Exponents

$x^a = \underbrace{x \cdot x \cdot x \cdot x \cdot x}_{\text{'a' times.}}$

x = base
a = exponent
x^a = power of 'a'

Product Rule:

To multiply when the bases are the same, write the base and add the exponents.

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

Ex. $x^3 \cdot x^8 = x^{11}$, $x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$

Ex. $2^4 \cdot 2^2 = 2^6$

Ex. $(x^2y)(x^3y^4) = (x \cdot x) \cdot y \cdot (x \cdot x \cdot x) \cdot y \cdot y \cdot y \cdot y$

$x \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y$

$x^5 \cdot y^5$

Quotient Rule:

TO ÷ WHEN 2 BASES ARE THE SAME WRITE THE BASE & SUBTRACT THE EXPONENTS.

$$\frac{x^m}{x^n} = x^{m-n}$$

Ex. $\frac{x^5}{x^2} = \frac{x \cdot x \cdot x \cdot x \cdot x}{x \cdot x} = x^3$

Ex $\frac{3^5}{3^3} = 3^{5-3} = 3^2$

Ex. $\frac{x^2 y^5}{x^1 y^3} = \frac{x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y}{x \cdot y \cdot y \cdot y}$

$= x^1 y^2$

Zero Exponent Rule:

ANY BASE (EXCEPT 0) RAISED TO THE POWER OF 0 is EQUAL TO 1.

$y^0 = 1$

$6^0 = 1$

$(7a^3b^{-1})^0 = 1$

$y^1 = y$

$y^2 = y \cdot y$

$y^0 = 1$

$0.\overline{5} = x$

$5.\overline{5}$ $\quad 10x$

$10x = 5.\overline{5}$

$-\quad 1x = 0.\overline{5}$

$\frac{9x}{9} = \frac{5}{9}$

$x = \frac{5}{9} = 0.\overline{5}$

$0.\overline{54} = x$

$54.\overline{54}$ $\quad 100x$

$100x = 54.\overline{54}$

$-\quad 1x = 0.\overline{54}$

$\frac{99x}{99} = \frac{54}{99}$

$0.\overline{54} = \frac{6}{11}$ ✓

$x = \frac{54}{99} \overset{\div 9}{=} \frac{6}{11}$ $\div 9$

Power Rule

To raise a power to another power, write the base and multiply the exponents.

$$(x^m)^n = x^{m \cdot n}$$

Ex. $(x^3)^2 = (x^3)(x^3) = x^{3+3} = x^6$

Ex: $(3^2)^4 = (3^2)(3^2)(3^2)(3^2) = 3^8$

Ex. $(z^5)^2 = z^{5 \cdot 2} = z^{10}$

Expanded Power Rule

The exponent outside the bracket effects everything inside the bracket.

Ex. $(2a)^3 = 2^3 \cdot a^3 = 8a^3$

Ex. $(6x^3)^2 = 6^2 \cdot (x^3)^2 = 36 \cdot x^{3 \cdot 2} = 36x^6$

Ex. $\left(\frac{x^2}{y}\right)^4 = \frac{(x^2)^4}{y^4} = \frac{x^{2 \cdot 4}}{y^4} = \frac{x^8}{y^4}$

Ex. $\left(\frac{2x}{3y^2}\right)^3 = \frac{2^3 \cdot x^3}{3^3 \cdot (y^2)^3} = \frac{8x^3}{27y^6}$

NEGATIVE EXPONENTS

SIGNALS MOVEMENT OF THE NUMERATOR OR DENOMINATOR OF A FRACTION ACROSS THE FRACTION BAR.

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

Ex: $x^{-3} = \frac{x^{-3}}{1} = \frac{1}{x^3}$

Ex: $4^{-2} = \frac{4^{-2}}{1} = \frac{1}{4^2}$

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

Ex: $\left(\frac{x^2}{y}\right)^{-3} = \left(\frac{y}{x^2}\right)^{3} = \frac{y^3}{x^6}$

* WATCH OUT:

AN EXPONENT APPLIES ONLY TO THE FACTOR IT IS DIRECTLY NEXT TO, UNLESS () ARE PRESENT.

$(-3)^2 = 9$ $\quad -3^2 = -9$