# Laws of Exponents

Remember... 
$$b^x \rightarrow$$
 "b raised to the power of x" where, b – base  $x$  – exponent

#1. PRODUCT - when multiplying...

"if the base is the same, then ADD the exponents."

#2. QUOTIENT - when dividing...

"if the base is the same, then <u>SUBTRACT</u> the exponents."

EXAMPLES:
$$\frac{\omega^{12}}{\omega^{4}} = b^{m-n}, b \neq 0$$

$$\frac{(13)^{10}}{(13)^{1}} = 129$$

$$= \omega^{8}$$

$$\frac{(3\alpha+4)^{10}}{(3\alpha+4)^{10}} = (3\alpha+4)^{7}$$

#3. POWER - when raising a power to another power... <u>MULTIPLY</u> the exponents."

EXAMPLES:
$$(\chi^{7})^{3} \qquad (\chi^{7})^{3} \qquad (\omega^{3})^{4}$$

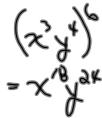
$$= \chi^{2} \qquad = \chi^{3} \qquad = \chi^{4}$$

### #4. POWER of a PRODUCT -

"when a product is raised to a power, each of the factors are raised to the power."

$$(a \times b)^m = a^m \times b^m$$

**EXAMPLES:** 



$$=9x^2y^3$$

## #5. POWER of a QUOTIENT -

"when a quotient is raised to a power, both the divisor and the dividend are raised to the power."

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m} , \quad a \& b \neq \mathbf{0}$$

**EXAMPLES**:

$$\left(\frac{\lambda_{10}}{\kappa_{1}}\right)_{3} = \frac{\lambda_{30}}{\kappa_{11}}$$

$$(5^3)^{1/6}$$
 $(5^3)^{1/6}$ 
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 $(5^3)^{1/6}$ 

#### #6. ZERO -

"any base raised to the power of zero is <u>ALWAYS</u> equal to 1."

EXAMPLES:

$$b^{0} = 1$$

$$\frac{\omega^{0}}{\omega^{0}} = \omega^{0} = 1$$

$$(3\omega)^6 = 1$$

## #7. Negative -

"any base is raised to a negative exponent equals the reciprocal base (FLIP) raised to the positive exponent."

$$b^{-m} = \frac{1}{b^m}$$
 OR  $\left(\frac{a}{b}\right)^{-m} = \left(\frac{b}{a}\right)^m = \frac{b^m}{a^m}$ 

**EXAMPLES**:

$$= \frac{3}{9} = \frac{3}{9} = \frac{3}{3} = \frac{3}{3} = \frac{3}{4} = \frac{1}{4(3)^{2}}$$
NOTE:

$$(negative\ base)^{even\ exp\ onent} 
ightarrow postive\ answer \ {
m AND} \ (negative\ base)^{odd\ exp\ onent} 
ightarrow negative\ answer \ }$$

$$(-3)^{106} = 3^{106}$$

$$(-3)^{105} = -3^{105}$$

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

#### Exponents and Radicals

Earlier, you learned that powers with integral exponents have a special meaning. The exponent  $\frac{1}{2}$  has a special meaning related to the principal square root of a number. principal square roots

In order to learn mathematics, it is helpful to make comparisons.

- The cube of 2 is 8, since  $2 \times 2 \times 2 = 8$ .
- The cube of 2 is shown by the symbol  $2^3 = 8$ .
- The principal cube root of 8 is 2, since  $2 \times 2 \times 2 = 8$ .
  - The principal cube root of 8 is shown by the means the principal radical symbol  $\sqrt[3]{8} = 2$ . cube root of 8.

Similarly, exponents that are rational have a special meaning.

Using exponent laws

Using radicals

$$8^{\frac{1}{3}} \times 8^{\frac{1}{3}} \times 8^{\frac{1}{3}} = 8^{\frac{1}{3} + \frac{1}{3} + \frac{1}{3}}$$

$$= 8 \leftarrow \text{Compare.} \longrightarrow = 8$$

Based on the above comparison,  $\sqrt[3]{8}$  and  $8^{\frac{1}{3}}$  behave in a similar way.

It seems reasonable to define  $\sqrt[3]{8} = 8^{\frac{1}{3}}$ 

In general, the nth principal root of a number is shown by

$$\sqrt[n]{a} = a^{\frac{1}{n}}$$

$$\sqrt[n]{a} = a^{\frac{1}{n}}$$

Fraction Exponents - To evaluate exponents that are fractions, the denominator of the fraction indicates which root to take and the numerator indicates which power the entire base is to be raised.

$$\begin{pmatrix} Q_{3}/3 \\ Q_{1}/3 \end{pmatrix} \not L$$

$$a^{\frac{m}{n}} = (\sqrt[n]{a})^m$$
or  $\sqrt[n]{a^n}$ 

**Examples:** 

$$1. 8^3 =$$

$$\int_{\mathcal{S}} \delta_{\mathcal{I}}$$

2. 
$$125^{-\frac{1}{3}} =$$

## More Examples...

a) 
$$125^{-\frac{2}{3}} = \frac{1}{\sqrt[3]{125}}$$

$$c) 8^{-\frac{1}{3}} = 1$$

e) 
$$125^{2\frac{1}{3}}$$
=  $125^{2\frac{1}{3}}$ 

b) 
$$256^{0.375}$$
  $256^{\circ}.375$  8
$$= (256)^{\circ} = (8)^{\circ} = (256)^{\circ}$$

$$= (256)^{\circ} = (256)^{\circ} = (256)^{\circ}$$

$$f) \left(84^{-2}\right)^{\frac{1}{4}}$$

$$81^{2/4}$$

$$81^{1/2}$$

$$81^{1/2}$$