

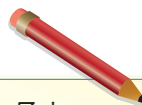
3.1 Algebraic Expressions

Essential Question How can you write and evaluate an expression that represents a real-life problem?

1 ACTIVITY: Reading and Re-Reading

Work with a partner.

- a. You babysit for 3 hours. You receive \$12. What is your hourly wage?
- Write the problem. Underline the important numbers and units you need to solve the problem.
 - Read the problem carefully a second time. Circle the key word for the question.



You babysit for 3 hours. You receive \$12.

What is your hourly wage?

- Write each important number or word, with its units, on a piece of paper. Write +, -, ×, ÷, and = on five other pieces of paper.



- Arrange the pieces of paper to answer the key word question, “What is your hourly wage?”
- Evaluate the expression that represents the hourly wage.

$$\begin{aligned} \text{hourly wage} &= \square \div \square && \text{Write.} \\ &= \square && \text{Evaluate.} \end{aligned}$$

❖ So, your hourly wage is \$ \square per hour.

- b. How can you use your hourly wage to find how much you will receive for any number of hours worked?

Algebraic Expressions

In this lesson, you will

- use order of operations to evaluate algebraic expressions.
- solve real-life problems.

2

ACTIVITY: Reading and Re-Reading**Math Practice****Make Sense of Quantities**

What are the units in the problem?
How does this help you write an expression?

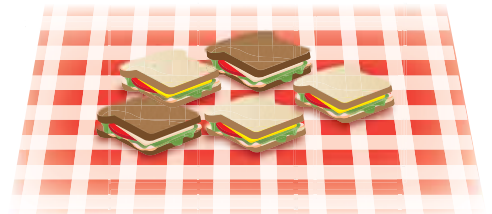
Work with a partner. Use the strategy shown in Activity 1 to write an expression for each problem. After you have written the expression, evaluate it using mental math or some other method.

- a. You wash cars for 2 hours. You receive \$6. How much do you earn per hour?



- b. You have \$60. You buy a pair of jeans and a shirt. The pair of jeans costs \$27. You come home with \$15. How much did you spend on the shirt?

- c. For lunch, you buy 5 sandwiches that cost \$3 each. How much do you spend?



- d. You are running a 4500-foot race. How much farther do you have to go after running 2000 feet?

- e. A young rattlesnake grows at a rate of about 20 centimeters per year. How much does a young rattlesnake grow in 2 years?

**What Is Your Answer?**

3. **IN YOUR OWN WORDS** How can you write and evaluate an expression that represents a real-life problem? Give one example with addition, one with subtraction, one with multiplication, and one with division.

Practice

Use what you learned about evaluating expressions to complete Exercises 4–7 on page 115.

Key Vocabulary

algebraic expression,
p. 112
terms, p. 112
variable, p. 112
coefficient, p. 112
constant, p. 112

An **algebraic expression** is an expression that may contain numbers, operations, and one or more symbols. Parts of an algebraic expression are called **terms**.

A symbol that represents one or more numbers is called a **variable**.

$$5p + 4$$

The numerical factor of a term that contains a variable is a **coefficient**.

A term without a variable is called a **constant**.

EXAMPLE 1 Identifying Parts of an Algebraic Expression

Identify the terms, coefficients, and constants in each expression.

a. $5x + 13$

$$\begin{array}{l} \underbrace{5x} + \underbrace{13} \\ \text{Terms: } 5x, \quad 13 \\ \text{Coefficient: } 5 \quad \downarrow \\ \text{Constant: } \quad \quad 13 \end{array}$$

b. $2z^2 + y + 3$

$$\begin{array}{l} \underbrace{2z^2} + \underbrace{y} + \underbrace{3} \\ \text{Terms: } 2z^2, \quad 1y, \quad 3 \\ \text{Coefficients: } 2, \quad 1 \quad \downarrow \\ \text{Constant: } \quad \quad \quad 3 \end{array}$$

Study Tip

A variable by itself has a coefficient of 1. So, the term y in Example 1(b) has a coefficient of 1.

On Your Own

Identify the terms, coefficients, and constants in the expression.

1. $12 + 10c$

2. $15 + 3w + \frac{1}{2}$

3. $z^2 + 9z$

EXAMPLE 2 Writing Algebraic Expressions Using Exponents

Write each expression using exponents.

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

Because d is used as a factor 4 times, its exponent is 4.

∴ So, $d \cdot d \cdot d \cdot d = d^4$.

b. $1.5 \cdot h \cdot h \cdot h$

Because h is used as a factor 3 times, its exponent is 3.

∴ So, $1.5 \cdot h \cdot h \cdot h = 1.5h^3$.

On Your Own

Write the expression using exponents.

4. $j \cdot j \cdot j \cdot j \cdot j \cdot j$

5. $9 \cdot k \cdot k \cdot k \cdot k \cdot k$

To evaluate an algebraic expression, substitute a number for each variable. Then use the order of operations to find the value of the numerical expression.

EXAMPLE 3 Evaluating Algebraic Expressions

a. Evaluate $k + 10$ when $k = 25$.

$$\begin{aligned} k + 10 &= 25 + 10 && \text{Substitute 25 for } k. \\ &= 35 && \text{Add 25 and 10.} \end{aligned}$$

b. Evaluate $4 \cdot n$ when $n = 12$.

$$\begin{aligned} 4 \cdot n &= 4 \cdot 12 && \text{Substitute 12 for } n. \\ &= 48 && \text{Multiply 4 and 12.} \end{aligned}$$

Study Tip

You can write the product of 4 and n in several ways.

$$\begin{aligned} 4 \cdot n \\ 4n \\ 4(n) \end{aligned}$$

On Your Own

6. Evaluate $24 + c$ when $c = 9$.

7. Evaluate $d - 17$ when $d = 30$.

EXAMPLE 4 Evaluating an Expression with Two Variables

Evaluate $a \div b$ when $a = 16$ and $b = \frac{2}{3}$.

$$\begin{aligned} a \div b &= 16 \div \frac{2}{3} && \text{Substitute 16 for } a \text{ and } \frac{2}{3} \text{ for } b. \\ &= 16 \cdot \frac{3}{2} && \text{Multiply by the reciprocal of } \frac{2}{3}, \text{ which is } \frac{3}{2}. \\ &= 24 && \text{Multiply.} \end{aligned}$$

On Your Own

Evaluate the expression when $p = 24$ and $q = 8$.

8. $p \div q$

9. $q + p$

10. $p - q$

11. pq

EXAMPLE 5 Evaluating Expressions with Two Operations

- a. Evaluate $3x - 14$ when $x = 5$.

$$\begin{aligned} 3x - 14 &= 3(5) - 14 && \text{Substitute 5 for } x. \\ &= 15 - 14 && \text{Using order of operations, multiply 3 and 5.} \\ &= 1 && \text{Subtract 14 from 15.} \end{aligned}$$

- b. Evaluate $z^2 + 8.5$ when $z = 2$.

$$\begin{aligned} z^2 + 8.5 &= 2^2 + 8.5 && \text{Substitute 2 for } z. \\ &= 4 + 8.5 && \text{Using order of operations, evaluate } 2^2. \\ &= 12.5 && \text{Add 4 and 8.5.} \end{aligned}$$

On Your Own

Now You're Ready
Exercises 43–51

Evaluate the expression when $y = 6$.

12. $5y + 1$ 13. $30 - 24 \div y$ 14. $y^2 - 7$ 15. $1.5 + y^2$

EXAMPLE 6 Real-Life Application



You are saving money to buy a skateboard. You begin with \$45 and you save \$3 each week. The expression $45 + 3w$ gives the amount of money you save after w weeks.

- a. How much will you have after 4 weeks, 10 weeks, and 20 weeks?
b. After 20 weeks, can you buy the skateboard? Explain.

Substitute the given number of weeks for w .

Number of Weeks, w	$45 + 3w$	Amount Saved
4	$45 + 3(4)$	$45 + 12 = \$57$
10	$45 + 3(10)$	$45 + 30 = \$75$
20	$45 + 3(20)$	$45 + 60 = \$105$

- b. After 20 weeks, you have \$105. So, you cannot buy the \$125 skateboard.

On Your Own

16. **WHAT IF?** In Example 6, the expression for how much money you have after w weeks is $45 + 4w$. Can you buy the skateboard after 20 weeks? Explain.



Vocabulary and Concept Check

1. **WHICH ONE DOESN'T BELONG?** Which expression does *not* belong with the other three? Explain your reasoning.

$2x + 1$

$5w \cdot c$

$3(4) + 5$

$y \div z$

2. **NUMBER SENSE** Which step in the order of operations is first? second? third? fourth?

Add or subtract from left to right.

Multiply or divide from left to right.

Evaluate terms with exponents.

Perform operations in parentheses.

3. **NUMBER SENSE** Will the value of the expression $20 - x$ *increase*, *decrease*, or *stay the same* as x increases? Explain.



Practice and Problem Solving

Write and evaluate an expression for the problem.

- You receive \$8 for raking leaves for 2 hours. What is your hourly wage?
- Music lessons cost \$20 per week. How much do 6 weeks of lessons cost?
- The scores on your first two history tests were 82 and 95. By how many points did you improve on your second test?
- You buy a hat for \$12 and give the cashier a \$20 bill. How much change do you receive?

Identify the terms, coefficients, and constants in the expression.

1 8. $7h + 3$

9. $g + 12 + 9g$

10. $5c^2 + 7d$

11. $2m^2 + 15 + 2p^2$

12. $6 + n^2 + \frac{1}{2}d$

13. $8x + \frac{x^2}{3}$



Terms: $2, x^2, y$
Coefficient: 2
Constant: none

14. **ERROR ANALYSIS** Describe and correct the error in identifying the terms, coefficients, and constants in the algebraic expression $2x^2y$.

15. **PERIMETER** You can use the expression $2\ell + 2w$ to find the perimeter of a rectangle where ℓ is the length and w is the width.

- Identify the terms, coefficients, and constants in the expression.
- Interpret the coefficients of the terms.



Write each expression using exponents.

2 16. $b \cdot b \cdot b$

17. $g \cdot g \cdot g \cdot g \cdot g$

18. $8 \cdot w \cdot w \cdot w \cdot w$

19. $5.2 \cdot y \cdot y \cdot y$

20. $a \cdot a \cdot c \cdot c$

21. $2.1 \cdot x \cdot z \cdot z \cdot z \cdot z$



$3 \cdot n \cdot n \cdot n \cdot n = 4n^3$

22. **ERROR ANALYSIS** Describe and correct the error in writing the product using exponents.

23. **AREA** Write an expression using exponents that represents the area of the square.



As I was going to St. Ives
I met a man with seven wives
Each wife had seven sacks
Each sack had seven cats
Each cat had seven kits
Kits, cats, sacks, wives
How many were going to St. Ives?

24. **ST. IVES** Suppose the man in the St. Ives poem has x wives, each wife has x sacks, each sack has x cats, and each cat has x kits. Write an expression using exponents that represents the total number of kits, cats, sacks, and wives going to St. Ives.

ALGEBRA Evaluate the expression when $a = 3$, $b = 2$, and $c = 12$.

3 25. $6 + a$

26. $b \cdot 5$

27. $c - 1$

28. $27 \div a$

29. $12 - b$

30. $c + 5$

31. $2a$

32. $c \div 6$

4 33. $a + b$

34. $c - a$

35. $\frac{c}{a}$

36. $b \cdot c$

37. **ERROR ANALYSIS** Describe and correct the error in evaluating the expression when $m = 8$.



$5m + 3 = 5 \cdot 8 + 3$
 $= 5 \cdot 11$
 $= 55$

38. **LAWNS** You earn $15n$ dollars for mowing n lawns. How much do you earn for mowing one lawn? seven lawns?

39. **PLANT** After m months, the height of a plant is $10 + 3m$ millimeters. How tall is the plant after eight months? three years?

Copy and complete the table.

40.

x	3	6	9
$x \cdot 8$			

41.

x	2	4	8
$64 \div x$			

42. **FALLING OBJECT** An object falls $16t^2$ feet in t seconds. You drop a rock from a bridge that is 75 feet above the water. Will the rock hit the water in 2 seconds? Explain.

ALGEBRA Evaluate the expression when $a = 10$, $b = 9$, and $c = 4$.

5 43. $2a + 3$

44. $4c - 7.8$

45. $\frac{a}{4} + \frac{1}{3}$

46. $\frac{24}{b} + 8$

47. $c^2 + 6$

48. $a^2 - 18$

49. $a + 9c$

50. $bc + 12.3$

51. $3a + 2b - 6c$

Standard Rentals
\$3



New Releases
\$4



52. **MOVIES** You rent x new releases and y standard rentals. Which expression tells you how much money you will need?

$3x + 4y$

$4x + 3y$

$7(x + y)$

53. **WATER PARK** You float 2000 feet along a “Lazy River” water ride. The ride takes less than 10 minutes. Give two examples of possible times and speeds. Illustrate the water ride with a drawing.

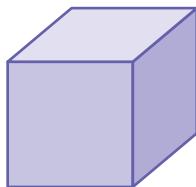
54. **SCIENCE CENTER** The expression $20a + 13c$ is the cost (in dollars) for a adults and c students to enter a science center.

a. How much does it cost for an adult? a student? Explain your reasoning.

b. Find the total cost for 4 adults and 24 students.

c. You find the cost for a group. Then the numbers of adults and students in the group both double. Does the cost double? Explain your answer using an example.

d. In part (b), the number of adults is cut in half, but the number of students doubles. Is the cost the same? Explain your answer.



x in.

55. **Reasoning** The volume of the cube is equal to four times the area of one of its faces. What is the volume of the cube?



Fair Game Review What you learned in previous grades & lessons

Find the value of the power. (Section 1.2)

56. 3^5

57. 8^3

58. 7^4

59. 2^8

60. **MULTIPLE CHOICE** Which numbers have a least common multiple of 24? (Section 1.6)

(A) 4, 6

(B) 2, 22

(C) 3, 8

(D) 6, 12