5.1 Algebraic Expressions

Learning Target: Evaluate algebraic expressions given values of their variables.

Success Criteria:
- I can identify parts of an algebraic expression.
- I can evaluate algebraic expressions with one or more variables.
- I can evaluate algebraic expressions with one or more operations.

EXPLORATION 1

Evaluating Expressions

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. Identify any missing information that is needed to answer each question. Then choose a reasonable quantity and write an expression for each problem. After you have written the expression, evaluate it using mental math or some other method.

a. You receive $24 for washing cars. How much do you earn per hour?

b. You buy 5 silicone baking molds at a craft store. How much do you spend?

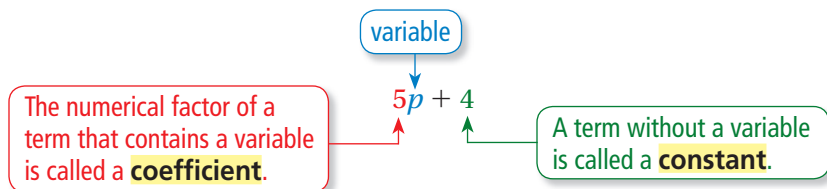c. You are running in a mud race. How much farther do you have to go after running 2000 feet?

d. A rattlesnake is 25 centimeters long when it hatches. The snake grows at a rate of about 1.6 centimeters per month for several months. What is the length of the rattlesnake?

An **algebraic expression** is an expression that may contain numbers, operations, and one or more *variables*. A **variable** is a symbol that represents one or more numbers. Each number or variable by itself, or product of numbers and variables in an algebraic expression, is called a **term**.

variable

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

$5p + 4$

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. $5x + 13$

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

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

$5x + 13$

Terms: $5x$, 13

Coefficient: 5

Constant: 13

$2z^2 + y + 3$

Terms: $2z^2$, $1y$, 3

Coefficients: 2, 1

Constant: 3

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

1. $12 + 10c$

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

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

Try It Write the expression using exponents.

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

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

Multi-Language Glossary at *BigIdeasMath.com*

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 $k = 25$.

$$k + 10 = 25 + 10 \qquad \text{Substitute 25 for } k.$$
$$= 35 \qquad \text{Add 25 and 10.}$$

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

$$4 \cdot n = 4 \cdot 12 \qquad \text{Substitute 12 for } n.$$
$$= 48 \qquad \text{Multiply 4 and 12.}$$

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

$4 \cdot n$
$4n$
$4(n)$

Try It

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

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

8. Evaluate $18 \div q$ when $q = \dfrac{1}{2}$.

EXAMPLE 4 **Evaluating an Expression with Two Variables**

a. Evaluate $n - m$ when $m = 12$ and $n = 30$.

$$n - m = 30 - 12 \qquad \text{Substitute 30 for } n \text{ and 12 for } m.$$
$$= 18 \qquad \text{Subtract 12 from 30.}$$

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

$$a \div b = 16 \div \dfrac{2}{3} \qquad \text{Substitute 16 for } a \text{ and } \dfrac{2}{3} \text{ for } b.$$
$$= 16 \cdot \dfrac{3}{2} \qquad \text{Multiply by the reciprocal of } \dfrac{2}{3}, \text{ which is } \dfrac{3}{2}.$$
$$= 24 \qquad \text{Multiply.}$$

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

9. $p \div q$

10. $q + p$

11. $p - q$

12. $p \cdot q$

EXAMPLE 5 **Evaluating Expressions with Two Operations**

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

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

b. Evaluate $n^2 + 8.5$ when $n = 2$.

$$n^2 + 8.5 = 2^2 + 8.5 \qquad \text{Substitute 2 for } n.$$
$$= 4 + 8.5 \qquad \text{Using order of operations, evaluate } 2^2.$$
$$= 12.5 \qquad \text{Add 4 and 8.5.}$$

Try It Evaluate the expression when $y = 6$.

13. $5y + 1$ **14.** $30 - 24 \div y$

15. $y^2 - 7$ **16.** $1.5 + y^2$

Self-Assessment *for Concepts & Skills*

Solve each exercise. Then rate your understanding of the success criteria in your journal.

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

$2x + 1$ $5w \cdot c$ $3(4) + 5$ $2y \cdot z$

18. ALGEBRAIC EXPRESSIONS Identify the terms, coefficients, and constants in the expression $9h + 1$.

EVALUATING EXPRESSIONS Evaluate the expression when $m = 8$.

19. $m - 7$ **20.** $5m + 4$

21. (MP) **NUMBER SENSE** Does the value of the expression $20 - x$ increase, decrease, or stay the same as x increases? Explain.

22. OPEN-ENDED Write an algebraic expression using more than one operation. When you evaluate the expression, how do you know which operation to perform first?

23. (MP) **STRUCTURE** Is the expression $8.2 \div m \cdot m \cdot m \cdot m$ the same as the expression $8.2 \div m^4$? Explain your reasoning.

EXAMPLE 6 **Modeling Real Life**

You are saving to buy a meteorite fragment for $125. You begin with $45 and you save $3 each week. The expression 45 + 3w gives the amount of money you save after w weeks. Can you buy the meteorite after 20 weeks?

Understand the problem.

You are given an expression that represents your savings after w weeks. You are asked whether you have enough money to buy a $125 meteorite after 20 weeks.

Make a plan.

To find the amount of money you save after 20 weeks, evaluate the expression when $w = 20$. Then compare the value of the expression to the price of the meteorite.

Solve and check.

$$45 + 3w = 45 + 3(20) \qquad \text{Substitute 20 for } w.$$
$$= 45 + 60 \qquad \text{Multiply 3 and 20.}$$
$$= 105 \qquad \text{Add 45 and 60.}$$

▶ You cannot buy the $125 meteorite after 20 weeks because you only have $105.

Another Method You start with $45, so you need to save another $125 - 45 = \$80$. At $3 per week, it will take you $\frac{80}{3} \approx 27$ weeks of saving.

$$45 + 3(27) = 45 + 81 = \$126 \checkmark$$

Self-Assessment *for Problem Solving*

Solve each exercise. Then rate your understanding of the success criteria in your journal.

24. The expression $12.25m + 29.99$ gives the cost (in dollars) of a gym membership for m months. You have $180 to spend on a membership. Can you buy a one-year membership?

25. **DIG DEEPER!** The expression $p - 15$ gives the amount (in dollars) you pay after using the coupon when the original amount of a purchase is p dollars. The expression $30 + 6n$ gives the amount of money (in dollars) you save after n weeks. A jacket costs $78. Can you buy the jacket after 6 weeks? Explain.

Coupon

Good for $15 off any purchase of $75 or more

5.1 Practice

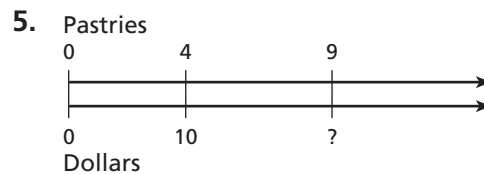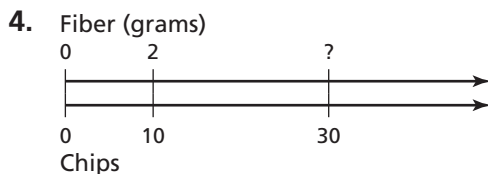Go to **BigIdeasMath.com** to get
HELP with solving the exercises.

▶ Review & Refresh

You ask 40 students which of three items from the
cafeteria they like the best. You record the results
on the piece of paper shown.

What is your favorite cafeteria food?
Pizza: 30%
Pasta: 18 students
Salad: 10 students
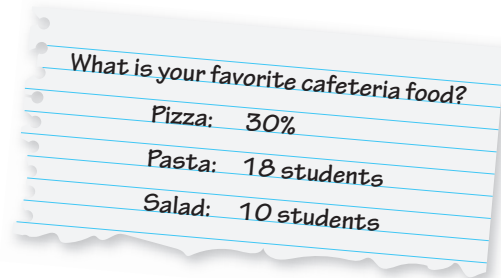
1. What percent of students answered salad?

2. How many students answered pizza?

3. What percent of students answered pasta?

Find the missing quantity in the double number line.

4. Fiber (grams)

```
0      2         ?
+------+---------+------->
0      10        30
```
Chips

5. Pastries

```
0      4         9
+------+---------+------->
0      10        ?
```
Dollars

Divide. Write the answer in simplest form.

6. $1\dfrac{3}{8} \div \dfrac{3}{4}$

7. $2\dfrac{7}{9} \div 2$

8. $4 \div 4\dfrac{2}{5}$

9. $3\dfrac{2}{3} \div 1\dfrac{2}{7}$

▶ Concepts, Skills, & Problem Solving

EVALUATING EXPRESSIONS Write and evaluate an expression for
the problem. (See Exploration 1, p. 201.)

10. The scores on your first two history tests are 82 and 95. By how many points
did you improve on your second test?

11. You buy a hat for $12 and give the cashier a $20 bill. How much change
do you receive?

12. You receive $8 for raking leaves for 2 hours. What is your hourly wage?

13. Music lessons cost $20 per week. How much do 6 weeks of lessons cost?

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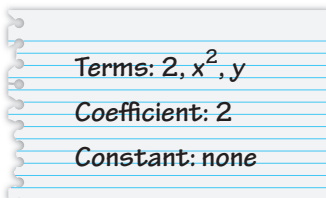in the expression.

14. $7h + 3$

15. $g + 12 + 9g$
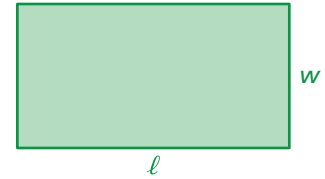
16. $5c^2 + 7d$

17. $2m^2 + 15 + 2p^2$

18. $6 + n^2 + \dfrac{1}{2}d$

19. $8x + \dfrac{x^2}{3}$

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

20. **YOU BE THE TEACHER** Your friend finds the terms,
coefficients, and constants in the algebraic expression
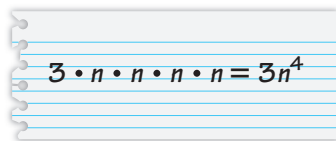$2x^2y$. Is your friend correct? Explain your reasoning.

21. 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.

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

   b. Interpret the coefficients of the terms.

USING EXPONENTS Write the expression using exponents.

22. $b \cdot b \cdot b$

23. $g \cdot g \cdot g \cdot g \cdot g$

24. $8 \cdot w \cdot w \cdot w \cdot w$

25. $5.2 \cdot y \cdot y \cdot y$

26. $a \cdot a \cdot c \cdot c$

27. $2.1 \cdot x \cdot z \cdot z \cdot z \cdot z$

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

28. YOU BE THE TEACHER Your friend writes the product using exponents. Is your friend correct? Explain your reasoning.

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

$5d$

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?

30. MP REASONING 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.

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

31. $6 + a$

32. $b \cdot 5$

33. $c - 1$

34. $27 \div a$

35. $12 - b$

36. $c + 5$

37. $2a$

38. $c \div 6$

39. $a + b$

40. $c + a$

41. $c - a$

42. $a - b$

43. $\dfrac{c}{a}$

44. $\dfrac{c}{b}$

45. $b \cdot c$

46. $c(a)$

47. MP PROBLEM SOLVING You earn $15n$ dollars for mowing n lawns. How much do you earn for mowing 1 lawn? 7 lawns?

EVALUATING EXPRESSIONS Copy and complete the table.

48.

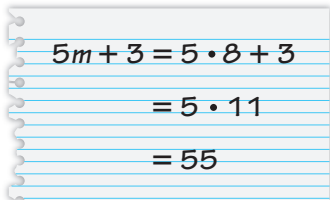| x	3	6	9
$x \cdot 8$			

49.

x	2	4	8
$64 \div x$			

50. MODELING REAL LIFE Due to gravity, 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.

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

51. $2a + 3$

52. $4c - 7.8$

53. $\dfrac{a}{4} + \dfrac{1}{3}$

54. $\dfrac{24}{b} + 8$

55. $c^2 + 6$

56. $a^2 - 18$

57. $a + 9c$

58. $bc + 12.3$

59. $3a + 2b - 6c$

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

60. YOU BE THE TEACHER Your friend evaluates the expression when $m = 8$. Is your friend correct? Explain your reasoning.

61. MP PROBLEM SOLVING After m months, the height of a plant is $(10 + 3m)$ millimeters. How tall is the plant after 8 months? 3 years?

62. MP STRUCTURE You use a video streaming service to rent x new releases and y standard rentals. Which expression tells you how much money you will need?

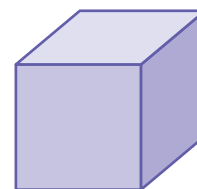| $3x + 4y$ | $4x + 3y$ | $7(x + y)$ |

Standard Rentals
$3

63. OPEN-ENDED 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.

New Releases
$4

64. DIG DEEPER! 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.

65. MP REASONING The volume of the cube (in cubic inches) is equal to four times the area of one of its faces (in square inches). What is the volume of the cube?

x in.