

2.1 – Review of Exponents Rules

Zero Exponent Property → $a^0 \rightarrow 1$ { If a base is raised to the power of 0, it becomes 1. }

$$3^0 = \boxed{1} \quad ; \quad (-\frac{1}{3})^0 = \boxed{1} \quad ; \quad ab^0 = \frac{a}{a(1)}$$

Negative Exponent Property → $a^{-n} \rightarrow \frac{1}{a^n}$ or $\frac{1}{a^{-n}} \rightarrow 1a^n \rightarrow a^n$

$$2^{-4} = \frac{1}{2^4} \rightarrow \boxed{\frac{1}{16}} \quad ; \quad \frac{1}{(-5)^{-2}} = (-5)^2 \rightarrow \boxed{25} \quad ; \quad \frac{x^2 y^{-3}}{z^{-1}} = \frac{x^2 z^1}{y^3}$$

- An algebraic expression is in SIMPLEST form when its written with only POSITIVE exponents.
- A “fractional” algebraic expression is in SIMPLEST form when there are NO common factors i.e., $\frac{7}{21} \rightarrow \frac{1}{3}$

Multiplying Powers with Same Base Property → $a^m \cdot a^n \rightarrow a^{m+n}$ { If multiplying powers w/ SAME base, ADD exponents! }

* When simplifying an exponential expression with more than one variable →

Combine the powers ONLY with the EXACT SAME base.

$$3^2 \cdot 3^3 = 3^{2+3} \rightarrow 3^5 \rightarrow \boxed{243} \quad ; \quad 3x^4 \cdot 4x^7 = (3 \cdot 4)x^{4+7} \rightarrow \boxed{12x^{11}} \quad ; \quad 2a^2 \cdot b^3 \cdot 5a^1 \cdot 8b^7 = (2 \cdot 5 \cdot 8)a^{2+1}b^{3+7} = \boxed{80a^3b^{10}}$$

* WRONG → 9^5 (Don't multiply bases!) 6^5 (multiply all coefficients!)

Raising a Power to a Power Property → $(a^m)^n \rightarrow a^{m \cdot n} \rightarrow a^{mn}$ { If raising a power to a power, MULTIPLY exponents. }

- * When simplifying an exponential expression that are being raised to another power → SIMPLIFY the expression inside the (parentheses) before raising anything to another power

$$(5^2)^3 = 5^{2(3)} \rightarrow 5^6 \rightarrow \boxed{15,625} \quad ; \quad (x^3)^5 = x^{3(5)} \rightarrow \boxed{x^{15}} \quad ; \quad (a^3 \cdot a^4 \cdot a^{-2})^2 = (a^{3+4+(-2)})^2 \rightarrow (a^5)^2 = \boxed{a^{10}}$$

Raising a Product to a Power Property → $(ab)^n \rightarrow a^n b^n$

$$(3x)^4 = 3^{1(4)} x^{1(4)} \rightarrow 3^4 x^4 \rightarrow \boxed{81x^4} \quad ; \quad (2z^4)^3 = 2^{1(3)} z^{4(3)} \rightarrow 2^3 z^{12} \rightarrow \boxed{8z^{12}}$$

Dividing Powers with the Same Base Property → $\frac{a^m}{a^n} \rightarrow a^{m-n}$ { If dividing powers w/ same base, SUBTRACT the exponents. }
* ALWAYS Top exponent - bottom exponent *

$$\frac{3^7}{3^5} = 3^{7-5} \rightarrow 3^2 \rightarrow \boxed{9} \quad ; \quad \frac{a^{14}b^5}{a^6b} = a^{14-6}b^{5-1} \rightarrow \boxed{a^8b^4} \quad ; \quad \frac{8x^{-2}y^5z^4}{24x^2y^7z^2} \rightarrow \left(\frac{8}{24}\right)x^{-2-2}y^{5-7}z^{4-2} = \frac{1}{3}x^0y^{-2}z^2 = \frac{1}{3} \cdot 1 \cdot y^{-2}z^2 = \frac{z^2}{3y^2}$$

Raising a Quotient to a Power Property $\rightarrow \left(\frac{a}{b}\right)^n \rightarrow \frac{a^n}{b^n}$ or $\left(\frac{a}{b}\right)^{-n} \rightarrow \left(\frac{b}{a}\right)^n \rightarrow \frac{b^n}{a^n}$

$\left(\frac{1}{5}\right)^3 \Rightarrow \frac{1^3}{5^3} \rightarrow \frac{1}{125}$; $\left(\frac{x^2}{y^5}\right)^6 \Rightarrow \frac{x^{2(6)}}{y^{5(6)}} \rightarrow \frac{x^{12}}{y^{30}}$; $\left(\frac{4}{m^7}\right)^{-2} \Rightarrow \left(\frac{m^7}{4}\right)^2 \rightarrow \frac{m^{7(2)}}{4^2} \rightarrow \frac{m^{14}}{16}$

Example 1: Simplify.

a.) $3^2 x^0 y^4$ \downarrow $9(1)y^4$ \downarrow $9y^4$	b.) $4m^{-3}n^5$ <i>only this will move!</i> $\frac{4n^5}{m^3}$	c.) $\frac{8}{4c^{-3}}$ <i>This moves!</i> <i>Simplify</i> $\frac{8c^3}{4}$ \downarrow $2c^3$	d.) $\frac{6^{-2}rs^{-4}}{(-4)^{-3}}$ \downarrow $\frac{(-4)^3 r}{6^2 s^4} \rightarrow \frac{-64r}{36s^4}$ <i>simplify</i> $\frac{-16r}{9s^4}$
e.) $\frac{5^{-2}a^8b^{-1}}{c^0d^{-2}}$ \downarrow $\frac{a^8d^2}{5^2b^1} \rightarrow \frac{a^8d^2}{25b}$	f.) $\frac{7s^0t^{-5}}{2^{-1}v^2}$ \downarrow $\frac{7(1)(2)}{t^5v^2} \rightarrow \frac{14}{t^5v^2}$	g.) $c^4 \cdot d^{-3} \cdot c^2$ $\frac{c^{4+2}}{d^3} \rightarrow \frac{c^6}{d^3}$	h.) $\frac{c^{-1}d^3}{c^5d^{-4}}$ $c^{-1-5} \cdot d^{3-(-4)}$ $c^{-6}d^7 \rightarrow \frac{d^7}{c^6}$
i.) $\frac{(2a^7)(4a^2)}{6a^3}$ $\frac{(2 \cdot 4)a^{7+2}}{6a^3}$ $\frac{8a^9}{6a^3} \rightarrow \frac{8}{6}a^{9-3} \rightarrow \frac{4}{3}a^6$	j.) $\left(\frac{6m^{-4}}{2m^6}\right)^2$ $\frac{9}{m^{20}}$ $(3m^{-4-6})^2$ $(3m^{-10})^2 \rightarrow 3^2 m^{-10(2)} \rightarrow 9m^{-20}$	k.) $(-4x^5yz^2)(x^{-5}y^{-3}z)$ $(-4)x^{5+(-5)}y^{1+(-3)}z^{2+1}$ $-4x^0y^{-2}z^3$ $-4(1)y^{-2}z^3 \rightarrow \frac{-4z^3}{y^2}$	l.) $\left(\frac{2d^5}{d^2}\right)^{-4}$ $(2d^{5-2})^{-4}$ $(2d^3)^{-4} \rightarrow \frac{1}{(2d^3)^4} \rightarrow \frac{1}{2^4 d^{3(4)}} = \frac{1}{16d^{12}}$
m.) $\frac{27m^3t^6}{3m^7t^{-5}}$ $\left(\frac{27}{3}\right)m^{3-7}t^{6-(-5)}$ $9m^{-4}t^{11} \rightarrow \frac{9t^{11}}{m^4}$	n.) $\frac{6}{24 \cdot a^{-4} \cdot a^2 \cdot b^{-1}}$ $\frac{6b^1}{24a^{-4+2}} \rightarrow \frac{6b}{24a^{-2}}$ $\frac{1a^2b}{4}$	o.) $(3f^4g^{-3}f^2)^3(g^5f^2g)^{-1}$ $(3f^{4+2}g^{-3})^3(g^5f^2g)^{-1}$ $(3f^6g^{-3})^3(g^6f^2)^{-1}$ $(3^3f^{6(3)}g^{-3(3)})(g^6(-1)f^2(-1))$ $(27f^{18}g^{-9})(g^{-6}f^{-2})$ $27f^{18+(-2)}g^{-9+(-6)} \rightarrow \frac{27f^{16}}{g^{15}}$	p.) $\left(\frac{-12k^{-3}}{3k^6}\right)^{-2}$ $(-4k^{-3-6})^{-2}$ $\left(\frac{-4}{k^9}\right)^{-2} \rightarrow \left(\frac{k^9}{-4}\right)^2 \rightarrow \frac{k^{18}}{16}$

Example 2: a.) Write each expression with only positive exponents.
b.) Evaluate each expression where $m = 2$ and $t = -3$.

a.) $2m^{-3}t^4 \rightarrow \frac{2t^4}{m^3} \rightarrow \frac{2(-3)^4}{2^3}$ $\frac{162}{8} \leftarrow \frac{2(81)}{8} \leftarrow$ $\frac{81}{4}$	b.) $\frac{4^{-1}}{m^t} \rightarrow \frac{1}{4^1 m^t} \rightarrow \frac{1}{4(2)^3}$ $2 \leftarrow \frac{8}{4} \leftarrow \frac{2^3}{4} \leftarrow$	c.) $5t^{-m} \rightarrow \frac{5}{t^m} \rightarrow \frac{5}{(-3)^2}$ $\frac{5}{9}$
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