

Lesson 3

Evaluating Algebraic Expressions with More than One Variable

Objectives

- ✓ learn to evaluate algebraic expressions with more than one variable
- ✓ use algebra to solve problems through applications



Example 1

Suppose you have some change in your pocket consisting of nickels, dimes and quarters.

How much money do you have if you have 6 nickels, 3 dimes, and 2 quarters?

Write and evaluate an algebraic expression denoting the problem.

Solution

First represent the unknowns using variables. Let n = the number of **n**ickels in your pocket, d = the number of **d**imes in your pocket, and q = the number of **q**uarters in your pocket. The value, in cents, of the coins in your pocket is equal to $5n + 10d + 25q$.

Since $n = 6$, $d = 3$, and $q = 2$,

$$\begin{aligned} 5n + 10d + 25q &= 5(6) + 10(3) + 25(2) \\ &= 30 + 30 + 50 \\ &= 110 \text{ cents or } \$1.10 \end{aligned}$$

Think Back



It is very important to write in words exactly what each variable represents. Remember to choose a letter that helps you recall what the variable represents. This will make writing algebraic expressions and using them easier.

*For example, using the letter n to represent the number of **n**ickels made it easier to see why $5n$ represents the value of the nickels.*

Example 2

Evaluate $2x - 5y$:

if $x = 7$ and $y = 2$

Solution

$2x - 5y = 2(7) - 5(2)$	Replace variables
$= 14 - 10$	Simplify each term
$= 4$	Combine terms

if $x = -3$ and $y = -5$

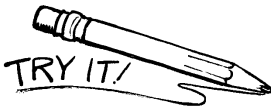
Solution

$2x - 5y = 2(-3) - 5(-5)$	Replace variables
$= -6 - (-25)$	Simplify each term
$= -6 + 25$	Change to addition
$= 19$	Combine terms



To evaluate an algebraic expression with more than one variable:

1. Replace each variable with a specific value.
2. Evaluate the new expression according to the accepted order of operations.



Evaluate $-5a + 6b$ if

1. $a = 2$ and $b = 3$

2. $a = -1$ and $b = 7$

3. $a = 6$ and $b = -2$

Example 3

Evaluate $5(a - b) + 6c$ if $a = 1$, $b = 2$, and $c = -4$.

Solution

$$5(a - b) + 6c = 5(1 - 2) + 6(-4)$$

$$= 5(-1) + (-24)$$

$$= -5 + (-24)$$

$$= -29$$

Replace variables with constants

Simplify within each term

Multiply

Combine terms

Example 4

Evaluate $x^2 + 2(x + y)^2$ if $x = -2$ and $y = 5$.

Solution

$x^2 + 2(x + y)^2 = (-2)^2 + 2(-2 + 5)^2$	Replace variables with constants
$= 4 + 2(3)^2$	Simplify within terms
$= 4 + 2(9)$	Square 3
$= 4 + 18$	Multiply
$= 22$	Combine terms



Evaluate each of these algebraic expressions for the given value of the variables.

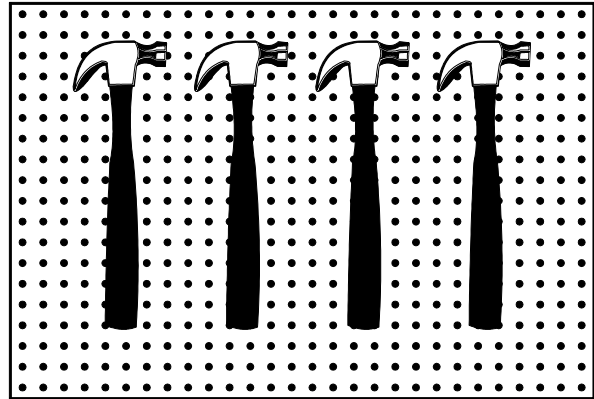
4. $4x - 5y + z$ if $x = -3$, $y = 2$, and $z = -1$

5. $3(a - b^2) + 4a^2$ if $a = 3$ and $b = 2$

Sometimes it is not only necessary to evaluate an algebraic expression, you must first write it.

Example 5

The local hardware store dealer needs more space to display hammers which are on a pegboard. Write an algebraic expression that represents the area of the rectangular pegboard of length, l , and width, w .



Solution

The area of a rectangle is its length times its width. Written algebraically the area is lw .

Which pegboard would give the store owner more space for the hammers?

1. a pegboard with length 5 feet and width 2.5 feet or
2. a pegboard with length 6 feet and width 2 feet?

Solution

If $l = 5$ and $w = 2.5$, the available area is $lw = 5(2.5) = 12.5$ or 12.5 square feet.

If $l = 6$ and $w = 2$, the available area is $lw = 6(2) = 12$ or 12 square feet of space.

The pegboard with length 5 feet and width 2.5 feet allows for more space.

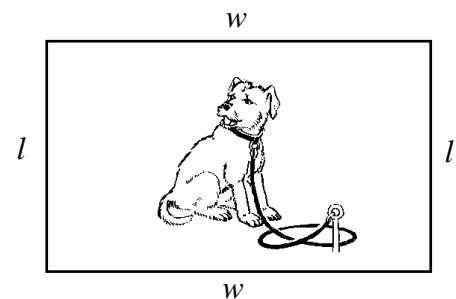
Problem Solving Tip



It often helps to make a sketch when solving problems.

Example 6

Hector wants to build a pen outside for his dog and needs to know how much fencing to buy. Write an algebraic expression that represents the amount of fencing he needs to buy if the pen has length, l , and width, w .



Think Back

You may also have written
 $l + w + l + w$ or $2l + 2w$.

Solution

The perimeter of a rectangle is twice the sum of its length and width. Written algebraically the perimeter is $2(l + w)$.

How much fencing does he need if the length of the pen is $5\frac{1}{2}$ feet and the width is 6 feet?

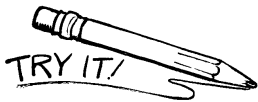
Solution

$$\begin{aligned} 2(l + w) &= 2(5\frac{1}{2} + 6) \\ &= 2(11\frac{1}{2}) \\ &= 22 + 1 \\ &= 23 \end{aligned}$$

Think Back

Remember that $11\frac{1}{2} = 11 + \frac{1}{2}$.
 $2(11\frac{1}{2}) = 2(11 + \frac{1}{2}) = 2(11) + 2(\frac{1}{2})$ by
the distributive property = $22 + 1$

Hector needs 23 feet of fencing.

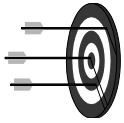


6. Sara wants to buy a new dress. She can spend one-third of her savings on the dress. She has some of her savings in a piggy bank and some in her purse. Write an algebraic expression to represent the amount of money she can spend. Be sure to indicate what each of your variables represent.

7. How much money can she spend on the dress if she has \$142.75 in her piggy bank and \$4.25 in her purse?

Review

1. Highlight the algorithm explaining how to evaluate an algebraic expression with more than one variable.
2. Write about one new thing that you learned in this lesson or write a question you would like to discuss with your mentor.



Practice Problems

Unit 3 Lesson 3

Directions: Write your answers in your math journal. Label this exercise Unit 3-Lesson 3 Set A, Set B, Set C, and Set D.

Set A

Evaluate each of these algebraic expressions using the given values of the variables.

1. $3a + 4b$ if $a = -4$ and $b = 1$
2. $4r - 7s$ if $r = 3$ and $s = -3$
3. $-\frac{2}{3}x + \frac{3}{4}y$ if $x = 18$ and $y = 24$
4. $3s - 2r + 4t$ if $s = -5$, $r = -3$, and $t = 9$
5. $6x + y - z$ if $x = 2$, $y = -7$, and $z = -1$

Set B

Evaluate each of these algebraic expressions using the given values of the variables.

1. $5(x + 2y) - x^3$ if $x = -1$ and $y = 8$
2. $\sqrt{x - y}$ if $x = 3$ and $y = -6$
3. $(x + 2)^2 + (y - x)^2$ if $x = 1$ and $y = 8$
4. $xy + z$ if $x = -3$, $y = 7$ and $z = 5$

Set C

1. Jose has some nickels and quarters in a jar.
 - a. Write an expression for the amount of money Jose has in the jar. Be sure to label your variables. (That is, be sure to explain what each of your variables represent.)
 - b. How much money is in the jar if there are 38 nickels and 15 quarters?
2. There are 11 cases of beans in the storeroom of a grocery store and three rows of beans on the shelf.
 - a. Write an algebraic expression that represents the total number of cans of beans. Be sure to label your variables.
 - b. How many beans are there if a case contains 12 cans and a row contains 15 cans?

3. Tickets to a play are \$2 for children and \$5 for adults.
 - a. Write an algebraic expression that represents the amount of money collected for the play tickets. Be sure to label your variables.
 - b. How much money was collected if 39 children's tickets and 15 adult tickets were sold?
4. Mrs. McGregor is going to put a concrete walk around her rectangular garden. The walk is to be 2 feet wide.
 - a. Write an algebraic expression to represent the outside perimeter of the walkway.
Let l = the length of the garden and w = the width of the garden. Hint: Make a sketch of the garden and walk to help you.
 - b. What is the outside perimeter of the walk if the length of the garden is 8 feet and its width is 5 feet?

Set D: Review

1. Name the constants and the variables in each of these algebraic expressions.
 - a. $3x - 16y^2$
 - b. $4ab + 6cd - 5$
2. Translate the following English expressions into algebraic expressions.
 - a. 5 less than a number x
 - b. the quotient of a number, y , and 6
 - c. two-thirds the product of a and b
 - d. a number, n , decreased by 13
3. Translate the following English expressions into algebraic expressions.
 - a. the number of cents in d dimes and q quarters
 - b. half the sum of t and the square of s
 - c. John's age 6 years ago if he is a years old today
 - d. the difference of the cube of x and the square of y
4. Write an English expression to represent each of these.
 - a. $3x^3 - 1$
 - b. $3(x^3 - 1)$

5. Find the value of each algebraic expression using the given values of the variables.
- a. $5(x - 2)$ if $x = 4$
 - b. $5x - 2$ if $x = 4$
 - c. $\frac{3}{x+1}$ if $x = -2$
 - d. $\frac{3}{x} + 1$ if $x = -2$
 - e. $x^2 - 2x + 3$ if $x = 3$
 - f. $x^2 - 2x + 3$ if $x = -3$
6. Katerina's father is 3 more than twice her age.
- a. If $k =$ Katerina's age, write an algebraic expression that represents her father's age.
 - b. How old is Katerina's father if she is 16?



1. $-5a + 6b = -5(2) + 6(3)$ Replace variables with constants
 $= -10 + 18$ Evaluate terms
 $= 8$ Combine terms
2. $-5a + 6b = -5(-1) + 6(7)$ Replace variables with constants
 $= 5 + 42$ Evaluate terms
 $= 47$ Combine terms
3. $-5a + 6b = -5(6) + 6(-2)$ Replace variables with constants
 $= -30 - 12$ Evaluate terms
 $= -42$ Combine terms
4. $4x - 5y + z = 4(-3) - 5(2) + (-1)$ Replace variables with constants
 $= -12 - 10 + (-1)$ Evaluate terms
 $= -23$ Combine terms
5. $3(a - b^2) + 4a^2 = 3(3 - 2^2) + 4(3)^2$ Replace variables with constants
 $= 3(3 - 4) + 4 \cdot 9$ Evaluate exponents
 $= 3(-1) + 36$ Simplify within terms
 $= -3 + 36$ Multiply
 $= 33$ Combine terms
6. Let $b =$ the amount of money in Sara's bank and $p =$ the amount of money in her purse.
 Sara may spend $\frac{1}{3}(b + p)$ dollars.
7. $\frac{1}{3}(b + p) = \frac{1}{3}(142.75 + 4.25)$
 $= \frac{1}{3}(147)$
 $= 49$
 Sara can spend \$49 dollars.



Career Watch

JOB INFORMATION ON THE INTERNET

The United States Department of Labor Bureau of Labor Statistics provides its *Occupational Outlook Handbook* on the Internet. You can find it at **<http://stats.bls.gov/ocohome.htm>**. You can type the name of the career you wish to research in the box at the top of the page, click the “go” button and find detailed information about a career, educational requirements and job prospects in that field.

For more help:

Go to **www.khanacademy.org/math/algebra**

Click on “Solving Linear Equations” under Topics and look at

Evaluating Expressions with Two Variables



Go to **www.khanacademy.org/math/algebra**

Click on “ck12.org Algebra 1 Examples” under Topics and look at Variable Expressions



End of Lesson 3