

# Order of Operations and Evaluating Expressions Guide Notes

**EVALUATE ALGEBRAIC EXPRESSIONS** means to find its numerical value.

**ORDER OF OPERATIONS** is a method used to evaluate an expression involving more than one operation. In algebraic expressions, it can only be evaluated if the values of the variables are known.

**Step 1** Replace the variables with their numerical values.

**Step 2** Evaluate expressions inside grouping symbols.

**Step 3** Evaluate all powers.

**Step 4** Do all multiplications and/or divisions from left to right.

**Step 5** Do all additions and/or subtractions from left to right.

**Example:** Evaluate  $z^4 - 3$ , if  $z = 2$ .

$$\begin{aligned} z^4 - 3 &= 2^4 - 3 \\ &= 16 - 3 \end{aligned}$$

Replace  $z$  with 2.

Evaluate  $2^4$

$$z^4 - 3 = 13$$

Subtract 16 and 3

**Sample Problem 1:** Evaluate each expression if  $x = 2$ ,  $y = 4$ , and  $z = 6$ .

a.  $x^3 + 10y = 2^3 + 10 \cdot 4 = 8 + 40 = 48$

b.  $\frac{22}{x} + 16 = \frac{22}{2} + 16 = 11 + 16 = 27$

c.  $\frac{z}{3} + y = \frac{6}{3} + 4 = 2 + 4 = 6$

d.  $y + z + x = 4 + 6 + 2 = 12$

e.  $x + 5 = 2 + 5 = 7$

**GROUPING SYMBOLS**, such as parentheses ( ) or brackets [ ], indicate the order in which the operations should be performed first.

**Example:** Evaluate  $a^2 - (b^3 - 4c)$ , if  $a = 8$ ,  $b = 5$ , and  $c = 3$ .

$$\begin{aligned} a^2 - (b^3 - 4c) &= 8^2 - (5^3 - 4 \cdot 3) \\ &= 64 - (125 - 4 \cdot 3) \\ &= 64 - (125 - 12) \\ &= 64 - 113 \end{aligned}$$

Replace  $a$  with 8,  $b$  with 5, and  $c$  with 3.

Evaluate  $8^2$  and  $5^3$

Multiply 4 and 3

Subtract 125 and 12

$$a^2 - (b^3 - 4c) = -49$$

Subtract 64 from 113

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**Sample Problem 2:** Evaluate each expression if  $r = 4$ ,  $s = 6$ ,  $t = 3$ , and  $u = 12$ .

$$f. \quad 2r + st^2 - u = 2(4) + (6)(3^2) - 12 = 8 + 6(9) - 12 = 54 - 4 = 50$$

$$g. \quad tu - rs = (3)(12) - (4)(6) = 36 - 24 = 12$$

$$h. \quad st - 4r = (6)(3) - 4(4) = 18 - 16 = 2$$

$$i. \quad r^3 + u + s^t = 4^3 + 12 + 6^3 = 64 + 12 + 216 = 292$$

$$j. \quad tu - 3r = (3)(12) - 3(4) = 36 - 12 = 24$$

**FRACTION BAR** is another type of grouping symbol. It indicates that the numerator and denominator should each be treated as a single value.

**Example:** Evaluate  $\frac{x^2-1}{4y^2}$ , if  $x = 9$ , and  $y = 2$ .

$$\begin{aligned} \frac{x^2-1}{4y^2} &= \frac{9^2-1}{4 \cdot 2^2} \\ &= \frac{81-1}{4 \cdot 4} \\ &= \frac{81-1}{16} \\ &= \frac{80}{16} \end{aligned}$$

Replace  $x$  with **9**, and  $y$  with **2**.

Evaluate  **$9^2$**  and  **$2^2$**

Multiply **4** and **81**

Subtract **81** from **1**

$$\frac{x^2-1}{4y^2} = 5$$

Divide **80** to **16**

**Sample Problem 3:** Evaluate each expression if  $r = 4$ ,  $s = 6$ ,  $t = 3$ , and  $u = 12$ .

$$a. \quad \frac{2r(s-t)}{tu-s} = \frac{2(4)(6-3)}{(3)(12)-6} = \frac{8(3)}{36-6} = \frac{24}{30} = \frac{4}{5}$$

$$b. \quad \frac{u}{s} + \frac{3s}{t^2} = \frac{12}{6} + \frac{3(6)}{3^2} = 2 + \frac{18}{9} = 2 + 2 = 4$$

$$c. \quad \frac{rs^2-3u}{2} = \frac{(4)(6^2)-3(12)}{2} = \frac{4(36)-36}{2} = \frac{144-36}{2} = \frac{108}{2} = 54$$

$$d. \quad \frac{3r+s}{t^2-s} = \frac{3(4)+6}{3^2-6} = \frac{12+6}{9-6} = \frac{18}{3} = 6$$

$$e. \quad \frac{2u+s^2}{r+2t} = \frac{2(12)+6^2}{4+2(3)} = \frac{24+36}{4+6} = \frac{60}{10} = 6$$