# Evaluating Variable Expressions

When evaluating variable expressions there are several things to remember:

1. Each variable (letter) represents some number.
2. Replace each variable with the number it represents.
3. Simplify the resulting numerical expression using the Order of Operations Agreement.
4. Your answer will be a number without a variable.

**EXAMPLE 1:** Evaluate $5x-3y$ when $x = 4$ and $y = -2$
This expression is read as "five times the value of $x$ minus three times the value of $y$." Note that when you have a number and a letter (variable) next to each other with nothing in between, it means to multiply.

1. Replace $x$ with 4 (you were told that $x$ has a value of 4), and replace $y$ with −2 (you were told that $y$ has a value of −2):

$$5x - 3y = 5(4) - 3(-2)$$

2. Simplify the resulting numerical expression:

| | |
|---|---|
| $5(4) - 3(-2)$ | perform the multiplication |
| $= 20 - (-6)$ | perform the subtraction |
| $= 20 + 6$ | rewrite (if desired) |
| $= 26$ | numerical answer |

**EXAMPLE 2:** Evaluate $5xy$ when $x = 6$ and $y = -4$

This expression is read as "five times the value of $x$ times the value of $y$." Note that when you have two letters (variables) next to each other and nothing in between, it also means to multiply.

1. Replace $x$ with 6 (you were told that $x$ has a value of 6), and replace $y$ with −4 (you were told that $y$ has a value of −4).

$$5xy = 5(6)(-4)$$

2. Simplify the resulting numerical expression:

| | |
|---|---|
| $5(6)(-4)$ | perform the first multiplication |
| $= 30(-4)$ | perform the second multiplication |
| $= -120$ | numerical answer |

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**EXAMPLE 3:** Evaluate $-x$ when $x = -5$

This expression is read as "the opposite of the value of *x*."

1. Replace *x* with $-5$ (you were told that *x* has a value of $-5$)

| | |
|---|---|
| $-x = -(-5)$ | |
| $= -(-5)$ | find the opposite of $-5$ |
| $= 5$ | numerical answer |

This may also be thought of as $-1$ times *x*:

| | |
|---|---|
| $-1 \cdot x = -1 \cdot (-5)$ | |
| $= -1 \cdot (-5)$ | perform the multiplication |
| $= 5$ | numerical answer |

This type of problem often causes difficulties for students. You must be careful to replace each variable with the value given and leave all other signs and symbols exactly as they were.

**EXAMPLE 4:** Evaluate $3x^3 - 2x^2$ when $x = 2$.

This expression is read as "three times the value of *x* cubed minus two times the value of *x* squared."

| | |
|---|---|
| $3(2)^3 - 2(2)^2$ | First make the substitution $(x = 2)$ |
| $= 3(8) - 2(4)$ | Evaluate. Simplify the exponents first. |
| $= 24 - 8$ | Follow the Order of Operations Agreement. (Multiply before you subtract.) |
| $= 16$ | Numerical answer |

**EXAMPLE 5:** Evaluate $-2x^3 - 4x^2 - x$ when $x = -3$.

| | |
|---|---|
| $-2(-3)^3 - 4(-3)^2 - (-3)$ | Make the substitution. |
| $= -2(-27) - 4(9) - (-3)$ | Simplify the exponents. |
| $= 54 - 36 - (-3)$ | Multiply |
| $= 54 - 36 + 3$ | Subtract |
| $= 18 + 3$ | Add |
| $= 21$ | Numerical Answer |

**EXAMPLE 6:** Evaluate $\dfrac{a^2 - b^2}{a + b}$ when $a = -2$ and $b = 4$.

This expression is read as "the value of *a* squared minus the value of *b* squared divided by the value of *a* plus the value of *b*."

| | |
|---|---|
| $\dfrac{(-2)^2 - (4)^2}{-2 + 4}$ | Make the substitution. |
| $= \dfrac{4 - 16}{-2 + 4}$ | Simplify the exponents. |
| $= -\dfrac{12}{2}$ | Simplify the numerator and denominator and reduce the fraction. |
| $= -6$ | Numerical answer |

REMEMBER that after we have made the substitutions we are simplifying the expression using the Order of Operations Agreement, which states:

1. Simplify all grouping symbols.
2. Simplify all exponential expressions.
3. Perform all multiplication and division as they occur going from left to right.
4. Perform all addition and subtraction as they occur going from left to right.

We call grouping symbols *parentheses* even though we know that includes brackets, braces, the absolute value symbol and a long fraction bar as well as parentheses. We can use the following phrase to help us remember the order:

| | | |
|---|---|---|
| | **P**arentheses (), [], {}, \| \|, etc. | **P**lease |
| | **E**xponents | **E**xcuse |
| Left to Right | **M**ultiplication | **M**y |
| | **D**ivision | **D**ear |
| Left to Right | **A**ddition | **A**unt |
| | **S**ubtraction | **S**ally |

REMEMBER that this does not mean that you must multiply before you divide. It depends on which operation comes first as you move from left to right. The same is true for addition and subtraction.

You have had experience evaluating variable expressions which are parts of geometric formulas. The formula $V = \pi r^2 h$ says to find the volume (*V*) of a right circular cylinder by multiplying the value of $\pi$ times the square of the value of the radius (*r*) times the height (*h*).

To find the volume of a cylinder with a height of 6 inches and a radius of 3 inches, you will evaluate the formula $V = \pi r^2 h$ when $\pi = 3.14$ (approximately), $r = 3$, and $h = 6$

$$V = \pi r^2 h$$

| | |
|---|---|
| $V = 3.14 \cdot (3)^2 \cdot 6$ | Replace each letter with its value |
| $V = 3.14 \cdot 9 \cdot 6$ | Apply the exponent |
| $V = 169.56 \text{ in}^3$ | Multiply |

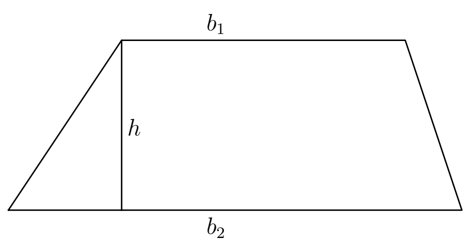
(Note: Volume is measured in cubic units.)

The answer is read "one hundred sixty-nine and fifty-six hundredths cubic inches."

The formulas needed for this section are usually printed inside the cover of your textbook.

The area ($A$) of a trapezoid is found using the formula $A = h\frac{(b_1 + b_2)}{2}$ where $h$ is the height and $b_1$ and $b_2$ are the bases (the parallel sides). The subscripts 1 and 2 tell us that the value of $b_1$ can be different from the value of $b_2$.

Find the area of the following trapezoid given h = 3 inches, $b_1$ = 5 inches, and $b_2$ = 8 inches:




$$A = h\frac{(b_1 + b_2)}{2}$$

$$A = 3\left(\frac{5+8}{2}\right)$$

$$A = 3\left(\frac{13}{2}\right)$$

$$A = \frac{39}{2} \text{ in}^2 = 19\frac{1}{2} \text{ in}^2$$

Notice that area is measured in square units; therefore, the answer is read "19 and one-half square inches."

**EXERCISES:**

1. Evaluate each variable expression by substituting the given value for each variable, and then simplifying using the Order of Operations Agreement:

   a. $-x^3 - 2x^2 + x,\ \ x = 2$

   d. $\dfrac{m^3 - n^2}{m - n},\quad m=3 \text{ and } n=-3$

   b. $-x^3 - 2x^2 + x,\ \ x = -2$

   e. $-2x^2 - x - 5,\quad x = -3$

   c. $6a^2 - a - 5,\ \ a = -1$

2. Use the formula $A = \pi r^2$ to find the area of a circle which has a radius of 10 feet. Use $\pi = 3.14$.

3. Use $A = h\dfrac{(b_1 + b_2)}{2}$ to find the area of a trapezoid with bases of 7 inches and 9 inches and a height of 4 inches.

4. Find the volume of a rectangular solid with a length of 3.6 meters, a width of 2 meters, and a height of 1.5 meters.

**KEY:**

1. a. –14 b. –2 c. 2 d. 3 e. –20
2. 314 $\text{ft}^2$ 3. 32 $\text{in}^2$ 4. 10.8 $\text{m}^3$

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