1-1 Exponent Rules

Simplify (Show why)

$x^2 \cdot x^4$

$XX \cdot XXXX = X^6$

$X^2 \cdot X^4 = X^{2+4} = X^6$

Product Rule for exponents

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

Simplify

$2^2 \cdot 2^3$

$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 2^5$

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

$3z^2 \cdot 4z^4$

$3 \cdot zz \cdot 4zzzz$

$12z^6$

$3 \cdot 4z^{2+4} = 12z^6$

You try

$(-3)^2 \cdot (-3)^3$

$(-3)^{2+3}$

$(-3)^5$

$5x^2 \cdot (-2x^5)$

$5 \cdot (-2) x^{2+5}$

$-10x^7$

Quotient Rule for exponents

$$\frac{a^m}{a^n} = a^{m-n} \quad \text{if } a \neq 0$$

Simplify

$$\frac{8^5}{8^3} = \frac{8 \cdot 8 \cdot 8 \cdot 8 \cdot 8}{8 \cdot 8 \cdot 8} = 8^{5-3} = 8^2$$

$$\frac{27z^9}{12z^4} = \frac{3 \cdot 9}{3 \cdot 4} z^{9-4} \Rightarrow \frac{9}{4} z^5$$

Simplify (Show Why)

$(3^2)^4$

$(3^2)(3^2)(3^2)(3^2)$

$3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$

3^8

$(3^2)^4 = 3^{2 \cdot 4} = 3^8$

Power rule for exponential expressions

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

Simplify

$(4^3)^5$ 4^{15}

$[(-3)^3]^2$ $(-3)^6$

$(6^3)^0$ $6^0 = 1$

Zero-exponent Rule

$$a^0 = 1 \qquad \text{if } a \neq 0$$

Simplify

$3^0 = 1$ $\pi^0 = 1$ $(\partial\theta + \Phi\Omega - \wp^{\Diamond})^0 = 1$

Negative-exponent Rule

$$a^{-n} = \frac{1}{a^n} \quad \text{or} \quad \frac{1}{a^{-n}} = a^n \qquad \text{if } a \neq 0$$

Simplify

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

$4x^{-5} = 4\left(\frac{1}{x^5}\right) = \frac{4}{x^5}$

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

Product to a power

$$(a \cdot b)^n = a^n \cdot b^n$$

Simplify

$(3z)^4$

$(3z)(3z)(3z)(3z)$

$3^4 z^4$

$(3y^{-2})^{-3}$

$3^{1 \cdot -3} y^{-2 \cdot -3}$

$3^{-3} y^6$

$(-3a^2)^2$

$(-3^1)^2 a^{2 \cdot 2}$

$3^2 a^4$

You try

$(2^2)^3$

$(2^2)^3$

2^6

$(z^3)^{-6}$

$z^{3 \cdot -6}$

z^{-18}

$(s^{-3})^{-7}$

$s^{-3 \cdot -7}$

s^{21}

You try

$(5y)^3$

$5^{1\cdot 3}y^{1\cdot 3}$

5^3y^3

$(4a^3)^{-2}$

$4^{1\cdot -2}a^{3\cdot -2}$

$4^{-2}a^{-6}$

Quotient to a power

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \quad \text{if } b \neq 0$$

$$\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n \quad \text{if } a \neq 0,\ b \neq 0$$

Simplify

$\left(\frac{w}{4}\right)^3$

$\frac{w^3}{4^3}$

$\left(\frac{2w^2}{y^3}\right)^4$

$\frac{2^4 w^{2\cdot 4}}{y^{3\cdot 4}}$

$\frac{2^4 w^8}{y^{12}}$

$\left(\frac{x}{2}\right)^{-5}$

$\left(\frac{2}{x}\right)^5$

$\frac{2^5}{x^5}$

Rules

$$a^0 = 1 \qquad \text{if } a \neq 0$$

$$a^{-n} = \frac{1}{a^n} \quad \text{or} \quad \frac{1}{a^{-n}} = a^n \qquad \text{if } a \neq 0$$

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

$$\frac{a^m}{a^n} = a^{m-n} \quad \text{if } a \neq 0$$

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

$$(a \cdot b)^n = a^n \cdot b^n$$

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \quad \text{if } b \neq 0$$

$$\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n \quad \text{if } a \neq 0,\ b \neq 0$$