# Study Guide

Exponential Notation E
03/01/2012

**Exponential Notation - E**

Exponents communicate the number of times a base number is used as a factor. The base number 5 to the 3rd power (with an exponent of 3) translates to 5 x 5 x 5. (5 to the 3rd power is not 5 x 3.) The result of 5 to the 3rd power is 125. To perform operations with exponents, all exponential properties must be understood.

To simplify an expression or to find the missing term in a simplified expression, apply the following exponential properties which are listed below.

$5^{?}$ ← exponent
↖ base

**Product of Powers:**

When multiplying two (or more) numbers with the same base that have exponents, the base remains the same and the exponents are added.

$$a^m \times a^n = a^{m+n}$$
$$5^3 \times 5^6 = 5^{3+6} = 5^9$$

**Power to a Power:**

When taking a number with an exponent to another power, the base remains the same and the exponents are multiplied.

$$(a^m)^n = a^{m \cdot n}$$
$$(5^3)^6 = 5^{3 \cdot 6} = 5^{18}$$

**The Power of Zero:**

Any number taken to the power of zero (except zero) equals 1.

$$a^0 = 1$$
$$5^0 = 1$$
$$100^0 = 1$$

**Negative Exponents:**

There is a rule for evaluating negative exponents.

$$a^{-m} = \frac{1}{a^m}$$
$$4^{-3} = \frac{1}{4^3}$$

**Example 1:** Simplify. $(3xz^3)(2x^4z^2)$

$$\overset{(1)}{(3 \cdot 2)(x^1 \cdot x^4)(z^3 \cdot z^2)} \qquad \overset{(2)}{(6)(x^{1+4})(z^{3+2})} \qquad \overset{(3)}{6x^5z^5}$$

Step 1: Separate the expression into products of whole numbers times products of variables with like bases. A variable or number that is written without an exponent automatically has an exponent of 1.
Step 2: First, multiply the whole numbers to get 6. Use the "Product of Powers" rule to evaluate the

terms in the second set of parentheses and the terms in the third set of parentheses.
Step 3: Add the exponents to complete the expression.

Answer: $6x^5z^5$

**Example 2:** Simplify. $(-2a^3b)^2$

$$(-2)^{2}\cdot(a^{3})^{2}\cdot(b)^{2} \qquad (-2)(-2)\cdot(a^{3\cdot2})\cdot(b^{1\cdot2}) \qquad 4(a^{6})(b^{2})$$
$$(1) \qquad\qquad (2) \qquad\qquad (3)$$
$$4a^{6}b^{2}$$

Step 1: Separate the expression into products of each of its terms. The exponent (2) is given to each term inside the parentheses.
Step 2: -2 to the second power is (-2)(-2). Use the "Power to a Power" rule to evaluate the rest of the expression.
Step 3: Multiply the powers to determine the exponents on the variables. The final expression can be written with the parentheses still in it, or without the parentheses. It is more acceptable to remove the parentheses.