

# Laws of Exponents

Whenever we have variables which contain exponents and have equal bases, we can do certain mathematical operations to them. Those operations are called the “Laws of Exponents”

$$\mathbf{b^x}$$

$$\mathbf{b = base} \quad \mathbf{x = exponent}$$

# Laws of Exponents

$$1. x^m \cdot x^n = x^{m+n}$$

$$2. (xy)^m = x^m y^m$$

$$3. (x^m)^n = x^{mn}$$

$$4. \left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$$

$$5a. \text{ if } m > n, \text{ then } \frac{x^m}{x^n} = x^{m-n}$$

$$5b. \text{ if } n > m, \text{ then } \frac{x^m}{x^n} = \frac{1}{x^{n-m}}$$

# Other Properties of Exponents

$$x^0 = 1 \quad x^{-1} = \frac{1}{x}$$

**Any single number or variable is always to the first power**

$$3 = 3^1$$

$$a = a^1$$

$$2x = 2^1 x^1 = (2x)^1$$



# Basic Examples

$$x^2 \cdot x^3 = x^{2+3} = x^5$$

$$(x^4)^3 = x^{4 \cdot 3} = x^{12}$$

$$(xy)^3 = x^3 y^3$$



# Basic Examples

$$\left(\frac{x}{y}\right)^3 = \frac{x^3}{y^3}$$

$$\frac{x^7}{x^4} = \frac{x^{7-4}}{1} = x^3$$

$$\frac{x^5}{x^7} = \frac{1}{x^{7-5}} = \frac{1}{x^2}$$



$$2a^3 \cdot 7a^4 = (2 \cdot 7)a^{3+4} = 14a^7$$

$$-5r^2 \cdot 8r^3 \cdot 2r^2 = (-5 \cdot 8 \cdot 2)r^{2+3+2} = -80r^7$$

$$(2m^2n^5)^3 = 2^{1 \cdot 3} m^{2 \cdot 3} n^{5 \cdot 3} = 2^3 m^6 n^{15} = 8m^6 n^{15}$$

$$(3xy)^3 = 3^3 x^3 y^3 = 27x^3 y^3$$

$$\left(\frac{2a}{3b}\right)^2 = \frac{2^2 a^2}{3^2 b^2} = \frac{4a^2}{9b^2}$$

$$\frac{8x^4}{2x} = \frac{8}{2} \frac{x^{4-1}}{1} = 4x^3$$

$$\frac{9z^3}{3z^5} = \frac{9}{3} \frac{1}{z^{5-3}} = 3 \frac{1}{z^2} = \frac{3}{z^2}$$



## More Examples

$$3x^3 y^2 z \cdot 7xyz^2 = (3 \cdot 7)x^{3+1} y^{2+1} z^{1+2} = \boxed{21x^4 y^3 z^3}$$

$$-8xy^2 \cdot 3xy \cdot (-2xy^3) = (-8 \cdot 3 \cdot -2)x^{1+1+1} y^{2+1+3} = \boxed{48x^3 y^6}$$

$$(3x^2 y^3)^2 (2xy^2)^2 = (3^{1 \cdot 2} x^{2 \cdot 2} y^{3 \cdot 2}) (2^{1 \cdot 2} x^{1 \cdot 2} y^{2 \cdot 2}) =$$

$$9x^4 y^6 \cdot 4x^2 y^4 = (9 \cdot 4)x^{4+2} y^{6+4} = \boxed{36x^6 y^{10}}$$

$$\left(\frac{5a^3 b}{3ab^2}\right)^3 = \frac{5^{1 \cdot 3} a^{3 \cdot 3} b^{1 \cdot 3}}{3^{1 \cdot 3} a^{1 \cdot 3} b^{2 \cdot 3}} = \frac{5^3 a^9 b^3}{3^3 a^3 b^6} = \frac{125a^9 b^3}{27a^3 b^6} = \frac{125a^{9-3}}{27b^{6-3}} = \boxed{\frac{125a^6}{27b^3}}$$