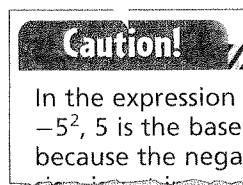
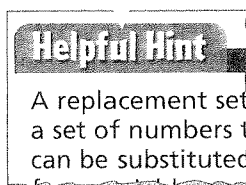
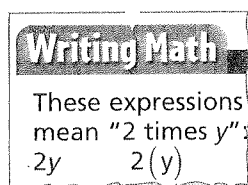
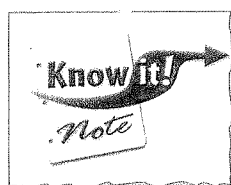


Reading Strategy: Use Your Book for Success

Understanding how your textbook is organized will help you locate and use helpful information.

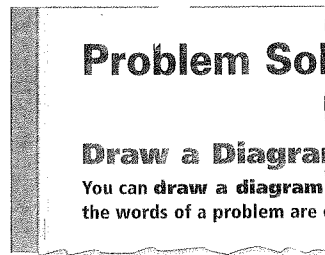
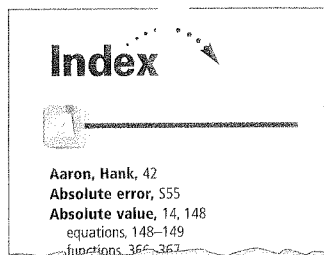
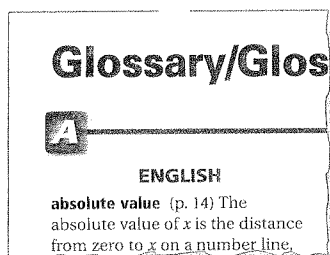
Pay attention to the **margin notes**. Know-It Note icons point out key information. Writing Math notes, Helpful Hints, and Caution notes help you understand concepts and avoid common mistakes.



The **Glossary** is found in the back of your textbook. Use it as a resource when you need the definition of an unfamiliar word or property.

The **Index** is located at the end of your textbook. Use it to locate the page where a particular concept is taught.

The **Problem-Solving Handbook** is found in the back of your textbook. These pages review strategies that can help you solve real-world problems.



Try This

Use your textbook for the following problems.

1. Use the index to find the page where each term is defined: *algebraic expression*, *like terms*, *ordered pair*, *real numbers*.
2. What mnemonic device is taught in a Helpful Hint in Lesson 1-6, Order of Operations?
3. Use the glossary to find the definition of each term: *additive inverse*, *constant*, *perfect square*, *reciprocal*.

1-1

Variables and Expressions

Objectives

Translate between words and algebra.

Evaluate algebraic expressions.

Vocabulary

variable

constant

numerical expression

algebraic expression

evaluate

Why learn this?

Variables and expressions can be used to determine how many plastic drink bottles must be recycled to make enough carpet for a house.

A home that is “green built” uses many recycled products, including carpet made from recycled plastic drink bottles. You can determine how many square feet of carpet can be made from a certain number of plastic drink bottles by using *variables, constants, and expressions.*

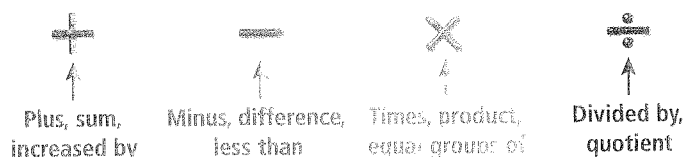
A **variable** is a letter or symbol used to represent a value that can change.

A **constant** is a value that does not change.

A **numerical expression** may contain only constants and/or operations.

An **algebraic expression** may contain variables, constants, and/or operations.

You will need to translate between algebraic expressions and words to be successful in math. The diagram below shows some of the ways to write mathematical operations with words.



Container City, in East London, UK, is a development buildings made from recycled shipping containers.

EXAMPLE 1 Translating from Algebraic Symbols to Words

Give two ways to write each algebraic expression in words.

A. $x + 3$

the sum of x and 3

x increased by 3

B. $m - 7$

the difference of m and 7

7 less than m

C. $2 \cdot y$

2 times y

the product of 2 and y

D. $k \div 5$

k divided by 5

the quotient of k and 5

Writing Math

These expressions all mean “2 times y ”:

$2y$ $2(y)$

$2 \cdot y$ $(2)(y)$

$2 \times y$ $(2)y$



Give two ways to write each algebraic expression in words.

1a. $4 - n$

1b. $\frac{t}{5}$

1c. $9 + q$

1d. $3(h)$

To translate words into algebraic expressions, look for words that indicate the action that is taking place.

Add	Subtract	Multiply	Divide
↑	↑	↑	↑
Put together, combine	Find how much more or less	Put together equal groups	Separate into equal groups

EXAMPLE 2 Translating from Words to Algebraic Symbols

- A** Eve reads 25 pages per hour. Write an expression for the number of pages she reads in h hours.
 h represents the number of hours that Eve reads.
 $25 \cdot h$ or $25h$ *Think: h groups of 25 pages.*
- B** Sam is 2 years younger than Sue, who is y years old. Write an expression for Sam's age.
 y represents Sue's age.
 $y - 2$ *Think: "younger than" means "less than."*
- C** William runs a mile in 12 minutes. Write an expression for the number of miles that William runs in m minutes.
 m represents the total time William runs.
 $\frac{m}{12}$ *Think: How many groups of 12 are in m ?*



CHECK IT OUT!

- 2a.** Lou drives at 65 mi/h. Write an expression for the number of miles that Lou drives in t hours.
- 2b.** Miriam is 5 cm taller than her sister, who is m cm tall. Write an expression for Miriam's height in centimeters.
- 2c.** Elaine earns \$32 per day. Write an expression for the amount that she earns in d days.

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.

EXAMPLE 3 Evaluating Algebraic Expressions

Evaluate each expression for $x = 8$, $y = 5$, and $z = 4$.

- A** $x + y$
 $x + y = 8 + 5$ *Substitute 8 for x and 5 for y .*
 $= 13$ *Simplify.*
- B** $\frac{x}{z}$
 $\frac{x}{z} = \frac{8}{4}$ *Substitute 8 for x and 4 for z .*
 $= 2$ *Simplify.*



CHECK IT OUT!

Evaluate each expression for $m = 3$, $n = 2$, and $p = 9$.

- 3a.** mn **3b.** $p - n$ **3c.** $p \div m$

EXAMPLE 4 Recycling Application

Approximately fourteen 20-ounce plastic drink bottles must be recycled to produce 1 square foot of carpet.

- a. Write an expression for the number of bottles needed to make c square feet of carpet.

The expression $14c$ models the number of bottles needed to make c square feet of carpet.

- b. Find the number of bottles needed to make 40, 120, and 224 square feet of carpet.

Evaluate $14c$ for $c = 40$, 120, and 224.

c	$14c$
40	$14(40) = 560$
120	$14(120) = 1680$
224	$14(224) = 3136$

To make 40 ft² of carpet, 560 bottles are needed.

To make 120 ft² of carpet, 1680 bottles are needed.

To make 224 ft² of carpet, 3136 bottles are needed.



Helpful Hint

A replacement set is a set of numbers that can be substituted for a variable. The replacement set in Example 4 is {40, 120, 224}.



4. To make one sweater, sixty-three 20-ounce plastic drink bottles must be recycled.
- a. Write an expression for the number of bottles needed to make s sweaters.
- b. Find the number of bottles needed to make 12, 25, and 50 sweaters.

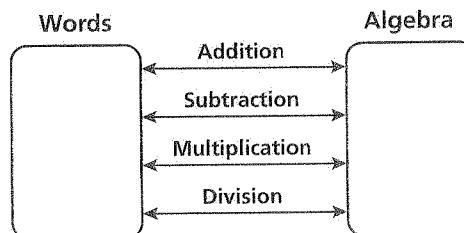
THINK AND DISCUSS

- Write two ways to suggest each of the following, using words or phrases: addition, subtraction, multiplication, division.
- Explain the difference between a numerical expression and an algebraic expression.

Know It!

Note

3. **GET ORGANIZED** Copy and complete the graphic organizer. Next to each operation, write a word phrase in the left box and its corresponding algebraic expression in the right box.



GUIDED PRACTICE

1. **Vocabulary** A(n) _____ is a value that can change. (*algebraic expression, constant, or variable*)

E EXAMPLE 1 Give two ways to write each algebraic expression in words.

p. 6

2. $n - 5$

3. $\frac{f}{3}$

4. $c + 15$

5. $9 - y$

6. $\frac{x}{12}$

7. $t + 12$

8. $8x$

9. $x - 3$

E EXAMPLE 2 10. George drives at 45 mi/h. Write an expression for the number of miles George travels in h hours.

p. 7

11. The length of a rectangle is 4 units greater than its width w . Write an expression for the length of the rectangle.

E EXAMPLE 3 Evaluate each expression for $a = 3$, $b = 4$, and $c = 2$.

p. 7

12. $a - c$

13. ab

14. $b \div c$

15. ac

E EXAMPLE 4 16. Brianna practices the piano 30 minutes each day.

p. 8

- a. Write an expression for the number of hours she practices in d days.
b. Find the number of hours Brianna practices in 2, 4, and 10 days.

PRACTICE AND PROBLEM SOLVING

Give two ways to write each algebraic expression in words.

17. $5p$

18. $4 - y$

19. $3 + x$

20. $3y$

21. $-3s$

22. $r \div 5$

23. $14 - t$

24. $x + 0.5$

25. Friday's temperature was 20° warmer than Monday's temperature t . Write an expression for Friday's temperature.

26. Ann sleeps 8 hours per night. Write an expression for the number of hours Ann sleeps in n nights.

Evaluate each expression for $r = 6$, $s = 5$, and $t = 3$.

27. $r - s$

28. $s + t$

29. $r \div t$

30. sr

31. Jim is paid for overtime when he works more than 40 hours per week.

- a. Write an expression for the number of hours he works overtime when he works h hours.
b. Find the number of hours Jim works overtime when he works 40, 44, 48, and 52 hours.

32. **Write About It** Write a paragraph that explains to another student how to evaluate an expression.

Write an algebraic expression for each verbal expression. Then write a real-world situation that could be modeled by the expression.

33. the product of 2 and x

34. b less than 17

35. 10 more than y

Independent Practice

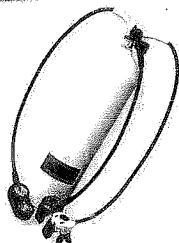
For ercises	See Example
7-24	1
5-26	2
7-30	3
31	4

Extra Practice

Practice p. S4

Application Practice p. S28

MULTI-STEP TEST PREP



36. This problem will prepare you for the Multi-Step Test Prep on page 38.

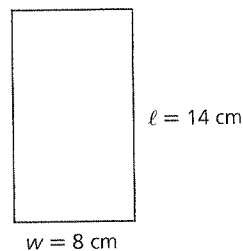
The air around you puts pressure on your body equal to 14.7 pounds per square inch (psi). When you are underwater, the water exerts additional pressure on your body. For each foot you are below the surface of the water, the pressure increases by 0.445 psi.

- What does 14.7 represent in the expression $14.7 + 0.445d$?
- What does d represent in the expression?
- What is the total pressure exerted on a person's body when $d = 8$ ft?

37. **Geometry** The length of a rectangle is 9 inches. Write an expression for the area of the rectangle if the width is w inches. Find the area of the rectangle when the width is 1, 8, 9, and 11 inches.

38. **Geometry** The perimeter of any rectangle is the sum of its lengths and widths. The area of any rectangle is the length ℓ times the width w .

- Write an expression for the perimeter of a rectangle.
- Find the perimeter of the rectangle shown.
- Write an expression for the area of a rectangle.
- Find the area of the rectangle shown.



Complete each table. Evaluate the expression for each value of x .

39.

x	$x + 12$
1	
2	
3	
4	

40.

x	$10x$
1	
5	
10	
15	

41.

x	$x \div 2$
12	
20	
26	
30	

LINK

Astronomy



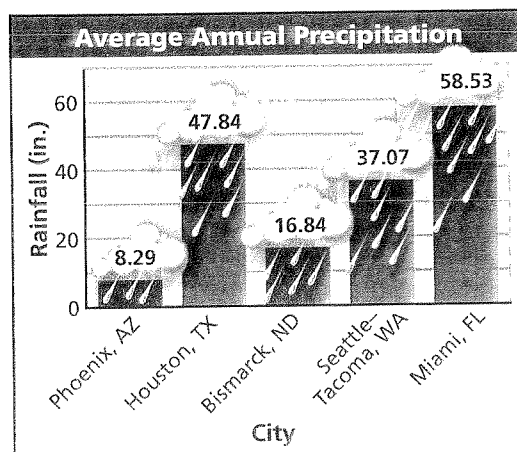
A crater on Canada's Devon Island is geologically similar to the surface of Mars. However, the temperature on Devon Island is about 37°F in summer, and the average summer temperature on Mars is -85°F .

42. **Astronomy** An object's weight on Mars can be found by multiplying 0.38 by the object's weight on Earth.

- An object weighs p pounds on Earth. Write an expression for its weight on Mars.
- Dana weighs 120 pounds, and her bicycle weighs 44 pounds. How much would Dana and her bicycle together weigh on Mars?

43. **Meteorology** Use the bar graph to write an expression for the average annual precipitation in New York, New York.

- The average annual precipitation in New York is m inches more than the average annual precipitation in Houston, Texas.
- The average annual precipitation in New York is s inches less than the average annual precipitation in Miami, Florida.



- 44. Critical Thinking** Compare algebraic expressions and numerical expressions. Give examples of each.

Write an algebraic expression for each verbal expression. Then evaluate the algebraic expression for the given values of x .

	Verbal	Algebraic	$x = 12$	$x = 14$
	x reduced by 5	$x - 5$	$12 - 5 = 7$	$14 - 5 = 9$
45.	7 more than x			
46.	The quotient of x and 2			
47.	The sum of x and 3			

- 48.** Claire has had her driver's license for 3 years. Bill has had his license for b fewer years than Claire. Which expression can be used to show the number of years Bill has had his driver's license?

(A) $3 + b$ (B) $b + 3$ (C) $3 - b$ (D) $b - 3$

- 49.** Which expression represents x ?

(F) $12 - 5$ (H) $12(5)$
(G) $12 + 5$ (J) $12 \div 5$



- 50.** Which situation is best modeled by the expression $25 - x$?

(A) George places x more video games on a shelf with 25 games.
(B) Sarah has driven x miles of a 25-mile trip.
(C) Amelia paid 25 dollars of an x dollar lunch that she shared with Ariel.
(D) Jorge has 25 boxes full of x baseball cards each.

CHALLENGE AND EXTEND

Evaluate each expression for the given values of the variables.

51. $2ab$; $a = 6$, $b = 3$ 52. $2x + y$; $x = 4$, $y = 5$ 53. $3x \div 6y$; $x = 6$, $y = 3$

- 54. Multi-Step** An Internet service provider charges \$9.95/month for the first 20 hours and \$0.50 for each additional hour. Write an expression representing the charges for h hours of use in one month when h is more than 20 hours. What is the charge for 35 hours?

SPIRAL REVIEW

The sum of the angle measures in a triangle is 180° . Find the measure of the third angle given the other two angle measures. (Previous course)

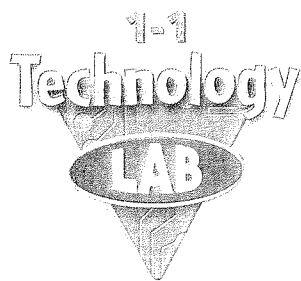
55. 45° and 90° 56. 120° and 20° 57. 30° and 60°

Write an equivalent fraction for each percent. (Previous course)

58. 25% 59. 50% 60. 75% 61. 100%

Find a pattern and use it to give the next three numbers. (Previous course)

62. 4, 12, 20, 28, ... 63. 3, 9, 27, 81, 243, ... 64. 2, 3, 5, 8, 12, ...



Create a Table to Evaluate Expressions

You can use a graphing calculator to quickly evaluate expressions for many values of the variable.

Use with Lesson 1-1

Activity 1

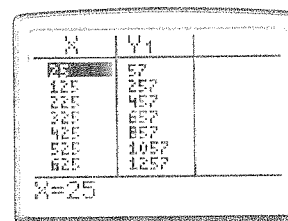
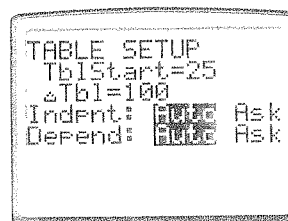
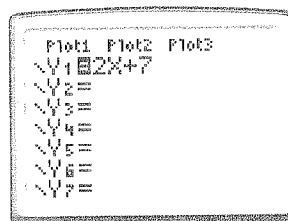
Evaluate $2x + 7$ for $x = 25, 125, 225, 325,$ and 425 .

1. Press $\boxed{Y=}$ and enter $2X+7$ for $Y1$.

2. Determine a pattern for the values of x .
The x -values start with 25 and increase by 100.

3. Press $\boxed{\text{TBLSET}}$ to view the *Table Setup* window.
Enter **25** as the starting value in $\text{TblStart}=\text{}$.
Enter **100** as the amount by which x changes in $\Delta\text{Tbl}=\text{}$.

4. Press $\boxed{\text{TABLE}}$ to create a table of values.
The first column shows values of x starting with 25 and increasing by 100.
The second column shows values of the expression $2x + 7$ when x is equal to the value in the first column.
You can use the arrow keys to view the table when x is greater than 625.



Try This

- Use the table feature of a graphing calculator to evaluate $5x - 7$ for $x = 4, 6, 8, 10,$ and 12 .
 - What value did you enter in $\text{TblStart}=\text{}$?
 - What value did you enter in $\Delta\text{Tbl}=\text{}$?
- Use the table feature of a graphing calculator to evaluate $3x + 4$ for $x = -5, -1, 3,$ $7,$ and 11 .
 - What value did you enter in $\text{TblStart}=\text{}$?
 - What value did you enter in $\Delta\text{Tbl}=\text{}$?

You can also use a spreadsheet program to evaluate expressions.

Activity 2

Evaluate $2x + 7$ for $x = 3, 5, 7, 9,$ and 11 .

- 1 In the first column, enter the values 3, 5, 7, 9, and 11.

	A	B	C	D	E	F	G
1	3						
2	5						
3	7						
4	9						
5	11						
6							

- 2 Enter the expression in cell B1.

To do this, type the following:
 $= 2 * A1 + 7$

	A	B	C	D	E	F	G
1	3	$=2*A1+7$					
2	5						
3	7						
4	9						
5	11						
6							

- 3 Press Enter.

The value of $2x + 7$ when $x = 3$ appears in cell B1.

	A	B	C	D	E	F	G
1	3	13					
2	5						
3	7						
4	9						
5	11						
6							

- 4 Copy the formula into cells B2, B3, B4, and B5.

Use the mouse to click on the lower right corner of cell B1. Hold down the mouse button and drag the cursor through cell B5.

	A	B	C	D	E	F	G
1	3	13					
2	5	17					
3	7	21					
4	9	25					
5	11	29					
6							

For each row in column B, the number that is substituted for x is the value in the same row of column A.

	A	B	C	D	E	F	G
1	3	13					
2	5	17					
3	7	21					
4	9	25					
5	11	29					
6							

You can continue the table by entering more values in column A and copying the formula from B1 into more cells in column B.

Try This

3. Use a spreadsheet program to evaluate $-2x + 9$ for $x = -5, -2, 1, 4,$ and 7 .
 - a. What values did you enter in column A?
 - b. What did you type in cell B1?
4. Use a spreadsheet program to evaluate $7x - 10$ for $x = 2, 7, 12, 17,$ and 22 .
 - a. What values did you enter in column A?
 - b. What did you type in cell B1?

1-2

Adding and Subtracting Real Numbers

Objectives

Add real numbers.

Subtract real numbers.

Vocabulary

real numbers

absolute value

opposites

additive inverse

Why learn this?

The total length of a penguin's dive can be determined by adding real numbers. (See Example 4.)

The set of all numbers that can be represented on a number line are called **real numbers**. You can use a number line to model addition and subtraction of real numbers.

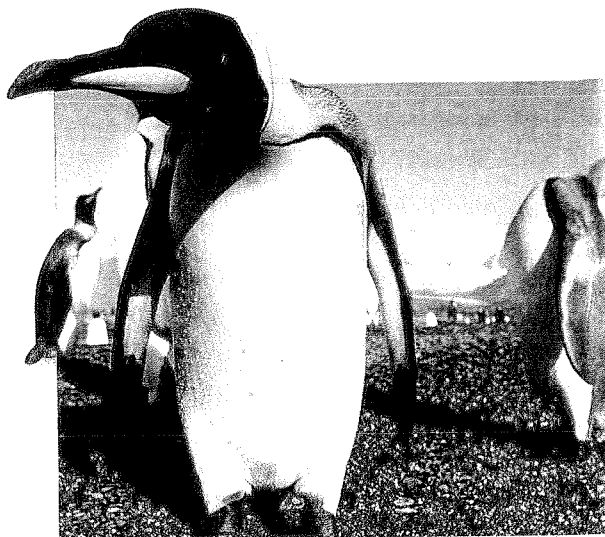
Addition

To model addition of a positive number, move right. To model addition of a negative number, move left.

Subtraction

To model subtraction of a positive number, move left.

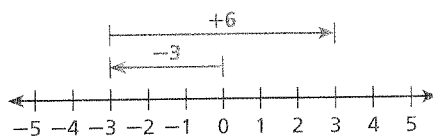
To model subtraction of a negative number, move right.



EXAMPLE 1 Adding and Subtracting Numbers on a Number Line

Add or subtract using a number line.

A $-3 + 6$

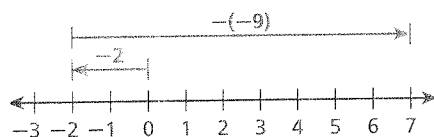


Start at 0. Move left to -3 .

To add 6, move right 6 units.

$$-3 + 6 = 3$$

B $-2 - (-9)$



Start at 0. Move left to -2 .

To subtract -9 , move right 9 units.

$$-2 - (-9) = 7$$



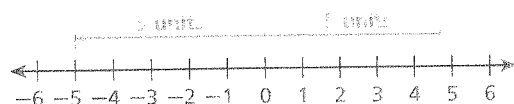
Add or subtract using a number line.

1a. $-3 + 7$

1b. $-3 - 7$

1c. $-5 - (-6.5)$

The **absolute value** of a number is its distance from zero on a number line. The absolute value of 5 is written as $|5|$.



$$|5| = 5$$

$$|-5| = 5$$

Adding Real Numbers

WORDS	NUMBERS
Adding Numbers with the Same Sign Add the absolute values and use the sign of the numbers.	$3 + 6$ 9 $-2 + (-9)$ -11
Adding Numbers with Different Signs Subtract the absolute values and use the sign of the number with the greater absolute value.	$-8 + 12$ 4 $3 + (-15)$ -12

EXAMPLE 2 Adding Real Numbers

Add.

A $-3 + (-16)$
 $(3 + 16 = 19)$
 -19

Same signs: add the absolute values.
 Both numbers are negative, so the sum is negative.

B $-13 + 7$
 $(13 - 7 = 6)$
 -6

Different signs: subtract the absolute values.
 Use the sign of the number with the greater absolute value.

C $6.2 + (-4.9)$
 $(6.2 - 4.9 = 1.3)$
 1.3

Different signs: subtract the absolute values.
 Use the sign of the number with the greater absolute value.



CHECK IT OUT!

Add.

2a. $-5 + (-7)$ 2b. $-13.5 + (-22.3)$ 2c. $52 + (-68)$

Two numbers are **opposites** if their sum is 0. A number and its opposite are **additive inverses** and are the same distance from zero. They have the same absolute value.

Helpful Hint

Because adding 0 to a number does not change the number's value, 0 is called the **additive identity**. Two numbers are additive inverses if their sum is the additive identity.

Inverse Property of Addition

WORDS	NUMBERS	ALGEBRA
The sum of a real number and its opposite is 0.	$6 + (-6) = (-6) + 6 = 0$	For any real number a , $a + (-a) = (-a) + a = 0$

To subtract signed numbers, you can use additive inverses. Subtracting a number is the same as adding the opposite of the number.

Subtracting Real Numbers

WORDS	NUMBERS	ALGEBRA
To subtract a number, add its opposite. Then follow the rules for adding signed numbers.	$3 - 8 = 3 + (-8)$ $= -5$	$a - b = a + (-b)$

EXAMPLE 3 Subtracting Real Numbers**Subtract.**

A $7 - 10$

$7 - 10 = 7 + (-10)$

$(10 - 7 = 3)$

-3

*To subtract 10, add -10 .**Different signs: subtract absolute values.**Use the sign of the number with the greater absolute value.*

B $-3 - (-12)$

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

$(12 - 3 = 9)$

9

*To subtract -12 , add 12.**Different signs: subtract absolute values.**Use the sign of the number with the greater absolute value.*

C $-\frac{1}{8} - \frac{3}{8}$

$-\frac{1}{8} - \frac{3}{8} = -\frac{1}{8} + \left(-\frac{3}{8}\right)$

$\left(\frac{1}{8} + \frac{3}{8} = \frac{4}{8} = \frac{1}{2}\right)$

$-\frac{1}{2}$

*To subtract $\frac{3}{8}$, add $-\frac{3}{8}$.**Same signs: add absolute values.**Both numbers are negative, so the sum is negative.*

D $22.5 - (-4)$

$22.5 - (-4) = 22.5 + 4$

$(22.5 + 4 = 26.5)$

26.5

*To subtract -4 , add 4.**Same signs: add absolute values.**Both numbers are positive, so the sum is positive.***Helpful Hint**

On many scientific and graphing calculators, there is one button to express the opposite of a number and a different button to express subtraction.

**Subtract.**

3a. $13 - 21$

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

3c. $-14 - (-12)$

EXAMPLE 4 Biology Application

An emperor penguin stands on an iceberg that extends 10 feet above the water. Then the penguin dives to an elevation of -67 feet to catch a fish. What is the total length of the penguin's dive?

elevation of iceberg minus elevation of fish

10

 $-$

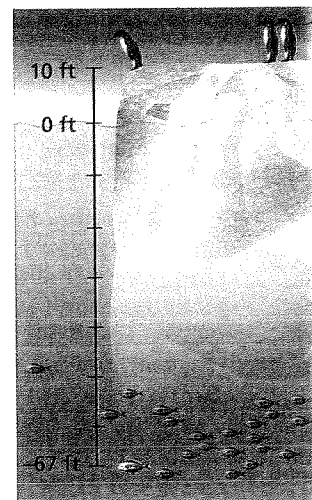
-67

$10 - (-67) = 10 + 67$

$= 77$

*To subtract -67 , add 67.**Same signs: add absolute values.*

The total length of the penguin's dive is 77 feet.

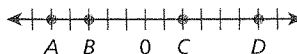


4. What if...? The tallest known iceberg in the North Atlantic rose 550 feet above the ocean's surface. How many feet would it be from the top of the tallest iceberg to the wreckage of the *Titanic*, which is at an elevation of $-12,468$ feet?

THINK AND DISCUSS

1. The difference of -7 and -5 is -2 . Explain why the difference is greater than -7 .

2. **GET ORGANIZED** Copy and complete the graphic organizer. For each pair of points, tell whether the sum and the difference of the first point and the second point are positive or negative.



Points	Sum	Difference
A, B		
B, A		
C, B		
D, A		

Know It!
Note

1-2

Exercises



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Homework Help Online

KEYWORD: MA11 1-2

Parent Resources Online

KEYWORD: MA7 Parent

GUIDED PRACTICE

1. **Vocabulary** The sum of a number and its ____?____ is always zero. (*opposite or absolute value*)

EXAMPLE 1 Add or subtract using a number line.

p. 14

2. $-4 + 7$	3. $-3.5 - 5$	4. $5.6 - 9.2$	5. $3 - \left(-6\frac{1}{4}\right)$
-------------	---------------	----------------	-------------------------------------

EXAMPLE 2 Add.

p. 15

6. $91 + (-11)$	7. $4\frac{3}{4} + \left(-3\frac{3}{4}\right)$	8. $15.6 + (-17.9)$	9. $-\frac{1}{16} + \frac{5}{8}$
-----------------	--	---------------------	----------------------------------

EXAMPLE 3 Subtract.

p. 16

10. $23 - 36$	11. $4.3 - 8.4$	12. $1\frac{1}{5} - 2\frac{4}{5}$	13. $\frac{7}{10} - \left(-\frac{2}{5}\right)$
---------------	-----------------	-----------------------------------	--

EXAMPLE 4 14. **Economics** The Dow Jones Industrial Average (DJIA) reports the average prices of stocks for 30 companies. Use the table to determine the total decrease in the DJIA for the two days.

DJIA 1987	
Friday, Oct. 16	-108.35
Monday, Oct. 19	-507.99

PRACTICE AND PROBLEM SOLVING

Add or subtract using a number line.

15. $-2 + 6$	16. $6 + (-2)$	17. $\frac{1}{4} - 12$	18. $-\frac{2}{5} + 6$
--------------	----------------	------------------------	------------------------

Add.

19. $-18 + (-12)$	20. $-2.3 + 3.5$	21. $-15 + 29$	22. $-4.8 + (-5.4)$
-------------------	------------------	----------------	---------------------

Subtract.

23. $12 - 22$	24. $-\frac{3}{4} - \left(-\frac{1}{4}\right)$	25. $38 - 24.6$	26. $\frac{2}{3} - \left(-\frac{1}{2}\right)$
---------------	--	-----------------	---

27. **Meteorology** A meteorologist reported that the day's high temperature was 17°F and the low temperature was -6°F . What was the difference between the day's high and low temperatures?

Independent Practice

or
Exercises See
Example

-18	1
-22	2
-26	3
7	4

Practice

actice p. 54

tion Practice p. 528

Evaluate the expression $n + (-5)$ for each value of n .

28. $n = 312$

29. $n = 5.75$

30. $n = -\frac{7}{12}$

31. $n = -7\frac{2}{5}$

Add or subtract.

32. $-8 - 3$

33. $-9 + (-3)$

34. $16 - (-16)$

35. $100 - 63$

36. $5.2 - 2.5$

37. $-4.7 - (-4.7)$

38. $\frac{2}{5} - \frac{7}{8}$

39. $\frac{2}{5} - \frac{3}{10}$

40. **Business** A restaurant manager lost \$415 in business during the month of January. Business picked up in February, and he ended that month with a profit of \$1580.

- What was the manager's profit after January and February?
- What if...?** The restaurant lost \$245 in business during the month of March. What was the manager's profit after January, February, and March?

Compare. Write $<$, $>$, or $=$.

41. $-4 - (-6)$ \geq $-7 - 3$

42. $|-51|$ \leq $|0|$

43. $3 - (-3)$ \leq $0 - (-3)$

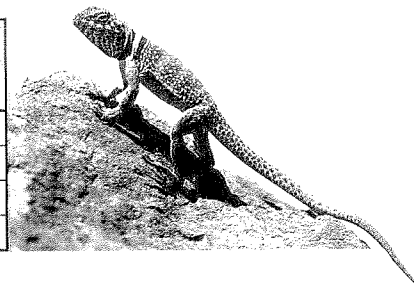
44. $-3 - 8$ \leq $-22 + 11$

45. $|-10 + 5|$ \leq $|-15|$

46. $9 + (-8)$ \leq $-12 + 13$

47. **Travel** Death Valley National Park is located in California. Use the table to determine the difference in elevation between the highest and lowest locations.

Death Valley National Park	
Location	Elevation (ft)
Badwater	-282
Emigrant Pass	5,318
Furnace Creek Airport	-210
Telescope Peak	11,049



Critical Thinking Tell whether each statement is sometimes, always, or never true. Explain.

- The value of the expression $-2 + n$ is less than the value of n .
- When b is positive, the expression $-b + (-b)$ is equal to 0.
- When x is negative, the value of the expression $x + 1$ is negative.
- ///ERROR ANALYSIS///** Which is incorrect? Explain the error.

A

$$\begin{array}{r} -5 - (-8) \\ -5 + (-8) \\ -13 \end{array}$$

B

$$\begin{array}{r} -5 - (-8) \\ -5 + (8) \\ 3 \end{array}$$

**MULTI-STEP
TEST PREP**



52. This problem will prepare you for the Multi-Step Test Prep on page 38.

- A plane flies at a height of 1800 feet directly over a 150-foot-tall building. How far above the building is the plane? Draw a diagram to explain your answer.
- The same plane then flies directly over a diver who is 80 feet below the surface of the water. How far is the plane above the diver? Draw a diagram to explain your answer.
- Subtract the diver's altitude of -80 feet from the plane's altitude of 1800 feet. Explain why this distance is greater than 1800 feet.

- 53. Write About It** Explain why addition and subtraction are called inverse operations. Use the following examples in your explanation:

$$8 + (-2) = 8 - 2 \quad 8 - (-2) = 8 + 2$$

- 54.** Which expression is equivalent to $|-3 + 5|$?

(A) $-3 - 5$ (B) $-3 + 5$ (C) $3 - 5$ (D) $3 + 5$

- 55.** At midnight, the temperature was -12°F . By noon, the temperature had risen 25°F . During the afternoon, it fell 10°F and fell another 3°F by midnight. What was the temperature at midnight?

(F) 0°F (G) 3°F (H) 12°F (J) 24°F

- 56.** The table shows the amounts Mr. Espinosa spent on lunch each day one week. What is the total amount Mr. Espinosa spent for lunch this week?

	Monday	Tuesday	Wednesday	Thursday	Friday
	5.40	4.16	7.07	5.40	9.52

(A) \$21.83 (B) \$22.03 (C) \$31.55 (D) \$36.95

CHALLENGE AND EXTEND

Simplify each expression.

57. $-1\frac{1}{5} + (-7.8)$ 58. $-\frac{1}{5} + 2.1$ 59. $9.75 + \left(-7\frac{3}{4}\right)$ 60. $-2\frac{3}{10} + 8.5$

For each pattern shown below, describe a possible rule for finding the next term. Then use your rule to write the next 3 terms.

61. 14, 10, 6, 2, ...

62. $-2, -\frac{8}{5}, -\frac{6}{5}, -\frac{4}{5}, \dots$

- 63. Geography** Sam visited two volcanoes, Cotapaxi and Sangay, and two caves, Sistema Huautla and Sistema Cheve. Cotapaxi, in Ecuador, has an elevation of 19,347 ft. Sangay, also in Ecuador, has an elevation of 17,159 ft. The main entrance of Sistema Huautla, in Mexico, has an elevation of 5051 ft. The main entrance of Sistema Cheve, also in Mexico, has an elevation of 9085 ft. What is the average elevation of these places?



SPIRAL REVIEW

Write each number as a terminating or repeating decimal. (Previous course)

64. $\frac{3}{16}$

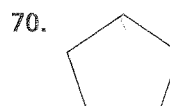
65. $\frac{2}{9}$

66. $\frac{15}{12}$

67. $\frac{4}{11}$

Divide each polygon into triangles to find the sum of its angle measures.

(Hint: Remember that the sum of the angle measures in a triangle is 180° .) (Previous course)



1-3

Multiplying and Dividing Real Numbers

Objectives

Multiply real numbers.

Divide real numbers.

Vocabulary

reciprocal

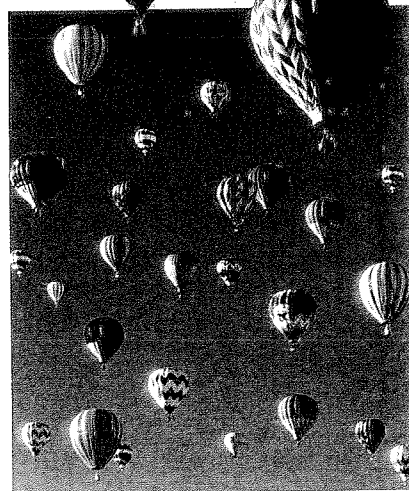
multiplicative inverse

Who uses this?

Hot-air balloon pilots can determine how far away from liftoff they will land by using multiplication. (See Example 4.)

When you multiply or divide two numbers, the signs of the numbers determine whether the result is positive or negative.

Numbers	Product/Quotient
Both positive	Positive
One negative	Negative
Both negative	Positive



Know It!

Note

Multiplying and Dividing Real Numbers

WORDS	NUMBERS	
Multiplying and Dividing Numbers with the Same Sign		
If two numbers have the same sign, their product or quotient is positive.	$4 \cdot 5 = 20$	$-15 \div (-3) = 5$
Multiplying and Dividing Numbers with Different Signs		
If two numbers have different signs, their product or quotient is negative.	$6(-3) = -18$	$-18 \div 2 = -9$
	$(-7)2 = -14$	$10 \div (-5) = -2$

EXAMPLE 1 Multiplying and Dividing Signed Numbers

Find the value of each expression.

A $-12 \cdot 5$
 -60

The product of two numbers with different signs is negative.

B $8\left(-\frac{5}{4}\right)$

$$= \left(\frac{8}{1}\right)\left(-\frac{5}{4}\right) = -\frac{40}{4} \quad \text{Multiply.}$$

$$= -10$$

The quotient of two numbers with different signs is negative.



Find the value of each expression.

1a. $35 \div (-5)$

1b. $-11(-4)$

1c. $-6(7)$

Helpful Hint

Because multiplying by 1 does not change a number's value, 1 is the *multiplicative identity*. Two numbers are multiplicative inverses if their product is the multiplicative identity.

Two numbers are **reciprocals** if their product is 1. A number and its reciprocal are called **multiplicative inverses**.

Inverse Property of Multiplication

WORDS

The product of a nonzero real number and its reciprocal is 1.

NUMBERS

$$4 \cdot \frac{1}{4} = \frac{1}{4} \cdot 4 = 1$$

$$-3 \cdot \left(-\frac{1}{3}\right) = -\frac{1}{3} \cdot (-3) = 1$$

ALGEBRA

For any real number a ($a \neq 0$),

$$a \cdot \frac{1}{a} = \frac{1}{a} \cdot a = 1$$

To divide by a number, you can multiply by its multiplicative inverse.

EXAMPLE 2 Dividing with Fractions

Divide.

A $-\frac{4}{5} \div \left(-\frac{8}{15}\right)$

$$-\frac{4}{5} \div \left(-\frac{8}{15}\right) = -\frac{4}{5} \left(-\frac{15}{8}\right)$$

$$= \frac{(-4)(-15)}{5(8)}$$

$$= \frac{60}{40} = \frac{3}{2}$$

To divide by $-\frac{8}{15}$, multiply by $-\frac{15}{8}$.

Multiply the numerators and multiply the denominators.

$-\frac{4}{5}$ and $-\frac{8}{15}$ have the same sign, so the quotient is positive.

B $-4 \div 9\frac{1}{4}$

$$-4 \div 9\frac{1}{4} = -\frac{4}{1} \div \frac{37}{4}$$

$$= -\frac{4}{1} \cdot \frac{4}{37}$$

$$= -\frac{4(4)}{1(37)} = -\frac{16}{37}$$

Write 4 as a fraction with a denominator of 1. Write $9\frac{1}{4}$ as an improper fraction.

To divide by $\frac{37}{4}$, multiply by $\frac{4}{37}$.

-4 and $9\frac{1}{4}$ have different signs, so the quotient is negative.



Divide.

2a. $-\frac{3}{4} \div (-9)$

2b. $\frac{3}{10} \div \left(-\frac{6}{5}\right)$

2c. $-\frac{5}{6} \div 1\frac{2}{3}$

The number 0 has special properties for multiplication and division.

Know It!

Note

Properties of Zero

WORDS	NUMBERS	ALGEBRA
Multiplication by Zero The product of any number and 0 is 0.	$\frac{1}{3} \cdot 0 = 0$ $0(-17) = 0$	$a \cdot 0 = 0$ $0 \cdot a = 0$
Zero Divided by a Number The quotient of 0 and any nonzero number is 0.	$\frac{0}{6} = 0$ $0 \div \frac{2}{3} = 0$	$\frac{0}{a} = 0$ ($a \neq 0$)
Division by Zero Division by 0 is undefined.	$12 \div 0 \neq$ $\frac{-5}{0} \neq$	$a \div 0 \neq$ $\frac{a}{0} \neq$

EXAMPLE 3 Multiplying and Dividing with Zero

Multiply or divide if possible.

- A** $0 \div 16.568$ Zero is divided by a nonzero number.
0 The quotient of zero and any nonzero number is 0.
- B** $63\frac{7}{8} \div 0$ A number is divided by zero.
undefined Division by zero is undefined.
- C** $1 \cdot 0$ A number is multiplied by zero.
0 The product of any number and 0 is 0.



Multiply or divide if possible.

3a. $0 \div \left(-8\frac{1}{6}\right)$

3b. $2.04 \div 0$

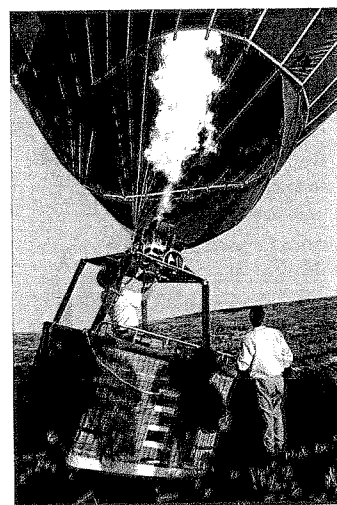
3c. $(-12,350)(0)$

EXAMPLE 4 Recreation Application

A hot-air balloon is taken for a 2.5-hour trip. The wind speed (and the speed of the balloon) is 4.75 mi/h. The balloon travels in a straight line parallel to the ground. How many miles away from the liftoff site will the balloon land?

Find the distance traveled at a rate of 4.75 mi/h for 2.5 hours. To find distance, multiply rate by time.

rate	times	time
4.75	•	2.5
$4.75 \cdot 2.5$		
11.875		



The hot-air balloon will land 11.875 miles from the liftoff site.



4. **What if...?** On another hot-air balloon trip, the wind speed is 5.25 mi/h. The trip is planned for 1.5 hours. The balloon travels in a straight line parallel to the ground. How many miles away from the liftoff site will the balloon land?

Know It!

Note

THINK AND DISCUSS

1. Explain how to use mental math to find the missing value: $\frac{4}{5} \cdot ? = 1$.

2. **GET ORGANIZED** Copy and complete the graphic organizer. In each blank, write “pos” or “neg” to indicate positive or negative.

Multiplying and Dividing Numbers

Multiplication		Division	
pos \times	= pos	pos \div	= pos
pos \times	= neg	pos \div	= neg
neg \times	= neg	neg \div	= neg
neg \times	= pos	neg \div	= pos



GUIDED PRACTICE

1. **Vocabulary** How do you find the *reciprocal* of $\frac{1}{2}$?

EXAMPLE 1 Find the value of each expression.

p. 20 2. $-72 \div (-9)$ 3. $11(-11)$ 4. $-7.2 \div 3.6$

EXAMPLE 2 Divide.

p. 21 5. $5 \div \frac{5}{7}$ 6. $\frac{4}{5} \div \left(-\frac{7}{5}\right)$ 7. $-\frac{2}{3} \div \left(-\frac{1}{3}\right)$ 8. $-\frac{16}{25} \div \left(-\frac{4}{5}\right)$

EXAMPLE 3 Multiply or divide if possible.

p. 22 9. $3.8 \div 0$ 10. $0(-27)$ 11. $0 \div \frac{2}{3}$ 12. $\frac{7}{8} \div 0$

EXAMPLE 4 13. **Entertainment** It is estimated that 7 million people saw off-Broadway shows in 2002. Assume that the average price of a ticket was \$30. How much money was spent on tickets for off-Broadway shows in 2002?

PRACTICE AND PROBLEM SOLVING

Find the value of each expression.

14. $-30 \div (-6)$ 15. $8(-4)$ 16. $-25(-12)$

Divide.

17. $-\frac{3}{20} \div \left(-\frac{1}{6}\right)$ 18. $\frac{3}{14} \div \frac{15}{28}$ 19. $-4\frac{1}{2} \div 1\frac{1}{2}$ 20. $2\frac{3}{4} \div \left(-1\frac{1}{2}\right)$

Multiply or divide if possible.

21. $0 \cdot 15$ 22. $-0.25 \div 0$ 23. $0 \div 1$ 24. $\frac{0}{1} \div 3$

25. **Weather** A cold front changes the temperature by -3°F each day. If the temperature started at 0°F , what will the temperature be after 5 days?

Multiply or divide.

26. $21 \div (-3)$ 27. $-100 \div 25$ 28. $-6 \div (-14)$ 29. $-6.2(10)$
30. $\frac{1}{2} \div \frac{1}{2}$ 31. $-3.75(-5)$ 32. $-12\frac{1}{2}(-3)$ 33. $17\left(\frac{1}{17}\right)$

34. **Critical Thinking** What positive number is the same as its reciprocal?

Evaluate each expression for $a = 4$, $b = -3$, and $c = -\frac{1}{2}$.

35. ab 36. $a \div c$ 37. bc 38. $c \div a$

Let p represent a positive number, n represent a negative number, and z represent zero. Tell whether each expression is positive, negative, zero, or undefined.

39. pn 40. pnz 41. $\frac{n}{p}$ 42. $-pz$
43. $-\frac{p}{n}$ 44. $-(pn)$ 45. $\frac{pn}{z}$ 46. $\frac{z}{n}$

Evaluate the expression $y \div \frac{3}{4}$ for each value of y .

47. $y = \frac{3}{4}$

48. $y = -\frac{9}{16}$

49. $y = \frac{3}{8}$

50. $y = -2\frac{1}{4}$

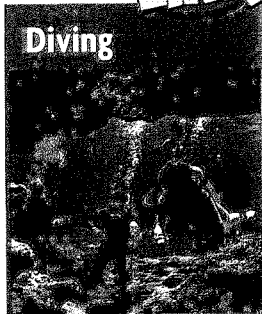
Evaluate the expression $\frac{1}{2} \div m$ for each value of m .

51. $m = -\frac{5}{2}$

52. $m = \frac{7}{8}$

53. $m = \frac{4}{9}$

54. $m = -5$



Florida is home to more than 300 freshwater springs, some of which are explored by cave divers.

55. Education Benjamin must have 120 credit hours of instruction to receive his college degree. Benjamin wants to graduate in 8 semesters without attending summer sessions. How many credit hours must Benjamin take on average each semester to graduate in 8 semesters?

56. Diving An underwater exploration team is swimming at a depth of -20 feet. Then they dive to an underwater cave that is at 7 times this depth. What is the depth of the underwater cave?

Multiply or divide. Then compare using $<$, $>$, or $=$.

57. $10 \left(-\frac{1}{2} \right) \quad 20 \div 4$

58. $16 \div (-2) \quad -2(-4)$

59. $-2\frac{2}{3} \div 3 \quad 5(-2.4)$

60. $20 \div 4 \quad \frac{3}{4} \div \left(-\frac{1}{2} \right)$

61. $2.1(-3.4) \quad -3.4(2.1)$

62. $0 \left(-\frac{3}{5} \right) \quad \frac{1}{2} \div \frac{1}{2}$

63. Critical Thinking There is a relationship between the number of negative factors and the sign of the product.

- What is the sign of the product of an even number of negative factors?
- What is the sign of the product of an odd number of negative factors?
- Explain why the number of negative factors affects the sign of the product.
- Does the number of positive factors affect the sign of the product? Explain.

Write each division expression as a multiplication expression.

64. $12 \div (-3)$

65. $75 \div 15$

66. $\frac{80}{-8}$

67. $\frac{-121}{11}$

Determine whether each statement is sometimes, always, or never true. Explain.

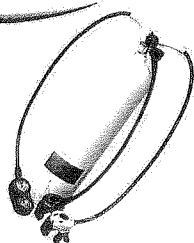
68. When t is negative, the expression $\frac{t}{10}$ is negative.

69. When n is positive, the expression $-6n$ is positive.

70. The value of the expression $4c$ is greater than the value of c .

71. Write About It The product of two factors is positive. One of the factors is negative. Explain how you can determine the sign of the second factor.

**MULTI-STEP
TEST PREP**



72. This problem will prepare you for the Multi-Step Test Prep on page 38.

- You swam 20 feet in 5 seconds. Use the formula $r = \frac{d}{t}$ to determine how fast you were swimming.
- A diver descended at a rate of 15 feet per minute. Make a table to show the diver's depth after 1, 2, and 5 minutes.
- Show two ways to find how far the diver descended in 5 minutes. Remember that multiplication is repeated addition.

73. A recipe for lemonade calls for $1\frac{1}{2}$ cups of lemon juice per batch. Berto estimates that he can get about $\frac{1}{4}$ cup of lemon juice from each lemon that he squeezes. Lemons cost \$0.45 each. What is the approximate amount Berto will need to spend on lemons to make a batch of lemonade?
 (A) \$0.70 (B) \$1.70 (C) \$2.70 (D) \$3.70
74. Robyn is buying carpet for her bedroom floor, which is a 15-foot-by-12-foot rectangle. If carpeting costs \$1.25 per square foot, how much will it cost Robyn to carpet her bedroom?
 (F) \$68 (G) \$144 (H) \$180 (J) \$225
75. **Short Response** In music notation, a half note is played $\frac{1}{2}$ the length of a whole note. A quarter note is played $\frac{1}{4}$ the length of a whole note. In a piece of music, the clarinets play 8 half notes. In the same length of time, the flutes play x quarter notes. Determine how many quarter notes the flutes play. Explain your method.

CHALLENGE AND EXTEND

Find the value of each expression.

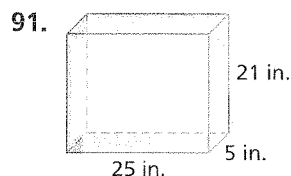
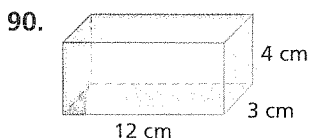
76. $(-2)(-2)(-2)$ 77. $\frac{5}{7} \cdot \frac{5}{7}$ 78. $5\left(-\frac{4}{5}\right)\left(-\frac{3}{4}\right)$
79. $\left|-\frac{1}{4}\right| \cdot |20|$ 80. $5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$ 81. $\left|-\frac{2}{5}\right| \cdot \left|\frac{5}{2}\right|$
82. $\frac{1}{2} \cdot \frac{2}{3} \cdot \frac{3}{4} \cdot \frac{4}{5}$ 83. $\left(-\frac{3}{4}\right)\left(-\frac{3}{4}\right)\left(-\frac{3}{4}\right)$ 84. $|(-4)(-4)(-4)|$

For each pattern shown below, describe a possible rule for finding the next term. Then use your rule to write the next 3 terms.

85. $-1, 2, -4, 8, \dots$ 86. $\frac{1}{63}, -\frac{1}{21}, \frac{1}{7}, -\frac{3}{7}, \dots$
87. $-5, 10, -15, 20, -25, \dots$ 88. $0.5, 0.25, 0.125, 0.0625, \dots$
89. A cleaning service charges \$49.00 to clean a one-bedroom apartment. If the work takes longer than 2 hours, the service charges \$18.00 for each additional hour. What would be the total cost for a job that took 4 hours to complete?

SPIRAL REVIEW

Find the surface area of each rectangular prism. (Previous course)



92. A prepaid phone card has a credit of 200 minutes. Write an expression for the number of minutes left on the card after t minutes have been used. (Lesson 1-1)

Compare. Write $<$, $>$, or $=$. (Lesson 1-2)

93. $-12 + 7$ $10 + (-5)$ 94. $|-14|$ -2
95. $|-7 + 11|$ $|-4|$ 96. $-20 + (-35)$ $-35 - 20$

1-4

Powers and Exponents

Objective

Simplify expressions containing exponents.

Vocabulary

power
base
exponent

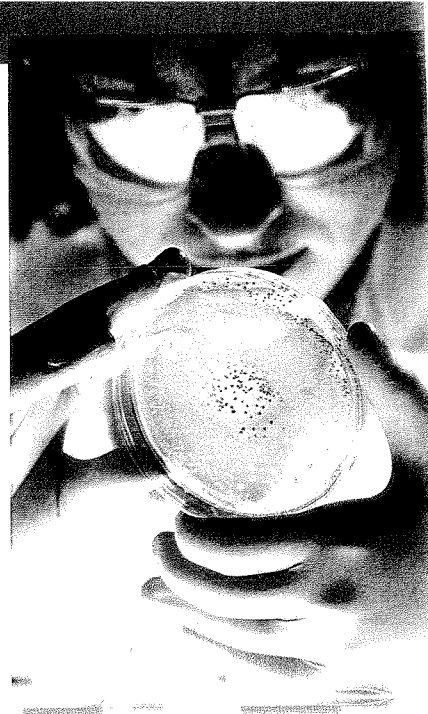
Who uses this?

Biologists use exponents to model the growth patterns of living organisms.

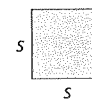
When bacteria divide, their number increases exponentially. This means that the number of bacteria is multiplied by the same factor each time the bacteria divide. Instead of writing repeated multiplication to express a product, you can use a power.

A **power** is an expression written with an *exponent* and a *base* or the value of such an expression. 3^2 is an example of a power.

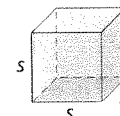
The base, 3, is the number that is used as a factor. 3^2 The exponent, 2, tells how many times the base, 3, is used as a factor.



When a number is raised to the second power, we usually say it is "squared." The area of a *square* is $s \cdot s = s^2$, where s is the side length.




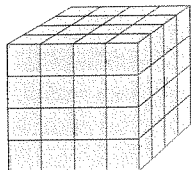
When a number is raised to the third power, we usually say it is "cubed." The volume of a *cube* is $s \cdot s \cdot s = s^3$, where s is the side length.



EXAMPLE 1 Writing Powers for Geometric Models

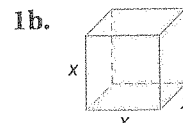
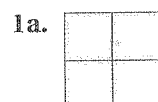
Write the power represented by each geometric model.

A  There are 3 rows of 3 dots. 3×3
The factor 3 is used 2 times.
 3^2

B  The figure is 4 cubes long, 4 cubes wide, and 4 cubes tall. $4 \times 4 \times 4$
The factor 4 is used 3 times.
 4^3



Write the power represented by each geometric model.



There are no easy geometric models for numbers raised to exponents greater than 3, but you can still write them using repeated multiplication or a base and exponent.

Reading Exponents			
Words	Multiplication	Power	Value
3 to the first power	3	3^1	3
3 to the second power, or 3 squared	$3 \cdot 3$	3^2	9
3 to the third power, or 3 cubed	$3 \cdot 3 \cdot 3$	3^3	27
3 to the fourth power	$3 \cdot 3 \cdot 3 \cdot 3$	3^4	81
3 to the fifth power	$3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$	3^5	243

EXAMPLE 2 Evaluating Powers

Simplify each expression.

A $(-2)^3$

$$(-2)(-2)(-2)$$

Use -2 as a factor 3 times.

$$-8$$

B -5^2

$$-1 \cdot 5 \cdot 5$$

Think of a negative sign in front of a power as multiplying by -1 . Find the product of -1 and two 5's.

$$-1 \cdot 25$$

$$-25$$

C $\left(\frac{2}{3}\right)^2$

$$\frac{2}{3} \cdot \frac{2}{3}$$

Use $\frac{2}{3}$ as a factor 2 times.

$$\frac{2}{3} \cdot \frac{2}{3} = \frac{4}{9}$$

Caution!

In the expression -5^2 , 5 is the base because the negative sign is not in parentheses.
In the expression $(-2)^3$, -2 is the base because of the parentheses.



CHECK IT OUT!

Simplify each expression.

2a. $(-5)^3$

2b. -6^2

2c. $\left(\frac{3}{4}\right)^3$

EXAMPLE 3 Writing Powers

Write each number as a power of the given base.

A 8; base 2

$$2 \cdot 2 \cdot 2$$

The product of three 2's is 8.

$$2^3$$

B -125 ; base -5

$$(-5)(-5)(-5)$$

The product of three -5 's is -125 .

$$(-5)^3$$



CHECK IT OUT!

Write each number as a power of the given base.

3a. 64; base 8

3b. -27 ; base -3

EXAMPLE 4 Problem-Solving Application



A certain bacterium splits into 2 bacteria every hour. There is 1 bacterium on a slide. If each bacterium on the slide splits once per hour, how many bacteria will be on the slide after 6 hours?

Understand the Problem

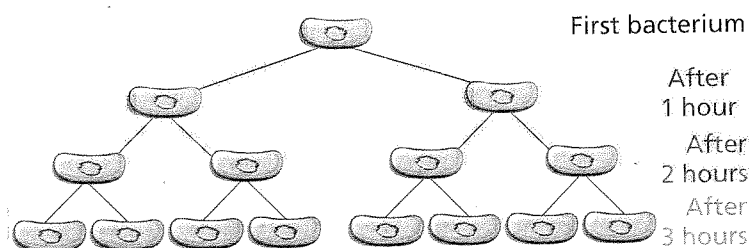
The **answer** will be the number of bacteria on the slide after 6 hours.

List the **important information**:

- There is 1 bacterium on a slide that divides into 2 bacteria.
- Each bacterium then divides into 2 more bacteria.

Make a Plan

Draw a diagram to show the number of bacteria after each hour.



Solve

Notice that after each hour, the number of bacteria is a power of 2.

After 1 hour: $1 \cdot 2 = 2$ or 2^1 bacteria on the slide

After 2 hours: $2 \cdot 2 = 4$ or 2^2 bacteria on the slide

After 3 hours: $4 \cdot 2 = 8$ or 2^3 bacteria on the slide

So, after the 6th hour, there will be 2^6 bacteria.

$2^6 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 64$ Multiply six 2's.

After 6 hours, there will be 64 bacteria on the slide.

Look Back

The numbers quickly become too large for a diagram, but a diagram helps you recognize a pattern. Then you can write the numbers as powers of 2.



4. What if...? How many bacteria will be on the slide after 8 hours?

THINK AND DISCUSS

1. Express 8^3 in words two ways.

2. **GET ORGANIZED** Copy and complete the graphic organizer. In each box, give an example and tell whether the expression is positive or negative.

	Even Exponent	Odd Exponent
Positive Base		
Negative Base		



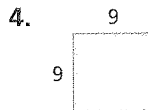
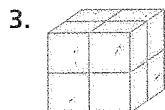
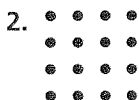


GUIDED PRACTICE

1. **Vocabulary** What does the *exponent* in the expression 5^6 tell you?

EXAMPLE 1 Write the power represented by each geometric model.

p. 26



EXAMPLE 2 Simplify each expression.

p. 27

5. 7^2

6. $(-2)^4$

7. $(-2)^5$

8. $-\left(\frac{1}{2}\right)^4$

EXAMPLE 3 Write each number as a power of the given base.

p. 27

9. 81; base 9

10. 100,000; base 10

11. -64; base -4

12. 10; base 10

13. 81; base 3

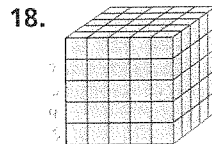
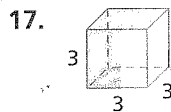
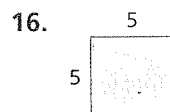
14. 36; base -6

EXAMPLE 4 **15. Technology** Jan wants to predict the number of hits she will get on her Web page. Her Web page received 3 hits during the first week it was posted. If the number of hits triples every week, how many hits will the Web page receive during the 5th week?

p. 28

PRACTICE AND PROBLEM SOLVING

Write the power represented by each geometric model.



Simplify each expression.

19. 3^3

20. $(-4)^2$

21. -4^2

22. $\left(-\frac{3}{5}\right)^2$

Write each number as a power of the given base.

23. 49; base 7

24. 1000; base 10

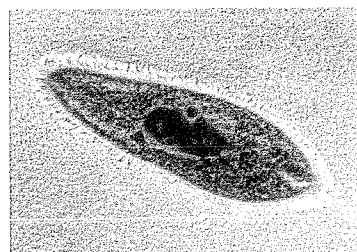
25. -8; base -2

26. 1,000,000; base 10

27. 64; base 4

28. 343; base 7

29. **Biology** Protozoa are single-celled organisms. *Paramecium aurelia* is one type of protozoan. The number of *Paramecium aurelia* protozoa doubles every 1.25 days. There was one protozoan on a slide 5 days ago. How many protozoa are on the slide now?



30. **Write About It** A classmate says that any number raised to an even power is positive. Give examples to explain whether your classmate is correct.

Compare. Write $<$, $>$, or $=$.

31. 3^2 3^3

32. 5^2 2^5

33. 4^2 2^4

34. 1^9 1^4

35. -2^3 $(-2)^3$

36. -3^2 $(-3)^2$

37. 10^2 2^6

38. 2^2 4^1

Independent Practice

or cises	See Example
-18	1
-22	2
-28	3
9	4

Extra Practice

Practice p. 54
Application Practice p. 528

Write each expression as repeated multiplication. Then simplify the expression.

39. 2^3

40. 1^7

41. $(-4)^3$


42. -4^3

43. $(-1)^3$

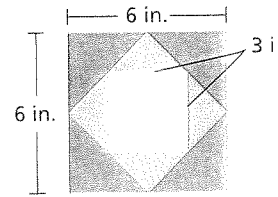
44. $(-1)^4$

45. $\left(\frac{1}{3}\right)^3$

46. -2.2^2

 47. **Geometry** The diagram shows an ornamental tile design.

- What is the area of the whole tile?
- What is the area of the white square?
- What is the area of the two shaded regions?



Write each expression using a base and an exponent.

48. $3 \cdot 3 \cdot 3 \cdot 3$

49. $6 \cdot 6$

50. $8 \cdot 8 \cdot 8 \cdot 8 \cdot 8$

51. $(-1)(-1)(-1)(-1)$

52. $(-7)(-7)(-7)$

53. $\left(\frac{1}{9}\right)\left(\frac{1}{9}\right)\left(\frac{1}{9}\right)$

54. **Art** A painting is made of 3 concentric squares. The side length of the largest square is 24 cm. What is the area of the painting?

55. **Estimation** A box is shaped like a cube with edges 22.7 centimeters long. What is the approximate volume of the box?

Write the exponent that makes each equation true.

56. $2^{\square} = 4$

57. $4^{\square} = 16$

58. $(-2)^{\square} = 16$

59. $5^{\square} = 625$

60. $-2^{\square} = -8$

61. $10^{\square} = 100$

62. $5^{\square} = 125$

63. $3^{\square} = 81$

64. **Entertainment** Mark and Becky play a coin toss game. Both start with one point. Every time the coin comes up heads, Mark doubles his score. Every time the coin comes up tails, Becky triples her score. The results of their game so far are shown in the table.

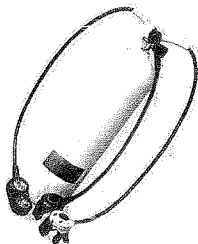
- What is Mark's score?
- What is Becky's score?
- What if...?** If they toss the coin 50 more times, who do you think will win? Why?

Coin Toss Results	
Heads	Tails
✓	✓
✓	✓
✓	✓
✓	
✓	

65. **Critical Thinking** The number of zeros in powers of 10 follow a pattern.

- Simplify each of the following: 10^2 , 10^3 , 10^4 .
- Explain what relationship you see between the exponent of a power of 10 and the number of zeros in the answer.

MULTI-STEP TEST PREP



66. This problem will prepare you for the Multi-Step Test Prep on page 38.

The formula $p = \frac{F}{A}$ shows that pressure p is the amount of force F exerted over an area A in square units.

- A 50-pound bag of flour sits on a block and exerts a force over an area of 100 in^2 . What is the pressure exerted on the block by the bag of flour?
- A weight exerts 64 pounds on each square foot of a diver's body. What force is exerted on each square *inch* of the diver's body? (*Hint:* Determine how many square inches are in one square foot.)

67. Which of the following is equal to 9^2 ?

- (A) $9 \cdot 2$ (B) 27 (C) 3^4 (D) -9^2

68. Which expression represents the same value as the product $(-16)(-16)(-16)(-16)$?

- (F) $(-16)4$ (G) $(-16)^4$ (H) -16^4 (J) $-(16 \cdot 4)$

69. A number raised to the third power is negative. What is true about the number?

- (A) The number is positive. (C) The number is even.
(B) The number is negative. (D) The number is odd.

70. A pattern exists as a result of raising -1 to consecutive whole numbers. Which is the best representation of the value of -1 raised to the 100th power?

$(-1)^n$	$(-1)^1$	$(-1)^2$	$(-1)^3$	$(-1)^4$	$(-1)^5$	$(-1)^6$
Value	-1	1	-1	1	-1	1

- (F) -1^{100} (G) -1 (H) 1 (J) 0

CHALLENGE AND EXTEND

Simplify each expression.

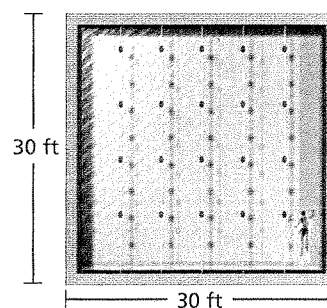
71. $(2^2)(2^2)(2^2)$

72. $(2^3)(2^3)(2^3)$

73. $(-4^2)(-4^2)(-4^2)(-4^2)$

74. **Design** The diagram shows the layout of a pool and the surrounding path. The path is 2.5 feet wide.

- What is the total area of the pool and path?
- What is the area of the pool?
- What is the area of the path?
- One bag of pebbles covers 10 square feet. How many bags of pebbles are needed to cover the path?



75. Exponents and powers have special properties.

- Write both 4^2 and 4^3 as a product of 4's.
- Write the product of the two expressions from part a. Write this product as a power of 4.
- Write About It** Add the exponents in the expressions 4^2 and 4^3 . Describe any relationship you see between your answer to part b and the sum of the exponents.

SPIRAL REVIEW

Find the mean of each data set by dividing the sum of the data by the number of items in the data set. (Previous course)

76. 7, 7, 8, 8

77. 1, 3, 5, 7, 9

78. 10, 9, 9, 12, 12

Give two ways to write each algebraic expression in words. (Lesson 1-1)

79. $5 - x$

80. $6n$

81. $c \div d$

82. $a + b$

Multiply or divide if possible. (Lesson 1-3)

83. $\frac{4}{5} \div \frac{8}{25}$

84. $0 \div \frac{6}{7}$

85. $-20(-14)$

86. $\frac{1}{2} \left(-\frac{4}{5} \right)$