

## Equations

**2A Equations and Formulas**

- Lab Model One-Step Equations
- 2-1 Solving Equations by Adding or Subtracting
- 2-2 Solving Equations by Multiplying or Dividing
- Lab Solve Equations by Graphing
- 2-3 Solving Two-Step and Multi-Step Equations
- Lab Model Equations with Variables on Both Sides
- 2-4 Solving Equations with Variables on Both Sides
- 2-5 Solving for a Variable
- 2-6 Solving Absolute-Value Equations

**2B Proportion and Percent**

- 2-7 Rates, Ratios, and Proportions
- 2-8 Applications of Proportions
- 2-9 Percents
- 2-10 Applications of Percents
- 2-11 Percent Increase and Decrease
- Lab Explore Changes in Population

**Chapter Focus**

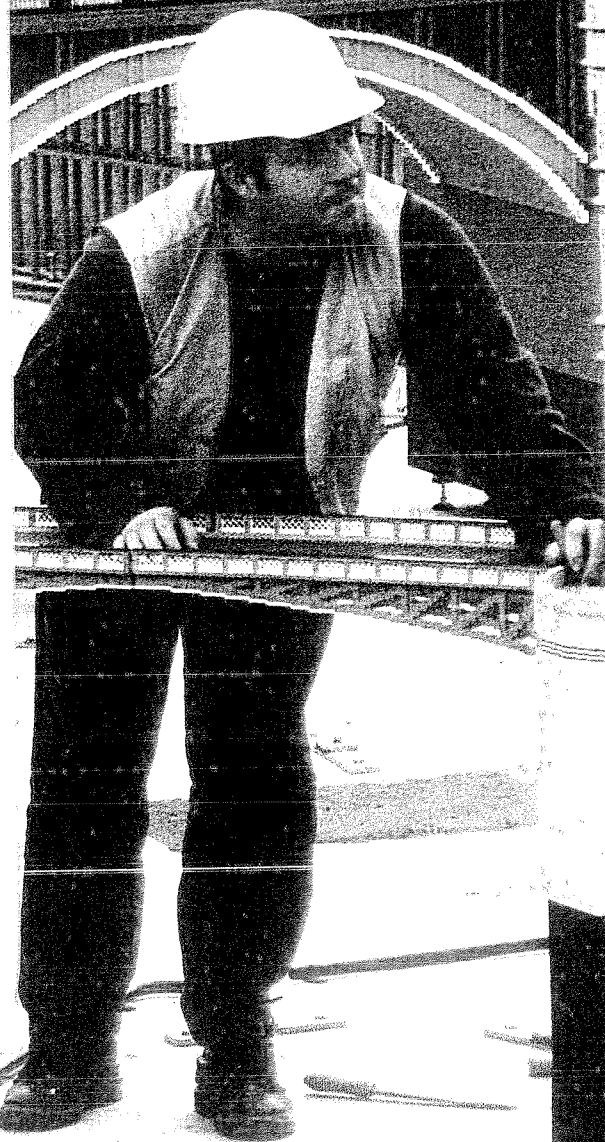
- Use properties of equality.
- Choose procedures to solve equations efficiently.
- Write and solve equations to solve problems.

**All in Proportion**

A common use of equations and proportional relationships is the construction of scale models.

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KEYWORD: MA7 ChProj



# ARE YOU READY?

## ✓ Vocabulary

Match each term on the left with a definition on the right.

- |                        |  |
|------------------------|--|
| 1. constant            | A. a mathematical phrase that contains operations, numbers, and/or variables |
| 2. expression          | B. a mathematical statement that two expressions are equivalent              |
| 3. order of operations | C. a process for evaluating expressions                                      |
| 4. variable            | D. a symbol used to represent a quantity that can change                     |
|                        | E. a value that does not change  |

## ✓ Order of Operations

Simplify each expression.

- |                     |                             |
|---------------------|-----------------------------|
| 5. $(7 - 3) \div 2$ | 6. $4 \cdot 6 \div 3$       |
| 7. $12 - 3 + 1$     | 8. $2 \cdot 10 \div 5$      |
| 9. $125 \div 5^2$   | 10. $7 \cdot 6 + 5 \cdot 4$ |

## ✓ Add and Subtract Integers

Add or subtract.

- |                |                  |                |                  |
|----------------|------------------|----------------|------------------|
| 11. $-15 + 19$ | 12. $-6 - (-18)$ | 13. $6 + (-8)$ | 14. $-12 + (-3)$ |
|----------------|------------------|----------------|------------------|

## ✓ Add and Subtract Fractions

Perform each indicated operation. Give your answer in the simplest form.

- |                                 |                                  |                                 |                                 |
|---------------------------------|----------------------------------|---------------------------------|---------------------------------|
| 15. $\frac{1}{4} + \frac{2}{3}$ | 16. $1\frac{1}{2} - \frac{3}{4}$ | 17. $\frac{3}{8} + \frac{2}{3}$ | 18. $\frac{3}{2} - \frac{2}{3}$ |
|---------------------------------|----------------------------------|---------------------------------|---------------------------------|

## ✓ Evaluate Expressions

Evaluate each expression for the given value of the variable.

- |                           |                          |
|---------------------------|--------------------------|
| 19. $2x + 3$ for $x = 7$  | 20. $3n - 5$ for $n = 7$ |
| 21. $13 - 4a$ for $a = 2$ | 22. $3y + 5$ for $y = 5$ |

## ✓ Connect Words and Algebra

23. Janie bought 4 apples and 6 bananas. Each apple cost \$0.75, and each banana cost \$0.60. Write an expression representing the total cost.
24. A rectangle has a width of 13 inches and a length of  $\ell$  inches. Write an expression representing the area of the rectangle.
25. Write a phrase that could be modeled by the expression  $n + 2n$ .

*Where You've Been*

practiced using operations in algebra.

used variables to represent quantities.

wrote expressions to represent situations.

simplified and evaluated expressions.

**In This Chapter****You will study**

- how to use inverse operations to solve equations containing variables.
- writing equations to represent situations.
- simplifying equations before solving.

*Where You're Going*

to compare unit prices for consumer products.

to calculate percentages in taxes, tips, interest, and commissions.

to create or interpret scale models and drawings.

to solve problems in science courses and all future math courses.

*Key**Vocabulary/Vocabulario*

equation	ecuación
formula	fórmula
identity	identidad
indirect measurement	medición indirecta
literal equation	ecuación literal
percent	porcentaje
percent change	porcentaje de cambio
proportion	proporción
ratio	razón
unit rate	tasa unitaria

*Vocabulary Connections*

To become familiar with some of the vocabulary terms in the chapter, consider the following. You may refer to the chapter, the glossary, or a dictionary if you like.

1. The word **equation** begins with the root *equa-*. List some other words that begin with *equa-*. What do all these words have in common?
2. The word *literal* means “of letters.” How might a **literal equation** be different from an equation like  $3 + 5 = 8$ ?
3. One definition of **identity** is “exact sameness.” An equation consists of two expressions. If an equation is an *identity*, what do you think is true about the expressions?
4. The word *per* means “for each,” and the word *cent* means “hundred.” How can you use these meanings to understand the term **percent**?

## Study Strategy: Use Your Own Words

Explaining a concept using your own words will help you better understand it. For example, learning to solve equations might seem difficult if the textbook doesn't use the same words that you would use.

As you work through each lesson:

- Identify the important ideas from the explanation in the book.
- Use your own words to explain the important ideas you identified.

### What Arturo Reads

To evaluate an expression is to find its value.

To evaluate an algebraic expression, substitute numbers for the variables in the expression and then simplify the expression.

A replacement set is a set of numbers that can be substituted for a variable.

### What Arturo Writes

Evaluate an expression—  
find the value.

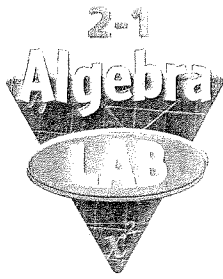
Substitute a number for  
each variable (letter), and  
find the answer.

Replacement set—numbers  
that can be substituted for  
a letter.

### Try This

Rewrite each paragraph in your own words.

1. Two numbers are opposites if their sum is 0. A number and its opposite are on opposite sides of zero on a number line, but are the same distance from zero.
2. The Commutative and Associative Properties of Addition and Multiplication allow you to rearrange an expression to simplify it.
3. The terms of an expression are the parts to be added or subtracted. Like terms are terms that contain the same variables raised to the same powers. Constants are also like terms.



# Model One-Step Equations

You can use algebra tiles and an equation mat to model and solve equations. To find the value of the variable, place or remove tiles to get the  $x$ -tile by itself on one side of the mat. You must place or remove the same number of yellow tiles or the same number of red tiles on both sides.

Use with Lesson 2-1

### KEY

= 1

= -1

### REMEMBER

+ = 0



## Activity

Use algebra tiles to model and solve  $x + 6 = 2$ .

MODEL	ALGEBRA
	<p>Model <math>x + 6 = 2</math> on the equation mat. The equation is on the right side of the mat.</p> $x + 6 = 2$
	<p>Place 4 red tiles on both sides of the mat. This represents adding <math>-4</math> to both sides of the equation.</p> $x + 6 + (-4) = 2 + (-4)$
	<p>Remove 4 yellow tiles from both sides of the mat.</p> $x + 2 = 1 + (-4)$
	$x = -4$

## Involved

Use algebra tiles to model and solve each equation.

1.  $x + 2 = 5$

2.  $x - 7 = 8$

3.  $x - 5 = 9$

4.  $x + 4 = 7$

# 2-1

# Solving Equations by Adding or Subtracting



### Who uses this?

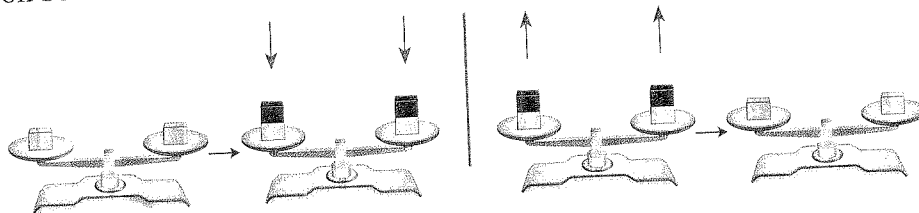
Athletes can use an equation to estimate their maximum heart rates. (See Example 4.)

An **equation** is a mathematical statement that two expressions are equal. A **solution of an equation** is a value of the variable that makes the equation true.

To find solutions, *isolate the variable*. A variable is isolated when it appears by itself on one side of an equation, and not at all on the other side. Isolate a variable by using inverse operations, which “undo” operations on the variable.

An equation is like a balanced scale. To keep the balance, perform the same operation on both sides.

**Inverse Operations**  
Add  $x$ .  $\longleftrightarrow$  Subtract  $x$ .



## EXAMPLE 1 Solving Equations by Using Addition

Solve each equation.

$$\begin{array}{r} \text{A} \quad x - 10 = 4 \\ x - 10 = 4 \\ + 10 \quad + 10 \\ \hline x = 14 \end{array}$$

Since 10 is subtracted from  $x$ , add 10 to both sides to undo the subtraction.

$$\begin{array}{r} \text{Check} \quad x - 10 = 4 \\ 14 - 10 \quad | \quad 4 \\ \hline 4 \quad | \quad 4 \checkmark \end{array}$$

To check your solution, substitute 14 for  $x$  in the original equation.

$$\begin{array}{r} \text{B} \quad \frac{2}{5} = m - \frac{1}{5} \\ \frac{2}{5} = m - \frac{1}{5} \\ + \frac{1}{5} \quad + \frac{1}{5} \\ \hline \frac{3}{5} = m \end{array}$$

Since  $\frac{1}{5}$  is subtracted from  $m$ , add  $\frac{1}{5}$  to both sides to undo the subtraction.

### Writing Math

Solutions are sometimes written in a *solution set*. For Example 1A, the solution set is  $\{14\}$ . For Example 1B, the solution set is  $\{\frac{3}{5}\}$ .



Solve each equation. Check your answer.

1a.  $n - 3.2 = 5.6$

1b.  $-6 = k - 6$

1c.  $16 = m - 9$

**EXAMPLE 2 Solving Equations by Using Subtraction**

Solve each equation. Check your answer.

**A**  $x + 7 = 9$

$$\begin{array}{r} x + 7 = 9 \\ -7 \quad -7 \\ \hline x = 2 \end{array}$$

Since 7 is added to  $x$ , subtract 7 from both sides to undo the addition.

**Check**

$$\begin{array}{r|l} x + 7 = 9 & \\ 2 + 7 & 9 \\ \hline 9 & 9 \checkmark \end{array}$$

To check your solution, substitute 2 for  $x$  in the original equation.

**B**  $0.7 = r + 0.4$

$$\begin{array}{r} 0.7 = r + 0.4 \\ -0.4 \quad -0.4 \\ \hline 0.3 = r \end{array}$$

Since 0.4 is added to  $r$ , subtract 0.4 from both sides to undo the addition.

**Check**

$$\begin{array}{r|l} 0.7 = r + 0.4 & \\ 0.7 & 0.3 + 0.4 \\ \hline 0.7 & 0.7 \checkmark \end{array}$$

To check your solution, substitute 0.3 for  $r$  in the original equation.

Solve each equation. Check your answer.

2a.  $d + \frac{1}{2} = 1$

2b.  $-5 = k + 5$

2c.  $6 + t = 14$

Remember that subtracting is the same as adding the opposite. When solving equations, you will sometimes find it easier to add an opposite to both sides instead of subtracting. For example, this method may be useful when the equation contains negative numbers.

**EXAMPLE 3 Solving Equations by Adding the Opposite**Solve  $-8 + b = 2$ .

$$\begin{array}{r} -8 + b = 2 \\ +8 \quad +8 \\ \hline b = 10 \end{array}$$

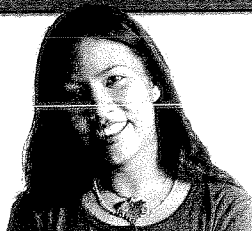
Since  $-8$  is added to  $b$ , add 8 to both sides.

Solve each equation. Check your answer.

3a.  $-2.3 + m = 7$

3b.  $-\frac{3}{4} + z = \frac{5}{4}$

3c.  $-11 + x = 33$

**Student to Student****Zero As a Solution**

**Ama Walker**  
Carson High School

I used to get confused when I got a solution of 0. But my teacher reminded me that 0 is a number just like any other number, so it can be a solution of an equation. Just check your answer and see if it works.

$$\begin{array}{r} x + 6 = 6 \\ -6 \quad -6 \\ \hline x = 0 \end{array} \quad \text{Check} \quad \begin{array}{r|l} x + 6 = 6 & \\ 0 + 6 & 6 \\ \hline 6 & 6 \checkmark \end{array}$$

## EXAMPLE 4 Fitness Application



A person's maximum heart rate is the highest rate, in beats per minute, that the person's heart should reach. One method to estimate maximum heart rate states that your age added to your maximum heart rate is 220. Using this method, write and solve an equation to find the maximum heart rate of a 15-year-old.

Age added to maximum heart rate is 220.

$$a + r = 220$$

$$a + r = 220$$

$$15 + r = 220$$

$$\begin{array}{r} 15 + r = 220 \\ -15 \quad -15 \\ \hline r = 205 \end{array}$$

$$r = 205$$

Write an equation to represent the relationship.

Substitute 15 for  $a$ . Since 15 is added to  $r$ , subtract 15 from both sides to undo the addition.

The maximum heart rate for a 15-year-old is 205 beats per minute. Since age added to maximum heart rate is 220, the answer should be less than 220. So 205 is a reasonable answer.



4. **What if...?** Use the method above to find a person's age if the person's maximum heart rate is 185 beats per minute.

The properties of equality allow you to perform inverse operations, as in the previous examples. These properties say that you can perform the same operation on both sides of an equation.

Know It!

Note

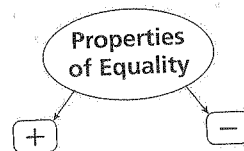
### Properties of Equality

WORDS	NUMBERS	ALGEBRA
<b>Addition Property of Equality</b> You can add the same number to both sides of an equation, and the statement will still be true.	$3 = 3$ $3 + 2 = 3 + 2$ $5 = 5$	$a = b$ $a + c = b + c$
<b>Subtraction Property of Equality</b> You can subtract the same number from both sides of an equation, and the statement will still be true.	$7 = 7$ $7 - 5 = 7 - 5$ $2 = 2$	$a = b$ $a - c = b - c$

### THINK AND DISCUSS

1. Describe how the Addition and Subtraction Properties of Equality are like a balanced scale.

2. **GET ORGANIZED** Copy and complete the graphic organizer: In each box, write an example of an equation that can be solved by using the given property, and solve it.



Know It!

Note



## GUIDED PRACTICE

1. **Vocabulary** Will the *solution of an equation* such as  $x - 3 = 9$  be a variable or a number? Explain.

Solve each equation. Check your answer.

SEE EXAMPLE 1  
p. 77

2.  $s - 5 = 3$

3.  $17 = w - 4$

4.  $k - 8 = -7$

5.  $x - 3.9 = 12.4$

6.  $8.4 = y - 4.6$

7.  $\frac{3}{8} = t - \frac{1}{8}$

SEE EXAMPLE 2  
p. 78

8.  $t + 5 = -25$

9.  $9 = s + 9$

10.  $42 = m + 36$

11.  $2.8 = z + 0.5$

12.  $b + \frac{2}{3} = 2$

13.  $n + 1.8 = 3$

SEE EXAMPLE 3  
p. 78

14.  $-10 + d = 7$

15.  $20 = -12 + v$

16.  $-46 + q = 5$

17.  $2.8 = -0.9 + y$

18.  $-\frac{2}{3} + c = \frac{2}{3}$

19.  $-\frac{5}{6} + p = 2$

SEE EXAMPLE 4  
p. 79

20. **Geology** In 1673, the Hope diamond was reduced from its original weight by about 45 carats, resulting in a diamond weighing about 67 carats. Write and solve an equation to find how many carats the original diamond weighed. Show that your answer is reasonable.

## PRACTICE AND PROBLEM SOLVING

Solve each equation. Check your answer.

21.  $1 = k - 8$

22.  $u - 15 = -8$

23.  $x - 7 = 10$

24.  $-9 = p - 2$

25.  $\frac{3}{7} = p - \frac{1}{7}$

26.  $q - 0.5 = 1.5$

27.  $6 = t - 4.5$

28.  $4\frac{2}{3} = r - \frac{1}{3}$

29.  $6 = x - 3$

30.  $1.75 = k - 0.75$

31.  $19 + a = 19$

32.  $4 = 3.1 + y$

33.  $m + 20 = 3$

34.  $-12 = c + 3$

35.  $v + 2300 = -800$

36.  $b + 42 = 300$

37.  $3.5 = n + 4$

38.  $b + \frac{1}{2} = \frac{1}{2}$

39.  $x + 5.34 = 5.39$

40.  $2 = d + \frac{1}{4}$

41.  $-12 + f = 3$

42.  $-9 = -4 + g$

43.  $-1200 + j = 345$

44.  $90 = -22 + a$

45.  $26 = -4 + y$

46.  $1\frac{3}{4} = -\frac{1}{4} + w$

47.  $-\frac{1}{6} + h = \frac{1}{6}$

48.  $-5.2 + a = -8$

49. **Finance** Luis deposited \$500 into his bank account. He now has \$4732. Write and solve an equation to find how much was in his account before the deposit. Show that your answer is reasonable.

50. **///ERROR ANALYSIS///** Below are two possible solutions to  $x + 12.5 = 21.6$ . Which is incorrect? Explain the error.

(A)

$$\begin{array}{r} x + 12.5 = 21.6 \\ - 12.5 \quad - 12.5 \\ \hline x = 9.1 \end{array}$$

(B)

$$\begin{array}{r} x + 12.5 = 21.6 \\ + 12.5 \quad + 12.5 \\ \hline x = 34.1 \end{array}$$

## Independent Practice

For Exercises	See Example
21-30	1
31-40	2
41-48	3
49	4

## Extra Practice

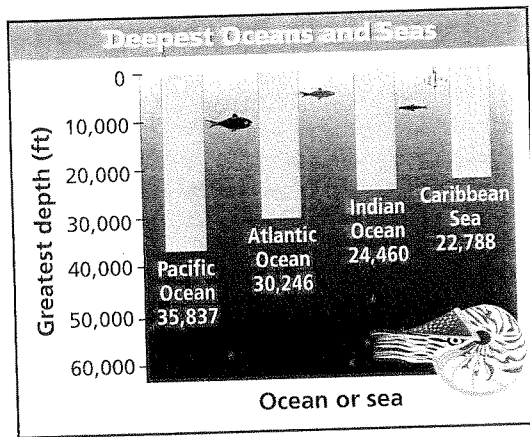
Skills Practice p. 56

Application Practice p. 529

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

51. Ten less than a number is equal to 12.
52. A number decreased by 13 is equal to 7.
53. Eight more than a number is 16.
54. A number minus 3 is  $-8$ .
55. The sum of 5 and a number is 6.
56. Two less than a number is  $-5$ .
57. The difference of a number and 4 is 9.

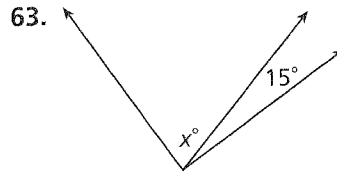
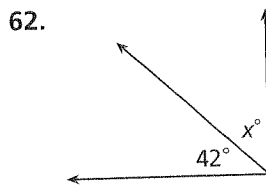
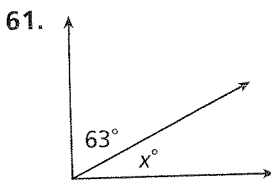
**58. Geology** The sum of the Atlantic Ocean's average depth (in feet) and its greatest depth is 43,126. Use the information in the graph to write and solve an equation to find the average depth of the Atlantic Ocean. Show that your answer is reasonable.



**59. School** Helene's marching band needs money to travel to a competition. Band members have raised \$560. They need to raise a total of \$1680. Write and solve an equation to find how much more they need. Show that your answer is reasonable.

**60. Economics** When you receive a loan to make a purchase, you often must make a down payment in cash. The amount of the loan is the purchase cost minus the down payment. Riva made a down payment of \$1500 on a used car. She received a loan of \$2600. Write and solve an equation to find the cost of the car. Show that your answer is reasonable.

**Geometry** The angles in each pair are complementary. Write and solve an equation to find each value of  $x$ . (*Hint: The measures of complementary angles add to  $90^\circ$ .*)



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

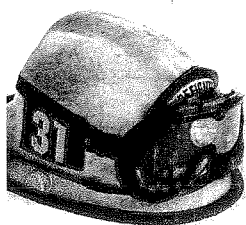
*Rates* are often used to describe how quickly something is moving or changing.

- a. A wildfire spreads at a rate of 1000 acres per day. How many acres will the fire cover in 2 days? Show that your answer is reasonable.
- b. How many acres will the fire cover in 5 days? Explain how you found your answer.
- c. Another wildfire spread for 7 days and covered a total of 780 square miles. How can you estimate the number of square miles the fire covered per day?



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**MULTI-STEP  
TEST PREP**



65. **Statistics** The range of a set of scores is 28, and the lowest score is 47. Write and solve an equation to find the highest score. (*Hint:* In a data set, the range is the difference between the highest and the lowest values.) Show that your answer is reasonable.
66. **Write About It** Describe a real-world situation that can be modeled by  $x + 5 = 25$ . Tell what the variable represents in your situation. Then solve the equation and tell what the solution means in the context of your problem.
67. **Critical Thinking** Without solving, tell whether the solution of  $-3 + z = 10$  will be greater than 10 or less than 10. Explain.



68. Which situation is best represented by  $x - 32 = 8$ ?
- (A) Logan withdrew \$32 from her bank account. After her withdrawal, her balance was \$8. How much was originally in her account?
- (B) Daniel has 32 baseball cards. Joseph has 8 fewer baseball cards than Daniel. How many baseball cards does Joseph have?
- (C) Room A contains 32 desks. Room B has 8 fewer desks. How many desks are in Room B?
- (D) Janelle bought a bag of 32 craft sticks for a project. She used 8 craft sticks. How many craft sticks does she have left?
69. For which equation is  $a = 8$  a solution?
- (F)  $15 - a = 10$     (G)  $10 + a = 23$     (H)  $a - 18 = 26$     (J)  $a + 8 = 16$
70. **Short Response** Julianna used a gift card to pay for an \$18 haircut. The remaining balance on the card was \$22.
- a. Write an equation that can be used to determine the original value of the card.
- b. Solve your equation to find the original value of the card.

### CHALLENGE AND EXTEND

Solve each equation. Check your answer.

71.  $3\frac{1}{5} + b = \frac{4}{5}$     72.  $x - \frac{7}{4} = \frac{2}{3}$     73.  $x + \frac{7}{4} = \frac{2}{3}$     74.  $x - \frac{4}{9} = \frac{4}{9}$
75. If  $p - 4 = 2$ , find the value of  $5p - 20$ .    76. If  $t + 6 = 21$ , find the value of  $-2t$ .
77. If  $x + 3 = 15$ , find the value of  $18 + 6x$ .    78. If  $2 + n = -11$ , find the value of  $6n$ .

### SPIRAL REVIEW

Multiply or divide. (*Lesson 1-3*)

79.  $-63 \div (-7)$     80.  $\frac{3}{7} \div \left(-\frac{4}{7}\right)$     81.  $(-12)(-6)$

Give the side length of a square with the given area. (*Lesson 1-5*)

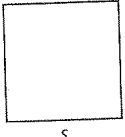
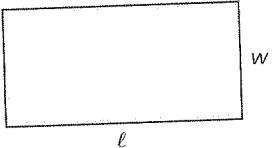
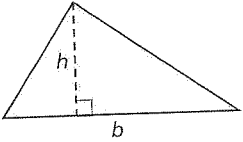
82.  $225 \text{ m}^2$     83.  $36 \text{ ft}^2$     84.  $100 \text{ cm}^2$

Simplify each expression. (*Lesson 1-6*)

85.  $8[-5 - (3 + 2)]$     86.  $1 - [4^2 - (12 - 15)^2]$     87.  $\frac{-12 + (-6)}{6}$

# Area of Composite Figures

Review the area formulas for squares, rectangles, and triangles in the table below.

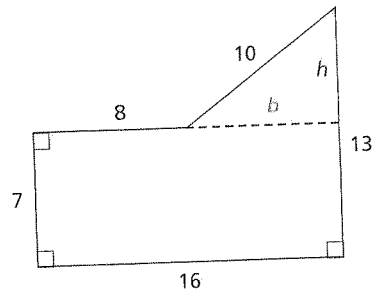
Squares	Rectangles	Triangles
		
$A = s^2$	$A = \ell w$	$A = \frac{1}{2}bh$

A composite figure is a figure that is composed of basic shapes. You can divide composite figures into combinations of squares, rectangles, and triangles to find their areas.

## Example

Find the area of the figure shown.

Divide the figure into a rectangle and a right triangle. Notice that you do not know the base or the height of the triangle. Use  $b$  and  $h$  to represent these lengths.



The bottom of the rectangle is 16 units long; the top of the rectangle is 8 units long plus the base of the triangle. Use this information to write and solve an equation.

$$\begin{array}{r} b + 8 = 16 \\ - 8 \quad - 8 \\ \hline b = 8 \end{array}$$

The right side of the figure is 13 units long: 7 units from the rectangle plus the height of the triangle. Use this information to write and solve an equation.

$$\begin{array}{r} h + 7 = 13 \\ - 7 \quad - 7 \\ \hline h = 6 \end{array}$$

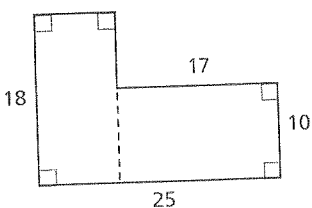
The area of the figure is the sum of the areas of the rectangle and the triangle.

$$\begin{aligned} &\begin{array}{l} \text{Area of rectangle} \\ \downarrow \\ A = \ell w + \frac{1}{2}bh \\ \downarrow \qquad \downarrow \\ A = 16(7) + \frac{1}{2}(8)(6) \\ A = 112 + 24 \\ A = 136 \text{ square units} \end{array} \end{aligned}$$

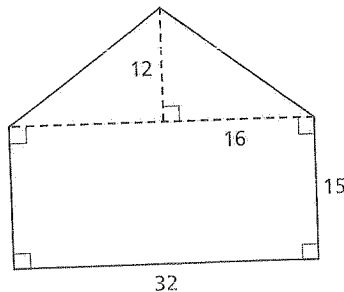
## Try This

Find the area of each composite figure.

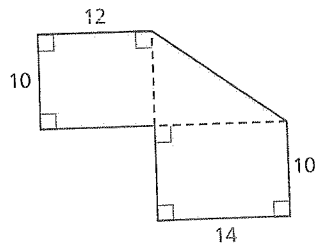
1.



2.



3.



# 2-2

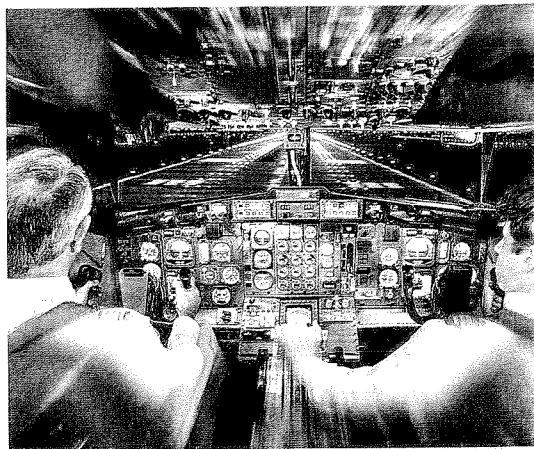
## Solving Equations by Multiplying or Dividing

### Objective

Solve one-step equations in one variable by using multiplication or division.

### Who uses this?

Pilots can make quick calculations by solving one-step equations. (See Example 4.)



Solving an equation that contains multiplication or division is similar to solving an equation that contains addition or subtraction. Use inverse operations to undo the operations on the variable.

Remember that an equation is like a balanced scale. To keep the balance, whatever you do on one side of the equation, you must also do on the other side.

**Inverse Operations**  
**Multiply by  $x$ .  $\longleftrightarrow$  Divide by  $x$ .**

### EXAMPLE 1 Solving Equations by Using Multiplication

Solve each equation. Check your answer.

$$\begin{aligned} \text{A} \quad -4 &= \frac{k}{-5} \\ (-5)(-4) &= (-5)\left(\frac{k}{-5}\right) \\ 20 &= k \end{aligned}$$

Since  $k$  is divided by  $-5$ , multiply both sides by  $-5$  to undo the division.

$$\begin{array}{r|l} \text{Check} & -4 = \frac{k}{-5} \\ & -4 \quad \frac{20}{-5} \\ & -4 \quad -4 \quad \checkmark \end{array}$$

To check your solution, substitute 20 for  $k$  in the original equation.

$$\begin{aligned} \text{B} \quad \frac{m}{3} &= 1.5 \\ (3)\left(\frac{m}{3}\right) &= (3)(1.5) \\ m &= 4.5 \end{aligned}$$

Since  $m$  is divided by 3, multiply both sides by 3 to undo the division.

$$\begin{array}{r|l} \text{Check} & \frac{m}{3} = 1.5 \\ & \frac{4.5}{3} \quad 1.5 \\ & 1.5 \quad 1.5 \quad \checkmark \end{array}$$

To check your solution, substitute 1.5 for  $m$  in the original equation.



Solve each equation. Check your answer.

1a.  $\frac{p}{5} = 10$

1b.  $-13 = \frac{y}{3}$

1c.  $\frac{c}{8} = 7$

**EXAMPLE 2 Solving Equations by Using Division**

Solve each equation. Check your answers.

**A**  $7x = 56$

$$\frac{7x}{7} = \frac{56}{7}$$

$$x = 8$$

Since  $x$  is multiplied by 7, divide both sides by 7 to undo the multiplication.

**Check**

$$\begin{array}{r|l} 7x = 56 & \\ 7(8) & 56 \\ \hline 56 & 56 \checkmark \end{array}$$

To check your solution, substitute 8 for  $x$  in the original equation.

**B**  $13 = -2w$

$$\frac{13}{-2} = \frac{-2w}{-2}$$

$$-6.5 = w$$

Since  $w$  is multiplied by  $-2$ , divide both sides by  $-2$  to undo the multiplication.

**Check**

$$\begin{array}{r|l} 13 = -2w & \\ 13 & -2(-6.5) \\ \hline 13 & 13 \checkmark \end{array}$$

To check your solution, substitute  $-6.5$  for  $w$  in the original equation.



Solve each equation. Check your answer.

2a.  $16 = 4c$

2b.  $0.5y = -10$

2c.  $15k = 75$

Remember that dividing is the same as multiplying by the reciprocal. When solving equations, you will sometimes find it easier to multiply by a reciprocal instead of dividing. This is often true when an equation contains fractions.

**EXAMPLE 3 Solving Equations That Contain Fractions**

Solve each equation.

**A**  $\frac{5}{9}v = 35$

$$\left(\frac{9}{5}\right)\frac{5}{9}v = \left(\frac{9}{5}\right)35$$

$$v = 63$$

The reciprocal of  $\frac{5}{9}$  is  $\frac{9}{5}$ . Since  $v$  is multiplied by  $\frac{5}{9}$ , multiply both sides by  $\frac{9}{5}$ .

**B**  $\frac{5}{2} = \frac{4y}{3}$

$$\frac{5}{2} = \frac{4y}{3}$$

$$\frac{5}{2} = \frac{4}{3}y$$

$\frac{4y}{3}$  is the same as  $\frac{4}{3}y$ .

$$\left(\frac{3}{4}\right)\frac{5}{2} = \left(\frac{3}{4}\right)\frac{4}{3}y$$

The reciprocal of  $\frac{4}{3}$  is  $\frac{3}{4}$ . Since  $y$  is multiplied by  $\frac{4}{3}$ , multiply both sides by  $\frac{3}{4}$ .

$$\frac{15}{8} = y$$



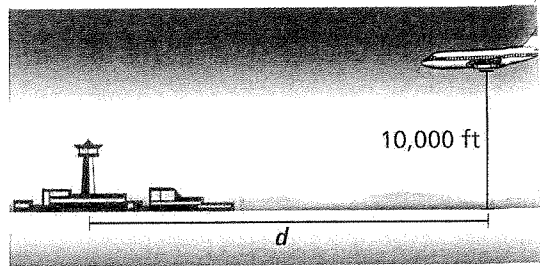
Solve each equation. Check your answer.

3a.  $-\frac{1}{4} = \frac{1}{5}b$

3b.  $\frac{4j}{6} = \frac{2}{3}$

3c.  $\frac{1}{6}w = 102$

**EXAMPLE 4 Aviation Application**



The distance in miles from the airport that a plane should begin descending, divided by 3, equals the plane's height above the ground in thousands of feet. If a plane is 10,000 feet above the ground, write and solve an equation to find the distance at which the pilot should begin descending.

**Caution!**

The equation uses the plane's height above the ground in *thousands* of feet. So substitute 10 for  $h$ , not 10,000.

Distance divided by 3 equals height in thousands of feet.

$$\frac{d}{3} = h \quad \text{Write an equation to represent the relationship.}$$

$$\frac{d}{3} = 10 \quad \text{Substitute 10 for } h. \text{ Since } d \text{ is divided by 3, multiply both sides by 3 to undo the division.}$$

$$(3)\frac{d}{3} = (3)10$$

$$d = 30$$

The pilot should begin descending 30 miles from the airport.



**4. What if...?** A plane began descending 45 miles from the airport. Use the equation above to find how high the plane was flying when the descent began.

You have now used four properties of equality to solve equations. These properties are summarized in the box below.

**Know It!**

*Note*

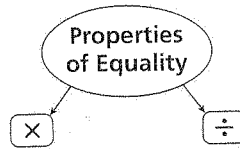
**Properties of Equality**

WORDS	NUMBERS	ALGEBRA
<b>Addition Property of Equality</b> You can add the same number to both sides of an equation, and the statement will still be true.	$3 = 3$ $3 + 2 = 3 + 2$ $5 = 5$	$a = b$ $a + c = b + c$
<b>Subtraction Property of Equality</b> You can subtract the same number from both sides of an equation, and the statement will still be true.	$7 = 7$ $7 - 5 = 7 - 5$ $2 = 2$	$a = b$ $a - c = b - c$
<b>Multiplication Property of Equality</b> You can multiply both sides of an equation by the same number, and the statement will still be true.	$6 = 6$ $6(3) = 6(3)$ $18 = 18$	$a = b$ $ac = bc$
<b>Division Property of Equality</b> You can divide both sides of an equation by the same nonzero number, and the statement will still be true.	$8 = 8$ $\frac{8}{4} = \frac{8}{4}$ $2 = 2$	$a = b$ $(c \neq 0)$ $\frac{a}{c} = \frac{b}{c}$

## THINK AND DISCUSS

1. Tell how the Multiplication and Division Properties of Equality are similar to the Addition and Subtraction Properties of Equality.

2. **GET ORGANIZED** Copy and complete the graphic organizer. In each box, write an example of an equation that can be solved by using the given property, and solve it.



**Know It!**  
Note

2-2

## Exercises

[go.hrw.com](http://go.hrw.com)  
**Homework Help Online**  
 KEYWORD: MA7 2-2  
**Parent Resources Online**  
 KEYWORD: MA7 Parent

### GUIDED PRACTICE

Solve each equation. Check your answer.

EXAMPLE 1  
p. 84

1.  $\frac{k}{4} = 8$

2.  $\frac{z}{3} = -9$

3.  $-2 = \frac{w}{-7}$

4.  $6 = \frac{t}{-5}$

5.  $\frac{g}{1.9} = 10$

6.  $2.4 = \frac{b}{5}$

EXAMPLE 2  
p. 85

7.  $4x = 28$

8.  $-64 = 8c$

9.  $-9j = -45$

10.  $84 = -12a$

11.  $4m = 10$

12.  $2.8 = -2h$

EXAMPLE 3  
p. 85

13.  $\frac{1}{2}d = 7$

14.  $15 = \frac{5}{6}f$

15.  $\frac{2}{3}s = -6$

16.  $9 = -\frac{3}{8}r$

17.  $\frac{1}{10} = \frac{4}{5}y$

18.  $\frac{1}{4}v = -\frac{3}{4}$

EXAMPLE 4  
p. 86

19. **Recreation** The Baseball Birthday Batter Package at a minor league ballpark costs \$192. The package includes tickets, drinks, and cake for a group of 16 children. Write and solve an equation to find the cost per child.

20. **Nutrition** An orange contains about 80 milligrams of vitamin C, which is 10 times as much as an apple contains. Write and solve an equation to find the amount of vitamin C in an apple.

### PRACTICE AND PROBLEM SOLVING

Solve each equation. Check your answer.

21.  $\frac{x}{2} = 12$

22.  $-40 = \frac{b}{5}$

23.  $-\frac{j}{6} = 6$

24.  $-\frac{n}{3} = -4$

25.  $-\frac{q}{5} = 30$

26.  $1.6 = \frac{d}{3}$

27.  $\frac{v}{10} = 5.5$

28.  $\frac{h}{8.1} = -4$

29.  $5t = -15$

30.  $49 = 7c$

31.  $-12 = -12u$

32.  $-7m = 63$

33.  $-52 = -4c$

34.  $11 = -2z$

35.  $5f = 1.5$

36.  $-8.4 = -4n$



**Independent Practice**

For Exercises	See Example
21–28	1
29–36	2
37–44	3
45	4

**Extra Practice**

Skills Practice p. 56

Application Practice p. S29


Solve each equation. Check your answer.

37.  $\frac{5}{2}k = 5$       38.  $-9 = \frac{3}{4}d$       39.  $-\frac{5}{8}b = 10$       40.  $-\frac{4}{5}g = -12$   
 41.  $\frac{4}{7}t = -2$       42.  $-\frac{4}{5}p = \frac{2}{3}$       43.  $\frac{2}{3} = -\frac{1}{3}q$       44.  $-\frac{5}{8} = -\frac{3}{4}a$

45. **Finance** After taxes, Alexandra's take-home pay is  $\frac{7}{10}$  of her salary before taxes. Write and solve an equation to find Alexandra's salary before taxes for the pay period that resulted in \$392 of take-home pay.

46. **Earth Science** Your weight on the Moon is about  $\frac{1}{6}$  of your weight on Earth. Write and solve an equation to show how much a person weighs on Earth if he weighs 16 pounds on the Moon. How could you check that your answer is reasonable?

47. **/// ERROR ANALYSIS ///** For the equation  $\frac{x}{3} = 15$ , a student found the value of  $x$  to be 5. Explain the error. What is the correct answer?

 **Geometry** The perimeter of a square is given. Write and solve an equation to find the length of each side of the square.

48.  $P = 36$  in.      49.  $P = 84$  in.      50.  $P = 100$  yd      51.  $P = 16.4$  cm

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

52. Five times a number is 45.  
 53. A number multiplied by negative 3 is 12.  
 54. A number divided by 4 is equal to 10.  
 55. The quotient of a number and 3 is negative 8.

56. **Statistics** The mean height of the students in Marta's class is 60 in. There are 18 students in her class. Write and solve an equation to find the total measure of all students' heights. (*Hint:* The mean is found by dividing the sum of all data values by the number of data values.)

57. **Finance** Lisa earned \$6.25 per hour at her after-school job. Each week she earned \$50. Write and solve an equation to show how many hours she worked each week.


58. **Critical Thinking** Will the solution of  $\frac{x}{2.1} = 4$  be greater than 4 or less than 4? Explain.

59. **Consumer Economics** Dion's long-distance phone bill was \$13.80. His long-distance calls cost \$0.05 per minute. Write and solve an equation to find the number of minutes he was charged for. Show that your answer is reasonable.

60. **Nutrition** An 8 oz cup of coffee has about 184 mg of caffeine. This is 5 times as much caffeine as in a 12 oz soft drink. Write and solve an equation to find about how much caffeine is in a 12 oz caffeinated soft drink. Round your answer to the nearest whole number. Show that your answer is reasonable.

Use the equation  $8y = 4x$  to find  $y$  for each value of  $x$ .

	$x$	$4x$	$8y = 4x$	$y$
61.	-4	$4(-4) = -16$	$8y = -16$	
62.	-2			
63.	0			
64.	2			



**LINK**  
**Statistics**

American Robert P. Wadlow (1918–1940) holds the record for world's tallest man—8 ft 11.1 in. He also holds world records for the largest feet and hands.  
 Source: Guinness World Records 2005



65. This problem will prepare you for the Multi-Step Test Prep on page 118.
- The formula for the mean of a data set is  $\text{mean} = \frac{\text{sum of data values}}{\text{number of data values}}$ . One summer, there were 1926 wildfires in Arizona. Which value does this number represent in the formula?
  - The mean number of acres burned by each wildfire was 96.21. Which value does this number represent in the formula?
  - Use the formula and information given to find how many acres were burned by wildfires in Arizona that summer. Round your answer to the nearest acre. Show that your answer is reasonable.

Solve each equation. Check your answer.

66.  $\frac{m}{6} = 1$

67.  $4x = 28$

68.  $1.2h = 14.4$

69.  $\frac{1}{5}x = 121$

70.  $2w = 26$

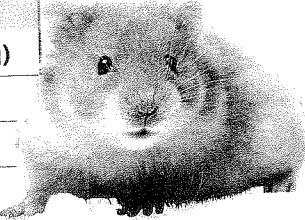
71.  $4b = \frac{3}{4}$

72.  $5y = 11$

73.  $\frac{n}{1.9} = 3$

**Biology** Use the table for Exercises 74 and 75.

Average Weight			
Animal	At Birth (g)	Adult Female (g)	Adult Male (g)
Hamster	2	130	110
Guinea pig	85	800	1050
Rat	5	275	480



- The mean weight of an adult male rat is 16 times the mean weight of an adult male mouse. Write and solve an equation to find the mean weight of an adult male mouse. Show that your answer is reasonable.
- On average, a hamster at birth weighs  $\frac{2}{3}$  the weight of a gerbil at birth. Write and solve an equation to find the average weight of a gerbil at birth. Show that your answer is reasonable.
- Write About It** Describe a real-world situation that can be modeled by  $3x = 42$ . Solve the equation and tell what the solution means in the context of your problem.

77. Which situation does NOT represent the equation  $\frac{d}{2} = 10$ ?

- Leo bought a box of pencils. He gave half of them to his brother. They each got 10 pencils. How many pencils were in the box Leo bought?
- Kasey evenly divided her money from baby-sitting into two bank accounts. She put \$10 in each account. How much did Kasey earn?
- Gilbert cut a piece of ribbon into 2-inch strips. When he was done, he had ten 2-inch strips. How long was the ribbon to start?
- Mattie had 2 more CDs than her sister Leona. If Leona had 10 CDs, how many CDs did Mattie have?

78. Which equation below shows a correct first step for solving  $3x = -12$ ?

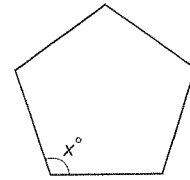
(F)  $3x + 3 = -12 + 3$

(H)  $3(3x) = 3(-12)$

(G)  $3x - 3 = -12 - 3$

(J)  $\frac{3x}{3} = \frac{-12}{3}$

79. In a regular pentagon, all of the angles are equal in measure. The sum of the angle measures is  $540^\circ$ . Which of the following equations could be used to find the measure of each angle?



- (A)  $\frac{x}{540} = 5$       (C)  $540x = 5$   
 (B)  $5x = 540$       (D)  $\frac{x}{5} = 540$
80. For which equation is  $m = 10$  a solution?  
 (F)  $5 = 2m$       (G)  $5m = 2$       (H)  $\frac{m}{2} = 5$       (J)  $\frac{m}{10} = 2$
81. **Short Response** Luisa bought 6 cans of cat food that each cost the same amount. She spent a total of \$4.80.
- Write an equation to determine the cost of one can of cat food. Tell what each part of your equation represents.
  - Solve your equation to find the cost of one can of cat food. Show each step.

### CHALLENGE AND EXTEND

Solve each equation. Check your answer.

82.  $(3\frac{1}{5})b = \frac{4}{5}$       83.  $(1\frac{1}{3})x = 2\frac{2}{3}$       84.  $(5\frac{4}{5})x = -52\frac{1}{5}$   
 85.  $(-2\frac{9}{10})k = -26\frac{1}{10}$       86.  $(1\frac{2}{3})w = 15\frac{1}{3}$       87.  $(2\frac{1}{4})d = 4\frac{1}{2}$

Find each indicated value.

88. If  $2p = 4$ , find the value of  $6p + 10$ .      89. If  $6t = 24$ , find the value of  $-5t$ .  
 90. If  $3x = 15$ , find the value of  $12 - 4x$ .      91. If  $\frac{n}{2} = -11$ , find the value of  $6n$ .  
 92. To isolate  $x$  in  $ax = b$ , what should you divide both sides by?  
 93. To isolate  $x$  in  $\frac{x}{a} = b$ , what operation should you perform on both sides of the equation?  
 94. **Travel** The formula  $d = rt$  gives the distance  $d$  that is traveled at a rate  $r$  in time  $t$ .  
 a. If  $d = 400$  and  $r = 25$ , what is the value of  $t$ ?  
 b. If  $d = 400$  and  $r = 50$ , what is the value of  $t$ ?  
 c. **What if...?** How did  $t$  change when  $r$  increased from 25 to 50?  
 d. **What if...?** If  $r$  is doubled while  $d$  remains the same, what is the effect on  $t$ ?

### SPIRAL REVIEW

Find each square root. (Lesson 1-5)

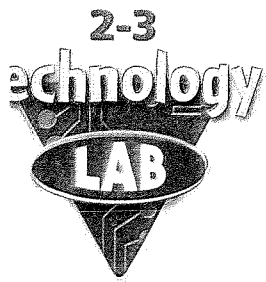
95.  $\sqrt{144}$       96.  $\sqrt{196}$       97.  $\sqrt{625}$       98.  $-\sqrt{9}$

Write and solve an equation that could be used to answer each question. (Lesson 2-1)

99. Lisa's age plus Sean's age is 17. Sean is 11 years old. How old is Lisa?  
 100. The length of a rectangle is 6 feet more than the width of the rectangle. The length is 32 feet. What is the width of the rectangle?

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

101.  $2 = a - 4$       102.  $x - 12 = -3$       103.  $z - 5 = 11$       104.  $-4 = x + 5$



# Solve Equations by Graphing

You can use graphs to solve equations. As you complete this activity, you will learn some of the connections between graphs and equations.

Use with Lesson 2-3

## Activity

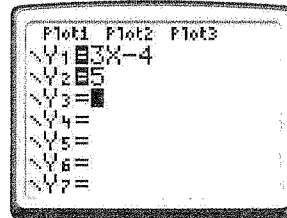
Solve  $3x - 4 = 5$ .

1 Press **Y=**. In  $Y_1$ , enter the left side of the equation,  $3x - 4$ .

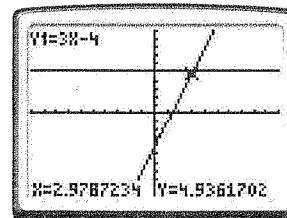
**Y=** 3 **X,T,θ,n** **-** 4 **ENTER**

In  $Y_2$ , enter the right side of the equation, 5.

**Y=** 5 **ENTER**

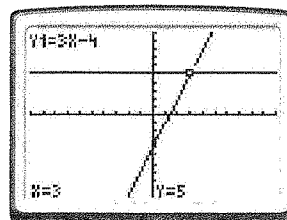


2 Press **GRAPH**. Press **TRACE**. The display will show the  $x$ - and  $y$ -values of a point on the first line. Press the right arrow key several times. Notice that the  $x$ - and  $y$ -values change.



3 Continue to trace as close as possible to the intersection of the two lines. The  $x$ -value of this point 2.9787..., is an approximation of the solution. The solution is about 3.

4 While still in trace mode, to check, press **3** **ENTER**. The display will show the  $y$ -value when  $x = 3$ . When  $x = 3$ ,  $y = 5$ . So 3 is the solution. You can also check this solution by substituting 3 for  $x$  in the equation:



Check

$$\begin{array}{r|l} 3x - 4 = 5 & \\ \hline 3(3) - 4 & 5 \\ 9 - 4 & 5 \\ 5 & 5 \checkmark \end{array}$$

## Try This

- Solve  $3x - 4 = 2$ ,  $3x - 4 = 17$ , and  $3x - 4 = -7$  by graphing.
- What does each line represent?
- Describe a procedure for finding the solution of  $3x - 4 = y$  for any value of  $y$ .
- Solve  $\frac{1}{2}x - 7 = -4$ ,  $\frac{1}{2}x - 7 = 0$ , and  $\frac{1}{2}x - 7 = 2$  by graphing.

