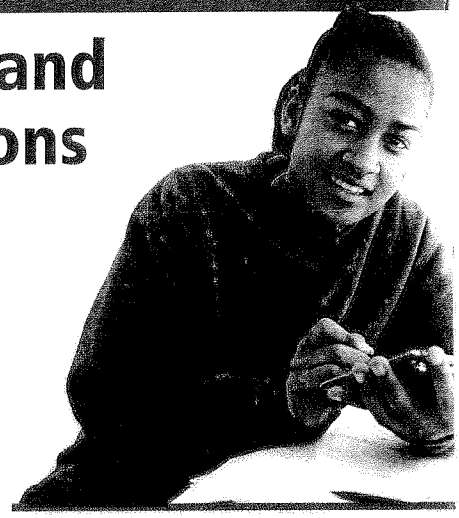


2-3

Solving Two-Step and Multi-Step Equations



Objective

Solve equations in one variable that contain more than one operation.

Why learn this?

Equations containing more than one operation can model real-world situations, such as the cost of a music club membership.

Alex belongs to a music club. In this club, students can buy a student discount card for \$19.95. This card allows them to buy CDs for \$3.95 each. After one year, Alex has spent \$63.40.

To find the number of CDs c that Alex bought, you can solve an equation.

$$\begin{array}{c} \text{Cost of discount card} \\ \downarrow \\ \text{Cost per CD} \rightarrow 3.95c + 19.95 = 63.40 \leftarrow \text{Total cost} \end{array}$$

Notice that this equation contains multiplication and addition. Equations that contain more than one operation require more than one step to solve. Identify the operations in the equation and the order in which they are applied to the variable. Then use inverse operations and work backward to undo them one at a time.

$$3.95c + 19.95 = 63.40$$

Operations in the Equation

- ① First c is multiplied by 3.95.
- ② Then 19.95 is added.



To Solve

- ① Subtract 19.95 from both sides of the equation.
- ② Then divide both sides by 3.95.

EXAMPLE 1 Solving Two-Step Equations

Solve $10 = 6 - 2x$. Check your answer.

$$\begin{array}{r} 10 = 6 - 2x \\ -6 \quad -6 \\ \hline 4 = -2x \end{array}$$

$$\begin{array}{r} 4 = -2x \\ \frac{4}{-2} = \frac{-2x}{-2} \end{array}$$

$$\begin{array}{r} -2 = 1x \\ -2 = x \end{array}$$

First x is multiplied by -2 . Then 6 is added.
Work backward: Subtract 6 from both sides.
Since x is multiplied by -2 , divide both sides by -2 to undo the multiplication.

Check

$$\begin{array}{r|l} 10 = 6 - 2x \\ 10 & 6 - 2(-2) \\ 10 & 6 - (-4) \\ 10 & 10 \checkmark \end{array}$$



Solve each equation. Check your answer.

- 1a. $-4 + 7x = 3$ 1b. $1.5 = 1.2y - 5.7$ 1c. $\frac{n}{7} + 2 = 2$

EXAMPLE 2 Solving Two-Step Equations That Contain Fractions

Solve $\frac{q}{15} - \frac{1}{5} = \frac{3}{5}$.

Method 1 Use fraction operations.

$$\frac{q}{15} - \frac{1}{5} = \frac{3}{5}$$

$$+ \frac{1}{5} \quad + \frac{1}{5}$$

$$\frac{q}{15} = \frac{4}{5}$$

$$15\left(\frac{q}{15}\right) = 15\left(\frac{4}{5}\right)$$

$$q = \frac{15 \cdot 4}{5}$$

$$q = \frac{60}{5}$$

$$q = 12$$

*Since $\frac{1}{5}$ is subtracted from $\frac{q}{15}$, add $\frac{1}{5}$ to both sides to undo the subtraction.**Since q is divided by 15, multiply both sides by 15 to undo the division.**Simplify.***Method 2** Multiply by the least common denominator (LCD) to clear the fractions.

$$\frac{q}{15} - \frac{1}{5} = \frac{3}{5}$$

$$15\left(\frac{q}{15} - \frac{1}{5}\right) = 15\left(\frac{3}{5}\right)$$

$$15\left(\frac{q}{15}\right) - 15\left(\frac{1}{5}\right) = 15\left(\frac{3}{5}\right)$$

$$q - 3 = 9$$

$$+ 3 \quad + 3$$

$$q = 12$$

*Multiply both sides by 15, the LCD of the fractions.**Distribute 15 on the left side.**Simplify.**Since 3 is subtracted from q , add 3 to both sides to undo the subtraction.***CHECK IT OUT!**

Solve each equation. Check your answer.

2a. $\frac{2x}{5} - \frac{1}{2} = 5$

2b. $\frac{3}{4}u + \frac{1}{2} = \frac{7}{8}$

2c. $\frac{1}{5}n - \frac{1}{3} = \frac{8}{3}$

Equations that are more complicated may have to be simplified before they can be solved. You may have to use the Distributive Property or combine like terms before you begin using inverse operations.

EXAMPLE 3 Simplifying Before Solving Equations

Solve each equation.

A $6x + 3 - 8x = 13$

$$6x + 3 - 8x = 13$$

$$6x - 8x + 3 = 13$$

$$-2x + 3 = 13$$

$$-3 \quad -3$$

$$-2x = 10$$

$$\frac{-2x}{-2} = \frac{10}{-2}$$

$$x = -5$$

*Use the Commutative Property of Addition.**Combine like terms.**Since 3 is added to $-2x$, subtract 3 from both sides to undo the addition.**Since x is multiplied by -2 , divide both sides by -2 to undo the multiplication.*

Helpful Hint

You can think of an opposite sign as a coefficient of -1 .

$$-(x + 2) = -1(x + 2)$$

and $-x = -1x$.

Solve each equation.

$$\text{B } 9 = 6 - (x + 2)$$

$$9 = 6 + (-1)(x + 2)$$

Write subtraction as addition of the opposite.

$$9 = 6 + (-1)(x) + (-1)(2)$$

Distribute -1 on the right side.

Simplify.

$$9 = 6 - x - 2$$

Use the Commutative Property of Addition.

Combine like terms.

$$9 = 6 - 2 - x$$

$$9 = 4 - x$$

Since 4 is added to $-x$, subtract 4 from both sides to undo the addition.

$$\begin{array}{r} -4 \\ -4 \end{array}$$

$$5 = -x$$

Since x is multiplied by -1 , divide both sides by -1 to undo the multiplication.

$$\begin{array}{r} 5 \\ -1 \\ -1 \end{array} = \begin{array}{r} -x \\ -1 \end{array}$$

$$-5 = x$$



Solve each equation. Check your answer.

3a. $2a + 3 - 8a = 8$

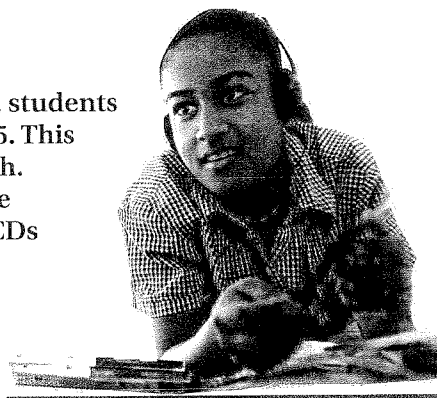
3b. $-2(3 - d) = 4$

3c. $4(x - 2) + 2x = 40$

EXAMPLE 4 Problem-Solving Application



Alex belongs to a music club. In this club, students can buy a student discount card for \$19.95. This card allows them to buy CDs for \$3.95 each. After one year, Alex has spent \$63.40. Write and solve an equation to find how many CDs Alex bought during the year.



Understand the Problem

The answer will be the number of CDs that Alex bought during the year.

List the important information:

- Alex paid \$19.95 for a student discount card.
- Alex pays \$3.95 for each CD purchased.
- After one year, Alex has spent \$63.40.

Make a Plan

Let c represent the number of CDs that Alex purchased. That means Alex has spent $3.95c$. However, Alex must also add the amount spent on the card.

Write an equation to represent this situation.

$$\text{total cost} = \text{cost of compact discs} + \text{cost of discount card}$$

$$63.40 = 3.95c + 19.95$$

3 Solve

$$\begin{array}{r}
 63.40 = 3.95c + 19.95 \\
 - 19.95 \quad - 19.95 \\
 \hline
 43.45 = 3.95c \\
 \frac{43.45}{3.95} = \frac{3.95c}{3.95} \\
 11 = c
 \end{array}$$

Since 19.95 is added to $3.95c$, subtract 19.95 from both sides to undo the addition.

Since c is multiplied by 3.95, divide both sides by 3.95 to undo the multiplication.

Alex bought 11 CDs during the year.

4 Look Back

Check that the answer is reasonable. The cost per CD is about \$4, so if Alex bought 11 CDs, this amount is about $11(4) = \$44$.

Add the cost of the discount card, which is about \$20: $44 + 20 = 64$. So the total cost was about \$64, which is close to the amount given in the problem, \$63.40.



4. Sara paid \$15.95 to become a member at a gym. She then paid a monthly membership fee. Her total cost for 12 months was \$735.95. How much was the monthly fee?

EXAMPLE 5 Solving Equations to Find an Indicated Value

If $3a + 12 = 30$, find the value of $a + 4$.

Step 1 Find the value of a .

$$\begin{array}{r}
 3a + 12 = 30 \\
 - 12 \quad - 12 \\
 \hline
 3a = 18 \\
 \frac{3a}{3} = \frac{18}{3} \\
 a = 6
 \end{array}$$

Since 12 is added to $3a$, subtract 12 from both sides to undo the addition.

Since a is multiplied by 3, divide both sides by 3 to undo the multiplication.

Step 2 Find the value of $a + 4$.

$$\begin{array}{r}
 a + 4 \\
 6 + 4 \\
 10
 \end{array}$$

To find the value of $a + 4$, substitute 6 for a . Simplify.



5. If $2x + 4 = -24$, find the value of $3x$.

THINK AND DISCUSS

1. Explain the steps you would follow to solve $2x + 1 = 7$. How is this procedure different from the one you would follow to solve $2x - 1 = 7$?
2. **GET ORGANIZED** Copy and complete the graphic organizer. In each box, write and solve a multi-step equation. Use addition, subtraction, multiplication, and division at least one time each.

Know It!
Note

Solving Multi-Step Equations	

GUIDED PRACTICE


Solve each equation. Check your answer.

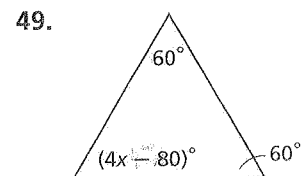
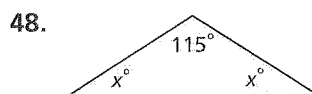
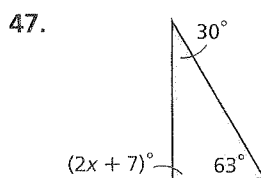
- SEE EXAMPLE 1 p. 92
- $4a + 3 = 11$
 - $8 = 3r - 1$
 - $42 = -2d + 6$
 - $x + 0.3 = 3.3$
 - $15y + 31 = 61$
 - $9 - c = -13$
- SEE EXAMPLE 2 p. 93
- $\frac{x}{6} + 4 = 15$
 - $\frac{1}{3}y + \frac{1}{4} = \frac{5}{12}$
 - $\frac{2}{7}j - \frac{1}{7} = \frac{3}{14}$
 - $15 = \frac{a}{3} - 2$
 - $4 - \frac{m}{2} = 10$
 - $\frac{x}{8} - \frac{1}{2} = 6$
- SEE EXAMPLE 3 p. 93
- $28 = 8x + 12 - 7x$
 - $2y - 7 + 5y = 0$
 - $2.4 = 3(m + 4)$
 - $3(x - 4) = 48$
 - $4t + 7 - t = 19$
 - $5(1 - 2w) + 8w = 15$
- SEE EXAMPLE 4 p. 94
- Transportation** Paul bought a student discount card for the bus. The card cost \$7 and allows him to buy daily bus passes for \$1.50. After one month, Paul spent \$29.50. How many daily bus passes did Paul buy?
- SEE EXAMPLE 5 p. 95
- If $3x - 13 = 8$, find the value of $x - 4$.
 - If $3(x + 1) = 7$, find the value of $3x$.
 - If $-3(y - 1) = 9$, find the value of $\frac{1}{2}y$.
 - If $4 - 7x = 39$, find the value of $x + 1$.

PRACTICE AND PROBLEM SOLVING

Solve each equation. Check your answer.

- $5 = 2g + 1$
 - $6h - 7 = 17$
 - $0.6v + 2.1 = 4.5$
 - $3x + 3 = 18$
 - $0.6g + 11 = 5$
 - $32 = 5 - 3t$
 - $2d + \frac{1}{5} = \frac{3}{5}$
 - $1 = 2x + \frac{1}{2}$
 - $\frac{z}{2} + 1 = \frac{3}{2}$
 - $\frac{2}{3} = \frac{4j}{6}$
 - $\frac{3}{4} = \frac{3}{8}x - \frac{3}{2}$
 - $\frac{1}{5} - \frac{x}{5} = -\frac{2}{5}$
 - $6 = -2(7 - c)$
 - $5(h - 4) = 8$
 - $-3x - 8 + 4x = 17$
 - $4x + 6x = 30$
 - $2(x + 3) = 10$
 - $17 = 3(p - 5) + 8$
- Consumer Economics** Jennifer is saving money to buy a bike. The bike costs \$245. She has \$125 saved, and each week she adds \$15 to her savings. How long will it take her to save enough money to buy the bike?
 - If $2x + 13 = 17$, find the value of $3x + 1$.
 - If $-(x - 1) = 5$, find the value of $-4x$.
 - If $5(y + 10) = 40$, find the value of $\frac{1}{4}y$.
 - If $9 - 6x = 45$, find the value of $x - 4$.

 **Geometry** Write and solve an equation to find the value of x for each triangle. (Hint: The sum of the angle measures in any triangle is 180° .)



Write an equation to represent each relationship. Solve each equation.

50. Seven less than twice a number equals 19.

51. Eight decreased by 3 times a number equals 2.

52. The sum of two times a number and 5 is 11.

53 History In 1963, Dr. Martin Luther King Jr. began his famous “I have a dream” speech with the words “Five score years ago, a great American, in whose symbolic shadow we stand, signed the Emancipation Proclamation.” The proclamation was signed by President Abraham Lincoln in 1863.

- a. Using the dates given, write and solve an equation that can be used to find the number of years in a score.
- b. How many score would represent 60?

Solve each equation. Check your answer.

54. $3t + 44 = 50$

55. $3(x - 2) = 18$

56. $15 = \frac{c}{3} - 2$

57. $2x + 6.5 = 15.5$

58. $3.9w - 17.9 = -2.3$

59. $17 = x - 3(x + 1)$

60. $5x + 9 = 39$

61. $15 + 5.5m = 70$

Biology Use the graph for Exercises 62 and 63.

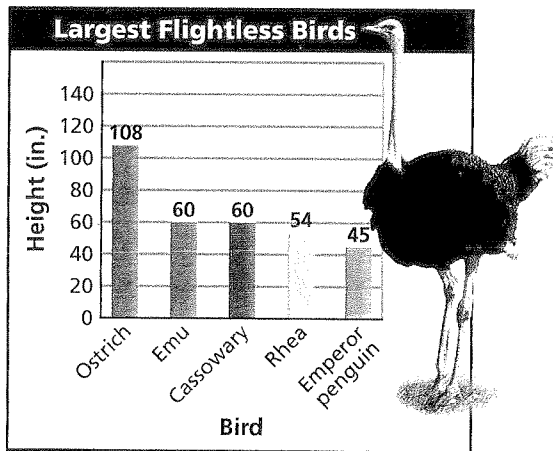
62. The height of an ostrich is 20 inches more than 4 times the height of a kiwi. Write and solve an equation to find the height of a kiwi. Show that your answer is reasonable.

63. Five times the height of a kakapo minus 70 equals the height of an emu. Write and solve an equation to find the height of a kakapo. Show that your answer is reasonable.

64. The sum of two consecutive whole numbers is 57. What are the two numbers? (*Hint:* Let n represent the first number. Then $n + 1$ is the next consecutive whole number.)

65. Stan’s, Mark’s, and Wayne’s ages are consecutive whole numbers. Stan is the youngest, and Wayne is the oldest. The sum of their ages is 111. Find their ages.

66. The sum of two consecutive even whole numbers is 206. What are the two numbers? (*Hint:* Let n represent the first number. What expression can you use to represent the second number?)



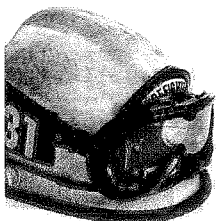
Source: The Top Ten of Everything

LINK

Luther King Jr. earned his bachelor's degree at Morehouse College in Atlanta. During his life he earned 3 degrees and was awarded 20 honorary degrees.

lib.lsu.edu

MULTI-STEP TEST PREP



67. This problem will prepare you for the Multi-Step Test Prep on page 118.

- a. The cost of fighting a certain forest fire is \$225 per acre. Complete the table.
- b. Write an equation for the relationship between the cost c of fighting the fire and the number of acres n .

Cost of Fighting Fire	
Acres	Cost (\$)
100	22,500
200	
500	
1000	
1500	
n	

68. **Critical Thinking** The equation $2(m - 8) + 3 = 17$ has more than one solution method. Give at least two different “first steps” to solve this equation.
69. **Write About It** Write a series of steps that you can use to solve any multi-step equation.



70. Lin sold 4 more shirts than Greg. Fran sold 3 times as many shirts as Lin. In total, the three sold 51 shirts. Which represents the number of shirts Greg sold?
 (A) $3g = 51$ (B) $3 + g = 51$ (C) $8 + 5g = 51$ (D) $16 + 5g = 51$
71. If $\frac{4m-3}{7} = 3$, what is the value of $7m - 5$?
 (F) 6 (G) 10.5 (H) 37 (J) 68.5
72. The equation $c = 48 + 0.06m$ represents the cost c of renting a car and driving m miles. Which statement best describes this cost?
 (A) The cost is a flat rate of \$0.06 per mile.
 (B) The cost is \$0.48 for the first mile and \$0.06 for each additional mile.
 (C) The cost is a \$48 fee plus \$0.06 per mile.
 (D) The cost is a \$6 fee plus \$0.48 per mile.
73. **Gridded Response** A telemarketer earns \$150 a week plus \$2 for each call that results in a sale. Last week she earned a total of \$204. How many of her calls resulted in sales?

CHALLENGE AND EXTEND

Solve each equation. Check your answer.

74. $\frac{9}{2}x + 18 + 3x = \frac{11}{2}$ 75. $\frac{15}{4}x - 15 = \frac{33}{4}$
76. $(x + 6) - (2x + 7) - 3x = -9$ 77. $(4x + 2) - (12x + 8) + 2(5x - 3) = 6 + 1$
78. Find a value for b so that the solution of $4x + 3b = -1$ is $x = 2$.
79. Find a value for b so that the solution of $2x - 3b = 0$ is $x = -9$.
80. **Business** The formula $p = nc - e$ gives the profit p when a number of items n are each sold at a cost c and expenses e are subtracted.
- If $p = 2500$, $n = 2000$, and $e = 800$, what is the value of c ?
 - If $p = 2500$, $n = 1000$, and $e = 800$, what is the value of c ?
 - What if...?** If n is divided in half while p and e remain the same, what is the effect on c ?

SPIRAL REVIEW

Write all classifications that apply to each real number. (Lesson 1-5)

81. $\sqrt{3}$ 82. -58 83. $2\frac{1}{3}$ 84. 0.17

Write each product using the Distributive Property. Then simplify. (Lesson 1-7)

85. $8(61)$ 86. $9(28)$ 87. $11(28)$ 88. $13(21)$

Solve each equation. Check your answer. (Lesson 2-1)

89. $17 = k + 4$ 90. $x - 18 = 3$ 91. $a + 6 = -12$ 92. $-7 = q - 7$



Model Equations with Variables on Both Sides

Algebra tile models can help you understand how to solve equations with variables on both sides.

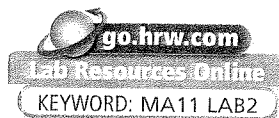
Use with Lesson 2-4

KEY



REMEMBER

$$x + (-x) = 0$$



Activity

Use algebra tiles to model and solve $5x - 2 = 2x + 10$.

MODEL	ALGEBRA
	<p>Model $5x - 2$ on the left side of the mat and $2x + 10$ on the right side.</p> <p>Remember that $5x - 2$ is the same as $5x + (-2)$.</p> $5x - 2 = 2x + 10$
	<p>Remove 2 x-tiles from both sides. This represents subtracting $2x$ from both sides of the equation.</p> $5x - 2 - 2x = 2x - 2x + 10$ $3x - 2 = 10$
	<p>Place 2 yellow tiles on both sides. This represents adding 2 to both sides of the equation.</p> <p>Remove zero pairs.</p> $3x - 2 + 2 = 10 + 2$ $3x = 12$
	<p>Separate each side into 3 equal groups.</p> <p>Each group is $\frac{1}{3}$ of the side.</p> <p>One x-tile is equivalent to 4 yellow tiles.</p> $\frac{1}{3}(3x) = \frac{1}{3}(12)$ $x = 4$

Try This

Use algebra tiles to model and solve each equation.

- $3x + 2 = 2x + 5$
- $5x + 12 = 2x + 3$
- $9x - 5 = 6x + 13$
- $x = -2x + 9$

2-4

Solving Equations with Variables on Both Sides

Objective

Solve equations in one variable that contain variable terms on both sides.

Vocabulary

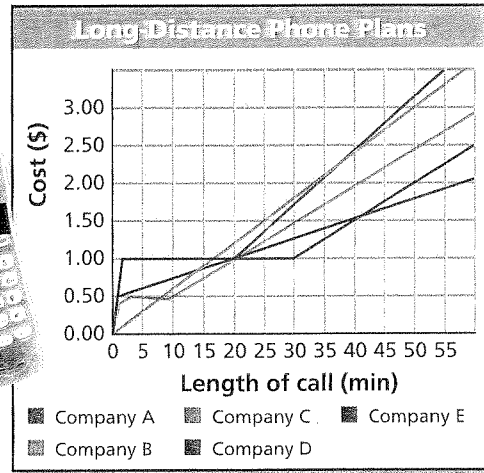
identity

Why learn this?

You can compare prices and find the best value.

Many phone companies offer low rates for long-distance calls without requiring customers to sign up for their services. To compare rates, solve an equation with variables on both sides.

To solve an equation like this, use inverse operations to “collect” variable terms on one side of the equation.



EXAMPLE 1 Solving Equations with Variables on Both Sides

Solve each equation.

A $7k = 4k + 15$

$$7k = 4k + 15$$

$$\begin{array}{r} -4k \\ -4k \end{array} \quad \begin{array}{r} -4k \\ -4k \end{array}$$

$$3k = 15$$

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

$$k = 5$$

To collect the variable terms on one side, subtract $4k$ from both sides.

Since k is multiplied by 3, divide both sides by 3 to undo the multiplication.

B $5x - 2 = 3x + 4$

$$5x - 2 = 3x + 4$$

$$\begin{array}{r} -3x \\ -3x \end{array} \quad \begin{array}{r} -3x \\ -3x \end{array}$$

$$2x - 2 = 4$$

$$\begin{array}{r} +2 \\ +2 \end{array} \quad \begin{array}{r} +2 \\ +2 \end{array}$$

$$2x = 6$$

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

$$x = 3$$

To collect the variable terms on one side, subtract $3x$ from both sides.

Since 2 is subtracted from $2x$, add 2 to both sides to undo the subtraction.

Since x is multiplied by 2, divide both sides by 2 to undo the multiplication.

Check $5x - 2 = 3x + 4$

$$\begin{array}{r|l} 5(3) - 2 & 3(3) + 4 \\ 15 - 2 & 9 + 4 \\ 13 & 13 \checkmark \end{array}$$

To check your solution, substitute 3 for x in the original equation.

Helpful Hint

Equations are often easier to solve when the variable has a positive coefficient. Keep this in mind when deciding on which side to “collect” variable terms.



Solve each equation. Check your answer.

1a. $4b + 2 = 3b$

1b. $0.5 + 0.3y = 0.7y - 0.3$

To solve more complicated equations, you may need to first simplify by using the Distributive Property or combining like terms.

EXAMPLE 2 Simplifying Each Side Before Solving Equations

Solve each equation.

A $2(y + 6) = 3y$

$$\begin{array}{r} \curvearrowright \\ 2(y + 6) = 3y \\ 2(y) + 2(6) = 3y \\ 2y + 12 = 3y \\ \underline{-2y} \quad \underline{-2y} \\ 12 = y \end{array}$$

Distribute 2 to the expression in parentheses.

To collect the variable terms on one side, subtract 2y from both sides.

Check $2(y + 6) = 3y$

$2(12 + 6)$	$3(12)$
$2(18)$	36
36	$36 \checkmark$

To check your solution, substitute 12 for y in the original equation.

B $2k - 5 = 3(1 - 2k)$

$$\begin{array}{r} \curvearrowright \\ 2k - 5 = 3(1 - 2k) \\ 2k - 5 = 3(1) - 3(2k) \\ 2k - 5 = 3 - 6k \\ \underline{+6k} \quad \underline{+6k} \\ 8k - 5 = 3 \\ \underline{+5} \quad \underline{+5} \\ 8k = 8 \\ \frac{8k}{8} = \frac{8}{8} \\ k = 1 \end{array}$$

Distribute 3 to the expression in parentheses.

To collect the variable terms on one side, add 6k to both sides.

Since 5 is subtracted from 8k, add 5 to both sides.

Since k is multiplied by 8, divide both sides by 8.

C $3 - 5b + 2b = -2 - 2(1 - b)$

$$\begin{array}{r} \curvearrowright \\ 3 - 5b + 2b = -2 - 2(1 - b) \\ 3 - 5b + 2b = -2 - 2(1) - 2(-b) \\ 3 - 5b + 2b = -2 - 2 + 2b \\ 3 - 3b = -4 + 2b \\ \underline{+3b} \quad \underline{+3b} \\ 3 = -4 + 5b \\ \underline{+4} \quad \underline{+4} \\ 7 = 5b \\ \frac{7}{5} = \frac{5b}{5} \\ 1.4 = b \end{array}$$

Distribute -2 to the expression in parentheses.

Combine like terms.

Add 3b to both sides.

Since -4 is added to 5b, add 4 to both sides.

Since b is multiplied by 5, divide both sides by 5.



Solve each equation. Check your answer.

2a. $\frac{1}{2}(b + 6) = \frac{3}{2}b - 1$

2b. $3x + 15 - 9 = 2(x + 2)$

An **identity** is an equation that is always true, no matter what value is substituted for the variable. The solutions of an identity are all real numbers. Some equations are always false. These equations have no solutions.

EXAMPLE 3 Infinitely Many Solutions or No Solutions

Writing Math

The solution set for Example 3B is an empty set—it contains no elements. The empty set can be written as \emptyset or $\{\}$.

Solve each equation.

A $x + 4 - 6x = 6 - 5x - 2$

$$x + 4 - 6x = 6 - 5x - 2$$

$$4 - 5x = 4 - 5x$$

$$\quad + 5x \quad + 5x$$

$$4 = 4 \checkmark$$

Identify like terms.

Combine like terms on the left and the right.

Add 5x to both sides.

True statement

The equation $x + 4 - 6x = 6 - 5x - 2$ is an identity. All values of x will make the equation true. All real numbers are solutions.

B $-8x + 6 + 9x = -17 + x$

$$-8x + 6 + 9x = -17 + x$$

$$x + 6 = -17 + x$$

$$\quad -x \quad \quad -x$$

$$6 = -17 \times$$

Identify like terms.

Combine like terms.

Subtract x from both sides.

False statement

The equation $-8x + 6 + 9x = -17 + x$ is always false. There is no value of x that will make the equation true. There are no solutions.



CHECK IT OUT! Solve each equation.

3a. $4y + 7 - y = 10 + 3y$

3b. $2c + 7 + c = -14 + 3c + 21$

EXAMPLE 4 Consumer Application

The long-distance rates of two phone companies are shown in the table. How long is a call that costs the same amount no matter which company is used? What is the cost of that call?

Phone Company	Charges
Company A	36¢ plus 3¢ per minute
Company B	6¢ per minute

Let m represent minutes, and write expressions for each company's cost.

When is 36¢ plus $\frac{3\text{¢ per}}{\text{minute}}$ times number of minutes the same as $\frac{6\text{¢ per}}{\text{minute}}$ times number of minutes?

$$36 + 3(m) = 6(m)$$

$$36 + 3m = 6m$$

$$\quad - 3m \quad - 3m$$

$$36 = 3m$$

$$\frac{36}{3} = \frac{3m}{3}$$

$$12 = m$$

To collect the variable terms on one side, subtract $3m$ from both sides.

Since m is multiplied by 3, divide both sides by 3 to undo the multiplication.

The charges will be the same for a 12-minute call using either phone service. To find the cost of this call, evaluate either expression for $m = 12$:

$$36 + 3m = 36 + 3(12) = 36 + 36 = 72 \quad 6m = 6(12) = 72$$

The cost of a 12-minute call through either company is 72¢.



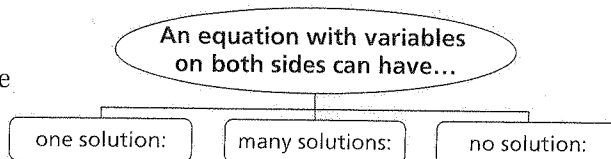
4. Four times Greg's age, decreased by 3 is equal to 3 times Greg's age, increased by 7. How old is Greg?

THINK AND DISCUSS

1. Tell which of the following is an identity. Explain your answer.

a. $4(a + 3) - 6 = 3(a + 3) - 6$ b. $8.3x - 9 + 0.7x = 2 + 9x - 11$

2. **GET ORGANIZED** Copy and complete the graphic organizer. In each box, write an example of an equation that has the indicated number of solutions.



Know It!
Note

2-4

Exercises



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Homework Help Online

KEYWORD: MA7 2-4

Parent Resources Online

KEYWORD: MA7 Parent

GUIDED PRACTICE

1. **Vocabulary** How can you recognize an identity?

Solve each equation. Check your answer.

EXAMPLE 1
p. 100

2. $2c + 5 = c + 4$

3. $8r + 4 = 10 + 2r$

4. $2x + 1 = x + 11$

5. $28 - 0.3y = 0.7y - 12$

EXAMPLE 2
p. 101

6. $-2(x + 3) = 4x - 3$

7. $3c - 4c + 1 = 5c + 2 + 3$

8. $5 + 3(q - 4) = 2(q + 1)$

9. $5 - (t + 3) = -1 + 2(t - 3)$

EXAMPLE 3
p. 102

10. $7x + 4 = -2x + 1 + 9x - 5$

11. $8x + 6 - 9x = 2 - x - 15$

12. $6y = 8 + 9 + 6y$

13. $6 - 2x - 1 = 4x + 8 - 6x - 3$

EXAMPLE 4
p. 102

14. **Consumer Economics** A house-painting company charges \$376 plus \$12 per hour. Another painting company charges \$280 plus \$15 per hour.

a. How long is a job for which both companies will charge the same amount?

b. What will that cost be?

PRACTICE AND PROBLEM SOLVING

Solve each equation. Check your answer.

15. $7a - 17 = 4a + 1$

16. $2b - 5 = 8b + 1$

17. $4x - 2 = 3x + 4$

18. $2x - 5 = 4x - 1$

19. $8x - 2 = 3x + 12.25$

20. $5x + 2 = 3x$

21. $3c - 5 = 2c + 5$

22. $-17 - 2x = 6 - x$

23. $3(t - 1) = 9 + t$

24. $5 - x - 2 = 3 + 4x + 5$

25. $2(x + 4) = 3(x - 2)$

26. $3m - 10 = 2(4m - 5)$

27. $5 - (n - 4) = 3(n + 2)$

28. $6(x + 7) - 20 = 6x$

29. $8(x + 1) = 4x - 8$

30. $x - 4 - 3x = -2x - 3 - 1$

31. $-2(x + 2) = -2x + 1$

32. $2(x + 4) - 5 = 2x + 3$

Independent Practice

For Exercises	See Example
15–22	1
23–29	2
30–32	3
33	4

Extra Practice

Skills Practice p. 56
Application Practice p. 529

33. Sports Justin and Tyson are beginning an exercise program to train for football season. Justin weighs 150 lb and hopes to gain 2 lb per week. Tyson weighs 195 lb and hopes to lose 1 lb per week.

- If the plan works, in how many weeks will the boys weigh the same amount?
- What will that weight be?

Write an equation to represent each relationship. Then solve the equation.


- Three times the sum of a number and 4 is the same as 18 more than the number.
- A number decreased by 30 is the same as 14 minus 3 times the number.
- Two less than 2 times a number is the same as the number plus 64.

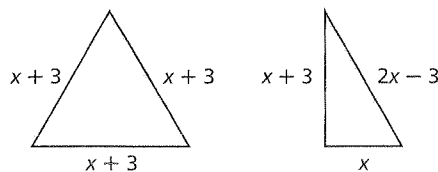
Solve each equation. Check your answer.

- | | | |
|---|-----------------------------|--------------------------------|
| 37. $2x - 2 = 4x + 6$ | 38. $3x + 5 = 2x + 2$ | 39. $4x + 3 = 5x - 4$ |
| 40. $-\frac{2}{5}p + 2 = \frac{1}{5}p + 11$ | 41. $5x + 24 = 2x + 15$ | 42. $5x - 10 = 14 - 3x$ |
| 43. $12 - 6x = 10 - 5x$ | 44. $5x - 7 = -6x - 29$ | 45. $1.8x + 2.8 = 2.5x + 2.1$ |
| 46. $2.6x + 18 = 2.4x + 22$ | 47. $1 - 3x = 2x + 8$ | 48. $\frac{1}{2}(8 - 6h) = h$ |
| 49. $3(x + 1) = 2x + 7$ | 50. $9x - 8 + 4x = 7x + 16$ | 51. $3(2x - 1) + 5 = 6(x + 1)$ |

52. Travel Rapid Rental Car company charges a \$40 rental fee, \$15 for gas, and \$0.25 per mile driven. For the same car, Capital Cars charges \$45 for rental and gas and \$0.35 per mile.

- Find the number of miles for which the companies' charges will be the same. Then find that charge. Show that your answers are reasonable.
- The Barre family estimates that they will drive about 95 miles during their vacation to Hershey, Pennsylvania. Which company should they rent their car from? Explain.
- What if...?** The Barres have extended their vacation and now estimate that they will drive about 120 miles. Should they still rent from the same company as in part b? Why or why not?
- Give a general rule for deciding which company to rent from.

 **53. Geometry** The triangles shown have the same perimeter. What is the value of x ?



MULTI-STEP TEST PREP



- This problem will prepare you for the Multi-Step Test Prep on page 118.
 - A fire currently covers 420 acres and continues to spread at a rate of 60 acres per day. How many total acres will be covered in the next 2 days? Show that your answer is reasonable.
 - Write an expression for the total area covered by the fire in d days.
 - The firefighters estimate that they can put out the fire at a rate of 80 acres per day. Write an expression for the total area that the firefighters can put out in d days.
 - Set the expressions in parts b and c equal. Solve for d . What does d represent?

LINK

Biology

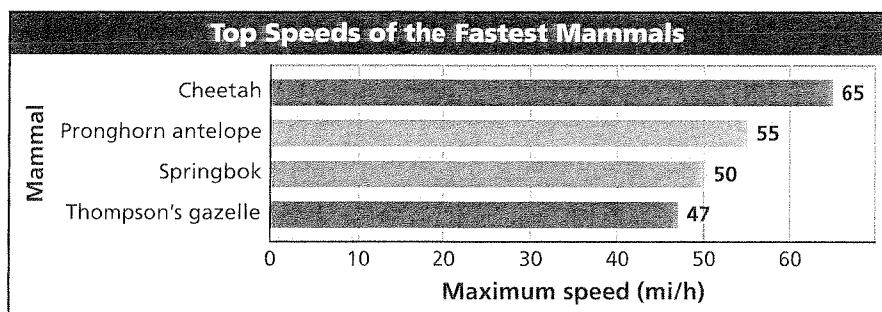


A cheetah's body is designed for fast running. Its tail acts like a rudder to help it make sharp turns. Its legs act like a spring to propel it forward.

cheetahspot.com

55. **Critical Thinking** Write an equation with variables on both sides that has no solution.

56. **Biology** The graph shows the maximum recorded speeds of the four fastest mammals.



Source: *The Top 10 of Everything*

- Write an expression for the distance in miles that a Thompson's gazelle can run at top speed in x hours.
- Write an expression for the distance in miles that a cheetah can run at top speed in x hours.
- A cheetah and a Thompson's gazelle are running at their top speeds. The cheetah is one mile behind the gazelle. Write an expression for the distance the cheetah must run to catch up with the gazelle.
- Write and solve an equation that represents how long the cheetah will have to run at top speed to catch up with the gazelle.
- A cheetah can maintain its top speed for only 300 yards. Will the cheetah be able to catch the gazelle? Explain.

57. **Write About It** Write a series of steps that you can use to solve any equation with variables on both sides.

TEST PREP

58. Lindsey's monthly magazine subscription costs \$1.25 per issue. Kenzie's monthly subscription costs \$1.50 per issue, but she received her first 2 issues free. Which equation can be used to find the number of months after which the girls will have paid the same amount?

- (A) $1.25m = 1.50m - 2$ (C) $1.25m = 1.50(m - 2)$
 (B) $1.25m = 1.50m - 2m$ (D) $1.25m = 3m - 1.50$

59. What is the numerical solution of the equation *7 times a number equals 3 less than 5 times that number*?

- (F) -1.5 (G) 0.25 (H) $\frac{2}{3}$ (J) 4

60. Three packs of markers cost \$9.00 less than 5 packs of markers. Which equation best represents this situation?

- (A) $5x + 9 = 3x$ (B) $3x + 9 = 5x$ (C) $3x - 9 = 5x$ (D) $9 - 3x = 5x$

61. Nicole has \$120. If she saves \$20 per week, in how many days will she have \$500?

- (F) 19 (G) 25 (H) 133 (J) 175

62. **Gridded Response** Solve $-2(x - 1) + 5x = 2(2x - 1)$.

CHALLENGE AND EXTEND

Solve each equation.

63. $4x + 2[4 - 2(x + 2)] = 2x - 4$

64. $\frac{x+5}{2} + \frac{x-1}{2} = \frac{x-1}{3}$

65. $\frac{2}{3}w - \frac{1}{4} = \frac{2}{3}\left(w - \frac{1}{4}\right)$

66. $-5 - 7 - 3f = -f - 2(f + 6)$

67. $\frac{2}{3}x + \frac{1}{2} = \frac{3}{5}x - \frac{5}{6}$

68. $x - \frac{1}{4} = \frac{x}{3} + 7\frac{3}{4}$

69. Find three consecutive integers such that twice the greatest integer is 2 less than 3 times the least integer.

70. Find three consecutive integers such that twice the least integer is 12 more than the greatest integer.

71. Rob had twice as much money as Sam. Then Sam gave Rob 1 quarter, 2 nickels, and 3 pennies. Rob then gave Sam 8 dimes. If they now have the same amount of money, how much money did Rob originally have? Check your answer.

SPIRAL REVIEW

Write an expression for the perimeter of each figure. (Lesson 1-1)

72. square with side x cm

73. equilateral triangle with side y cm

Multiply or divide. (Lesson 1-3)

74. $6.1 \div 0$

75. $3(-21)$

76. $0 \div \frac{7}{8}$

77. $\frac{2}{5} \div \frac{1}{10}$

78. $5 \div (-5)$

79. $\frac{-16}{-8}$

80. $-1000 \div (-0.001)$

81. $500(-0.25)$

Solve each equation. Check your answer. (Lesson 2-3)

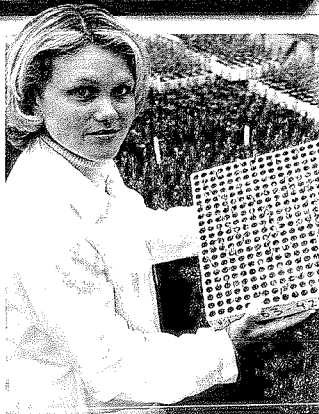
82. $4x - 44 = 8$

83. $2(x - 3) = 24$

84. $-1 = \frac{x}{4} - 3$

85. $2x + 6 = 12$

Career Path



Beth Simmons
Biology major

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Career Resources Online
KEYWORD: MA7 Career

Q: What math classes did you take in high school?

A: Algebra 1 and 2, Geometry, and Precalculus

Q: What math classes have you taken in college?

A: Two calculus classes and a calculus-based physics class

Q: How do you use math?

A: I use math a lot in physics. Sometimes I would think a calculus topic was totally useless, and then we would use it in physics class! In biology, I use math to understand populations.

Q: What career options are you considering?

A: When I graduate, I could teach, or I could go to graduate school and do more research. I have a lot of options.