

# CHAPTER 2 UNDERSTANDING VARIABLES AND SOLVING EQUATIONS

## 2.1 Introduction to Variables

### 2.1 Margin Exercises

- The expression is  $c + 15$ .  
The variable  $c$  represents the class limit.  
The constant is 15.
- (a) Evaluate the expression  $c + 3$  when  $c$  is 25.  
 $c + 3$  Replace  $c$  with 25.  
 $25 + 3$   
28 books must be ordered.  
(b) Evaluate the expression  $c + 3$  when  $c$  is 60.  
 $c + 3$  Replace  $c$  with 60.  
 $60 + 3$   
63 books must be ordered.
- (a) Evaluate the expression  $4s$  when  $s$  is 3 feet.  
 $4s$  Replace  $s$  with 3 feet.  
 $4 \cdot 3$  feet  
12 feet  
The perimeter of the square table is 12 feet.  
(b) Evaluate the expression  $4s$  when  $s$  is 7 miles.  
 $4s$  Replace  $s$  with 7 miles.  
 $4 \cdot 7$  miles  
28 miles  
The perimeter of the square park is 28 miles.
- Evaluate the expression  $100 + \frac{a}{2}$  when  $a$  is 40.  
 $100 + \frac{a}{2}$  Replace  $a$  with 40.  
 $100 + \frac{40}{2}$  Divide.  
 $100 + 20$  Add.  
120  
The approximate systolic blood pressure is 120.
- (a) Evaluate the expression  $\frac{t}{g}$  when  $t$  is 532 and  $g$  is 4.  
 $\frac{t}{g}$  Replace  $t$  with 532 and  $g$  with 4.  
 $\frac{532}{4}$  Divide.  
133  
The average score is 133.

Value of $x$	Value of $y$	Expression $x - y$
100	5	$100 - 5$ is 95
3	7	$3 - 7$ is $-4$
8	0	$8 - 0$ is 8

- (a) Multiplying any number  $a$  by 0 gives a product of 0.  
 $a \cdot 0 = 0$  or  $0 \cdot a = 0$   
(b) Changing the grouping of addends ( $a, b, c$ ) does not change the sum.  
 $(a + b) + c = a + (b + c)$
- (a)  $x^5$  can be written as  $x \cdot x \cdot x \cdot x \cdot x$   
(b)  $4a^2b^2$  can be written as  $4 \cdot a \cdot a \cdot b \cdot b$   
(c)  $-10xy^3$  can be written as  $-10 \cdot x \cdot y \cdot y \cdot y$   
(d)  $s^4tu^2$  can be written as  $s \cdot s \cdot s \cdot s \cdot t \cdot u \cdot u$
- (a)  $y^3$  means  
 $y \cdot y \cdot y$  Replace  $y$  with  $-5$ .  
 $\underbrace{-5 \cdot -5 \cdot -5}_{25 \cdot -5}$  Multiply left to right.  
 $-125$
- (b)  $r^2s^2$  means  
 $r \cdot r \cdot s \cdot s$  Replace  $r$  with 6 and  $s$  with 3.  
 $\underbrace{6 \cdot 6 \cdot 3 \cdot 3}_{36 \cdot 3 \cdot 3}$  Multiply left to right.  
 $\underbrace{108 \cdot 3}_{324}$
- (c)  $10xy^2$  means  
 $10 \cdot x \cdot y \cdot y$  Replace  $x$  with 4 and  $y$  with  $-3$ .  
 $\underbrace{10 \cdot 4 \cdot -3 \cdot -3}_{40 \cdot -3 \cdot -3}$  Multiply left to right.  
 $\underbrace{-120 \cdot -3}_{360}$
- (d)  $-3c^4$  means  
 $-3 \cdot c \cdot c \cdot c \cdot c$  Replace  $c$  with 2.  
 $\underbrace{-3 \cdot 2 \cdot 2 \cdot 2 \cdot 2}_{-6 \cdot 2 \cdot 2 \cdot 2}$  Multiply left to right.  
 $\underbrace{-12 \cdot 2 \cdot 2}_{-24 \cdot 2}$   
 $-48$

### 2.1 Section Exercises

- $c + 4$   $c$  is the variable.  
4 is the constant.

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2.  $d + 6$   $d$  is the variable.  
6 is the constant.
3.  $-3 + m$   $m$  is the variable.  
 $-3$  is the constant.
4.  $-4 + n$   $n$  is the variable.  
 $-4$  is the constant.
5.  $5h$   $h$  is the variable.  
5 is the coefficient.
6.  $3s$   $s$  is the variable.  
3 is the coefficient.
7.  $2c - 10$   $c$  is the variable.  
2 is the coefficient.  
10 is the constant.
8.  $6b - 1$   $b$  is the variable.  
6 is the coefficient.  
1 is the constant.
9.  $x - y$  Both  $x$  and  $y$  are variables.
10.  $xy$  Both  $x$  and  $y$  are variables.
11.  $-6g + 9$   $g$  is the variable.  
 $-6$  is the coefficient.  
9 is the constant.
12.  $-10k + 15$   $k$  is the variable.  
 $-10$  is the coefficient.  
15 is the constant.
13. Expression (rule) for ordering robes:  $g + 10$   
(a) Evaluate the expression when there are 654 graduates.  
 $g + 10$  Replace  $g$  with 654.  
 $\underline{654 + 10}$  Follow the rule and add.  
664 robes must be ordered.  
(b) Evaluate the expression when there are 208 graduates.  
 $g + 10$  Replace  $g$  with 208.  
 $\underline{208 + 10}$  Follow the rule and add.  
218 robes must be ordered.  
(c) Evaluate the expression when there are 95 graduates.  
 $g + 10$  Replace  $g$  with 95.  
 $\underline{95 + 10}$  Follow the rule and add.  
105 robes must be ordered.
14. Expression (rule) for degrees:  $c + 37$   
(a)  $45 + 37$  is 82 degrees.  
(b)  $33 + 37$  is 70 degrees.
- (c)  $58 + 37$  is 95 degrees.
15. Expression (rule) for finding perimeter of equilateral triangle of side length  $s$ :  $3s$   
(a) Evaluate the expression when  $s$ , the side length, is 11 inches.  
 $3s$  Replace  $s$  with 11.  
 $\underline{3 \cdot 11}$  Follow the rule and multiply.  
33 inches is the perimeter.  
(b) Evaluate the expression when  $s$ , the side length, is 3 feet.  
 $3s$  Replace  $s$  with 3.  
 $\underline{3 \cdot 3}$  Follow the rule and multiply.  
9 feet is the perimeter.
16. Expression (rule) for perimeter:  $5s$   
(a)  $5 \cdot 25$  meters is 125 meters.  
(b)  $5 \cdot 8$  inches is 40 inches.
17. Expression (rule) for ordering brushes:  $3c - 5$   
(a) Evaluate the expression when  $c$ , the class size, is 12.  
 $3c - 5$  Replace  $c$  with 12.  
 $\underline{3 \cdot 12} - 5$  Multiply before subtracting.  
 $\underline{36 - 5}$   
31 brushes must be ordered.  
(b) Evaluate the expression when  $c$ , the class size, is 16.  
 $3c - 5$  Replace  $c$  with 16.  
 $\underline{3 \cdot 16} - 5$  Multiply before subtracting.  
 $\underline{48 - 5}$   
43 brushes must be ordered.
18. Expression (rule) for doughnuts:  $2n - 4$   
(a)  $2 \cdot 13 - 4$  is 22 doughnuts.  
(b)  $2 \cdot 18 - 4$  is 32 doughnuts.
19. Expression (rule) for average test score, where  $p$  is the total points and  $t$  is the number of tests:  $p/t$   
(a) Evaluate the expression when  $p$ , the total points, is 332 and  $t$ , the number of tests, is 4.  
 $\frac{p}{t}$  Replace  $p$  with 332 and  $t$  with 4.  
 $\frac{332}{4}$  Follow the rule and divide.  
83 points is the average test score.

(b) Evaluate the expression when  $p$ , the total points, is 637 and  $t$ , the number of tests, is 7.

$\frac{p}{t}$  Replace  $p$  with 637 and  $t$  with 7.

$\frac{637}{7}$  Follow the rule and divide.

91 points is the average test score.

20. Expression (rule) for buses:  $\frac{p}{b}$

(a)  $\frac{176}{44}$  is 4 buses.

(b)  $\frac{72}{36}$  is 2 buses.

21.

Value of $x$	Expression $x + x + x + x$	Expression $4x$
12	$12 + 12 + 12 + 12$ is 48	$4 \cdot 12$ is 48
0	$0 + 0 + 0 + 0$ is 0	$4 \cdot 0$ is 0
-5	$-5 + -5 + -5 + -5$ is -20	$4 \cdot -5$ is -20

22.

Value of $y$	Expression $3y$	Expression $y + 2y$
10	$3(10)$ is 30	$10 + 2(10)$ is $10 + 20$ , or 30
-3	$3(-3)$ is -9	$-3 + 2(-3)$ is $-3 + -6$ , or -9
0	$3(0) = 0$	$0 + 2(0)$ is $0 + 0$ , or 0

23.

Value of $x$	Value of $y$	Expression $-2x + y$
-4	5	$-2(-4) + 5$ is $8 + 5$ , or 13
-6	-2	$-2(-6) + -2$ is $12 + -2$ , or 10
0	-8	$-2(0) + -8$ is $0 + -8$ , or -8

24.

Value of $x$	Value of $y$	Expression $-2xy$
-4	5	$-2 \cdot -4 \cdot 5$ is 40
-6	-2	$-2 \cdot -6 \cdot -2$ is -24
0	-8	$-2 \cdot 0 \cdot -8$ is 0

25. A variable is a letter that represents the part of a rule that varies or changes depending on the situation. An expression expresses, or tells, the rule for doing something. For example,  $c + 5$  is an expression, and  $c$  is the variable.

26. The number part in a multiplication expression is the coefficient. For example, 4 is the coefficient in  $4s$ . A constant is a number that is added or subtracted in an expression. It does not vary. For example, 5 is the constant in  $c + 5$ .

27. Let  $b$  represent "a number." Multiplying a number by 1 leaves the number unchanged.

$$b \cdot 1 = b \quad \text{or} \quad 1 \cdot b = b$$

28. Adding 0 to any number leaves the number unchanged.

$$b + 0 = b \quad \text{or} \quad 0 + b = b$$

29. Let  $b$  represent "any number." Any number divided by 0 is undefined.

$$\frac{b}{0} \text{ is undefined} \quad \text{or} \quad b \div 0 \text{ is undefined.}$$

30. Multiplication distributes over addition.

$$a(b + c) = a \cdot b + a \cdot c$$

31.  $c^6$  written without exponents is

$$c \cdot c \cdot c \cdot c \cdot c \cdot c$$

32.  $d^7$  is  $d \cdot d \cdot d \cdot d \cdot d \cdot d \cdot d$

33.  $x^4y^3$  written without exponents is

$$x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y$$

34.  $c^2d^5$  is  $c \cdot c \cdot d \cdot d \cdot d \cdot d \cdot d$

35.  $-3a^3b$  can be written as  $-3 \cdot a \cdot a \cdot a \cdot b$ .  
The exponent 3 applies only to the base  $a$ .

36.  $-8m^2n$  is  $-8 \cdot m \cdot m \cdot n$

37.  $9xy^2$  can be written as  $9 \cdot x \cdot y \cdot y$ .  
The exponent 2 applies only to the base  $y$ .

38.  $5ab^4$  is  $5 \cdot a \cdot b \cdot b \cdot b \cdot b$

39.  $-2c^5d$  can be written as  $-2 \cdot c \cdot c \cdot c \cdot c \cdot c \cdot d$ .  
The exponent 5 applies only to the base  $c$ .

40.  $-4x^3y$  is  $-4 \cdot x \cdot x \cdot x \cdot y$

41.  $a^3bc^2$  can be written as  $a \cdot a \cdot a \cdot b \cdot c \cdot c$ .  
The exponent 3 applies only to the base  $a$ .  
The exponent 2 applies only to the base  $c$ .

42.  $x^2yz^6$  is  $x \cdot x \cdot y \cdot z \cdot z \cdot z \cdot z \cdot z \cdot z$

43. Evaluate  $t^2$  when  $t$  is -4.

$t^2$  means

$t \cdot t$  Replace  $t$  with -4.

$\underbrace{-4 \cdot -4}$  Multiply.

$$16$$

44.  $r^2 = r \cdot r$

Replace  $r$  with -3.

$$-3 \cdot -3 = 9$$

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45. Evaluate  $rs^3$  when  $r$  is  $-3$  and  $s$  is  $2$ .

$rs^3$  means  
 $r \cdot s \cdot s \cdot s$  Replace  $r$  with  $-3$  and  $s$  with  $2$ .  
 $\underbrace{-3 \cdot 2 \cdot 2 \cdot 2}_{-6 \cdot 2 \cdot 2}$  Multiply left to right.  
 $\underbrace{-12 \cdot 2}_{-24}$

46.  $s^4t = s \cdot s \cdot s \cdot s \cdot t$   
 Replace  $s$  with  $2$  and  $t$  with  $-4$ .  
 $2 \cdot 2 \cdot 2 \cdot 2 \cdot -4 = -64$

47. Evaluate  $3rs$  when  $r$  is  $-3$  and  $s$  is  $2$ .

$3rs$  means  
 $3 \cdot r \cdot s$  Replace  $r$  with  $-3$  and  $s$  with  $2$ .  
 $\underbrace{3 \cdot -3 \cdot 2}_{-9 \cdot 2}$  Multiply left to right.  
 $-18$

48.  $6st$   
 Replace  $s$  with  $2$  and  $t$  with  $-4$ .  
 $6 \cdot 2 \cdot -4 = -48$

49. Evaluate  $-2s^2t^2$  when  $s$  is  $2$  and  $t$  is  $-4$ .

$-2s^2t^2$  means  
 $-2 \cdot s \cdot s \cdot t \cdot t$  Replace  $s$  with  $2$  and  $t$  with  $-4$ .  
 $\underbrace{-2 \cdot 2 \cdot 2 \cdot -4 \cdot -4}_{-4 \cdot 2 \cdot -4 \cdot -4}$  Multiply left to right.  
 $\underbrace{-8 \cdot -4 \cdot -4}_{32 \cdot -4}$   
 $-128$

50.  $-4rs^4 = -4 \cdot r \cdot s \cdot s \cdot s \cdot s$   
 Replace  $r$  with  $-3$  and  $s$  with  $2$ .  
 $-4 \cdot -3 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 192$

51. Evaluate  $r^2s^5t^3$  when  $r$  is  $-3$ ,  $s$  is  $2$ , and  $t$  is  $-4$ , using a calculator.

$r^2s^5t^3$  Replace  $r$  with  $-3$ ,  $s$  with  $2$ , and  $t$  with  $-4$ .  
 $\underbrace{(-3)^2(2)^5(-4)^3}_{(9)(32)(-64)}$  Use the  $y^x$  key.  
 $\underbrace{(288)(-64)}_{-18,432}$  Multiply left to right.

52.  $r^3s^4t^2$  Use a calculator.  
 Replace  $r$  with  $-3$ ,  $s$  with  $2$ , and  $t$  with  $-4$ .  
 $(-3)^3(2)^4(-4)^2 = (-27)(16)(16) = -6912$

53. Evaluate  $-10r^5s^7$  when  $r$  is  $-3$  and  $s$  is  $2$ , using a calculator.

$-10r^5s^7$  Replace  $r$  with  $-3$  and  $s$  with  $2$ .  
 $-10 \underbrace{(-3)^5}_{(-243)} \underbrace{(2)^7}_{(128)}$  Use the  $y^x$  key.  
 $\underbrace{-10(-243)(128)}_{2430(128)}$  Multiply left to right.  
 $311,040$

54.  $-5s^6t^5$  Use a calculator.  
 Replace  $s$  with  $2$  and  $t$  with  $-4$ .  
 $-5(2)^6(-4)^5 = -5(64)(-1024) = 327,680$

55. Evaluate  $|xy| + |xyz|$  when  $x$  is  $4$ ,  $y$  is  $-2$ , and  $z$  is  $-6$ .

$|xy| + |xyz|$  Replace  $x$  with  $4$ ,  $y$  with  $-2$ , and  $z$  with  $-6$ .  
 $\underbrace{|4 \cdot -2|}_{|8|} + \underbrace{|4 \cdot -2 \cdot -6|}_{|-8 \cdot -6|}$  Multiply left to right within the absolute value signs.  
 $|8| + |48|$  Evaluate the absolute values.  
 $\underbrace{8 + 48}_{56}$  Add.

56.  $x + |y^2| + |xz| = x + |y \cdot y| + |x \cdot z|$   
 Replace  $x$  with  $4$ ,  $y$  with  $-2$ , and  $z$  with  $-6$ .  
 $4 + |-2 \cdot -2| + |4 \cdot -6| = 4 + |4| + |-24|$   
 $= 4 + 4 + 24$   
 $= 32$

57. Evaluate  $\frac{z^2}{-3y + z}$  when  $z$  is  $-6$  and  $y$  is  $-2$ .

$\frac{z^2}{-3y + z}$  Replace  $z$  with  $-6$  and  $y$  with  $-2$ .  
 $\frac{(-6)^2}{-3(-2) + -6}$  Follow the order of operations.  
 $\frac{36}{0}$  Numerator:  $(-6)^2 = -6 \cdot -6 = 36$   
 Denominator:  $-3(-2) + -6 = 6 + -6$   
 Undefined Division by 0 is undefined.

58.  $\frac{y^2}{x + 2y} = \frac{y \cdot y}{x + 2 \cdot y}$  Replace  $x$  with  $4$ , and  $y$  with  $-2$ .

$= \frac{-2 \cdot -2}{4 + 2 \cdot -2}$   
 $= \frac{4}{4 + -4}$   
 $= \frac{4}{0}$ , which is undefined.

59. (a) Evaluate  $\frac{s}{5}$  when  $s$  is 15 seconds.

$\frac{s}{5}$  Replace  $s$  with 15.

$\frac{15}{5}$  Divide.

3 miles

- (b) Evaluate  $\frac{s}{5}$  when  $s$  is 10 seconds.

$\frac{s}{5}$  Replace  $s$  with 10.

$\frac{10}{5}$  Divide.

2 miles

- (c) Evaluate  $\frac{s}{5}$  when  $s$  is 5 seconds.

$\frac{s}{5}$  Replace  $s$  with 5.

$\frac{5}{5}$  Divide.

1 mile

60. (a) Using part (c) of Exercise 59, the distance covered in  $2\frac{1}{2}$  seconds is half of the distance covered in 5 seconds, or  $\frac{1}{2}$  mile.

(b) Using part (a) of Exercise 59, the time to cover  $1\frac{1}{2}$  miles is half the time to cover 3 miles, or  $7\frac{1}{2}$  seconds. Or, using parts (b) and (c), find the number halfway between 5 seconds and 10 seconds

(c) Using parts (a) and (b) of Exercise 59, find the number halfway between 10 seconds and 15 seconds; that is  $12\frac{1}{2}$  seconds.

## 2.2 Simplifying Expressions

### 2.2 Margin Exercises

1. (a)  $3b^2 + -3b + 3 + b^3 + b$

The like terms are  $-3b$  and  $b$  since the variable parts match; both are  $b$ .

The coefficients are  $-3$  and  $1$ .

- (b)  $-4xy + 4x^2y + -4xy^2 + -4 + 4$

The like terms are the constants,  $-4$  and  $4$ . There are no variable parts.

- (c)  $5r^2 + 2r + -2r^2 + 5 + 5r^3$

The like terms are  $5r^2$  and  $-2r^2$  since the variable parts match; both are  $r^2$ .

The coefficients are  $5$  and  $-2$ .

- (d)  $-10 + -x + -10x + -x^2 + -10y$

The like terms are  $-x$  and  $-10x$  since the variable parts match; both are  $x$ .

The coefficients are  $-1$  and  $-10$ .

2. (a)  $10b + 4b + 10b$  These are like terms.  
 $(10 + 4 + 10)b$  Add the coefficients.  
 $24b$  The variable part,  $b$ , stays the same.

- (b)  $y^3 + 8y^3$  These are like terms.  
 $1y^3 + 8y^3$  Rewrite  $y^3$  as  $1y^3$ .  
 $(1 + 8)y^3$  Add the coefficients.  
 $9y^3$  The variable part,  $y^3$ , stays the same.

- (c)  $-7n - n$  These are like terms.  
 $-7n - 1n$  Rewrite  $n$  as  $1n$ .  
 $-7n + -1n$  Change to addition.  
 $(-7 + -1)n$  Add the coefficients.  
 $-8n$  The variable part,  $n$ , stays the same.

- (d)  $3c - 5c - 4c$  These are like terms.  
 $3c + -5c + -4c$  Change to addition.  
 $(3 + -5 + -4)c$  Add the coefficients.  
 $-6c$  The variable part,  $c$ , stays the same.

- (e)  $-9xy + xy$  These are like terms.  
 $-9xy + 1xy$  Rewrite  $xy$  as  $1xy$ .  
 $(-9 + 1)xy$  Add the coefficients.  
 $-8xy$  The variable part,  $xy$ , stays the same.

- (f)  $-4p^2 - 3p^2 + 8p^2$  These are like terms.  
 $-4p^2 + -3p^2 + 8p^2$  Change to addition.  
 $(-4 + -3 + 8)p^2$  Add the coefficients.  
 $1p^2$  or  $p^2$  The variable part,  $p^2$ , stays the same.

- (g)  $ab - ab$  These are like terms.  
 $1ab - 1ab$  Rewrite  $ab$  as  $1ab$ .  
 $1ab + -1ab$  Change to addition.  
 $(1 + -1)ab$  Add the coefficients.  
 $0ab$  Zero times anything is zero.  
 $0$

3. (a)  $3b^2 + 4d^2 + 7b^2$  Rewrite using the commutative property.  
 $3b^2 + 7b^2 + 4d^2$  Combine  $3b^2 + 7b^2$ .  
 $(3 + 7)b^2 + 4d^2$  Add the coefficients.  
 $10b^2 + 4d^2$

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(b)  $4a + b - 6a + b$  Change to addition.  
 $4a + b + ^{-}6a + b$  Rewrite using the commutative property.  
 $4a + ^{-}6a + b + b$  Rewrite  $b$  as  $1b$ .  
 $4a + ^{-}6a + 1b + 1b$   
 $(4 + ^{-}6)a + (1 + 1)b$  Add the coefficients of like terms.  
 $^{-}2a + 2b$

(c)  $^{-}6x + 5 + 6x + 2$  Rewrite using the commutative property.  
 $^{-}6x + 6x + 5 + 2$  Add the coefficients of like terms.  
 $(^{-}6 + 6)x + (5 + 2)$   
 $0x + 7$  Zero times anything is zero.  
 $0 + 7$   
 $7$

(d)  $2y - 7 - y + 7$  Change to addition.  
 $2y + ^{-}7 + ^{-}y + 7$  Rewrite  $^{-}y$  as  $^{-}1y$ .  
 $2y + ^{-}7 + ^{-}1y + 7$  Rewrite using the commutative property.  
 $2y + ^{-}1y + ^{-}7 + 7$  Add the coefficients of like terms.  
 $(2 + ^{-}1)y + (^{-}7 + 7)$   
 $1y + 0$   
 $1y$  or  $y$

(e)  $^{-}3x - 5 + 12 + 10x$  Change to addition.  
 $^{-}3x + ^{-}5 + 12 + 10x$  Rewrite using the commutative property.  
 $^{-}3x + 10x + ^{-}5 + 12$  Add the coefficients of like terms.  
 $(^{-}3 + 10)x + (^{-}5 + 12)$   
 $7x + 7$

4. (a)  $7(4c)$  can be written as  
 $(7 \cdot 4) \cdot c$   
 $28 \cdot c$   
 $28c$

(b)  $^{-}3(5y^3)$  can be written as  
 $(^{-}3 \cdot 5) \cdot y^3$   
 $^{-}15 \cdot y^3$   
 $^{-}15y^3$

(c)  $20(^{-}2a)$  can be written as  
 $(20 \cdot ^{-}2) \cdot a$   
 $^{-}40 \cdot a$   
 $^{-}40a$

(d)  $^{-}10(^{-}x)$  Rewrite  $^{-}x$  as  $^{-}1x$ .  
 $^{-}10(^{-}1x)$  can be written as  
 $(^{-}10 \cdot ^{-}1) \cdot x$   
 $10 \cdot x$   
 $10x$

5. (a)  $7(a + 10)$  can be written as  
 $7 \cdot a + 7 \cdot 10$   
 $7a + 70$

(b)  $3(x - 3)$  can be written as  
 $3 \cdot x - 3 \cdot 3$   
 $3x - 9$

(c)  $4(2y + 6)$  can be written as  
 $4 \cdot 2y + 4 \cdot 6$   
 $4 \cdot 2 \cdot y + 24$   
 $8 \cdot y + 24$   
 $8y + 24$

(d)  $^{-}5(3b + 2)$   
 $^{-}5 \cdot 3b + ^{-}5 \cdot 2$   
 $^{-}15b + ^{-}10$  Change addition to subtraction.  
 $^{-}15b - 10$

(e)  $^{-}8(c + 4)$   
 $^{-}8 \cdot c + ^{-}8 \cdot 4$   
 $^{-}8c + ^{-}32$  Change addition to subtraction.  
 $^{-}8c - 32$

6. (a)  $^{-}4 + 5(y + 1)$  Distributive property  
 $^{-}4 + 5 \cdot y + 5 \cdot 1$   
 $^{-}4 + 5y + 5$  Rewrite using the commutative property.  
 $^{-}4 + 5 + 5y$  Combine constants.  
 $1 + 5y$  or  $5y + 1$

(b)  $2(3w + 4) - 5$  Distributive property  
 $2 \cdot 3w + 2 \cdot 4 - 5$  Multiply.  
 $6w + 8 - 5$  Combine constants.  
 $6w + 3$

(c)  $5(6x - 2) + 3x$  Distributive property  
 $5 \cdot 6x - 5 \cdot 2 + 3x$   
 $30x - 10 + 3x$  Change to addition.  
 $30x + ^{-}10 + 3x$  Rewrite using the commutative property.  
 $30x + 3x + ^{-}10$   
 $(30 + 3)x + ^{-}10$  Add the coefficients of like terms.  
 $33x + ^{-}10$  or  $33x - 10$

(d)  $21 + 7(a^2 - 3)$  Distributive property  
 $21 + 7 \cdot a^2 - \underbrace{7 \cdot 3}$   
 $21 + 7a^2 - 21$  Change to addition.  
 $21 + 7a^2 + ^{-}21$  Rewrite using the commutative property.  
 $\underbrace{21 + ^{-}21} + 7a^2$  Combine constants.  
 $\underbrace{0 + 7a^2}_{7a^2}$

(e)  $^{-}y + 3(2y + 5) - 18$  Distributive property  
 $^{-}y + \underbrace{3 \cdot 2y} + \underbrace{3 \cdot 5} - 18$  Rewrite  $^{-}y$  as  $^{-}1y$ .  
 $^{-}1y + 6y + 15 + ^{-}18$  Change to addition.  
 $\underbrace{(-1 + 6)}y + (15 + ^{-}18)$  Add the coefficients of like terms.  
 $5y + ^{-}3$  or  $5y - 3$

## 2.2 Section Exercises

- $2b^2$  and  $b^2$  are the only like terms in the expression. The variable parts match; both are  $b^2$ . The coefficients are 2 and 1.
- $x^3$  and  $2x^3$  are like terms. The coefficients are 1 and 2.
- $^{-}xy$  and  $2xy$  are the like terms in the expression. The variable parts match; both are  $xy$ . The coefficients are  $^{-}1$  and 2.
- $^{-}a^2b$  and  $^{-}3a^2b$  are like terms. The coefficients are  $^{-}1$  and  $^{-}3$ .
- 7, 3, and  $^{-}4$  are like terms. There are no variable parts; constants are considered like terms.
- $^{-}5$ , 1, and 4 are like terms. There are no variable parts; constants are considered like terms.
- $6r + 6r$  These are like terms.  
Add the coefficients.  
 $(6 + 6)r$   
 $12r$  The variable part,  $r$ , stays the same.
- $4t + 10t = (4 + 10)t$   
 $= 14t$
- $x^2 + 5x^2$  These are like terms.  
Rewrite  $x^2$  as  $1x^2$ .  
 $1x^2 + 5x^2$  Add the coefficients.  
 $(1 + 5)x^2$   
 $6x^2$  The variable part,  $x^2$ , stays the same.
- $9y^3 + y^3 = 9y^3 + 1y^3$   
 $= (9 + 1)y^3$   
 $= 10y^3$

11.  $p - 5p$  These are like terms.  
Rewrite  $p$  as  $1p$ .  
 $1p - 5p$  Change to addition.  
 $1p + ^{-}5p$  Add the coefficients.  
 $(1 + ^{-}5)p$   
 $^{-}4p$  The variable part,  $p$ , stays the same.

12.  $n - 3n = 1n + ^{-}3n$   
 $= (1 + ^{-}3)n$   
 $= ^{-}2n$

13.  $^{-}2a^3 - a^3$  These are like terms.  
Rewrite  $a^3$  as  $1a^3$ .  
 $^{-}2a^3 - 1a^3$  Change to addition.  
 $^{-}2a^3 + ^{-}1a^3$  Add the coefficients.  
 $(^{-}2 + ^{-}1)a^3$   
 $^{-}3a^3$  The variable part,  $a^3$ , stays the same.

14.  $^{-}10x^2 - x^2 = ^{-}10x^2 - 1x^2$   
 $= ^{-}10x^2 + ^{-}1x^2$   
 $= (^{-}10 + ^{-}1)x^2$   
 $= ^{-}11x^2$

15.  $\underbrace{c - c}$   
 $0$  Any number minus itself is 0.

16.  $\underbrace{b^2 - b^2}$   
 $0$  Any number minus itself is 0.

17.  $9xy + xy - 9xy$  These are like terms.  
Rewrite  $xy$  as  $1xy$ .  
 $9xy + 1xy - 9xy$  Change to addition.  
 $9xy + 1xy + ^{-}9xy$  Add the coefficients.  
 $(9 + 1 + ^{-}9)xy$   
 $1xy$  or  $xy$  The variable part,  $xy$ , stays the same.

18.  $r^2s - 7r^2s + 7r^2s = 1r^2s + ^{-}7r^2s + 7r^2s$   
 $= (1 + ^{-}7 + 7)r^2s$   
 $= 1r^2s$  or  $r^2s$

19.  $5t^4 + 7t^4 - 6t^4$  These are like terms.  
Change to addition.  
 $5t^4 + 7t^4 + ^{-}6t^4$  Add the coefficients.  
 $(5 + 7 + ^{-}6)t^4$   
 $6t^4$  The variable part,  $t^4$ , stays the same.

20.  $10mn - 9mn + 3mn = 10mn + ^{-}9mn + 3mn$   
 $= (10 + ^{-}9 + 3)mn$   
 $= 4mn$

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- 21.**  $y^2 + y^2 + y^2 + y^2$  These are like terms.  
Write in the understood coefficient of 1.  
 $1y^2 + 1y^2 + 1y^2 + 1y^2$   
 $(1 + 1 + 1 + 1)y^2$  Add the coefficients.  
 $4y^2$  The variable part,  $y^2$ , stays the same.
- 22.**  $a + a + a = 1a + 1a + 1a$   
 $= (1 + 1 + 1)a$   
 $= 3a$
- 23.**  $-x - 6x - x$  These are like terms. Rewrite  $-x$  as  $-1x$  and  $x$  as  $1x$ .  
 $-1x - 6x - 1x$  Change to addition.  
 $-1x + -6x + -1x$  Add the coefficients.  
 $(-1 + -6 + -1)x$   
 $-8x$  The variable part,  $x$ , stays the same.
- 24.**  $-y - y - 3y = -1y - 1y - 3y$   
 $= -1y + -1y + -3y$   
 $= (-1 + -1 + -3)y$   
 $= -5y$
- 25.**  $8a + 4b + 4a$  Use the commutative property to rewrite the expression so that like terms are next to each other.  
 $8a + 4a + 4b$  Add the coefficients of like terms.  
 $(8 + 4)a + 4b$   
 $12a + 4b$  The variable part,  $a$ , stays the same.
- 26.**  $6x + 5y + 4y = 6x + (5 + 4)y$   
 $= 6x + 9y$
- 27.**  $6 + 8 + 7rs$  Use the commutative property to put the constants at the end.  
 $7rs + 6 + 8$  Add the coefficients of like terms.  
 $7rs + 14$  The only like terms are constants.
- 28.**  $10 + 2c^2 + 15 = 2c^2 + 10 + 15$   
 $= 2c^2 + 25$
- 29.**  $a + ab^2 + ab^2$  Write in the understood coefficient of 1.  
 $1a + 1ab^2 + 1ab^2$  Add the coefficients of like terms.  
 $1a + (1 + 1)ab^2$   
 $1a + 2ab^2$  The variable part,  $ab^2$ , stays the same.  
or  
 $a + 2ab^2$
- 30.**  $n + mn + n = 1n + 1mn + 1n$   
 $= 1mn + 1n + 1n$   
 $= 1mn + 2n$  or  $mn + 2n$
- 31.**  $6x + y - 8x + y$  Write in the understood coefficients of 1.  
Change to addition.  
 $6x + 1y + -8x + 1y$  Rewrite using the commutative property.  
 $6x + -8x + 1y + 1y$  Add the coefficients of like terms.  
 $(6 + -8)x + (1 + 1)y$   
 $-2x + +2y$   
 $-2x + 2y$
- 32.**  $d + 3c - 7c + 3d = 1d + 3c + -7c + 3d$   
 $= 3c + -7c + 1d + 3d$   
 $= (3 + -7)c + (1 + 3)d$   
 $= -4c + 4d$
- 33.**  $8b^2 - a^2 - b^2 + a^2$  Write in the understood coefficient of 1.  
 $8b^2 - 1a^2 - 1b^2 + 1a^2$  Change to addition.  
 $8b^2 + -1a^2 + -1b^2 + 1a^2$  Rewrite using the commutative property.  
 $8b^2 + -1b^2 + -1a^2 + 1a^2$  Add the coefficients of like terms.  
 $(8 + -1)b^2 + (-1 + 1)a^2$   
 $7b^2 + 0 \cdot a^2$   
 $7b^2 + 0$   
 $7b^2$
- 34.**  $5ab - ab + 3a^2b - 4ab = 5ab + -1ab + 3a^2b + -4ab$   
 $= 5ab + -1ab + -4ab + 3a^2b$   
 $= (5 + -1 + -4)ab + 3a^2b$   
 $= 0ab + 3a^2b$   
 $= 3a^2b$
- 35.**  $-x^3 + 3x - 3x^2 + 2$   
There are no like terms. The expression cannot be simplified.
- 36.**  $a^2b - 2ab - ab^3 + 3a^3b$   
There are no like terms. The expression cannot be simplified.



37.  $-9r + 6t - s - 5r + s + t - 6t + 5s - r$   
Write in the understood coefficient of 1.  
Change to addition.  
 $-9r + 6t + -1s + -5r + 1s + 1t + -6t + 5s + -1r$   
Rewrite using the commutative property.  
 $-9r + -5r + -1r + -1s + 1s + 5s + 6t + 1t + -6t$   
Add the coefficients of like terms.  
$$\underbrace{(-9 + -5 + -1)}_{-15r} r + \underbrace{(-1 + 1 + 5)}_{+5s} s + \underbrace{(6 + 1 + -6)}_{+1t} t$$
  
$$-15r + 5s + t$$
38.  $-x - 3y + 4z + x - z + 5y - 8x - y$   
 $= -1x + -3y + 4z + 1x + -1z + 5y + -8x + -1y$   
 $= -1x + 1x + -8x + -3y + 5y + -1y + 4z + -1z$   
 $= (-1 + 1 + -8)x + (-3 + 5 + -1)y + (4 + -1)z$   
 $= -8x + 1y + 3z$  or  $-8x + y + 3z$
39. By using the associative property, we can write  $3(10a)$  as  
 $(3 \cdot 10) \cdot a = 30 \cdot a = 30a.$   
So,  $3(10a)$  simplifies to  $30a.$
40.  $8(4b) = (8 \cdot 4)b$   
 $= 32b$
41. By using the associative property, we can write  $-4(2x^2)$  as  
 $(-4 \cdot 2) \cdot x^2 = -8 \cdot x^2 = -8x^2.$   
So,  $-4(2x^2)$  simplifies to  $-8x^2.$
42.  $-7(3b^3) = (-7 \cdot 3)b^3$   
 $= -21b^3$
43. By using the associative property, we can write  $5(-4y^3)$  as  
 $(5 \cdot -4) \cdot y^3 = -20 \cdot y^3 = -20y^3.$   
So,  $5(-4y^3)$  simplifies to  $-20y^3.$
44.  $2(-6x) = (2 \cdot -6)x$   
 $= -12x$
45. By using the associative property, we can write  $-9(-2cd)$  as  
 $(-9 \cdot -2) \cdot c \cdot d = 18 \cdot c \cdot d = 18cd.$   
So,  $-9(-2cd)$  simplifies to  $18cd.$
46.  $-6(-4rs) = (-6 \cdot -4)rs$   
 $= 24rs$
47. By using the associative property, we can write  $7(3a^2bc)$  as  
 $(7 \cdot 3) \cdot a^2 \cdot b \cdot c = 21 \cdot a^2 \cdot b \cdot c = 21a^2bc.$   
So,  $7(3a^2bc)$  simplifies to  $21a^2bc.$
48.  $4(2xy^2z^2) = (4 \cdot 2)xy^2z^2$   
 $= 8xy^2z^2$
49.  $-12(-w)$  Write in the understood coefficient of  $-1.$   
 $-12(-1w)$  Rewrite using the associative property.  
 $(-12 \cdot -1)w$   
 $12 \cdot w$   
 $12w$
50.  $-10(-k) = -10(-1k)$   
 $= (-10 \cdot -1)k$   
 $= 10k$
51.  $6(b + 6)$  Distributive property  
 $6 \cdot b + 6 \cdot 6$   
 $6b + 36$
52.  $5(a + 3) = 5 \cdot a + 5 \cdot 3$   
 $= 5a + 15$
53.  $7(x - 1)$  Distributive property  
 $7 \cdot x - 7 \cdot 1$   
 $7x - 7$
54.  $4(y - 4) = 4 \cdot y - 4 \cdot 4$   
 $= 4y - 16$
55.  $3(7t + 1)$  Distributive property  
 $3 \cdot 7t + 3 \cdot 1$   
 $21t + 3$
56.  $8(2c + 5) = 8 \cdot 2c + 8 \cdot 5$   
 $= 16c + 40$
57.  $-2(5r + 3)$  Distributive property  
 $-2 \cdot 5r + -2 \cdot 3$   
 $-10r + -6$  Change addition to subtraction of the opposite.  
 $-10r - 6$
58.  $-5(6z + 2) = -5 \cdot 6z + -5 \cdot 2$   
 $= -30z + -10$   
or  $-30z - 10$
59.  $-9(k + 4)$  Distributive property  
 $-9 \cdot k + -9 \cdot 4$   
 $-9k + -36$  Change addition to subtraction of the opposite.  
 $-9k - 36$
60.  $-3(p + 7) = -3 \cdot p + -3 \cdot 7$   
 $= -3p + -21$   
or  $-3p - 21$
61.  $50(m - 6)$  Distributive property  
 $50 \cdot m - 50 \cdot 6$   
 $50m - 300$

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62.  $25(n - 1) = 25 \cdot n - 25 \cdot 1$   
 $= 25n - 25$

63.  $10 + 2(4y + 3)$  Distributive property  
 $10 + 2 \cdot 4y + 2 \cdot 3$   
 $10 + 8y + 6$  Rewrite using the commutative property.  
 $8y + 10 + 6$  Combine like terms.  
 $8y + 16$

64.  $4 + 7(x^2 + 3) = 4 + 7 \cdot x^2 + 7 \cdot 3$   
 $= 4 + 7x^2 + 21$   
 $= 7x^2 + 25$

65.  $6(a^2 - 2) + 15$  Distributive property  
 $6 \cdot a^2 - 6 \cdot 2 + 15$   
 $6a^2 - 12 + 15$  Combine like terms.  
 $6a^2 + 3$

66.  $5(b - 4) + 25 = 5 \cdot b - 5 \cdot 4 + 25$   
 $= 5b - 20 + 25$   
 $= 5b + -20 + 25$   
 $= 5b + 5$

67.  $2 + 9(m - 4)$  Distributive property  
 $2 + 9 \cdot m - 9 \cdot 4$   
 $2 + 9m - 36$  Change to addition.  
 $2 + 9m + -36$  Rewrite using the commutative property.  
 $9m + 2 + -36$  Add the coefficients of like terms.  
 $9m + -34$  Change addition to subtraction of the opposite.  
 $9m - 34$

68.  $6 + 3(n - 8) = 6 + 3 \cdot n - 3 \cdot 8$   
 $= 6 + 3n - 24$   
 $= 6 + 3n + -24$   
 $= 3n + -18$  or  $3n - 18$

69.  $-5(k + 5) + 5k$  Distributive property  
 $-5 \cdot k + -5 \cdot 5 + 5k$   
 $-5k + -25 + 5k$  Rewrite using the commutative property.  
 $-5k + 5k + -25$  Add the coefficients of like terms.  
 $\underbrace{(-5 + 5)}_0 k + -25$   
 $0k + -25$  Zero times any number is 0.  
 $\underbrace{0 + -25}_{-25}$   
 $-25$  Zero added to any number is the number

70.  $-7(p + 2) + 7p = -7 \cdot p + -7 \cdot 2 + 7p$   
 $= -7p + -14 + 7p$   
 $= 0p + -14$   
 $= 0 + -14$   
 $= -14$

71.  $4(6x - 3) + 12$  Distributive property  
 $4 \cdot 6x - 4 \cdot 3 + 12$   
 $24x - 12 + 12$  Change to addition.  
 $24x + -12 + 12$  Combine like terms. Any number plus its opposite is 0.  
 $24x + 0$   
 $24x$

72.  $6(3y - 3) + 18 = 6 \cdot 3y - 6 \cdot 3 + 18$   
 $= 18y - 18 + 18$   
 $= 18y + -18 + 18$   
 $= 18y$

73.  $5 + 2(3n + 4) - n$  Distributive property  
 $5 + 2 \cdot 3n + 2 \cdot 4 - n$  Rewrite  $n$  as  $1n$ .  
 $5 + 6n + 8 - 1n$  Change to addition.  
 $5 + 6n + 8 + -1n$  Rewrite using the commutative property.  
 $5 + 8 + 6n + -1n$  Add the coefficients of like terms.  
 $(5 + 8) + (6 + -1)n$   
 $13 + 5n$  or  $5n + 13$

74.  $8 + 8(4z + 5) - z = 8 + 8 \cdot 4z + 8 \cdot 5 - 1z$   
 $= 8 + 32z + 40 + -1z$   
 $= 31z + 48$

75.  $-p + 6(2p - 1) + 5$  Distributive property  
 $-p + 6 \cdot 2p - 6 \cdot 1 + 5$   
 $-p + 12p - 6 + 5$  Rewrite  $-p$  as  $-1p$ .  
 $-1p + 12p - 6 + 5$  Change to addition.  
 $(-1 + 12)p + (-6 + 5)$  Add the coefficients of like terms.  
 $11p + -1$  Change addition to subtraction of the opposite.  
 $11p - 1$

76.  $-k + 3(4k - 1) + 2 = -1k + 3 \cdot 4k - 3 \cdot 1 + 2$   
 $= -1k + 12k - 3 + 2$   
 $= -1k + 12k + -3 + 2$   
 $= 11k + -1$  or  $11k - 1$

77. A simplified expression still has variables, but is written in a simpler way. When evaluating an expression, the variables are all replaced by specific numbers and the final result is a numerical answer.

$$\begin{array}{ll}
 78. \quad 5(3x + 2) & 5(2 + 3x) \\
 = 5 \cdot 3x + 5 \cdot 2 & = 5 \cdot 2 + 5 \cdot 3x \\
 = 15x + 10 & = 10 + 15x
 \end{array}$$

The answers are equivalent because of the commutative property of addition.

79. Like terms have matching variable parts, that is, matching letters and exponents. The coefficients do not have to match. Examples will vary. Possible examples: In  $-6x + 9 + x$ , the terms  $-6x$  and  $x$  are like terms. In  $4k + 3 - 8k^2 + 10$ , the terms 3 and 10 are like terms.

80. Add the coefficients of like terms. If no coefficient is shown, it is assumed to be 1. Keep the variable part the same. Examples will vary.

$$81. \quad \underbrace{-2x + 7x}_{5x} + 8$$

Keep the variable part unchanged when combining like terms.

82. In the last step, do not change the sign of the first term. The correct answer is  $-4a - 5$ .

$$83. \quad -4(3y) - 5 + 2(5y + 7) \quad \text{Distributive property}$$

$$-4 \cdot 3y - 5 + 2 \cdot 5y + 2 \cdot 7$$

Change subtraction to adding the opposite.  
Group like terms and add the coefficients.

$$\begin{array}{l}
 -12y - 5 + 10y + 14 \\
 -12y + -5 + 10y + 14 \\
 \underbrace{-12y + 10y}_{-2y} + \underbrace{-5 + 14}_9 \\
 -2y + 9
 \end{array}$$

$$\begin{array}{l}
 84. \quad 6(-3x) - 9 + 3(-2x + 6) = -18x - 9 + 3 \cdot -2x + 3 \cdot 6 \\
 = -18x + -9 + -6x + 18 \\
 = -24x + 9
 \end{array}$$

$$\begin{array}{l}
 85. \quad -10 + 4(-3b + 3) + 2(6b - 1) \\
 \text{Distributive property} \\
 -10 + 4 \cdot -3b + 4 \cdot 3 + 2 \cdot 6b - 2 \cdot 1 \\
 -10 + -12b + 12 + 12b - 2 \\
 \text{Change to addition.} \\
 -10 + -12b + 12 + 12b + -2 \\
 \text{Group like terms and add the coefficients.} \\
 \underbrace{-12b + 12b}_{0b} + \underbrace{-10 + 12 + -2}_0 \\
 0b + 0 \\
 0
 \end{array}$$

$$\begin{array}{l}
 86. \quad 12 + 2(4a - 4) + 4(-2a - 1) \\
 = 12 + 2 \cdot 4a - 2 \cdot 4 + 4 \cdot -2a - 4 \cdot 1 \\
 = 12 + 8a - 8 + -8a - 4 \\
 = 12 + 8a + -8 + -8a + -4 \\
 = 0
 \end{array}$$

$$\begin{array}{l}
 87. \quad -5(-x + 2) + 8(-x) + 3(-2x - 2) + 16 \\
 \text{Distributive property} \\
 -5 \cdot -x + -5 \cdot 2 + 8 \cdot -x + 3 \cdot -2x - 3 \cdot 2 + 16 \\
 5x + -10 + -8x + -6x - 6 + 16 \\
 \text{Change to addition.} \\
 5x + -10 + -8x + -6x + -6 + 16 \\
 \text{Group like terms and add the coefficients.} \\
 \underbrace{5x + -8x + -6x}_{-9x} + \underbrace{-10 + -6 + 16}_0 \\
 -9x
 \end{array}$$

$$\begin{array}{l}
 88. \quad -7(-y) + 6(y - 1) + 3(-2y) + 6 - y \\
 = 7y + 6y - 6 + -6y + 6 - y \\
 = 7y + 6y + -6 + -6y + 6 + -1y \\
 = 6y
 \end{array}$$

### Summary Exercises on Variables and Expressions

- $-10 - m$   $m$  is the variable.  
 $-10$  is the constant.
- $-8cd$   $c$  and  $d$  are the variables.  
 $-8$  is the coefficient.
- $6 + 4x$   $x$  is the variable.  
4 is the coefficient.  
6 is the constant.
- Expression (rule) for finding the perimeter of an octagon of side length  $s$ :  $8s$ 
  - Evaluate the expression when  $s$ , the side length, is 4 yards.  
 $8s$  Replace  $s$  with 4.  
 $8 \cdot 4$  Follow the rule and multiply.  
32 yards is the perimeter.
  - Evaluate the expression when  $s$ , the side length, is 15 inches.  
 $8s$  Replace  $s$  with 15.  
 $8 \cdot 15$  Follow the rule and multiply.  
120 inches is the perimeter.

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5. Expression (rule) for finding the total cost of a car with down payment  $d$ , monthly payment  $m$ , and number of payments  $t$ :  $d + mt$

(a) Evaluate the expression when the down payment is \$3000, the monthly payment is \$280, and the number of payments is 36.

$$d + mt \quad \text{Replace } d \text{ with } \$3000, m \text{ with } \$280, \text{ and } t \text{ with } 36.$$

$$\underbrace{\$3000 + \$280 \cdot 36}_{\$3000 + \$10,080} \quad \text{Multiply before adding.}$$

\$13,080 is the total cost of the car.

(b) Evaluate the expression when the down payment is \$1750, the monthly payment is \$429, and the number of payments is 48.

$$d + mt \quad \text{Replace } d \text{ with } \$1750, m \text{ with } \$429, \text{ and } t \text{ with } 48.$$

$$\underbrace{\$1750 + \$429 \cdot 48}_{\$1750 + \$20,592} \quad \text{Multiply before adding.}$$

\$22,342 is the total cost of the car.

6.  $ad^4$  written without exponents is

$$a \cdot d \cdot d \cdot d \cdot d$$

7.  $b^3cd$  written without exponents is

$$b \cdot b \cdot b \cdot c \cdot d$$

8.  $-7ab^5c^2$  written without exponents is

$$-7 \cdot a \cdot b \cdot b \cdot b \cdot b \cdot b \cdot c \cdot c$$

9.  $w^4 = w \cdot w \cdot w \cdot w$

Replace  $w$  with 5.

$$\underbrace{5 \cdot 5 \cdot 5 \cdot 5}_{25 \cdot 5 \cdot 5}_{125 \cdot 5}_{625} \quad \text{Multiply left to right.}$$

10.  $5xz$

Replace  $x$  with  $-2$  and  $z$  with 0.

If 0 is multiplied by any number, the result is 0. Thus, there is no need to make any calculations since the result is 0.

11.  $yz^2$

Replace  $y$  with  $-6$  and  $z$  with 0.

If 0 is multiplied by any number, the result is 0. Thus, there is no need to make any calculations since the result is 0.

12.  $wxy$

Replace  $w$  with 5,  $x$  with  $-2$ , and  $y$  with  $-6$ .

$$\underbrace{5 \cdot (-2) \cdot (-6)}_{-10 \cdot (-6)} \quad \text{Multiply left to right.}$$

$$60$$

13.  $x^3 = x \cdot x \cdot x$

Replace  $x$  with  $-2$ .

$$\underbrace{(-2) \cdot (-2) \cdot (-2)}_{4 \cdot (-2)} \quad \text{Multiply left to right.}$$

$$-8$$

14.  $-4wy$

Replace  $w$  with 5 and  $y$  with  $-6$ .

$$\underbrace{-4 \cdot 5 \cdot (-6)}_{-20 \cdot (-6)} \quad \text{Multiply left to right.}$$

$$120$$

15.  $3xy^2 = 3 \cdot x \cdot y \cdot y$

Replace  $x$  with  $-2$  and  $y$  with  $-6$ .

$$\underbrace{3 \cdot (-2) \cdot (-6) \cdot (-6)}_{-6 \cdot (-6) \cdot (-6)} \quad \text{Multiply left to right.}$$

$$\underbrace{36 \cdot (-6)}_{-216}$$

16.  $w^2x^5 = w \cdot w \cdot x \cdot x \cdot x \cdot x \cdot x$

Replace  $w$  with 5 and  $x$  with  $-2$ .

$$\underbrace{5 \cdot 5 \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2)}_{25 \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2)} \quad \text{Multiply left to right.}$$

$$\underbrace{-50 \cdot (-2) \cdot (-2) \cdot (-2) \cdot (-2)}_{100 \cdot (-2) \cdot (-2) \cdot (-2)} \quad \text{Multiply left to right.}$$

$$\underbrace{-200 \cdot (-2) \cdot (-2)}_{400 \cdot (-2)} \quad \text{Multiply left to right.}$$

$$-800$$

17.  $-7wx^4y^3$  Use a calculator.

Replace  $w$  with 5,  $x$  with  $-2$ , and  $y$  with  $-6$ .

$$-7(5)(-2)^4(-6)^3 = -35(16)(-216) = 120,960$$

18.  $10b + 4b + 10b = (10 + 4 + 10)b$
- $$= 24b$$

19.  $-3x - 5 + 12 + 10x = -3x + 10x + -5 + 12$
- $$= (-3 + 10)x + (-5 + 12)$$
- $$= 7x + 7$$

20.  $-8(c + 4) = -8 \cdot c + -8 \cdot 4$
- $$= -8c + -32$$
- or  $-8c - 32$

21.  $-9xy + 9xy = (-9 + 9)xy$   
 $= 0xy$   
 $= 0$
22.  $-4(-3c^2d) = (-4 \cdot -3) \cdot c^2d$   
 $= 12c^2d$
23.  $3f - 5f - 4f = 3f + -5f + -4f$   
 $= (3 + -5 + -4)f$   
 $= -6f$
24.  $2(3w + 4) = 2 \cdot 3w + 2 \cdot 4$   
 $= (2 \cdot 3)w + 2 \cdot 4$   
 $= 6w + 8$
25.  $-a - 6b - a = -a + -6b + -a$   
 $= -a + -a + -6b$   
 $= -1a + -1a + -6b$   
 $= (-1 + -1) \cdot a + -6b$   
 $= -2a + -6b$   
 or  $-2a - 6b$
26.  $-10(-5x^3y^2) = (-10 \cdot -5) \cdot x^3y^2$   
 $= 50x^3y^2$
27.  $5r^2 + 2r - 2r^2 + 5r^3$   
 $= 5r^3 + 5r^2 + -2r^2 + 2r$   
 $= 5r^3 + (5 + -2)r^2 + 2r$   
 $= 5r^3 + 3r^2 + 2r$
28.  $21 + 7(h^2 - 3) = 21 + 7 \cdot h^2 - 7 \cdot 3$   
 $= 21 + 7h^2 - 21$   
 $= 7h^2$
29.  $-3(m + 3) + 3m = -3 \cdot m + -3 \cdot 3 + 3m$   
 $= -3m + 3m + -9$   
 $= (-3 + 3) \cdot m + -9$   
 $= 0m + -9$   
 $= 0 + -9$   
 $= -9$
30.  $-4(8y - 5) + 5 = -4 \cdot 8y - -4 \cdot 5 + 5$   
 $= (-4 \cdot 8) \cdot y - -20 + 5$   
 $= -32y + 20 + 5$   
 $= -32y + 25$
31.  $2 + 12(3x - 1) = 2 + 12 \cdot 3x - 12 \cdot 1$   
 $= 2 + (12 \cdot 3) \cdot x - 12$   
 $= 2 + -12 + 36x$   
 $= -10 + 36x$   
 or  $36x - 10$
32.  $-n + 5(4n - 2) + 11 = -n + 5 \cdot 4n - 5 \cdot 2 + 11$   
 $= -n + (5 \cdot 4) \cdot n - 10 + 11$   
 $= -n + 20n + -10 + 11$   
 $= (-1 + 20) \cdot n + 1$   
 $= 19n + 1$

33. (a) Simplifying the expression correctly:

$$6(n + 2) = 6 \cdot n + 6 \cdot 2$$

$$= 6n + 12$$

The student forgot to multiply  $6 \cdot 2$ .

- (b) Simplifying the expression correctly:

$$-5(-4a) = (-5 \cdot -4) \cdot a$$

$$= 20a$$

Two negative factors give a *positive* product.

- (c) Simplifying the expression correctly:

$$3y + 2y - 10 = (3 + 2)y - 10$$

$$= 5y - 10$$

Keep the variable part unchanged; that is, adding  $ys$  to  $ys$  gives an answer with  $ys$ , not  $y^2s$ .

34. In the last step, do not change the sign of the first term; keep  $-7x$  as  $-7x$ . The correct answer is  $-7x - 9$ .

## 2.3 Solving Equations Using Addition

### 2.3 Margin Exercises

1. (a)  $c + 15 = 80$  Given equation  
 $95 + 15 \stackrel{?}{=} 80$  Replace  $c$  with 95.  
 $110 \neq 80$   
 No, 95 is not the solution.  
 $65 + 15 \stackrel{?}{=} 80$  Replace  $c$  with 65.  
 $80 = 80$   
 Yes, 65 is the solution. (No need to check 70)
- (b)  $28 = c - 4$  Given equation  
 $28 \stackrel{?}{=} 20 - 4$  Replace  $c$  with 20.  
 $28 \neq 16$   
 No, 20 is not the solution.  
 $28 \stackrel{?}{=} 24 - 4$  Replace  $c$  with 24.  
 $28 \neq 20$   
 No, 24 is not the solution.  
 $28 \stackrel{?}{=} 32 - 4$  Replace  $c$  with 32.  
 $28 = 28$   
 Yes, 32 is the solution.
2. (a) Solve  $12 = y + 5$ .  
 To get  $y$  by itself add the opposite of 5,  $-5$ , to both sides.  
 $12 = y + 5$   
 $\frac{-5}{7} = \frac{-5}{7}$   
 $7 = y$  The solution is 7.

*continued*

**Check:**  $12 = y + 5$  Replace  $y$  with 7.  
 $12 = 7 + 5$   
 $12 = 12$  Balances

(b) Solve  $b - 2 = -6$ .

Change to addition.

$$b + -2 = -6$$

To get  $b$  by itself add the opposite of  $-2$ ,  $+2$ , to both sides.

$$\begin{array}{r} b + -2 = -6 \\ +2 \quad +2 \\ \hline b + 0 = -4 \end{array}$$

$$b = -4 \text{ The solution is } -4.$$

**Check:**  $b - 2 = -6$  Replace  $b$  with  $-4$ .  
 $-4 - 2 = -6$   
 $-4 + -2 = -6$   
 $-6 = -6$  Balances

3. (a)  $2 - 8 = k - 2$

Rewrite both sides by changing subtraction to addition. Combine like terms.

$$\begin{array}{r} 2 + -8 = k + -2 \\ -6 = k + -2 \end{array}$$

To get  $k$  by itself add the opposite of  $-2$ ,  $+2$ , to both sides.

$$\begin{array}{r} -6 = k + -2 \\ +2 \quad +2 \\ \hline -4 = k \end{array} \text{ The solution is } -4.$$

**Check:**  $2 - 8 = k - 2$  Replace  $k$  with  $-4$ .  
 $2 - 8 = -4 - 2$   
 $2 + -8 = -4 + -2$   
 $-6 = -6$  Balances

(b)  $4r + 1 - 3r = -8 + 11$

Change to addition.

$$4r + 1 + -3r = -8 + 11$$

Rewrite the left side by using the commutative property.

$$\begin{array}{r} 4r + -3r + 1 = -8 + 11 \text{ Combine like terms.} \\ 1r + 1 = 3 \text{ To get } r \text{ by itself add} \\ -1 \quad -1 \text{ } -1 \text{ to both sides.} \\ \hline 1r + 0 = 2 \\ 1r = 2 \\ \text{or } r = 2 \text{ The solution is } 2. \end{array}$$

**Check:**  
 $4r + 1 - 3r = -8 + 11$  Replace  $r$  with 2.  
 $4 \cdot 2 + 1 - 3 \cdot 2 = -8 + 11$   
 $8 + 1 - 6 = 3$   
 $9 - 6 = 3$   
 $3 = 3$  Balances

### 2.3 Section Exercises

1.  $n - 50 = 8$  Given equation  
 $58 - 50 \stackrel{?}{=} 8$  Replace  $n$  with 58.  
 $8 = 8$   
 Yes, 58 is the solution.  
 (No need to check 42 and 60.)

2.  $r - 20 = 5$  Given equation  
 Replace  $r$  with 15, 30, and 25.  
 $15 - 20 \stackrel{?}{=} 5$   $30 - 20 \stackrel{?}{=} 5$   $25 - 20 \stackrel{?}{=} 5$   
 $15 + -20 \stackrel{?}{=} 5$   $10 \neq 5$   $5 = 5$   
 $-5 \neq 5$   
 25 is the solution.

3.  $-6 = y + 10$  Given equation  
 $-6 \stackrel{?}{=} -4 + 10$  Replace  $y$  with  $-4$ .  
 $-6 \neq 6$   
 No,  $-4$  is not the solution.  
 $-6 \stackrel{?}{=} -16 + 10$  Replace  $y$  with  $-16$ .  
 $-6 = -6$   
 Yes,  $-16$  is the solution.

4.  $-4 = x + 13$  Given equation  
 Replace  $x$  with 17,  $-17$ , and  $-9$ .  
 $-4 \stackrel{?}{=} 17 + 13$   $-4 \stackrel{?}{=} -17 + 13$   $-4 \stackrel{?}{=} -9 + 13$   
 $-4 \neq 30$   $-4 = -4$   $-4 \neq 4$   
 $-17$  is the solution.

5.  $t + 12 = 0$  Given equation  
 $0 + 12 \stackrel{?}{=} 0$  Replace  $t$  with 0.  
 $12 \neq 0$   
 No, 0 is not the solution.  
 $-12 + 12 \stackrel{?}{=} 0$  Replace  $t$  with  $-12$ .  
 $0 = 0$   
 Yes,  $-12$  is the solution.

6.  $b - 8 = 0$  Given equation  
 $8 - 8 = 0$  Replace  $b$  with 8.  
 $0 = 0$   
 Yes, 8 is the solution.

7.  $p + 5 = 9$  Add the opposite of 5,  $-5$ , to both sides.

$$\frac{-5}{p+0} = \frac{-5}{4}$$

$$p = 4 \quad \text{The solution is 4.}$$

**Check:**  $p + 5 = 9$  Replace  $p$  with 4.  
 $4 + 5 = 9$   
 $9 = 9$  Balances

8.  $a + 3 = 12$  Add  $-3$  to both sides.

$$\frac{-3}{a+0} = \frac{-3}{9}$$

$$a = 9 \quad \text{The solution is 9.}$$

**Check:**  $a + 3 = 12$  Replace  $a$  with 9.  
 $9 + 3 = 12$   
 $12 = 12$  Balances

9.  $8 = r - 2$  Change to addition.  
 $8 = r + -2$  Add the opposite of  $-2$ , 2, to both sides.

$$\frac{2}{10} = \frac{2}{r+0}$$

$$10 = r \quad \text{The solution is 10.}$$

**Check:**  $8 = r - 2$  Replace  $r$  with 10.  
 $8 = 10 - 2$   
 $8 = 8$  Balances

10.  $3 = b - 5$  Change to addition.  
 $3 = b + -5$  Add 5 to both sides.

$$\frac{5}{8} = \frac{5}{b+0}$$

$$8 = b \quad \text{The solution is 8.}$$

**Check:**  $3 = b - 5$  Replace  $b$  with 8.  
 $3 = 8 - 5$   
 $3 = 3$  Balances

11.  $-5 = n + 3$  Add the opposite of 3,  $-3$ , to both sides.

$$\frac{-3}{-8} = \frac{-3}{n+0}$$

$$-8 = n \quad \text{The solution is } -8.$$

**Check:**  $-5 = n + 3$  Replace  $n$  with  $-8$ .  
 $-5 = -8 + 3$   
 $-5 = -5$  Balances

12.  $-1 = a + 8$  Add  $-8$  to both sides.

$$\frac{-8}{-9} = \frac{-8}{a+0}$$

$$-9 = a \quad \text{The solution is } -9.$$

**Check:**  $-1 = a + 8$  Replace  $a$  with  $-9$ .  
 $-1 = -9 + 8$   
 $-1 = -1$  Balances

13.  $-4 + k = 14$  Add the opposite of  $-4$ , 4, to both sides.

$$\frac{4}{0+k} = \frac{4}{18}$$

$$k = 18 \quad \text{The solution is 18.}$$

**Check:**  $-4 + k = 14$  Replace  $k$  with 18.  
 $-4 + 18 = 14$   
 $14 = 14$  Balances

14.  $-9 + y = 7$  Add 9 to both sides.

$$\frac{9}{0+y} = \frac{9}{16}$$

$$y = 16 \quad \text{The solution is 16.}$$

**Check:**  $-9 + y = 7$  Replace  $y$  with 16.  
 $-9 + 16 = 7$   
 $7 = 7$  Balances

15.  $y - 6 = 0$  Change to addition.  
 $y + -6 = 0$  Add the opposite of  $-6$ , 6, to both sides.

$$\frac{6}{y+0} = \frac{6}{6}$$

$$y = 6 \quad \text{The solution is 6.}$$

**Check:**  $y - 6 = 0$  Replace  $y$  with 6.  
 $6 - 6 = 0$  Change to addition.  
 $6 + -6 = 0$   
 $0 = 0$  Balances

16.  $k - 15 = 0$  Change to addition.  
 $k + -15 = 0$  Add 15 to both sides.

$$\frac{15}{k+0} = \frac{15}{15}$$

$$k = 15 \quad \text{The solution is 15.}$$

**Check:**  $k - 15 = 0$  Replace  $k$  with 15.  
 $15 - 15 = 0$   
 $0 = 0$  Balances

17.  $7 = r + 13$  Add the opposite of 13,  $-13$ , to both sides.

$$\frac{-13}{-6} = \frac{-13}{r+0}$$

$$-6 = r \quad \text{The solution is } -6.$$

**Check:**  $7 = r + 13$  Replace  $r$  with  $-6$ .  
 $7 = -6 + 13$   
 $7 = 7$  Balances

18.  $12 = z + 19$  Add  $-19$  to both sides.

$$\frac{-19}{-7} = \frac{-19}{z+0}$$

$$-7 = z \quad \text{The solution is } -7.$$

**Check:**  $12 = z + 19$  Replace  $z$  with  $-7$ .  
 $12 = -7 + 19$   
 $12 = 12$  Balances

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19.  $x - 12 = -1$  Change to addition.  
 $x + -12 = -1$  Add the opposite of  $-12$ ,  
 $12$ , to both sides.

$$\frac{12}{x + 0} = \frac{12}{-11}$$

$x = 11$  The solution is 11.

**Check:**  $x - 12 = -1$  Replace  $x$  with 11.  
 $11 - 12 = -1$  Change to addition.  
 $11 + -12 = -1$   
 $-1 = -1$  Balances

20.  $m - 3 = -9$  Change to addition.  
 $m + -3 = -9$  Add 3 to both sides.

$$\frac{+3}{m + 0} = \frac{+3}{-6}$$

$m = -6$  The solution is  $-6$ .

**Check:**  $m - 3 = -9$  Replace  $m$  with  $-6$ .  
 $-6 - 3 = -9$   
 $-6 + -3 = -9$   
 $-9 = -9$  Balances

21.  $-5 = -2 + t$  Add the opposite of  $-2$ ,  
 $2$ , to both sides.

$$\frac{2}{-3} = \frac{2}{0 + t}$$

$-3 = t$  The solution is  $-3$ .

**Check:**  $-5 = -2 + t$  Replace  $t$  with  $-3$ .  
 $-5 = -2 + -3$   
 $-5 = -5$  Balances

22.  $-1 = -10 + w$  Add 10 to both sides.

$$\frac{10}{9} = \frac{10}{0 + w}$$

$9 = w$  The solution is 9.

**Check:**  $-1 = -10 + w$  Replace  $w$  with 9.  
 $-1 = -10 + 9$   
 $-1 = -1$  Balances

23. The given solution is  $-2$ .

**Check:**  $z - 5 = 3$  Replace  $z$  with  $-2$ .  
 $-2 - 5 = 3$  Change to addition.  
 $-2 + -5 = 3$   
 $-7 \neq 3$  Does not balance

Correct solution:

$z - 5 = 3$  Change to addition.  
 $z + -5 = 3$  Add the opposite of  $-5$ ,  
 $5$ , to both sides.

$$\frac{5}{z + 0} = \frac{5}{8}$$

$z = 8$  The solution is 8.

**Check:**  $z - 5 = 3$  Replace  $z$  with 8.  
 $8 - 5 = 3$  Change to addition.  
 $8 + -5 = 3$   
 $3 = 3$  Balances

24. The given solution is 13.

**Check:**  $x - 9 = 4$  Replace  $x$  with 13.  
 $13 - 9 = 4$   
 $4 = 4$  Balances

13 is the correct solution.

25. The given solution is  $-18$ .

**Check:**  $7 + x = -11$  Replace  $x$  with  $-18$ .  
 $7 + -18 = -11$   
 $-11 = -11$  Balances

$-18$  is the correct solution.

26. The given solution is  $-5$ .

**Check:**  $2 + k = -7$  Replace  $k$  with  $-5$ .  
 $2 + -5 = -7$   
 $-3 \neq -7$  Does not balance

Correct solution:

$2 + k = -7$  Add the opposite of 2,  
 $-2$ , to both sides.

$$\frac{-2}{0 + k} = \frac{-2}{-9}$$

$k = -9$  The correct solution is  $-9$ .

**Check:**  $2 + k = -7$  Replace  $k$  with  $-9$ .  
 $2 + -9 = -7$   
 $-7 = -7$  Balances

27. The given solution is 10.

**Check:**  $-10 = -10 + b$  Replace  $b$  with 10.  
 $-10 = -10 + 10$   
 $-10 \neq 0$  Does not balance

Correct solution:

$-10 = -10 + b$  Add the opposite of  $-10$ ,  
 $10$ , to both sides.

$$\frac{10}{0} = \frac{10}{0 + b}$$

$0 = b$  The solution is 0.

**Check:**  $-10 = -10 + b$  Replace  $b$  with 0.  
 $-10 = -10 + 0$   
 $-10 = -10$  Balances

28. The given solution is 0.

**Check:**  $0 = -14 + a$  Replace  $a$  with 0.  
 $0 = -14 + 0$   
 $0 \neq -14$  Does not balance



Correct solution:

$$0 = -14 + a \text{ Add the opposite of } -14, \\ 14, \text{ to both sides.}$$

$$\frac{14}{14} = \frac{14}{0 + a}$$

$$14 = a \quad \text{The correct solution is 14.}$$

**Check:**  $0 = -14 + a$  Replace  $a$  with 14.

$$0 = -14 + 14$$

$$0 = 0 \quad \text{Balances}$$

29.  $c - 4 = -8 + 10$  Simplify the right side.

$$c - 4 = 2 \quad \text{Change to addition.}$$

$$c + -4 = 2 \quad \text{Add 4 to both sides.}$$

$$\frac{4}{c + 0} = \frac{4}{6}$$

$$c = 6 \quad \text{The solution is 6.}$$

**Check:**  $c - 4 = -8 + 10$  Replace  $c$  with 6.

$$6 - 4 = -8 + 10$$

$$2 = 2 \quad \text{Balances}$$

30.  $b - 8 = 10 - 6$

$$b - 8 = 4$$

$$\frac{8}{b + 0} = \frac{8}{12}$$

$$b = 12 \quad \text{The solution is 12.}$$

**Check:**  $b - 8 = 10 - 6$

$$12 - 8 = 10 - 6$$

$$4 = 4 \quad \text{Balances}$$

31.  $-1 + 4 = y - 2$  Simplify the left side.

$$3 = y - 2 \quad \text{Change to addition.}$$

$$3 = y + -2 \quad \text{Add 2 to both sides.}$$

$$\frac{2}{5} = \frac{2}{y + 0}$$

$$5 = y \quad \text{The solution is 5.}$$

**Check:**  $-1 + 4 = y - 2$  Replace  $y$  with 5.

$$-1 + 4 = 5 - 2 \quad \text{Change to addition.}$$

$$-1 + 4 = 5 + -2$$

$$3 = 3 \quad \text{Balances}$$

32.  $2 + 3 = k - 4$

$$5 = k - 4$$

$$\frac{4}{9} = \frac{4}{k + 0}$$

$$9 = k \quad \text{The solution is 9.}$$

**Check:**  $2 + 3 = k - 4$

$$2 + 3 = 9 - 4$$

$$5 = 5 \quad \text{Balances}$$

33.  $10 + b = -14 - 6$  Change to addition.

$$10 + b = -14 + -6 \quad \text{Add.}$$

$$10 + b = -20 \quad \text{Add } -10$$

$$\frac{-10}{0 + b} = \frac{-10}{-30} \quad \text{to both sides.}$$

$$0 + b = -30$$

$$b = -30 \quad \text{The solution is } -30.$$

**Check:**

$$10 + b = -14 - 6 \quad \text{Replace } b \text{ with } -30.$$

$$10 + -30 = -14 + -6$$

$$-20 = -20 \quad \text{Balances}$$

34.  $1 + w = -8 - 8$

$$1 + w = -8 + -8$$

$$1 + w = -16$$

$$\frac{-1}{0 + w} = \frac{-1}{-17}$$

$$0 + w = -17$$

$$w = -17 \quad \text{The solution is } -17.$$

**Check:**  $1 + w = -8 - 8$

$$1 + -17 = -8 + -8$$

$$-16 = -16 \quad \text{Balances}$$

35.  $t - 2 = 3 - 5$  Change to addition.

$$t + -2 = 3 + -5 \quad \text{Simplify the right side.}$$

$$t + -2 = -2 \quad \text{Add 2 to both sides.}$$

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

$$t = 0 \quad \text{The solution is 0.}$$

**Check:**  $t - 2 = 3 - 5$  Replace  $t$  with 0.

$$0 - 2 = 3 - 5 \quad \text{Change to addition.}$$

$$0 + -2 = 3 + -5$$

$$-2 = -2 \quad \text{Balances}$$

36.  $p - 8 = -10 + 2$

$$p - 8 = -8$$

$$p + -8 = -8$$

$$\frac{8}{p + 0} = \frac{8}{0}$$

$$p = 0 \quad \text{The solution is 0.}$$

**Check:**  $p - 8 = -10 + 2$

$$0 - 8 = -10 + 2$$

$$-8 = -8 \quad \text{Balances}$$

37.  $10z - 9z = -15 + 8$  Change to addition.

$$10z + -9z = -15 + 8 \quad \text{Combine like terms.}$$

$$1z = -7 \quad 1z \text{ is the same as } z.$$

$$z = -7 \quad \text{The solution is } -7.$$

**Check:**

$$10z - 9z = -15 + 8 \quad \text{Replace } z \text{ with } -7.$$

$$10 \cdot -7 - 9 \cdot -7 = -15 + 8$$

$$-70 - -63 = -7$$

Change to addition.

$$-70 + 63 = -7$$

$$-7 = -7 \quad \text{Balances}$$

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38.  $2r - r = 5 - 10$   
 $2r + ^{-1}r = 5 + ^{-1}10$   
 $1r = ^{-5}$   
 $r = ^{-5}$  The solution is  $^{-5}$ .
- Check:**  $2r - r = 5 - 10$   
 $2 \cdot ^{-5} - ^{-5} = 5 - 10$   
 $^{-1}0 + ^{+5} = 5 + ^{-1}10$   
 $^{-5} = ^{-5}$  Balances
39.  $^{-5}w + 2 + 6w = ^{-4} + 9$  Rearrange and  
 combine like terms.  
 $\underline{\underline{^{-5}w + 6w}} + 2 = \underline{\underline{^{-4} + 9}}$   
 $1w + 2 = 5$  Add  $^{-2}$  to both sides.  
 $\underline{\underline{^{-2}}}$   $\underline{\underline{^{-2}}}$   
 $1w + 0 = 3$   
 $w = 3$  The solution is 3.
- Check:**  
 $^{-5}w + 2 + 6w = ^{-4} + 9$  Replace  $w$  with 3.  
 $^{-5} \cdot 3 + 2 + 6 \cdot 3 = ^{-4} + 9$   
 $^{-15} + 2 + 18 = ^{-4} + 9$   
 $5 = 5$  Balances
40.  $^{-2}t + 4 + 3t = 6 - 7$   
 $1t + 4 = 6 + ^{-7}$   
 $t + 4 = ^{-1}$   
 $\underline{\underline{^{-4}}}$   $\underline{\underline{^{-4}}}$   
 $t + 0 = ^{-5}$   
 $t = ^{-5}$  The solution is  $^{-5}$ .
- Check:**  
 $^{-2}t + 4 + 3t = 6 - 7$   
 $^{-2}(-5) + 4 + 3(-5) = 6 - 7$   
 $10 + 4 + ^{-15} = 6 + ^{-7}$   
 $14 + ^{-15} = ^{-1}$   
 $^{-1} = ^{-1}$  Balances
41.  $^{-3} - 3 = 4 - 3x + 4x$  Change to addition.  
 $\underline{\underline{^{-3} + ^{-3}}} = 4 + \underline{\underline{^{-3}x + 4x}}$  Combine like terms.  
 $^{-6} = 4 + 1x$  Add  $^{-4}$  to both sides.  
 $\underline{\underline{^{-4}}}$   $\underline{\underline{^{-4}}}$   
 $^{-10} = 0 + 1x$   
 $^{-10} = 1x$   $1x$  is the same as  $x$ .  
 $^{-10} = x$  The solution is  $^{-10}$ .
42.  $^{-5} - 5 = ^{-2} - 6b + 7b$   
 $^{-5} + ^{-5} = ^{-2} + ^{-6}b + 7b$   
 $^{-10} = ^{-2} + 1b$   
 $^{-10} = ^{-2} + b$   
 $\underline{\underline{+2}}$   $\underline{\underline{+2}}$   
 $^{-8} = 0 + b$   
 $^{-8} = b$  The solution is  $^{-8}$ .
43.  $^{-3} + 7 - 4 = ^{-2}a + 3a$  Change to addition.  
 $^{-3} + 7 + ^{-4} = ^{-2}a + 3a$  Combine like terms.  
 $0 = 1a$   
 $0 = a$  The solution is 0.
44.  $6 - 11 + 5 = ^{-8}c + 9c$   
 $6 + ^{-11} + 5 = ^{-8}c + 9c$   
 $0 = 1c$   
 $0 = c$  The solution is 0.
45.  $y - 75 = ^{-100}$  Change to addition.  
 $y + ^{-75} = ^{-100}$  Add 75 to both sides.  
 $\underline{\underline{75}}$   $\underline{\underline{75}}$   
 $y + 0 = ^{-25}$   
 $y = ^{-25}$  The solution is  $^{-25}$ .
46.  $a - 200 = ^{-100}$   
 $a + ^{-200} = ^{-100}$   
 $\underline{\underline{200}}$   $\underline{\underline{200}}$   
 $a + 0 = 100$   
 $a = 100$  The solution is 100.
47.  $^{-}x + 3 + 2x = 18$  Rearrange and  
 combine like terms.  
 $1x + 3 = 18$  Add  $^{-3}$  to both sides.  
 $\underline{\underline{^{-3}}}$   $\underline{\underline{^{-3}}}$   
 $1x + 0 = 15$   
 $x = 15$  The solution is 15.
48.  $^{-}s + 2s - 4 = 13$   
 $^{-1}s + 2s + ^{-4} = 13$   
 $1s + ^{-4} = 13$   
 $\underline{\underline{4}}$   $\underline{\underline{4}}$   
 $1s + 0 = 17$   
 $s = 17$  The solution is 17.
49.  $82 = ^{-31} + k$  Add 31 to both sides.  
 $\underline{\underline{31}}$   $\underline{\underline{31}}$   
 $113 = 0 + k$   
 $113 = k$  The solution is 113.
50.  $^{-5} = 72 + w$   
 $\underline{\underline{^{-72}}}$   $\underline{\underline{^{-72}}}$   
 $^{-77} = w$  The solution is  $^{-77}$ .
51.  $^{-2} + 11 = 2b - 9 - b$  Change to addition.  
 $^{-2} + 11 = 2b + ^{-9} + ^{-}b$  Rearrange and  
 combine like terms.  
 $9 = 1b + ^{-9}$  Add 9 to both sides.  
 $\underline{\underline{9}}$   $\underline{\underline{9}}$   
 $18 = 1b + 0$   
 $18 = b$  The solution is 18.

$$\begin{array}{r}
 52. \quad -6 + 7 = 2h - 1 - h \\
 -6 + 7 = 2h +^{-1} +^{-1}h \\
 1 = 1h +^{-1} \\
 \begin{array}{r}
 1 \qquad 1 \\
 \hline
 2 = 1h + 0 \\
 2 = h
 \end{array}
 \end{array}$$

The solution is 2.

$$\begin{array}{r}
 53. \quad r - 6 = 7 - 10 - 8 \quad \text{Change to addition.} \\
 r +^{-6} = 7 +^{-10} +^{-8} \quad \text{Combine like terms.} \\
 r +^{-6} =^{-11} \quad \text{Add 6 to both sides.} \\
 \begin{array}{r}
 6 \qquad 6 \\
 \hline
 r + 0 =^{-5} \\
 r =^{-5}
 \end{array}
 \end{array}$$

The solution is  $-5$ .

$$\begin{array}{r}
 54. \quad m - 5 = 2 - 9 + 1 \\
 m +^{-5} = 2 +^{-9} + 1 \\
 m +^{-5} =^{-6} \\
 \begin{array}{r}
 5 \qquad 5 \\
 \hline
 m + 0 =^{-1} \\
 m =^{-1}
 \end{array}
 \end{array}$$

The solution is  $-1$ .

$$\begin{array}{r}
 55. \quad -14 = n + 91 \quad \text{Add }^{-91} \text{ to both sides.} \\
 \begin{array}{r}
^{-91} \qquad^{-91} \\
 \hline
^{-105} = n + 0 \\
^{-105} = n
 \end{array}
 \end{array}$$

The solution is  $-105$ .

$$\begin{array}{r}
 56. \quad 66 = x - 28 \\
 66 = x +^{-28} \\
 \begin{array}{r}
+28 \qquad+28 \\
 \hline
 94 = x + 0 \\
 94 = x
 \end{array}
 \end{array}$$

The solution is 94.

$$\begin{array}{r}
 57. \quad -9 + 9 = 5 + h \quad \text{Combine like terms.} \\
 0 = 5 + h \quad \text{Add }^{-5} \text{ to both sides.} \\
 \begin{array}{r}
^{-5} \qquad^{-5} \\
 \hline
^{-5} = 0 + h \\
^{-5} = h
 \end{array}
 \end{array}$$

The solution is  $-5$ .

$$\begin{array}{r}
 58. \quad 18 - 18 = 6 + p \\
 0 = 6 + p \\
 \begin{array}{r}
^{-6} \qquad^{-6} \\
 \hline
^{-6} = 0 + p \\
^{-6} = p
 \end{array}
 \end{array}$$

The solution is  $-6$ .

59. No, the solution is  $-14$ , the number used to replace  $x$  in the original equation.

$$\begin{array}{r}
 60. \quad \text{Check: } -3 - 6 = n - 5 \\
 -3 +^{-6} =^{-2} +^{-5} \\
 -9 \neq^{-7} \quad \text{Does not balance}
 \end{array}$$

To correct the errors, change  $-3 - 6$  to  $-3 +^{-6}$ . Then, add 5 to both sides, not  $-5$ . The correct solution is  $-4$ .

$$61. \quad g + 10 = 305 \quad \text{Add the opposite of } 10,^{-10}, \text{ to both sides.}$$

$$\begin{array}{r}
^{-10} \qquad^{-10} \\
 \hline
 g + 0 = 295 \\
 g = 295
 \end{array}$$

There were 295 graduates this year.

$$\begin{array}{r}
 62. \quad g + 10 = 278 \\
 \begin{array}{r}
^{-10} \qquad^{-10} \\
 \hline
 g + 0 = 268 \\
 g = 268
 \end{array}
 \end{array}$$

There were 268 graduates last year.

$$\begin{array}{r}
 63. \quad 92 = c + 37 \quad \text{Add }^{-37} \text{ to both sides.} \\
 \begin{array}{r}
^{-37} \qquad^{-37} \\
 \hline
 55 = c + 0 \\
 55 = c
 \end{array}
 \end{array}$$

When the temperature is 92 degrees, a field cricket chirps 55 times (in 15 seconds).

$$\begin{array}{r}
 64. \quad 77 = c + 37 \\
 \begin{array}{r}
^{-37} \qquad^{-37} \\
 \hline
 40 = c + 0 \\
 40 = c
 \end{array}
 \end{array}$$

When the temperature is 77 degrees, a field cricket chirps 40 times (in 15 seconds).

$$\begin{array}{r}
 65. \quad p - 65 = 45 \quad \text{Change to addition.} \\
 p +^{-65} = 45 \quad \text{Add 65 to both sides.} \\
 \begin{array}{r}
 65 \qquad 65 \\
 \hline
 p + 0 = 110 \\
 p = 110
 \end{array}
 \end{array}$$

Ernesto's parking fees average \$110 per month in winter.

$$\begin{array}{r}
 66. \quad p - 56 = 98 \\
 \begin{array}{r}
 56 \qquad 56 \\
 \hline
 p + 0 = 154 \\
 p = 154
 \end{array}
 \end{array}$$

Aimee's parking fees average \$154 per month in winter.

**64 Chapter 2 Understanding Variables and Solving Equations**

**67.**  $-17 - 1 + 26 - 38 = -3 - m - 8 + 2m$   
 Change all subtractions to additions.  
 Write the understood coefficient of 1.  
 $-17 + -1 + 26 + -38 = -3 + -1m + -8 + 2m$   
 Use the commutative property to group like terms on the right side.  
 $-17 + -1 + 26 + -38 = -3 + -8 + -1m + 2m$   
 Combine like terms on each side.  
 $-30 = -11 + 1m$   
 To get  $m$  by itself, add the opposite of  $-11$ , 11, to both sides.  
 $-30 = -11 + 1m$   
 $\frac{11}{19} = \frac{11}{1m}$   
 $-19 = m$  The solution is  $-19$ .

**68.**  $19 - 38 - 9 + 11 = -t - 6 + 2t - 6$   
 $19 + -38 + -9 + 11 = -1t + -6 + 2t + -6$   
 $-17 = 1t + -12$   
 $\frac{12}{-5} = \frac{12}{1t + 0}$   
 $-5 = t$  The solution is  $-5$ .

**69.**  $-6x + 2x + 6 + 5x = |0 - 9| - |-6 + 5|$   
 Change subtraction within absolute value to addition and rearrange the terms.  
 $-6x + 2x + 5x + 6 = |0 + -9| - |-6 + 5|$   
 Simplify inside absolute value signs. Collect like terms.  
 $1x + 6 = |-9| - |-1|$   
 Evaluate absolute values.  
 $1x + 6 = 9 - 1$   
 Change to addition.  
 $1x + 6 = 9 + -1$   
 $1x + 6 = 8$  Add  $-6$  to both sides.  
 $\frac{-6}{1x + 0} = \frac{-6}{2}$   
 $x = 2$  The solution is 2.

**70.**  $-h - |-9 - 9| + 8h - 6h = -12 - |-5 + 0|$   
 $-h - |-9 + -9| + 8h + -6h = -12 - |-5|$   
 $-1h - |-18| + 8h + -6h = -12 - 5$   
 $-1h - 18 + 8h + -6h = -12 + -5$   
 $1h - 18 = -17$   
 $1h + -18 = -17$   
 $\frac{18}{h + 0} = \frac{18}{1}$   
 $h = 1$

The solution is 1.

**71. (a)** Equations will vary. Some possibilities are:

$n - 1 = -3$  Change to addition.  
 $n + -1 = -3$  Add 1 to both sides.  
 $\frac{1}{n + 0} = \frac{1}{-2}$   
 $n = -2$  The solution is  $-2$ .  
 $8 = x + 10$  Add the opposite of 10,  $-10$ , to both sides.  
 $\frac{-10}{-2} = \frac{-10}{x + 0}$   
 $-2 = x$  The solution is  $-2$ .

**(b)** Equations will vary. Some possibilities are:

$y + 6 = 6$  Add the opposite of 6,  $-6$ , to both sides.  
 $\frac{-6}{y + 0} = \frac{-6}{0}$   
 $y = 0$  The solution is 0.  
 $-5 = -5 + b$  Add the opposite of  $-5$ , 5, to both sides.

$\frac{5}{0} = \frac{5}{0 + b}$   
 $0 = b$  The solution is 0.

**72. (a)**  $x + 1 = 1\frac{1}{2}$  Add the opposite of 1,  $-1$ , to both sides.

$\frac{-1}{x + 0} = \frac{-1}{\frac{1}{2}}$   
 $x = \frac{1}{2}$  The solution is  $\frac{1}{2}$ .

**(b)**  $\frac{1}{4} = y - 1$  Change to addition.  
 Add the opposite of  $-1$ , 1, to both sides.

$\frac{1}{4} = y + -1$   
 $\frac{1}{4} = y$  or  $y = \frac{5}{4}$  The solution is  $\frac{5}{4}$ .

**(c)**  $\$2.50 + n = \$3.35$  Add the opposite of  $\$2.50$ ,  $-\$2.50$ , to both sides.

$\frac{-\$2.50}{\$0 + n} = \frac{-\$2.50}{\$0.85}$   
 $n = \$0.85$  The solution is  $\$0.85$ .

**(d)** Equations will vary. Some possibilities are:

$a - \$7.32 = \$9.16$  The solution is  $\$16.48$ .  
 $5c - \$11.20 = 4c - \$2.00$  The solution is  $\$9.20$ .

## 2.4 Solving Equations Using Division

### 2.4 Margin Exercises

1. (a) Solve  $4s = 44$ .

Use division to undo multiplication. Divide *both* sides by the coefficient of the variable, which is 4.

$$\frac{4s}{4} = \frac{44}{4}$$

$$s = 11$$

The solution is 11.

**Check:**  $4s = 44$  Replace  $s$  with 11.  
 $4 \cdot 11 = 44$   
 $44 = 44$  Balances

- (b)  $27 = -9p$  Divide *both* sides by  $-9$ .

$$\frac{27}{-9} = \frac{-9p}{-9}$$

$$-3 = p$$

The solution is  $-3$ .

**Check:**  $27 = -9p$  Replace  $p$  with  $-3$ .  
 $27 = -9 \cdot -3$   
 $27 = 27$  Balances

- (c)  $-40 = -5x$  Divide *both* sides by  $-5$ .

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

$$8 = x$$

The solution is 8.

**Check:**  $-40 = -5x$  Replace  $x$  with 8.  
 $-40 = -5 \cdot 8$   
 $-40 = -40$  Balances

- (d)  $7t = -70$  Divide *both* sides by 7.

$$\frac{7t}{7} = \frac{-70}{7}$$

$$t = -10$$

The solution is  $-10$ .

**Check:**  $7t = -70$  Replace  $t$  with  $-10$ .  
 $7 \cdot -10 = -70$   
 $-70 = -70$  Balances

2. (a)  $-28 = -6n + 10n$  Combine like terms.  
 $-28 = 4n$  Divide *both* sides by 4.

$$\frac{-28}{4} = \frac{4n}{4}$$

$$-7 = n$$

The solution is  $-7$ .

**Check:**  
 $-28 = -6n + 10n$  Replace  $n$  with  $-7$ .  
 $-28 = -6 \cdot -7 + 10 \cdot -7$   
 $-28 = 42 + -70$   
 $-28 = -28$  Balances

- (b)  $p - 14p = -2 + 18 - 3$  Change to addition.  
 Rewrite  $p$  as  $1p$ .

$$1p + -14p = -2 + 18 + -3$$

$$-13p = 13$$

Combine like terms.  
 Divide *both* sides by  $-13$ .

$$\frac{-13p}{-13} = \frac{13}{-13}$$

$$p = -1$$

The solution is  $-1$ .

**Check:**

$$p - 14p = -2 + 18 - 3$$
 Replace  $p$  with  $-1$ .

$$-1 - 14 \cdot -1 = -2 + 18 - 3$$

$$-1 - -14 = 16 - 3$$

$$-1 + 14 = 13$$

$$13 = 13$$

Balances

3. (a)  $-k = -12$  Write in the understood  $-1$  as the coefficient of  $k$ .

$$-1k = -12$$
 Divide *both* sides by  $-1$ .

$$\frac{-1k}{-1} = \frac{-12}{-1}$$

$$k = 12$$

The solution is 12.

**Check:**

$$-k = -12$$

$$-1k = -12$$
 Replace  $k$  with 12.

$$-1 \cdot 12 = -12$$

$$-12 = -12$$
 Balances

- (b)  $7 = -t$  Write  $-t$  as  $-1t$ .

$$7 = -1t$$
 Divide *both* sides by  $-1$ .

$$\frac{7}{-1} = \frac{-1t}{-1}$$

$$-7 = t$$

The solution is  $-7$ .

**Check:**  $7 = -t$

$$7 = -1t$$
 Replace  $t$  with  $-7$ .

$$7 = -1 \cdot -7$$

$$7 = 7$$
 Balances

- (c)  $-m = -20$  Write  $-m$  as  $-1m$ .

$$-1m = -20$$
 Divide *both* sides by  $-1$ .

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

$$m = 20$$

The solution is 20.

**Check:**

$$-m = -20$$

$$-1m = -20$$
 Replace  $m$  with 20.

$$-1 \cdot 20 = -20$$

$$-20 = -20$$
 Balances

## 2.4 Section Exercises

- 1.
- $6z = 12$
- Divide
- both*
- sides by 6.

$$\frac{6z}{6} = \frac{12}{6}$$

 $z = 2$  The solution is 2.
**Check:**  $6z = 12$  Replace  $z$  with 2.

$$6 \cdot 2 = 12$$

$$12 = 12 \quad \text{Balances}$$

- 2.
- $8k = 24$
- Check:**
- $8k = 24$

$$\frac{8k}{8} = \frac{24}{8}$$

$$k = 3$$

Balances

$$8 \cdot 3 = 24$$

$$24 = 24$$

The solution is 3.

- 3.
- $48 = 12r$
- Divide
- both*
- sides by 12.

$$\frac{48}{12} = \frac{12r}{12}$$

$$4 = r$$
 The solution is 4.

**Check:**  $48 = 12r$  Replace  $r$  with 4.

$$48 = 12 \cdot 4$$

$$48 = 48 \quad \text{Balances}$$

- 4.
- $99 = 11m$
- Check:**
- $99 = 11m$

$$\frac{99}{11} = \frac{11m}{11}$$

$$9 = m$$

Balances

$$99 = 11 \cdot 9$$

$$99 = 99$$

The solution is 9.

- 5.
- $3y = 0$
- Divide
- both*
- sides by 3.

$$\frac{3y}{3} = \frac{0}{3}$$

$$y = 0$$

The solution is 0.

**Check:**  $3y = 0$  Replace  $y$  with 0.

$$3 \cdot 0 = 0$$

$$0 = 0 \quad \text{Balances}$$

- 6.
- $5a = 0$
- Check:**
- $5a = 0$

$$\frac{5a}{5} = \frac{0}{5}$$

$$a = 0$$

Balances

$$5 \cdot 0 = 0$$

$$0 = 0$$

The solution is 0.

- 7.
- $-7k = 70$
- Divide
- both*
- sides by
- $-7$
- .

$$\frac{-7k}{-7} = \frac{70}{-7}$$

$$k = -10$$
 The solution is  $-10$ .

**Check:**  $-7k = 70$  Replace  $k$  with  $-10$ .

$$-7 \cdot -10 = 70$$

$$70 = 70 \quad \text{Balances}$$

- 8.
- $-6y = 36$
- Check:**
- $-6y = 36$

$$\frac{-6y}{-6} = \frac{36}{-6}$$

$$y = -6$$

Balances

$$-6 \cdot -6 = 36$$

$$36 = 36$$

The solution is  $-6$ .

- 9.
- $-54 = -9r$
- Divide
- both*
- sides by
- $-9$
- .

$$\frac{-54}{-9} = \frac{-9r}{-9}$$

$$6 = r$$

The solution is 6.

**Check:**  $-54 = -9r$  Replace  $r$  with 6.

$$-54 = -9 \cdot 6$$

$$-54 = -54 \quad \text{Balances}$$

- 10.
- $-36 = -4p$
- Check:**
- $-36 = -4p$

$$\frac{-36}{-4} = \frac{-4p}{-4}$$

$$9 = p$$

Balances

$$-36 = -4 \cdot 9$$

$$-36 = -36$$

The solution is 9.

- 11.
- $-25 = 5b$
- Divide
- both*
- sides by 5.

$$\frac{-25}{5} = \frac{5b}{5}$$

$$-5 = b$$

The solution is  $-5$ .**Check:**  $-25 = 5b$  Replace  $b$  with  $-5$ .

$$-25 = 5 \cdot -5$$

$$-25 = -25 \quad \text{Balances}$$

- 12.
- $-70 = 10x$
- Check:**
- $-70 = 10x$

$$\frac{-70}{10} = \frac{10x}{10}$$

$$-7 = x$$

Balances

$$-70 = 10 \cdot -7$$

$$-70 = -70$$

The solution is  $-7$ .

- 13.
- $2r = -7 + 13$
- Combine like terms.

$$2r = 6$$

Divide *both* sides by 2.

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

$$r = 3$$

The solution is 3.

**Check:**  $2r = -7 + 13$  Replace  $r$  with 3.

$$2 \cdot 3 = -7 + 13$$

$$6 = 6 \quad \text{Balances}$$

- 14.
- $6y = 28 - 4$
- Check:**
- $6y = 28 - 4$

$$6y = 24$$

$$6 \cdot 4 = 28 - 4$$

$$\frac{6y}{6} = \frac{24}{6}$$

$$y = 4$$

Balances

$$24 = 24$$

The solution is 4.

15.  $-12 = 5p - p$  Change to addition.  
 $-12 = 5p + -p$  Rewrite  $-p$  as  $-1p$ .  
 $-12 = 5p + -1p$  Combine like terms.  
 $-12 = 4p$  Divide *both* sides by 4.  
 $\frac{-12}{4} = \frac{4p}{4}$   
 $-3 = p$  The solution is  $-3$ .
- Check:**  $-12 = 5p - p$  Replace  $p$  with  $-3$ .  
 $-12 = 5 \cdot -3 - -3$   
 $-12 = -15 - -3$  Change to addition.  
 $-12 = -15 + +3$   
 $-12 = -12$  Balances
16.  $20 = z - 11z$  Change to addition.  
 $20 = 1z + -11z$  Combine like terms.  
 $20 = -10z$  Divide *both* sides by  $-10$ .  
 $\frac{20}{-10} = \frac{-10z}{-10}$   
 $-2 = z$  The solution is  $-2$ .
- Check:**  $20 = z - 11z$  Replace  $z$  with  $-2$ .  
 $20 = -2 - 11 \cdot -2$   
 $20 = -2 - -22$  Change to addition.  
 $20 = -2 + +22$   
 $20 = 20$  Balances
17.  $3 - 28 = 5a$  Change to addition.  
 $3 + -28 = 5a$  Combine like terms.  
 $\frac{-25}{5} = \frac{5a}{5}$  Divide *both* sides by 5.  
 $-5 = a$  The solution is  $-5$ .
18.  $-55 + 7 = 8n$   
 $-48 = 8n$  Divide *both* sides by 8.  
 $\frac{-48}{8} = \frac{8n}{8}$   
 $-6 = n$  The solution is  $-6$ .
19.  $x - 9x = 80$  Change to addition.  
 $x + -9x = 80$  Rewrite  $x$  as  $1x$ .  
 $1x + -9x = 80$  Combine like terms.  
 $-8x = 80$  Divide *both* sides by  $-8$ .  
 $\frac{-8x}{-8} = \frac{80}{-8}$   
 $x = -10$  The solution is  $-10$ .
20.  $4c - c = -27$   
 $4c - 1c = -27$   
 $3c = -27$  Divide *both* sides by 3.  
 $\frac{3c}{3} = \frac{-27}{3}$   
 $c = -9$  The solution is  $-9$ .
21.  $13 - 13 = 2w - w$  Change to addition.  
 $13 + -13 = 2w + -w$  Rewrite  $-w$  as  $-1w$ .  
 $13 + -13 = 2w + -1w$  Combine like terms.  
 $0 = 1w$   $1w$  is the same as  $w$ .  
 $0 = w$  The solution is 0.
22.  $-11 + 11 = 8t - 7t$   
 $0 = 8t + -7t$   
 $0 = 1t$   
 $0 = t$  The solution is 0.
23.  $3t + 9t = 20 - 10 + 26$  Change to addition.  
 $3t + 9t = 20 + -10 + 26$  Combine like terms.  
 $12t = 36$  Divide *both* sides by 12.  
 $\frac{12t}{12} = \frac{36}{12}$   
 $t = 3$  The solution is 3.
24.  $6m + 6m = 40 + 20 - 12$   
 $12m = 60 + -12$   
 $12m = 48$  Divide *both* sides by 12.  
 $\frac{12m}{12} = \frac{48}{12}$   
 $m = 4$  The solution is 4.
25.  $0 = -9t$  Divide *both* sides by  $-9$ .  
 $\frac{0}{-9} = \frac{-9t}{-9}$   
 $0 = t$  The solution is 0.
26.  $-10 = 10b$  Divide *both* sides by 10.  
 $\frac{-10}{10} = \frac{10b}{10}$   
 $-1 = b$  The solution is  $-1$ .
27.  $-14m + 8m = 6 - 60$  Change to addition.  
 $-14m + 8m = 6 + -60$  Combine like terms.  
 $-6m = -54$  Divide *both* sides by  $-6$ .  
 $\frac{-6m}{-6} = \frac{-54}{-6}$   
 $m = 9$  The solution is 9.
28.  $7w - 14w = 1 - 50$   
 $7w + -14w = 1 + -50$   
 $-7w = -49$  Divide *both* sides by  $-7$ .  
 $\frac{-7w}{-7} = \frac{-49}{-7}$   
 $w = 7$  The solution is 7.

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**29.**  $100 - 96 = 31y - 35y$  Change to addition.  
 $100 + ^{-}96 = 31y + ^{-}35y$  Combine like terms.  
 Divide *both* sides by  $^{-}4$ .  
 $4 = ^{-}4y$   
 $\frac{4}{^{-}4} = \frac{^{-}4y}{^{-}4}$   
 $^{-}1 = y$  The solution is  $^{-}1$ .

**30.**  $150 - 139 = 20x - 9x$   
 $150 + ^{-}139 = 20x + ^{-}9x$   
 Divide *both* sides by 11.  
 $11 = 11x$   
 $\frac{11}{11} = \frac{11x}{11}$   
 $1 = x$  The solution is 1.

**31.**  $3(2z) = ^{-}30$  To multiply on the left, use the associative property.  
 $(3 \cdot 2) \cdot z = ^{-}30$   
 $6z = ^{-}30$  Divide *both* sides by 6.  
 $\frac{6z}{6} = \frac{^{-}30}{6}$   
 $z = ^{-}5$  The solution is  $^{-}5$ .

**32.**  $2(4k) = 16$  To multiply on the left, use the associative property.  
 $(2 \cdot 4) \cdot k = 16$   
 $8k = 16$  Divide *both* sides by 8.  
 $\frac{8k}{8} = \frac{16}{8}$   
 $k = 2$  The solution is 2.

**33.**  $50 = ^{-}5(5p)$  To multiply on the right, use the associative property.  
 $50 = (^{-}5 \cdot 5) \cdot p$   
 $50 = ^{-}25p$  Divide *both* sides by  $^{-}25$ .  
 $\frac{50}{^{-}25} = \frac{^{-}25p}{^{-}25}$   
 $^{-}2 = p$  The solution is  $^{-}2$ .

**34.**  $60 = 4(^{-}3a)$  To multiply on the right, use the associative property.  
 $60 = (4 \cdot ^{-}3) \cdot a$   
 $60 = ^{-}12a$  Divide *both* sides by  $^{-}12$ .  
 $\frac{60}{^{-}12} = \frac{^{-}12a}{^{-}12}$   
 $^{-}5 = a$  The solution is  $^{-}5$ .

**35.**  $^{-}2(^{-}4k) = 56$  Associative property  
 $(^{-}2 \cdot ^{-}4) \cdot k = 56$   
 $8k = 56$  Divide *both* sides by 8.  
 $\frac{8k}{8} = \frac{56}{8}$   
 $k = 7$  The solution is 7.

**36.**  $^{-}5(4r) = ^{-}80$   
 $^{-}20r = ^{-}80$  Divide *both* sides by  $^{-}20$ .  
 $\frac{^{-}20r}{^{-}20} = \frac{^{-}80}{^{-}20}$   
 $r = 4$  The solution is 4.

**37.**  $^{-}90 = ^{-}10(^{-}3b)$  Associative property  
 $^{-}90 = (^{-}10 \cdot ^{-}3) \cdot b$   
 $^{-}90 = 30b$  Divide *both* sides by 30.  
 $\frac{^{-}90}{30} = \frac{30b}{30}$   
 $^{-}3 = b$  The solution is  $^{-}3$ .

**38.**  $^{-}90 = ^{-}5(^{-}2y)$   
 $^{-}90 = 10y$  Divide *both* sides by 10.  
 $\frac{^{-}90}{10} = \frac{10y}{10}$   
 $^{-}9 = y$  The solution is  $^{-}9$ .

**39.**  $^{-}x = 32$  Write in the understood  $^{-}1$ .  
 $^{-}1x = 32$  Divide *both* sides by  $^{-}1$ .  
 $\frac{^{-}1x}{^{-}1} = \frac{32}{^{-}1}$   
 $x = ^{-}32$  The solution is  $^{-}32$ .

**40.**  $^{-}c = 23$  Write in the understood  $^{-}1$ .  
 $^{-}1c = 23$  Divide *both* sides by  $^{-}1$ .  
 $\frac{^{-}1c}{^{-}1} = \frac{23}{^{-}1}$   
 $c = ^{-}23$  The solution is  $^{-}23$ .

**41.**  $^{-}2 = ^{-}w$  Write in the understood  $^{-}1$ .  
 $^{-}2 = ^{-}1w$  Divide *both* sides by  $^{-}1$ .  
 $\frac{^{-}2}{^{-}1} = \frac{^{-}1w}{^{-}1}$   
 $2 = w$  The solution is 2.

**42.**  $^{-}75 = ^{-}t$  Write in the understood  $^{-}1$ .  
 $^{-}75 = ^{-}1t$  Divide *both* sides by  $^{-}1$ .  
 $\frac{^{-}75}{^{-}1} = \frac{^{-}1t}{^{-}1}$   
 $75 = t$  The solution is 75.

**43.**  $^{-}n = ^{-}50$  Write in the understood  $^{-}1$ .  
 $^{-}1n = ^{-}50$  Divide *both* sides by  $^{-}1$ .  
 $\frac{^{-}1n}{^{-}1} = \frac{^{-}50}{^{-}1}$   
 $n = 50$  The solution is 50.

**44.**  $^{-}x = ^{-}1$  Write in the understood  $^{-}1$ .  
 $^{-}1x = ^{-}1$  Divide *both* sides by  $^{-}1$ .  
 $\frac{^{-}1x}{^{-}1} = \frac{^{-}1}{^{-}1}$   
 $x = 1$  The solution is 1.



45.  $10 = -p$  Write in the understood  $-1$ .  
 $10 = -1p$  Divide *both* sides by  $-1$ .  
 $\frac{10}{-1} = \frac{-1p}{-1}$   
 $-10 = p$  The solution is  $-10$ .

46.  $100 = -k$  Write in the understood  $-1$ .  
 $100 = -1k$  Divide *both* sides by  $-1$ .  
 $\frac{100}{-1} = \frac{-1k}{-1}$   
 $-100 = k$  The solution is  $-100$ .

47. Each solution is the opposite of the number in the equation. So the rule is: When you change the sign of the variable from negative to positive, then change the number in the equation to its opposite. In  $-x = 5$ , the opposite of 5 is  $-5$ , so  $x = -5$ .

48. You can divide both sides of an equation by the same nonzero number and keep the equation balanced.

49. Divide by the coefficient of  $x$ , which is 3, *not* by the opposite of 3.

$$3x = 16 - 1$$

$$3x = 15$$

$$\frac{3x}{3} = \frac{15}{3}$$

$$x = 5$$

The correct solution is 5.

50. Equations will vary. Some possibilities are (i)  $-5x = 20$  and (ii)  $12 - 20 = 2x$ .

(i)  $-5x = 20$  Divide *both* sides by  $-5$ .  
 $\frac{-5x}{-5} = \frac{20}{-5}$   
 $x = -4$  The solution is  $-4$ .

(ii)  $12 - 20 = 2x$  Change to addition.  
 $12 + -20 = 2x$  Combine like terms.  
 $\frac{-8}{2} = \frac{2x}{2}$  Divide *both* sides by 2.  
 $-4 = x$  The solution is  $-4$ .

51.  $3s = 45$  Divide *both* sides by 3.  
 $\frac{3s}{3} = \frac{45}{3}$   
 $s = 15$

The length of one side is 15 feet.

52.  $3s = 63$  Divide *both* sides by 3.  
 $\frac{3s}{3} = \frac{63}{3}$   
 $s = 21$

The length of one side is 21 inches.

53.  $120 = 5s$  Divide *both* sides by 5.  
 $\frac{120}{5} = \frac{5s}{5}$   
 $24 = s$

The length of one side is 24 meters.

54.  $335 = 5s$  Divide *both* sides by 5.  
 $\frac{335}{5} = \frac{5s}{5}$   
 $67 = s$

The length of one side is 67 yards.

55.  $89 - 116 = -4(-4y) - 9(2y) + y$

Use the associative property to simplify the products.

$$89 - 116 = (-4 \cdot -4) \cdot y - (9 \cdot 2) \cdot y + y$$

$$89 - 116 = 16y - 18y + y$$

Change to addition. Combine like terms.

$$89 + -116 = 16y + -18y + y$$

$$-27 = -1y$$

Divide both sides by the coefficient,  $-1$ , to get  $y$  by itself.

$$\frac{-27}{-1} = \frac{-1y}{-1}$$

$$27 = y$$

The solution is 27.

56.  $58 - 208 = -b + 8(-3b) + 5(-5b)$   
 $58 + -208 = -b + -24b + -25b$   
 $-150 = -50b$   
 $\frac{-150}{-50} = \frac{-50b}{-50}$   
 $3 = b$

The solution is 3.

57.  $-37(14x) + 28(21x) = |72 - 72| + |-166 + 96|$

Simplify within the absolute values.

$$-37(14x) + 28(21x) = |0| + |-70|$$

Simplify the absolute values.

$$-37(14x) + 28(21x) = 0 + 70$$

Use the associative property to multiply on the left.

$$(-37 \cdot 14) \cdot x + (28 \cdot 21) \cdot x = 0 + 70$$

$$-518x + 588x = 70$$

Combine like terms.

$$70x = 70$$

Divide both sides by the coefficient, 70, to get  $x$  by itself.

*continued*

$$\frac{70x}{70} = \frac{70}{70}$$

$x = 1$  The solution is 1.

58.  $6a - 10a - 3(2a) = |-25 - 25| - 5(8)$

$$6a + ^{-}10a - 6a = |-25 + ^{-}25| - 40$$

$$6a + ^{-}10a + ^{-}6a = |-50| - 40$$

$$^{-}10a = 50 - 40$$

$$^{-}10a = 10$$

$$\frac{^{-}10a}{^{-}10} = \frac{10}{^{-}10}$$

$$a = ^{-}1$$

The solution is  $^{-}1$ .

## 2.5 Solving Equations with Several Steps

### 2.5 Margin Exercises

1. (a)  $2r + 7 = 13$  To get  $2r$  by itself, add

$$\begin{array}{r} ^{-}7 \quad ^{-}7 \\ \hline 2r + 0 = 6 \end{array}$$

$2r = 6$  To solve for  $r$ , divide both sides by the coefficient, 2.

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

$r = 3$  The solution is 3.

**Check:**  $2r + 7 = 13$

$$2 \cdot 3 + 7 = 13$$

$$6 + 7 = 13$$

$$13 = 13 \quad \text{Balances}$$

(b)  $20 = 6y - 4$  Change to addition.

$$20 = 6y + ^{-}4 \quad \text{Add 4 to both sides.}$$

$$\begin{array}{r} 4 \quad 4 \\ \hline 24 = 6y + 0 \end{array}$$

$$24 = 6y \quad \text{Divide both sides by 6.}$$

$$\frac{24}{6} = \frac{6y}{6}$$

$$4 = y \quad \text{The solution is 4.}$$

**Check:**  $20 = 6y - 4$

$$20 = 6 \cdot 4 - 4$$

$$20 = 24 - 4$$

$$20 = 20 \quad \text{Balances}$$

(c)  $^{-}10z - 9 = 11$  Change to addition.

$$^{-}10z + ^{-}9 = 11 \quad \text{Add 9 to both sides.}$$

$$\begin{array}{r} 9 \quad 9 \\ \hline ^{-}10z + 0 = 20 \end{array}$$

$^{-}10z = 20$  Divide both sides by  $^{-}10$ .

$$\frac{^{-}10z}{^{-}10} = \frac{20}{^{-}10}$$

$$z = ^{-}2 \quad \text{The solution is } ^{-}2.$$

**Check:**  $^{-}10z - 9 = 11$

$$^{-}10 \cdot ^{-}2 - 9 = 11$$

$$20 - 9 = 11$$

$$11 = 11 \quad \text{Balances}$$

2. (a) Solve with the variable on *left* side.

$$3y - 1 = 2y + 7 \quad \text{Add } ^{-}2y \text{ to both sides.}$$

$$\begin{array}{r} ^{-}2y \quad ^{-}2y \\ \hline 1y - 1 = 0 + 7 \end{array} \quad \text{Change to addition.}$$

$$1y + ^{-}1 = 7 \quad \text{Add 1 to both sides.}$$

$$\begin{array}{r} 1 \quad 1 \\ \hline 1y + 0 = 8 \end{array}$$

$$1y = 8$$

$$\text{or } y = 8 \quad \text{The solution is 8.}$$

Solve with the variable on the *right* side.

$$3y - 1 = 2y + 7 \quad \text{Add } ^{-}3y \text{ to both sides.}$$

$$\begin{array}{r} ^{-}3y \quad ^{-}3y \\ \hline 0 - 1 = ^{-}1y + 7 \end{array}$$

$$^{-}1 = ^{-}1y + 7 \quad \text{Add } ^{-}7 \text{ to both sides.}$$

$$\begin{array}{r} ^{-}7 \quad ^{-}7 \\ \hline ^{-}8 = ^{-}1y + 0 \end{array}$$

$$^{-}8 = ^{-}1y \quad \text{Divide both sides by } ^{-}1.$$

$$\begin{array}{r} ^{-}8 \quad ^{-}1y \\ \hline ^{-}1 = ^{-}1 \end{array}$$

$$8 = y \quad \text{The solution is 8.}$$

(b) Solve with the variable on *left* side.

$$3p - 2 = p - 6 \quad \text{Rewrite } p \text{ as } 1p.$$

$$3p - 2 = 1p - 6 \quad \text{Add } ^{-}1p \text{ to both sides.}$$

$$\begin{array}{r} ^{-}1p \quad ^{-}1p \\ \hline 2p - 2 = 0 - 6 \end{array} \quad \text{Change to addition.}$$

$$2p + ^{-}2 = ^{-}6 \quad \text{Add 2 to both sides.}$$

$$\begin{array}{r} 2 \quad 2 \\ \hline 2p + 0 = ^{-}4 \end{array}$$

$$2p = ^{-}4 \quad \text{Divide both sides by 2.}$$

$$\begin{array}{r} 2p \quad ^{-}4 \\ \hline \frac{2p}{2} = \frac{^{-}4}{2} \end{array}$$

$$p = ^{-}2 \quad \text{The solution is } ^{-}2.$$

Solve with the variable on the *right* side.

$$3p - 2 = p - 6 \quad \text{Rewrite } p \text{ as } 1p.$$

$$3p - 2 = 1p - 6 \quad \text{Add } ^{-}3p \text{ to both sides.}$$

$$\begin{array}{r} ^{-}3p \quad ^{-}3p \\ \hline 0 - 2 = ^{-}2p - 6 \end{array}$$

$$^{-}2 = ^{-}2p - 6 \quad \text{Add 6 to both sides.}$$

$$\begin{array}{r} 6 \quad 6 \\ \hline 4 = ^{-}2p + 0 \end{array}$$

$$4 = ^{-}2p \quad \text{Divide both sides by } ^{-}2.$$

$$\begin{array}{r} 4 \quad ^{-}2p \\ \hline \frac{4}{^{-}2} = \frac{^{-}2p}{^{-}2} \end{array}$$

$$^{-}2 = p \quad \text{The solution is } ^{-}2.$$

3. (a)  $-12 = 4(y - 1)$  Distribute on the right.  
 $-12 = 4 \cdot y - 4 \cdot 1$   
 $-12 = 4y - 4$  Change to addition.  
 $-12 = 4y + ^{-}4$  Add 4 to both sides.

$$\begin{array}{r} 4 \qquad 4 \\ \hline ^{-}8 = 4y + 0 \end{array}$$

$^{-}8 = 4y$  Divide both sides by 4.  
 $\frac{^{-}8}{4} = \frac{4y}{4}$   
 $^{-}2 = y$  The solution is  $^{-}2$ .

**Check:**  $-12 = 4(y - 1)$  Replace  $y$  with  $^{-}2$ .  
 $-12 = 4(^{-}2 - 1)$   
 $-12 = 4(^{-}3)$   
 $-12 = ^{-}12$  Balances

(b)  $5(m + 4) = 20$  Distribute on the left.  
 $5 \cdot m + 5 \cdot 4 = 20$   
 $5m + 20 = 20$  Add  $^{-}20$  to both sides.

$$\begin{array}{r} ^{-}20 \quad ^{-}20 \\ \hline 5m + 0 = 0 \end{array}$$

$5m = 0$  Divide both sides by 5.  
 $\frac{5m}{5} = \frac{0}{5}$   
 $m = 0$  The solution is 0.

**Check:**  $5(m + 4) = 20$  Replace  $m$  with 0.  
 $5(0 + 4) = 20$   
 $5(4) = 20$   
 $20 = 20$  Balances

(c)  $6(t - 2) = 18$  Distribute on the left.  
 $6 \cdot t - 6 \cdot 2 = 18$   
 $6t - 12 = 18$  Change to addition.  
 $6t + ^{-}12 = 18$  Add 12 to both sides.

$$\begin{array}{r} 12 \quad 12 \\ \hline 6t + 0 = 30 \end{array}$$

$6t = 30$  Divide both sides by 6.  
 $\frac{6t}{6} = \frac{30}{6}$   
 $t = 5$  The solution is 5.

**Check:**  $6(t - 2) = 18$  Replace  $t$  with 5.  
 $6(5 - 2) = 18$   
 $6(3) = 18$   
 $18 = 18$  Balances

4. (a)  $3(b + 7) = 2b - 1$  Distribute on the left.  
 $3 \cdot b + 3 \cdot 7 = 2b - 1$   
 $3b + 21 = 2b - 1$  Variables to the left.  
 $^{-}2b$   $^{-}2b$  Add  $^{-}2b$  to both sides.

$$\begin{array}{r} ^{-}2b \qquad ^{-}2b \\ \hline 1b + 21 = 0 - 1 \end{array}$$

$1b + 21 = ^{-}1$  Add  $^{-}21$  to both sides.  
 $\frac{^{-}21}{^{-}21} \quad \frac{^{-}21}{^{-}21}$   
 $1b + 0 = ^{-}22$   
 $1b = ^{-}22$   
or  $b = ^{-}22$  The solution is  $^{-}22$ .

**Check:**  $3(b + 7) = 2b - 1$   
 $3(^{-}22 + 7) = 2 \cdot ^{-}22 - 1$   
 $3(^{-}15) = ^{-}44 - 1$   
 $^{-}45 = ^{-}45$  Balances

(b)  $6 - 2n = 14 + 4(n - 5)$  Distribute.  
 $6 - 2n = 14 + 4 \cdot n - 4 \cdot 5$   
 $6 - 2n = 14 + 4n - 20$  Add the opposite.  
 $6 + ^{-}2n = 14 + 4n + ^{-}20$  Combine like terms.  
 $6 + ^{-}2n = ^{-}6 + 4n$  Add  $2n$  to both sides.

$$\begin{array}{r} 2n \qquad 2n \\ \hline 6 + 0 = ^{-}6 + 6n \end{array}$$

$6 = ^{-}6 + 6n$  Add 6 to both sides.  
 $\frac{6}{6} \quad \frac{6}{6}$   
 $12 = 0 + 6n$   
 $12 = 6n$  Divide both sides by 6.  
 $\frac{12}{6} = \frac{6n}{6}$   
 $2 = n$  The solution is 2.

**Check:**  $6 - 2n = 14 + 4(n - 5)$   
 $6 - 2 \cdot 2 = 14 + 4(2 - 5)$   
 $6 - 4 = 14 + 4(^{-}3)$   
 $2 = 14 + ^{-}12$   
 $2 = 2$  Balances

## 2.5 Section Exercises

1.  $7p + 5 = 12$  To get  $7p$  by itself, add  $^{-}5$  to both sides.

$$\begin{array}{r} ^{-}5 \quad ^{-}5 \\ \hline 7p + 0 = 7 \end{array}$$

$7p = 7$  Divide both sides by 7.  
 $\frac{7p}{7} = \frac{7}{7}$   
 $p = 1$  The solution is 1.

**Check:**  $7p + 5 = 12$   
 $7(1) + 5 = 12$   
 $7 + 5 = 12$   
 $12 = 12$  Balances

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$$\begin{array}{l}
 2. \quad 6k + 3 = 15 \quad \text{Check:} \quad 6k + 3 = 15 \\
 \quad \quad \underline{-3 \quad -3} \quad \quad \quad \quad 6(2) + 3 = 15 \\
 6k + 0 = 12 \quad \quad \quad \quad 12 + 3 = 15 \\
 \quad \quad \quad \quad \quad \quad \quad \quad 15 = 15 \\
 \quad \quad \quad \quad \quad \quad \quad \quad \quad \text{Balances} \\
 \quad \quad \quad \quad \frac{6k}{6} = \frac{12}{6} \\
 \quad \quad \quad \quad k = 2
 \end{array}$$

The solution is 2.

$$\begin{array}{l}
 3. \quad 2 = 8y - 6 \quad \text{Change to addition.} \\
 2 = 8y + ^{-}6 \quad \text{To get } 8y \text{ by itself, add} \\
 \underline{6 \quad \quad \quad 6} \quad \text{6 to both sides.} \\
 8 = 8y + 0 \quad \text{Divide both sides by 8.} \\
 \frac{8}{8} = \frac{8y}{8} \\
 1 = y \quad \quad \text{The solution is 1.}
 \end{array}$$

**Check:**  $2 = 8y - 6$   
 $2 = 8(1) - 6$   
 $2 = 8 - 6$   
 $2 = 2$  Balances

$$\begin{array}{l}
 4. \quad 10 = 11p - 12 \quad \text{Check:} \quad 10 = 11p - 12 \\
 10 = 11p + ^{-}12 \quad \quad \quad \quad 10 = 11(2) - 12 \\
 \underline{12 \quad \quad \quad 12} \quad \quad \quad \quad 10 = 22 - 12 \\
 22 = 11p + 0 \quad \quad \quad \quad 10 = 10 \\
 \frac{22}{11} = \frac{11p}{11} \quad \quad \quad \quad \text{Balances} \\
 2 = p
 \end{array}$$

The solution is 2.

$$\begin{array}{l}
 5. \quad ^{-}3m + 1 = 1 \quad \text{To get } ^{-}3m \text{ by itself, add} \\
 \underline{-1 \quad -1} \quad \quad \quad \quad ^{-}1 \text{ to both sides.} \\
 ^{-}3m + 0 = 0 \\
 ^{-}3m = 0 \quad \text{Divide both sides by } ^{-}3. \\
 \frac{-3m}{-3} = \frac{0}{-3} \\
 m = 0 \quad \text{The solution is 0.}
 \end{array}$$

**Check:**  $^{-}3m + 1 = 1$   
 $^{-}3(0) + 1 = 1$   
 $0 + 1 = 1$   
 $1 = 1$  Balances

$$\begin{array}{l}
 6. \quad ^{-}4k + 5 = 5 \quad \text{Check:} \quad ^{-}4k + 5 = 5 \\
 \underline{-5 \quad -5} \quad \quad \quad \quad ^{-}4(0) + 5 = 5 \\
 ^{-}4k + 0 = 0 \quad \quad \quad \quad 0 + 5 = 5 \\
 \quad \quad \quad \quad \quad \quad \quad \quad 5 = 5 \\
 \quad \quad \quad \quad \frac{-4k}{-4} = \frac{0}{-4} \quad \quad \quad \quad \text{Balances} \\
 \quad \quad \quad \quad k = 0
 \end{array}$$

The solution is 0.

$$\begin{array}{l}
 7. \quad 28 = ^{-}9a + 10 \quad \text{To get } ^{-}9a \text{ by itself, add} \\
 \underline{-10 \quad -10} \quad \quad \quad \quad ^{-}10 \text{ to both sides.} \\
 18 = ^{-}9a + 0 \\
 18 = ^{-}9a \quad \text{Divide both sides by } ^{-}9. \\
 \frac{18}{-9} = \frac{-9a}{-9} \\
 ^{-}2 = a \quad \quad \quad \text{The solution is } ^{-}2.
 \end{array}$$

**Check:**  $28 = ^{-}9a + 10$   
 $28 = ^{-}9(^{-}2) + 10$   
 $28 = 18 + 10$   
 $28 = 28$  Balances

$$\begin{array}{l}
 8. \quad 75 = ^{-}10w + 25 \\
 \underline{-25 \quad -25} \\
 50 = ^{-}10w + 0 \\
 \frac{50}{-10} = \frac{-10w}{-10} \\
 ^{-}5 = w
 \end{array}$$

The solution is  $^{-}5$ .

**Check:**  $75 = ^{-}10w + 25$   
 $75 = ^{-}10(^{-}5) + 25$   
 $75 = 50 + 25$   
 $75 = 75$  Balances

$$\begin{array}{l}
 9. \quad ^{-}5x - 4 = 16 \quad \text{Change to addition.} \\
 ^{-}5x + ^{-}4 = 16 \quad \text{To get } ^{-}5x \text{ by itself, add} \\
 \underline{4 \quad 4} \quad \text{4 to both sides.} \\
 ^{-}5x + 0 = 20 \\
 ^{-}5x = 20 \quad \text{Divide both sides by } ^{-}5. \\
 \frac{-5x}{-5} = \frac{20}{-5} \\
 x = ^{-}4 \quad \text{The solution is } ^{-}4.
 \end{array}$$

**Check:**  $^{-}5x - 4 = 16$   
 $^{-}5(^{-}4) - 4 = 16$   
 $20 - 4 = 16$   
 $16 = 16$  Balances

$$\begin{array}{l}
 10. \quad ^{-}12b - 3 = 21 \quad \text{Check:} \quad ^{-}12b - 3 = 21 \\
 ^{-}12b + ^{-}3 = 21 \quad \quad \quad \quad ^{-}12(^{-}2) - 3 = 21 \\
 \underline{3 \quad 3} \quad \quad \quad \quad 24 - 3 = 21 \\
 ^{-}12b + 0 = 24 \quad \quad \quad \quad 21 = 21 \\
 \frac{-12b}{-12} = \frac{24}{-12} \quad \quad \quad \quad \text{Balances} \\
 b = ^{-}2
 \end{array}$$

The solution is  $^{-}2$ .

11. Solve with the variable on the
- left*
- side.

$$\begin{aligned}
 6p - 2 &= 4p + 6 && \text{Change to addition.} \\
 6p + ^{-}2 &= 4p + 6 && \text{Add } ^{-}4p \text{ to both sides.} \\
 \frac{-4p}{2p + ^{-}2} &= \frac{-4p}{0 + 6} \\
 2p + ^{-}2 &= 6 && \text{Add 2 to both sides.} \\
 \frac{2}{2} &= \frac{2}{2} \\
 \hline
 2p + 0 &= 8 \\
 2p &= 8 && \text{Divide both sides by 2.} \\
 \frac{2p}{2} &= \frac{8}{2} \\
 p &= 4 && \text{The solution is 4.}
 \end{aligned}$$

Solve with the variable on the *right* side.

$$\begin{aligned}
 6p - 2 &= 4p + 6 && \text{Change to addition.} \\
 6p + ^{-}2 &= 4p + 6 && \text{Add } ^{-}6p \text{ to both sides.} \\
 \frac{-6p}{0 + ^{-}2} &= \frac{-6p}{^{-}2p + 6} \\
 ^{-}2 &= ^{-}2p + 6 && \text{Add } ^{-}6 \text{ to both sides.} \\
 \frac{-6}{^{-}8} &= \frac{-6}{^{-}2p + 0} \\
 ^{-}8 &= ^{-}2p && \text{Divide both sides by } ^{-}2. \\
 \frac{-8}{^{-}2} &= \frac{-2p}{^{-}2} \\
 4 &= p && \text{The solution is 4.}
 \end{aligned}$$

**Check:**

$$\begin{aligned}
 6p - 2 &= 4p + 6 \\
 6(4) - 2 &= 4(4) + 6 \\
 24 - 2 &= 16 + 6 \\
 22 &= 22 && \text{Balances}
 \end{aligned}$$

- 12.
- Left side:**

$$\begin{aligned}
 5y - 5 &= 2y + 10 && \text{Right side:} \\
 \frac{-2y}{3y - 5} &= \frac{-2y}{0 + 10} && \frac{5y - 5}{0 - 5} = \frac{2y + 10}{^{-}3y + 10} \\
 3y + ^{-}5 &= 10 && ^{-}5 = ^{-}3y + 10 \\
 \frac{5}{3y + 0} &= \frac{5}{15} && \frac{-10}{^{-}15} = \frac{-10}{^{-}3y + 0} \\
 \frac{3y}{3} &= \frac{15}{3} && \frac{-15}{^{-}3} = \frac{-3y}{^{-}3} \\
 y &= 5 && 5 = y
 \end{aligned}$$

The solution is 5.

**Check:**

$$\begin{aligned}
 5y - 5 &= 2y + 10 \\
 5(5) - 5 &= 2(5) + 10 \\
 25 - 5 &= 10 + 10 \\
 20 &= 20 && \text{Balances}
 \end{aligned}$$

13. Solve with the variable on the
- left*
- side.

$$\begin{aligned}
 ^{-}2k - 6 &= 6k + 10 && \text{Change to addition.} \\
 ^{-}2k + ^{-}6 &= 6k + 10 && \text{Add } ^{-}6k \text{ to} \\
 &&& \text{both sides.} \\
 \frac{-6k}{^{-}8k + ^{-}6} &= \frac{-6k}{0 + 10} \\
 ^{-}8k + ^{-}6 &= 10 && \text{Add 6 to} \\
 &&& \text{both sides.} \\
 \frac{6}{^{-}8k + 0} &= \frac{6}{16} && \text{Divide both sides} \\
 &&& \text{by } ^{-}8. \\
 \frac{-8k}{^{-}8} &= \frac{16}{^{-}8} \\
 k &= ^{-}2 && \text{The solution is } ^{-}2.
 \end{aligned}$$

Solve with the variable on the *right* side.

$$\begin{aligned}
 ^{-}2k - 6 &= 6k + 10 && \text{Change to addition.} \\
 ^{-}2k + ^{-}6 &= 6k + 10 && \text{Add } 2k \text{ to} \\
 &&& \text{both sides.} \\
 \frac{2k}{0 + ^{-}6} &= \frac{2k}{8k + 10} \\
 ^{-}6 &= 8k + 10 && \text{Add } ^{-}10 \text{ to} \\
 &&& \text{both sides.} \\
 \frac{-10}{^{-}16} &= \frac{-10}{8k + 0} && \text{Divide both sides} \\
 &&& \text{by 8.} \\
 \frac{-16}{8} &= \frac{8k}{8} \\
 ^{-}2 &= k && \text{The solution is } ^{-}2.
 \end{aligned}$$

**Check:**

$$\begin{aligned}
 ^{-}2k - 6 &= 6k + 10 \\
 ^{-}2(^{-}2) - 6 &= 6(^{-}2) + 10 \\
 4 + ^{-}6 &= ^{-}12 + 10 \\
 ^{-}2 &= ^{-}2 && \text{Balances}
 \end{aligned}$$

- 14.
- Left side:**

$$\begin{aligned}
 5x + 4 &= ^{-}3x - 4 && \text{Right side:} \\
 \frac{3x}{8x + 4} &= \frac{3x}{0 - 4} && \frac{5x + 4}{^{-}5x} = \frac{^{-}3x - 4}{^{-}5x} \\
 8x + 4 &= ^{-}4 && 0 + 4 = \frac{^{-}8x - 4}{^{-}8x - 4} \\
 \frac{-4}{8x + 0} &= \frac{-4}{^{-}8} && 4 = \frac{4}{^{-}8x + ^{-}4} \\
 \frac{8x}{8} &= \frac{-8}{^{-}8} && \frac{4}{4} = \frac{4}{4} \\
 x &= ^{-}1 && 8 = \frac{^{-}8x + 0}{^{-}8x + 0} \\
 &&& \frac{8}{^{-}8} = \frac{^{-}8x}{^{-}8} \\
 &&& ^{-}1 = x
 \end{aligned}$$

The solution is  $-1$ .

**Check:**

$$\begin{aligned}
 5x + 4 &= ^{-}3x - 4 \\
 5(^{-}1) + 4 &= ^{-}3(^{-}1) - 4 \\
 ^{-}5 + 4 &= 3 + ^{-}4 \\
 ^{-}1 &= ^{-}1
 \end{aligned}$$

Balances

15. Solve with the variable on the *left* side.

$$\begin{array}{rcl}
 -18 + 7a & = & 2a + 7 \quad \text{Add } -2a \text{ to} \\
 & & \text{both sides.} \\
 \hline
 -18 + 5a & = & 0 + 7 \\
 -18 + 5a & = & 7 \quad \text{Add 18 to} \\
 & & \text{both sides.} \\
 \hline
 18 & & 18 \\
 0 + 5a & = & 25 \\
 5a & = & 25 \quad \text{Divide both} \\
 & & \text{sides by 5.} \\
 \hline
 \frac{5a}{5} & = & \frac{25}{5} \\
 a & = & 5 \quad \text{The solution is 5.}
 \end{array}$$

Solve with the variable on the *right* side.

$$\begin{array}{rcl}
 -18 + 7a & = & 2a + 7 \quad \text{Add } -7a \text{ to} \\
 & & \text{both sides.} \\
 \hline
 -18 + 0 & = & -5a + 7 \\
 -18 & = & -5a + 7 \quad \text{Add } -7 \text{ to} \\
 & & \text{both sides.} \\
 \hline
 -7 & & -7 \\
 -25 & = & -5a + 0 \\
 -25 & = & -5a \quad \text{Divide both} \\
 & & \text{sides by } -5. \\
 \hline
 \frac{-25}{-5} & = & \frac{-5a}{-5} \\
 5 & = & a \quad \text{The solution is 5.}
 \end{array}$$

**Check:**

$$\begin{array}{l}
 -18 + 7a = 2a + 7 \\
 -18 + 7(5) = 2(5) + 7 \\
 -18 + 35 = 10 + 7 \\
 17 = 17 \quad \text{Balances}
 \end{array}$$

16. **Left side:**

$$\begin{array}{rcl}
 -9 + 2z & = & 9z + 12 \\
 \hline
 -9 + -7z & = & 0 + 12 \\
 -9 + -7z & = & 12 \\
 9 & & 9 \\
 \hline
 0 + -7z & = & 21 \\
 -7z & = & 21 \\
 \hline
 \frac{-7z}{-7} & = & \frac{21}{-7} \\
 z & = & -3 \quad \text{The solution is } -3.
 \end{array}$$

**Right side:**

$$\begin{array}{rcl}
 -9 + 2z & = & 9z + 12 \\
 \hline
 -2z & & -2z \\
 -9 + 0 & = & 7z + 12 \\
 -9 & = & 7z + 12 \\
 \hline
 -12 & & -12 \\
 -21 & = & 7z + 0 \\
 -21 & = & 7z \\
 \hline
 \frac{-21}{7} & = & \frac{7z}{7} \\
 -3 & = & z \quad \text{The solution is } -3.
 \end{array}$$

**Check:**

$$\begin{array}{l}
 -9 + 2z = 9z + 12 \\
 -9 + 2(-3) = 9(-3) + 12 \\
 -9 + -6 = -27 + 12 \\
 -15 = -15 \quad \text{Balances}
 \end{array}$$

17.

$$\begin{array}{rcl}
 8(w - 2) & = & 32 \quad \text{Distribute.} \\
 8w - 16 & = & 32 \quad \text{Change to addition.} \\
 8w + -16 & = & 32 \quad \text{Add 16 to both sides.} \\
 \hline
 16 & & 16 \\
 8w + 0 & = & 48 \\
 8w & = & 48 \quad \text{Divide both sides by 8.} \\
 \hline
 \frac{8w}{8} & = & \frac{48}{8} \\
 w & = & 6 \quad \text{The solution is 6.}
 \end{array}$$

18.

$$\begin{array}{rcl}
 9(b - 4) & = & 27 \\
 9b - 36 & = & 27 \\
 9b + -36 & = & 27 \\
 \hline
 36 & & 36 \\
 9b + 0 & = & 63 \\
 9b & = & 63 \\
 \hline
 \frac{9b}{9} & = & \frac{63}{9} \\
 b & = & 7 \quad \text{The solution is 7.}
 \end{array}$$

19.

$$\begin{array}{rcl}
 -10 & = & 2(y + 4) \quad \text{Distribute.} \\
 -10 & = & 2y + 8 \quad \text{Add } -8 \text{ to both sides.} \\
 \hline
 -8 & & -8 \\
 -18 & = & 2y + 0 \\
 -18 & = & 2y \quad \text{Divide both sides by 2.} \\
 \hline
 \frac{-18}{2} & = & \frac{2y}{2} \\
 -9 & = & y \quad \text{The solution is } -9.
 \end{array}$$

20.

$$\begin{array}{rcl}
 -3 & = & 3(x + 6) \\
 -3 & = & 3x + 18 \\
 \hline
 -18 & & -18 \\
 -21 & = & 3x + 0 \\
 -21 & = & 3x \\
 \hline
 \frac{-21}{3} & = & \frac{3x}{3} \\
 -7 & = & x \quad \text{The solution is } -7.
 \end{array}$$

21.  $-4(t + 2) = 12$  Distribute.  
 $-4t + -8 = 12$  Add 8 to both sides.  

$$\begin{array}{r} 8 \\ \hline -4t + 0 = 20 \end{array}$$
 $-4t = 20$  Divide both sides by  $-4$ .  

$$\frac{-4t}{-4} = \frac{20}{-4}$$
 $t = -5$  The solution is  $-5$ .
22.  $-5(k + 3) = 25$   
 $-5k + -15 = 25$   

$$\begin{array}{r} 15 \\ \hline -5k + 0 = 40 \end{array}$$
 $\frac{-5k}{-5} = \frac{40}{-5}$   
 $k = -8$  The solution is  $-8$ .
23.  $6(x - 5) = -30$  Distribute.  
 $6x - 30 = -30$  Change to addition.  
 $6x + -30 = -30$  Add 30 to both sides.  

$$\begin{array}{r} 30 \\ \hline 6x + 0 = 0 \end{array}$$
 $6x = 0$  Divide both sides by 6.  

$$\frac{6x}{6} = \frac{0}{6}$$
 $x = 0$  The solution is 0.
24.  $7(r - 7) = -49$   
 $7r - 49 = -49$   
 $7r + -49 = -49$   

$$\begin{array}{r} 49 \\ \hline 7r + 0 = 0 \end{array}$$
 $\frac{7r}{7} = \frac{0}{7}$   
 $r = 0$  The solution is 0.
25.  $-12 = 12(h - 2)$  Distribute.  
 $-12 = 12h - 24$  Change to addition.  
 $-12 = 12h + -24$  Add 24 to both sides.  

$$\begin{array}{r} 24 \\ \hline 12 = 12h + 0 \end{array}$$
 $12 = 12h$  Divide both sides by 12.  

$$\frac{12}{12} = \frac{12h}{12}$$
 $1 = h$  The solution is 1.
26.  $-11 = 11(c - 3)$   
 $-11 = 11c - 33$   
 $-11 = 11c + -33$   

$$\begin{array}{r} 33 \\ \hline 22 = 11c + 0 \end{array}$$
 $\frac{22}{11} = \frac{11c}{11}$   
 $2 = c$  The solution is 2.
27.  $0 = -2(y + 2)$  Distribute.  
 $0 = -2y + -4$  Add 4 to both sides.  

$$\begin{array}{r} 4 \\ \hline 4 = -2y + 0 \end{array}$$
 $4 = -2y$  Divide both sides by  $-2$ .  

$$\frac{4}{-2} = \frac{-2y}{-2}$$
 $-2 = y$  The solution is  $-2$ .
28.  $0 = -9(b + 1)$   
 $0 = -9b + -9$   

$$\begin{array}{r} 9 \\ \hline 9 = -9b + 0 \end{array}$$
 $\frac{9}{-9} = \frac{-9b}{-9}$   
 $-1 = b$  The solution is  $-1$ .
29.  $6m + 18 = 0$  To get  $6m$  by itself, add  $-18$  to both sides.  

$$\begin{array}{r} -18 \\ \hline 6m + 0 = -18 \end{array}$$
 $6m = -18$  Divide both sides by 6.  

$$\frac{6m}{6} = \frac{-18}{6}$$
 $m = -3$  The solution is  $-3$ .
30.  $8p - 40 = 0$   
 $8p + -40 = 0$   

$$\begin{array}{r} 40 \\ \hline 8p + 0 = 40 \end{array}$$
 $\frac{8p}{8} = \frac{40}{8}$   
 $p = 5$  The solution is 5.
31.  $6 = 9w - 12$  Change to addition.  
 $6 = 9w + -12$  Add 12 to both sides.  

$$\begin{array}{r} 12 \\ \hline 18 = 9w + 0 \end{array}$$
 $18 = 9w$  Divide both sides by 9.  

$$\frac{18}{9} = \frac{9w}{9}$$
 $2 = w$  The solution is 2.
32.  $8 = 8h + 24$   

$$\begin{array}{r} -24 \\ \hline -16 = 8h + 0 \end{array}$$
 $\frac{-16}{8} = \frac{8h}{8}$   
 $-2 = h$  The solution is  $-2$ .

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33.  $5x = 3x + 10$  Add  $-3x$  to both sides to get the variable term on one side.

$$\begin{array}{r} -3x \quad -3x \\ \hline 2x = 0 + 10 \\ 2x = 10 \quad \text{Divide both sides by 2.} \\ \hline \frac{2x}{2} = \frac{10}{2} \\ x = 5 \quad \text{The solution is 5.} \end{array}$$

34.  $7n = -2n - 36$   
 $7n = -2n + -36$

$$\begin{array}{r} 2n \quad 2n \\ \hline 9n = 0 + -36 \\ 9n = -36 \\ \hline \frac{9n}{9} = \frac{-36}{9} \\ n = -4 \quad \text{The solution is } -4. \end{array}$$

35.  $2a + 11 = 8a - 7$  Change to addition.  
 $2a + 11 = 8a + -7$  Add  $-2a$  to both sides.

$$\begin{array}{r} -2a \quad -2a \\ \hline 0 + 11 = 6a + -7 \\ 11 = 6a + -7 \quad \text{Add 7 to both sides.} \\ \hline \frac{7}{7} = \frac{6a + -7}{7} \\ 18 = 6a + 0 \\ 18 = 6a \quad \text{Divide both sides by 6.} \\ \hline \frac{18}{6} = \frac{6a}{6} \\ 3 = a \quad \text{The solution is 3.} \end{array}$$

36.  $r - 10 = 10r + 8$   
 $1r + -10 = 10r + 8$

$$\begin{array}{r} -1r \quad -1r \\ \hline 0 + -10 = 9r + 8 \\ -10 = 9r + 8 \\ \hline \frac{-8}{-8} = \frac{9r + 8}{-8} \\ -18 = 9r + 0 \\ \hline \frac{-18}{9} = \frac{9r}{9} \\ -2 = r \quad \text{The solution is } -2. \end{array}$$

37.  $7 - 5b = 28 + 2b$  Change to addition.  
 $7 + -5b = 28 + 2b$  Add  $5b$  to both sides.

$$\begin{array}{r} 5b \quad 5b \\ \hline 7 + 0 = 28 + 7b \\ 7 = 28 + 7b \quad \text{Add } -28 \text{ to both sides.} \\ \hline \frac{-28}{-28} = \frac{7}{-28} \\ -21 = 0 + 7b \\ -21 = 7b \quad \text{Divide both sides by 7.} \\ \hline \frac{-21}{7} = \frac{7b}{7} \\ -3 = b \quad \text{The solution is } -3. \end{array}$$

38.  $1 - 8t = -9 - 3t$   
 $1 + -8t = -9 + -3t$

$$\begin{array}{r} 8t \quad 8t \\ \hline 1 + 0 = -9 + 5t \\ 1 = -9 + 5t \\ \hline \frac{9}{9} = \frac{-9 + 5t}{9} \\ 10 = 0 + 5t \\ \hline \frac{10}{5} = \frac{5t}{5} \\ 2 = t \quad \text{The solution is 2.} \end{array}$$

39.  $-20 + 2k = k - 4k$  Change to addition.  
 $-20 + 2k = k + -4k$  Combine like terms.  
 $-20 + 2k = -3k$  Add  $-2k$  to both sides.

$$\begin{array}{r} -2k \quad -2k \\ \hline -20 + 0 = -5k \\ -20 = -5k \quad \text{Divide both sides by } -5. \\ \hline \frac{-20}{-5} = \frac{-5k}{-5} \\ 4 = k \quad \text{The solution is 4.} \end{array}$$

40.  $6y - y = -16 + y$   
 $6y + -1y = -16 + 1y$

$$\begin{array}{r} 5y = -16 + 1y \\ \hline \frac{-1y}{-1y} = \frac{-16 + 1y}{-1y} \\ 4y = -16 + 0 \\ \hline \frac{4y}{4} = \frac{-16}{4} \\ y = -4 \quad \text{The solution is } -4. \end{array}$$

41.  $10(c - 6) + 4 = 2 + c - 58$  Distribute.  
 $10c - 60 + 4 = 2 + c - 58$  Change to addition.  
 $10c + -60 + 4 = 2 + c + -58$  Group like terms.

$$\begin{array}{r} 10c + -60 + 4 = 2 + -58 + c \quad \text{Combine like terms.} \\ 10c + -56 = -56 + c \quad \text{Add } -c \text{ to both sides.} \\ \hline \frac{-c}{-c} = \frac{-56 + c}{-c} \\ 9c + -56 = -56 + 0 \\ 9c + -56 = -56 \quad \text{Add 56 to both sides.} \\ \hline \frac{56}{56} = \frac{-56}{56} \\ 9c + 0 = 0 \quad \text{Divide both sides by 9.} \\ \hline \frac{9c}{9} = \frac{0}{9} \\ c = 0 \quad \text{The solution is 0.} \end{array}$$



$$\begin{aligned}
 42. \quad & 8(z + 7) - 6 = z + 60 - 10 \\
 & 8z + 56 - 6 = z + 60 - 10 \\
 & 8z + 56 - 6 = z + 60 - 10 \\
 & 8z + 50 = z + 60 - 10 \\
 & \frac{-1z}{7z + 50} = \frac{-1z}{0 + 50} \\
 & 7z + 50 = 50 \\
 & \frac{-50}{7z + 0} = \frac{-50}{0} \\
 & 7z = 0 \\
 & \frac{7z}{7} = \frac{0}{7} \\
 & z = 0
 \end{aligned}$$

The solution is 0.

$$\begin{aligned}
 43. \quad & -18 + 13y + 3 = 3(5y - 1) - 2 \quad \text{Distribute.} \\
 & -18 + 13y + 3 = 15y - 3 - 2 \quad \text{Add the opposites.} \\
 & -18 + 13y + 3 = 15y - 3 + -2 \quad \text{Group like terms.} \\
 & 13y + -18 + 3 = 15y + -3 + -2 \quad \text{Combine like terms.} \\
 & \frac{13y + -15}{-13y} = \frac{15y + -5}{-13y} \quad \text{Add } -13y \text{ to both sides.} \\
 & 0 + -15 = 2y + -5 \\
 & \frac{-15}{5} = \frac{2y + -5}{5} \quad \text{Add 5 to both sides.} \\
 & -10 = 2y + 0 \\
 & -10 = 2y \quad \text{Divide both sides by 2.} \\
 & \frac{-10}{2} = \frac{2y}{2} \\
 & -5 = y
 \end{aligned}$$

The solution is -5.

$$\begin{aligned}
 44. \quad & 3 + 5h - 9 = 4(3h + 4) - 1 \\
 & 3 + 5h + -9 = 12h + 16 + -1 \\
 & 5h + -6 = 12h + 15 \\
 & \frac{-5h}{0 + -6} = \frac{-5h}{7h + 15} \\
 & -6 = 7h + 15 \\
 & \frac{-15}{-21} = \frac{-15}{7h + 0} \\
 & \frac{-21}{7} = \frac{7h}{7} \\
 & -3 = h
 \end{aligned}$$

The solution is -3.

$$\begin{aligned}
 45. \quad & 6 - 4n + 3n = 20 - 35 \quad \text{Change to addition.} \\
 & 6 + -4n + 3n = 20 + -35 \quad \text{Combine like terms.} \\
 & 6 + -1n = -15 \quad \text{Add } -6 \text{ to both sides.} \\
 & \frac{-6}{0 + -1n} = \frac{-6}{-6} \\
 & 0 + -1n = -21 \\
 & \frac{-1n}{-1} = \frac{-21}{-1} \\
 & n = 21 \quad \text{The solution is 21.}
 \end{aligned}$$

$$\begin{aligned}
 46. \quad & -19 + 8 = 6p - 7p - 5 \\
 & -19 + 8 = 6p + -7p + -5 \\
 & -11 = -1p + -5 \\
 & \frac{5}{-6} = \frac{5}{-1p + 0} \\
 & \frac{-6}{-1} = \frac{-6}{-1p} \\
 & 6 = p \quad \text{The solution is 6.}
 \end{aligned}$$

$$\begin{aligned}
 47. \quad & 6(c - 2) = 7(c - 6) \quad \text{Distribute.} \\
 & 6c - 12 = 7c - 42 \quad \text{Change to addition.} \\
 & 6c + -12 = 7c + -42 \quad \text{Add } -6c \text{ to both sides.} \\
 & \frac{-6c}{0 + -12} = \frac{-6c}{1c + -42} \\
 & -12 = 1c + -42 \quad \text{Add 42 to both sides.} \\
 & \frac{42}{30} = \frac{42}{1c + 0} \\
 & 30 = c \quad \text{The solution is 30.}
 \end{aligned}$$

$$\begin{aligned}
 48. \quad & -3(5 + x) = 4(x - 2) \\
 & -15 + -3x = 4x - 8 \\
 & \frac{3x}{-15 + 0} = \frac{3x}{7x - 8} \\
 & -15 = 7x + -8 \\
 & \frac{8}{-7} = \frac{8}{7x + 0} \\
 & \frac{-7}{7} = \frac{7x}{7} \\
 & -1 = x \quad \text{The solution is } -1.
 \end{aligned}$$

$$\begin{aligned}
 49. \quad & -5(2p + 2) - 7 = 3(2p + 5) \quad \text{Distribute.} \\
 & -10p + -10 - 7 = 6p + 15 \quad \text{Change to addition.} \\
 & -10p + -10 + -7 = 6p + 15 \quad \text{Combine like terms.} \\
 & -10p + -17 = 6p + 15 \quad \text{Add } -6p \text{ to both sides.} \\
 & \frac{-6p}{-16p + -17} = \frac{-6p}{0 + 15} \\
 & -16p + -17 = 15 \quad \text{Add 17 to both sides.} \\
 & \frac{17}{-16p + 0} = \frac{17}{17} \\
 & -16p + 0 = 32 \quad \text{Divide both sides by } -16. \\
 & \frac{-16p}{-16} = \frac{32}{-16} \\
 & p = -2 \quad \text{The solution is } -2.
 \end{aligned}$$

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$$\begin{aligned}
 50. \quad & 4(3m - 6) = 72 + 3(m - 8) \\
 & 12m - 24 = 72 + 3m - 24 \\
 & 12m + ^{-}24 = 72 + 3m + ^{-}24 \\
 & 12m + ^{-}24 = 3m + 48 \\
 & \frac{-3m}{9m + ^{-}24} = \frac{-3m}{0 + 48} \\
 & 9m + ^{-}24 = 48 \\
 & \frac{24}{9m + 0} = \frac{24}{48} \\
 & 9m + 0 = 72 \\
 & \frac{9m}{9} = \frac{72}{9} \\
 & m = 8 \quad \text{The solution is 8.}
 \end{aligned}$$

$$\begin{aligned}
 51. \quad & ^{-}6b - 4b + 7b = 10 - b + 3b \quad \text{Change to addition.} \\
 & ^{-}6b + ^{-}4b + 7b = 10 + ^{-}b + 3b \quad \text{Combine like terms.} \\
 & \quad ^{-}3b = 10 + 2b \quad \text{Add } ^{-}2b \text{ to} \\
 & \quad \frac{-2b}{-5b} = \frac{-2b}{10 + 0} \quad \text{both sides.} \\
 & \quad ^{-}5b = 10 + 0 \\
 & \quad ^{-}5b = 10 \quad \text{Divide both sides} \\
 & \quad \quad \quad \text{by } ^{-}5. \\
 & \quad \frac{-5b}{-5} = \frac{10}{-5} \\
 & \quad b = ^{-}2 \quad \text{The solution is } ^{-}2.
 \end{aligned}$$

$$\begin{aligned}
 52. \quad & w + 8 - 5w = ^{-}w - 15w + 11w \\
 & 1w + 8 + ^{-}5w = ^{-}1w + ^{-}15w + 11w \\
 & \quad ^{-}4w + 8 = ^{-}5w \\
 & \quad \frac{4w}{0 + 8} = \frac{4w}{^{-}1w} \\
 & \quad \frac{8}{^{-}1} = \frac{^{-}1w}{^{-}1} \\
 & \quad ^{-}8 = w
 \end{aligned}$$

The solution is  $-8$ .

$$\begin{aligned}
 53. \quad & \text{The series of steps may vary. One possibility is:} \\
 & ^{-}2t - 10 = 3t + 5 \quad \text{Change to addition.} \\
 & ^{-}2t + ^{-}10 = 3t + 5 \quad \text{Add } 2t \text{ to both sides} \\
 & \quad \frac{2t}{0 + ^{-}10} = \frac{2t}{5t + 5} \quad \text{(addition property).} \\
 & \quad ^{-}5 = ^{-}5 \quad \text{Add } ^{-}5 \text{ to both sides} \\
 & \quad \quad \quad \text{(addition property).} \\
 & \quad \frac{-15}{5} = \frac{5t}{5} \quad \text{Divide both sides by } 5 \\
 & \quad ^{-}3 = t \quad \text{(division property).}
 \end{aligned}$$

The solution is  $-3$ .

54. Multiplication distributes over both addition and subtraction. Examples will vary. Some possibilities are  $3(2y + 6)$  is  $6y + 18$  and  $5(x - 3)$  is  $5x - 15$ .

$$\begin{aligned}
 55. \quad & \text{Check: } ^{-}8 + 4a = 2a + 2 \\
 & \quad ^{-}8 + 4(3) = 2(3) + 2 \\
 & \quad ^{-}8 + 12 = 6 + 2 \\
 & \quad 4 \neq 8
 \end{aligned}$$

The check does not balance, so 3 is not the correct solution. The student added  $-2a$  to  $-8$  on the left side, instead of adding  $-2a$  to  $4a$ . The correct solution, obtained using  $-8 + 2a = 2$ ,  $2a = 10$ , is  $a = 5$ .

$$\begin{aligned}
 56. \quad & \text{Check: } 2(x + 4) = ^{-}16 \\
 & \quad 2(^{-}10 + 4) = ^{-}16 \\
 & \quad 2(^{-}6) = ^{-}16 \\
 & \quad ^{-}12 \neq ^{-}16
 \end{aligned}$$

The check does not balance, so  $-10$  is not the correct solution.

$$\begin{aligned}
 & 2(x + 4) = ^{-}16 \quad \text{Student did not} \\
 & \quad 2x + 8 = ^{-}16 \quad \text{distribute the 2} \\
 & \quad \quad ^{-}8 \quad \quad ^{-}8 \quad \text{over the 4.} \\
 & \quad \frac{2x + 0}{2} = \frac{^{-}24}{2} \\
 & \quad x = ^{-}12
 \end{aligned}$$

The correct solution is  $-12$ .

57. (a) It must be negative, because the sum of two positive numbers is always positive.

(b) The sum of  $x$  and a positive number is negative, so  $x$  must be negative.

58. (a) It must be positive, because the sum of two negative numbers is always negative.

(b) The sum of  $d$  and a negative number is positive, so  $d$  must be positive.

59. (a) It must be positive. When the signs are the same, the product is positive, and when the signs are different, the product is negative.

(b) The product of  $n$  and a negative number is negative, so  $n$  must be positive.

60. (a) It must be negative also. When the signs are different, the product is negative, and when the signs match, the product is positive.

(b) The product of  $y$  and a negative number is positive, so  $y$  must be negative.

### Chapter 2 Review Exercises

1. (a) In the expression  $-3 + 4k$ ,  $k$  is the variable, 4 is the coefficient, and  $-3$  is the constant term.

(b) The term that has 20 as the constant term and  $-9$  as the coefficient is  $-9y + 20$ .

2. (a) Evaluate  $4c + 10$  when  $c$  is 15.

$$\begin{array}{l} 4c + 10 \quad \text{Replace } c \text{ with 15.} \\ \underline{4 \cdot 15} + 10 \\ \underline{60 + 10} \\ 70 \quad \text{Order 70 test tubes.} \end{array}$$

- (b) Evaluate  $4c + 10$  when  $c$  is 24.

$$\begin{array}{l} 4c + 10 \quad \text{Replace } c \text{ with 24.} \\ \underline{4 \cdot 24} + 10 \\ \underline{96 + 10} \\ 106 \quad \text{Order 106 test tubes.} \end{array}$$

3. (a)  $x^2y^4$  means  $x \cdot x \cdot y \cdot y \cdot y \cdot y$

(b)  $5ab^3$  means  $5 \cdot a \cdot b \cdot b \cdot b$

4. (a)  $n^2$  means

$$\begin{array}{l} n \cdot n \quad \text{Replace } n \text{ with } ^{-}3. \\ \underline{-3 \cdot ^{-}3} \\ 9 \end{array}$$

- (b)  $n^3$  means

$$\begin{array}{l} n \cdot n \cdot n \quad \text{Replace } n \text{ with } ^{-}3. \\ \underline{-3 \cdot ^{-}3 \cdot ^{-}3} \\ \underline{9 \cdot ^{-}3} \\ ^{-}27 \end{array}$$

- (c)  $^{-}4mp^2$  means

$$\begin{array}{l} ^{-}4 \cdot m \cdot p \cdot p \quad \text{Replace } m \text{ with 2} \\ \quad \quad \quad \text{and } p \text{ with 4.} \\ \underline{-4 \cdot 2 \cdot 4 \cdot 4} \\ \underline{-8 \cdot 4 \cdot 4} \\ \underline{-32 \cdot 4} \\ ^{-}128 \end{array}$$

- (d)  $5m^4n^2$  means

$$\begin{array}{l} 5 \cdot m \cdot m \cdot m \cdot m \cdot n \cdot n \quad \text{Replace } m \text{ with 2} \\ \quad \quad \quad \text{and } n \text{ with } ^{-}3. \\ \underline{5 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot ^{-}3 \cdot ^{-}3} \\ \underline{10 \cdot 2 \cdot 2 \cdot 2 \cdot ^{-}3 \cdot ^{-}3} \\ \underline{20 \cdot 2 \cdot 2 \cdot ^{-}3 \cdot ^{-}3} \\ \underline{40 \cdot 2 \cdot ^{-}3 \cdot ^{-}3} \\ \underline{80 \cdot ^{-}3 \cdot ^{-}3} \\ \underline{-240 \cdot ^{-}3} \\ 720 \end{array}$$

5.  $ab + ab^2 + 2ab$

$$\begin{array}{l} \underline{1ab} + ab^2 + \underline{2ab} \quad \text{Combine like terms.} \\ 3ab + ab^2 \quad \text{or} \quad ab^2 + 3ab \end{array}$$

6.  $^{-}3x + 2y - x - 7$  Rewrite  $x$  as  $1x$ .

$$^{-}3x + 2y - 1x - 7 \quad \text{Change to addition.}$$

$$\underline{-3x} + 2y + \underline{-1x} + ^{-}7 \quad \text{Combine like terms.}$$

$$^{-}4x + 2y + ^{-}7 \quad \text{or} \quad ^{-}4x + 2y - 7$$

7.  $^{-}8(^{-}2g^3)$  Associative property

$$\begin{array}{l} (^{-}8 \cdot ^{-}2) \cdot g^3 \\ 16 \cdot g^3 \\ 16g^3 \end{array}$$

8.  $4(3r^2t)$  Associative property

$$\begin{array}{l} (4 \cdot 3) \cdot r^2t \\ 12 \cdot r^2t \\ 12r^2t \end{array}$$

9.  $5(k + 2)$  Distribute.

$$\begin{array}{l} 5 \cdot k + 5 \cdot 2 \\ 5k + 10 \end{array}$$

10.  $^{-}2(3b + 4)$  Distribute.

$$\begin{array}{l} ^{-}2 \cdot 3b + ^{-}2 \cdot 4 \\ ^{-}6b + ^{-}8 \quad \text{or} \quad ^{-}6b - 8 \end{array}$$

11.  $3(2y - 4) + 12$  Distribute.

$$\begin{array}{l} \underline{3 \cdot 2y} - \underline{3 \cdot 4} + 12 \\ 6y - 12 + 12 \\ 6y + ^{-}12 + 12 \\ 6y + 0 \\ 6y \end{array}$$

12.  $^{-}4 + 6(4x + 1) - 4x$  Distribute.

$$\begin{array}{l} ^{-}4 + 24x + 6 - 4x \\ ^{-}4 + 24x + 6 + ^{-}4x \\ 2 + 20x \quad \text{or} \quad 20x + 2 \end{array}$$

13. Expressions will vary. One possibility is  $6a^3 + a^2 + 3a - 6$ .

14.  $16 + n = 5$  Add  $^{-}16$  to both sides.

$$\begin{array}{r} ^{-}16 \\ \hline 0 + n = ^{-}11 \\ n = ^{-}11 \end{array}$$

The solution is  $^{-}11$ .

**Check:**  $16 + n = 5$

$$16 + ^{-}11 = 5$$

$$5 = 5 \quad \text{Balances}$$

15.  $^{-}4 + 2 = 2a - 6 - a$

$$^{-}4 + 2 = 2a + ^{-}6 + ^{-}1a$$

$$^{-}2 = 1a + ^{-}6$$

$$\underline{6} \qquad \qquad \underline{6}$$

$$\underline{4} = \underline{1a + 0}$$

$$4 = a$$

The solution is 4.

*continued*

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**Check:**  $-4 + 2 = 2a - 6 - a$

$$-4 + 2 = 2(4) - 6 - 4$$

$$-2 = 8 - 6 - 4$$

$$-2 = 2 - 4$$

$$-2 = -2 \quad \text{Balances}$$

16.  $48 = -6m$  Divide both sides by  $-6$ .

$$\frac{48}{-6} = \frac{-6m}{-6}$$

$$-8 = m \quad \text{The solution is } -8.$$

17.  $k - 5k = -40$

$$1k - 5k = -40$$

$$1k + -5k = -40 \quad \text{Combine like terms.}$$

$$-4k = -40 \quad \text{Divide both sides by } -4.$$

$$\frac{-4k}{-4} = \frac{-40}{-4}$$

$$k = 10 \quad \text{The solution is } 10.$$

18.  $-17 + 11 + 6 = 7t$

$$0 = 7t \quad \text{Divide both sides by } 7.$$

$$\frac{0}{7} = \frac{7t}{7}$$

$$0 = t \quad \text{The solution is } 0.$$

19.  $-2p + 5p = 3 - 21$

$$-2p + 5p = 3 + -21$$

$$3p = -18 \quad \text{Divide both sides by } 3.$$

$$\frac{3p}{3} = \frac{-18}{3}$$

$$p = -6 \quad \text{The solution is } -6.$$

20.  $-30 = 3(-5r)$

$$-30 = -15r \quad \text{Divide both sides by } -15.$$

$$\frac{-30}{-15} = \frac{-15r}{-15}$$

$$2 = r \quad \text{The solution is } 2.$$

21.  $12 = -h$

$$12 = -1h$$

$$\frac{12}{-1} = \frac{-1h}{-1}$$

$$-12 = h \quad \text{The solution is } -12.$$

22.  $12w - 4 = 8w + 12$

$$12w + -4 = 8w + 12$$

$$\frac{-8w}{4w + -4} = \frac{-8w}{0 + 12}$$

$$4w + -4 = 12$$

Add 4 to both sides.

$$\frac{4}{4w + 0} = \frac{4}{16}$$

$$4w = 16$$

Divide both sides by 4.

$$\frac{4w}{4} = \frac{16}{4}$$

$$w = 4$$

The solution is 4.

23.  $0 = -4(c + 2)$  Distribute.

$$0 = -4 \cdot c + -4 \cdot 2$$

$$0 = -4c + -8$$

$$\frac{8}{8} = \frac{-4c + 0}{8} \quad \text{Add 8 to both sides.}$$

$$8 = -4c$$

Divide both sides by  $-4$ .

$$\frac{8}{-4} = \frac{-4c}{-4}$$

$$-2 = c$$

The solution is  $-2$ .

24.  $34 = 2n + 4$  Add  $-4$  to both sides.

$$\frac{-4}{30} = \frac{-4}{2n + 0}$$

$$30 = 2n \quad \text{Divide both sides by } 2.$$

$$\frac{30}{2} = \frac{2n}{2}$$

$$15 = n$$

The number of employees is 15.

25. [2.5]  $12 + 7a = 4a - 3$  Add  $-4a$  to both sides.

$$\frac{-4a}{12 + 3a} = \frac{-4a}{0 - 3}$$

$$12 + 3a = -3$$

$$\frac{-12}{0 + 3a} = \frac{-12}{-15}$$

$$0 + 3a = -15 \quad \text{Divide both sides by } 3.$$

$$\frac{3a}{3} = \frac{-15}{3}$$

$$a = -5$$

The solution is  $-5$ .

26. [2.5]  $-2(p - 3) = -14$  Distribute.  
 Add  $-6$  to both sides.

$$\begin{array}{r} -2p + 6 = -14 \\ \underline{-6 \quad -6} \\ -2p + 0 = -20 \\ \underline{-2p \quad -20} \\ -2 \quad -2 \\ p = 10 \end{array}$$

The solution is 10.

27. [2.5]  $10y = 6y + 20$  Add  $-6y$  to both sides.

$$\begin{array}{r} -6y \quad -6y \\ \underline{4y = 0 + 20} \\ \underline{4y \quad 20} \\ 4 \quad 4 \\ y = 5 \end{array}$$

The solution is 5.

28. [2.5]  $2m - 7m = 5 - 20$  Add the opposites.  
 Combine like terms.  
 Divide both sides by  $-5$ .

$$\begin{array}{r} 2m +^{-}7m = 5 +^{-}20 \\ -5m = -15 \\ \underline{-5m \quad -15} \\ -5 \quad -5 \\ m = 3 \end{array}$$

The solution is 3.

29. [2.5]  $20 = 3x - 7$   
 $20 = 3x +^{-}7$

$$\begin{array}{r} 7 \quad 7 \\ \underline{27 = 3x + 0} \\ \underline{27 \quad 3x} \\ 3 \quad 3 \\ 9 = x \end{array}$$

The solution is 9.

30. [2.5]  $b + 6 = 3b - 8$

$$\begin{array}{r} -3b \quad -3b \\ \underline{-2b + 6 = 0 - 8} \\ -2b + 6 = -8 \\ \underline{-6 \quad -6} \\ -2b + 0 = -14 \\ \underline{-2b \quad -14} \\ -2 \quad -2 \\ b = 7 \end{array}$$

The solution is 7.

31. [2.3]  $z + 3 = 0$   
 $\underline{-3 \quad -3}$   
 $z + 0 = -3$   
 $z = -3$  The solution is  $-3$ .

32. [2.5]  $3(2n - 1) = 3(n + 3)$  Distribute.

$$\begin{array}{r} 6n - 3 = 3n + 9 \\ \underline{-3n \quad -3n} \\ 3n - 3 = 0 + 9 \\ 3n - 3 = 9 \quad \text{Add 3 to both sides.} \\ \underline{3 \quad 3} \\ 3n + 0 = 12 \\ \underline{3n \quad 12} \\ 3 \quad 3 \\ n = 4 \end{array}$$

The solution is 4.

33. [2.5]  $-4 + 46 = 7(-3t + 6)$  Distribute.  
 $-4 + 46 = -21t + 42$   
 Add  $-42$  to both sides.

$$\begin{array}{r} -42 \quad -42 \\ \underline{0 = -21t + 0} \\ 0 = -21t \\ \underline{-21 \quad -21} \\ 0 = t \end{array}$$

The solution is 0.

34. [2.5]  $6 + 10d - 19 = 2(3d + 4) - 1$  Distribute.  
 $6 + 10d +^{-}19 = 6d + 8 - 1$   
 $-13 + 10d = 6d + 7$

$$\begin{array}{r} -6d \quad -6d \\ \underline{-13 + 4d = 0 + 7} \\ -13 + 4d = 7 \quad \text{Add 13 to both sides.} \\ \underline{13 \quad 13} \\ 0 + 4d = 20 \\ \underline{4d \quad 20} \\ 4 \quad 4 \\ d = 5 \end{array}$$

The solution is 5.

35. [2.5]  $-4(3b + 9) = 24 + 3(2b - 8)$  Distribute.  
 $-12b - 36 = 24 + 6b - 24$   
 $-12b +^{-}36 = 24 + 6b +^{-}24$   
 Add  $12b$  to both sides.

$$\begin{array}{r} 12b \quad 12b \\ \underline{0 +^{-}36 = 18b} \\ -36 = 18b \\ \underline{18 \quad 18} \\ -2 = b \end{array}$$

The solution is  $-2$ .

## Chapter 2 Test

1. In the expression  $-7w + 6$ ,  $-7$  is the coefficient,  $w$  is the variable, and 6 is the constant term.

2. Evaluate the expression  $3a + 2c$  when  $a$  is 45 and  $c$  is 21.

$$\begin{aligned} &3a + 2c \\ &3 \cdot 45 + 2 \cdot 21 \\ &135 + 42 \\ &177 \end{aligned}$$

Buy 177 hot dogs.

3.  $x^5y^3$  means  $x \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y$

4.  $4ab^4$  means  $4 \cdot a \cdot b \cdot b \cdot b \cdot b$

5.  $-2s^2t$  means

$$\begin{aligned} &-2 \cdot s \cdot s \cdot t && \text{Replace } s \text{ with } -5 \\ &&& \text{and } t \text{ with } 4. \\ &\underbrace{-2 \cdot -5 \cdot -5 \cdot 4}_{10 \cdot -5 \cdot 4} \\ &\quad \underbrace{-50 \cdot 4}_{-200} \end{aligned}$$

6. 
$$\begin{aligned} &3w^3 - 8w^3 + w^3 \\ &3w^3 - 8w^3 + 1w^3 \\ &\underbrace{3w^3 + -8w^3}_{-5w^3} + 1w^3 \\ &\quad \underbrace{-5w^3 + 1w^3}_{-4w^3} \end{aligned}$$

7. 
$$\begin{aligned} &xy - xy \\ &1xy - 1xy \\ &(1 - 1)xy \\ &0xy \\ &0 \end{aligned}$$

8. 
$$\begin{aligned} &-6c - 5 + 7c + 5 \\ &-6c + -5 + 7c + 5 \\ &\underbrace{-6c + 7c}_{1c} + \underbrace{-5 + 5}_{0} \\ &1c + 0 \\ &1c \text{ or } c \end{aligned}$$

9.  $3m^2 - 3m + 3mn$   
There are no like terms.  
The expression cannot be simplified.

10.  $-10(4b^2)$  Associative property of multiplication

$$\begin{aligned} &(-10 \cdot 4) \cdot b^2 \\ &-40b^2 \end{aligned}$$

11.  $-5(-3k)$  Associative property of multiplication

$$\begin{aligned} &(-5 \cdot -3) \cdot k \\ &15k \end{aligned}$$

12.  $7(3t + 4)$  Distributive property

$$\begin{aligned} &7(3t) + 7(4) \\ &21t + 28 \end{aligned}$$

13.  $-4(a + 6)$  Distributive property

$$\begin{aligned} &-4 \cdot a + -4 \cdot 6 \\ &-4a + -24 \\ &-4a - 24 \end{aligned}$$

14.  $-8 + 6(x - 2) + 5$

$$\begin{aligned} &-8 + 6x - 12 + 5 \\ &-8 + 6x + -12 + 5 && \text{Combine like terms.} \\ &6x + -15 && \text{or } 6x - 15 \end{aligned}$$

15.  $-9b - c - 3 + 9 + 2c$

$$\begin{aligned} &-9b - 1c - 3 + 9 + 2c \\ &-9b + -1c + -3 + 9 + 2c && \text{Combine like terms.} \\ &-9b + c + 6 \end{aligned}$$

16.  $-4 = x - 9$  **Check:**  $-4 = x - 9$

$$\begin{aligned} \frac{9}{5} &= \frac{x + 0}{5} && -4 = 5 - 9 \\ 9 &= x && -4 = -4 \\ &&& \text{Balances} \end{aligned}$$

The solution is 5.

17.  $-7w = 77$  **Check:**  $-7w = 77$

$$\begin{aligned} \frac{-7w}{-7} &= \frac{77}{-7} && -7 \cdot -11 = 77 \\ w &= -11 && 77 = 77 \\ &&& \text{Balances} \end{aligned}$$

The solution is  $-11$ .

18.  $-p = 14$  **Check:**  $-p = 14$

$$\begin{aligned} -1p &= 14 && -1p = 14 \\ \frac{-1p}{-1} &= \frac{14}{-1} && -1 \cdot -14 = 14 \\ p &= -14 && 14 = 14 \\ &&& \text{Balances} \end{aligned}$$

The solution is  $-14$ .

19.  $-15 = -3(a + 2)$  **Check:**  $-15 = -3(a + 2)$

$$\begin{aligned} -15 &= -3a - 6 && -15 = -3(3 + 2) \\ \frac{6}{-9} &= \frac{-3a}{-9} && -15 = -3(5) \\ \frac{-9}{-3} &= \frac{-3a}{-3} && -15 = -15 \\ 3 &= a && \text{Balances} \end{aligned}$$

The solution is 3.

$$\begin{array}{rcl}
 20. & 6n + 8 - 5n & = & -4 + 4 \\
 & 6n + 8 + ^{-}5n & = & 0 \\
 & n + 8 & = & 0 \\
 & \quad ^{-}8 & & ^{-}8 \\
 \hline
 & n & = & ^{-}8
 \end{array}$$

The solution is  $-8$ .

$$\begin{array}{rcl}
 21. & 5 - 20 = 2m - 3m \\
 & 5 + ^{-}20 = 2m + ^{-}3m \\
 & \quad ^{-}15 = ^{-}1m \\
 & \frac{{}^{-}15}{^{-}1} = \frac{{}^{-}1m}{^{-}1} \\
 & 15 = m
 \end{array}$$

The solution is 15.

$$\begin{array}{rcl}
 22. & ^{-}2x + 2 & = & 5x + 9 \quad \text{Add } 2x \text{ to both sides.} \\
 \hline
 & 2 & = & 7x + 9 \\
 & \quad ^{-}9 & & \quad ^{-}9 \\
 \hline
 & ^{-}7 & = & 7x \\
 & \quad ^{-}7 & & \quad ^{-}7 \\
 \hline
 & ^{-}1 & = & x
 \end{array}$$

The solution is  $-1$ .

$$\begin{array}{rcl}
 23. & 3m - 5 & = & 7m - 13 \\
 \hline
 & ^{-}3m & & ^{-}3m \\
 & 0 - 5 & = & 4m - 13 \\
 & \quad ^{-}5 & = & 4m - 13 \quad \text{Add 13} \\
 & & & \text{to both sides.} \\
 & \quad 13 & & \quad 13 \\
 \hline
 & 8 & = & 4m \\
 & \quad 4 & = & \quad 4 \\
 \hline
 & 2 & = & m
 \end{array}$$

The solution is 2.

$$\begin{array}{rcl}
 24. & 2 + 7b - 44 & = & ^{-}3b + 12 + 9b \\
 & 7b - 42 & = & 6b + 12 \\
 & \quad ^{-}6b & & \quad ^{-}6b \\
 \hline
 & 1b - 42 & = & 12 \\
 & & & \text{Add 42 to} \\
 & & & \text{both sides.} \\
 & \quad 42 & & 42 \\
 \hline
 & 1b & = & 54 \\
 & b & = & 54
 \end{array}$$

The solution is 54.

$$\begin{array}{rcl}
 25. & 3c - 24 = 6(c - 4) & \text{Distribute.} \\
 & 3c - 24 = 6c - 24 \\
 & \quad ^{-}3c & & \quad ^{-}3c \\
 \hline
 & ^{-}24 = 3c - 24 & \text{Add 24 to} \\
 & & \text{both sides.} \\
 & \quad 24 & & \quad 24 \\
 \hline
 & 0 = 3c \\
 & \quad 0 & = & 3c \\
 & \quad 3 & = & 3 \\
 & 0 = c
 \end{array}$$

The solution is 0.

26. Equations will vary. Two possibilities are  $x - 5 = -9$  and  $-24 = 6y$ .

Solving:

$$\begin{array}{rcl}
 x - 5 & = & ^{-}9 \\
 \hline
 +5 & +5 & \\
 \hline
 x & = & ^{-}4
 \end{array}
 \qquad
 \begin{array}{rcl}
 ^{-}24 & = & 6y \\
 \hline
 ^{-}24 & = & 6y \\
 6 & = & 6 \\
 \hline
 ^{-}4 & = & y
 \end{array}$$

