 7 \cdot 7 && \text{Use 7 as a factor 2 times.} \\ &= 49 && \text{Multiply.}\end{aligned}$$

16. 14^3

SOLUTION:

$$\begin{aligned}14^3 &= 14 \cdot 14 \cdot 14 && \text{Use 14 as a factor 3 times.} \\ &= 2744 && \text{Multiply.}\end{aligned}$$

17. 2^6

SOLUTION:

$$\begin{aligned}2^6 &= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 && \text{Use 2 as a factor 6 times.} \\ &= 64 && \text{Multiply.}\end{aligned}$$

18. $35 - 3 \cdot 8$

SOLUTION:

$$\begin{aligned}35 - 3 \cdot 8 &= 35 - 24 && \text{Multiply 3 by 8.} \\ &= 11 && \text{Subtract 24 from 35.}\end{aligned}$$

19. $18 \div 9 + 2 \cdot 6$

SOLUTION:

$$\begin{aligned}18 \div 9 + 2 \cdot 6 &= 2 + 2 \cdot 6 && \text{Divide 18 by 9.} \\ &= 2 + 12 && \text{Multiply 2 by 6.} \\ &= 14 && \text{Add 2 and 12.}\end{aligned}$$

20. $10 + 8^3 \div 16$

SOLUTION:

$$\begin{aligned}10 + 8^3 \div 16 &= 10 + 512 \div 16 && \text{Evaluate powers.} \\ &= 10 + 32 && \text{Divide 512 by 16.} \\ &= 42 && \text{Add 10 and 32.}\end{aligned}$$

21. $24 \div 6 + 2^3 \cdot 4$

SOLUTION:

$$\begin{aligned}24 \div 6 + 2^3 \cdot 4 &&& \text{Original expression} \\ &= 24 \div 6 + 8 \cdot 4 && \text{Evaluate powers.} \\ &= 4 + 8 \cdot 4 && \text{Divide 24 by 6.} \\ &= 4 + 32 && \text{Multiply 8 by 4.} \\ &= 36 && \text{Add 4 and 32.}\end{aligned}$$

1-2 Order of Operations

22. $(11 \cdot 7) - 9 \cdot 8$

SOLUTION:

$$\begin{aligned}(11 \cdot 7) - 9 \cdot 8 & \text{ Original expression} \\ = (77) - 9 \cdot 8 & \text{ Multiply 11 by 7.} \\ = 77 - 72 & \text{ Multiply 9 by 8.} \\ = 5 & \text{ Subtract 72 from 77.}\end{aligned}$$

23. $29 - 3(9 - 4)$

SOLUTION:

$$\begin{aligned}29 - 3(9 - 4) & \text{ Original expression} \\ = 29 - 3(5) & \text{ Subtract 4 from 9.} \\ = 29 - 15 & \text{ Multiply 3 by 5.} \\ = 14 & \text{ Subtract 15 from 29.}\end{aligned}$$

24. $(12 - 6) \cdot 5^2$

SOLUTION:

$$\begin{aligned}(12 - 6) \cdot 5^2 & \text{ Original expression} \\ = (6) \cdot 5^2 & \text{ Subtract 6 from 12.} \\ = 6 \cdot 25 & \text{ Evaluate powers.} \\ = 150 & \text{ Multiply 6 by 25.}\end{aligned}$$

25. $3^5 - (1 + 10^2)$

SOLUTION:

$$\begin{aligned}3^5 - (1 + 10^2) & \text{ Original expression} \\ = 3^5 - (1 + 100) & \text{ Evaluate powers.} \\ = 3^5 - 101 & \text{ Add 1 and 100.} \\ = 243 - 101 & \text{ Evaluate powers.} \\ = 142 & \text{ Subtract 101 from 243.}\end{aligned}$$

26. $108 \div [3(9 + 3^2)]$

SOLUTION:

$$\begin{aligned}108 \div [3(9 + 3^2)] & \text{ Original expression} \\ = 108 \div [3(9 + 9)] & \text{ Evaluate powers.} \\ = 108 \div [3(18)] & \text{ Add 9 and 9.} \\ = 108 \div [54] & \text{ Multiply 3 by 18.} \\ = 2 & \text{ Divide 108 by 54.}\end{aligned}$$

27. $[(6^3 - 9) \div 23]4$

SOLUTION:

$$\begin{aligned}[(6^3 - 9) \div 23]4 & \text{ Original expression} \\ = [(216 - 9) \div 23]4 & \text{ Evaluate powers.} \\ = [(207) \div 23]4 & \text{ Subtract 9 from 216.} \\ = [9]4 & \text{ Divide 207 by 23.} \\ = 36 & \text{ Multiply 9 by 4.}\end{aligned}$$

28. $\frac{8 + 3^3}{12 - 7}$

SOLUTION:

$$\begin{aligned}\frac{8 + 3^3}{12 - 7} & = \frac{8 + 27}{12 - 7} \quad \text{Evaluate powers.} \\ & = \frac{35}{5} \quad 8 + 27 = 35, 12 - 7 = 5 \\ & = 7 \quad \text{Divide 35 by 7.}\end{aligned}$$

29. $\frac{(1 + 6)9}{5^2 - 4}$

SOLUTION:

$$\begin{aligned}\frac{(1 + 6)9}{5^2 - 4} & = \frac{(7)9}{25 - 4} \quad 1 + 6 = 7 \\ & = \frac{(7)9}{25 - 4} \quad \text{Evaluate powers.} \\ & = \frac{63}{21} \quad 7 \cdot 9 = 63, 25 - 4 = 21 \\ & = 3 \quad \text{Divide 63 by 21}\end{aligned}$$

Evaluate each expression if $g = 2$, $r = 3$, and $t = 11$.

30. $g + 6t$

SOLUTION:

Replace g with 2 and t with 11.

$$\begin{aligned}g + 6t & = 2 + 6(11) \quad \text{Substitute.} \\ & = 2 + 66 \quad \text{Multiply 2 and 11.} \\ & = 68 \quad \text{Add 2 and 66.}\end{aligned}$$

1-2 Order of Operations

31. $7 - gr$

SOLUTION:

Replace g with 2 and r with 3.

$$\begin{aligned}7 - gr &= 7 - (2)(3) && \text{Substitute.} \\ &= 7 - 6 && \text{Multiply 2 by 3.} \\ &= 1 && \text{Subtract 6 from 7.}\end{aligned}$$

32. $r^2 + (g^3 - 8)^3$

SOLUTION:

Replace g with 2 and r with 3.

$$\begin{aligned}r^2 + (g^3 - 8)^3 &= 3^2 + (2^3 - 8)^3 && \text{Substitute.} \\ &= 3^2 + (8 - 8)^3 && \text{Evaluate powers.} \\ &= 3^2 + (0)^3 && \text{Subtract 8 from 8} \\ &= 9 + 0 && \text{Evaluate powers.} \\ &= 9 && \text{Add 9 and 0.}\end{aligned}$$

33. $(2t + 3g) \div 4$

SOLUTION:

Replace g with 2 and t with 11.

$$\begin{aligned}(2t + 3g) \div 4 &= (2(11) + 3(2)) \div 4 && \text{Substitute.} \\ &= (22 + 6) \div 4 && \text{Multiply 2 by 11 and 3 by 2.} \\ &= (28) \div 4 && \text{Add 22 and 6.} \\ &= 7 && \text{Divide 28 by 4.}\end{aligned}$$

34. $t^2 + 8rt + r^2$

SOLUTION:

Replace t with 11 and r with 3.

$$\begin{aligned}t^2 + 8rt + r^2 &= 11^2 + 8(3)(11) + 3^2 && \text{Substitute.} \\ &= 121 + 8(3)(11) + 9 && \text{Evaluate powers.} \\ &= 121 + 264 + 9 && \text{Multiply 8 by 3 and 11.} \\ &= 394 && \text{Add 121, 264 and 9.}\end{aligned}$$

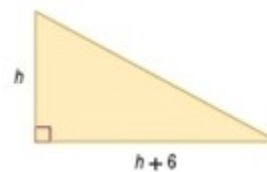
35. $3g(g + r)^2 - 1$

SOLUTION:

Replace g with 2 and r with 3.

$$\begin{aligned}3g(g + r)^2 - 1 &= 3(2)(2 + 3)^2 - 1 && \text{Substitute.} \\ &= 3(2)(5)^2 - 1 && \text{Add 2 and 3.} \\ &= 3(2)(25) - 1 && \text{Evaluate powers.} \\ &= 6(25) - 1 && \text{Multiply 3 by 2.} \\ &= 150 - 1 && \text{Multiply 6 by 25.} \\ &= 149 && \text{Subtract 1 from 150.}\end{aligned}$$

36. **GEOMETRY** Write an algebraic expression to represent the area of the triangle. Then evaluate it to find the area when $h = 12$ inches.



SOLUTION:

The formula for area of a triangle is $\frac{1}{2}bh$. This triangle has a base of $h + 6$ and a height of h . So, the expression for the area is $\frac{1}{2}h(h + 6)$.

Plug in 12 for h to evaluate the area. Replace a with 8, b with 4, and c with 16.

$$\begin{aligned}\frac{1}{2}h(h + 6) &= \frac{1}{2}(12)(12 + 6) && \text{Substitute.} \\ &= \frac{1}{2}(12)(18) && \text{Add 12 and 6.} \\ &= 6(18) && \text{Multiply } \frac{1}{2} \text{ and 12.} \\ &= 108 && \text{Multiply 6 and 18.}\end{aligned}$$

So, the area of the triangle is 108 square inches when the height is 12 inches.

1-2 Order of Operations

37. **AMUSEMENT PARKS** In 2004, there were 3344 amusement parks and arcades. This decreased by 148 by 2009. Write and evaluate an expression to find the number of amusement parks and arcades in 2009.

SOLUTION:

Since the word *decreased* suggests subtraction, the expression is $3344 - 148$. When evaluated, the difference is 3196. So, the number of amusement parks and arcades in 2009 was 3196.

38. **CCSS STRUCTURE** Kamilah works at the Duke University Athletic Ticket Office. If p represents a preferred season ticket, b represents a blue zone ticket, and g represents a general admission ticket, interpret and then evaluate the following expressions.

Duke University Football Ticket Prices	
Preferred Season Ticket	\$100
Blue Zone	\$80
General Admission	\$70

Source: Duke University

- a. $45b$
- b. $15p + 35g$
- c. $6p + 11b + 22g$

SOLUTION:

a. Since b represents a blue zone ticket, then $45b$ the cost of 45 blue zone tickets; $45(80) = \$3600$.

b. Since p represents a preferred season ticket and g represents a general admission tickets, then $15p + 35g$ represents the cost of 15 preferred and 35 general tickets; $15(100) + 35(70) = \$3950$.

c. Since p represents a preferred season ticket, b represents a blue zone ticket, and g represents a general admission ticket, then $6p + 11b + 22g$ represents the total cost of 6 preferred, 11 blue zone, and 22 general admission tickets; $6(100) + 11(80) + 22(70) = \3020 .

Evaluate each expression.

39. 4^2

SOLUTION:

$$4^2 = 4 \cdot 4 \quad \text{Use 4 as a factor 2 times.}$$

$$= 16 \quad \text{Multiply.}$$

40. 12^3

SOLUTION:

$$12^3 = 12 \cdot 12 \cdot 12 \quad \text{Use 12 as a factor 3 times.}$$

$$= 1728 \quad \text{Multiply.}$$

41. 3^6

SOLUTION:

$$3^6 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \quad \text{Use 3 as a factor 6 times.}$$

$$= 729 \quad \text{Multiply.}$$

42. 11^5

SOLUTION:

$$11^5 = 11 \cdot 11 \cdot 11 \cdot 11 \cdot 11 \quad \text{Use 11 as a factor 5 times.}$$

$$= 161,051 \quad \text{Multiply.}$$

43. $(3 - 4^2)^2 + 8$

SOLUTION:

$$(3 - 4^2)^2 + 8 \quad \text{Original expression}$$

$$= (3 - 16)^2 + 8 \quad \text{Evaluate powers.}$$

$$= (-13)^2 + 8 \quad \text{Subtract 16 from 3.}$$

$$= 169 + 8 \quad \text{Evaluate powers.}$$

$$= 177 \quad \text{Add 169 and 8.}$$

44. $23 - 2(17 + 3^3)$

SOLUTION:

$$23 - 2(17 + 3^3) \quad \text{Original expression}$$

$$= 23 - 2(17 + 27) \quad \text{Evaluate powers.}$$

$$= 23 - 2(44) \quad \text{Add 17 and 27.}$$

$$= 23 - 88 \quad \text{Multiply 2 by 44.}$$

$$= -65 \quad \text{Subtract 88 from 23.}$$

1-2 Order of Operations

45. $3[4 - 8 + 4^2(2 + 5)]$

SOLUTION:

$$\begin{aligned} 3[4 - 8 + 4^2(2 + 5)] & \text{ Original expression} \\ = 3[4 - 8 + 4^2(7)] & \text{ Add 2 and 5.} \\ = 3[4 - 8 + 16(7)] & \text{ Evaluate powers.} \\ = 3[4 - 8 + 112] & \text{ Multiply 16 and 7.} \\ = 3[-4 + 112] & \text{ Subtract 8 from 4.} \\ = 3[108] & \text{ Subtract 4 from 112.} \\ = 324 & \text{ Multiply 3 by 108.} \end{aligned}$$

46. $\frac{2 \cdot 8^2 - 2^2 \cdot 8}{2 \cdot 8}$

SOLUTION:

$$\begin{aligned} \frac{2 \cdot 8^2 - 2^2 \cdot 8}{2 \cdot 8} & \text{ Original expression} \\ = \frac{2 \cdot 64 - 4 \cdot 8}{2 \cdot 8} & \text{ Evaluate powers.} \\ = \frac{128 - 32}{2 \cdot 8} & 2 \cdot 64 = 128, 4 \cdot 8 = 32 \\ = \frac{128 - 32}{16} & \text{ Multiply 2 and 8} \\ = \frac{96}{16} & \text{ Subtract 32 from 128.} \\ = 6 & \text{ Simplify.} \end{aligned}$$

47. $25 + \left[(16 - 3 \cdot 5) + \frac{12 + 3}{5} \right]$

SOLUTION:

$$\begin{aligned} 25 + \left[(16 - 3 \cdot 5) + \frac{12 + 3}{5} \right] & \text{ Original expression.} \\ = 25 + \left[(16 - 15) + \frac{12 + 3}{5} \right] & \text{ Multiply 3 and 5.} \\ = 25 + \left[(16 - 15) + \frac{15}{5} \right] & \text{ Add 12 and 3.} \\ = 25 + [(1) + 3] & \text{ Subtract 15 from 16.} \\ = 25 + [4] & \text{ Add 1 and 3.} \\ = 29 & \text{ Add 25 and 4.} \end{aligned}$$

48. $7^3 - \frac{2}{3}(13 \cdot 6 + 9)4$

SOLUTION:

$$\begin{aligned} 7^3 - \frac{2}{3}(13 \cdot 6 + 9)4 & \text{ Original expression} \\ = 7^3 - \frac{2}{3}(78 + 9)4 & \text{ Multiply 13 and 6.} \\ = 7^3 - \frac{2}{3}(87)4 & \text{ Add 78 and 9.} \\ = 7^3 - (58)4 & \text{ Multiply } \frac{2}{3} \text{ and 87.} \\ = 343 - (58)4 & \text{ Evaluate powers.} \\ = 343 - 232 & \text{ Multiply 58 and 4.} \\ = 111 & \text{ Subtract 232 from 343.} \end{aligned}$$

Evaluate each expression if $a = 8$, $b = 4$, and $c = 16$.

49. $a^2bc - b^2$

SOLUTION:

Replace a with 8, b with 4, and c with 16.

$$\begin{aligned} a^2bc - b^2 & \\ = (8^2)(4)(16) - 4^2 & \text{ Substitute.} \\ = 64(4)(16) - 16 & \text{ Evaluate powers.} \\ = 256(16) - 16 & \text{ Multiply 64 and 4.} \\ = 4096 - 16 & \text{ Multiply 256 and 16.} \\ = 4080 & \text{ Subtract 16 from 4096.} \end{aligned}$$

50. $\frac{c^2}{b^2} + \frac{b^2}{a^2}$

SOLUTION:

Replace a with 8, b with 4, and c with 16.

$$\begin{aligned} \frac{c^2}{b^2} + \frac{b^2}{a^2} & = \frac{16^2}{4^2} + \frac{4^2}{8^2} \text{ Substitute.} \\ & = \frac{256}{16} + \frac{16}{64} \text{ Evaluate powers.} \\ & = 16 + \frac{1}{4} \text{ Simplify.} \\ & = 16\frac{1}{4} \text{ Add 16 and } \frac{1}{4}. \\ & = \frac{65}{4} \text{ Rewrite fraction.} \end{aligned}$$

1-2 Order of Operations

$$51. \frac{2b + 3c^2}{4a^2 - 2b}$$

SOLUTION:

Replace a with 8, b with 4, and c with 16.

$$\begin{aligned} \frac{2b + 3c^2}{4a^2 - 2b} &= \frac{2(4) + 3(16^2)}{4(8^2) - 2(4)} && \text{Substitute.} \\ &= \frac{2(4) + 3(256)}{4(64) - 2(4)} && \text{Evaluate powers.} \\ &= \frac{8 + 768}{4(64) - 2(4)} && 2 \cdot 4 = 8, 3 \cdot 256 = 768 \\ &= \frac{8 + 768}{256 - 8} && 4 \cdot 64 = 256, 2 \cdot 4 = 8 \\ &= \frac{776}{256 - 8} && \text{Add 8 and 768.} \\ &= \frac{776}{248} && \text{Subtract 8 from 256.} \\ &= \frac{97}{31} && \text{Simplify.} \end{aligned}$$

$$52. \frac{3ab + c^2}{a}$$

SOLUTION:

Replace a with 8, b with 4, and c with 16.

$$\begin{aligned} \frac{3ab + c^2}{a} &= \frac{3(8)(4) + 16^2}{8} && \text{Substitute.} \\ &= \frac{3(8)(4) + 256}{8} && \text{Evaluate powers.} \\ &= \frac{24(4) + 256}{8} && \text{Multiply 3 and 8.} \\ &= \frac{96 + 256}{8} && \text{Multiply 24 and 4.} \\ &= \frac{352}{8} && \text{Add 96 and 256.} \\ &= 44 && \text{Simplify.} \end{aligned}$$

$$53. \left(\frac{a}{b}\right)^2 - \frac{c}{a-b}$$

SOLUTION:

Replace a with 8, b with 4, and c with 16.

$$\begin{aligned} \left(\frac{a}{b}\right)^2 - \frac{c}{a-b} &= \left(\frac{8}{4}\right)^2 - \frac{16}{8-4} && \text{Substitute.} \\ &= (2)^2 - \frac{16}{4} && \text{Divide 8 by 4.} \\ &= (2)^2 - \frac{16}{4} && \text{Subtract 4 from 8.} \\ &= 4 - \frac{16}{4} && \text{Evaluate powers.} \\ &= 4 - 4 && \text{Divide 16 by 4.} \\ &= 0 && \text{Subtract 4 from 4.} \end{aligned}$$

$$54. \frac{2a-b^2}{ab} + \frac{c-a}{b^2}$$

SOLUTION:

Replace a with 8, b with 4, and c with 16.

$$\begin{aligned} \frac{2a-b^2}{ab} + \frac{c-a}{b^2} &= \frac{2(8)-4^2}{(8)(4)} + \frac{16-8}{4^2} && \text{Substitute.} \\ &= \frac{2(8)-16}{(8)(4)} + \frac{16-8}{16} && \text{Evaluate powers.} \\ &= \frac{16-16}{(8)(4)} + \frac{16-8}{16} && \text{Multiply 2 and 8.} \\ &= \frac{16-16}{32} + \frac{16-8}{16} && \text{Multiply 8 and 4.} \\ &= \frac{0}{32} + \frac{8}{16} && \text{Subtract 16 from 16.} \\ &= 0 + \frac{1}{2} && \text{Simplify.} \\ &= \frac{1}{2} && \text{Add } \frac{1}{2} \text{ and 0.} \end{aligned}$$

1-2 Order of Operations

55. **SALES** One day, 28 small and 12 large spaces were rented. Another day, 30 small and 15 large spaces were rented. Write and evaluate an expression to show the total rent collected.



SOLUTION:

To find how much money was earned for each type of space, multiply the number of spaces by the price per space. Then, to find the total cost, add each of these products together. So, the expression would be $28(7) + 12(9.75) + 30(7) + 15(9.75)$.

Evaluate the expression to find the total cost.

$$\begin{aligned} 28(7) + 12(9.75) + 30(7) + 15(9.75) \\ = 196 + 117 + 210 + 146.25 \\ = 669.25 \end{aligned}$$

The total amount of money collected was \$669.25.

56. **SHOPPING** Evelina is shopping for back-to-school clothes. She bought 3 skirts, 2 pairs of jeans, and 4 sweaters. Write and evaluate an expression to find out how much money Evelina spent on clothes, without including sales tax.

Clothing	
skirt	\$25.99
jeans	\$39.99
sweater	\$22.99

SOLUTION:

To find how much money Evelina spent on clothes, multiply the price of the item by the number bought. Then, to find the total cost, add each of these products together. So, the expression would be $3(25.99) + 2(39.99) + 4(22.99)$.

$$\begin{aligned} 3(25.99) + 2(39.99) + 4(22.99) \\ = 77.97 + 79.98 + 91.96 \\ = 249.91 \end{aligned}$$

Evelina spent \$249.91 on clothes, without including sales tax.

1-2 Order of Operations

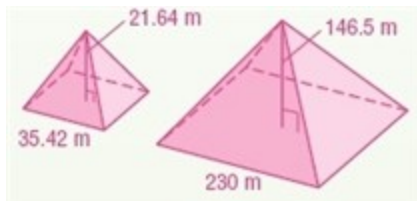
57. **PYRAMIDS** The pyramid at the Louvre has a square base with a side of 35.42 meters and a height of 21.64 meters. The Great Pyramid in Egypt has a square base with a side of 230 meters and a height of 146.5 meters.

The expression for the volume of a pyramid is $\frac{1}{3}Bh$, where B is the area of the base and h is the height.

- Draw both pyramids and label the dimensions.
- Write a verbal expression for the difference in volume of the two pyramids.
- Write an algebraic expression for the difference in volume of the two pyramids. Find the difference in volume.

SOLUTION:

a.



- The formula for the volume of a pyramid is one-third times the area of the base times the height. To find the difference in volume between the two pyramids, subtract them. The verbal expression is *one third times 230 squared times 146.5 minus one third times 35.42 squared times 21.64.*

- Change the words to numbers for the algebraic expression.

$$\begin{aligned} & \frac{1}{3}(230)^2(146.5) - \frac{1}{3}(35.42)^2(21.64) \\ & \approx 2,583,283.333 - 9049.677765 \\ & \approx 2,574,233.656 \end{aligned}$$

The difference in volume of the two pyramids is about 2,547,233.656 cubic meters.

58. **FINANCIAL LITERACY** A sales representative receives an annual salary s , an average commission each month c , and a bonus b for each sales goal that she reaches.

- Write an algebraic expression to represent her total earnings in one year if she receives four equal bonuses.
- Suppose her annual salary is \$52,000 and her average commission is \$1225 per month. If each of the four bonuses equals \$1150, what does she earn annually?

SOLUTION:

- To find the total salary, add her annual salary to 12 times her commission plus her 4 equal bonuses. So, the expression would be $s + 12c + 4b$.

- Evaluate the expression in part a when $s = 52,000$, $c = 1225$, and $b = 1150$.

$$\begin{aligned} s + 12c + 4b &= 52,000 + 12(1225) + 4(1150) \\ &= 52,000 + 14,700 + 4600 \\ &= 71,300 \end{aligned}$$

The sales representative earns \$71,300 a year.

59. **ERROR ANALYSIS** Tara and Curtis are simplifying $[4(10) - 3^2] + 6(4)$. Is either of them correct? Explain your reasoning.

Tara	Curtis
$= [4(10) - 9] + 6(4)$	$= [4(10) - 9] + 6(4)$
$= 4(1) + 6(4)$	$= (40 - 9) + 6(4)$
$= 4 + 6(4)$	$= 31 + 6(4)$
$= 4 + 24$	$= 31 + 24$
$= 28$	$= 55$

SOLUTION:

Tara did not follow the order of operations. She subtracted 9 from 10 before multiplying 4 by 10. Curtis did follow the order of operations.

Curtis is correct.

1-2 Order of Operations

60. **REASONING** Explain how to evaluate $a[(b - c) \div d] - f$ if you were given values for $a, b, c, d,$ and f . How would you evaluate the expression differently if the expression was $a \cdot b - c \div d - f$?

SOLUTION:

Sample answer: First subtract c from b and then divide by d . Then multiply that by a and then subtract f .

Without grouping symbols, first a and b would be multiplied together, then c would be divided by d , and then c divided by d would be subtracted from a multiplied by b . Then f would be subtracted from the result.

61. **CCSS PERSEVERANCE** Write an expression using the whole numbers 1 to 5 using all five digits and addition and/or subtraction to create a numeric expression with a value of 3.

SOLUTION:

$$\begin{aligned}5 + 4 - 3 - 2 - 1 &= 9 - 3 - 2 - 1 \\ &= 6 - 2 - 1 \\ &= 4 - 1 \\ &= 3\end{aligned}$$

62. **OPEN ENDED** Write an expression that uses exponents, at least three different operations and two sets of parentheses. Explain the steps you would take to evaluate the expression.

SOLUTION:

Sample answer: $[88 - (2 + 4)^2] \div 2^2 \cdot 2$ The first step to evaluating this expression is to add 2 and 4 in the parentheses. Next, raise that sum to the second power. Then, subtract this from 88 to evaluate the brackets. Fourth, square 2. Divide the bracket answer by the square of 2. Last, multiply the quotient by 2 to get the final answer.

63. **WRITING IN MATH** Choose a geometric formula and explain how the order of operations applies when using the formula.

SOLUTION:

Sample answer: Area of a trapezoid $\frac{1}{2}h(b_1 + b_2)$; according to order of operations you have to add the lengths of the bases together first and then multiply by the height and by $\frac{1}{2}$.

64. **WRITING IN MATH** Equivalent expressions have the same value. Are the expressions $(30 + 17) \times 10$ and $10 \times 30 + 10 \times 17$ equivalent? Explain why or why not?

SOLUTION:

The expressions are equivalent. To simplify the first expression, simplify the expression in the parentheses first to get 47. Then multiply by 10 to get 470.

$$\begin{aligned}(30 + 17) \times 10 &= (47) \times 10 \\ &= 470\end{aligned}$$

The order of operations states to multiply before adding. So, perform the multiplication first in the second expression. The result is $300 + 170$. Then add to get 470.

$$\begin{aligned}10 \times 30 + 10 \times 17 &= 300 + 170 \\ &= 470\end{aligned}$$

65. Let m represent the number of miles. Which algebraic expression represents the number of feet in m miles?

A $5280m$

B $\frac{5280}{m}$

C $m + 5280$

D $5280 - m$

SOLUTION:

There are 5280 feet in one mile. So, $5280m$ is the algebraic expression that represents the number of feet in one mile which is A, .

1-2 Order of Operations

66. SHORT RESPONSE

Simplify: $[10 + 15(2^3)] \div [7(2^2) - 2]$

Step 1 $[10 + 15(8)] \div [7(4) - 2]$

Step 2 $[10 + 120] \div [28 - 2]$

Step 3 $130 \div 26$

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

Which is the first *incorrect* step? Explain the error.

SOLUTION:

In Step 3, divide 130 by 26. The answer is 5. Step 4 states that the answer is $\frac{1}{5}$. This is incorrect.

67. **EXTENDED RESPONSE** Consider the rectangle below.



Part A Which expression models the area of the rectangle?

F $4 + 3 \times 8$

G $3 \times (4 + 8)$

H $3 \times 4 + 8$

J $3^2 + 8^2$

Part B Draw one or more rectangles to model the other expressions.

SOLUTION:

Part A

The group of squares on the left of the vertical black line is 3 squares by 4 squares, so they can be represented by 3×4 . The group of squares on the right of the vertical black line is 3 squares by 8 squares, so they can be represented by 3×8 . These two expressions can be combined into $3 \times (4 + 8)$ which is answer choice G.

Part B

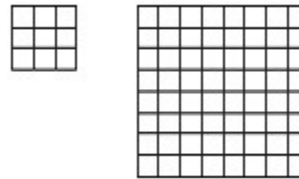
Choice F is a block of 4 squares in addition to a block of 3 squares by 8 squares.



Choice H is a block of 3 squares by 4 squares in addition to a block of 8 squares.

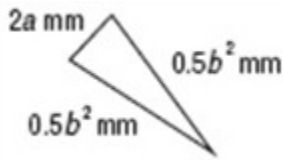


Choice J is a block of 3 squares by 3 squares in addition to a block of 8 squares by 8 squares.



1-2 Order of Operations

68. **GEOMETRY** What is the perimeter of the triangle if $a = 9$ and $b = 10$?



- A 164 mm
B 118 mm
C 28 mm
D 4 mm

SOLUTION:

First evaluate each side for $a = 9$ and $b = 10$.

$$\begin{aligned} 2a &= 2(9) \\ &= 18 \end{aligned}$$

$$\begin{aligned} 0.5b^2 &= 0.5(10)^2 \\ &= 0.5(100) \\ &= 50 \end{aligned}$$

So, the sides of the triangle are 18 millimeters, 50 millimeters, and 50 millimeters. To find the perimeter of a triangle, find the sum of the sides. $18 + 50 + 50 = 118$

So, the perimeter of the triangle is 118 millimeters. The correct answer is B.

Write a verbal expression for each algebraic expression.

69. $14 - 9c$

SOLUTION:

The expression shows the difference of two terms. The term $9c$ represents 9 times c . So, the verbal expression *14 minus 9 times c* can be used to describe the algebraic expression $14 - 9c$.

70. $k^3 + 13$

SOLUTION:

The expression shows the sum of two terms. The term k^3 represents k to the third power. So, the verbal expression *k cubed plus 13* can be used to describe the algebraic expression $k^3 + 13$.

71. $\frac{4 - v}{w}$

SOLUTION:

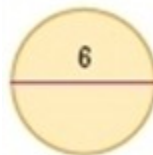
The expression shows the quotient of a difference and a number. So, the verbal expression *the difference of 4 and v divided by w* can be used to describe the algebraic expression $\frac{4 - v}{w}$.

72. **MONEY** Destiny earns \$8 per hour babysitting and \$15 for each lawn she mows. Write an expression to show the amount of money she earns babysitting h hours and mowing m lawns.

SOLUTION:

To find the money Destiny earns for each job, multiply the amount she earns by the number of hours or jobs she has done. She makes \$8 an hour babysitting and \$15 for each lawn she mows. So, $8h + 15m$ is an expression to show the amount of money she earns.

Find the area of each figure.



- 73.

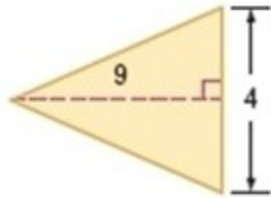
SOLUTION:

The radius is half the diameter, or 3.

$$\begin{aligned} A &= \pi r^2 && \text{Area formula.} \\ &= \pi \cdot 3^2 && \text{Replace } r \text{ with 3.} \\ &= \pi \cdot 9 && \text{Evaluate powers.} \\ &= 9\pi && \text{Simplify.} \end{aligned}$$

The area is 9π square units.

1-2 Order of Operations



74.

SOLUTION:

$$\begin{aligned}
 A &= \frac{1}{2}bh && \text{Area formula.} \\
 &= \frac{1}{2} \cdot 4 \cdot 9 && \text{Replace } b \text{ with 4 and } h \text{ with 9.} \\
 &= 18 && \text{Simplify.}
 \end{aligned}$$

The area of the triangle is 18 square units.



75.

SOLUTION:

$$\begin{aligned}
 A &= \ell w && \text{Area formula.} \\
 &= 12 \cdot b && \text{Replace } \ell \text{ with 12 and } w \text{ with } b. \\
 &= 12b && \text{Multiply 12 by } b.
 \end{aligned}$$

The area of the rectangle is $12b$ square units.

76. **SCHOOL** Aaron correctly answered 27 out of 30 questions on his last biology test. What percent of the questions did he answer correctly?

SOLUTION:

The part is 27 and the base is 30. Let p represent the percent.

$$\frac{a}{b} = \frac{p}{100} \quad \text{Percent Proportion}$$

$$\frac{27}{30} = \frac{p}{100} \quad a = 27, b = 30$$

$$27 \cdot 100 = 30 \cdot p \quad \text{Find the cross products.}$$

$$2700 = 30p \quad \text{Simplify.}$$

$$\frac{2700}{30} = \frac{30p}{30} \quad \text{Divide each side by 100.}$$

$$90 = p \quad \text{Simplify.}$$

Aaron answered 90% of the questions correctly.

Find the value of each expression.

77. $5.65 - 3.08$

SOLUTION:

$$\begin{aligned}
 5.65 - 3.08 &= 5.65 + (-3.08) \\
 &= 2.57
 \end{aligned}$$

78. $6 \div \frac{4}{5}$

SOLUTION:

$$\begin{aligned}
 6 \div \frac{4}{5} &= \frac{6}{1} \cdot \frac{5}{4} \\
 &= \frac{30}{4} \\
 &= \frac{15}{2}
 \end{aligned}$$

79. $4.85(2.72)$

SOLUTION:

The product of two integers with the same sign is positive.

$$4.85(2.72) = 13.192$$

80. $1\frac{1}{12} + 3\frac{2}{3}$

SOLUTION:

Write $1\frac{1}{12}$ as $\frac{13}{12}$ and $3\frac{2}{3}$ as $\frac{11}{3}$. The LCD for 12 and 3 is 12.

$$\begin{aligned}
 1\frac{1}{12} + 3\frac{2}{3} &= \frac{13}{12} + \frac{11}{3} \\
 &= \frac{13}{12} + \frac{44}{12} && \text{Rename } \frac{11}{3} \text{ as } \frac{44}{12}. \\
 &= \frac{57}{12} && \text{Add the numerators.} \\
 &= \frac{19}{4} && \text{Simplify.} \\
 &= 4\frac{3}{4} && \text{Evaluate powers.}
 \end{aligned}$$

1-2 Order of Operations

81. $\frac{4}{9} \cdot \frac{3}{2}$

SOLUTION:

Multiply the numerators and multiply the denominators.

$$\begin{aligned}\frac{4}{9} \cdot \frac{3}{2} &= \frac{4 \cdot 3}{9 \cdot 2} && \text{Multiply.} \\ &= \frac{12}{18} && \text{Simplify.} \\ &= \frac{2}{3} && \text{Simplify.}\end{aligned}$$

82. $7\frac{3}{4} - 4\frac{7}{10}$

SOLUTION:

Write $7\frac{3}{4}$ as $\frac{31}{4}$ and $4\frac{7}{10}$ as $\frac{47}{10}$. The LCD of 4 and 10 is 20.

$$\begin{aligned}7\frac{3}{4} - 4\frac{7}{10} &= \frac{31}{4} - \frac{47}{10} \\ &= \frac{155}{20} - \frac{94}{20} && \frac{31}{4} = \frac{155}{20}, \frac{47}{10} = \frac{94}{20} \\ &= \frac{61}{20} && \text{Subtract the numerators.} \\ &= 3\frac{1}{20} && \text{Simplify.}\end{aligned}$$

1-3 Properties of Numbers

Evaluate each expression. Name the property used in each step.

1. $(1 \div 5)5 \cdot 14$

SOLUTION:

$$\begin{aligned} & (1 \div 5)5 \cdot 14 \\ & = \frac{1}{5} \cdot 5 \cdot 14 && \text{Substitution} \\ & = 1 \cdot 14 && \text{Multiplicative Inverse} \\ & = 14 && \text{Multiplicative Identity} \end{aligned}$$

2. $6 + 4(19 - 15)$

SOLUTION:

$$\begin{aligned} & 6 + 4(19 - 15) \\ & = 6 + 4(4) && \text{Substitution} \\ & = 6 + 16 && \text{Substitution} \\ & = 22 && \text{Substitution} \end{aligned}$$

3. $5(14 - 5) + 6(3 + 7)$

SOLUTION:

$$\begin{aligned} & 5(14 - 5) + 6(3 + 7) \\ & = 5(9) + 6(10) && \text{Substitution} \\ & = 45 + 60 && \text{Substitution} \\ & = 105 && \text{Substitution} \end{aligned}$$

4. **FINANCIAL LITERACY** Carolyn has 9 quarters, 4 dimes, 7 nickels, and 2 pennies, which can be represented as $9(25) + 4(10) + 7(5) + 2$. Evaluate the expression to find how much money she has. Name the property used in each step.

SOLUTION:

$$\begin{aligned} & 9(25) + 4(10) + 7(5) + 2 \\ & = 225 + 40 + 35 + 2 && \text{Substitution} \\ & = 302 && \text{Substitution} \end{aligned}$$

Carolyn has 302¢ or \$3.02.

Evaluate each expression using the properties of numbers. Name the property used in each step.

5. $23 + 42 + 37$

SOLUTION:

$$\begin{aligned} & 23 + 42 + 37 \\ & = 23 + 37 + 42 && \text{Commutative (+)} \\ & = (23 + 27) + 42 && \text{Associative (+)} \\ & = 60 + 42 && \text{Substitution} \\ & = 102 && \text{Substitution} \end{aligned}$$

6. $2.75 + 3.5 + 4.25 + 1.5$

SOLUTION:

$$\begin{aligned} & 2.75 + 3.5 + 4.25 + 1.5 \\ & = 2.75 + 4.25 + 3.5 + 1.5 && \text{Comm. (+)} \\ & = (2.75 + 4.25) + (3.5 + 1.5) && \text{Assoc. (+)} \\ & = 7 + 5 && \text{Substitution} \\ & = 12 && \text{Substitution} \end{aligned}$$

7. $3 \cdot 7 \cdot 10 \cdot 2$

SOLUTION:

$$\begin{aligned} & 3 \cdot 7 \cdot 10 \cdot 2 \\ & = 3 \cdot 2 \cdot 7 \cdot 10 && \text{Commutative (}\times\text{)} \\ & = (3 \cdot 2) \cdot (7 \cdot 10) && \text{Associative (}\times\text{)} \\ & = 6 \cdot 70 && \text{Substitution} \\ & = 420 && \text{Substitution} \end{aligned}$$

8. $\frac{1}{4} \cdot 24 \cdot \frac{2}{3}$

SOLUTION:

$$\begin{aligned} & \frac{1}{4} \cdot 24 \cdot \frac{2}{3} \\ & = \frac{1}{4} \cdot \left(24 \cdot \frac{2}{3}\right) && \text{Associative (}\times\text{)} \\ & = \frac{1}{4} \cdot 16 && \text{Substitution} \\ & = 4 && \text{Substitution} \end{aligned}$$

1-3 Properties of Numbers

Evaluate each expression. Name the property used in each step.

9. $3(22 - 3 \cdot 7)$

SOLUTION:

$$\begin{aligned} & 3(22 - 3 \cdot 7) \\ &= 3(22 - 21) \\ &= 3(1) \\ &= 3 \end{aligned}$$

Substitution
Substitution
Multiplicative Identity

10. $7 + (9 - 3^2)$

SOLUTION:

$$\begin{aligned} & 7 + (9 - 3^2) \\ &= 7 + (9 - 9) \\ &= 7 + 0 \\ &= 7 \end{aligned}$$

Substitution
Additive Inverse
Additive Identity

11. $\frac{3}{4}[4 \div (7 - 4)]$

SOLUTION:

$$\begin{aligned} & \frac{3}{4}[4 \div (7 - 4)] \\ &= \frac{3}{4}[4 \div 3] \\ &= \frac{3}{4} \cdot \frac{4}{3} \\ &= 1 \end{aligned}$$

Substitution
Substitution
Multiplicative Inverse

12. $[3 \div (2 \cdot 1)] \frac{2}{3}$

SOLUTION:

$$\begin{aligned} & [3 \div (2 \cdot 1)] \frac{2}{3} \\ &= [3 \div 2] \frac{2}{3} \\ &= \frac{3}{2} \cdot \frac{2}{3} \\ &= 1 \end{aligned}$$

Multiplicative Identity
Substitution
Multiplicative Inverse

13. $2(3 \cdot 2 - 5) + 3 \cdot \frac{1}{3}$

SOLUTION:

$$\begin{aligned} & 2(3 \cdot 2 - 5) + 3 \cdot \frac{1}{3} \\ &= 2(6 - 5) + 3 \cdot \frac{1}{3} \\ &= 2(1) + 3 \cdot \frac{1}{3} \\ &= 2 + 3 \cdot \frac{1}{3} \\ &= 2 + 1 \\ &= 3 \end{aligned}$$

Substitution
Substitution
Multiplicative Identity
Multiplicative Inverse
Substitution

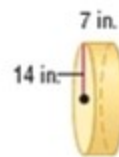
14. $6 \cdot \frac{1}{6} + 5(12 \div 4 - 3)$

SOLUTION:

$$\begin{aligned} & 6 \cdot \frac{1}{6} + 5(12 \div 4 - 3) \\ &= 6 \cdot \frac{1}{6} + 5(3 - 3) \\ &= 6 \cdot \frac{1}{6} + 5(0) \\ &= 6 \cdot \frac{1}{6} + 0 \\ &= 1 + 0 \\ &= 1 \end{aligned}$$

Substitution
Additive Inverse
Mult. Prop. of Zero
Multiplicative Inverse
Additive Identity

15. **GEOMETRY** The expression $2 \cdot \frac{22}{7} \cdot 14^2 + 2 \cdot \frac{22}{7} \cdot 14 \cdot 7$ represents the approximate surface area of the cylinder below. Evaluate this expression to find the approximate surface area. Name the property used in each step.



SOLUTION:

$$\begin{aligned} & 2 \cdot \frac{22}{7} \cdot 14^2 + 2 \cdot \frac{22}{7} \cdot 14 \cdot 7 \\ &= 2 \cdot \frac{22}{7} \cdot 196 + 2 \cdot \frac{22}{7} \cdot 14 \cdot 7 \quad \text{Substitution} \\ &= \frac{44}{7} \cdot 196 + \frac{44}{7} \cdot 14 \cdot 7 \quad \text{Substitution} \\ &= 1232 + 616 \quad \text{Substitution} \\ &= 1848 \quad \text{Substitution} \end{aligned}$$

So, the surface area is 1848 square inches.

1-3 Properties of Numbers

16. **CCSS REASONING** A traveler checks into a hotel on Friday and checks out the following Tuesday morning. Use the table to find the total cost of the room including tax.

Hotel Rates Per Day		
Day	Room Charge	Sales Tax
Monday–Friday	\$72	\$5.40
Saturday–Sunday	\$63	\$5.10

SOLUTION:

Let T = total cost of the room. Add the price of the room and sales tax for each day from Friday to Tuesday.

T = room and tax for Friday + room and tax for Saturday + room and tax for Sunday + room and tax for Monday

$$\begin{aligned} T &= (72 + 5.40) + (63 + 5.10) + (63 + 5.10) + (72 + 5.40) \\ &= 77.40 + 68.10 + 68.10 + 77.40 \\ &= 145.50 + 145.50 \\ &= 291 \end{aligned}$$

The total cost of the room is \$291.

Evaluate each expression using properties of numbers. Name the property used in each step.

17. $25 + 14 + 15 + 36$

SOLUTION:

$$\begin{aligned} &25 + 14 + 15 + 36 \\ &= 25 + 15 + 14 + 36 && \text{Commutative (+)} \\ &= (25 + 15) + (14 + 36) && \text{Associative (+)} \\ &= 40 + 50 && \text{Substitution} \\ &= 90 && \text{Substitution} \end{aligned}$$

18. $11 + 7 + 5 + 13$

SOLUTION:

$$\begin{aligned} &11 + 7 + 5 + 13 \\ &= 11 + 5 + 7 + 13 && \text{Commutative (+)} \\ &= (11 + 5) + (7 + 13) && \text{Associative (+)} \\ &= 16 + 20 && \text{Substitution} \\ &= 36 && \text{Substitution} \end{aligned}$$

19. $3\frac{2}{3} + 4 + 5\frac{1}{3}$

SOLUTION:

$$\begin{aligned} &3\frac{2}{3} + 4 + 5\frac{1}{3} \\ &= 3\frac{2}{3} + 5\frac{1}{3} + 4 && \text{Commutative (+)} \\ &= \left(3\frac{2}{3} + 5\frac{1}{3}\right) + 4 && \text{Associative (+)} \\ &= 9 + 4 && \text{Substitution} \\ &= 13 && \text{Substitution} \end{aligned}$$

20. $4\frac{4}{9} + 7\frac{2}{9}$

SOLUTION:

$$\begin{aligned} &4\frac{4}{9} + 7\frac{2}{9} \\ &= 4 + \frac{4}{9} + 7 + \frac{2}{9} && \text{Substitution} \\ &= 4 + 7 + \frac{4}{9} + \frac{2}{9} && \text{Commutative (+)} \\ &= 4 + 7 + \left(\frac{4}{9} + \frac{2}{9}\right) && \text{Associative (+)} \\ &= 11 + \frac{6}{9} && \text{Substitution} \\ &= 11\frac{6}{9} && \text{Substitution} \\ &= 11\frac{2}{3} && \text{Substitution} \end{aligned}$$

21. $4.3 + 2.4 + 3.6 + 9.7$

SOLUTION:

$$\begin{aligned} &4.3 + 2.4 + 3.6 + 9.7 \\ &= 4.3 + 9.7 + 2.4 + 3.6 && \text{Commutative (+)} \\ &= (4.3 + 9.7) + (2.4 + 3.6) && \text{Associative (+)} \\ &= 14 + 6 && \text{Substitution} \\ &= 20 && \text{Substitution} \end{aligned}$$

1-3 Properties of Numbers

22. $3.25 + 2.2 + 5.4 + 10.75$

SOLUTION:

$$\begin{aligned} & 3.25 + 2.2 + 5.4 + 10.75 \\ & = 3.25 + 10.75 + 2.2 + 5.4 && \text{Comm. (+)} \\ & = (3.25 + 10.75) + (2.2 + 5.4) && \text{Assoc. (+)} \\ & = 14 + 7.6 && \text{Substitution} \\ & = 21.6 && \text{Substitution} \end{aligned}$$

23. $12 \cdot 2 \cdot 6 \cdot 5$

SOLUTION:

$$\begin{aligned} & 12 \cdot 2 \cdot 6 \cdot 5 \\ & = 12 \cdot 6 \cdot 2 \cdot 5 && \text{Commutative (}\times\text{)} \\ & = (12 \cdot 6) \cdot (2 \cdot 5) && \text{Associative (}\times\text{)} \\ & = 72 \cdot 10 && \text{Substitution} \\ & = 720 && \text{Substitution} \end{aligned}$$

24. $2 \cdot 8 \cdot 10 \cdot 2$

SOLUTION:

$$\begin{aligned} & 2 \cdot 8 \cdot 10 \cdot 2 \\ & = (2 \cdot 8) \cdot (10 \cdot 2) && \text{Associative (}\times\text{)} \\ & = 16 \cdot 20 && \text{Substitution} \\ & = 320 && \text{Substitution} \end{aligned}$$

25. $0.2 \cdot 4 \cdot 6 \cdot 5$

SOLUTION:

$$\begin{aligned} & 0.2 \cdot 4 \cdot 6 \cdot 5 \\ & = (0.2 \cdot 4 \cdot 6) \cdot 5 && \text{Associative (}\times\text{)} \\ & = 0.92 \cdot 5 && \text{Substitution} \\ & = 4.6 && \text{Substitution} \end{aligned}$$

26. $3.5 \cdot 3 \cdot 6$

SOLUTION:

$$\begin{aligned} & 3.5 \cdot 3 \cdot 6 \\ & = 3.5 \cdot (3 \cdot 6) && \text{Associative (}\times\text{)} \\ & = 3.5 \cdot 18 && \text{Substitution} \\ & = 63 && \text{Substitution} \end{aligned}$$

27. $1\frac{5}{6} \cdot 24 \cdot 3\frac{1}{11}$

SOLUTION:

$$\begin{aligned} & 1\frac{5}{6} \cdot 24 \cdot 3\frac{1}{11} \\ & = 1\frac{5}{6} \cdot \left(24 \cdot 3\frac{1}{11}\right) && \text{Associative (}\times\text{)} \\ & = 1\frac{5}{6} \cdot \left(\frac{24}{1} \cdot \frac{34}{11}\right) && \text{Substitution} \\ & = 1\frac{5}{6} \cdot \frac{816}{11} && \text{Substitution} \\ & = \frac{11}{6} \cdot \frac{816}{11} && \text{Substitution} \\ & = \frac{8976}{66} && \text{Substitution} \\ & = 136 && \text{Substitution} \end{aligned}$$

28. $2\frac{3}{4} \cdot 1\frac{1}{8} \cdot 32$

SOLUTION:

$$\begin{aligned} & 2\frac{3}{4} \cdot 1\frac{1}{8} \cdot 32 \\ & = \left(2\frac{3}{4} \cdot 1\frac{1}{8}\right) \cdot 32 && \text{Associative (}\times\text{)} \\ & = \left(\frac{11}{4} \cdot \frac{9}{8}\right) \cdot 32 && \text{Substitution} \\ & = \frac{99}{32} \cdot 32 && \text{Substitution} \\ & = 99 && \text{Substitution} \end{aligned}$$

1-3 Properties of Numbers

29. **SCUBA DIVING** The sign shows the equipment rented or sold by a scuba diving store.

THE DEEP SCUBA SUPPLIES	
SPECIALS	
Underwater Camera	\$18.99
RENTALS	
Air Tanks	\$ 7.50
Wet Suit	\$10.95
Dive Flag	\$ 5.00

a. Write two expressions to represent the total sales after renting 2 wet suits, 3 air tanks, 2 dive flags, and selling 5 underwater cameras.

b. What are the total sales?

SOLUTION:

a. Sample answer: $2(10.95) + 3(7.5) + 2(5) + 5(18.99)$; $2(10.95 + 5) + 3(7.5) + 5(18.99)$

b.

$$\begin{aligned} &2(10.95) + 3(7.5) + 2(5) + 5(18.99) \\ &= 21.9 + 22.5 + 10 + 94.95 \\ &= 149.35 \end{aligned}$$

The total sales are \$149.35.

30. **COOKIES** Bobby baked 2 dozen chocolate chip cookies, 3 dozen sugar cookies, and a dozen oatmeal raisin cookies. How many total cookies did he bake?

SOLUTION:

Let T represent the total number of cookies. There are 12 cookies in one dozen.

$$\begin{aligned} T &= 2(12) + 3(12) + 1(12) \\ &= 24 + 36 + 12 \\ &= (24 + 36) + 12 \\ &= 60 + 12 \\ &= 72 \end{aligned}$$

Bobby baked a total of 72 cookies.

Evaluate each expression if $a = -1$, $b = 4$, and $c = 6$.

31. $4a + 9b - 2c$

SOLUTION:

$$\begin{aligned} 4a + 9b - 2c &= 4(-1) + 9(4) - 2(6) \\ &= -4 + 36 - 12 \\ &= 32 - 12 \\ &= 20 \end{aligned}$$

32. $-10c + 3a + a$

SOLUTION:

$$\begin{aligned} -10c + 3a + a &= -10(6) + 3(-1) + (-1) \\ &= -60 + (-3) + (-1) \\ &= -63 + (-1) \\ &= -64 \end{aligned}$$

33. $a - b + 5a - 2b$

SOLUTION:

$$\begin{aligned} a - b + 5a - 2b &= (-1) - 4 + 5(-1) - 2(4) \\ &= -1 - 4 + (-5) - 8 \\ &= (-1 - 4) + (-5 - 8) \\ &= -5 + (-13) \\ &= -18 \end{aligned}$$

34. $8a + 5b - 11a - 7b$

SOLUTION:

$$\begin{aligned} 8a + 5b - 11a - 7b &= 8(-1) + 5(4) - 11(-1) - 7(4) \\ &= -8 + 20 + 11 - 28 \\ &= (-8 + 20) + (11 - 28) \\ &= 12 + (-17) \\ &= -5 \end{aligned}$$

35. $3c^2 + 2c + 2c^2$

SOLUTION:

$$\begin{aligned} 3c^2 + 2c + 2c^2 &= 3(6^2) + 2(6) + 2(6^2) \\ &= 3(36) + 2(6) + 2(36) \\ &= 108 + 12 + 72 \\ &= (108 + 12) + 72 \\ &= 120 + 72 \\ &= 192 \end{aligned}$$

1-3 Properties of Numbers

36. $3a - 4a^2 + 2a$

SOLUTION:

$$\begin{aligned} 3a - 4a^2 + 2a &= 3(-1) - 4(-1)^2 + 2(-1) \\ &= -3 - 4(1) - 2 \\ &= -3 - 4 - 2 \\ &= (-3 - 4) - 2 \\ &= -7 - 2 \\ &= -9 \end{aligned}$$

37. **FOOTBALL** A football team is on the 35-yard line. The quarterback is sacked at the line of scrimmage. The team gains 0 yards, so they are still at the 35-yard line. Which identity or property does this represent? Explain.

SOLUTION:

If a football team starts on the 35-yard line and gains zero yards, it can be represented by the equation $35 + 0 = 35$. This represents the Additive Identity, which states that the sum of any number and zero is equal to the number.

Find the value of x . Then name the property used.

38. $8 = 8 + x$

SOLUTION:

Because $8 + 0 = 8$, $x = 0$.
Additive Identity

39. $3.2 + x = 3.2$

SOLUTION:

Because $3.2 + 0 = 3.2$, $x = 0$.
Additive Identity

40. $10x = 10$

SOLUTION:

Because $10(1) = 10$, $x = 1$.
Multiplicative Identity

41. $\frac{1}{2} \cdot x = \frac{1}{2} \cdot 7$

SOLUTION:

Because $\frac{1}{2} \cdot 7 = \frac{1}{2} \cdot 7$, $x = 7$.
Reflexive Property

42. $x + 0 = 5$

SOLUTION:

Because $5 + 0 = 5$, $x = 5$.
Additive Identity

43. $1 \cdot x = 3$

SOLUTION:

Because $1 \cdot 3 = 3$, $x = 3$.
Multiplicative Identity

44. $5 \cdot \frac{1}{5} = x$

SOLUTION:

Because $5 \cdot \frac{1}{5} = 1$, $x = 1$.
Multiplicative Inverse

45. $2 + 8 = 8 + x$

SOLUTION:

Because $2 + 8 = 8 + 2$, $x = 2$.
Commutative Property

46. $x + \frac{3}{4} = 3 + \frac{3}{4}$

SOLUTION:

Because $3 + \frac{3}{4} = 3 + \frac{3}{4}$, $x = 3$.
Reflexive Property

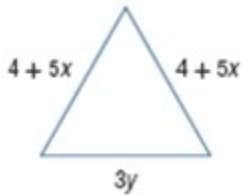
47. $\frac{1}{3} \cdot x = 1$

SOLUTION:

Because $\frac{1}{3} \cdot 3 = 1$, $x = 3$.
Multiplicative Inverse

1-3 Properties of Numbers

48. **GEOMETRY** Write an expression to represent the perimeter of the triangle. Then find the perimeter if $x = 2$ and $y = 7$.



SOLUTION:

To write an expression for the perimeter, add all three sides of the triangle.

$$(4 + 5x) + (4 + 5x) + (3y) = 4 + 5x + 4 + 5x + 3y$$

To find the perimeter, evaluate the expression above when $x = 2$ and $y = 7$.

$$\begin{aligned} 4 + 5x + 4 + 5x + 3y &= 4 + 5(2) + 4 + 5(2) + 3(7) \\ &= 4 + 10 + 4 + 10 + 21 \\ &= 14 + 14 + 21 \\ &= 28 + 21 \\ &= 49 \end{aligned}$$

So, the perimeter is 49 units.

49. **SPORTS** Tickets to a baseball game cost \$25 each plus a \$4.50 handling charge per ticket. If Sharon has a coupon for \$10 off and orders 4 tickets, how much will she be charged?

SOLUTION:

To find how much Sharon will pay for 4 tickets at \$25, you must multiply. You also need to take into account the \$4.50 handling charge per ticket and her \$10 off coupon. Let C represent the total cost. Write an equation.

$$\begin{aligned} C &= (4 \cdot 25) + (4 \cdot 4.50) - 10 \\ &= 100 + 18 - 10 \\ &= 118 - 10 \\ &= 108 \end{aligned}$$

So, Sharon will be charged \$108.

50. **CCSS PRECISION** The table shows the prices on children's clothing.

- a. Interpret the expression $5(8.99) + 2(2.99) + 7(5.99)$.

- b. Write and evaluate three different expressions that represent 8 pairs of shorts and 8 tops.

- c. If you buy 8 shorts and 8 tops, you receive a discount of 15%. Find the greatest and least amount of money you can spend on the 16 items at the sale.

Shorts	Shirts	Tank Tops
\$7.99	\$8.99	\$6.99
\$5.99	\$4.99	\$2.99

SOLUTION:

- a. The cost of a shirt is \$8.99, so the cost for 5 shirts is $5(8.99)$.

The cost of a tank top is \$2.99, so the cost 2 tank tops is $2(2.99)$.

The cost of a pair of shorts is \$5.99, so the cost of 7 shorts is $7(5.99)$.

$5(8.99) + 2(2.99) + 7(5.99)$ represents the total cost for 5 shirts, 2 tank tops, and 7 shorts.

- b. Select 8 shorts at \$ 7.99 and 4 tops at \$4.99 and 4 at \$6.99.

$$\begin{aligned} &8(7.99) + 4(4.99) + 4(6.99) \\ &= 63.92 + 19.96 + 27.96 \\ &= 111.84 \end{aligned}$$

Select 4 shorts at \$ 7.99 and 4 shorts at \$5.00. Then choose 4 tops at \$4.99 and 4 at \$2.99.

$$\begin{aligned} &4(7.99) + 4(5.99) + 4(4.99) + 4(2.99) \\ &= 31.96 + 23.96 + 19.96 + 11.96 \\ &= 87.84 \end{aligned}$$

Select 8 shorts at \$ 5.99 and 4 tops at \$8.99 and 4 at \$2.99.

$$\begin{aligned} &8(5.99) + 4(8.99) + 4(2.99) \\ &= 47.92 + 35.96 + 11.96 \\ &= 95.84 \end{aligned}$$

- c. The greatest amount of money you could spend on 8 shorts and 8 tops is if you purchase the most expensive shorts and tops.

1-3 Properties of Numbers

$$8(7.99) + 8(8.99) = 63.92 + 71.92 \\ = 135.84$$

A 15% discount is the same as 85% of the total price.

$$135.84 \cdot 0.85 \approx 115.46$$

The most the 16 items can cost is \$115.46.

The least amount of money you could spend on 8 shorts and 8 tops is if you purchase the least expensive shorts and tops.

$$8(5.99) + 8(2.99) = 47.92 + 23.92 \\ = 71.84$$

A 15% discount is the same as 85% of the total price.

$$71.84 \cdot 0.85 \approx 61.06$$

The least the 16 items can cost is \$61.06.

51. **GEOMETRY** A regular octagon measures $(3x + 5)$ units on each side. What is the perimeter if $x = 2$?

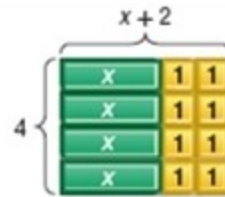
SOLUTION:

The perimeter is equal to the sum of the sides of the octagon. Because there are 8 equal sides, the perimeter of the octagon can be represented by the equation $P = 8(3x + 5)$. Substitute $x = 2$ into the equation and solve.

$$P = 8[3(2) + 5] \\ = 8[6 + 5] \\ = 8[11] \\ = 88$$

The perimeter is 88 units.

52. **MULTIPLE REPRESENTATIONS** You can use *algebra tiles* to model and explore algebraic expressions. The rectangular tile has an area of x , with dimensions 1 by x . The small square tile has an area of 1, with dimensions 1 by 1.



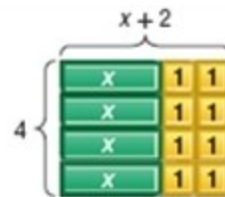
- a. **CONCRETE** Make a rectangle with algebra tiles to model the expression $4(x + 2)$ as shown above. What are the dimensions of this rectangle? What is its area?

- b. **ANALYTICAL** What are the areas of the green region and of the yellow region?

- c. **VERBAL** Complete this statement: $4(x + 2) = \underline{\quad}$. Write a convincing argument to justify your statement.

SOLUTION:

a.



length: $x + 2$; width: 4

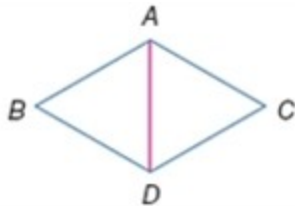
$$A = lw \\ = (x + 2) \cdot 4 \\ = 4(x + 2)$$

- b. The area of the green region is $4x$.
The area of the yellow section is $4 \cdot 2$ or 8.

- c. The area of the rectangle is $x + 1 + 1 + x + 1 + 1 + x + 1 + 1 + x + 1 + 1$ or $4x + 8$. Therefore, $4(x + 2) = 4x + 8$.

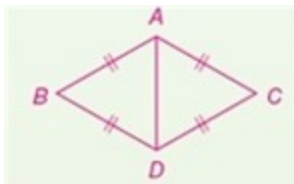
1-3 Properties of Numbers

53. **GEOMETRY** A proof is a logical argument in which each statement you make is supported by a statement that is accepted as true. It is given that $\overline{AB} \cong \overline{CD}$, $\overline{AB} \cong \overline{BD}$, and $\overline{AB} \cong \overline{AC}$. Pedro wants to prove $\triangle ADB \cong \triangle ADC$. To do this, he must show that $\overline{AD} \cong \overline{AD}$, $\overline{AB} \cong \overline{DC}$, and $\overline{BD} \cong \overline{AC}$.



- a. Copy the figure and label on your drawing that $\overline{AB} \cong \overline{CD}$, $\overline{AB} \cong \overline{BD}$, and $\overline{AB} \cong \overline{AC}$.
- b. Explain how he can use the Reflexive and Transitive Properties to prove $\triangle ADB \cong \triangle ADC$.
- c. If the length of \overline{AC} is x cm, write an equation for the perimeter of the quadrilateral $ACDB$.

SOLUTION:



- a.
- b. $\overline{AD} \cong \overline{AD}$ by the Reflexive Property. The Transitive Property shows that if $\overline{AB} \cong \overline{AC}$ and $\overline{AC} \cong \overline{DC}$, then $\overline{AB} \cong \overline{DC}$, and if $\overline{AB} \cong \overline{BD}$ and $\overline{AB} \cong \overline{AC}$, then $\overline{BD} \cong \overline{AC}$.
- c. $P = x + x + x + x$

54. **OPEN ENDED** Write two equations showing the Transitive Property of Equality. Justify your reasoning.

SOLUTION:

Sample answer: Consider the two equations $5 = 3 + 2$ and $3 + 2 = 4 + 1$. Since each equation has a $3 + 2$, we can substitute 5 for $3 + 2$ in the second equation. Then $5 = 4 + 1$.

Consider the two equations, $5 + 7 = 8 + 4$ and $8 + 4 = 12$. Since each equation has $8 + 4$, we can substitute $5 + 7$ for $8 + 4$ in the second equation. Then $5 + 7 = 12$.

55. **CCSS ARGUMENTS** Explain why 0 has no multiplicative inverse.

SOLUTION:

Sample answer: You cannot divide by 0.

56. **REASONING** The sum of any two whole numbers is always a whole number. So, the set of whole numbers $\{0, 1, 2, 3, 4, \dots\}$ is said to be closed under addition. This is an example of the Closure Property. State whether each statement is *true* or *false*. If false, justify your reasoning.

a. The set of whole numbers is closed under subtraction.

b. The set of whole numbers is closed under multiplication.

c. The set of whole numbers is closed under division.

SOLUTION:

a. False; Sample answer: $3 - 4 = -1$, which is not a whole number.

b. true

c. False; Sample answer: $2 \div 3 = \frac{2}{3}$, which is not a whole number.

1-3 Properties of Numbers

57. **CHALLENGE** Does the Commutative Property *sometimes*, *always* or *never* hold for subtraction? Explain your reasoning.

SOLUTION:

Sometimes; when a number is subtracted by itself then it holds but otherwise it does not.

58. **REASONING** Explain whether 1 can be an additive identity. Give an example to justify your answer.

SOLUTION:

No; $3 + 1 \neq 3$

59. **WHICH ONE DOESN'T BELONG?** Identify the equation that does not belong with the other three. Explain your reasoning.

$$x + 12 = 12 + x$$

$$7h = h \cdot 7$$

$$1 + a = a + 1$$

$$(2j)k = 2(jk)$$

SOLUTION:

$(2j)k = 2(jk)$; The other three equations illustrate the Commutative Property of Addition or Multiplication. This equation represents the Associative Property of Multiplication.

60. **WRITING IN MATH** Determine whether the Commutative Property applies to division. Justify your answer.

SOLUTION:

The Commutative Property does not apply to division. For $a \div b = b \div a$ to be true, a and b must be nonzero and equal or opposites.

61. A deck is shaped like a rectangle with a width of 12 feet and a length of 15 feet. What is the area of the deck?

A 3 ft^2

B 27 ft^2

C 108 ft^2

D 180 ft^2

SOLUTION:

$$\begin{aligned} A &= \ell w \\ &= (12)(15) \\ &= 180 \end{aligned}$$

The area is 180 square feet, so the answer is D.

1-3 Properties of Numbers

62. **GEOMETRY** A box in the shape of a rectangular prism has a volume of 56 cubic inches. If the length of each side is multiplied by 2, what will be the approximate volume of the box?



F 112 in.^3

G 224 in.^3

H 336 in.^3

J 448 in.^3

SOLUTION:

If every side length is doubled and we know that $V = lwh$, replace l , w , and h , with $2l$, $2w$, and $2h$, respectively.

$$V = lwh = 56$$

$$V = (2l)(2w)(2h)$$

$$= 8lwh$$

$$= 8(56)$$

$$= 448$$

The volume is 448 cubic inches, so the answer is J.

63. $27 \div 3 + (12 - 4) =$

A $\frac{11}{5}$

B $\frac{27}{11}$

C 17

D 25

SOLUTION:

$$27 \div 3 + (12 - 4) = 9 + 8$$

$$= 17$$

The answer is C.

64. **GRIDDED RESPONSE** Ms. Beal had 1 bran muffin, 16 ounces of orange juice, 3 ounces of sunflower seeds, 2 slices of turkey, and half a cup of spinach. Find the total number of grams of protein she consumed.

Protein Content	
Food	Protein (g)
bran muffin (1)	3
orange juice (8 oz)	2
sunflower seeds (1 oz)	2
turkey (1 slice)	12
spinach (1 c)	5

SOLUTION:

$$1(3) + 2(2) + 3(2) + 2(12) + \frac{1}{2}(5)$$

$$= 3 + 4 + 6 + 24 + 2.5$$

$$= 39.5$$

Ms. Beal consumed 39.5 grams of protein.

Evaluate each expression.

65. $3 \cdot 5 + 1 - 2$

SOLUTION:

$$3 \cdot 5 + 1 - 2 \quad \text{Original expression}$$

$$= 15 + 1 - 2 \quad \text{Multiply 3 by 5.}$$

$$= 16 - 2 \quad \text{Add 15 and 1.}$$

$$= 14 \quad \text{Subtract 2 from 16.}$$

66. $14 \div 2 \cdot 6 - 5^2$

SOLUTION:

$$14 \div 2 \cdot 6 - 5^2 \quad \text{Original expression}$$

$$= 14 \div 2 \cdot 6 - 25 \quad \text{Evaluate powers.}$$

$$= 7 \cdot 6 - 25 \quad \text{Divide 14 by 2.}$$

$$= 42 - 25 \quad \text{Multiply 7 by 6.}$$

$$= 17 \quad \text{Subtract 25 from 42.}$$

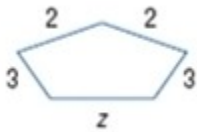
1-3 Properties of Numbers

$$67. \frac{3 \cdot 9^2 - 3^2 \cdot 9}{3 \cdot 9}$$

SOLUTION:

$$\begin{aligned} & \frac{3 \cdot 9^2 - 3^2 \cdot 9}{3 \cdot 9} && \text{Original expression} \\ & = \frac{3 \cdot 81 - 9 \cdot 9}{3 \cdot 9} && \text{Evaluate powers.} \\ & = \frac{243 - 81}{3 \cdot 9} && \text{Multiply 3 by 81 and 9 by 9.} \\ & = \frac{243 - 81}{27} && \text{Multiply 3 by 9.} \\ & = \frac{162}{27} && \text{Subtract 81 from 243.} \\ & = 6 && \text{Simplify.} \end{aligned}$$

68. **GEOMETRY** Write an expression for the perimeter of the figure.



SOLUTION:

To find the perimeter, find the sum of all the side lengths.

$$\begin{aligned} P &= 3 + 2 + 2 + 3 + z \\ &= 10 + z \end{aligned}$$

Find the perimeter and area of each figure.

69. a rectangle with length 5 feet and width 8 feet

SOLUTION:

Use the formula $P = 2l + 2w$ to find the perimeter of the rectangle.

$$\begin{aligned} P &= 2(5) + 2(8) \\ &= 10 + 16 \\ &= 26 \end{aligned}$$

The perimeter is 26 feet. Next, use the formula $A = lw$ to find the area of the rectangle.

$$\begin{aligned} A &= 5(8) \\ &= 40 \end{aligned}$$

The area is 40 square feet.

70. a square with length 4.5 inches

SOLUTION:

Use the formula $P = 4s$ to find the perimeter of the square.

$$\begin{aligned} P &= 4(4.5) \\ &= 18 \end{aligned}$$

The perimeter is 18 inches.

Use the formula $A = s^2$ to find the area of the square.

$$\begin{aligned} A &= 4.5(4.5) \\ &= 20.25 \end{aligned}$$

The area is 20.25 square inches.

71. **SURVEY** Andrew took a survey of his friends to find out their favorite type of music. Of the 34 friends surveyed, 22 said they liked rock music the best. What percent like rock music the best?

SOLUTION:

The part is 22 and the base is 34. Let p represent the percent.

$$\begin{aligned} \frac{a}{b} &= \frac{p}{100} && \text{Percent Proportion} \\ \frac{22}{34} &= \frac{p}{100} && a = 22, b = 34 \\ 34p &= 2200 && \text{Find the cross products.} \\ 34p &= 2200 && \text{Find the cross products.} \\ p &\approx 64.7 && \text{Evaluate powers.} \end{aligned}$$

About 64.7% like rock music best.

Name the reciprocal of each number.

72. $\frac{6}{17}$

SOLUTION:

Because $\frac{6}{17} \cdot \frac{17}{6} = 1$, the reciprocal is $\frac{17}{6}$.

1-3 Properties of Numbers

$$73. \frac{2}{23}$$

SOLUTION:

Because $\frac{2}{23} \cdot \frac{23}{2} = 1$, the reciprocal is $\frac{23}{2}$.

$$74. 3\frac{4}{5}$$

SOLUTION:

$$3\frac{4}{5} = \frac{19}{5}$$

Because $\frac{19}{5} \cdot \frac{5}{19} = 1$, the reciprocal is $\frac{5}{19}$.

So, the reciprocal is $\frac{5}{19}$.

Find each product. Express in simplest form.

$$75. \frac{12}{15} \cdot \frac{3}{14}$$

SOLUTION:

$$\begin{aligned} \frac{12}{15} \cdot \frac{3}{14} &= \frac{\cancel{12}^6 \cdot 3}{15 \cdot \cancel{14}_7} \\ &= \frac{6 \cdot 3}{15 \cdot 7} && \text{Divide by GCF, 2.} \\ &= \frac{36}{210} && \text{Multiply.} \\ &= \frac{6}{35} && \text{Simplify.} \end{aligned}$$

$$76. \frac{5}{7} \cdot \left(-\frac{4}{5}\right)$$

SOLUTION:

$$\begin{aligned} \frac{5}{7} \cdot \left(-\frac{4}{5}\right) &= \frac{\cancel{5}^1 \cdot (-4)}{7 \cdot \cancel{5}_1} \\ &= \frac{1 \cdot (-4)}{7 \cdot 1} && \text{Divide by GCF, 5.} \\ &= -\frac{4}{7} && \text{Multiply.} \end{aligned}$$

$$77. \frac{10}{11} \cdot \frac{21}{35}$$

SOLUTION:

$$\begin{aligned} \frac{10}{11} \cdot \frac{21}{35} &= \frac{\cancel{10}^2 \cdot 21}{11 \cdot \cancel{35}_7} \\ &= \frac{2 \cdot 21}{11 \cdot 7} && \text{Divide by the GCF, 5.} \\ &= \frac{210}{385} && \text{Multiply.} \\ &= \frac{6}{11} && \text{Simplify.} \end{aligned}$$

$$78. \frac{63}{65} \cdot \frac{120}{126}$$

SOLUTION:

$$\begin{aligned} \frac{63}{65} \cdot \frac{120}{126} &= \frac{\cancel{63}^9 \cdot \cancel{120}^{24}}{\cancel{65}^{13} \cdot \cancel{126}_2} \\ &= \frac{1 \cdot 24}{13 \cdot 2} && \text{Divide by GCF, 315.} \\ &= \frac{24}{26} && \text{Multiply.} \\ &= \frac{12}{13} && \text{Simplify.} \end{aligned}$$

$$79. -\frac{4}{3} \cdot \left(-\frac{9}{2}\right)$$

SOLUTION:

$$\begin{aligned} -\frac{4}{3} \cdot \left(-\frac{9}{2}\right) &= \frac{-4 \cdot (-9)}{3 \cdot 2} \\ &= \frac{2 \cdot 3}{1 \cdot 1} && \text{Divide by the GCF, 6.} \\ &= \frac{6}{1} && \text{Multiply.} \\ &= 6 && \text{Simplify.} \end{aligned}$$

1-3 Properties of Numbers

80. $\frac{1}{3} \cdot \frac{2}{5}$

SOLUTION:

$$\frac{1}{3} \cdot \frac{2}{5} = \frac{1 \cdot 2}{3 \cdot 5} \quad \text{Multiply.}$$

$$= \frac{2}{15} \quad \text{Simplify.}$$

1-4 The Distributive Property

1. **PILOT** A pilot at an air show charges \$25 per passenger for rides. If 12 adults and 15 children ride in one day, write and evaluate an expression to describe the situation.

SOLUTION:

If she took 12 adults and 15 children for rides in one day, then she earned $25(12 + 15)$ dollars.

$$\begin{aligned}25(12 + 15) &= 25(12) + 25(15) \\ &= 300 + 375 \\ &= 675\end{aligned}$$

So, the pilot earned \$675.

Use the Distributive Property to rewrite each expression. Then evaluate.

2. $14(51)$

SOLUTION:

$$\begin{aligned}14(51) &= 14(50 + 1) && \text{Rewrite 51 as } 50 + 1. \\ &= 14(50) + 14(1) && \text{Distributive Property} \\ &= 700 + 14 && \text{Multiply.} \\ &= 714 && \text{Add.}\end{aligned}$$

3. $6\frac{1}{9}(9)$

SOLUTION:

$$\begin{aligned}6\frac{1}{9}(9) &= \left(6 + \frac{1}{9}\right)9 && \text{Rewrite } 6\frac{1}{9} \text{ as } 6 + \frac{1}{9}. \\ &= 6(9) + \frac{1}{9}(9) && \text{Distributive Property} \\ &= 54 + 1 && \text{Multiply.} \\ &= 55 && \text{Add.}\end{aligned}$$

Use the Distributive Property to rewrite each expression. Then simplify.

4. $2(4 + t)$

SOLUTION:

$$\begin{aligned}2(4 + t) &= 2(4) + 2(t) \\ &= 8 + 2t\end{aligned}$$

5. $(g - 9)5$

SOLUTION:

$$\begin{aligned}(g - 9)5 &= g(5) + (-9)(5) \\ &= 5g - 45\end{aligned}$$

Simplify each expression. If not possible, write *simplified*.

6. $15m + m$

SOLUTION:

$$\begin{aligned}15m + m &= (15 + 1)m \\ &= 16m\end{aligned}$$

7. $3x^3 + 5y^3 + 14$

SOLUTION:

The expression $3x^3 + 5y^3 + 14$ is simplified because it contains no like terms or parentheses.

8. $(5m + 2m)10$

SOLUTION:

$$\begin{aligned}(5m + 2m)10 &= 10(5m) + 10(2m) \\ &= 50m + 20m \\ &= (50 + 20)m \\ &= 70m\end{aligned}$$

Write an algebraic expression for each verbal expression. Then simplify, indicating the properties used.

9. 4 times the sum of 2 times x and six

SOLUTION:

The word *times* suggest multiplication and the word *sum* suggests addition. So, the verbal expression *4 times the sum of 2 times x and six* can be represented by the algebraic expression $4(2x + 6)$.

$$\begin{aligned}4(2x + 6) \\ &= 4(2x) + 4(6) && \text{Distributive Property} \\ &= 8x + 24 && \text{Multiply.}\end{aligned}$$

1-4 The Distributive Property

10. one half of 4 times y plus the quantity of y and 3

SOLUTION:

The words *one half of* and *times* suggest multiplication and the words *plus* and *quantity of* suggest addition. So, the verbal expression *one half of 4 times y plus the quantity of y and 3* can be represented by the algebraic expression $\frac{1}{2}(4y) + (y + 3)$.

$$\frac{1}{2}(4y) + (y + 3)$$

$$= 2y + y + 3$$

$$= 3y + 3$$

Multiply.

Simplify.

11. **TIME MANAGEMENT** Margo uses dots to track her activities on a calendar. Red dots represent homework, yellow dots represent work, and green dots represent track practice. In a typical week, she uses 5 red dots, 3 yellow dots, and 4 green dots. How many activities does Margo do in 4 weeks?

SOLUTION:

To find how many activities Margo does in 4 weeks, multiply 4 times the sum of the activities she does in one week.

$$4(5 + 3 + 4) = 4(5) + 4(3) + 4(4)$$

$$= 20 + 12 + 16$$

$$= 48$$

Margo does 48 activities in 4 weeks.

12. **CCSS REASONING** The Red Cross is holding blood drives in two locations. In one day, Center 1 collected 715 pints and Center 2 collected 1035 pints. Write and evaluate an expression to estimate the total number of pints of blood donated over a 3-day period.

SOLUTION:

To find the total number of pints of blood donated over a 30-day period, multiply 3 times the sum of 715 and 1035.

$$3(715 + 1035) = 3(715) + 3(1035)$$

$$= 2145 + 3105$$

$$= 5250$$

So, about 5250 pints of blood were donated over a 3-day period.

Use the Distributive Property to rewrite each expression. Then evaluate.

13. $(4 + 5)6$

SOLUTION:

$$(4 + 5)6 = 4(6) + 5(6) \quad \text{Distributive Property}$$

$$= 24 + 30 \quad \text{Multiply.}$$

$$= 54 \quad \text{Add.}$$

14. $7(13 + 12)$

SOLUTION:

$$7(13 + 12) = 7(13) + 7(12) \quad \text{Distributive Property}$$

$$= 91 + 84 \quad \text{Multiply.}$$

$$= 175 \quad \text{Add.}$$

15. $6(6 - 1)$

SOLUTION:

$$6(6 - 1) = 6(6) - 6(1) \quad \text{Distributive Property}$$

$$= 36 - 6 \quad \text{Multiply.}$$

$$= 30 \quad \text{Add.}$$

16. $(3 + 8)15$

SOLUTION:

$$(3 + 8)15 = 3(15) + 8(15) \quad \text{Distributive Property}$$

$$= 45 + 120 \quad \text{Multiply.}$$

$$= 165 \quad \text{Add.}$$

1-4 The Distributive Property

17. $14(8 - 5)$

SOLUTION:

$$\begin{aligned}14(8 - 5) &= 14(8) - 14(5) && \text{Distributive Property} \\ &= 112 - 70 && \text{Multiply.} \\ &= 42 && \text{Add.}\end{aligned}$$

18. $(9 - 4)19$

SOLUTION:

$$\begin{aligned}(9 - 4)19 &= 9(19) + (-4)(19) && \text{Distributive Property} \\ &= 171 + (-76) && \text{Multiply.} \\ &= 95 && \text{Add.}\end{aligned}$$

19. $4(7 - 2)$

SOLUTION:

$$\begin{aligned}4(7 - 2) &= 4(7) - 4(2) && \text{Distributive Property} \\ &= 28 - 8 && \text{Multiply.} \\ &= 20 && \text{Add.}\end{aligned}$$

20. $7(2 + 1)$

SOLUTION:

$$\begin{aligned}7(2 + 1) &= 7(2) + 7(1) && \text{Distributive Property} \\ &= 14 + 7 && \text{Multiply.} \\ &= 21 && \text{Add.}\end{aligned}$$

21. $7 \cdot 497$

SOLUTION:

$$\begin{aligned}7 \cdot 497 &= 7(500 - 3) && \text{Rewrite 497 as } 500 - 3. \\ &= 7(500) - 7(3) && \text{Distributive Property} \\ &= 3500 - 21 && \text{Multiply.} \\ &= 3479 && \text{Add.}\end{aligned}$$

22. $6(525)$

SOLUTION:

$$\begin{aligned}6(525) &= 6(500 + 25) && \text{Rewrite 525 as } 500 + 25. \\ &= 6(500) + 6(25) && \text{Distributive Property} \\ &= 3000 + 150 && \text{Multiply.} \\ &= 3150 && \text{Add.}\end{aligned}$$

23. $36 \cdot 3\frac{1}{4}$

SOLUTION:

$$\begin{aligned}36 \cdot 3\frac{1}{4} &= 36\left(3 + \frac{1}{4}\right) && \text{Rewrite } 3\frac{1}{4} \text{ as } 3 + \frac{1}{4}. \\ &= 36(3) + 36\left(\frac{1}{4}\right) && \text{Distributive Property} \\ &= 108 + 9 && \text{Multiply.} \\ &= 117 && \text{Add.}\end{aligned}$$

24. $\left(4\frac{2}{7}\right)21$

SOLUTION:

$$\begin{aligned}\left(4\frac{2}{7}\right)21 &= \left(4 + \frac{2}{7}\right)21 && \text{Rewrite } 4\frac{2}{7} \text{ as } 4 + \frac{2}{7}. \\ &= 4(21) + \frac{2}{7}(21) && \text{Distributive Property} \\ &= 84 + 6 && \text{Multiply.} \\ &= 90 && \text{Add.}\end{aligned}$$

Use the Distributive Property to rewrite each expression. Then simplify.

25. $2(x + 4)$

SOLUTION:

$$\begin{aligned}2(x + 4) &= 2(x) + 2(4) && \text{Distributive Prop.} \\ &= 2x + 8 && \text{Multiply.}\end{aligned}$$

26. $(5 + n)3$

SOLUTION:

$$\begin{aligned}(5 + n)3 &= 5(3) + n(3) && \text{Distributive Prop.} \\ &= 15 + 3n && \text{Multiply.}\end{aligned}$$

27. $(4 - 3m)8$

SOLUTION:

$$\begin{aligned}(4 - 3m)8 &= 4(8) + (-3m)(8) && \text{Distributive Property} \\ &= 32 - 24m && \text{Multiply.}\end{aligned}$$

28. $-3(2x - 6)$

SOLUTION:

$$\begin{aligned}-3(2x - 6) &= (-3)(2x) + (-3)(-6) && \text{Distributive Property} \\ &= -6x + 18 && \text{Multiply.}\end{aligned}$$

Simplify each expression. If not possible, write *simplified*.

29. $13r + 5r$

SOLUTION:

$$\begin{aligned}13r + 5r &= (13 + 5)r && \text{Distributive Property} \\ &= 18r && \text{Substitution}\end{aligned}$$

1-4 The Distributive Property

30. $3x^3 - 2x^2$

SOLUTION:

The expression $3x^3 - 2x^2$ is simplified because it contains no like terms or parentheses.

31. $7m + 7 - 5m$

SOLUTION:

$$\begin{aligned} &7m + 7 - 5m \\ &= 7m + (-5m) + 7 && \text{Commutative (+) Property} \\ &= [7 + (-5)]m + 7 && \text{Distributive Property} \\ &= 2m + 7 && \text{Substitution} \end{aligned}$$

32. $5z^2 + 3z + 8z^2$

SOLUTION:

$$\begin{aligned} &5z^2 + 3z + 8z^2 \\ &= 5z^2 + 8z^2 + 3z && \text{Commutative (+) Property} \\ &= (5 + 8)z^2 + 3z && \text{Distributive Property} \\ &= 13z^2 + 3z && \text{Substitution} \end{aligned}$$

33. $(2 - 4n)17$

SOLUTION:

$$\begin{aligned} &(2 - 4n)17 \\ &= 2(17) + (-4n)(17) && \text{Distributive Property} \\ &= 34 - 68n && \text{Multiply.} \end{aligned}$$

34. $11(4d + 6)$

SOLUTION:

$$\begin{aligned} &11(4d + 6) \\ &= 11(4d) + 11(6) && \text{Distributive Property} \\ &= 44d + 66 && \text{Multiply.} \end{aligned}$$

35. $7m + 2m + 5p + 4m$

SOLUTION:

$$\begin{aligned} &7m + 2m + 5p + 4m \\ &= 7m + 2m + 4m + 5p && \text{Commutative (+) Property} \\ &= (7 + 2 + 4)m + 5p && \text{Distributive Property} \\ &= 13m + 5p && \text{Substitution} \end{aligned}$$

36. $3x + 7(3x + 4)$

SOLUTION:

$$\begin{aligned} &3x + 7(3x + 4) \\ &= 3x + 7(3x) + 7(4) && \text{Distributive Property} \\ &= 3x + 21x + 28 && \text{Multiply.} \\ &= (3 + 21)x + 28 && \text{Distributive Property} \\ &= 24x + 28 && \text{Substitution} \end{aligned}$$

37. $4(fg + 3g) + 5g$

SOLUTION:

$$\begin{aligned} &4(fg + 3g) + 5g \\ &= 4(fg) + 4(3g) + 5g && \text{Distributive Property} \\ &= 4fg + 12g + 5g && \text{Multiply.} \\ &= 4fg + (12 + 5)g && \text{Distributive Property} \\ &= 4fg + 17g && \text{Add.} \end{aligned}$$

Write an algebraic expression for each verbal expression. Then simplify, indicating the properties used.

38. the product of 5 and m squared, increased by the sum of the square of m and 5

SOLUTION:

The word *product* suggests multiplication and the words *increased by* suggest addition. To square a number means to raise it to the second power. So, the verbal expression *the product of 5 and m squared, increased by the sum of the square of m and 5* can be represented by the algebraic expression $5m^2 + (m^2 + 5)$.

$$\begin{aligned} &5m^2 + (m^2 + 5) \\ &= (5m^2 + m^2) + 5 && \text{Associative (+)} \\ &= (5 + 1)m^2 + 5 && \text{Distributive Property} \\ &= 6m^2 + 5 && \text{Substitution} \end{aligned}$$

1-4 The Distributive Property

39. 7 times the sum of a squared and b minus 4 times the sum of a squared and b

SOLUTION:

The word *times* suggests multiplication, the word *minus* suggest subtraction, and the word *sum* suggests addition. To square a number means to raise it to the second power. So, the verbal expression *7 times the sum of a squared and b minus 4 times the sum of a squared and b* can be represented by the algebraic expression $7(a^2 + b) - 4(a^2 + b)$.

$$\begin{aligned} & 7(a^2 + b) - 4(a^2 + b) \\ &= 7(a^2) + 7(b) - 4(a^2) - 4(b) && \text{Distributive Property} \\ &= 7a^2 - 4a^2 + 7b - 4b && \text{Commutative (+)} \\ &= (7 - 4)a^2 + (7 - 4)b && \text{Distributive Property} \\ &= 3a^2 + 3b && \text{Substitution} \end{aligned}$$

40. **GEOMETRY** Find the perimeter of an isosceles triangle with side lengths of $5 + x$, $5 + x$, and xy . Write in simplest form.

SOLUTION:

To find the perimeter of the triangle, find the sum of the sides.

$$\begin{aligned} P &= (5 + x) + (5 + x) + xy && \text{Perimeter formula} \\ &= xy + 5 + 5 + x + x && \text{Commutative (+)} \\ &= xy + 10 + (1 + 1)x && \text{Distributive Property} \\ &= xy + 10 + 2x && \text{Substitution} \end{aligned}$$

The perimeter is $xy + 10 + 2x$ units.

41. **GEOMETRY** A regular hexagon measures $3x + 5$ units on each side. What is the perimeter in simplest form?

SOLUTION:

A hexagon has 6 sides. In a regular hexagon, all of the sides are equal in length. To find the perimeter of a regular hexagon that measures $3x + 5$ units on each side, multiply 6 by $3x + 5$.

$$\begin{aligned} 6(3x + 5) &= 6(3x) + 6(5) \\ &= 18x + 30 \end{aligned}$$

The hexagon has a perimeter of $18x + 30$ units.

Simplify each expression.

42. $6x + 4y + 5x$

SOLUTION:

$$\begin{aligned} & 6x + 4y + 5x \\ &= 6x + 5x + 4y && \text{Commutative (+) Property} \\ &= (6 + 5)x + 4y && \text{Distributive Property} \\ &= 11x + 4y && \text{Substitution} \end{aligned}$$

43. $3m + 5g + 6g + 11m$

SOLUTION:

$$\begin{aligned} & 3m + 5g + 6g + 11m \\ &= 3m + 11m + 5g + 6g && \text{Commutative (+) Property} \\ &= (3 + 11)m + (5 + 6)g && \text{Distributive Property} \\ &= 14m + 11g && \text{Substitution} \end{aligned}$$

44. $4a + 5a^2 + 2a^2 + a^2$

SOLUTION:

$$\begin{aligned} & 4a + 5a^2 + 2a^2 + a^2 \\ &= 5a^2 + 2a^2 + a^2 + 4a && \text{Commutative (+) Property} \\ &= (5 + 2 + 1)a^2 + 4a && \text{Distributive Property} \\ &= 8a^2 + 4a && \text{Substitution} \end{aligned}$$

45. $5k + 3k^3 + 7k + 9k^3$

SOLUTION:

$$\begin{aligned} & 5k + 3k^3 + 7k + 9k^3 \\ &= 3k^3 + 9k^3 + 5k + 7k && \text{Commutative (+) Property} \\ &= (3 + 9)k^3 + (5 + 7)k && \text{Distributive Property} \\ &= 12k^3 + 12k && \text{Substitution} \end{aligned}$$

46. $6d + 4(3d + 5)$

SOLUTION:

$$\begin{aligned} & 6d + 4(3d + 5) \\ &= 6d + 4(3d) + 4(5) && \text{Distributive Property} \\ &= 6d + 12d + 20 && \text{Commutative (+) Property} \\ &= (6 + 12)d + 20 && \text{Distributive Property} \\ &= 18d + 20 && \text{Substitution} \end{aligned}$$

1-4 The Distributive Property

47. $2(6x + 4) + 7x$

SOLUTION:

$$\begin{aligned} &2(6x + 4) + 7x \\ &= 2(6x) + 2(4) + 7x && \text{Substitution} \\ &= 12x + 8 + 7x && \text{Commutative (+) Property} \\ &= 12x + 7x + 8 && \text{Distributive Property} \\ &= (12 + 7)x + 8 && \text{Distributive Property} \\ &= 19x + 8 && \text{Substitution} \end{aligned}$$

48. **FOOD** Kenji is picking up take-out food for his study group.

Menu	
Item	Cost (\$)
sandwich	2.49
cup of soup	1.29
side salad	0.99
drink	1.49

- a. Interpret the expression $4(2.49) + 3(1.29) + 3(0.99) + 5(1.49)$

- b. How much would it cost if Kenji bought four of each item on the menu?

SOLUTION:

- a. the cost of four sandwiches, three soups, three salads, and five drinks

- b. To find how much it cost if Kenji bought four of each item on the menu, multiply 4 times the sum of the cost of one of each item.

$$\begin{aligned} 4(2.49 + 1.29 + 0.99 + 1.49) &= 4(6.26) \\ &= 25.04 \end{aligned}$$

It would cost Kenji \$25.04 if he bought four of each item on the menu.

Use the Distributive Property to rewrite each expression. Then simplify.

49. $\left(\frac{1}{3} - 2b\right)27$

SOLUTION:

$$\begin{aligned} &\left(\frac{1}{3} - 2b\right)27 \\ &= \frac{1}{3}(27) + (-2b)(27) && \text{Distributive Property} \\ &= 9 - 54b && \text{Multiply.} \end{aligned}$$

50. $4(8p + 4q - 7r)$

SOLUTION:

$$\begin{aligned} &4(8p + 4q - 7r) \\ &= 4(8p) + 4(4q) + 4(-7r) && \text{Distributive Property} \\ &= 32p + 16q - 28r && \text{Substitution} \end{aligned}$$

51. $6(2c - cd^2 + d)$

SOLUTION:

$$\begin{aligned} &6(2c - cd^2 + d) \\ &= 6(2c) + 6(-cd^2) + 6(d) && \text{Distributive Property} \\ &= 12c - 6cd^2 + 6d && \text{Substitution} \end{aligned}$$

Simplify each expression. If not possible, write *simplified*.

52. $6x^2 + 14x - 9x$

SOLUTION:

$$\begin{aligned} 6x^2 + 14x - 9x &= 6x^2 + (14 - 9)x \\ &= 6x^2 + 5x \end{aligned}$$

53. $4y^3 + 3y^3 + y^4$

SOLUTION:

$$\begin{aligned} 4y^3 + 3y^3 + y^4 &= (4 + 3)y^3 + y^4 \\ &= 7y^3 + y^4 \end{aligned}$$

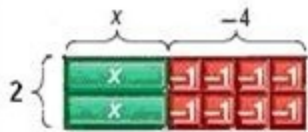
1-4 The Distributive Property

54. $a + \frac{a}{5} + \frac{2}{5}a$

SOLUTION:

$$\begin{aligned} a + \frac{a}{5} + \frac{2}{5}a &= \left(1 + \frac{1}{5} + \frac{2}{5}\right)a \\ &= \left(\frac{5}{5} + \frac{1}{5} + \frac{2}{5}\right)a \\ &= \frac{8}{5}a \end{aligned}$$

55. **MULTIPLE REPRESENTATIONS** The area of the model is $2(x - 4)$ or $2x - 8$. The expression $2(x - 4)$ is in *factored form*.



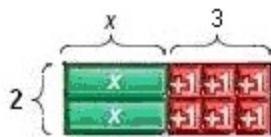
- a. GEOMETRIC** Use algebra tiles to form a rectangle with area $2x + 6$. Use the result to write $2x + 6$ in factored form.

- b. TABULAR** Use algebra tiles to form rectangles to represent each area in the table. Record the factored form of each expression.

Area	Factored Form
$2x + 6$	
$3x + 3$	
$3x - 12$	
$5x + 10$	

- c. VERBAL** Explain how you could find the factored form of an expression.

SOLUTION:



- a.**
The area of the rectangle is $x + 3 + x + 3 = 2x + 6$ and $2x + 6 = 2(x + 3)$.

b.

Area	Algebra Tiles	Factored Form
$2x + 6$		$2(x + 3)$
$3x + 3$		$3(x + 1)$
$3x - 12$		$3(x - 4)$
$5x + 10$		$5(x + 2)$

- c.** Divide each term of the expression by the same number. Then write the expression as a product.

56. **CCSS PERSEVERANCE** Use the Distributive Property to simplify $6x^2[(3x - 4) + (4x + 2)]$.

SOLUTION:

$$\begin{aligned} &6x^2[(3x - 4) + (4x + 2)] \\ &= 6x^2[3x + 4x + (-4) + 2] \quad \text{Commutative (+) Property} \\ &= 6x^2[(3+4)x + (-2)] \quad \text{Distributive Property} \\ &= 6x^2[7x + (-2)] \quad \text{Substitution} \\ &= 6x^2(7x) + 6x^2(-2) \quad \text{Distributive Property} \\ &= 42x^3 - 12x^2 \quad \text{Multiply.} \end{aligned}$$

57. **REASONING** Should the Distributive Property be a property of multiplication, addition, or both? Explain your answer.

SOLUTION:

The Distributive Property should be considered a property of both. Both operations are used in $a(b + c) = ab + ac$.

1-4 The Distributive Property

58. **WRITING IN MATH** Why is it helpful to represent verbal expressions algebraically?

SOLUTION:

Algebraic expressions are helpful because they are easier to interpret and apply than verbal expressions. They can also be rewritten in a more simplified or manageable form.

Consider the example: Sara purchased 3 post cards at \$1.50 and 2 key chains at \$3.00.

$$3(1.50) + 2(3.00) = \$10.50$$

If the prices are doubled, it is easier to calculate the value if the verbal expression is written as an algebraic expression.

$$3(1.50 \cdot 2) + 2(3.00 \cdot 2) = 3(3.00) + 2(6.00) = 21$$

59. **WRITING IN MATH** Use the data about skating below to explain how the Distributive Property can be used to calculate quickly. Also, compare the two methods of finding the total Calories burned.

SOLUTION:

John burns approximately 420 Calories per hour by inline skating. The chart below shows the time he spent inline skating in one week.

Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Time (h)	1	$\frac{1}{2}$	0	1	0	2	$2\frac{1}{2}$

Method 1 Rate Times Total Time

$$\begin{aligned} & 420\left(1 + \frac{1}{2} + 1 + 2 + 2\frac{1}{2}\right) \\ &= 420(7) \\ &= 2940 \end{aligned}$$

Method 2 Sum of Daily Calories Burned

$$\begin{aligned} & 420(1) + 420\left(\frac{1}{2}\right) + 420(0) + 420(1) + 420(2) + 420\left(2\frac{1}{2}\right) \\ &= 420 + 210 + 420 + 840 + 1050 \\ &= 2940 \end{aligned}$$

60. Which illustrates the Symmetric Property of Equality?

A If $a = b$, then $b = a$.

B If $a = b$, and $b = c$, then $a = c$.

C If $a = b$, then $b = c$.

D If $a = a$, then $a + 0 = a$.

SOLUTION:

Choice D sort of relates to the Additive Identity, but in fact does not illustrate any property. Choice B illustrates the Transitive Property. Choice C does not illustrate any properties. The Symmetric Property states that if the first part equals the second part, then the second part must equal the first part. This is illustrated by Choice A.

So, Choice A is the correct answer.

61. Anna is three years younger than her sister Emily. Which expression represents Anna's age if we express Emily's age as y years?

F $y + 3$

G $y - 3$

H $3y$

J $\frac{3}{y}$

SOLUTION:

If Anna is 3 years younger than Emily, and Emily is y years old, then Anna is $y - 3$ years old. Choice G is the correct answer.

1-4 The Distributive Property

62. Which property is used below?

If $4xy^2 = 8y^2$ and $8y^2 = 72$, then $4xy^2 = 72$.

A Reflexive Property

B Substitution Property

C Symmetric Property

D Transitive Property

SOLUTION:

The Transitive Property says that if $a = b$ and $b = c$, then $a = c$. So, "If $4xy^2 = 8y^2$ and $8y^2 = 72$, then $4xy^2 = 72$," shows the Transitive Property. Replace a with $4xy^2$, b with $8y^2$, and c with 72. Choice D is the correct answer.

63. **SHORT RESPONSE** A drawer contains the socks in the chart. What is the probability that a randomly chosen sock is blue?

Color	Number
white	16
blue	12
black	8

SOLUTION:

probability = $\frac{\text{number of favorable outcomes}}{\text{number of possible outcomes}}$

The number of possible outcomes is $16 + 12 + 8$ or 36.

So, $P(\text{blue}) = \frac{12}{36} = \frac{1}{3}$ or about 33.3%.

Evaluate each expression. Name the property used in each step.

64. $14 + 23 + 8 + 15$

SOLUTION:

$$\begin{aligned} &14 + 23 + 8 + 15 \\ &= (14 + 23) + (8 + 15) && \text{Associative (+)} \\ &= 37 + 23 && \text{Substitution} \\ &= 60 && \text{Substitution} \end{aligned}$$

65. $0.24 \cdot 8 \cdot 7.05$

SOLUTION:

$$\begin{aligned} &0.24 \cdot 8 \cdot 7.05 \\ &= (0.24 \cdot 8) \cdot 7.05 && \text{Associative (\times)} \\ &= 1.92 \cdot 7.05 && \text{Substitution} \\ &= 13.536 && \text{Substitution} \end{aligned}$$

66. $1\frac{1}{4} \cdot 9 \cdot \frac{5}{6}$

SOLUTION:

$$\begin{aligned} &1\frac{1}{4} \cdot 9 \cdot \frac{5}{6} \\ &= \left(1\frac{1}{4} \cdot 9\right) \frac{5}{6} && \text{Associative (\times)} \\ &= 11\frac{1}{4} \cdot \frac{5}{6} && \text{Substitution} \\ &= 9\frac{3}{8} && \text{Substitution} \end{aligned}$$

67. **SPORTS** Braden runs 6 times a week for 30 minutes and lifts weights 3 times a week for 20 minutes. Write and evaluate an expression for number of hours Braden works out in 4 weeks.

SOLUTION:

To find the number of hours Braden works out in 4 weeks, multiply the number of minutes he works out divided by 60 by 4.

$$\begin{aligned} \frac{4[6(30) + 3(20)]}{60} &= \frac{4(180 + 60)}{60} \\ &= \frac{4(240)}{60} \\ &= \frac{960}{60} \\ &= 16 \end{aligned}$$

So, Braden works out 16 hours in 4 weeks.

1-4 The Distributive Property

SPORTS Refer to the table showing Blanca's cross-country times for the first 8 meets of the season. Round answers to the nearest second

Cross Country	
Meet	Time
1	22:31
2	22:21
3	21:48
4	22:01
5	21:48
6	20:56
7	20:34
8	20:15

68. Find the mean of the data.

SOLUTION:

The times are given in minutes and seconds. Rewrite the times so that they are in seconds by multiplying the number of minutes by 60 and then adding the seconds.

Time in Minutes:Seconds	Time in Seconds
22:31	1351
22:21	1341
21:48	1308
22:01	1321
21:48	1308
20:56	1256
20:34	1236
20:15	1215

To find the mean, find the sum of the times and divide by 8.

$$1351 + 1341 + 1308 + 1321 + 1308 + 1256 + 1236 + 1215 = 10,336$$

$$10,336 \div 8 = 1292$$

The mean is 1292 seconds or 21:32.

69. Find the median of the data.

SOLUTION:

To find the median, order the data from least to greatest. The data in order from least to greatest are {20:15, 20:34, 20:56, 21:48, 21:48, 22:01, 22:21, 22:31}. The times are given in minutes and seconds. Rewrite the times so that they are in seconds by multiplying the number of minutes by 60 and then adding the seconds.

Time in Minutes:Seconds	Time in Seconds
20:15	1215
20:34	1236
20:56	1256
21:48	1308
21:48	1308
22:01	1321
22:21	1341
22:31	1351

The median is in the middle. There are two numbers in the middle, 1308 and 1308, so the median is the average of those numbers.

$$\frac{1308 + 1308}{2} = \frac{2616}{2} = 1308$$

So, the median is 1308 seconds or 21:48.

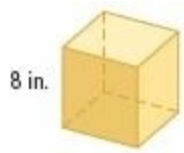
70. Find the mode of the data.

SOLUTION:

The mode is the number or numbers that appear most often in a set of data. The time 21:48 appears most often, so the mode is 21:48.

1-4 The Distributive Property

71. **SURFACE AREA** What is the surface area of the cube?



SOLUTION:

To find the surface area of the cube, multiply the area of one face by 6.

$$\begin{aligned} SA &= 6 \ell w \\ &= 6(8)(8) \\ &= 384 \end{aligned}$$

So, the surface area is 384 square inches.

Evaluate each expression.

72. $12(7 + 2)$

SOLUTION:

$$\begin{aligned} 12(7 + 2) &= 12(7) + 12(2) \\ &= 84 + 24 \\ &= 108 \end{aligned}$$

73. $11(5) - 8(5)$

SOLUTION:

$$\begin{aligned} 11(5) - 8(5) &= 55 - 40 \\ &= 15 \end{aligned}$$

74. $(13 - 9) \cdot 4$

SOLUTION:

$$\begin{aligned} (13 - 9) \cdot 4 &= 4 \cdot 4 \\ &= 16 \end{aligned}$$

75. $3(6) + 7(6)$

SOLUTION:

$$\begin{aligned} 3(6) + 7(6) &= (3 + 7)6 \\ &= 10(6) \\ &= 60 \end{aligned}$$

76. $(1 + 19) \cdot 8$

SOLUTION:

$$\begin{aligned} (1 + 19) \cdot 8 &= 20 \cdot 8 \\ &= 160 \end{aligned}$$

77. $16(5 + 7)$

SOLUTION:

$$\begin{aligned} 16(5 + 7) &= 16(5) + 16(7) \\ &= 80 + 112 \\ &= 192 \end{aligned}$$

1-5 Equations

Find the solution set of each equation if the replacement set is {11, 12, 13, 14, 15}.

1. $n + 10 = 23$

SOLUTION:

n	$n + 10 = 23$	True or False?
11	$11 + 10 = 23$	False
12	$12 + 10 = 23$	False
13	$13 + 10 = 23$	True
14	$14 + 10 = 23$	False
15	$15 + 10 = 23$	False

The solution set is {13}.

2. $7 = \frac{c}{2}$

SOLUTION:

c	$7 = \frac{c}{2}$	True or False?
11	$7 = \frac{11}{2}$	False
12	$7 = \frac{12}{2}$	False
13	$7 = \frac{13}{2}$	False
14	$7 = \frac{14}{2}$	True
15	$7 = \frac{15}{2}$	False

The solution set is {14}.

3. $29 = 3x - 7$

SOLUTION:

x	$29 = 3x - 7$	True or False?
11	$29 = 3(11) - 7$	False
12	$29 = 3(12) - 7$	True
13	$29 = 3(13) - 7$	False
14	$29 = 3(14) - 7$	False
15	$29 = 3(15) - 7$	False

The solution set is {12}.

4. $(k - 8)12 = 84$

SOLUTION:

k	$(k - 8)12 = 84$	True or False
11	$(11 - 8)12 = 84$	False
12	$(12 - 8)12 = 84$	False
13	$(13 - 8)12 = 84$	False
14	$(14 - 8)12 = 84$	False
15	$(15 - 8)12 = 84$	True

The solution set is {15}.

5. **MULTIPLE CHOICE** Solve $\frac{d+5}{10} = 2$.

A 10

B 15

C 20

D 25

SOLUTION:

d	$\frac{d+5}{10} = 2$	True or False?
10	$\frac{10+5}{10} = 2$	False
15	$\frac{15+5}{10} = 2$	True
20	$\frac{20+5}{10} = 2$	False
25	$\frac{25+5}{10} = 2$	False

The correct answer is B.

Solve each equation.

6. $x = 4(6) + 3$

SOLUTION:

$$\begin{aligned}
 x &= 4(6) + 3 && \text{Original Equation} \\
 &= 24 + 3 && \text{Multiply.} \\
 &= 27 && \text{Add 24 and 3.}
 \end{aligned}$$

1-5 Equations

7. $14 - 82 = w$

SOLUTION:

$$14 - 82 = w \quad \text{Original Equation}$$

$$-68 = w \quad \text{Subtract 82 from 14.}$$

8. $5 + 22a = 2 + 10 \div 2$

SOLUTION:

$$5 + 22a = 2 + 10 \div 2 \quad \text{Original Equation}$$

$$5 + 22a = 2 + 5 \quad \text{Divide 10 by 2.}$$

$$5 + 22a = 7 \quad \text{Add 2 and 5.}$$

Test values for a .

$$5 + 22(1) = 27$$

$$5 + 22(0) = 5$$

7 is in between 5 and 27, and is very close to 5, so the solution should be close to 0. Try a few more.

$$5 + 22\left(\frac{1}{2}\right) = 16$$

$$5 + 22\left(\frac{1}{4}\right) = 10.25$$

$$5 + 22\left(\frac{1}{8}\right) = 7.75$$

$$5 + 22\left(\frac{1}{10}\right) = 7.2$$

$$5 + 22\left(\frac{1}{11}\right) = 2$$

Through a good amount of guessing, we have come to a solution of $\frac{1}{11}$.

9. $(2 \cdot 5) + \frac{c^3}{3} = c^3 \div (1^5 + 2) + 10$

SOLUTION:

$$(2 \cdot 5) + \frac{c^3}{3} = c^3 \div (1^5 + 2) + 10 \quad \text{Original equation}$$

$$(2 \cdot 5) + \frac{c^3}{3} = c^3 \div (1 + 2) + 10 \quad \text{Evaluate powers}$$

$$10 + \frac{c^3}{3} = c^3 \div (1 + 2) + 10 \quad \text{Multiply 2 by 5.}$$

$$10 + \frac{c^3}{3} = c^3 \div 3 + 10 \quad \text{Add 1 and 2.}$$

$$10 + \frac{c^3}{3} = \frac{c^3}{3} + 10 \quad \text{Divide } c^3 \text{ by 3.}$$

$$\frac{c^3}{3} + 10 = \frac{c^3}{3} + 10 \quad \text{Comm. Prop.}$$

Notice that the left side of the equation is identical to the right side of the equation. No matter what value is substituted for c , the left side of the equation will always be equal to the right side of the equation. So, the equation will always be true. The solution is all real numbers.

10. **RECYCLING** San Francisco has a recycling facility that accepts unused paint. Volunteers blend and mix the paint into different colors and give it away in 5-gallon buckets. Write and solve an equation to find the number of buckets of paint given away from the 30,000 gallons that are donated.

SOLUTION:

Let b represent the number of buckets of paint and let g represent the gallons of paint donated.

$$b = \frac{g}{5}$$

$$b = \frac{30,000}{5} \quad \text{Replace } g \text{ with 30,000.}$$

$$b = 6,000 \quad \text{Divide 30,000 by 5.}$$

So, 6000 buckets of paint are given away.

1-5 Equations

Find the solution set of each equation if the replacement sets are y : {1, 3, 5, 7, 9} and z : {10, 12, 14, 16, 18}.

11. $z + 10 = 22$

SOLUTION:

z	$z + 10 = 22$	True or False?
10	$10 + 10 = 22$	False
12	$12 + 10 = 22$	True
14	$14 + 10 = 22$	False
16	$16 + 10 = 22$	False
18	$18 + 10 = 22$	False

The solution set is {12}.

12. $52 = 4z$

SOLUTION:

z	$52 = 4z$	True or False?
10	$52 = 4 \cdot 10$	False
12	$52 = 4 \cdot 12$	False
14	$52 = 4 \cdot 14$	False
16	$52 = 4 \cdot 16$	False
18	$52 = 4 \cdot 18$	False

There is no solution.

13. $\frac{15}{y} = 3$

SOLUTION:

y	$\frac{15}{y} = 3$	True or False?
1	$\frac{15}{1} = 3$	False
3	$\frac{15}{3} = 3$	False
5	$\frac{15}{5} = 3$	True
7	$\frac{15}{7} = 3$	False
9	$\frac{15}{9} = 3$	False

The solution set is {5}.

14. $17 = 24 - y$

SOLUTION:

y	$17 = 24 - y$	True or False?
1	$17 = 24 - 1$	False
3	$17 = 24 - 3$	False
5	$17 = 24 - 5$	False
7	$17 = 24 - 7$	True
9	$17 = 24 - 9$	False

The solution set is {7}.

15. $2z - 5 = 27$

SOLUTION:

z	$2z - 5 = 27$	True or False?
10	$2(10) - 5 = 27$	False
12	$2(12) - 5 = 27$	False
14	$2(14) - 5 = 27$	False
16	$2(16) - 5 = 27$	True
18	$2(18) - 5 = 27$	False

The solution set is {16}.

16. $4(y + 1) = 40$

SOLUTION:

y	$4(y + 1) = 40$	True or False?
1	$4(1 + 1) = 40$	False
3	$4(3 + 1) = 40$	False
5	$4(5 + 1) = 40$	False
7	$4(7 + 1) = 40$	False
9	$4(9 + 1) = 40$	True

The solution set is {9}.

1-5 Equations

17. $22 = \frac{60}{y} + 2$

SOLUTION:

y	$22 = \frac{60}{y} + 2$	True or False?
1	$22 = \frac{60}{1} + 2$	False
3	$22 = \frac{60}{3} + 2$	True
5	$22 = \frac{60}{5} + 2$	False
7	$22 = \frac{60}{7} + 2$	False
9	$22 = \frac{60}{9} + 2$	False

The solution set is $\{3\}$.

18. $111 = z^2 + 11$

SOLUTION:

z	$111 = z^2 + 11$	True or False?
10	$111 = (10)^2 + 11$	True
12	$111 = (12)^2 + 11$	False
14	$111 = (14)^2 + 11$	False
16	$111 = (16)^2 + 11$	False
18	$111 = (18)^2 + 11$	False

The solution set is $\{10\}$.

Solve each equation.

19. $a = 32 - 9(2)$

SOLUTION:

$a = 32 - 9(2)$ Original equation

$a = 32 - 18$ Multiply 9 by 2.

$a = 14$ Subtract 18 from 32.

20. $w = 56 \div (2^2 + 3)$

SOLUTION:

$w = 56 \div (2^2 + 3)$ Original equation

$w = 56 \div (4 + 3)$ Evaluate power.

$w = 56 \div 7$ Add 4 and 3.

$w = 8$ Divide 56 by 7.

21. $\frac{27+5}{16} = g$

SOLUTION:

$\frac{27+5}{16} = g$ Original equation

$\frac{32}{16} = g$ Add 27 and 5.

$2 = g$ Divide 32 by 16.

22. $\frac{12 \cdot 5}{15-3} = y$

SOLUTION:

$\frac{12 \cdot 5}{15-3} = y$ Original equation

$\frac{60}{15-3} = y$ Multiply 12 by 5.

$\frac{60}{12} = y$ Subtract 3 from 15.

$5 = y$ Divide 60 by 12.

23. $r = \frac{9(6)}{(8+1)3}$

SOLUTION:

$r = \frac{9(6)}{(8+1)3}$ Original equation

$r = \frac{54}{(9)3}$ Multiply 9 by 6.

$r = \frac{54}{27}$ Multiply 54 by 27.

$r = 2$ Divide 54 by 27.

1-5 Equations

$$24. a = \frac{4(14-1)}{3(6)-5} + 7$$

SOLUTION:

$$a = \frac{4(14-1)}{3(6)-5} + 7 \quad \text{Original equation}$$

$$a = \frac{4(13)}{18-5} + 7 \quad \text{Subtract 1 from 14.}$$

$$a = \frac{52}{18-5} + 7 \quad \text{Multiply 4 by 13.}$$

$$a = \frac{52}{13} + 7 \quad \text{Subtract 5 from 18.}$$

$$a = 4 + 7 \quad \text{Divide 52 by 13.}$$

$$a = 11 \quad \text{Add 4 and 7.}$$

$$25. (4 - 2^2 + 5)w = 25$$

SOLUTION:

$$(4 - 2^2 + 5)w = 25 \quad \text{Original equation}$$

$$(4 - 4 + 5)w = 25 \quad \text{Evaluate power.}$$

$$(0 + 5)w = 25 \quad \text{Subtract 4 from 4.}$$

$$5w = 25 \quad \text{Simplify.}$$

$$w = 5 \quad \text{Divide each side by 5.}$$

$$26. 7 + x - (3 + 32 \div 8) = 3$$

SOLUTION:

$$7 + x - (3 + 32 \div 8) = 3 \quad \text{Original equation}$$

$$7 + x - (3 + 4) = 3 \quad \text{Divide 32 by 8.}$$

$$7 + x - 7 = 3 \quad \text{Add 3 and 4.}$$

$$7 + (-7) + x = 3 \quad \text{Commutative Property.}$$

$$0 + x = 3 \quad \text{Subtract 7 from 7.}$$

$$x = 3 \quad \text{Simplify.}$$

$$27. 3^2 - 2 \cdot 3 + u = (3^3 - 3 \cdot 8)(2) + u$$

SOLUTION:

$$3^2 - 2 \cdot 3 + u = (3^3 - 3 \cdot 8)(2) + u$$

$$9 - 2 \cdot 3 + u = (27 - 3 \cdot 8)(2) + u \quad \text{Evaluate power.}$$

$$9 - 6 + u = (27 - 3 \cdot 8)(2) + u \quad \text{Multiply.}$$

$$9 - 6 + u = (27 - 24)(2) + u \quad \text{Multiply.}$$

$$9 - 6 + u = 3(2) + u \quad \text{Subtract.}$$

$$3 + u = 3(2) + u \quad \text{Subtract.}$$

$$3 + u = 6 + u \quad \text{Multiply.}$$

No matter what real value is substituted for u , the left side of the equation will always be three less than the right side of the equation. So, the equation will never be true, and there is no solution.

$$28. (3 \cdot 6 \div 2)v + 10 = 3^2v + 9$$

SOLUTION:

$$(3 \cdot 6 \div 2)v + 10 = 3^2v + 9 \quad \text{Original equation}$$

$$(18 \div 2)v + 10 = 3^2v + 9 \quad \text{Multiply 3 by 6.}$$

$$(18 \div 2)v + 10 = 9v + 9 \quad \text{Evaluate power.}$$

$$9v + 10 = 9v + 9 \quad \text{Divide 18 by 2.}$$

No matter what real value is substituted for v , the left side of the equation will always be one more than the right side of the equation. So, the equation will never be true, and there is no solution.

$$29. 6k + (3 \cdot 10 - 8) = (2 \cdot 3)k + 22$$

SOLUTION:

$$6k + (3 \cdot 10 - 8) = (2 \cdot 3)k + 22 \quad \text{Original equation}$$

$$6k + (30 - 8) = 6k + 22 \quad \text{Multiply 2 by 3.}$$

$$6k + (30 - 8) = 6k + 22 \quad \text{Multiply 2 by 3.}$$

$$6k + 22 = 6k + 22 \quad \text{Subtract 24 from 27.}$$

No matter what value is substituted for h , the left side of the equation will always be equal to the right side of the equation. So, the equation will always be true. The solution is all real numbers.

$$30. (3 \cdot 5)t + (21 - 12) = 15t + 3^2$$

SOLUTION:

$$(3 \cdot 5)t + (21 - 12) = 15t + 3^2 \quad \text{Original equation}$$

$$15t + 9 = 15t + 9 \quad \text{Evaluate power.}$$

$$15t + 9 = 15t + 9 \quad \text{Multiply 2 by 3.}$$

$$15t + 9 = 15t + 9 \quad \text{Subtract 24 from 27.}$$

No matter what value is substituted for h , the left side of the equation will always be equal to the right side of the equation. So, the equation will always be true. The solution is all real numbers.

1-5 Equations

$$31. (2^4 - 3 \cdot 5)q + 13 = (2 \cdot 9 - 4^2)q + \left(\frac{3 \cdot 4}{12} - 1\right)$$

SOLUTION:

$$(2^4 - 3 \cdot 5)q + 13 = (2 \cdot 9 - 4^2)q + \left(\frac{3 \cdot 4}{12} - 1\right)$$

$$(16 - 3 \cdot 5)q + 13 = (2 \cdot 9 - 4^2)q + \left(\frac{3 \cdot 4}{12} - 1\right)$$

$$(16 - 15)q + 13 = (2 \cdot 9 - 4^2)q + \left(\frac{3 \cdot 4}{12} - 1\right)$$

$$(16 - 15)q + 13 = (2 \cdot 9 - 16)q + \left(\frac{3 \cdot 4}{12} - 1\right)$$

$$(16 - 15)q + 13 = (18 - 16)q + \left(\frac{3 \cdot 4}{12} - 1\right)$$

$$(16 - 15)q + 13 = (18 - 16)q + \left(\frac{12}{12} - 1\right)$$

$$(16 - 15)q + 13 = (18 - 16)q + \left(\frac{12}{12} - 1\right)$$

$$1q + 13 = (18 - 16)q + (1 - 1)$$

$$1q + 13 = 2q + (1 - 1)$$

$$q + 13 = 2q + 0$$

$$q + 13 = 2q$$

Test values of q for which the statement is true.

$$10 + 13 \stackrel{?}{=} 2(10)$$

$$23 \neq 20$$

$$12 + 13 \stackrel{?}{=} 2(12)$$

$$25 \neq 24$$

$$13 + 13 \stackrel{?}{=} 2(13)$$

$$26 = 26$$

The only value for q that makes the equation true is

13. So, $q = 13$.

$$32. \frac{3 \cdot 22}{18 + 4}r - \left(\frac{4^2}{9 + 7} - 1\right) = r + \left(\frac{8 \cdot 9}{3} \div 3\right)$$

SOLUTION:

$$\frac{3 \cdot 22}{18 + 4}r - \left(\frac{4^2}{9 + 7} - 1\right) = r + \left(\frac{8 \cdot 9}{3} \div 3\right)$$

$$\frac{66}{18 + 4}r - \left(\frac{4^2}{9 + 7} - 1\right) = r + \left(\frac{8 \cdot 9}{3} \div 3\right) \quad \text{Multiply.}$$

$$\frac{66}{18 + 4}r - \left(\frac{16}{9 + 7} - 1\right) = r + \left(\frac{8 \cdot 9}{3} \div 3\right) \quad 4^2 = 16$$

$$\frac{66}{18 + 4}r - \left(\frac{16}{16} - 1\right) = r + \left(\frac{8 \cdot 9}{3} \div 3\right) \quad \text{Add.}$$

$$\frac{66}{18 + 4}r - \left(\frac{16}{16} - 1\right) = r + \left(\frac{72}{3} \div 3\right) \quad \text{Multiply.}$$

$$\frac{66}{22}r - \left(\frac{16}{16} - 1\right) = r + \left(\frac{72}{3} \div 3\right) \quad \text{Add.}$$

$$3r - (1 - 1) = r + \left(\frac{72}{3} \div 3\right) \quad \text{Divide.}$$

$$3r - (1 - 1) = r + (24 \div 3) \quad \text{Divide.}$$

$$3r - 0 = r + (24 \div 3) \quad \text{Subtract.}$$

$$3r - 0 = r + 8 \quad \text{Divide.}$$

$$3r = r + 8 \quad \text{Simplify.}$$

Test values of r for which the statement is true.

$$3(0) \stackrel{?}{=} 0 + 8$$

$$0 \neq 8$$

$$3(2) \stackrel{?}{=} 2 + 8$$

$$6 \neq 10$$

$$3(4) \stackrel{?}{=} 4 + 8$$

$$12 = 12$$

The only value for r that makes the equation true is

4. So, $r = 4$.

1-5 Equations

33. **SCHOOL** A conference room can seat a maximum of 85 people. The principal and two counselors need to meet with the school's juniors to discuss college admissions. If each student must bring a parent with them, how many students can attend each meeting? Assume that each student has a unique set of parents.

SOLUTION:

Let j represent the number of juniors. Then $2j$ represents every student-parent pair. Write an equation to represent how many students can attend each meeting.

$$3 + 2j = 85$$

Test values of j for which the statement is true.

$$3 + 2(20) \stackrel{?}{=} 85$$

$$3 + 40 \stackrel{?}{=} 85$$

$$43 \neq 85$$

$$3 + 2(40) \stackrel{?}{=} 85$$

$$3 + 80 \stackrel{?}{=} 85$$

$$83 \neq 85$$

$$3 + 2(41) \stackrel{?}{=} 85$$

$$3 + 82 \stackrel{?}{=} 85$$

$$85 = 85$$

The only value for j that makes the equation true is 41. So, 41 students can attend each meeting.

34. **CCSS MODELING** The perimeter of a regular octagon is 128 inches. Find the length of each side.

SOLUTION:

A regular octagon has 8 congruent sides. Let P represent the perimeter of the regular octagon and x represent the side length. Write an equation.

$$P = x + x + x + x + x + x + x + x$$

$$128 = 8x$$

The only value for x that makes the equation true is 16. So, $x = 16$. So, the length of each side is 16 inches.

35. **SPORTS** A 200-pound athlete who trains for four hours per day requires 2836 Calories for basic energy requirements. During training, the same athlete requires an additional 3091 Calories for extra energy requirements. Write an equation to find C , the total daily Calorie requirement for this athlete. Then solve the equation.

SOLUTION:

Let C represent the total daily Calorie requirement for the athlete.

$$C = 2836 + 3091$$

$$C = 5927$$

So, an athlete needs 5927 Calories per day.

36. **ENERGY** An electric generator can power 3550 watts of electricity. Write and solve an equation to find how many 75-watt light bulbs a generator could power.

SOLUTION:

Let x represent the number of light bulbs the generator could power.

$$3550 = 75x$$

$$\frac{3550}{75} \approx 47.3$$

The only value for x that makes the equation true is between 47 and 48.

So, the generator can power about 47 light bulbs.

Make a table of values for each equation if the replacement set is $\{-2, -1, 0, 1, 2\}$.

37. $y = 3x - 2$

SOLUTION:

x	$3x - 2$	y
-2	$3(-2) - 2$	-8
-1	$3(-1) - 2$	-5
0	$3(0) - 2$	-2
1	$3(1) - 2$	1
2	$3(2) - 2$	4

1-5 Equations

38. $3.25x + 0.75 = y$

SOLUTION:

x	$3.25x + 0.75$	y
-2	$3.25(-2) + 0.75$	-5.75
-1	$3.25(-1) + 0.75$	-2.5
0	$3.25(0) + 0.75$	0.75
1	$3.25(1) + 0.75$	4
2	$3.25(2) + 0.75$	7.25

Solve each equation using the given replacement set.

39. $t - 13 = 7$; {10, 13, 17, 20}

SOLUTION:

t	$t - 13 = 7$	True or False?
10	$10 - 13 = 7$	False
13	$13 - 13 = 7$	False
17	$17 - 13 = 7$	False
20	$20 - 13 = 7$	True

The solution set is {20}.

40. $14(x + 5) = 126$; {3, 4, 5, 6, 7}

SOLUTION:

x	$14(x + 5) = 126$	True or False?
3	$14(3 + 5) = 126$	False
4	$14(4 + 5) = 126$	True
5	$14(5 + 5) = 126$	False
6	$14(6 + 5) = 126$	False
7	$14(7 + 5) = 126$	False

The solution set is {4}.

41. $22 = \frac{n}{3}$; {62, 64, 66, 68, 70}

SOLUTION:

n	$22 = \frac{n}{3}$	True or False?
62	$22 = \frac{62}{3}$	False
64	$22 = \frac{64}{3}$	False
66	$22 = \frac{66}{3}$	True
68	$22 = \frac{68}{3}$	False
70	$22 = \frac{70}{3}$	False

The solution set is {66}.

42. $35 = \frac{g-8}{2}$; {78, 79, 80, 81}

SOLUTION:

g	$35 = \frac{g-8}{2}$	True or False?
78	$35 = \frac{78-8}{2}$	True
79	$35 = \frac{79-8}{2}$	False
80	$35 = \frac{80-8}{2}$	False
81	$35 = \frac{81-8}{2}$	False

The solution set is {78}.

1-5 Equations

Solve each equation.

$$43. \frac{3(9)-2}{1+4} = d$$

SOLUTION:

$$\frac{3(9)-2}{1+4} = d \quad \text{Original equation}$$

$$\frac{27-2}{1+4} = d \quad \text{Multiply 3 and 9.}$$

$$\frac{27-2}{5} = d \quad \text{Add 1 and 4.}$$

$$\frac{25}{5} = d \quad \text{Subtract 2 from 27.}$$

$$5 = d \quad \text{Divide 25 by 5.}$$

$$44. j = 15 \div 3 \cdot 5 - 4^2$$

SOLUTION:

$$j = 15 \div 3 \cdot 5 - 4^2 \quad \text{Original equation}$$

$$j = 15 \div 3 \cdot 5 - 16 \quad \text{Evaluate power.}$$

$$j = 5 \cdot 5 - 16 \quad \text{Divide 15 by 3.}$$

$$j = 25 - 16 \quad \text{Multiply 5 by 5.}$$

$$j = 9 \quad \text{Subtract 16 from 25.}$$

$$45. c + (3^2 - 3) = 21$$

SOLUTION:

$$c + (3^2 - 3) = 21 \quad \text{Original equation}$$

$$c + (9 - 3) = 21 \quad \text{Evaluate power.}$$

$$c + 6 = 21 \quad \text{Subtract 3 from 9.}$$

$$c = 15 \quad \text{Subtract 6 from each side.}$$

$$46. (3^3 - 3 \cdot 9) + (7 - 2^2)b = 24b$$

SOLUTION:

$$(3^3 - 3 \cdot 9) + (7 - 2^2)b = 24b \quad \text{Original equation}$$

$$(27 - 3 \cdot 9) + (7 - 2^2)b = 24b \quad \text{Evaluate power.}$$

$$(27 - 3 \cdot 9) + (7 - 4)b = 24b \quad \text{Evaluate power.}$$

$$(27 - 27) + (7 - 4)b = 24b \quad \text{Multiply 3 by 9.}$$

$$0 + (7 - 4)b = 24b \quad \text{Subtract 27 from 27.}$$

$$0 + 3b = 24b \quad \text{Subtract 4 from 7.}$$

$$3b = 24b \quad \text{Simplify.}$$

The only value for b that makes the equation true is 0. So, the equation has a unique solution of $b = 0$.

47. **CCSS SENSE-MAKING** Blood flow rate can be

expressed as $F = \frac{p_1 - p_2}{r}$, where F is the flow rate, p_1 and p_2 are the initial and final pressure exerted against the blood vessel's walls, respectively, and r is the resistance created by the size of the vessel.

a. Write and solve an equation to determine the resistance of the blood vessel for an initial pressure of 100 millimeters of mercury Hg, a final pressure of 0 millimeters of mercury Hg, and a flow rate of 5 liters per minute.

b. Use the equation to complete the table.

Initial Pressure p_1 (mm Hg)	Final Pressure p_2 (mm Hg)	Resistance r (mm Hg/L/min)	Blood Flow Rate F (L/min)
100	0		5
100	0	30	
	5	40	4
90		10	6

SOLUTION:

a.

$$F = \frac{p_1 - p_2}{r}$$

$$5 = \frac{100 - 0}{r}$$

$$5 = \frac{100}{r}$$

Test values of r for which the statement is true.

$$\frac{100}{5} = 20$$

$$\frac{100}{10} = 10$$

$$\frac{100}{20} = 5$$

The only value for r that makes the equation true is 20. So, the resistance is 20 mm Hg/L/min.

b. Row 1: The resistance is 20 mm Hg/L/min as determined in part a.

Row 2:

1-5 Equations

$$F = \frac{P_1 - P_2}{r}$$

$$F = \frac{100 - 0}{30}$$

$$F = \frac{100}{30}$$

$$F \approx 3.33$$

Row 3:

$$F = \frac{P_1 - P_2}{r}$$

$$4 = \frac{P_1 - 5}{40}$$

Test values of p_1 for which the statement is true.

$$\frac{5-5}{40} = 0$$

$$\frac{45-5}{40} = 1$$

$$\frac{245-5}{40} = 6$$

$$\frac{205-5}{40} = 5$$

$$\frac{165-5}{40} = 4$$

The only value for p_1 that makes the equation true is 165. So the initial pressure is 165 mm Hg.

Row 4:

$$F = \frac{P_1 - P_2}{r}$$

$$6 = \frac{90 - P_2}{10}$$

Initial Pressure P_1 (mm Hg)	Final Pressure P_2 (mm Hg)	Resistance r (mm Hg/L/min)	Blood Flow Rate F (L/min)
100	0	20	5
100	0	30	≈ 3.33
165	5	40	4
90	30	10	6

The only value for p_2 that makes the equation true is 30. So, the final pressure is 30 mm Hg.

Determine whether the given number is a solution of the equation.

48. $x + 6 = 15$; 9

SOLUTION:

$$x + 6 = 15$$

$$9 + 6 \stackrel{?}{=} 15$$

$$15 = 15$$

9 is a solution.

49. $12 + y = 26$; 14

SOLUTION:

$$12 + y = 26$$

$$12 + 14 \stackrel{?}{=} 26$$

$$26 = 26$$

14 is a solution.

50. $2t - 10 = 4$; 3

SOLUTION:

$$2t - 10 = 4$$

$$2(3) - 10 \stackrel{?}{=} 4$$

$$6 - 10 \stackrel{?}{=} 4$$

$$-4 \neq 4$$

3 is not a solution.

51. $3r + 7 = -5$; 2

SOLUTION:

$$3r + 7 = -5$$

$$3(2) + 7 \stackrel{?}{=} -5$$

$$6 + 7 \stackrel{?}{=} -5$$

$$13 \neq -5$$

2 is not a solution.

1-5 Equations

52. $6 + 4m = 18$; 3

SOLUTION:

$$6 + 4m = 18$$

$$6 + 4(3) \stackrel{?}{=} 18$$

$$6 + 12 \stackrel{?}{=} 18$$

$$18 = 18$$

3 is a solution.

53. $-5 + 2p = -11$; -3

SOLUTION:

$$-5 + 2p = -11$$

$$-5 + 2(-3) \stackrel{?}{=} -11$$

$$-5 - 6 \stackrel{?}{=} -11$$

$$-11 = -11$$

-3 is a solution.

54. $\frac{q}{2} = 20$; 10

SOLUTION:

$$\frac{q}{2} = 20$$

$$\frac{10}{2} \stackrel{?}{=} 20$$

$$5 \neq 20$$

10 is not a solution.

55. $\frac{w-4}{5} = -3$; -11

SOLUTION:

$$\frac{w-4}{5} = -3$$

$$\frac{-11-4}{5} \stackrel{?}{=} -3$$

$$\frac{-15}{5} \stackrel{?}{=} -3$$

$$-3 = -3$$

-11 is a solution.

56. $\frac{g}{3} - 4 = 12$; 48

SOLUTION:

$$\frac{g}{3} - 4 = 12$$

$$\frac{48}{3} - 4 \stackrel{?}{=} 12$$

$$16 - 4 \stackrel{?}{=} 12$$

$$12 = 12$$

48 is a solution.

Make a table of values for each equation if the replacement set is $\{-2, -1, 0, 1, 2\}$.

57. $y = 3x + 5$

SOLUTION:

x	$3x + 5$	y
-2	$3(-2) + 5$	-1
-1	$3(-1) + 5$	2
0	$3(0) + 5$	5
1	$3(1) + 5$	8
2	$3(2) + 5$	11

58. $-2x - 3 = y$

SOLUTION:

x	$-2x - 3$	y
-2	$-2(-2) - 3$	1
-1	$-2(-1) - 3$	-1
0	$-2(0) - 3$	-3
1	$-2(1) - 3$	-5
2	$-2(2) - 3$	-7

1-5 Equations

59. $y = \frac{1}{2}x + 2$

SOLUTION:

x	$\frac{1}{2}x + 2$	y
-2	$\frac{1}{2}(-2) + 2$	1
-1	$\frac{1}{2}(-1) + 2$	1.5
0	$\frac{1}{2}(0) + 2$	2
1	$\frac{1}{2}(1) + 2$	2.5
2	$\frac{1}{2}(2) + 2$	3

60. $4.2x - 1.6 = y$

SOLUTION:

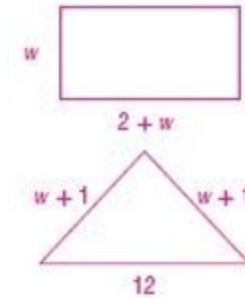
x	$4.2x - 1.6$	y
-2	$4.2(-2) - 1.6$	-10
-1	$4.2(-1) - 1.6$	-5.8
0	$4.2(0) - 1.6$	-1.6
1	$4.2(1) - 1.6$	2.6
2	$4.2(2) - 1.6$	6.8

61. **GEOMETRY** The length of a rectangle is 2 inches greater than the width. The length of the base of an isosceles triangle is 12 inches, and the lengths of the other two sides are 1 inch greater than the width of the rectangle.

- Draw a picture of each figure and label the dimensions.
- Write two expressions to find the perimeters of the rectangle and triangle.
- Find the width of the rectangle if the perimeters of the figures are equal.

SOLUTION:

a.



- b. The formula for the perimeter of a rectangle is $P = 2l + 2w$.

$$\begin{aligned}
 P &= 2(2 + w) + 2w \\
 &= 2(2) + 2w + 2w \\
 &= 4 + (2 + 2)w \\
 &= 4 + 4w
 \end{aligned}$$

The formula for the perimeter of a triangle is $P = a + b + c$.

$$\begin{aligned}
 P &= (w + 1) + (w + 1) + 12 \\
 &= w + w + 1 + 1 + 12 \\
 &= (1 + 1)w + 14 \\
 &= 2w + 14
 \end{aligned}$$

- c. Because the perimeters are equal, set the expression from parts **a** and **b** equal to each other and solve for w .

$$\begin{aligned}
 4w + 4 &= 2(w + 1) + 12 \\
 4w + 4 &= 2w + 2 + 12 \\
 4w + 4 &= 2w + 14
 \end{aligned}$$

Test values for w .

1-5 Equations

$$4(1) + 4 \stackrel{?}{=} 2(1) + 14$$

$$8 \neq 16$$

$$4(2) + 4 \stackrel{?}{=} 2(2) + 14$$

$$12 \neq 18$$

$$4(4) + 4 \stackrel{?}{=} 2(4) + 14$$

$$20 \neq 22$$

$$4(5) + 4 \stackrel{?}{=} 2(5) + 14$$

$$24 = 24$$

The only value of w that makes the equation true is 5. So, $w = 5$ inches.

62. **CONSTRUCTION** The construction of a building requires 10 tons of steel per story.

a. Define a variable and write an equation for the number of tons of steel required if the building has 15 stories.

b. How many tons of steel are needed?

SOLUTION:

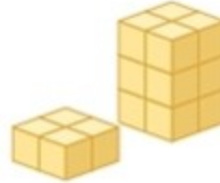
a. Let t represent tons of steel. There are 10 tons of steel required for every story and there are 15 stories, so the total number of tons of steel required can be found by multiplying 10 by 15. $t = 10(15)$

b.
 $t = 10(15)$
 $= 150$

So, 150 tons of steel are needed.

63. **MULTIPLE REPRESENTATIONS** In this problem, you will further explore writing equations.

a. **CONCRETE** Use centimeter cubes to build a tower similar to the one shown below.



b. **TABULAR** Copy and complete the table shown below. Record the number of layers in the tower and the number of cubes used in the table.

Layers	1	2	3	4	5	6	7
Cubes	?	?	?	?	?	?	?

c. **ANALYTICAL** As the number of layers in the tower increases, how does the number of cubes in the tower change?

d. **ALGEBRAIC** Write a rule that gives the number of cubes in terms of the number of layers in the tower.

SOLUTION:

a. For example, towers built with two layers should have 8 cubes, towers built with 4 layers should have 16 cubes, and towers built with 6 layers should have 24 cubes.

b.

Layers	1	2	3	4	5	6	7
Cubes	4	8	12	16	20	24	28

c. Each layer adds 4 more cubes to the tower.

d. The number of cubes = $4L$, where L is the number of layers in the tower.

1-5 Equations

64. **REASONING** Compare and contrast an expression and an equation.

SOLUTION:

Sample answer: An equation contains an equal sign and an expression does not. An equation is made up of 2 expressions and an equal sign. For example, $2x + 5$ and $4x$ are expressions and $2x + 5 = 4x$ is an equation.

65. **OPEN ENDED** Write an equation that is an identity.

SOLUTION:

Sample answer: An identity is an equation that is true for every value of the variable. Thus, $3x + 12 = 3(x + 4)$ is an identity since $2x + 12 = 3x + 12$.

66. **REASONING** Explain why an open sentence always has at least one variable.

SOLUTION:

An open sentence is a mathematical statement with one or more variables. Therefore if a sentence does not contain a variable, it cannot be an open sentence.

67. **CCSS CRITIQUE** Tom and Li-Cheng are solving the equation $x = 4(3 - 2) + 6 \div 8$. Is either of them correct? Explain your reasoning.

$$\begin{aligned} & \text{Tom} \\ x &= 4(3 - 2) + 6 \div 8 \\ &= 4(1) + 6 \div 8 \\ &= 4 + 6 \div 8 \\ &= 4 + \frac{6}{8} \\ &= 4\frac{3}{4} \end{aligned}$$

$$\begin{aligned} & \text{Li-Cheng} \\ x &= 4(3 - 2) + 6 \div 8 \\ &= 4(1) + 6 \div 8 \\ &= 4 + 6 \div 8 \\ &= 10 \div 8 \\ &= \frac{5}{4} \end{aligned}$$

SOLUTION:

Tom; Tom evaluated inside the parenthesis first. Then he performed multiplication and then division. Finally Tom added. Li-Cheng did evaluate inside the parenthesis first. However, next, she added $6 + 4$ instead of dividing 6 by 8 . She did not follow the order of operations.

68. **CHALLENGE** Find all of the solutions of $x^2 + 5 = 30$

SOLUTION:

For the equation $x^2 + 5 = 30$ to be true, the value of x^2 must be 25 . Both 5^2 and $(-5)^2$ result in 25 . So, the equation has two solutions, 5 and -5 .

1-5 Equations

69. **OPEN ENDED** Write an equation that involves two or more operations with a solution of -7 .

SOLUTION:

$$3x - 2 = -23$$

$$3(-7) - 2 \stackrel{?}{=} -23$$

$$-21 - 2 \stackrel{?}{=} -23$$

$$-23 = -23$$

70. **WRITING IN MATH** Explain how you can determine that an equation has no real numbers as a solution. How can you determine that an equation has all real numbers as solutions?

SOLUTION:

Sample answer: Equations with no real numbers for solutions may have the same variables on each side of the equation, but are different by some number or operation. For example, the equation $3x + 1 = 3x + 2$ will have no solution since 1 can never equal 2.

Equations that have all of the real numbers as solutions are equations with the same variables and same numbers and operations on both sides of the equation. For example, the equations $3x + 6 = 3x + 6$ or $3x + 6 = 3(x + 2)$ have all real numbers as their solutions since the left side of the equation will always equal the right for any value of x .

71. Which of the following is not an equation?

A $y = 6x - 4$

B $\frac{a+4}{2} = \frac{1}{4}$

C $(4 \cdot 3b) + (8 \div 2c)$

D $55 = 6 + d^2$

SOLUTION:

Equations have an equality symbol, so choice **C** is not an equation. It is an expression.

72. **SHORT RESPONSE** The expected attendance for the Drama Club production is 65% of the student body. If the student body consists of 300 students, how many students are expected to attend?

SOLUTION:

Use the percent equation to find 65% of 300 students. The base is 300 and the percent is 65. Let a represent the part.

$$\frac{a}{b} = \frac{p}{100} \quad \text{Percent Proportion}$$

$$\frac{a}{300} = \frac{65}{100} \quad b = 300, p = 65$$

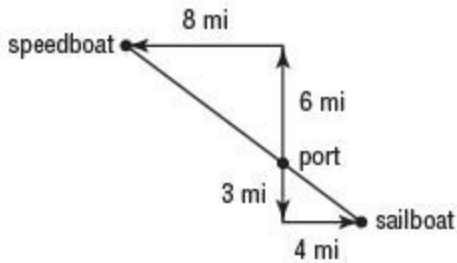
$$19,500 = 100a \quad \text{Find the cross products.}$$

$$195 = a \quad \text{Simplify.}$$

195 students are expected to attend.

1-5 Equations

73. **GEOMETRY** A speedboat and a sailboat take off from the same port. The diagram shows their travel. What is the distance between the boats?



- F 12 mi
G 15 mi
H 18 mi
J 24 mi

SOLUTION:

The distance between the speedboat and the port can be calculated by:

$$\begin{aligned} 8^2 + 6^2 &= c^2 \\ 64 + 36 &= c^2 \\ 100 &= c^2 \\ 10 &= c \end{aligned}$$

The distance between the port and the sailboat can be calculated by:

$$\begin{aligned} 3^2 + 4^2 &= x^2 \\ 9 + 16 &= x^2 \\ 25 &= x^2 \\ 5 &= x \end{aligned}$$

Therefore, the distance between the sailboat and the speedboat is $10 + 5 = 15$ miles, so the correct answer is G.

74. Michelle can read 1.5 pages per minute. How many pages can she read in two hours?

- A 90 pages
B 150 pages
C 120 pages
D 180 pages

SOLUTION:

Let t represent time in minutes. Two hours is equal to 120 minutes.

$$\begin{aligned} 1.5t &= 1.5(120) \\ &= 180 \end{aligned}$$

The answer is 180 pages. So, the correct answer is D.

75. **ZOO** A zoo has about 500 children and 750 adults visit each day. Write an expression to represent about how many visitors the zoo will have over a month.

SOLUTION:

Each day, there are $500 + 750$ people. Therefore, we need to multiply this sum by the total number of days in a month to find the total number of visitors per month. If a month has 30 days, the expression can be written as $30(500 + 750)$.

Find the value of p in each equation. Then name the property that is used.

76. $7.3 + p = 7.3$

SOLUTION:

Because $7.3 + 0 = 7.3$, $p = 0$;
Additive Identity

77. $12p = 1$

SOLUTION:

$p = \frac{1}{12}$. Since $12 \cdot \frac{1}{12} = 1$, Multiplicative Inverse is used.

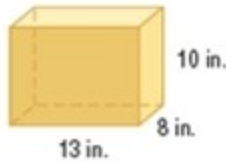
1-5 Equations

78. $1p = 4$

SOLUTION:

Because $1(4) = 4$, $p = 4$.
Multiplicative Identity

79. **MOVING BOXES** The figure shows the dimensions of the boxes Steve uses to pack. How many cubic inches can each box hold?



SOLUTION:

$$\begin{aligned}V &= \ell wh \\ &= (13)(8)(10) \\ &= 1040\end{aligned}$$

So, the box can hold 1040 cubic inches.

Express each percent as a fraction.

80. 35%

SOLUTION:

$$\begin{aligned}35\% &= \frac{35}{100} \\ &= \frac{7}{20}\end{aligned}$$

81. 15%

SOLUTION:

$$\begin{aligned}15\% &= \frac{15}{100} \\ &= \frac{3}{20}\end{aligned}$$

82. 28%

SOLUTION:

$$\begin{aligned}28\% &= \frac{28}{100} \\ &= \frac{7}{25}\end{aligned}$$

For each problem, determine whether you need an estimate or an exact answer. Then solve.

83. **TRAVEL** The distance from Raleigh, North Carolina, to Philadelphia, Pennsylvania, is approximately 428 miles. The average gas mileage of José's car is 45 miles per gallon. About how many gallons of gas will be needed to make the trip?

SOLUTION:

You are asked to find about how many gallons, which means an estimate. Let g represent gallons of gas. Write an equation. Use 450 as an estimate of 428 for an easy division.

$$\begin{aligned}g &= \frac{450}{45} \\ g &= 10\end{aligned}$$

Jose will need about 10 gallons of gas to make the trip.

84. **PART-TIME JOB** An employer pays \$8.50 per hour. If 20% of pay is withheld for taxes, what are the take-home earnings from 28 hours of work?

SOLUTION:

You are asked to find the take-home earnings, so you need to find an exact value. Before taxes, 28 hours of work earns $28(8.50)$, or \$238. Withholding 20% is the same as finding 80%. Use the percent equation to find 80% of \$238. The base is 239 and the percent is 80. Let a represent the part.

$$\frac{a}{b} = \frac{p}{100} \quad \text{Percent Proportion}$$

$$\frac{a}{238} = \frac{80}{100} \quad b = 239, p = 80$$

$$19,040 = 100a \quad \text{Find the cross product.}$$

$$190.4 = a \quad \text{Simplify.}$$

So, the take-home earnings are \$190.40.

Find each sum or difference.

85. $1.14 + 5.6$

SOLUTION:

$$1.14 + 5.6 = 6.74$$

1-5 Equations

86. $4.28 - 2.4$

SOLUTION:

$$4.28 - 2.4 = 1.88$$

87. $8 - 6.35$

SOLUTION:

$$8 - 6.35 = 1.65$$

88. $\frac{4}{5} + \frac{1}{6}$

SOLUTION:

The LCS for 5 and 6 is 30. Rename $\frac{4}{5}$ as $\frac{24}{30}$ and $\frac{1}{6}$ as $\frac{5}{30}$.

$$\begin{aligned}\frac{4}{5} + \frac{1}{6} &= \frac{24}{30} + \frac{5}{30} \\ &= \frac{24+5}{30} && \text{Add the numerators.} \\ &= \frac{29}{30} && \text{Simplify.}\end{aligned}$$

89. $\frac{2}{7} + \frac{3}{4}$

SOLUTION:

The LCD for 4 and 7 is 28. Rename $\frac{2}{7}$ as $\frac{8}{28}$ and $\frac{3}{4}$ as $\frac{21}{28}$.

$$\begin{aligned}\frac{2}{7} + \frac{3}{4} &= \frac{8}{28} + \frac{21}{28} \\ &= \frac{8+21}{28} && \text{Add the numerators.} \\ &= \frac{29}{28} && \text{Simplify.}\end{aligned}$$

90. $\frac{6}{8} - \frac{1}{2}$

SOLUTION:

The LCD for 8 and 2 is 8. Rename $\frac{1}{2}$ as $\frac{4}{8}$.

$$\begin{aligned}\frac{6}{8} - \frac{1}{2} &= \frac{6}{8} - \frac{4}{8} \\ &= \frac{6-4}{8} && \text{Subtract the numerators.} \\ &= \frac{2}{8} && \text{Simplify.} \\ &= \frac{1}{4} && \text{Rename the fraction.}\end{aligned}$$

1-6 Relations

Express each relation as a table, a graph, and a mapping. Then determine the domain and range.

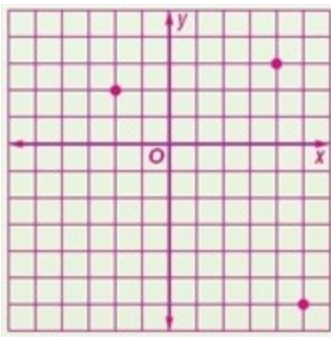
1. $\{(4, 3), (-2, 2), (5, -6)\}$

SOLUTION:

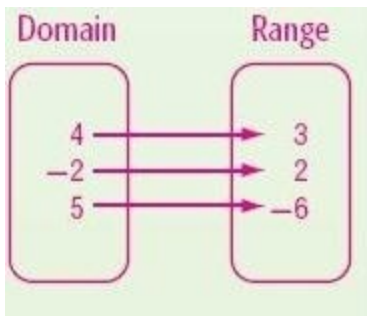
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
4	3
-2	2
5	-6

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-2, 4, 5\}$, and the range is $\{-6, 2, 3\}$.

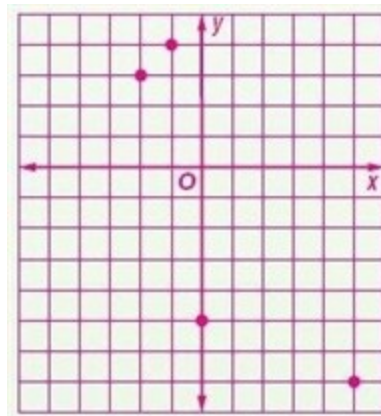
2. $\{(5, -7), (-1, 4), (0, -5), (-2, 3)\}$

SOLUTION:

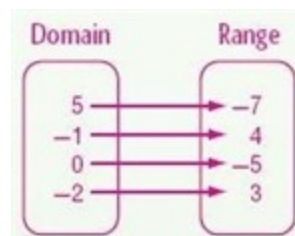
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
5	-7
-1	4
0	-5
-2	3

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-2, -1, 0, 5\}$ and the range is $\{-7, -5, 3, 4\}$.

1-6 Relations

Identify the independent and dependent variables for each relation.

3. Increasing the temperature of a compound inside a sealed container increases the pressure inside a sealed container.

SOLUTION:

The temperature of the compound is the independent variable because it is unaffected by the pressure of the compound. The pressure of the compound is the dependent variable because it depends on the temperature.

4. Mike's cell phone is part of a family plan. If he uses more minutes than his share, then there are fewer minutes available for the rest of his family.

SOLUTION:

The number of minutes Mike uses on his cell phone is the independent variable because it is unaffected by the number of minutes that are left. The number of minutes that are left is the dependent variable because it depends on the number of minutes Mike uses.

5. Julian is buying concert tickets for him and his friends. The more concert tickets he buys the greater the cost.

SOLUTION:

The number of concert tickets is the independent variable because it is unaffected by the cost of tickets. The cost of tickets is the dependent variable because it depends on the number of concert tickets.

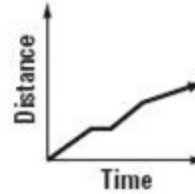
6. A store is having a sale over Labor Day weekend. The more purchases, the greater the profits.

SOLUTION:

The number of purchases is the independent variable because it is unaffected by the profits. The profit is the dependent variable because it depends on the number purchases.

CCSS MODELING Describe what is happening in each graph.

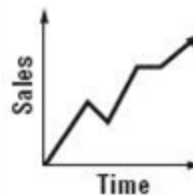
7. The graph represents the distance the track team runs during a practice.



SOLUTION:

First the line increases at a positive slope. This represents the track team running or walking at a steady pace. Next, the slope is zero. This indicates that the team stops for a short period of time. Then, the line increases at a positive slope, about the same pace as the beginning of the run. This represents the track team running or walking at a steady pace. Finally, the line increases at a positive slope, but at a rate less than the 1st and 3rd part of the run. This indicates that the team runs or walks at a steady pace, but at a slower pace.

8. The graph represents revenues generated through an online store.



SOLUTION:

The slope at the left of the graph is positive. This indicates that the sales initially increase. Next, the slope is negative, indicated that the sales are decreasing. Then, the slope increases again at the same rate, indicating the sales are increasing at a steady rate. Then the slope is zero for a short period of time. This indicates that there are no sales during this time. Then, the slope increases but at a slower rate than before. This indicates that the sales are increasing but at a slower rate.

1-6 Relations

Express each relation as a table, a graph, and a mapping. Then determine the domain and range.

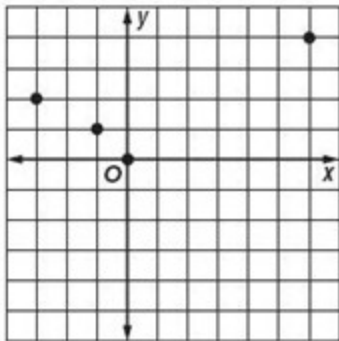
9. $\{(0, 0), (-3, 2), (6, 4), (-1, 1)\}$

SOLUTION:

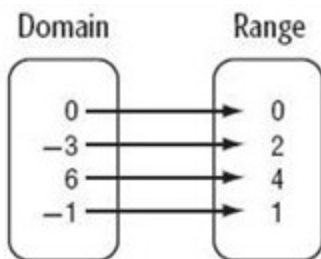
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
0	0
-3	2
6	4
-1	1

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-3, -1, 0, 6\}$, and the range is $\{0, 1, 2, 4\}$.

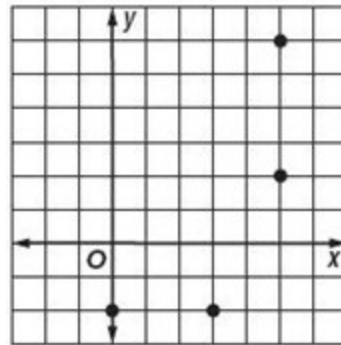
10. $\{(5, 2), (5, 6), (3, -2), (0, -2)\}$

SOLUTION:

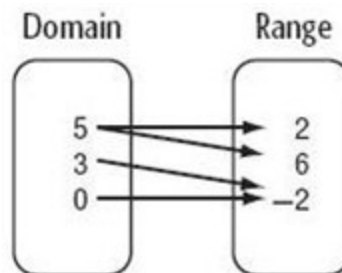
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
5	2
5	6
3	-2
0	-2

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{0, 3, 5\}$, and the range is $\{-2, 2, 6\}$.

1-6 Relations

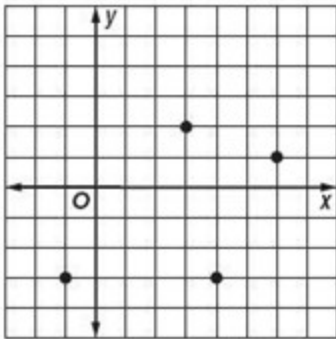
11. $\{(6, 1), (4, -3), (3, 2), (-1, -3)\}$

SOLUTION:

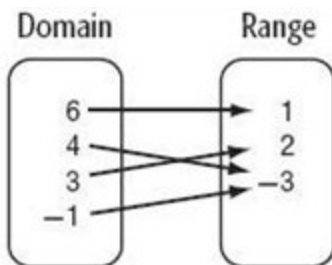
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
6	1
4	-3
3	2
-1	-3

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-1, 3, 4, 6\}$, and the range is $\{-3, 1, 2\}$.

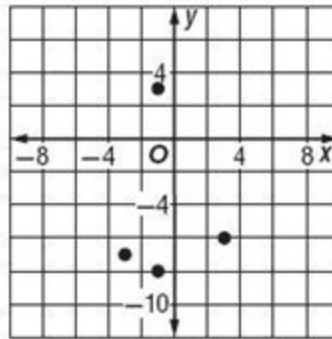
12. $\{(-1, 3), (3, -6), (-1, -8), (-3, -7)\}$

SOLUTION:

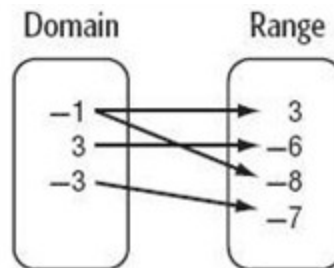
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
-1	3
3	-6
-1	-8
-3	-7

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-3, 1, 3\}$, and the range is $\{-8, -7, -6, 3\}$.

1-6 Relations

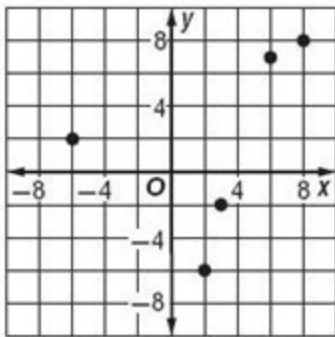
13. $\{(6, 7), (3, -2), (8, 8), (-6, 2), (2, -6)\}$

SOLUTION:

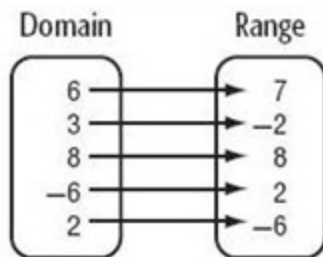
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
6	7
3	-2
8	8
-6	2
2	-6

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-6, 2, 3, 6, 8\}$, and the range is $\{-6, -2, 2, 7, 8\}$.

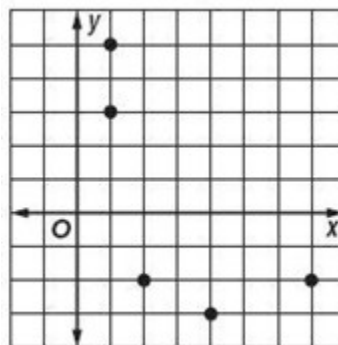
14. $\{(4, -3), (1, 3), (7, -2), (2, -2), (1, 5)\}$

SOLUTION:

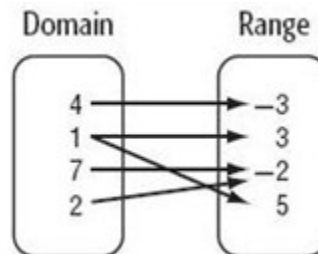
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
4	-3
1	3
7	-2
2	-2
1	5

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{1, 2, 4, 7\}$, and the range is $\{-3, -2, 3, 5\}$.

1-6 Relations

Identify the independent and dependent variables for each relation.

15. The Spanish classes are having a fiesta lunch. Each student that attends is to bring a Spanish side dish or dessert. The more students that attend, the more food there will be.

SOLUTION:

The number of students who attend the fiesta is the independent variable because it is unaffected by the amount of food that there will be at the fiesta. The amount of food that there will be at the fiesta is the dependent variable because it depends on the number of students who attend the fiesta.

16. The faster you drive your car, the longer it will take to come to a complete stop.

SOLUTION:

The speed of the car is the independent variable because it is unaffected by the length of time it takes to stop the car. The length of time it takes to stop the car is the dependent variable because it depends on the speed of the car.

CCSS MODELING Describe what is happening in each graph.

17. The graph represents the height of a bungee jumper.



SOLUTION:

The slope initially is zero, indicating that the bungee jumper is walking to the place to jump. Next, the slope is negative. This indicates that the bungee jumper is falling. Then, the slope is increasing, indicating the the bungee jumper is bouncing up.

The slope is then negative, indicating the bungee jumper is falling. Then the slope is increasing, indicating the the bungee jumper is bouncing up. The slope is then negative again, indicating the bungee jumper is falling until the bungee cord stops.

18. The graph represents the sales of lawn mowers.



SOLUTION:

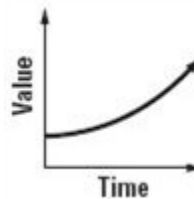
The positive slope of the first section of the graph indicates that lawn mower sales are increasing as time goes on. The next section of the graph is horizontal (zero slope) because sales are steady for that period of time.

The next section of the graph has a steep positive slope showing that the rate of mower sales is quickly increasing. Then, the graph becomes horizontal as sales are high and steady. Finally, sales begin to quickly drop off as the graph takes on a negative slope.

The last section of the graph shows that sales continue to decrease, but at a slower rate. Sales continue to diminish until sales stop altogether at the end of the graph.

CCSS MODELING Describe what is happening in each graph.

19. The graph represents the value of a rare baseball card.



SOLUTION:

The slope of the line is positive and constantly increasing. This indicates that the value of the rare baseball card increases over time, at an increasing rate.

1-6 Relations

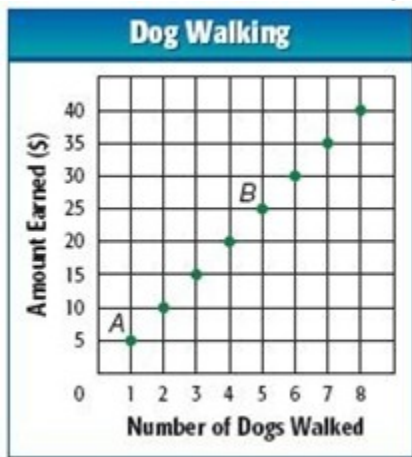
20. The graph represents the distance covered on an extended car ride.



SOLUTION:

The slope is either positive or zero throughout the time period. Initially, the car is moving at a steady rate. Then, the slope is zero indicating the car stopped. Then, the slope is positive, but at greater than the initial leg. This indicated that the car is now moving at a faster pace. The slope is zero again, indicating the car stops for the second time. Then, the slope is positive indicating that the car is moving again.

For Exercises 21–23, use the graph below.



21. Name the ordered pair at point *A* and explain what it represents.

SOLUTION:

The value of the x -coordinate corresponds to the variable on the horizontal axis, while the value of the y -coordinate corresponds to the variable on the vertical axis. The ordered pair at point *A* is (1, 5). It represents the amount of money the dog walker earns, \$5, for walking 1 dog.

22. Name the ordered pair at point *B* and explain what it represents.

SOLUTION:

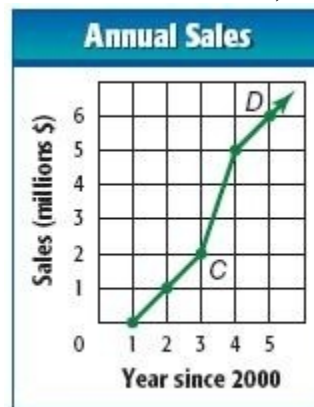
The value of the x -coordinate corresponds to the variable on the horizontal axis, while the value of the y -coordinate corresponds to the variable on the vertical axis. The ordered pair at point *B* is (5, 25). It represents the amount of money the dog walker earns, \$25, for walking 5 dogs.

23. Identify the independent and dependent variables for the relation.

SOLUTION:

The number of dogs walked is the independent variable because it is unaffected by the amount earned. The amount earned is the dependent variable because it depends on the number of dogs walked.

For Exercises 24–26, use the graph below.



24. Name the ordered pair at point *C* and explain what it represents.

SOLUTION:

The value of the x -coordinate corresponds to the variable on the horizontal axis, while the value of the y -coordinate corresponds to the variable on the vertical axis. The ordered pair at point *C* is (3, 2). It represents the amount earned in sales, \$2 million, in the year 2003.

1-6 Relations

25. Name the ordered pair at point D and explain what it represents.

SOLUTION:

The value of the x -coordinate corresponds to the variable on the horizontal axis, while the value of the y -coordinate corresponds to the variable on the vertical axis. The ordered pair at point D is $(5, 6)$. It represents the amount earned in sales, \$6 million, in the year 2005.

26. Identify the independent and dependent variables.

SOLUTION:

The year is the independent variable because it is unaffected by the sales. The amount of sales is the dependent variable because it depends on the year.

Express each relation as a set of ordered pairs. Describe the domain and range.

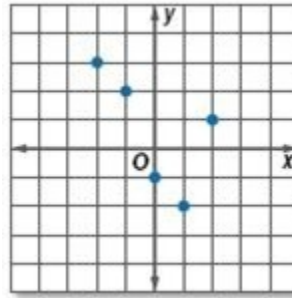
Buying Aquarium Fish	
Number of Fish	Total Cost
1	\$2.50
2	\$4.50
5	\$10.50
8	\$16.50

27.

SOLUTION:

To express the relation as a set of ordered pairs, write the number of fish as the x -coordinate and the corresponding total cost as the y -coordinate. So, the ordered pairs are $\{(1, 2.50), (2, 4.50), (5, 10.50), (8, 16.50)\}$.

The domain is the set of x -coordinates and the range is the set of y -coordinates. So, the domain is $\{1, 2, 5, 8\}$, and the range is $\{2.50, 4.50, 10.50, 16.50\}$.



28.

SOLUTION:

To express the relation as a set of ordered pairs, write the x -coordinates of the points followed by the corresponding y -coordinates. So, the ordered pairs are $\{(-2, 3), (-1, 2), (0, -1), (1, -2), (2, 1)\}$. The domain is the set of x -coordinates and the range is the set of y -coordinates. So, the domain is $\{-2, -1, 0, 1, 2\}$, and the range is $\{3, 2, -1, -2, 1\}$.

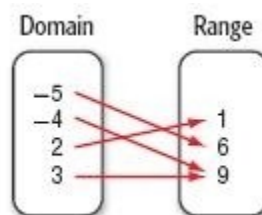
Express the relation in each table, mapping, or graph as a set of ordered pairs.

x	y
4	-1
8	9
-2	-6
7	-3

29.

SOLUTION:

To express the relation as a set of ordered pairs, write the x -coordinates followed by the corresponding y -coordinates. So, the ordered pairs are $\{(4, -1), (8, 9), (-2, -6), (7, -3)\}$.

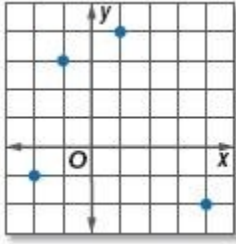


30.

SOLUTION:

To express the relation as a set of ordered pairs, write the values in the domain as the x -coordinates and the corresponding range values as the y -coordinates. So, the ordered pairs are $\{(-5, 6), (-4, 9), (2, 1), (3, 9)\}$.

1-6 Relations



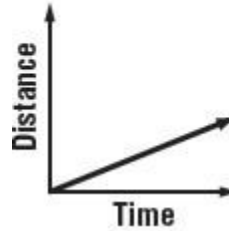
31.

SOLUTION:

To express the relation as a set of ordered pairs, write the x -coordinates of the points followed by the corresponding y -coordinates. So, the ordered pairs are $\{(4, -2), (-1, 3), (-2, -1), (1, 4)\}$.

32. **SPORTS** In a triathlon, athletes swim 2.4 miles, bicycle 112 miles, and then run 26.2 miles. Their total time includes transition time from one activity to the next. Which graph best represents a participant in a triathlon? Explain.

Graph A



Graph B



Graph C



SOLUTION:

Graph A represents an athlete going the same speed the entire race. Graph B had three different speeds and two stopping points. Graph C has two different speeds and one stopping period. Since there must be two stopping periods in a triathlon, Graph B is correct.

1-6 Relations

Draw a graph to represent each situation.

33. **ANTIQUES** A grandfather clock that is over 100 years old has increased in value from when it was first purchased.

SOLUTION:

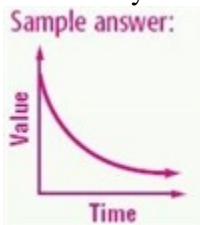
Sample answer: As time increases, so does the value of the clock.



34. **CAR** A car depreciates in value. The value decreases quickly in the first few years.

SOLUTION:

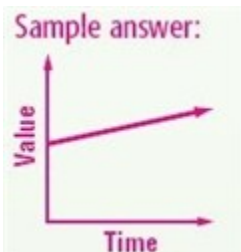
Sample answer: As time increases, the value of the car decreases. It decreases quickly at first and then more slowly.



35. **REAL ESTATE** A house typically increases in value over time.

SOLUTION:

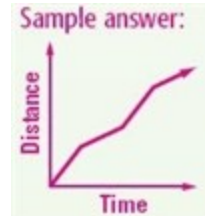
Sample answer: As time increases, the value of the house increases.



36. **EXERCISE** An athlete alternates between running and walking during a workout.

SOLUTION:

Sample answer: When the athlete is running the distance increases more rapidly over time. When the athlete is walking, the distance increases more slowly over time.



37. **PHYSIOLOGY** A typical adult has about 2 pounds of water for every 3 pounds of body weight. This can

be represented by the equation $w = 2\left(\frac{b}{3}\right)$, where w

is the weight of water in pounds and b is the body weight in pounds.

a. Make a table to show the relation between body and water weight for people weighing 100, 105, 110, 115, 120, 125, and 130 pounds. Round to the nearest tenth if necessary.

b. What are the independent and dependent variables?

c. State the domain and range, and then graph the relation.

d. Reverse the independent and dependent variables. Graph this relation. Explain what the graph indicates in this circumstance.

SOLUTION:

a. To find the water weight, replace b with the body weight in the equation $w = 2\left(\frac{b}{3}\right)$.

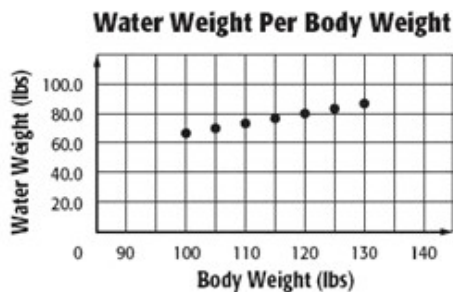
Body Weight (lbs)	Water Weight (lbs)
100	$2\left(\frac{100}{3}\right) \approx 66.7$
105	$2\left(\frac{105}{3}\right) = 70$
110	$2\left(\frac{110}{3}\right) \approx 73.3$

1-6 Relations

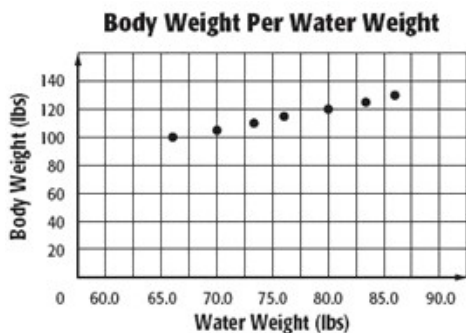
115	$2\left(\frac{115}{3}\right) \approx 76.7$
120	$2\left(\frac{120}{3}\right) = 80$
125	$2\left(\frac{125}{3}\right) \approx 83.3$
130	$2\left(\frac{130}{3}\right) \approx 86.7$

b. The body weight in pounds, b , is the independent variable because it is unaffected by the weight of water in pounds, w . The weight of water in pounds, w , is the dependent variable because it depends on the body weight in pounds, b .

c. The domain is the set of x -coordinates for the independent variable and the range is the set of y -coordinates from the dependent variable. So, the domain is $\{100, 105, 110, 115, 120, 125, 130\}$, and the range is $\{66.7, 70, 73.3, 76.7, 80, 83.3, 86.7\}$. Graph the body weight (the independent variable) on the x -axis and the water weight (the dependent variable) on the y -axis.



d. The water weight becomes the independent variable and is graphed on the x -axis. The body weight becomes the dependent variable and is graphed on the y -axis.



This graph indicates that the body weight is dependent on the water weight. As the water weight increases, the body weight also increases.

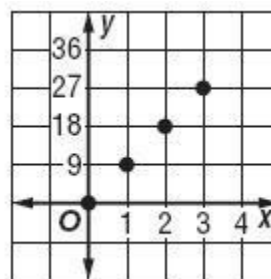
38. **OPEN ENDED** Describe a real-life situation that can be represented using a relation and discuss how one of the quantities in the relation depends on the other. Then represent the relation in three different ways.

SOLUTION:

Sample answer: The number of movie tickets bought and the total cost of the tickets can be represented using a relation. The total cost depends on the number of tickets bought. Let each ticket cost \$9.00. You can represent this relation as a table.

Number of Tickets	Total Cost
0	\$0.00
1	\$9.00
2	\$18.00
3	\$27.00

You can also represent it as a graph. The number of tickets is the independent variable and should be graphed on the x -axis. The total cost is the dependent variable and should be graphed on the y -axis.



You can represent the relation as a set of ordered pairs where the number of tickets is the x -coordinate and total cost is y -coordinate. The ordered pairs are $\{(0, 0), (1, 9), (2, 18), (3, 27)\}$.

1-6 Relations

39. **CHALLENGE** Describe a real-world situation where it is reasonable to have a negative number included in the domain or range.

SOLUTION:

Sample answer: It is reasonable to have a negative number included in the domain or range when dealing with temperature or financial data. For example, it is reasonable to have a negative number included in the domain or range when looking at the average temperature in Alaska each month during a given year.

40. **CCSS PRECISION** Compare and contrast dependent and independent variables.

SOLUTION:

Sample answer: A dependent variable is determined by the independent variable for a given relation. The value of the dependent variable *depends* on the value of the independent variable, whereas, the value of the independent variable is *independent* of the value of the dependent variable.

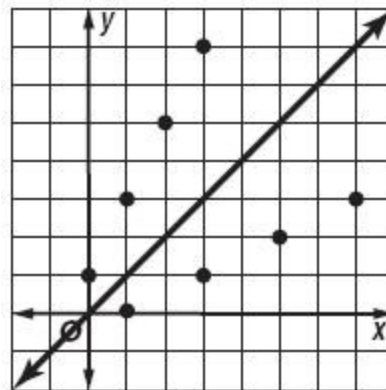
For example, consider a relation that relates the amount of medication in your blood stream over time. Time is the independent variable, since you have not control it. The amount of medication in your blood stream is the dependent variable. The amount of medicine is dependent on the time it has been in your body.

41. **CHALLENGE** The table presents a relation. Graph the ordered pairs. Then reverse the y -coordinate and the x -coordinate in each ordered pair. Graph these ordered pairs on the same coordinate plane. Graph the line $y = x$. Describe the relationship between the two sets of ordered pairs.

x	y
0	1
1	3
2	5
3	7

SOLUTION:

Reversing the coordinates gives $(1, 0)$, $(3, 1)$, $(5, 2)$, and $(7, 3)$.



Each point in the original relation is the same distance from the line as the corresponding point of the reverse relation. The graphs are symmetric about the line $y = x$.

1-6 Relations

42. **WRITING MATH** Use the data about the pressure of water below to explain the difference between dependent and an independent variables.

The deeper in the ocean you are, the greater pressure is on your body. This is because there is more water over you. The force of gravity pulls the water weight down, creating a greater pressure. The equation that relates the total pressure of the water to the depth of the water is $P = rgh$, where P = the pressure, r = the density of water, g = the acceleration of gravity, and h = the height of water above you.

SOLUTION:

The value of a dependent variable is dependent on the value of the independent variable. As you dive deeper in the ocean, the pressure on the body is increased. Thus, the independent variable is the depth of water. The pressure exerted under the water depends on the height or depth of the water. Therefore, the pressure is the dependent variable. .

43. A school's cafeteria employees surveyed 250 students asking what beverage they drank with lunch. They used the data to create this table.

Beverage	Number of Students
milk	38
chocolate milk	112
juice	75
water	25

What percent of the students surveyed preferred drinking juice with lunch?

- A 25%
B 30%
C 35%
D 40%

SOLUTION:

To find the percent of students surveyed who preferred drinking juice with lunch, use the percent equation $\frac{a}{b} = \frac{p}{100}$. The part is 75 and the base is 250. Let p represent the percent.

$$\frac{a}{b} = \frac{p}{100} \quad \text{Percent Proportion}$$

$$\frac{75}{250} = \frac{p}{100} \quad a = 75, b = 250$$

$$7500 = 250p \quad \text{Find the cross products.}$$

$$\frac{7500}{250} = \frac{250p}{250} \quad \text{Divide each side by 250.}$$

$$30 = p \quad \text{Simplify.}$$

So, 30% of the students surveyed preferred drinking juice with lunch. Choice B is the correct answer.

1-6 Relations

44. Which of the following is equivalent to $6(3 - g) + 2(11 - g)$?

F $2(20 - g)$

G $8(14 - g)$

H $8(5 - g)$

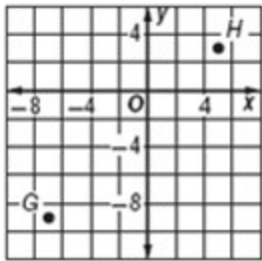
J $40 - g$

SOLUTION:

$$\begin{aligned} & 6(3 - g) + 2(11 - g) \\ &= 6(3) - 6(g) + 2(11) - 2(g) \\ &= 18 - 6g + 22 - 2g \\ &= -8g + 40 \\ &= 8(-g + 5) \\ &= 8(5 - g) \end{aligned}$$

So, Choice H is the correct answer.

45. **SHORT RESPONSE** Grant and Hector want to build a clubhouse at the midpoint between their houses. If Grant's house is at point G and Hector's house is at point H , what will be the coordinates of the clubhouse?



SOLUTION:

The coordinates for point G are $(-7, -9)$. The coordinates for point H are $(5, 3)$. To find the coordinates of clubhouse, you must find the midpoint between Grant's and Hector's houses.

By counting half way down from Hector to Grant the coordinate $(-1, -3)$ is reached.

Also, the midpoint of two points is found by finding the average of the coordinates. -1 is the average of -7 and 5 , and -3 is the average of -9 and 3 .

So, the coordinates of the clubhouse are $(-1, -3)$.

46. If $3b = 2b$, which of the following is true?

A $b = 0$

B $b = \frac{2}{3}$

C $b = 1$

D $b = \frac{3}{2}$

SOLUTION:

$$\begin{aligned} 3b &= 2b \\ 3b - 2b &= 2b - 2b \\ b &= 0 \end{aligned}$$

Choice A is the correct answer.

Solve each equation.

47. $6(a + 5) = 42$

SOLUTION:

$$\begin{aligned} 6(a + 5) &= 42 \\ 6a + 30 &= 42 \\ 6a + 30 - 30 &= 42 - 30 \\ 6a &= 12 \\ \frac{6a}{6} &= \frac{12}{6} \\ a &= 2 \end{aligned}$$

48. $92 = k + 11$

SOLUTION:

$$\begin{aligned} 92 &= k + 11 \\ 92 - 11 &= k + 11 - 11 \\ 81 &= k \end{aligned}$$

1-6 Relations

$$49. 17 = \frac{45}{w} + 2$$

SOLUTION:

$$17 = \frac{45}{w} + 2$$

$$17 - 2 = \frac{45}{w} + 2 - 2$$

$$15 = \frac{45}{w}$$

$$15w = 45$$

$$w = 3$$

50. **HOT-AIR BALLOON** A hot-air balloon owner charges \$150 for a one-hour ride. If he gave 6 rides on Saturday and 5 rides on Sunday, write and evaluate an expression to describe his total income for the weekend.

SOLUTION:

To find his total income for the weekend, multiply the cost of each ride, \$150, by the sum of the number of rides on Saturday and Sunday. This can be represented by the expression $150(6 + 5)$.

$$\begin{aligned} 150(6 + 5) &= 150(11) \\ &= 1650 \end{aligned}$$

So, the balloon owner made \$1650.

51. **LOLLIPOPS** A bag of lollipops contains 19 cherry, 13 grape, 8 sour apple, 15 strawberry, and 9 orange flavored lollipops. What is the probability of drawing a sour apple flavored lollipop?

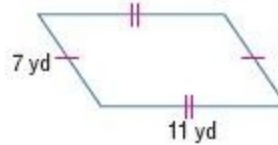
SOLUTION:

$$\text{Probability} = \frac{\text{number of favorable outcomes}}{\text{number of possible outcomes}}$$

$$\begin{aligned} P(\text{sour apple lollipop}) &= \frac{8}{19 + 13 + 8 + 15 + 9} \\ &= \frac{8}{64} \\ &= \frac{1}{8} \end{aligned}$$

So, the probability of drawing a sour apple flavored lollipop is $\frac{1}{8}$.

Find the perimeter of each figure.

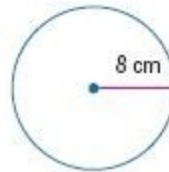


52.

SOLUTION:

$$\begin{aligned} P &= 2\ell + 2w \\ &= 2(7) + 2(11) \\ &= 14 + 22 \\ &= 36 \end{aligned}$$

So, the perimeter is 36 yards.

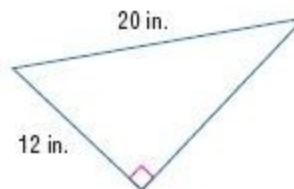


53.

SOLUTION:

$$\begin{aligned} C &= 2\pi r \\ &= 2\pi(8) \\ &= 16\pi \approx 50.27 \end{aligned}$$

So, the perimeter is about 50.27 centimeters.



54.

SOLUTION:

Use the Pythagorean theorem to find the length of the third side of the right triangle.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 12^2 + b^2 &= 20^2 \\ 144 + b^2 &= 400 \\ b^2 &= 256 \\ b &= 16 \end{aligned}$$

The perimeter is the sum of the lengths of the sides.
 $P = 12 + 16 + 20$ or 48 inches.

1-6 Relations

Evaluate each expression.

55. 8^2

SOLUTION:

$$\begin{aligned}8^2 &= 8 \cdot 8 \\ &= 64\end{aligned}$$

56. $(-6)^2$

SOLUTION:

$$\begin{aligned}(-6)^2 &= (-6)(-6) \\ &= 36\end{aligned}$$

57. $(2.5)^2$

SOLUTION:

$$\begin{aligned}(2.5)^2 &= (2.5)(2.5) \\ &= 6.25\end{aligned}$$

58. $(-1.8)^2$

SOLUTION:

$$\begin{aligned}(-1.8)^2 &= (-1.8)(-1.8) \\ &= 3.24\end{aligned}$$

59. $(3 + 4)^2$

SOLUTION:

$$\begin{aligned}(3+4)^2 &= 7^2 \\ &= 7 \cdot 7 \\ &= 49\end{aligned}$$

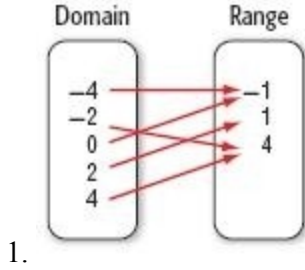
60. $(1 - 4)^2$

SOLUTION:

$$\begin{aligned}(1-4)^2 &= (-3)^2 \\ &= (-3)(-3) \\ &= 9\end{aligned}$$

1-7 Functions

Determine whether each relation is a function. Explain.



SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. So, this relation is a function.

Domain	Range
2	6
5	7
6	9
6	10

2.

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. In the domain, the value 6 is paired with both 9 and 10. So, this relation is not a function.

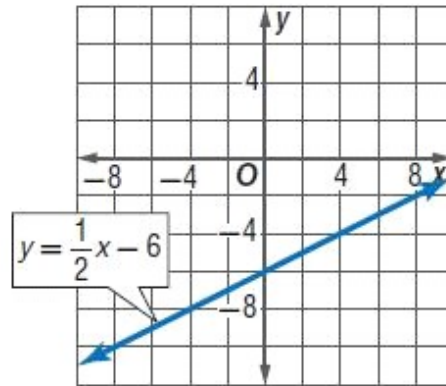
3. $\{(2, 2), (-1, 5), (5, 2), (2, -4)\}$

SOLUTION:

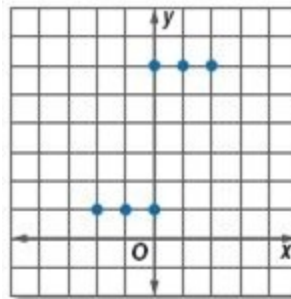
A function is a relation in which each element of the domain is paired with exactly one element of the range. In the domain, the value 2 is paired with 2 and -4. So, this relation is not a function.

4. $y = \frac{1}{2}x - 6$

SOLUTION:



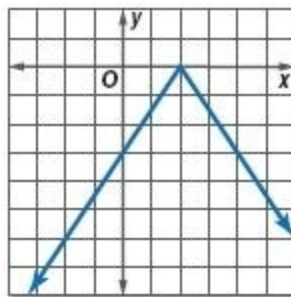
This is a function because no vertical line can be drawn so that it intersects the graph more than once.



5.

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. When $x = 0$, $y = 1$ and $y = 6$. So, this relation is not a function.

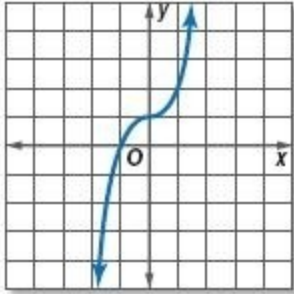


6.

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.

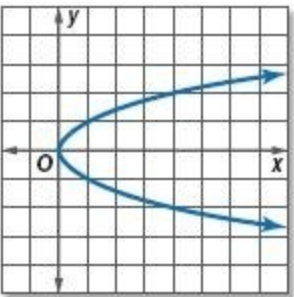
1-7 Functions



7.

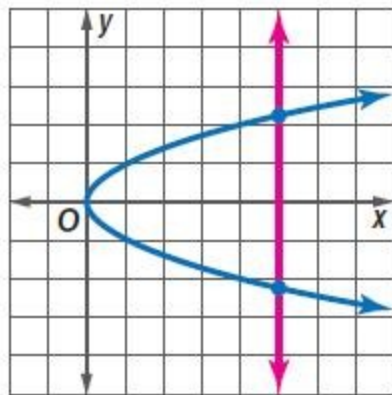
SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.



8.

SOLUTION:



This is not a function because a vertical line can be drawn so that it intersects the graph more than once.

9. **SCHOOL ENROLLMENT** The table shows the total enrollment in U.S. public schools.

School Year	2004–05	2005–06	2006–07	2007–08
Enrollment (in thousands)	48,560	48,710	48,948	49,091

Source: *The World Almanac*

a. Write a set of ordered pairs representing the data in the table if x is the number of school years since 2004–2005.

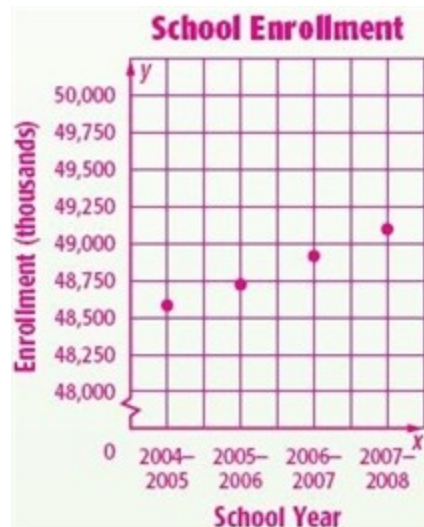
b. Draw a graph showing the relationship between the year and enrollment.

c. Describe the domain and range of the data.

SOLUTION:

a. The school year is the domain for this relation. The enrollment is the range. So, when creating ordered pairs, the school year is first and the enrollment is second. The ordered pairs for this data are $\{(0, 48,560), (1, 48,710), (2, 48,948), (3, 49,091)\}$.

b.



c. The domain is the school year and the range is the enrollment.

1-7 Functions

10. **CCSS REASONING** The cost of sending cell phone pictures is given by $y = 0.25x$, where x is the number of pictures sent, and y is the cost in dollars.

a. Write the equation in function notation. Interpret the function in terms of the context.

b. Find $f(5)$ and $f(12)$. What do these values represent?

c. Determine the domain and range of this function.

SOLUTION:

In function notation, $f(x)$ represents the range. So, the function looks like $f(x) = 0.25x$ written in function notation.

$$\begin{aligned}f(x) &= 0.25x \\f(5) &= 0.25(5) \\&= 1.25 \\f(x) &= 0.25x \\f(12) &= 0.25(12) \\&= 3\end{aligned}$$

So, it costs \$1.25 to send 5 photos and \$3.00 to send 12 photos. The domain is the number of pictures sent and the cost is the range.

If $f(x) = 6x + 7$ and $g(x) = x^2 - 4$, find each value.

11. $f(-3)$

SOLUTION:

$$\begin{aligned}f(x) &= 6(x) + 7 && \text{Original equation} \\f(-3) &= 6(-3) + 7 && \text{Replace } x \text{ with } -3. \\&= -18 + 7 && \text{Multiply.} \\&= -11 && \text{Add.}\end{aligned}$$

12. $f(m)$

SOLUTION:

$$\begin{aligned}f(x) &= 6(x) + 7 && \text{Original equation} \\f(m) &= 6(m) + 7 && \text{Replace } x \text{ with } m. \\&= 6m + 7 && \text{Multiply.}\end{aligned}$$

13. $f(r - 2)$

SOLUTION:

$$\begin{aligned}f(x) &= 6(x) + 7 && \text{Original equation} \\f(r - 2) &= 6(r - 2) + 7 && \text{Replace } x \text{ with } r - 2 \\&= 6r - 12 + 7 && \text{Distributive Property} \\&= 6r - 5 && \text{Add.}\end{aligned}$$

14. $g(5)$

SOLUTION:

$$\begin{aligned}g(x) &= (x)^2 - 4 && \text{Original equation} \\g(5) &= (5)^2 - 4 && \text{Replace } x \text{ with } 5. \\&= 25 - 4 && \text{Evaluate powers.} \\&= 21 && \text{Subtract.}\end{aligned}$$

15. $g(a) + 9$

SOLUTION:

$$\begin{aligned}g(x) + 9 &= [(x)^2 - 4] + 9 && \text{Original equation} \\g(a) + 9 &= [(a)^2 - 4] + 9 && \text{Replace } x \text{ with } a \\&= [a^2 - 4] + 9 && \text{Evaluate powers.} \\&= a^2 - 4 + 9 && \text{Simplify.} \\&= a^2 + 5 && \text{Add.}\end{aligned}$$

16. $g(-4t)$

SOLUTION:

$$\begin{aligned}g(x) &= (x)^2 - 4 && \text{Original equation} \\g(-4t) &= (-4t)^2 - 4 && \text{Replace } x \text{ with } -4t. \\&= 16t^2 - 4 && \text{Evaluate powers.}\end{aligned}$$

17. $f(q + 1)$

SOLUTION:

$$\begin{aligned}f(x) &= 6(x) + 7 && \text{Original equation} \\f(q + 1) &= 6(q + 1) + 7 && \text{Replace } x \text{ with } q + 1. \\&= 6q + 6 + 7 && \text{Distributive property} \\&= 6q + 13 && \text{Add.}\end{aligned}$$

1-7 Functions

18. $f(2) + g(2)$

SOLUTION:

$$f(x) + g(x) = [6(x) + 7] + [(x)^2 - 4]$$

$$f(2) + g(2) = [6(2) + 7] + [(2)^2 - 4] \quad x = 2$$

$$= [6(2) + 7] + [4 - 4] \quad 2^2 = 4$$

$$= [12 + 7] + [4 - 4] \quad \text{Multiply.}$$

$$= [19] + [4 - 4] \quad \text{Add.}$$

$$= [19] + [0] \quad \text{Subtract.}$$

$$= 19 \quad \text{Multiply.}$$

19. $g(-b)$

SOLUTION:

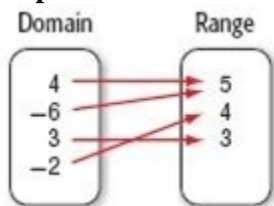
$$g(x) = (x)^2 - 4 \quad \text{Original equation}$$

$$g(-b) = (-b)^2 - 4 \quad \text{Replace } x \text{ with } -b.$$

$$= b^2 - 4 \quad \text{Evaluate powers.}$$

Determine whether each relation is a function.

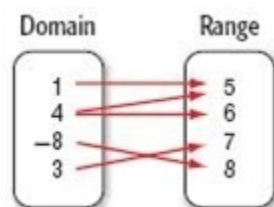
Explain.



20.

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. So, this relation is a function.



21.

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. In the domain, the value 4 is paired with both 5 and 6. So, this relation is not a function.

Domain	Range
4	6
-5	3
6	-3
-5	5

22.

SOLUTION:

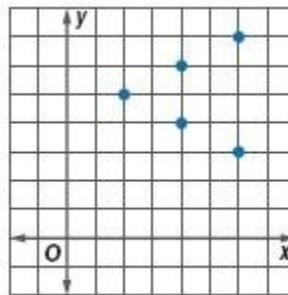
A function is a relation in which each element of the domain is paired with exactly one element of the range. In the domain, the value -5 is paired with both 3 and 5. So, this relation is not a function.

Domain	Range
-4	2
3	-5
4	2
9	-7
-3	-5

23.

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. So, this relation is a function.

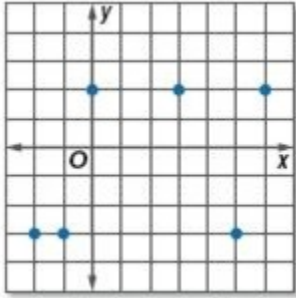


24.

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. When $x = 4$, $y = 4$ and $y = 6$. So, this relation is not a function.

1-7 Functions



25.

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.

26. **CCSS SENSE-MAKING** The table shows the median home prices in the United States, from 2007 to 2009.

Year	Median Home Price (\$)
2007	234,300
2008	213,200
2009	212,200

- Write a set of ordered pairs representing the data in the table.
- Draw a graph showing the relationship between the year and price.
- What is the domain and range for this data?

SOLUTION:

- The year is the domain for this relation. The median price is the range. So, when creating ordered pairs, the year is first and the median price is second. The ordered pairs for this data are $\{(2007, 234,300), (2008, 213,200), (2009, 212,200)\}$.

b.



- The domain is the year. The range is the median home price.

Determine whether each relation is a function.

27. $\{(5, -7), (6, -7), (-8, -1), (0, -1)\}$

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. So, this relation is a function.

1-7 Functions

28. $\{(4, 5), (3, -2), (-2, 5), (4, 7)\}$

SOLUTION:

A function is a relation in which each element of the domain is paired with exactly one element of the range. The value 4 is paired with 5 and 7. So, this relation is not a function.

29. $y = -8$

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.

30. $x = 15$

SOLUTION:

This is not a function because a vertical line can be drawn so that it intersects the graph more than once.

31. $y = 3x - 2$

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.

32. $y = 3x + 2y$

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.

If $f(x) = -2x - 3$ and $g(x) = x^2 + 5x$, find each value.

33. $f(-1)$

SOLUTION:

$$\begin{aligned} f(x) &= -2(x) - 3 && \text{Original equation} \\ f(-1) &= -2(-1) - 3 && \text{Replace } x \text{ with } -1. \\ &= 2 - 3 && \text{Multiply.} \\ &= -1 && \text{Subtract.} \end{aligned}$$

34. $f(6)$

SOLUTION:

$$\begin{aligned} f(x) &= -2(x) - 3 && \text{Original equation} \\ f(6) &= -2(6) - 3 && \text{Replace } x \text{ with } 6. \\ &= -12 - 3 && \text{Multiply.} \\ &= -15 && \text{Subtract.} \end{aligned}$$

35. $g(2)$

SOLUTION:

$$\begin{aligned} g(x) &= (x)^2 + 5x && \text{Original equation} \\ g(2) &= (2)^2 + 5(2) && \text{Replace } x \text{ with } 2. \\ &= 4 + 5(2) && \text{Evaluate powers.} \\ &= 4 + 10 && \text{Multiply.} \\ &= 14 && \text{Add.} \end{aligned}$$

36. $g(-3)$

SOLUTION:

$$\begin{aligned} g(x) &= (x)^2 + 5x && \text{Original equation} \\ g(-3) &= (-3)^2 + 5(-3) && \text{Replace } x \text{ with } -3. \\ &= 9 + 5(-3) && \text{Evaluate powers.} \\ &= 9 + (-15) && \text{Multiply.} \\ &= -6 && \text{Add.} \end{aligned}$$

37. $g(-2) + 2$

SOLUTION:

$$\begin{aligned} g(x) + 2 &= [(x)^2 + 5x] + 2 \\ g(-2) + 2 &= [(-2)^2 + 5(-2)] + 2 && x = -2 \\ &= [4 + 5(-2)] + 2 && (-2)^2 = 4 \\ &= [4 + (-10)] + 2 && \text{Multiply.} \\ &= [-6] + 2 && \text{Add.} \\ &= -4 && \text{Add.} \end{aligned}$$

38. $f(0) - 7$

SOLUTION:

$$\begin{aligned} f(x) - 7 &= [-2(x) - 3] - 7 && \text{Original equation} \\ f(0) - 7 &= [-2(0) - 3] - 7 && \text{Replace } x \text{ with } 0. \\ &= [0 - 3] - 7 && \text{Multiply.} \\ &= [-3] - 7 && \text{Simplify.} \\ &= -10 && \text{Subtract.} \end{aligned}$$

39. $f(4y)$

SOLUTION:

$$\begin{aligned} f(x) &= -2(x) - 3 && \text{Original equation} \\ f(4y) &= -2(4y) - 3 && \text{Replace } x \text{ with } 4y. \\ &= -8y - 3 && \text{Multiply.} \end{aligned}$$

1-7 Functions

40. $g(-6m)$

SOLUTION:

$$g(x) = (x)^2 + 5(x) \quad \text{Original equation}$$

$$\begin{aligned} g(-6m) &= (-6m)^2 + 5(-6m) && \text{Replace } x \text{ with } -6m. \\ &= 36m + 5(-6m) && \text{Evaluate powers.} \\ &= 36m - 30m && \text{Multiply.} \end{aligned}$$

41. $f(c - 5)$

SOLUTION:

$$f(x) = -2(x) - 3 \quad \text{Original equation}$$

$$\begin{aligned} f(c - 5) &= -2(c - 5) - 3 && \text{Replace } x \text{ with } c - 5. \\ &= -2c + 10 - 3 && \text{Distributive Property} \\ &= -2c + 7 && \text{Subtract.} \end{aligned}$$

42. $f(r + 2)$

SOLUTION:

$$f(x) = -2(x) - 3 \quad \text{Original equation}$$

$$\begin{aligned} f(r + 2) &= -2(r + 2) - 3 && \text{Replace } x \text{ with } r + 2. \\ &= -2r - 4 - 3 && \text{Distributive Property} \\ &= -2r - 7 && \text{Subtract.} \end{aligned}$$

43. $5[f(d)]$

SOLUTION:

$$f(x) = -2(x) - 3 \quad \text{Original equation}$$

$$5[f(x)] = 5[-2(x) - 3] \quad \text{Product of 5 and } f(x)$$

$$5[f(d)] = 5[-2(d) - 3] \quad \text{Replace } x \text{ with } d.$$

$$\begin{aligned} &= 5[-2d - 3] && \text{Multiply.} \\ &= -10d - 15 && \text{Distributive Property} \end{aligned}$$

44. $3[g(n)]$

SOLUTION:

$$g(x) = (x)^2 + 5x \quad \text{Original equation}$$

$$3[g(x)] = 3[(x)^2 + 5x] \quad \text{Product of 3 and } g(x)$$

$$3[g(n)] = 3[(n)^2 + 5(n)] \quad \text{Replace } x \text{ with } n$$

$$= [n^2 + 5(n)] \quad \text{Evaluate powers.}$$

$$= 3[n^2 + 5n] \quad \text{Multiply.}$$

$$= 3n^2 + 15n \quad \text{Distributive Property}$$

45. **EDUCATION** The average national math test scores $f(t)$ for 17-year-olds can be represented as a function of the national science scores t by $f(t) = 0.8t + 72$.

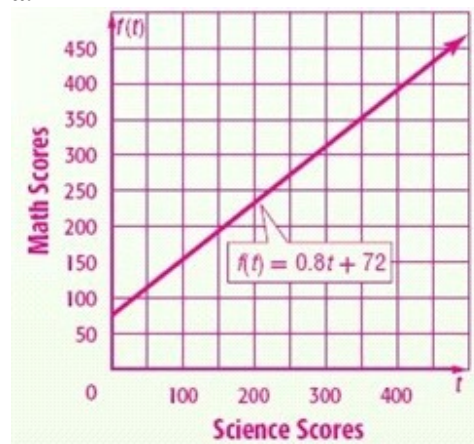
a. Graph this function. Interpret the function in terms of the context.

b. What is the science score that corresponds to a math score of 308?

c. What is the domain and range of this function?

SOLUTION:

a.



When the science score is 0, the math score is 72. For each point the science score increases, the math score increases by 0.8 point.

b.

$$308 = 0.8t + 72$$

$$308 - 72 = 0.8t + 72 - 72 \quad \text{Subtract.}$$

$$236 = 0.8t \quad \text{Simplify.}$$

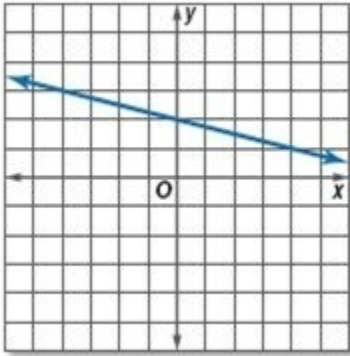
$$\frac{236}{0.8} = \frac{0.8t}{0.8} \quad \text{Divide.}$$

$$295 = t \quad \text{Simplify.}$$

c. The domain is the independent variable or x -variable. Thus the domain is the set of science scores. The range is the dependent variable or the y -variable. Thus, the range is the set of math scores.

1-7 Functions

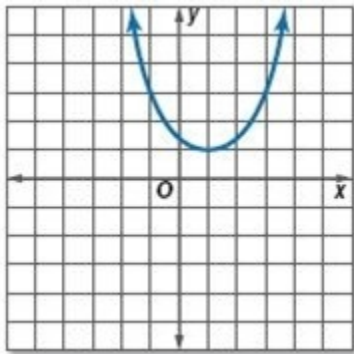
Determine whether each relation is a function.



46.

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.



47.

SOLUTION:

This is a function because no vertical line can be drawn so that it intersects the graph more than once.

48. **BABYSITTING** Christina earns \$7.50 an hour babysitting.

a. Write an algebraic expression to represent the money Christina will earn if she works h hours.

b. Choose five values for the number of hours Christina can babysit. Create a table with h and the value for the amount of money she will make during that time.

c. Use the values in your table to create a graph.

d. Does it make sense to connect the points in your graph with a line? Why or why not?

SOLUTION:

a. To find the money Christina will make babysitting, multiply the number of hours she worked by her pay

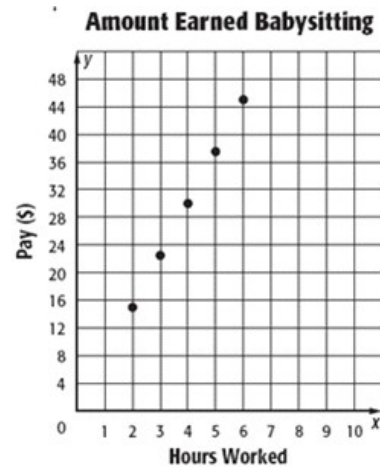
or \$7.50. So, an algebraic expression to represent the money she earns is $\$7.50h$.

b. Sample answer:

Sample Answer:

h	$\$7.50h$
3	\$22.50
5	\$37.50
2	\$15
4	\$30
6	\$45

c.



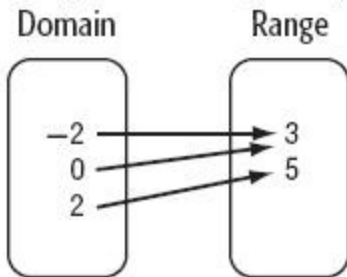
d. By connecting the points, all values between the numbers are included. So, the points should be connected because they could pay Christina for partial hours that she worked.

1-7 Functions

49. **OPEN ENDED** Write a set of three ordered pairs that represent a function. Choose another display that represents this function.

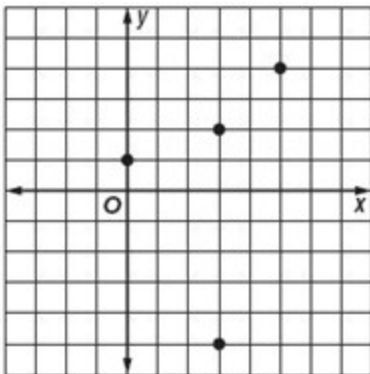
SOLUTION:

$\{(-2, 3), (0, 3), (2, 5)\}$ is a set of ordered pairs. A mapping is another display that represents the function. Place the x -coordinates in the domain and the y -coordinates in the range. Link each value in the domain with the corresponding value in the range.



50. **REASONING** The set of ordered pairs $\{(0, 1), (3, 2), (3, -5), (5, 4)\}$ represents a relation between x and y . Graph the set of ordered pairs. Determine whether the relation is a function. Explain.

SOLUTION:



A function is a relation in which each element of the domain is paired with exactly one element of the range. The value 3 is paired with -5 and 2 . So, this relation is not a function.

51. **CHALLENGE** Consider $f(x) = -4.3x - 2$. Write $f(g + 3.5)$ and simplify by combining like terms.

SOLUTION:

$$\begin{aligned} f(g + 3.5) &= -4.3(g + 3.5) - 2 \\ &= -4.3g - 15.05 - 2 \\ &= -4.3g - 17.05 \end{aligned}$$

52. **WRITE A QUESTION** A classmate graphed a set of ordered pairs and used the vertical line test to determine whether it was a function. Write a question to help her decide if the same strategy can be applied to a mapping.

SOLUTION:

If the classmate could see the ordered pair in another way, it could help her see the relation. So, "Isn't a mapping another representation of a set of ordered pairs?" is a good question to ask.

53. **CCSS PERSEVERENCE** If $f(3b - 1) = 9b - 1$, find one possible expression for $f(x)$.

SOLUTION:

Our input is " $3b - 1$ " and our output is " $9b - 1$ ". We need to find a function that convert the input to the output. Let's look at the variable first. What can we do to $3b$ to change it to $9b$? $3 \times 3 = 9$, so let's multiply by 3. Let $f(x) = 3x$. Test the function.

$$\begin{aligned} f(x) &= 3x \\ f(3b - 1) &= 3(3b - 1) \\ &= 9b - 3 \end{aligned}$$

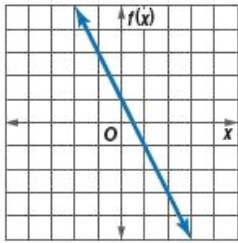
We did not get $9b - 1$, but we were close. How can we change the " -3 " to a " -1 "? Add 2. Now, let's try $f(x) = 3x + 2$.

$$\begin{aligned} f(x) &= 3x + 2 \\ f(3b - 1) &= 3(3b - 1) + 2 \\ &= 9b - 3 + 2 \\ &= 9b - 1 \end{aligned}$$

We have found a function that works.

1-7 Functions

54. **ERROR ANALYSIS** Corazon thinks $f(x)$ and $g(x)$ are representations of the same function. Maggie disagrees. Who is correct? Explain your reasoning.



x	$g(x)$
-1	1
0	-1
1	-3
2	-5
3	-7

SOLUTION:

The graph has a y -intercept of 1. It also contains the point $(1, -1)$, which we can use to determine the slope:

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{-1 - 1}{1 - 0} \\ &= \frac{-2}{1} \\ &= -2 \end{aligned}$$

The equation for $f(x)$ is: $f(x) = -2x + 1$.

For the table, we can see that as x increases by 1, $g(x)$ decreases by 2, which means the slope of $g(x)$ is -2 . But the y -intercept for $g(x)$ is $(0, -1)$, giving $g(x) = -2x - 1$.

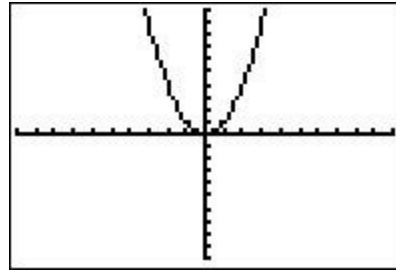
The graph and table are representative of different functions.

55. **WRITING IN MATH** How can you determine whether a relation represents a function?

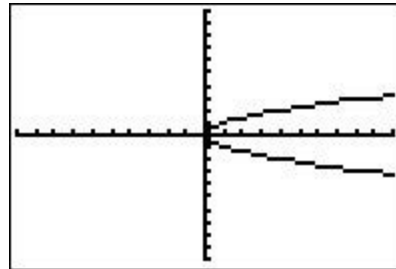
SOLUTION:

A relation is a function if each element of the domain is paired with exactly one element of the range. If given a graph, this means that it must pass the vertical line test.

Function



Not a function



If given a table, or a set of ordered pairs, you can look to see if any value of the domain has more than one corresponding value in the range.

Function

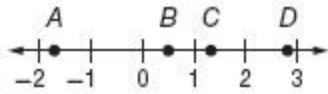
x	y
1	-3
2	-6
3	-9
4	-12

Not a function

x	y
-1	2
0	3
0	-3
1	-2

1-7 Functions

56. Which point on the number line represents a number whose square is less than itself?



A A

B B

C C

D D

SOLUTION:

Consider the squares of all the numbers.

Point	Value	Square
A	-1.75	3.0625
B	0.5	0.25
C	1.33	1.7689
D	2.85	8.1225

From the table, point B represents a number whose square is less than itself. Choice B is the correct answer.

57. Determine which of the following relations is a function.

F $\{(-3, 2), (4, 1), (-3, 5)\}$

G $\{(2, -1), (4, -1), (2, 6)\}$

H $\{(-3, -4), (-3, 6), (8, -2)\}$

J $\{(5, -1), (3, -2), (-2, -2)\}$

SOLUTION:

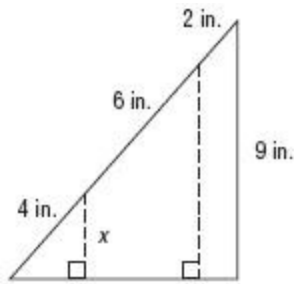
Consider the domain and range for each choice.

Choice	Domain	Range
F $\{(-3, 2), (4, 1), (-3, 5)\}$	-3, 4	2, 1, 5
G $\{(2, -1), (4, -1), (2, 6)\}$	2, 4	-1, 6
H $\{(-3, -4), (-3, 6), (8, -2)\}$	-3, 8	-4, 6, -2
J $\{(5, -1), (3, -2), (-2, -2)\}$	5, 3, -2	-1, -2

From the table, choice J is the only one with three numbers in the domain row. The other rows have less, because one of the domain members is repeated. Thus, $\{(5, -1), (3, -2), (-2, -2)\}$ is the only relation where each element of the domain is paired with exactly one element of the range. So, choice J is the correct answer.

1-7 Functions

58. **GEOMETRY** What is the value of x ?



- A 3 in.
B 4 in.
C 5 in.
D 6 in.

SOLUTION:

Properties of similar triangles can be used to find x . The triangle with a hypotenuse of 4 is similar to the triangle with a leg of 9. Set up a proportion to find x . Let the hypotenuse of each triangle be the numerator and let the corresponding leg of each triangle be the denominator of each ratio.

$$\frac{4}{x} = \frac{12}{9}$$

$$12x = 36 \quad \text{Cross multiply.}$$

$$\frac{12x}{12} = \frac{36}{12} \quad \text{Divide by 12.}$$

$$x = 3 \quad \text{Simplify.}$$

So, x is 3 inches. Choices C and D are not possible since the leg of the triangle can not be longer than the hypotenuse. Choice B would make the x the same length as the hypotenuse. That would only work if the hypotenuse of the larger triangle equals the height of 9, which is not the case. Thus choice A is the correct answer.

59. **SHORT RESPONSE** Camille made 16 out of 19 of her serves during her first volleyball game. She made 13 out of 16 of her serves during her second game. During which game did she make a greater percent of her serves?

SOLUTION:

First, each number of serves needs to be made into a percentage. Then, compare the percentages to see which is greater.

$$\frac{16}{19} \approx .84 = 84\%$$

$$\frac{13}{16} \approx .81 = 81\%$$

In her first game, she made 84% of her serves, which is more than her second game of 81%.

Solve each equation.

60. $x = \frac{27+3}{10}$

SOLUTION:

$$\begin{aligned} x &= \frac{27+3}{10} \\ &= \frac{30}{10} \\ &= 3 \end{aligned}$$

61. $m = \frac{3^2+4}{7-5}$

SOLUTION:

$$\begin{aligned} m &= \frac{3^2+4}{7-5} \\ &= \frac{9+4}{7-5} \\ &= \frac{13}{2} \end{aligned}$$

62. $z = 32 + 4(-3)$

SOLUTION:

$$\begin{aligned} z &= 32 + 4(-3) \\ &= 32 + (-12) \\ &= 20 \end{aligned}$$

1-7 Functions

63. **SCHOOL SUPPLIES** The table shows the prices of some items Tom needs. If he needs 4 glue sticks, 10 pencils, and 4 notebooks, write and evaluate an expression to determine Tom's cost.

School Supplies Prices	
glue stick	\$1.99
pencil	\$0.25
notebook	\$1.85

SOLUTION:

To find the amount Tom will spend, multiply the price by the number of each item purchased. The sum of these will give the total cost. Let g be the number of glue sticks, p the number of pencils, and n the number of notebooks. Substitute 4 for g , 10 for p , and 4 for n .

$$\begin{aligned}
 C &= 1.99g + 0.25p + 1.85n \\
 &= 1.99(4) + 0.25(10) + 1.85(4) && \text{Substitute.} \\
 &= 7.96 + 2.5 + 7.4 && \text{Multiply.} \\
 &= 17.86 && \text{Add.}
 \end{aligned}$$

The total cost of the school supplies Tom needs is \$17.86.

Write a verbal expression for each algebraic expression.

64. $4y + 2$

SOLUTION:

The expression shows the sum of two terms, $4y$ and 2. Because the 4 and y are written next to each other, they are being multiplied. So, the verbal expression *four times y plus two* can be used to describe the algebraic expression $4y + 2$.

65. $\frac{2}{3}x$

SOLUTION:

Because $\frac{2}{3}$ and x are next to each other, they are being multiplied. So, the verbal expression *two-thirds times x* can be used to describe the algebraic

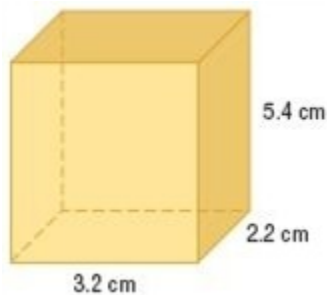
expression $\frac{2}{3}x$.

66. $a^2b + 5$

SOLUTION:

The expression shows the sum of two terms, a^2b and 5. Because a^2 and b are next to each other, they are being multiplied. The factor a^2 represents a number raised to the second power. So, the verbal expression *a squared times b plus 5* can be used to describe the algebraic expression $a^2b + 5$.

Find the volume of each rectangular prism.



- 67.

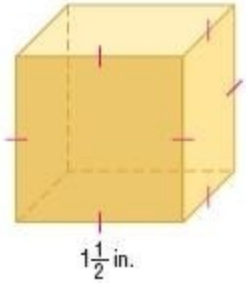
SOLUTION:

Replace l with 3.2, w with 2.2, and h with 5.4.

$$\begin{aligned}
 V &= lwh \\
 &= (3.2)(2.2)(5.4) && \text{Substitute.} \\
 &= 38.016 && \text{Multiply.}
 \end{aligned}$$

So, the volume of the rectangular prism is 38.016 cubic centimeters.

1-7 Functions



68.

SOLUTION:

The length, width, and height of the solid are each $1\frac{1}{2}$ in.

$$V = \ell wh$$

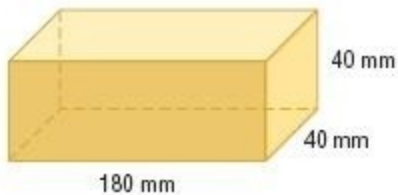
$$= 1\frac{1}{2} \cdot 1\frac{1}{2} \cdot 1\frac{1}{2} \quad \text{Substitute.}$$

$$= \frac{3}{2} \cdot \frac{3}{2} \cdot \frac{3}{2} \quad \text{Rewrite } 1\frac{1}{2} \text{ as } \frac{3}{2}.$$

$$= \frac{27}{8} \quad \text{Multiply.}$$

$$= 3\frac{3}{8} \quad \text{Simplify.}$$

So, the volume of the rectangular prism is $3\frac{3}{8}$ cubic inches.



69.

SOLUTION:

Let $\ell = 180$, $w = 40$, and $h = 40$.

$$V = \ell wh$$

$$= 180 \cdot 40 \cdot 40 \quad \text{Substitute.}$$

$$= 288,000 \quad \text{Multiply.}$$

So, the volume of the rectangular prism is 288,000 cubic millimeters.

Evaluate each expression.

70. If $x = 3$, then $6x - 5 = \underline{\quad}$.

SOLUTION:

$$\begin{aligned} 6(3) - 5 &= 18 - 5 \\ &= 13 \end{aligned}$$

71. If $n = -1$, then $2n + 1 = \underline{\quad}$.

SOLUTION:

$$\begin{aligned} 2(-1) + 1 &= -2 + 1 \\ &= -1 \end{aligned}$$

72. If $p = 4$, then $3p + 4 = \underline{\quad}$.

SOLUTION:

$$\begin{aligned} 3(4) + 4 &= 12 + 4 \\ &= 16 \end{aligned}$$

73. If $q = 7$, then $7q - 9 = \underline{\quad}$.

SOLUTION:

$$\begin{aligned} 7(7) - 9 &= 49 - 9 \\ &= 40 \end{aligned}$$

74. If $y = 10$, then $8y - 15 = \underline{\quad}$.

SOLUTION:

$$\begin{aligned} 8(10) - 15 &= 80 - 15 \\ &= 65 \end{aligned}$$

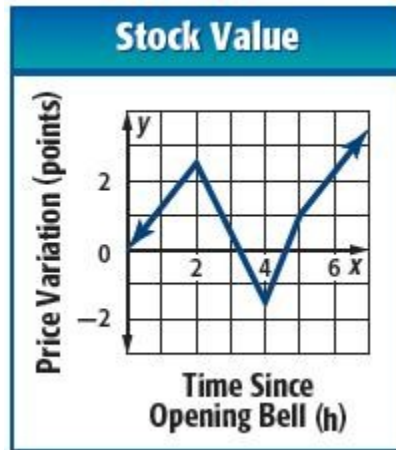
75. If $k = -11$, then $4k + 6 = \underline{\quad}$.

SOLUTION:

$$\begin{aligned} 4(-11) + 6 &= -44 + 6 \\ &= -38 \end{aligned}$$

1-8 Interpreting Graphs of Functions

CCSS SENSE-MAKING Identify the function graphed as linear or nonlinear. Then estimate and interpret the intercepts of the graph, any symmetry, where the function is positive, negative, increasing, and decreasing, the x -coordinate of any relative extrema, and the end behavior of the graph.



1.

SOLUTION:

Linear or Nonlinear:

The graph is not a line, so the function is nonlinear.

y-Intercept: The y -intercept is 0, so there is no change in the stock value at the opening bell.

x-Intercepts: The x -intercepts are 0, about 3.2, and about 4.5, so there is no change in the stock value after 0 hours, after about 3.2 hours, and after about 4.5 hours after the opening bell.

Symmetry: The graph has no line symmetry. So the price variations at different times did not go up and down at regular intervals.

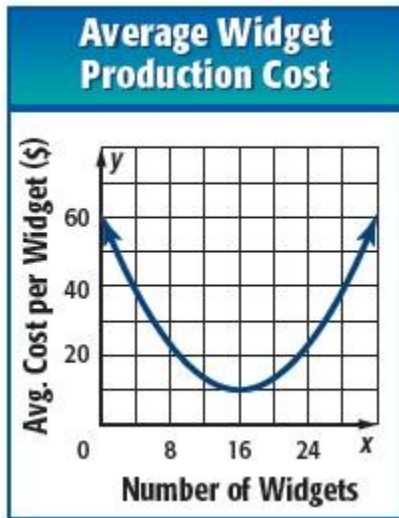
Positive/Negative: The function is positive between x -values of 0 to about 3.2, and 4.5 and greater. So the stock value was higher than the opening price for the first 3.2 hours and after 4.5 hours. The function is negative between x -values of about 3.2 and 4.5. The value was less than the starting value from about 3.2 hours until 4.5 hours after the opening bell.

Increasing/Decreasing: The function increases for x -values from 0 to 2, decreases from 2 to 4, and increases for 4 and greater. The stock value starts the day increasing in value for the first 2 hours, then it goes down in value from 2 hours until 4 hours, and after 4 hours it goes up in value for the remainder of the day.

Relative Extrema: There is a relative maximum of about 2.4 at $x = 2$ and a relative minimum of about -1.4 at $x = 4$. The stock had a relative high value of about 2.4 points above the opening price after 2 hours and then a relative low value of about 1.4 points below the opening price after 4 hours.

End Behavior: As x increases, y increases. As the day goes on, the stock increases in value.

1-8 Interpreting Graphs of Functions



2.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y-intercept is about 60, so there is an initial production cost of about \$60.

x-Intercept: There are no x-intercepts, so the cost per widget will never be \$0.

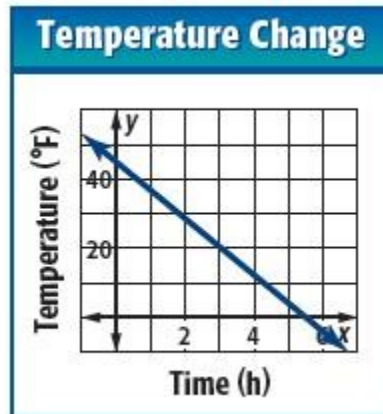
Symmetry: The graph has line symmetry about the line $x = 16$. The cost of producing 0 to 16 widgets is the same as the cost of producing 16 to 32 widgets.

Positive/Negative: The function is always positive. There is always a cost for producing any number of widgets.

Increasing/Decreasing: The function decreases between x-values of 0 to 16, and increases for x-values between 16 and 32. The average production cost decreases for making 0 to 16 widgets and then goes up for producing 16 to 32 widgets.

Relative Extrema: There is a relative minimum of 10 at $x = 16$. The lowest production cost of \$10 per widget occurs when 16 widgets are produced.

End Behavior: As x increases, y increases. As greater numbers of widgets are produced, the average cost per widget will continue to increase.



3.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y-intercept is about 60, so there is an initial production cost of about \$60.

x-Intercept: There are no x-intercepts, so the cost per widget will never be \$0.

Symmetry: The graph has line symmetry about the line $x = 16$. The cost of producing 0 to 16 widgets is the same as the cost of producing 16 to 32 widgets.

Positive/Negative: The function is always positive. There is always a cost for producing any number of widgets.

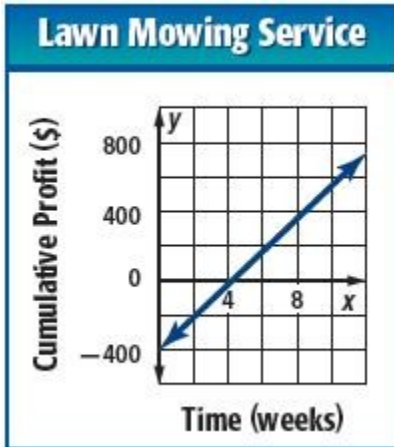
Increasing/Decreasing: The function decreases between x-values of 0 to 16, and increases for x-values between 16 and 32. The average production cost decreases for making 0 to 16 widgets and then goes up for producing 16 to 32 widgets.

Relative Extrema: There is a relative minimum of 10 at $x = 16$. The lowest production cost of \$10 per widget occurs when 16 widgets are produced.

End Behavior: As x increases, y increases. As greater numbers of widgets are produced, the average cost per widget will continue to increase.

1-8 Interpreting Graphs of Functions

CCSS SENSE-MAKING Identify the function graphed as linear or nonlinear. Then estimate and interpret the intercepts of the graph, any symmetry, where the function is positive, negative, increasing, and decreasing, the x -coordinate of any relative extrema, and the end behavior of the graph.



4.

SOLUTION:

Linear or Nonlinear: The graph is a line, so the function is linear.

y-Intercept: The y -intercept is about 45, so the temperature was about 45° F when the measurement started.

x-Intercept: The x -intercept is about 5.5, so after about 5.5 hours, the temperature was 0° F.

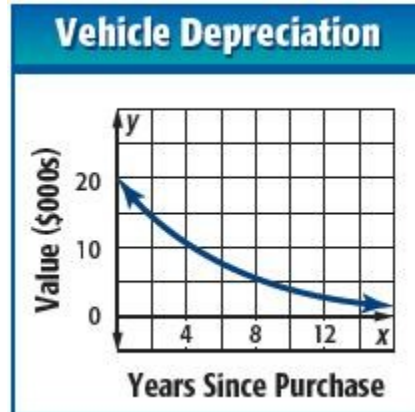
Symmetry: The graph has no line symmetry. So the temperature did not go up and down at regular intervals.

Positive/Negative: The function is positive between x -values of 0 to about 5.5, and negative for values greater than 5.5. The temperature is above zero for the first 5.5 hours, and then below zero after 5.5 hours.

Increasing/Decreasing: The function decreases over the entire domain. The temperature is going down for the entire time.

Relative Extrema: There are no extrema. This indicates no high or low temperature in the time span.

End Behavior: As x increases, y decreases. As the time increases, the function predicts that temperature will continue to drop, which is not very likely.



5.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y -intercept is about 20, which means that the purchase price of the vehicle was about \$20,000.

x-Intercept: There is no x -intercept, so the value of the vehicle is never \$0.

Positive/Negative: The function is positive for all values of x . This means that the value of the vehicle will always be greater than \$0.

Increasing/Decreasing: The function is decreasing for all values of x . The vehicle is losing value over time.

Relative Extrema: The function has no relative minima or maxima. There is no maximum or minimum vehicle value.

End Behavior: As x -increases, y -decreases. This means that the value of the car is expected to continue to decrease.

1-8 Interpreting Graphs of Functions



6.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y-intercept is about 5, which means that the company has a profit of about \$5000 without spending any money on advertising.

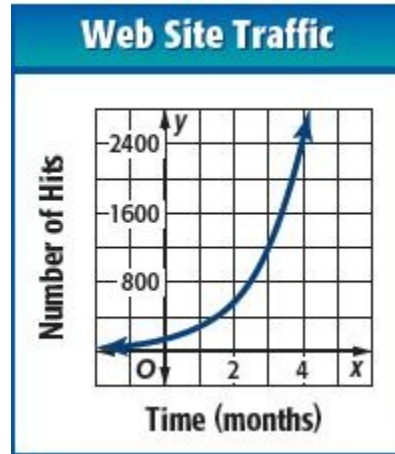
x-Intercept: The x-intercepts are about -1 and about 21. This indicates that the profit is \$0 for advertising expenses of \$-1000 or \$21,000. The -1 intercept has no meaning, since the company can not spend a negative amount of money on advertising.

Positive/Negative: The function is positive between about 0 and 21 and negative for about $x < -1$ and for about $x > 21$. This means that if the company spends between \$0 and about \$21,000 on advertising, they will make a profit, but if they spend more than \$21,000, the advertising expense will cut profits. An advertising expense greater than \$21,000 will put the company in debt.

Increasing/Decreasing: The function is increasing for $x < 10$ and decreasing for $x > 10$. The profit increases with more advertising spending until \$10,000 is spent. Spending more than \$10,000 on advertising decreases profit.

Relative Extrema: There is a relative maximum at about $x = 10$. This means that spending \$10,000 in advertising will be the most profitable amount to spend.

End Behavior: As x increases, y decreases, and as x decreases, y decreases. This means that spending more or less than \$10,000 in advertising would result in less profit.



7.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y-intercept is about 100. This means that the web site had 100 hits before the time began.

x-Intercept: There is no x-intercept, so the number of hits was never 0.

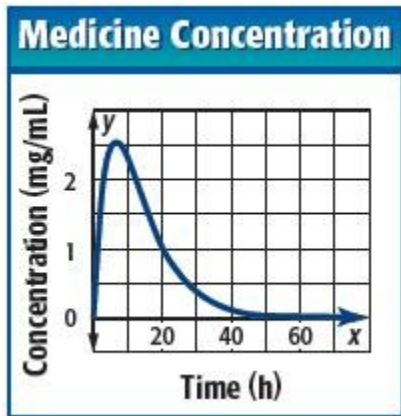
Positive/Negative: The function is positive for all values of x . This means that the web site has never experienced a time of inactivity.

Increasing/Decreasing: The function is increasing for all values of x . This means that the web site has never experienced a time of inactivity.

Relative Extrema: The function has no relative minima or maxima. There is no maximum or minimum number of hits.

End Behavior: As x increases, y increases. This means that the upward trend in the number of hits is expected to continue.

1-8 Interpreting Graphs of Functions



8.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y-intercept is 0, which means that at the start, there was no medicine in the bloodstream.

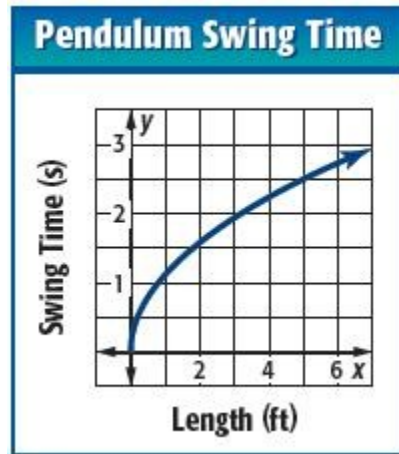
x-Intercept: There appears to be no x-intercept, which means that the medicine does not ever fully leave the bloodstream for the time shown.

Positive/Negative: The function is positive for all values of x, which means that after the medicine is taken, there is always some amount in the bloodstream.

Increasing/Decreasing: The function is increasing between about $x = 0$ and $x = 8$ and decreasing for $x > 8$. This means that the concentration of medicine increased over the first 8 hours to a maximum concentration of about 2.5 mg/mL, and then decreased.

Relative Extrema: The function has a relative maximum of about 1.5 at about $x = 8$. This means that the concentration of medicine was at a maximum of about 2.5 mg/mL after 8 hours.

End Behavior: As x increases, y decreases towards 0. This means that the concentration of medicine in the bloodstream becomes less and less, until there is practically none left.



9.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

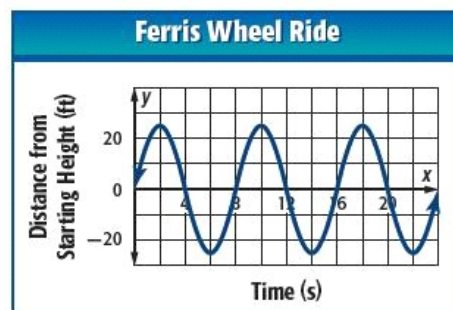
x- and y-Intercept: The x- and y-intercept is 0, which means for a pendulum with no length cannot complete a swing.

Positive/Negative: The function is positive for all values of x, so swing time is never negative.

Increasing/Decreasing: The function is increasing for all values of x. This means that as the pendulum gets longer, the time it takes for it to complete one full swing increases.

Relative Extrema: The function has no relative minima or maxima. There is no maximum or minimum swing time.

End Behavior: Also, as x increases, y increases, so as the pendulum gets longer, the time it takes for it to complete one full swing increases.



10.

FERRIS WHEEL At the beginning of a Ferris wheel ride, a passenger cart is located at the same height as the center of the wheel. The position y in feet of this cart relative to the center t seconds after the ride starts is given by the function graphed above. Identify and interpret the key features of the graph. (Hint: Look for a pattern in the graph to help you describe its end behavior.)

1-8 Interpreting Graphs of Functions

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The y -intercept is 0, indicating that the cart started at the same height as the center of the wheel.

x-Intercepts: The x -intercepts are 4, 8, 12, 16, 20, and 24, indicating that the ride returned to this same height 4, 8, 12, 16, and 20 seconds after the ride started.

Positive/Negative: The function is positive between times 0 and 4, 8 and 12, and 16 and 20 seconds. During these times, the cart was higher than the center of the wheel. The function is negative between times 4 and 8, 12 and 16, and 20 and 24 seconds. During these times, the car was lower than the center of the wheel.

Increasing/Decreasing: The function is increasing between times 0 and 2, 6 and 10, 14 and 18, and 22 and 24 seconds. During these times, the wheel was rotating such that the cart was ascending. The function is decreasing between times 2 and 6, 10 and 14, 18 and 22 seconds. During these times, the wheel was rotating such that the cart was descending.

Relative Extrema: The cart reached a maximum height of about 25 feet above the center of the wheel 2, 10, and 18 seconds after the ride started and a minimum height of about 25 feet below the center of the wheel 6, 14, and 22 seconds after the ride started.

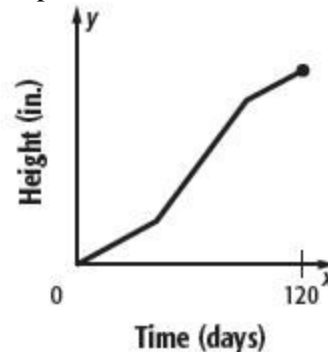
End Behavior: The up and down pattern in the graph suggests that if the ride continues for more than 24 seconds, the cart will continue to move back and forth between 25 feet above and 25 feet below the center of the wheel.

Sketch a graph of a function that could represent each situation. Identify and interpret the intercepts of the graph, where the graph is increasing and decreasing, and any relative extrema.

11. the height of a corn plant from the time the seed is planted until it reaches maturity 120 days later

SOLUTION:

Sample answer:



x- and y-Intercepts: The function has a y -intercept of 0 and an x -intercept of 0, indicating that the plant started with no height as a seed in the ground.

Increasing/Decreasing: The function is increasing over its domain, so that plant was always getting taller.

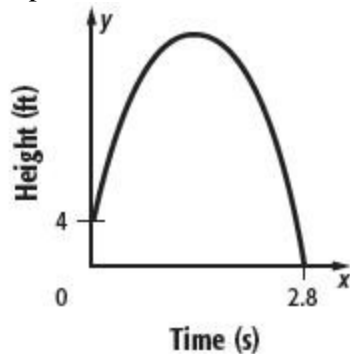
Relative Extrema: The function has no relative extrema, so the plant has no maximum or minimum height.

1-8 Interpreting Graphs of Functions

12. the height of a football from the time it is punted until it reaches the ground 2.8 seconds later

SOLUTION:

Sample answer:



x- and y-Intercepts: The function has a y-intercept of 4 and an x-intercept of 2.8, indicating that the ball started at a height of 4 feet and returned to ground level after 2.8 seconds.

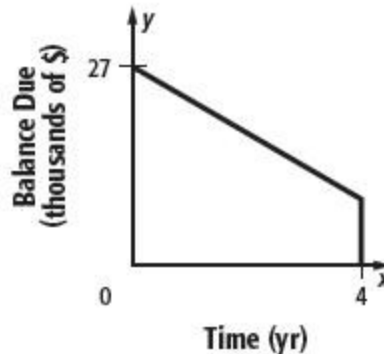
Increasing/Decreasing: The function is increasing between approximately 0 and 1.5 seconds after the punt and decreasing between 1.5 and 2.8 seconds after the punt.

Relative Extrema: The function has a relative maximum at about 1.5 seconds after the punt. At this time, the punt reached its maximum height.

13. the balance due on a car loan from the date the car was purchased until it was sold 4 years later

SOLUTION:

Sample answer:



x- and y-Intercepts: The function has a y-intercept of 27, indicating that the initial balance of the loan was \$27,000. The x-intercept of 4 indicates that the loan was paid off after 4 years.

Increasing/Decreasing: The function is decreasing over its entire domain, indicating that the amount owed on the loan was always decreasing.

Relative Extrema: The function has no relative extrema. There was no maximum or minimum balance due.

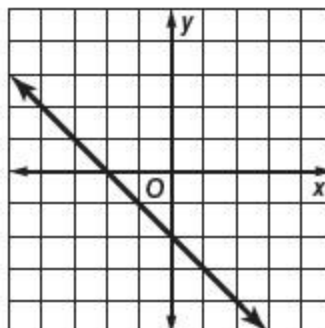
Sketch graphs of functions with the following characteristics.

14. The graph is linear with an x-intercept at -2 . The graph is positive for $x < -2$, and negative for $x > -2$.

SOLUTION:

The graph is linear, so it is a line. The x-intercept is -2 , so the plot the point $(-2, 0)$. The function is positive for $x < -2$ and negative for $x > -2$, so the portion to the left of $(-2, 0)$ is above the x-axis and the portion to the right of $(-2, 0)$ is below the x-axis.

Sample graph:



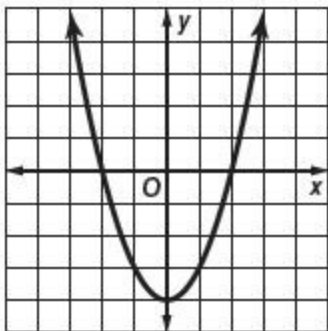
1-8 Interpreting Graphs of Functions

15. A nonlinear graph has x -intercepts at -2 and 2 and a y -intercept at -4 . The graph has a relative minimum of -4 at $x = 0$. The graph is decreasing for $x < 0$ and increasing for $x > 0$.

SOLUTION:

Plot the x -intercepts at $(-2, 0)$ and $(2, 0)$ and the y -intercept at $(0, -4)$. Since the graph is nonlinear and decreasing for $x < 0$, draw a smooth curve starting somewhere to the left and above $(-2, 0)$ that moves down through $(-2, 0)$ to $(-4, 0)$. Since the graph has a relative minimum at $x = 0$ and is increasing for $x > 0$, turn at the point $(-4, 0)$ and draw a smooth curve moving up as you move right, through $(2, 0)$ and continuing to the upper right portion of the graph.

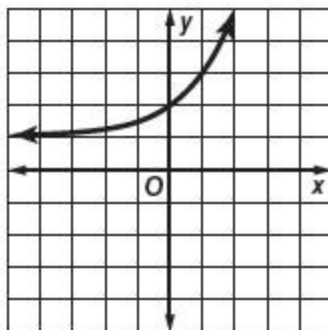
Sample graph:



16. A nonlinear graph has a y -intercept at 2 , but no x -intercepts. The graph is positive and increasing for all values of x .

SOLUTION:

The graph is nonlinear, so it is a curve not a line. The y -intercept is 2 , so plot $(0, 2)$. Because there are no x -intercepts, the graph never intersects the x -axis. The function values are all positive and everywhere increasing, so the graph must curve upward from left to right. Sample graph:



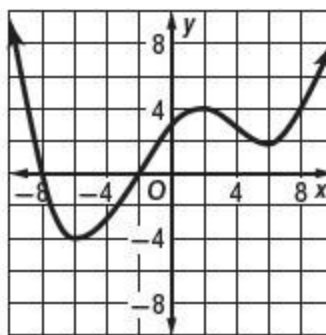
17. A nonlinear graph has x -intercepts at -8 and -2 and a y -intercept at 3 . The graph has relative minimums at $x = -6$ and $x = 6$ and a relative maximum at $x = 2$. The graph is positive for $x < -8$ and $x > -2$ and negative between $x = -8$ and $x = -2$. As x decreases, y increases and as x increases, y increases.

SOLUTION:

The graph is a curve that passes through $(-8, 0)$, $(-2, 0)$, and $(0, 3)$. The relative minimums at $x = -6$ and $x = 6$ indicate that the curve dips down at those x -values. The relative maximum indicates that the graph curves up at $x = 2$.

The graph is above the x -axis for $x < -8$ and $x > -2$ and below the x -axis otherwise. The end behavior indicates that the graph points upward on both the left and right.

Sample graph:



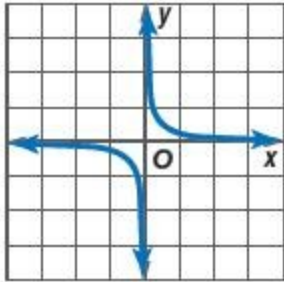
18. **CCSS CRITIQUE** Katara thinks that all linear functions have exactly one x -intercept. Desmond thinks that a linear function can have at most one x -intercept. Is either of them correct? Explain your reasoning.

SOLUTION:

Neither is correct. While many linear functions have one x -intercept, there are linear functions that have no x -intercept like $y = 2$. The linear function $y = 0$ has infinitely many x -intercepts.

1-8 Interpreting Graphs of Functions

19. **CHALLENGE** Describe the end behavior of the graph shown.



SOLUTION:

The graph approaches the x -axis as x increases and as x decreases. The function value of points on the x -axis is 0. Thus as x increases or decreases, y approaches 0.

20. **REASONING** Determine whether the following statement is *true* or *false*. Explain.

Functions have at most one y -intercept.

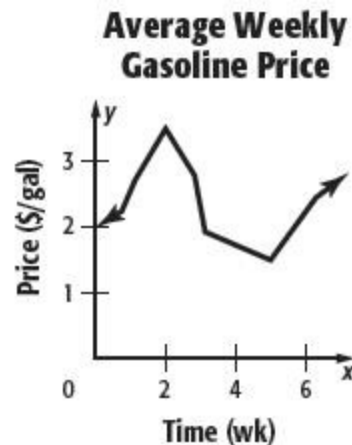
SOLUTION:

True; a function can have no more than one y -intercept. If a graph has more than one y -intercept, then it is not the graph of a function. When a relation has more than one y -intercept, then two points, $(0, a)$ and $(0, b)$, will cause the graph of the relation to fail the Vertical Line Test and not be a function. A function can also have no y -intercept if it is not defined for $x = 0$.

21. **OPEN ENDED** Sketch the graph of a function with one relative maximum and one relative minimum that could represent a real-world function. Label each axis and include appropriate units. Then identify and interpret the relative extrema of your graph.

SOLUTION:

The graph has a relative maximum at about $x = 2$ and a relative minimum at about $x = 4.5$. This means that the weekly gasoline price spiked around week 2 at a high of about \$3.50/gal and dipped around week 5 to a low of about \$1.50/gal.



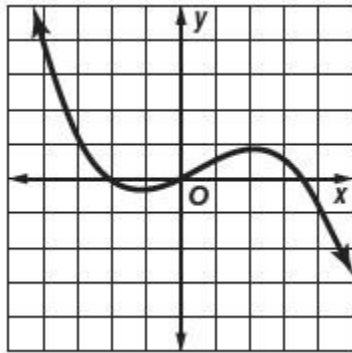
22. **WRITING IN MATH** Describe how you would identify the key features of a graph described in this lesson using a table of values for a function.

SOLUTION:

You could observe what the value of y is when x is zero to determine the y -intercept, and look for x -values that have a corresponding y -value of zero to determine the x -intercepts of the graph. The function is positive for x -values that have positive corresponding y -values and negative for x -values that have negative corresponding y -values. The function is increasing where as the x -values increase, the corresponding y -values increase and decreasing where as the x -values decrease, the corresponding y -values decrease. A relative maximum is located where the y -values change from increasing to decreasing. A relative minimum is located where the y -values change from decreasing to increasing. To describe the end behavior of the function, observe the value of y as x decreases and the value of y as x increases, noticing whether it continues to increase, decrease, or approach a specific value.

1-8 Interpreting Graphs of Functions

23. Which sentence best describes the end behavior of the function shown?



- A** As x increases, y increases, and as x decreases, y increases.
- B** As x increases, y increases, and as x decreases, y decreases.
- C** As x increases, y decreases, and as x decreases, y increases.
- D** As x increases, y decreases, and as x decreases, y decreases.

SOLUTION:

The graph points upward on the left, so as x decreases, y increases. The graph points downward on the right, so as x increases, y decreases. This is choice C.

24. Which illustrates the Transitive Property of Equality?

- F** If $c = 1$, then $c \times \frac{1}{c} = 1$.
- G** If $c = d$ and $d = f$, then $c = f$.
- H** If $c = d$, then $d = c$.
- J** If $c = d$ and $d = c$, then $c = 1$.

SOLUTION:

The Transitive Property of Equality says that if one quantity equals a second quantity and the second quantity equals a third quantity, then the first quantity equals the third quantity. In this case, the first quantity is c , the second quantity is d and the third quantity is f . Choice G illustrates the Transitive Property.

25. Simplify the expression $5d(7 - 3) - 16d + 3 \cdot 2d$.

- A** $10d$
- B** $14d$
- C** $21d$
- D** $25d$

SOLUTION:

$$\begin{aligned} & 5d(7 - 3) - 16d + 3 \cdot 2d \\ &= 5d(4) - 16d + 3 \cdot 2d && \text{Subtraction.} \\ &= 5d(4) - 16d + 6d && \text{Multiply.} \\ &= 20d - 16d + 6d && \text{Multiply.} \\ &= 4d + 6d && \text{Simplify.} \\ &= 10d && \text{Simplify.} \end{aligned}$$

Choice A is correct.

26. What is the probability of selecting a red card or an ace from a standard deck of cards?

- F** $\frac{11}{26}$
- G** $\frac{1}{2}$
- H** $\frac{7}{13}$
- J** $\frac{15}{26}$

SOLUTION:

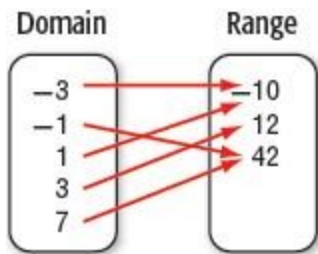
There are 26 red cards, and 4 aces in a deck of cards 2 of which are also red. So there are $26 + 4 - 2$ or 28 cards that are red or an ace.

$$P(\text{red card or ace}) = \frac{28}{52} \text{ or } \frac{7}{13}$$

Choice H is correct.

1-8 Interpreting Graphs of Functions

Determine whether each relation is a function.



27.

SOLUTION:

Each element of the domain is paired with a unique member of the range, so this is a function.

28. $\{(0, 2), (3, 5), (0, -1), (-2, 4)\}$

SOLUTION:

Each element of the domain is not paired with a unique member of the range, 0 is paired with both 2 and -1 . So this is not a function.

x	y
17	6
18	6
19	5
20	4

29.

SOLUTION:

Each element of the domain is paired with a unique member of the range, so this is a function.

30. **GEOMETRY** Express the relation in the graph at the right as a set of ordered pairs. Describe the domain and range.

SOLUTION:

Write an ordered pair for each point in the graph of the relation. $\{(1, 3), (2, 6), (3, 9), (4, 12), (5, 15), (6, 18), (7, 21)\}$

The domain is the set of all x -coordinates.

Domain: $\{1, 2, 3, 4, 5, 6, 7\}$

The range is the set of all y -coordinates.

Range: $\{3, 6, 9, 12, 15, 18, 21\}$

Use the Distributive Property to rewrite each expression.

31. $\frac{1}{2}d(2d + 6)$

SOLUTION:

$$\frac{1}{2}d(2d + 6)$$

$$= \frac{1}{2}d(2d) + \frac{1}{2}d(6) \quad \text{Distributive Property}$$

$$= \frac{1}{2}(2)d(d) + \frac{1}{2}d(6) \quad \text{Associative Property}$$

$$= d^2 + 3d \quad \text{Simplify.}$$

32. $-h(6h - 1)$

SOLUTION:

$$= -h(6h - 1)$$

$$= -h(6h) - (-h)(1) \quad \text{Distributive Property}$$

$$= -h(h)(6) - (-h)(1) \quad \text{Associative Property}$$

$$= -6h^2 - (-h) \quad \text{Simplify.}$$

$$= -6h^2 + h \quad \text{Simplify.}$$

33. $3z - 6x$

SOLUTION:

$$= 3z - 6x$$

$$= 3(z) - 3(2x) \quad \text{Distributive Property}$$

$$= 3(z - 2x) \quad \text{Distributive Property}$$

34. **CLOTHING** Robert has 30 socks in his sock drawer. 16 of the socks are white, 6 are black, 2 are red, and 6 are yellow. What is the probability that he randomly pulls out a black sock?

SOLUTION:

$$P(\text{black sock}) = \frac{6}{30} \text{ or } \frac{1}{5}$$

Evaluate each expression.

35. $(-7)^2$

SOLUTION:

$$(-7)^2 = (-7)(-7)$$

$$= 49$$

1-8 Interpreting Graphs of Functions

36. 3.2^2

SOLUTION:

$$\begin{aligned}(3.2)^2 &= (3.2)(3.2) \\ &= 10.24\end{aligned}$$

37. $(-4.2)^2$

SOLUTION:

$$\begin{aligned}(-4.2)^2 &= (-4.2)(-4.2) \\ &= 17.64\end{aligned}$$

38. $\left(\frac{1}{4}\right)^2$

SOLUTION:

$$\begin{aligned}\left(\frac{1}{4}\right)^2 &= \left(\frac{1}{4}\right)\left(\frac{1}{4}\right) \\ &= \left(\frac{1}{16}\right)\end{aligned}$$

Mid-Chapter Quiz

Write a verbal expression for each algebraic expression.

1. $21 - x^3$

SOLUTION:

The expression shows the difference of the terms 21 and x^3 . The term x^3 represents a number raised to the third power. So, the verbal expression *twenty-one minus x to the third power* can be used to describe the algebraic expression $21 - x^3$.

2. $3m^5 + 9$

SOLUTION:

The expression shows the sum of two terms, $3m^5$ and 9. The term $3m^5$ represents the number 3 being multiplied by m^5 , or a number raised to the fifth power. So, the verbal expression *the sum of three times m to the fifth power and nine* can be used to describe the algebraic expression $3m^5 + 9$.

Write the algebraic expression for each verbal expression.

3. five more than s squared

SOLUTION:

The word *more* suggests addition. So, the verbal expression *five more than s^2* can be represented by $s^2 + 5$.

4. four times y to the fourth power

SOLUTION:

The word *times* suggests multiplication. So, the verbal expression *four times y to the fourth power* can be represented by $4y^4$.

5. **CAR RENTAL** The XYZ Car Rental Agency charges a flat rate of \$29 per day plus \$0.32 per mile driven. Write an algebraic expression for the rental cost of a car for x days that is driven y miles.

SOLUTION:

To write the expression, multiply the rental cost per day by the number of days. Then, multiply the cost per mile driven by the number of miles driven. Last, add the two to represent the total rental cost of a car.
 $29x + 0.32y$

Evaluate each expression.

6. $24 \div 3 - 2 \cdot 3$

SOLUTION:

$$24 \div 3 - 2 \cdot 3 = 8 - 6 \\ = 2$$

7. $5 + 2^2$

SOLUTION:

$$5 + 2^2 = 5 + 4 \\ = 9$$

8. $4(3 + 9)$

SOLUTION:

$$4(3 + 9) = 4(12) \\ = 48$$

9. $36 - 2(1 + 3)^2$

SOLUTION:

$$36 - 2(1 + 3)^2 = 36 - 2(4)^2 \\ = 36 - 2(16) \\ = 36 - 32 \\ = 4$$

10. $\frac{40 - 2^3}{4 + 3(2^2)}$

SOLUTION:

$$\frac{40 - 2^3}{4 + 3(2^2)} = \frac{40 - 8}{4 + 3(2^2)} \quad \text{Evaluate powers.} \\ = \frac{40 - 8}{4 + 3(4)} \quad \text{Evaluate powers.} \\ = \frac{40 - 8}{4 + 12} \quad \text{Multiply 3 by 4.} \\ = \frac{32}{4 + 12} \quad \text{Subtract 8 from 40.} \\ = \frac{32}{16} \quad \text{Add 4 and 12.} \\ = 2 \quad \text{Simplify.}$$

Mid-Chapter Quiz

11. **AMUSEMENT PARK** The costs tickets to a local amusement park are shown. Write and evaluate an expression to find the total cost for 5 adults and 8 children.

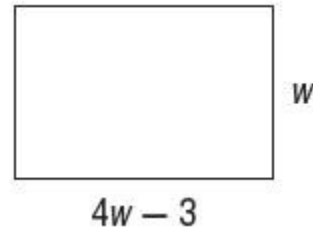


SOLUTION:

To write the expression, multiply the number of adults by the cost per adult. Then, multiply the number of children by the cost per child. Last, add the two to find the total cost for the group.

$$\begin{aligned}5(45) + 8(25) &= 225 + 200 \\ &= 425\end{aligned}$$

12. **MULTIPLE CHOICE** Write an algebraic expression to represent the perimeter of the rectangle shown below. Then evaluate it to find the perimeter when $w = 8$ cm.



- A 37 cm
B 232 cm
C 74 cm
D 45 cm

SOLUTION:

To write the expression, use the formula for the perimeter of a rectangle $P = 2l + 2w$. Substitute the length of the rectangle for l and simplify.

$$\begin{aligned}P &= 2l + 2w && \text{Perimeter formula} \\ &= 2(4w - 3) + 2w && l = (4w - 3) \\ &= 2(4w) - 2(3) + 2w && \text{Distributive Property} \\ &= 8w - 6 + 2w && \text{Multiply.} \\ &= 8w + 2w - 6 && \text{Commutative Property} \\ &= (8 + 2)w - 6 && \text{Distributive Property} \\ &= 10w - 6 && \text{Add 8 and 2.}\end{aligned}$$

To find the perimeter, evaluate $10w - 6$ when $w = 8$.

$$\begin{aligned}10w - 6 &= 10(8) - 6 \\ &= 80 - 6 \\ &= 74\end{aligned}$$

The correct answer is C.

Mid-Chapter Quiz

Evaluate each expression. Name the property used in each step.

13. $(8 - 2^3) + 21$

SOLUTION:

$$\begin{aligned}(8 - 2^3) + 21 & \\ = (8 - 8) + 21 & \text{Substitution} \\ = 0 + 21 & \text{Additive Inverse} \\ = 21 & \text{Additive Identity}\end{aligned}$$

14. $3(1 \div 3) \cdot 9$

SOLUTION:

$$\begin{aligned}3(1 \div 3) \cdot 9 & \\ = 3 \cdot \frac{1}{3} \cdot 9 & \text{Substitution} \\ = 1 \cdot 9 & \text{Multiplicative Inverse} \\ = 9 & \text{Multiplicative Identity}\end{aligned}$$

15. $[5 \div (3 \cdot 1)] \frac{3}{5}$

SOLUTION:

$$\begin{aligned}[5 \div (3 \cdot 1)] \frac{3}{5} & \\ = [5 \div 3] \frac{3}{5} & \text{Multiplicative Identity} \\ = \frac{5}{3} \cdot \frac{3}{5} & \text{Substitution} \\ = 1 & \text{Multiplicative Inverse}\end{aligned}$$

16. $18 + 35 + 32 + 15$

SOLUTION:

$$\begin{aligned}18 + 35 + 32 + 15 & \\ = 18 + 35 + 32 + 15 & \text{Commutative Prop. (+)} \\ = (18 + 32) + (35 + 15) & \text{Associative Prop. (+)} \\ = 50 + 50 & \text{Substitution} \\ = 100 & \text{Additive Identity}\end{aligned}$$

17. $0.25 \cdot 7 \cdot 4$

SOLUTION:

$$\begin{aligned}0.25 \cdot 7 \cdot 4 & \\ = 0.25 \cdot (7 \cdot 4) & \text{Associative Property } (\times) \\ = 0.25 \cdot 28 & \text{Substitution} \\ = 7 & \text{Substitution}\end{aligned}$$

Use the Distributive Property to rewrite each expression. Then evaluate.

18. $3(5 + 2)$

SOLUTION:

$$\begin{aligned}3(5 + 2) &= 3(5) + 3(2) \\ &= 15 + 6 \\ &= 21\end{aligned}$$

19. $(9 - 6)12$

SOLUTION:

$$\begin{aligned}(9 - 6)12 &= 9(12) + (-6)(6) \\ &= 108 + (-72) \\ &= 36\end{aligned}$$

20. $8(7 - 4)$

SOLUTION:

$$\begin{aligned}8(7 - 4) &= 8(7) - 8(4) \\ &= 56 - 32 \\ &= 24\end{aligned}$$

Use the Distributive Property to rewrite each expression. Then simplify.

21. $4(x + 3)$

SOLUTION:

$$\begin{aligned}4(x + 3) &= 4(x) + 4(3) \\ &= 4x + 12\end{aligned}$$

22. $(6 - 2y)7$

SOLUTION:

$$\begin{aligned}(6 - 2y)7 &= 6(7) + (-2y)(7) \\ &= 42 + (-14y) \\ &= 42 - 14y\end{aligned}$$

Mid-Chapter Quiz

23. $-5(3m - 2)$

SOLUTION:

$$\begin{aligned} -5(3m - 2) &= -5(3m) - (-5)(2) \\ &= -5(3m) - (-10) \\ &= -15m + 10 \end{aligned}$$

24. **DVD SALES**

A video store chain has three locations. Use the information in the table below to write and evaluate an expression to estimate the total number of DVD's sold over a 4-day period.

Location	Daily Sales Numbers
Location 1	145
Location 2	211
Location 3	184

SOLUTION:

To write an expression to estimate the total number of DVD's sold in 4 days, add the sales totals for each location to find the total sold in one day. Then, multiply the daily total by 4.

So, the expression is $4(145 + 211 + 184)$.

$$\begin{aligned} 4(145 + 211 + 184) &= 4(540) \\ &= 2160 \end{aligned}$$

So, about 2160 DVD's sold over a 4-day period.

25. **MULTIPLE CHOICE**

Rewrite the expression $(8 - 3p)(-2)$ using the Distributive Property

F $16 - 6p$

G $-10p$

H $-16 + 6p$

J $10p$

SOLUTION:

$$\begin{aligned} (8 - 3p)(-2) &= 8(-2) + (-3p)(-2) \\ &= -16 + 6p \end{aligned}$$

The correct answer is H.

Practice Test - Chapter 1

Write an algebraic expression for each verbal expression.

1. six more than a number

SOLUTION:

Let n represent a number. The phrase *more than* suggests addition. So, the verbal expression *six more than a number* can be written as the algebraic expression $n + 6$.

2. twelve less than the product of three and a number

SOLUTION:

Let n represent a number. The phrase *less than* suggests subtraction, and the word *product* suggests multiplication. So, the verbal expression *twelve less than the product of three and a number* can be written as the algebraic expression $3n - 12$.

3. four divided by the difference between a number and seven

SOLUTION:

Let n represent a number. The phrase *divided by* suggests division, and the word *difference* suggests subtraction. So, the verbal expression *four divided by the difference between a number and seven* can be written as the algebraic expression $\frac{4}{n-7}$.

Evaluate each expression.

4. $32 \div 4 + 2^3 - 3$

SOLUTION:

$$\begin{aligned} 32 \div 4 + 2^3 - 3 \\ = 32 \div 4 + 8 - 3 & \text{ Evaluate powers.} \\ = 8 + 8 - 3 & \text{ Divide 32 by 4.} \\ = 16 - 3 & \text{ Add 8 and 8.} \\ = 13 & \text{ Subtract 3 from 16.} \end{aligned}$$

5. $\frac{(2 \cdot 4)^2}{7+3^2}$

SOLUTION:

$$\begin{aligned} \frac{(2 \cdot 4)^2}{7+3^2} &= \frac{(8)^2}{7+3^2} && \text{Multiply 2 by 4.} \\ &= \frac{(8)^2}{7+9} && \text{Evaluate powers.} \\ &= \frac{64}{7+9} && \text{Evaluate powers.} \\ &= \frac{64}{16} && \text{Add 7 and 9.} \\ &= 4 && \text{Simplify.} \end{aligned}$$

6. **MULTIPLE CHOICE** Find the value of the expression $a^2 + 2ab + b^2$ if $a = 6$ and $b = 4$.

A 68

B 92

C 100

D 121

SOLUTION:

$$\begin{aligned} a^2 + 2ab + b^2 &= (6)^2 + 2(6)(4) + (4)^2 \\ &= 36 + 48 + 16 \\ &= 100 \end{aligned}$$

So, choice C is the correct answer..

Evaluate each expression. Name the property used in each step.

7. $13 + (16 - 4^2)$

SOLUTION:

$$\begin{aligned} 13 + (16 - 4^2) \\ = 13 + (16 - 16) & \text{ Substitution} \\ = 13 + 0 & \text{ Additive Inverse} \\ = 13 & \text{ Additive Identity} \end{aligned}$$

Practice Test - Chapter 1

8. $\frac{2}{9}[9 \div (7 - 5)]$

SOLUTION:

$$\begin{aligned} & \frac{2}{9}[9 \div (7 - 5)] \\ &= \frac{2}{9}[9 \div 2] && \text{Substitution} \\ &= \frac{2}{9} \cdot \frac{9}{2} && \text{Substitution} \\ &= 1 && \text{Multiplicative Inverse} \end{aligned}$$

9. $37 + 29 + 13 + 21$

SOLUTION:

$$\begin{aligned} & 37 + 29 + 13 + 21 \\ &= 37 + 13 + 29 + 21 && \text{Comm. Prop. (+)} \\ &= (37 + 13) + (29 + 21) && \text{Assoc. Prop. (+)} \\ &= 50 + 50 && \text{Substitution} \\ &= 100 && \text{Substitution} \end{aligned}$$

Rewrite each expression using the Distributive Property. Then simplify.

10. $4(x + 3)$

SOLUTION:

$$\begin{aligned} 4(x + 3) &= 4(x) + 4(3) \\ &= 4x + 12 \end{aligned}$$

11. $(5p - 2)(-3)$

SOLUTION:

$$\begin{aligned} (5p - 2)(-3) &= 5p(-3) - 2(-3) \\ &= -15p + 6 \end{aligned}$$

12. **MOVIE TICKETS** A company operates three movie theaters. The chart shows the typical number of tickets sold each week at the three locations. Write and evaluate an expression for the total typical number of tickets sold by all three locations in four weeks.

Location	Tickets Sold
A	438
B	374
C	512

SOLUTION:

To find the number of tickets sold in one week by all three locations, find the sum of the tickets sold or $438 + 374 + 512$. To find the number of tickets sold by all three locations in four weeks, multiply the expression for one week by 4.

$$\begin{aligned} 4(438 + 374 + 512) &= 4(1324) \\ &= 5296 \end{aligned}$$

So, 5296 tickets are sold by all three locations in 4 weeks.

Find the solution of each equation if the replacement sets are $x: \{1, 3, 5, 7, 9\}$ and $y: \{2, 4, 6, 8, 10\}$.

13. $3x - 9 = 12$

SOLUTION:

x	$3x - 9 = 12$	True or False?
1	$3(1) - 9 = 12$	False
3	$3(3) - 9 = 12$	False
5	$3(5) - 9 = 12$	False
7	$3(7) - 9 = 12$	True
9	$3(9) - 9 = 12$	False

Practice Test - Chapter 1

14. $y^2 - 5y - 11 = 13$

SOLUTION:

y	$y^2 - 5y - 11 = 13$	True or False?
2	$(2)^2 - 5(2) - 11 = 13$	False
4	$(4)^2 - 5(4) - 11 = 13$	False
6	$(6)^2 - 5(6) - 11 = 13$	False
8	$(8)^2 - 5(8) - 11 = 13$	True
10	$(10)^2 - 5(10) - 11 = 13$	False

15. **CELL PHONES** The ABC Cell Phone Company offers a plan that includes a flat fee of \$29 per month plus a \$0.12 charge per minute. Write an equation to find C , the total monthly cost for m minutes. Then solve the equation for $m = 50$.

SOLUTION:

Write an equation to represent the cost. The cost has two parts; a fixed cost of \$29 and variable cost of \$0.12 per minute.

$$C = 29 + 0.12m$$

$$\begin{aligned} C &= 29 + 0.12(50) \\ &= 29 + 6 \\ &= 35 \end{aligned}$$

So, the total monthly cost for 50 minutes is \$35.

Express the relation shown in each table, mapping, or graph as a set of ordered pairs.

x	y
-2	4
1	2
3	0
4	-2

16.

SOLUTION:

To express the relation as a set of ordered pairs, write the x -coordinates followed by the corresponding y -coordinates. So, the ordered pairs are $\{(-2, 4), (1, 2), (3, 0), (4, -2)\}$.



17.

SOLUTION:

To express the relation as a set of ordered pairs, write the x -coordinates followed by the corresponding y -coordinates. So, the ordered pairs are $\{(-3, 2), (-3, 4), (-1, 0), (1, -2), (3, 0)\}$.

18. **MULTIPLE CHOICE** Determine the domain and range for the relation $\{(2, 5), (-1, 3), (0, -1), (3, 3), (-4, -2)\}$.

F D: $\{2, -1, 0, 3, -4\}$, R: $\{5, 3, -1, 3, -2\}$

G D: $\{5, 3, -1, 3, -2\}$, R: $\{2, -1, 0, 3, 4\}$

H D: $\{0, 1, 2, 3, 4\}$, R: $\{-4, -3, -2, -1, 0\}$

J D: $\{2, -1, 0, 3, -4\}$, R: $\{2, -1, 0, 3, 4\}$

SOLUTION:

The domain is the list of x -values, D: $\{2, -1, 0, 3, -4\}$. The range is the list of y -values, R: $\{5, 3, -1, 3, -2\}$. So, choice F is the correct answer.

19. Determine whether the relation $\{(2, 3), (-1, 3), (0, 4), (3, 2), (-2, 3)\}$ is a function.

SOLUTION:

A function is a relationship between input and output. In a function, there is exactly one output for each input. So, this relation is a function.

If $f(x) = 5 - 2x$ and $g(x) = x^2 + 7x$, find each value.

20. $g(3)$

SOLUTION:

$$\begin{aligned} g(3) &= (3)^2 + 7(3) && \text{Replace } x \text{ with } 3. \\ &= 9 + 7(3) && \text{Evaluate Powers.} \\ &= 9 + 21 && \text{Multiply } 7 \text{ and } 3. \\ &= 30 && \text{Add } 9 \text{ and } 21 \end{aligned}$$

Practice Test - Chapter 1

21. $f(-6y)$

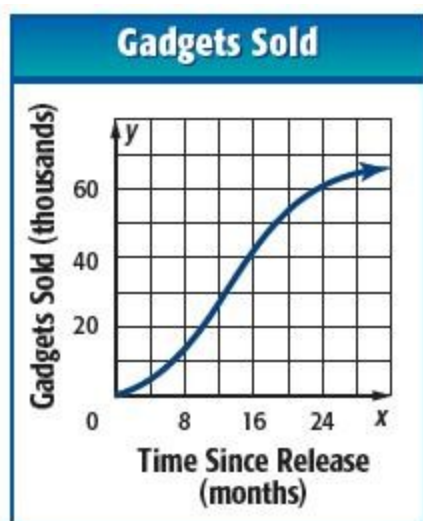
SOLUTION:

$$f(-6y)$$

$$= 5 - 2(-6y) \quad \text{Replace } x \text{ with } -6y.$$

$$= 5 + 12y \quad \text{Multiply } -2 \text{ by } (-6y).$$

22. Identify the function graphed as linear or nonlinear. Then estimate and interpret the intercepts of the graph, any symmetry, where the function is positive, negative, increasing, and decreasing, the x -coordinate of any relative extrema, and the end behavior of the graph.



SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

x - and y -Intercepts: The x - and y -intercepts are 0. This means that no gadgets have been sold prior to being released.

Symmetry: The graph has no line symmetry.

Positive/Negative: The function is positive for all values of x , so the total number of gadgets sold is always positive.

Increasing/Decreasing: The function is increasing for all values of x so the total number of gadgets sold is always increasing.

Extrema: There are no relative maximum or relative minimum values.

End Behavior: As x increases, y increases. As time increases, the total number of gadgets sold continues to increase, but at a much slower rate than during months 0 to 24.

Preparing for Standardized Tests - Chapter 1

Read each problem. Eliminate any unreasonable answers. Then use the information in the problem to solve.

1. Coach Roberts expects 35% of the student body to turn out for a pep rally. If there are 560 students, how many does Coach Roberts expect to attend the pep rally?

- A 184
B 196
C 214
D 390

SOLUTION:

35% is less than half, and half of the student body is 280 students. So, answer choice D can be eliminated because 390 is more than 280.

Use the percent equation to find 35% of 560 students. The base is 560 and the percent is 35. Let a be the represent the part.

$$\frac{a}{b} = \frac{p}{100} \quad \text{Percent Proportion}$$

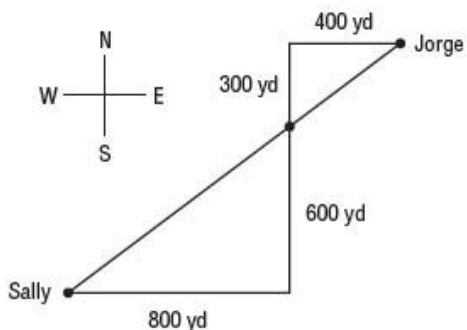
$$\frac{a}{560} = \frac{35}{100} \quad b = 560, p = 35$$

$$19,600 = 100a \quad \text{Find the cross products.}$$

$$196 = a \quad \text{Simplify.}$$

So, Coach Roberts, expects 196 students to attend the pep rally. Choice B is the correct answer.

2. Jorge and Sally leave school at the same time. Jorge walks 300 yards north and then 400 yards east. Sally rides her bike 600 yards south and then 800 yards west. What is the distance between the two students?



- F 500 yd

- G 750 yd

- H 1,200 yd

- J 1,500 yd

SOLUTION:

Let J represent Jorge's distance from school. Use the Pythagorean Theorem to solve for J .

$$J^2 = 300^2 + 400^2 \quad \text{Pyth. Thm.}$$

$$J^2 = 90,000 + 160,000 \quad \text{Evaluate powers.}$$

$$J^2 = 250,000 \quad \text{Addition.}$$

$$J = \sqrt{250,000} \quad \text{Take square root.}$$

$$J = 500 \quad \text{Evaluate.}$$

Choice F can be eliminated because the distance between the two students is more than just Jorge's distance from school, which is 500 yards. Let S represent Sally's distance from school.

$$S^2 = 600^2 + 800^2 \quad \text{Pyth. Thm.}$$

$$S^2 = 360,000 + 640,000 \quad \text{Evaluate powers.}$$

$$S^2 = 1,000,000 \quad \text{Addition.}$$

$$S = \sqrt{1,000,000} \quad \text{Take square root.}$$

$$S = 1000 \quad \text{Evaluate.}$$

Choice G can be eliminated because Sally's distance from school is more than 750 yards.

The distance between the two students is $500 + 1000 = 1500$, or 1500 yards. So, choice J is the correct answer..

Preparing for Standardized Tests - Chapter 1

3. What is the range of the relation below?
{(1, 2), (3, 4), (5, 6), (7, 8)}

- A** all real numbers
B all even numbers
C {2, 4, 6, 8}
D {1, 3, 5, 7}

SOLUTION:

Answers A and B can be eliminated because the set of numbers given in this problem only has four points. The range is the set of y -values: {2, 4, 6, 8}. So, choice C is the correct answer.

4. The expression $3n + 1$ gives the total number of squares needed to make each figure of the pattern where n is the figure number. How many squares will be needed to make Figure 9?

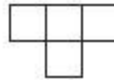


Figure 1

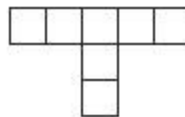


Figure 2

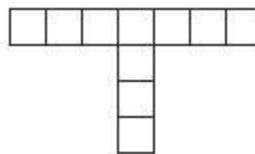


Figure 3

- F** 28 squares
G 32.5 squares
H 56 squares
J 88.5 squares

SOLUTION:

Choices G and J can be eliminated because they have a fraction of a square. This pattern does not create a half of a square. For Figure 9, $n = 9$.

$$\begin{aligned} 3n + 1 &= 3(9) + 1 \\ &= 27 + 1 \\ &= 28 \end{aligned}$$

So, choice F is the correct answer.

Preparing for Standardized Tests - Chapter 1

5. The expression $3x - (2x + 4x - 6)$ is equivalent to

A $-3x - 6$

B $-3x + 6$

C $3x + 6$

D $3x - 6$

SOLUTION:

The -1 needs to be distributed across the terms in parentheses. This means the expression will end with “+ 6.” Choices A and D can be eliminated because they end with “- 6.”

$$\begin{aligned} 3x - (2x + 4x - 6) &= 3x - (6x - 6) \\ &= 3x - 6x + 6 \\ &= -3x + 6 \end{aligned}$$

So, choice B is the correct answer.

Standardized Test Practice - Cumulative, Chapter 1

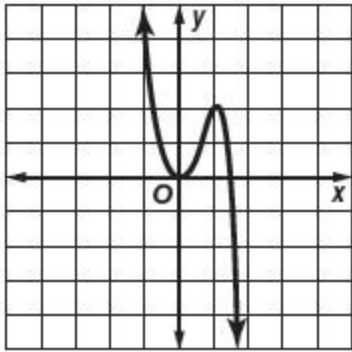
1. Evaluate the expression 2^6 .
- A 12
 - B 32
 - C 64
 - D 128

SOLUTION:

$$\begin{aligned} 2^6 &= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \\ &= 64 \end{aligned}$$

Because $2^6 = 64$, the correct answer is C.

2. Which sentence best describes the end behavior of the function shown?



- F As x increases, y increases, and as x decreases, y increases.
- G As x increases, y increases, and as x decreases, y decreases.
- H As x increases, y decreases, and as x decreases, y increases.
- J As x increases, y decreases, and as x decreases, y decreases.

SOLUTION:

The graph points upward on the left, so as x decreases, y increases. The graph points downward on the right, so as x increases, y decreases. This is choice H.

3. Let y represent the number of yards. Which algebraic expression represents the number of feet in y ?

- A $y - 3$
- B $y + 3$
- C $3y$
- D $\frac{3}{y}$

SOLUTION:

Since there are three feet in every yard, to find the feet in y yards multiply 3 times the number of yards represented by y . This gives the expression $3y$ so C is the correct answer.

4. What is the domain of the following relation?

- $\{(1, 3), (-6, 4), (8, 5)\}$
- F $\{3, 4, 5\}$
 - G $\{-6, 1, 8\}$
 - H $\{-6, 1, 3, 4, 5, 8\}$
 - J $\{1, 3, 4, 5, 8\}$

SOLUTION:

The domain consists of the x values of the set of ordered pairs. In this case, the x values are 1, -6 , and 8. Therefore the correct solution set is G.

Standardized Test Practice - Cumulative, Chapter 1

5. The table shows the number of some of the items sold at the concession stand at the first day of a soccer tournament. Estimate how many items were sold from the concession stand through out the four days of the tournament.

Concession Sales Day 1 Results	
Item	Number Sold
Popcorn	78
Hot Dogs	80
Chip	48
Sodas	51
Bottled Water	92

- A 1350 items
B 1400 items
C 1450 items
D 1500 items

SOLUTION:

To find the total number of items sold on the first day, add an estimation of each of the items, rounding to the nearest whole number, $80 + 80 + 50 + 50 + 90 = 350$.

Since this is for only one day, take and multiply 350 by 4 because the tournament lasted 4 days, $350 \cdot 4 = 1400$.

It is estimated that there were 1400 items sold over the 4 day period so the correct answer is B.

6. There are 24 more cars than twice the number of trucks for sale at a dealership. If there are 100 cars for sale, how many trucks are there for sale at the dealership?

- F 28
G 32
H 34
J 38

SOLUTION:

Let t = the number of trucks. Since there are 24 more cars than twice the number of trucks, $24 + 2t = 100$.

$$\begin{aligned}24 + 2t &= 100 \\2t &= 76 \\t &= 38\end{aligned}$$

There are 38 trucks at the dealership so the correct answer is J.

7. Refer to the relation in the table below. Which of the following values would result in the relation *not* being a function?

x	-6	-2	0	?	3	5
y	-1	8	3	-3	4	0

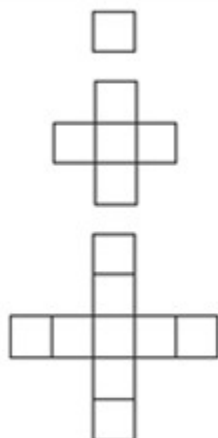
- A -1
B 3
C 7
D 8

SOLUTION:

If the missing value were 3, then there would be two x values paired with two different y values. Since a function requires that an element is paired with exactly one element of the range, this relation would not be a function so B is the correct answer.

Standardized Test Practice - Cumulative, Chapter 1

8. The edge of each box in the pattern is 1 unit long.



- Make a table showing the perimeters of the first 3 figures in the pattern.
- Look for a pattern in the perimeters of the shapes. Write an algebraic expression for the perimeter of Figure n .
- What would the perimeter of Figure 10 in the pattern?

SOLUTION:

a.

Figure	Perimeter
Figure 1	4 units
Figure 2	12 units
Figure 3	20 units

b.

Let n be the figure number. The figure started with one square. Each new figure has four more squares than the prior figure but only two of the sides of each of the squares become part of the perimeter. This can be represented by the expression below. The 4 is from the first squares 4 sides and the expression $8(n-1)$ represents the eight sides that become part of the perimeter when 4 squares are added to each figure.

$$4 + 8(n-1) = 4 + 8n - 8$$

$$= 8n - 4$$

c. For Figure 10, $n = 10$.

$$4 + 8(n-1) = 4 + 8(10-1)$$

$$= 4 + 8(9)$$

$$= 4 + 72$$

$$= 76$$

So, the perimeter of Figure 10 is 76 units.

9. The table shows the costs of certain items at a corner hardware store.

Item	Cost
box of nails	\$3.80
box of screws	\$5.25
claw hammer	\$12.95
electric drill	\$42.50

- Write two expressions to represent the total cost of 3 boxes of nails, 2 boxes of screws, 2 hammers, and 1 electric drill.
- What is the total cost of the items purchased?

SOLUTION:

- For each item multiply the costs by the number of items purchased and add these together for the total.
 $3(3.80) + 2(5.25) + 2(12.95) + 42.50$

Because addition is commutative, the order of the addends can be changed to produce a second answer:

$$3(3.80) + 2(5.25) + 42.50 + 2(12.95)$$

- To find the total perform order of operations by doing the multiplication first and the addition second.

$$3(3.80) + 2(5.25) + 2(12.95) + 42.50$$

$$= 11.40 + 10.50 + 25.90 + 42.5$$

$$= 90.30$$

The total cost of the items purchased is \$90.30.

Standardized Test Practice - Cumulative, Chapter 1

10. **GRIDDED RESPONSE** Evaluate the expression below.

$$\frac{5^3 \cdot 4^2 - 5^2 \cdot 4^3}{5 \cdot 4}$$

SOLUTION:

$$\begin{aligned} & \frac{5^3 \cdot 4^2 - 5^2 \cdot 4^3}{5 \cdot 4} && \text{Original expression} \\ & = \frac{125 \cdot 16 - 25 \cdot 64}{5 \cdot 4} && \text{Evaluate powers.} \\ & = \frac{2000 - 1600}{20} && \text{Multiply 5 by 4.} \\ & = \frac{400}{20} && \text{Subtract 1600 from 2000.} \\ & = 20 && \text{Simplify.} \end{aligned}$$

11. Use the equation $y = 2(4 + x)$ to answer each question.
- a. Complete the following table for the different values of x .

x	y
1	
2	
3	
4	
5	
6	

- b. Plot the points from the table on a coordinate grid. What do you notice about the points?
- c. Make a conjecture about the relationship between the change in x and the change in y .

SOLUTION:

a. $y = 2(4 + x)$

$$\begin{aligned} x &= 1; \\ y &= 2(4 + x) \\ y &= 2(4 + 1) \\ y &= 2(5) \\ y &= 10 \end{aligned}$$

$$x = 2;$$

$$\begin{aligned} y &= 2(4 + x) \\ y &= 2(4 + 2) \\ y &= 2(8) \\ y &= 16 \end{aligned}$$

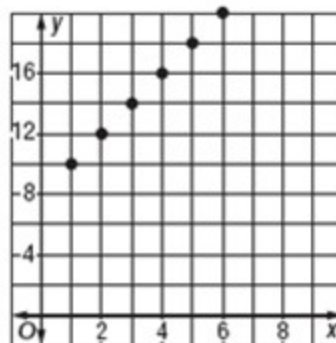
$$\begin{aligned} x &= 3; \\ y &= 2(4 + x) \\ y &= 2(4 + 3) \\ y &= 2(7) \\ y &= 14 \end{aligned}$$

$$\begin{aligned} x &= 4; \\ y &= 2(4 + x) \\ y &= 2(4 + 4) \\ y &= 2(8) \\ y &= 16 \end{aligned}$$

$$\begin{aligned} x &= 5; \\ y &= 2(4 + x) \\ y &= 2(4 + 5) \\ y &= 2(9) \\ y &= 18 \end{aligned}$$

$$\begin{aligned} x &= 6; \\ y &= 2(4 + x) \\ y &= 2(4 + 6) \\ y &= 2(10) \\ y &= 20 \end{aligned}$$

b.

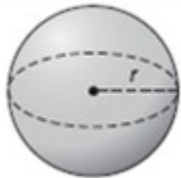


The points lie in a straight line.

- c. Sample answer: When x increases by 1, y increases by 2.

Standardized Test Practice - Cumulative, Chapter 1

12. The volume of a sphere is four-thirds the product of π and the radius cubed.



- a.** Write an expression for the volume of a sphere with radius r .
b. Find the volume of a sphere with a radius of 6 centimeters. Describe how you found your answer.

SOLUTION:

a.

The volume of a sphere is four-thirds the product of π and the radius cubed.

$$V = \frac{4}{3} \pi r^3$$

- b.** Substitute 6 for r in the expression. Take 6 to the third power which is 216. Multiply by 4 which is 864, then divide by 3 which is 288. Pi is irrational so it appears in the answer.

$$\begin{aligned} V &= \frac{4}{3} \pi r^3 \\ &= \frac{4}{3} \pi (6)^3 \\ &= \frac{4}{3} \pi (216) \\ &= \frac{864}{3} \pi \\ &= 288\pi \end{aligned}$$

Study Guide and Review -Chapter 1

State whether each sentence is *true* or *false* . If *false* , replace the underlined term to make a **true sentence**.

1. An exponent indicates the number the base is to be multiplied by.

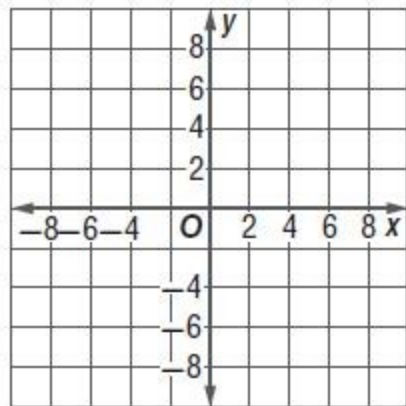
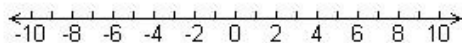
SOLUTION:

The exponent indicates the number of times the base is multiplied by itself. For example, in the expression 3^4 4 indicates the number 3 is multiplied by itself 4 times. So, the statement is true.

2. A coordinate system is formed by the intersection of two number lines.

SOLUTION:

A coordinate system is formed by the intersection of two number lines, the *horizontal axis* and the *vertical axis*. Consider the number line.



If you place one vertical and cross at the 0 point, then the intersection forms a coordinate system. So, the statement is true.

3. An expression is in simplest form when it contains like terms and parentheses.

SOLUTION:

An expression is in simplest form when it contains no like terms or parentheses. For example, $\frac{4x}{12x^2}$ is not in simplest form because the numerator and denominator have a common factor of $4x$. So, the statement is false. An expression is *not* in simplest form when it contains like terms and parentheses.

4. In an expression involving multiplication, the quantities being multiplied are called factors.

SOLUTION:

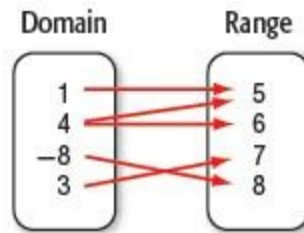
In an expression involving multiplication, the quantities being multiplied are called factors. For example, in the expression $(3x + 5)2x$, $(3x + 5)$ and $2x$ are factors. So, the statement is true.

5. In a function, there is exactly one output for each input.

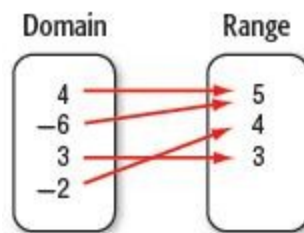
SOLUTION:

A function is a relationship between input and output. In a function, there is exactly one output for each input. The domain is the input and the output is the range.

Not a function:



Function:



So, the statement is true.

6. Order of operations tells us to always perform multiplication before subtraction.

SOLUTION:

The rule that lets you know which operation to perform first is called the order of operations.

Consider the expression $3(2) - 4$. If you perform the subtraction before the multiplication you get $3(2) - 4 = 3(-2)$ or -6 . If you perform the multiplication first, you get $3(2) - 4 = 6 - 4$ or 2 . The correct answer is 2 .

So, the statement is true.

Study Guide and Review -Chapter 1

7. Since the product of any number and 1 is equal to the number, 1 is called the multiplicative inverse.

SOLUTION:

A multiplicative *inverse* is two numbers with a product of 1. The statement is false. Since the product of any number and 1 is equal to the number, 1 is called the multiplicative *identity*.

Write a verbal expression for each algebraic expression.

8. $h - 7$

SOLUTION:

The expression shows h minus seven. So, the verbal expression *the difference between h and 7* can be used to describe the algebraic expression $h - 7$.

9. $3x^2$

SOLUTION:

The expression shows the product of the factors 3 and x^2 . The factor x^2 represents a number raised to the second power or squared. So, the verbal expression, *the product of 3 and x squared* can be used to describe the algebraic expression $3x^2$.

10. $5 + 6m^3$

SOLUTION:

The expression shows the sum of 5 and $6m^3$. The term $6m^3$ represents the product of the factors 6 and m^3 . The factor m^3 represents a number raised to the third power or cubed. So, the verbal expression *five more than the product of six and m cubed* can be used to describe the algebraic expression $5 + 6m^3$.

Write an algebraic expression for each verbal expression.

11. a number increased by 9

SOLUTION:

Let x represent a number. The word *increased* suggests addition. So, the verbal expression *a number increased by 9* can be written as the algebraic expression $x + 9$.

12. two thirds of a number d to the third power

SOLUTION:

The words *two-thirds of* suggest multiplication. So, the verbal expression *two-thirds of a number d to the third power* can be written as the algebraic expression $\frac{2}{3}d^3$.

13. 5 less than four times a number

SOLUTION:

Let x represent a number. The words *less than* suggest subtraction, and the word *times* suggests multiplication. So, the verbal expression *5 less than four times a number* can be written as the algebraic expression $4x - 5$.

Evaluate each expression.

14. 2^5

SOLUTION:

$$\begin{aligned} 2^5 &= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \\ &= 32 \end{aligned}$$

15. 6^3

SOLUTION:

$$\begin{aligned} 6^3 &= 6 \cdot 6 \cdot 6 \\ &= 216 \end{aligned}$$

16. 4^4

SOLUTION:

$$\begin{aligned} 4^4 &= 4 \cdot 4 \cdot 4 \cdot 4 \\ &= 256 \end{aligned}$$

17. **BOWLING** Fantastic Pins Bowling Alley charges \$2.50 for shoe rental plus \$3.25 for each game. Write an expression representing the cost to rent shoes and bowl g games.

SOLUTION:

Let g represent the number of games. To find the cost of g games, multiply the cost of one game, \$3.25, by g . To find the total cost, add the result to the cost of shoe rental. So, the expression $2.50 + 3.25g$ represents the cost to rent shoes and bowl g games.

Study Guide and Review -Chapter 1

Evaluate each expression.

18. $24 - 4 \cdot 5$

SOLUTION:

$$\begin{aligned} 24 - 4 \cdot 5 &= 24 - 20 && \text{Multiply 4 by 5.} \\ &= 4 && \text{Subtract 20 from 24.} \end{aligned}$$

19. $15 + 3^2 - 6$

SOLUTION:

$$\begin{aligned} 15 + 3^2 - 6 &= 15 + 9 - 6 && \text{Evaluate powers.} \\ &= 24 - 6 && \text{Add 15 and 9.} \\ &= 18 && \text{Subtract 6 from 24.} \end{aligned}$$

20. $7 + 2(9 - 3)$

SOLUTION:

$$\begin{aligned} 7 + 2(9 - 3) &= 7 + 2(6) && \text{Subtract 3 from 9.} \\ &= 7 + 12 && \text{Multiply 2 by 6.} \\ &= 19 && \text{Add 7 and 12.} \end{aligned}$$

21. $8 \cdot 4 - 6 \cdot 5$

SOLUTION:

$$\begin{aligned} 8 \cdot 4 - 6 \cdot 5 &= 32 - 6 \cdot 5 && \text{Multiply 8 by 4.} \\ &= 32 - 30 && \text{Multiply 6 by 5.} \\ &= 2 && \text{Subtract 30 from 32.} \end{aligned}$$

22. $[(2^5 - 5) \div 9]11$

SOLUTION:

$$\begin{aligned} [(2^5 - 5) \div 9]11 &= [(32 - 5) \div 9]11 && 2^5 = 32 \\ &= (27 \div 9)11 && \text{Subtract.} \\ &= 3(11) && \text{Divide.} \\ &= 33 && \text{Multiply.} \end{aligned}$$

23. $\frac{11+4^2}{5^2-4^2}$

SOLUTION:

$$\begin{aligned} \frac{11+4^2}{5^2-4^2} &= \frac{11+16}{5^2-4^2} && \text{Evaluate powers.} \\ &= \frac{11+16}{25-4^2} && \text{Evaluate powers.} \\ &= \frac{11+16}{25-16} && \text{Evaluate powers.} \\ &= \frac{27}{25-16} && \text{Add 11 and 16.} \\ &= \frac{27}{9} && \text{Subtract 16 from 25.} \\ &= 3 && \text{Simplify.} \end{aligned}$$

Evaluate each expression if $a = 4$, $b = 3$, and $c = 9$.

24. $c + 3a$

SOLUTION:

Replace c with 9 and a with 4.

$$\begin{aligned} c + 3a &= 9 + 3(4) && \text{Substitute.} \\ &= 9 + 12 && \text{Multiply 3 by 4.} \\ &= 21 && \text{Evaluate powers.} \end{aligned}$$

25. $5b^2 \div c$

SOLUTION:

Replace b with 3 and c with 9.

$$\begin{aligned} 5b^2 \div c &= 5(3^2) \div 9 && \text{Substitute.} \\ &= 5(9) \div 9 && \text{Evaluate powers.} \\ &= 45 \div 9 && \text{Multiply 5 by 9.} \\ &= 5 && \text{Divide 45 by 9.} \end{aligned}$$

Study Guide and Review -Chapter 1

26. $(a^2 + 2bc) \div 7$

SOLUTION:

Replace a with 4, b with 3 and c with 9.

$$\begin{aligned} & (a^2 + 2bc) \div 7 \\ &= [4^2 + 2(3)(9)] \div 7 \quad \text{Substitute.} \\ &= [16 + 2(3)(9)] \div 7 \quad \text{Evaluate powers.} \\ &= [4^2 + 6(9)] \div 7 \quad \text{Multiply 2 by 3.} \\ &= (16 + 54) \div 7 \quad \text{Multiply 6 by 9.} \\ &= 70 \div 7 \quad \text{Add 16 and 54.} \\ &= 10 \quad \text{Divide 70 by 7.} \end{aligned}$$

27. **ICE CREAM** The cost of a one-scoop sundae is \$2.75, and the cost of a two-scoop sundae is \$4.25. Write and evaluate an expression to find the total cost of 3 one-scoop sundaes and 2 two-scoop sundaes.

SOLUTION:

To find the cost of 3 one-scoop sundaes and 2 two-scoop sundaes, multiply the cost of a one-scoop sundae by 3 and add that to the product of 2 and the cost of a two-scoop sundae. So, the expression $2.75(3) + 4.25(2)$ can be used to find the total cost of 3 one-scoop sundaes and 2 two-scoop sundaes.

$$\begin{aligned} 2.75(3) + 4.25(2) &= 8.25 + 8.5 \\ &= 16.75 \end{aligned}$$

The total cost of 3 one-scoop sundaes and 2 two-scoop sundaes is \$16.75.

Evaluate each expression using properties of numbers. Name the property used in each step.

28. $18 \cdot 3(1 \div 3)$

SOLUTION:

$$\begin{aligned} & 18 \cdot 3(1 \div 3) \\ &= 18 \cdot (3) \left(\frac{1}{3}\right) \quad \text{Substitution} \\ &= 18 \cdot 1 \quad \text{Multiplicative Inverse} \\ &= 18 \quad \text{Multiplicative Identity} \end{aligned}$$

29. $[5 \div (8 - 6)] \frac{2}{5}$

SOLUTION:

$$\begin{aligned} & [5 \div (8 - 6)] \frac{2}{5} \\ &= [5 \div 2] \frac{2}{5} \quad \text{Substitution} \\ &= \frac{5}{2} \cdot \frac{2}{5} \quad \text{Substitution} \\ &= 1 \quad \text{Multiplicative Inverse} \end{aligned}$$

30. $(16 - 4^2) + 9$

SOLUTION:

$$\begin{aligned} & (16 - 4^2) + 9 \\ &= 16 - 16 + 9 \quad \text{Substitution} \\ &= 0 + 9 \quad \text{Additive Inverse} \\ &= 9 \quad \text{Additive Identity} \end{aligned}$$

31. $2 \cdot \frac{1}{2} + 4(4 \cdot 2 - 7)$

SOLUTION:

$$\begin{aligned} & 2 \cdot \frac{1}{2} + 4(4 \cdot 2 - 7) \\ &= 2 \cdot \frac{1}{2} + 4(8 - 7) \quad \text{Substitution} \\ &= 2 \cdot \frac{1}{2} + 4(1) \quad \text{Substitution} \\ &= 1 + 4(1) \quad \text{Multiplicative Inverse} \\ &= 1 + 4 \quad \text{Multiplicative Identity} \\ &= 5 \quad \text{Substitution} \end{aligned}$$

32. $18 + 41 + 32 + 9$

SOLUTION:

$$\begin{aligned} & 18 + 41 + 32 + 9 \\ &= 18 + 32 + 41 + 9 \quad \text{Commutative (+)} \\ &= (18 + 32) + (41 + 9) \quad \text{Associative (+)} \\ &= 50 + 50 \quad \text{Substitution} \\ &= 100 \quad \text{Substitution} \end{aligned}$$

Study Guide and Review -Chapter 1

33. $7\frac{2}{5} + 5 + 2\frac{3}{5}$

SOLUTION:

$$\begin{aligned} &7\frac{2}{5} + 5 + 2\frac{3}{5} \\ &= 7\frac{2}{5} + 2\frac{3}{5} + 5 && \text{Commutative (+)} \\ &= \left(7\frac{2}{5} + 2\frac{3}{5}\right) + 5 && \text{Associative (+)} \\ &= 10 + 5 && \text{Substitution} \\ &= 15 && \text{Substitution} \end{aligned}$$

34. $8 \cdot 0.5 \cdot 5$

SOLUTION:

$$\begin{aligned} &8 \cdot 0.5 \cdot 5 \\ &= 8 \cdot 5 \cdot 0.5 && \text{Commutative (\times)} \\ &= (8 \cdot 5) \cdot 0.5 && \text{Associative (\times)} \\ &= 40 \cdot 0.5 && \text{Substitution} \\ &= 20 && \text{Substitution} \end{aligned}$$

35. $5.3 + 2.8 + 3.7 + 6.2$

SOLUTION:

$$\begin{aligned} &5.3 + 2.8 + 3.7 + 6.2 \\ &= 5.3 + 3.7 + 2.8 + 6.2 && \text{Commutative (+)} \\ &= (5.3 + 3.7) + (2.8 + 6.2) && \text{Associative (+)} \\ &= 9 + 9 && \text{Substitution} \\ &= 18 && \text{Substitution} \end{aligned}$$

36. **SCHOOL SUPPLIES** Monica needs to purchase a binder, a textbook, a calculator, and a workbook for her algebra class. The binder costs \$9.25, the textbook \$32.50, the calculator \$18.75, and the workbook \$15.00. Find the total cost for Monica's algebra supplies.

SOLUTION:

To find the total cost for Monica's Algebra supplies, find the sum of the costs of the binder, the textbook, the calculator and the workbook.
 $\$9.25 + \$32.50 + \$18.75 + \$15.00 = \$75.50$
So, the total cost for Monica's Algebra supplies is \$75.50.

Use the Distributive Property to rewrite each expression. Then evaluate.

37. $(2 + 3)6$

SOLUTION:

$$\begin{aligned} (2 + 3)6 &= 2(6) + 3(6) \\ &= 12 + 18 \\ &= 30 \end{aligned}$$

38. $5(18 + 12)$

SOLUTION:

$$\begin{aligned} 5(18 + 12) &= 5(18) + 5(12) \\ &= 90 + 60 \\ &= 150 \end{aligned}$$

39. $8(6 - 2)$

SOLUTION:

$$\begin{aligned} 8(6 - 2) &= 8(6) - 8(2) \\ &= 48 - 16 \\ &= 32 \end{aligned}$$

40. $(11 - 4)3$

SOLUTION:

$$\begin{aligned} (11 - 4)3 &= 11(3) - 4(3) \\ &= 33 - 12 \\ &= 21 \end{aligned}$$

41. $-2(5 - 3)$

SOLUTION:

$$\begin{aligned} -2(5 - 3) &= -2(5) - (-2)(3) \\ &= -10 - (-6) \\ &= -10 + 6 \\ &= -4 \end{aligned}$$

42. $(8 - 3)4$

SOLUTION:

$$\begin{aligned} (8 - 3)4 &= 8(4) - 3(4) \\ &= 32 - 12 \\ &= 20 \end{aligned}$$

Study Guide and Review -Chapter 1

Rewrite each expression using the Distributive Property. Then simplify.

43. $3(x + 2)$

SOLUTION:

$$\begin{aligned} 3(x + 2) &= 3(x) + 3(2) \\ &= 3x + 6 \end{aligned}$$

44. $(m + 8)4$

SOLUTION:

$$\begin{aligned} (m + 8)4 &= m(4) + 8(4) \\ &= 4m + 32 \end{aligned}$$

45. $6(d - 3)$

SOLUTION:

$$\begin{aligned} 6(d - 3) &= 6(d) - 6(3) \\ &= 6d - 18 \end{aligned}$$

46. $-4(5 - 2t)$

SOLUTION:

$$\begin{aligned} -4(5 - 2t) &= -4(5) - (-4)(2t) \\ &= -20 - (-8t) \\ &= -20 + 8t \end{aligned}$$

47. $(9y - 6)(-3)$

SOLUTION:

$$\begin{aligned} (9y - 6)(-3) &= 9y(-3) - 6(-3) \\ &= -27y + 18 \end{aligned}$$

48. $-6(4z + 3)$

SOLUTION:

$$\begin{aligned} -6(4z + 3) &= -6(4z) + (-6)(3) \\ &= -24z - 18 \end{aligned}$$

49. **TUTORING** Write and evaluate an expression for the number of tutoring lessons Mrs. Green gives in 4 weeks.

Tutoring Schedule	
Day	Students
Monday	3
Tuesday	5
Wednesday	4

SOLUTION:

To find the number of tutoring lessons Mrs. Green gives in 4 weeks, multiply 4 by the sum of the number of students Mrs. Green tutors on Monday, Tuesday, and Wednesday. So, the expression $4(3 + 5 + 4)$ can be used to find the number of tutoring lessons Mrs. Green gives in 4 weeks.

$$\begin{aligned} 4(3 + 5 + 4) &= 4(12) \\ &= 48 \end{aligned}$$

So, Mrs. Green gives 48 tutoring lessons in 4 weeks.

Find the solution set of each equation if the replacement sets are x : {1, 3, 5, 7, 9} and y : {6, 8, 10, 12, 14}

50. $y - 9 = 3$

SOLUTION:

y	$y - 9 = 3$	True or False?
6	$6 - 9 = 3$	False
8	$8 - 9 = 3$	False
10	$10 - 9 = 3$	False
12	$12 - 9 = 3$	True
14	$14 - 9 = 3$	False

The solution set is {12}.

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51. $14 + x = 21$

SOLUTION:

x	$14 + x = 21$	True or False?
1	$14 + 1 = 21$	False
3	$14 + 3 = 21$	False
5	$14 + 5 = 21$	False
7	$14 + 7 = 21$	True
9	$14 + 9 = 21$	False

The solution set is $\{7\}$.

52. $4y = 32$

SOLUTION:

y	$4y = 32$	True or False?
6	$4(6) = 32$	False
8	$4(8) = 32$	True
10	$4(10) = 32$	False
12	$4(12) = 32$	False
14	$4(14) = 32$	False

The solution set is $\{8\}$.

53. $3x - 11 = 16$

SOLUTION:

x	$3x - 11 = 16$	True or False?
1	$3(1) - 11 = 16$	False
3	$3(2) - 11 = 16$	False
5	$3(5) - 11 = 16$	False
7	$3(7) - 11 = 16$	False
9	$3(9) - 11 = 16$	True

The solution set is $\{9\}$.

54. $\frac{42}{y} = 7$

SOLUTION:

y	$\frac{42}{y} = 7$	True or False?
6	$\frac{42}{6} = 7$	True
8	$\frac{42}{8} = 7$	False
10	$\frac{42}{10} = 7$	False
12	$\frac{42}{12} = 7$	False
14	$\frac{42}{14} = 7$	False

The solution set is $\{6\}$.

55. $2(x - 1) = 8$

SOLUTION:

x	$2(x - 1) = 8$	True or False?
1	$2(1 - 1) = 8$	False
3	$2(3 - 1) = 8$	False
5	$2(5 - 1) = 8$	True
7	$2(7 - 1) = 8$	False
9	$2(9 - 1) = 8$	False

The solution set is $\{5\}$.

Solve each equation.

56. $a = 24 - 7(3)$

SOLUTION:

$$a = 24 - 7(3)$$

$$a = 24 - 21$$

$$a = 3$$

57. $z = 63 \div (3^2 - 2)$

SOLUTION:

$$z = 63 \div (3^2 - 2)$$

$$z = 63 \div (9 - 2)$$

$$z = 63 \div 7$$

$$z = 9$$

Study Guide and Review -Chapter 1

58. **AGE** Shandra's age is four more than three times Sherita's age. Write an equation for Shandra's age. Then solve the equation if Sherita's is 3 years old.

SOLUTION:

Let K = Sherita's age.

Let E = Shandra's age.

The words *more than* suggest addition and the word *times* suggests multiplication. So, $3K + 4 = E$. To find Shandra's age when Sherita is 3, replace the K in the equation with 3 and solve for E .

$$3K + 4 = E$$

$$3(3) + 4 = E$$

$$9 + 4 = E$$

$$13 = E$$

So, Shandra is 13 years old.

Express each relation as a table, a graph, and a mapping. Then determine the domain and range.

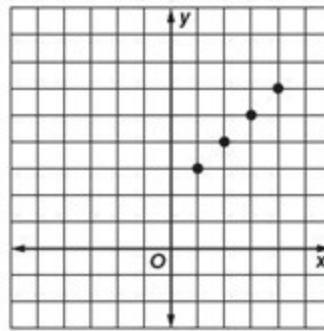
59. $\{(1, 3), (2, 4), (3, 5), (4, 6)\}$

SOLUTION:

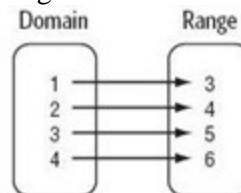
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
1	3
2	4
3	5
4	6

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{1, 2, 3, 4\}$, and the range is $\{3, 4, 5, 6\}$.

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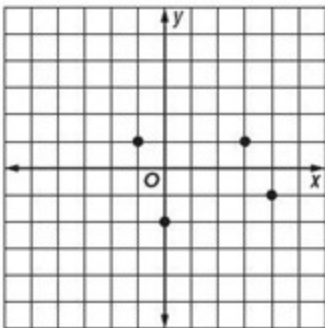
60. $\{(-1, 1), (0, -2), (3, 1), (4, -1)\}$

SOLUTION:

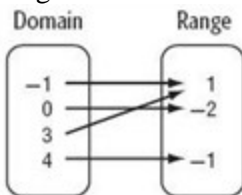
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
-1	1
0	-2
3	1
4	-1

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-1, 0, 3, 4\}$, and the range is $\{-2, -1, 1\}$.

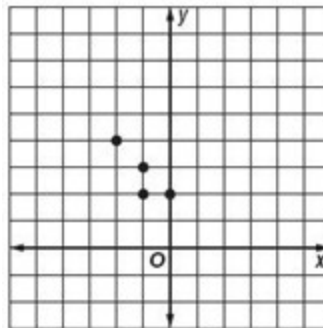
61. $\{(-2, 4), (-1, 3), (0, 2), (-1, 2)\}$

SOLUTION:

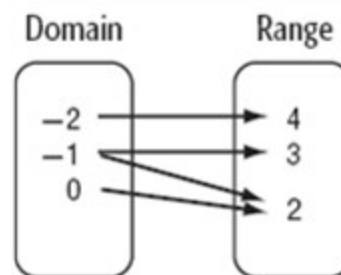
Table: Place the x -coordinates into the first column of the table. Place the corresponding y -coordinates in the second column of the table.

x	y
-2	4
-1	3
0	2
-1	2

Graph: Graph each ordered pair on a coordinate plane.



Mapping: List the x -values in the domain and the y -values in the range. Draw arrows from the x -values in the domain to the corresponding y -values in the range.



The domain is $\{-2, -1, 0\}$, and the range is $\{2, 3, 4\}$.

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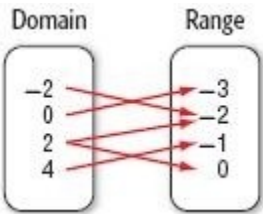
Express the relation shown in each table, mapping, or graph as a set of ordered pairs.

x	y
5	3
3	-1
1	2
-1	0

62.

SOLUTION:

To express the relation as a set of ordered pairs, write the x -coordinates followed by the corresponding y -coordinates. So, the ordered pairs are $\{(5, 3), (3, -1), (1, 2), (-1, 0)\}$.



63.

SOLUTION:

To express the relation as a set of ordered pairs, write the values in the domain as the x -coordinates and the corresponding range values as the y -coordinates. So, the ordered pairs are $\{(-2, -2), (0, -3), (2, -2), (2, 0), (4, -1)\}$.

64. **GARDENING** On average, 7 plants grow for every 10 seeds of a certain type planted. Make a table to show the relation between seeds planted and plants growing for 50, 100, 150, and 200 seeds. Then state the domain and range and graph the relation.

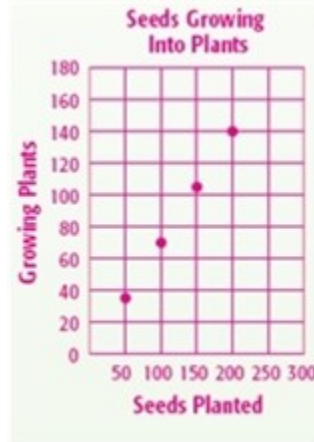
SOLUTION:

To find the number of plants that grow for a certain number of seeds, divide the number of seeds by 10 and then multiply by 7.

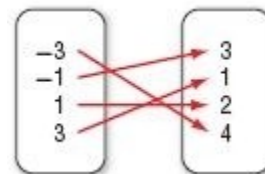
Planted	Growing
50	$50 \div 10 \times 7 = 35$
100	$100 \div 10 \times 7 = 70$
150	$150 \div 10 \times 7 = 105$
200	$200 \div 10 \times 7 = 140$

The domain is the number of seeds planted, $\{50, 100, 150, 200\}$. The range is the number of plants growing, $\{35, 70, 105, 140\}$.

Graph the number of seeds planted on the x -axis and the number of plants growing on the y -axis. Then, graph the ordered pairs from the table.



Determine whether each relation is a function.

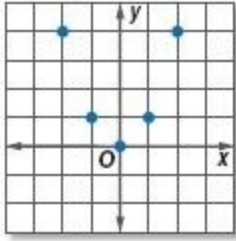


65.

SOLUTION:

A function is a relationship between input and output. In a function, there is exactly one output for each input. So, this relation is a function.

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66.

SOLUTION:

A function is a relationship between input and output. In a function, there is exactly one output for each input. So, this relation is a function.

67. $\{(8, 4), (6, 3), (4, 2), (2, 1), (6, 0)\}$

SOLUTION:

A function is a relationship between input and output. In a function, there is exactly one output for each input. For this function the x value of 6 has two different y outputs: 3 and 0, so it is not a function.

If $f(x) = 2x + 4$ and $g(x) = x^2 - 3$, find each value.

68. $f(-3)$

SOLUTION:

$$f(x) = 2(x) + 4 \quad \text{Original equation}$$

$$f(-3) = 2(-3) + 4 \quad \text{Replace } x \text{ with } -3.$$

$$= -6 + 4 \quad \text{Multiply.}$$

$$= -2 \quad \text{Add.}$$

69. $g(2)$

SOLUTION:

$$g(x) = x^2 - 3 \quad \text{Original equation}$$

$$g(2) = 2^2 - 3 \quad \text{Replace } x \text{ with } 2.$$

$$= 4 - 3 \quad \text{Evaluate powers.}$$

$$= 1 \quad \text{Subtract.}$$

70. $f(0)$

SOLUTION:

$$f(x) = 2(x) + 4 \quad \text{Original equation}$$

$$f(0) = 2(0) + 4 \quad \text{Replace } x \text{ with } 0.$$

$$= 0 + 4 \quad \text{Multiply.}$$

$$= 4 \quad \text{Add.}$$

71. $g(-4)$

SOLUTION:

$$g(x) = (x)^2 - 3 \quad \text{Original equation}$$

$$g(-4) = (-4)^2 - 3 \quad \text{Replace } x \text{ with } -4.$$

$$= 16 - 3 \quad \text{Evaluate powers.}$$

$$= 13 \quad \text{Subtract.}$$

72. $f(m+2)$

SOLUTION:

$$f(x) = 2x + 4 \quad \text{Original equation}$$

$$f(m+2) = 2(m+2) + 4 \quad \text{Replace } x \text{ with } m+2.$$

$$= 2m + 4 + 4 \quad \text{Distributive Property}$$

$$= 2m + 8 \quad \text{Add.}$$

73. $g(3p)$

SOLUTION:

$$g(x) = x^2 - 3 \quad \text{Original equation}$$

$$g(3p) = (3p)^2 - 3 \quad \text{Replace } x \text{ with } 3p.$$

$$= 9p^2 - 3 \quad \text{Evaluate powers.}$$

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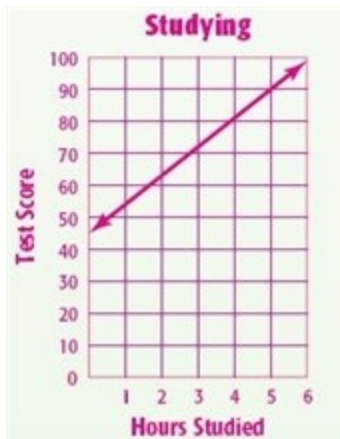
74. **GRADES** A teacher claims that the relationship between number of hours studied for a test and test score can be described by $g(x) = 45 + 9x$, where x represents the number of hours studied. Graph this function.

SOLUTION:

To graph the function, first make a table of values.

x	$g(x) = 45 + 9x$
1	$g(1) = 45 + 9(1) = 54$
2	$g(2) = 45 + 9(2) = 63$
3	$g(3) = 45 + 9(3) = 72$
4	$g(4) = 45 + 9(4) = 81$
5	$g(5) = 45 + 9(5) = 90$

Graph the hours studied, x , on the x -axis and the test scores, $g(x)$, on the y -axis. Then, graph the ordered pairs in the table. Draw a line through the points.



75. Identify the function graphed as linear or nonlinear. Then estimate and interpret the intercepts of the graph, any symmetry, where the function is positive, negative, increasing, and decreasing, the x -coordinate of any relative extrema, and the end behavior of the graph.

SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.

y-Intercept: The graph intersects the y -axis at about $(0, 56)$, so the y -intercept is about 5.6. This means that about 56,000 U.S. patents were granted in 1980.

x-Intercept: The graph does not intersect the x -axis, so there is no x -intercept. This means that in no year were 0 patents granted.

Symmetry: The graph has no line symmetry.

Positive/Negative: The function is positive for all values of x , so the number of patents will always have a positive value.

Increasing/Decreasing: The function is increasing for all values of x .

Extrema: The y -intercept is a relative minimum, so the number of patents granted was at its lowest in 1980.

End Behavior: As x increases, y increases. As x decreases, y decreases.