

# 1.1

## Solving Simple Equations

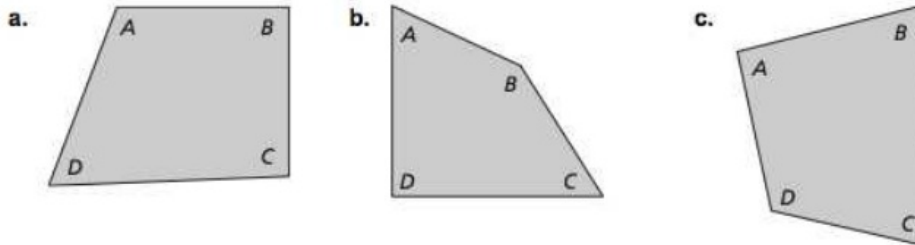
For use with Exploration 1.1

**Essential Question** How can you use simple equations to solve real-life problems?

### 1 EXPLORATION: Measuring Angles

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

**Work with a partner.** Use a protractor to measure the angles of each quadrilateral. Complete the table to organize your results. (The notation  $m\angle A$  denotes the measure of angle  $A$ .) How precise are your measurements?



Quadrilateral	$m\angle A$ (degrees)	$m\angle B$ (degrees)	$m\angle C$ (degrees)	$m\angle D$ (degrees)	$m\angle A + m\angle B + m\angle C + m\angle D$
a.					
b.					
c.					

### 2 EXPLORATION: Making a Conjecture

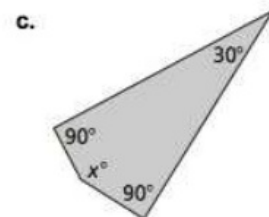
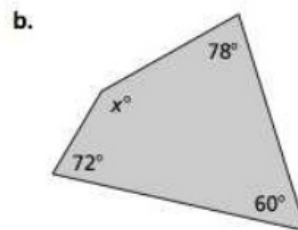
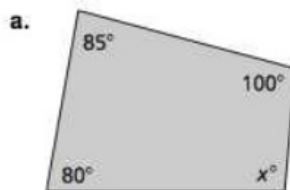
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

**Work with a partner.** Use the completed table in Exploration 1 to write a conjecture about the sum of the angle measures of a quadrilateral. Draw three quadrilaterals that are different from those in Exploration 1 and use them to justify your conjecture.

**1.1 Solving Simple Equations (continued)****3 EXPLORATION: Applying Your Conjecture**

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

**Work with a partner.** Use the conjecture you wrote in Exploration 2 to write an equation for each quadrilateral. Then solve the equation to find the value of  $x$ . Use a protractor to check the reasonableness of your answer.

**Communicate Your Answer**

- How can you use simple equations to solve real-life problems?
- Draw your own quadrilateral and cut it out. Tear off the four corners of the quadrilateral and rearrange them to affirm the conjecture you wrote in Exploration 2. Explain how this affirms the conjecture.

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# 1.1

## Notetaking with Vocabulary

For use after Lesson 1.1

In your own words, write the meaning of each vocabulary term.

conjecture

rule

theorem

equation

linear equation in one variable

solution

inverse operations

equivalent equations

### Core Concepts

#### Addition Property of Equality

**Words** Adding the same number to each side of an equation produces an equivalent equation.

**Algebra** If  $a = b$ , then  $a + c = b + c$ .

**Notes:**

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## **1.1** Notetaking with Vocabulary (continued)

### **Subtraction Property of Equality**

**Words** Subtracting the same number from each side of an equation produces an equivalent equation.

**Algebra** If  $a = b$ , then  $a - c = b - c$ .

**Notes:**

### **Multiplication Property of Equality**

**Words** Multiplying each side of an equation by the same nonzero number produces an equivalent equation.

**Algebra** If  $a = b$ , then  $a \cdot c = b \cdot c$ ,  $c \neq 0$ .

**Notes:**

### **Division Property of Equality**

**Words** Dividing each side of an equation by the same nonzero number produces an equivalent equation.

**Algebra** If  $a = b$ , then  $a \div c = b \div c$ ,  $c \neq 0$ .

**Notes:**

### **Four Step Approach to Problem Solving**

- 1. Understand the Problem** What is the unknown? What information is being given? What is being asked?
- 2. Make a Plan** This plan might involve one or more of the problem-solving strategies shown on the following page.
- 3. Solve the Problem** Carry out your plan. Check that each step is correct.
- 4. Look Back** Examine your solution. Check that your solution makes sense in the original statement of the problem.

**Notes:**

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## 1.1 Notetaking with Vocabulary (continued)

### Common Problem-Solving Strategies

Use a verbal model.	Guess, check, and revise.
Draw a diagram.	Sketch a graph or number line.
Write an equation.	Make a table.
Look for a pattern.	Make a list.
Work backward.	Break the problem into parts.

### Notes:

### Extra Practice

In Exercises 1–9, solve the equation. Justify each step. Check your solution.

1.  $w + 4 = 16$

2.  $x + 7 = -12$

3.  $-15 + w = 6$

4.  $z - 5 = 8$

5.  $-2 = y - 9$

6.  $7q = 35$

7.  $4b = -52$

8.  $3 = \frac{q}{11}$

9.  $\frac{n}{-2} = -15$

10. A coupon subtracts \$17.95 from the price  $p$  of a pair of headphones. You pay \$71.80 for the headphones after using the coupon. Write and solve an equation to find the original price of the headphones.

11. After a party, you have  $\frac{2}{5}$  of the brownies you made left over. There are 16 brownies left. How many brownies did you make for the party?

# 1.2 Solving Multi-Step Equations

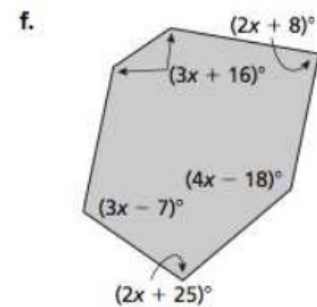
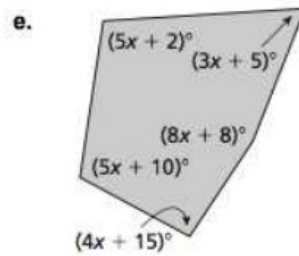
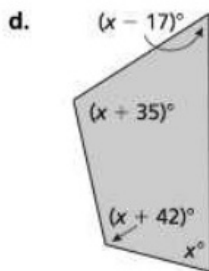
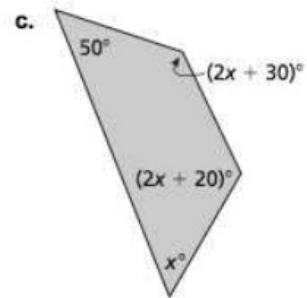
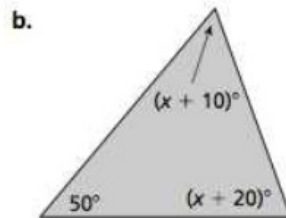
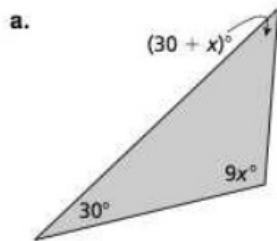
For use with Exploration 1.2

**Essential Question** How can you use multi-step equations to solve real-life problems?

## 1 EXPLORATION: Solving for the Angle Measures of a Polygon

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

**Work with a partner.** The sum  $S$  of the angle measures of a polygon with  $n$  sides can be found using the formula  $S = 180(n - 2)$ . Write and solve an equation to find each value of  $x$ . Justify the steps in your solution. Then find the angle measures of each polygon. How can you check the reasonableness of your answers?



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## 1.2 Solving Multi-Step Equations (continued)

### 2 EXPLORATION: Writing a Multi-Step Equation

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner.

- a. Draw an irregular polygon.
  
  
  
  
  
  
  
  
  
  
- b. Measure the angles of the polygon. Record the measurements on a separate sheet of paper.
  
  
  
  
  
  
  
  
  
  
- c. Choose a value for  $x$ . Then, using this value, work backward to assign a variable expression to each angle measure, as in Exploration 1.
  
  
  
  
  
  
  
  
  
  
- d. Trade polygons with your partner.
  
  
  
  
  
  
  
  
  
  
- e. Solve an equation to find the angle measures of the polygon your partner drew. Do your answers seem reasonable? Explain.

### Communicate Your Answer

3. How can you use multi-step equations to solve real-life problems?
  
  
  
  
  
  
  
  
  
  
4. In Exploration 1, you were given the formula for the sum  $S$  of the angle measures of a polygon with  $n$  sides. Explain why this formula works.
  
  
  
  
  
  
  
  
  
  
5. The sum of the angle measures of a polygon is  $1080^\circ$ . How many sides does the polygon have? Explain how you found your answer.

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## 1.2

### Notetaking with Vocabulary

For use after Lesson 1.2

In your own words, write the meaning of each vocabulary term.

inverse operations

mean

### Core Concepts

#### Solving Multi-Step Equations

To solve a multi-step equation, simplify each side of the equation, if necessary. Then use inverse operations to isolate the variable.

**Notes:**



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**1.2** Notetaking with Vocabulary (continued)

**Extra Practice**

In Exercises 1–14, solve the equation. Check your solution.

1.  $3x + 4 = 19$

2.  $5z - 13 = -3$

3.  $17 = z - (-9)$

4.  $15 = 2 + 4 - d$

5.  $\frac{f}{4} - 5 = -9$

6.  $\frac{q + (-5)}{3} = 8$

7.  $5x + 3x = 28$

8.  $5z - 2z - 4 = -7$

9.  $12x + 4 + 2x = 39$

10.  $9z - 5 - 4z = -5$

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**1.2** Notetaking with Vocabulary (continued)

11.  $3(z + 7) = 21$

12.  $-4(z - 12) = 42$

13.  $33 = 12r - 3(9 - r)$

14.  $7 + 3(2g - 6) = -29$

15. You can represent an odd integer with the expression  $2n + 1$ , where  $n$  is any integer. Write and solve an equation to find three consecutive odd integers that have a sum of 63.
16. One angle of a triangle has a measure of  $66^\circ$ . The measure of the third angle is  $57^\circ$  more than  $\frac{1}{2}$  the measure of the second angle. The sum of the angle measures of a triangle is  $180^\circ$ . What is the measure of the second angle? What is the measure of the third angle?
17. Your cousin is 8 years older than your brother. Three years ago, your cousin was twice as old as your brother. How old is your cousin now? How old is your brother now?

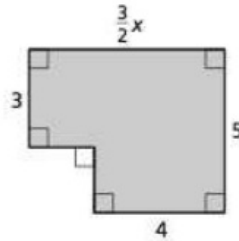
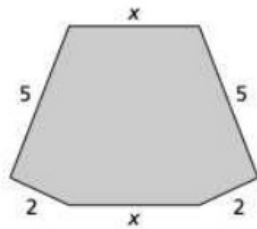
**1.3**

**Solving Equations with Variables on Both Sides**  
For use with Exploration 1.3

**Essential Question** How can you solve an equation that has variables on both sides?

**1 EXPLORATION: Perimeter**

**Work with a partner.** The two polygons have the same perimeter. Use this information to write and solve an equation involving  $x$ . Explain the process you used to find the solution. Then find the perimeter of each polygon.



**2 EXPLORATION: Perimeter and Area**

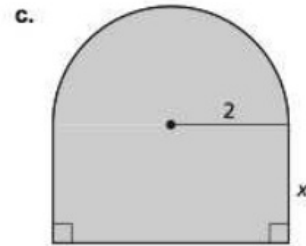
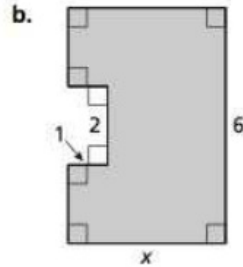
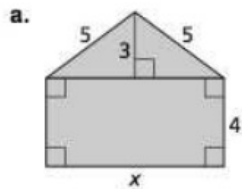
**Work with a partner.**

- Each figure has the unusual property that the value of its perimeter (in feet) is equal to the value of its area (in square feet). Use this information to write an equation for each figure.
- Solve each equation for  $x$ . Explain the process you used to find the solution.
- Find the perimeter and area of each figure.

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**1.3 Solving Equations with Variables on Both Sides (continued)**

**2 EXPLORATION: Perimeter and Area (continued)**



**Communicate Your Answer**

3. How can you solve an equation that has variables on both sides?
  
  
  
  
  
  
  
  
  
  
4. Write three equations that have the variable  $x$  on both sides. The equations should be different from those you wrote in Explorations 1 and 2. Have your partner solve the equations.

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## 1.3

### Notetaking with Vocabulary

For use after Lesson 1.3

In your own words, write the meaning of each vocabulary term.

identity

### Core Concepts

#### Solving Equations with Variables on Both Sides

To solve an equation with variables on both sides, simplify one or both sides of the equation, if necessary. Then use inverse operations to collect the variable terms on one side, collect the constant terms on the other side, and isolate the variable.

**Notes:**

#### Special Solutions of Linear Equations

Equations do not always have one solution. An equation that is true for all values of the variable is an **identity** and has *infinitely many solutions*. An equation that is not true for any value of the variable has *no solution*.

**Notes:**

**1.3** Notetaking with Vocabulary (continued)**Steps for Solving Linear Equations**

Here are several steps you can use to solve a linear equation. Depending on the equation, you may not need to use some steps.

**Step 1** Use the Distributive Property to remove any grouping symbols.

**Step 2** Simplify the expression on each side of the equation.

**Step 3** Collect the variable terms on one side of the equation and the constant terms on the other side.

**Step 4** Isolate the variable.

**Step 5** Check your solution.

**Notes:**

**Extra Practice**

In Exercises 1–10, solve the equation. Check your solution.

1.  $12 - 3x = -6x$

2.  $7 - 5z = 17 + 5z$

3.  $3k + 45 = 8k + 25$

4.  $\frac{3}{4}(48 - 16x) = 4(4 + 2x)$

5.  $5q + 6 = 2q - 2 + q$

6.  $8 + 6x - 10x = 16 - 8x$

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**1.3** Notetaking with Vocabulary (continued)

7.  $6a - 4 = 3a + 5$

8.  $2(4b - 6) = 4(3b - 7)$

9.  $8(2r - 3) - r = 3(3r + 2)$

10.  $3x - 8(2x + 3) = -6(2x + 5)$

In Exercises 11–14, solve the equation. Determine whether the equation has *one solution*, *no solution*, or *infinitely many solutions*.

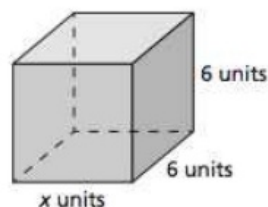
11.  $6(4s + 12) = 8(3s - 14)$

12.  $16f + 24 = 8(2f + 3)$

13.  $\frac{1}{2}(10 + 12n) = \frac{1}{3}(15n + 15)$

14.  $\frac{2}{3}(6j + 9) = 3j + 7$

15. The value of the surface area of a rectangular prism is equal to the value of the volume of the rectangular prism. Write and solve an equation to find the value of  $x$ .



**1.4****Solving Absolute Value Equations**

For use with Exploration 1.4

**Essential Question** How can you solve an absolute value equation?**1 EXPLORATION: Solving an Absolute Value Equation Algebraically****Work with a partner.** Consider the absolute value equation  $|x + 2| = 3$ .

- Describe the values of  $x + 2$  that make the equation true. Use your description to write two linear equations that represent the solutions of the absolute value equation.
- Use the linear equations you wrote in part (a) to find the solutions of the absolute value equation.
- How can you use linear equations to solve an absolute value equation?

**2 EXPLORATION: Solving an Absolute Value Equation Graphically**Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.**Work with a partner.** Consider the absolute value equation  $|x + 2| = 3$ .

- On a real number line, locate the point for which  $x + 2 = 0$ .



- Locate the points that are 3 units from the point you found in part (a). What do you notice about those points?
- How can you use a number line to solve an absolute value equation?



**1.4 Solving Absolute Value Equations (continued)**

**3 EXPLORATION: Solving an Absolute Value Equation Numerically**

Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Consider the absolute value equation  $|x + 2| = 3$ .

- a. Use a spreadsheet, as shown, to solve the absolute value equation.

	A	B
1	x	$ x + 2 $
2	-6	4
3	-5	
4	-4	
5	-3	
6	-2	
7	-1	
8	0	
9	1	
10	2	

*abs(A2 + 2)*

- b. Compare the solutions you found using the spreadsheet with those you found in Explorations 1 and 2. What do you notice?

- c. How can you use a spreadsheet to solve an absolute value equation?

**Communicate Your Answer**

4. How can you solve an absolute value equation?
5. What do you like or dislike about the algebraic, graphical, and numerical methods for solving an absolute value equation? Give reasons for your answers.

**1.4****Notetaking with Vocabulary**

For use after Lesson 1.4

In your own words, write the meaning of each vocabulary term.

absolute value equation

extraneous solution

**Core Concepts****Properties of Absolute Value**Let  $a$  and  $b$  be real numbers. Then the following properties are true.

1.  $|a| \geq 0$

2.  $|-a| = |a|$

3.  $|ab| = |a||b|$

4.  $\left|\frac{a}{b}\right| = \frac{|a|}{|b|}, b \neq 0$

**Notes:**

**1.4** Notetaking with Vocabulary (continued)**Solving Absolute Value Equations**

To solve  $|ax + b| = c$  when  $c \geq 0$ , solve the related linear equations

$$ax + b = c \quad \text{or} \quad ax + b = -c.$$

When  $c < 0$ , the absolute value equation  $|ax + b| = c$  has no solution because absolute value always indicates a number is not negative.

**Notes:**

**Solving Equations with Two Absolute Values**

To solve  $|ax + b| = |cx + d|$ , solve the related linear equations

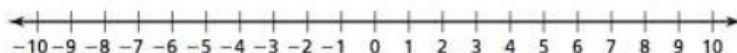
$$ax + b = cx + d \quad \text{or} \quad ax + b = -(cx + d).$$

**Notes:**

**Extra Practice**

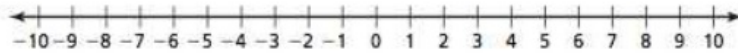
In Exercises 1–5, solve the equation. Graph the solution(s), if possible.

1.  $|3x + 12| = 0$

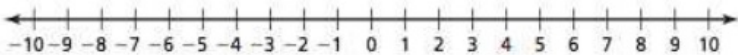


**1.4** Notetaking with Vocabulary (continued)

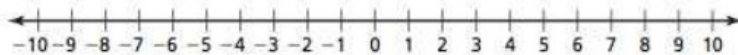
2.  $|y + 2| = 8$



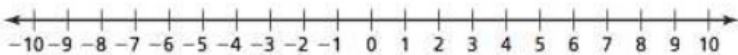
3.  $-4|7 - 6k| = 14$



4.  $\left|\frac{d}{3}\right| = 3$



5.  $3|2x + 5| + 10 = 37$



In Exercises 6–9, solve the equation. Check your solutions.

6.  $|20x| = |4x + 16|$

7.  $|p + 4| = |p - 2|$

8.  $|4q + 9| = |2q - 1|$

9.  $|2x - 7| = |2x + 9|$

**1.5****Rewriting Equations and Formulas**

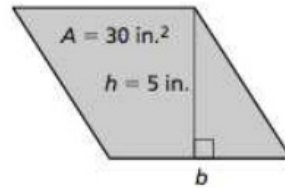
For use with Exploration 1.5

**Essential Question** How can you use a formula for one measurement to write a formula for a different measurement?

**1 EXPLORATION:** Using an Area Formula

Work with a partner.

- a. Write a formula for the area  $A$  of a parallelogram.



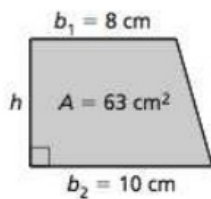
- b. Substitute the given values into the formula.  
Then solve the equation for  $b$ . Justify each step.
- c. Solve the formula in part (a) for  $b$  without first substituting values into the formula. Justify each step.
- d. Compare how you solved the equations in parts (b) and (c). How are the processes similar? How are they different?

**1.5** Rewriting Equations and Formulas (continued)

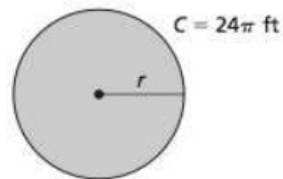
**2** **EXPLORATION:** Using Area, Circumference, and Volume Formulas

**Work with a partner.** Write the indicated formula for each figure. Then write a new formula by solving for the variable whose value is not given. Use the new formula to find the value of the variable.

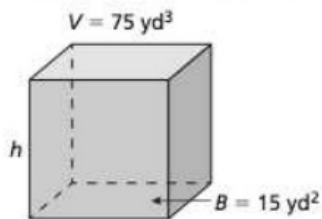
a. Area  $A$  of a trapezoid



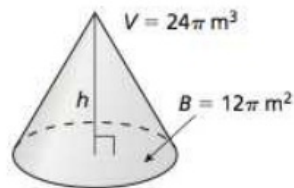
b. Circumference  $C$  of a circle



c. Volume  $V$  of a rectangular prism



d. Volume  $V$  of a cone



**Communicate Your Answer**

3. How can you use a formula for one measurement to write a formula for a different measurement? Give an example that is different from those given in Explorations 1 and 2.

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## 1.5

### Notetaking with Vocabulary

For use after Lesson 1.5

In your own words, write the meaning of each vocabulary term.

literal equation

formula

### Core Concepts

#### Common Formulas

**Temperature**  $F$  = degrees Fahrenheit,  $C$  = degrees Celsius

$$C = \frac{5}{9}(F - 32)$$

**Simple Interest**  $I$  = interest,  $P$  = principal,

$r$  = annual interest rate (decimal form),

$t$  = time (years)

$$I = Prt$$

**Distance**  $d$  = distance traveled,  $r$  = rate,  $t$  = time

$$d = rt$$

**Notes:**

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**1.5** Notetaking with Vocabulary (continued)

**Extra Practice**

In Exercises 1–6, solve the literal equation for  $y$ .

1.  $y - 2x = 15$

2.  $4x + y = 2$

3.  $5x - 2 = 8 + 5y$

4.  $y + x = 11$

5.  $3x - y = -4$

6.  $3x + 1 = 7 - 4y$

In Exercises 7–12, solve the literal equation for  $x$ .

7.  $y = 10x - 4x$

8.  $q = 3x + 9xz$

9.  $r = 4 + 7x - 5x$

10.  $y + 4x = 10x - 6$

11.  $4g + r = 2r - 2x$

12.  $3z + 8 = 12 + 3x - z$

In Exercises 13–16, solve the formula for the indicated variable.

13. Area of a triangle:  $A = \frac{1}{2}bh$ ; Solve for  $b$ .

14. Volume of a cone:  $V = \frac{1}{3}\pi r^2 h$ ; Solve for  $h$ .



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**1.5** Notetaking with Vocabulary (continued)

15. Ohm's Law:  $I = \frac{V}{R}$ ; Solve for  $R$ .

16. Ideal Gas Law:  $PV = nRT$ ; Solve for  $R$ .

17. The amount  $A$  of money in an account after simple interest has been earned is given by the formula  $A = P + Prt$  where  $P$  is the principal,  $r$  is the annual interest rate in decimal form, and  $t$  is the time in years.

a. Solve the formula for  $r$ .

b. The amount of money in an account after interest has been earned is \$1080, the principal is \$1000, and the time is 2 years. What is the annual interest rate?

c. Solve the formula for  $P$ .

