Algebra

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Number Rules

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$$a \cdot 0 = 0 \qquad\qquad 1 \cdot a = a$$

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Expand Rules

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$$-(a \pm b) = -a \pm b \qquad\qquad a(b + c) = ab + ac$$

$$a(b + c)(d + e) = abd + abe + acd + ace \qquad\qquad (a + b)(c + d) = ac + ad + bc + bd$$

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Fractions Rules

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$$\frac{0}{a} = 0, \quad a \neq 0 \qquad\qquad \frac{a}{1} = a$$

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

$$\left(\frac{a}{b}\right)^{-c} = \left(\left(\frac{a}{b}\right)^{-1}\right)^{c} = \left(\frac{b}{a}\right)^{c} \qquad\qquad a^{-1} = \frac{1}{a}$$

$$a^{-b} = \frac{1}{a^b} \qquad\qquad \frac{-a}{-b} = \frac{a}{b}$$

$$\frac{-a}{b} = -\frac{a}{b} \qquad\qquad \frac{a}{-b} = -\frac{a}{b}$$

$$\frac{\frac{a}{b}}{c} = \frac{a \cdot c}{b} \qquad\qquad \frac{\frac{b}{c}}{a} = \frac{b}{c \cdot a}$$

$$\frac{\frac{1}{b}}{c} = \frac{c}{b}$$

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Absolute Rules

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$$|-a| = |a| \qquad\qquad |a| = a, \quad a \geq 0$$

$$|ax| = a|x|, \quad a \geq 0$$

Exponent Rules

$1^a = 1$ $\qquad\qquad$ $a^1 = a$

$a^0 = 1, \quad a \neq 0$ $\qquad\qquad$ $0^a = 0, \quad a \neq 0$

$(ab)^n = a^n b^n$ $\qquad\qquad$ $\frac{a^m}{a^n} = a^{m-n}, \quad m > n$

$\frac{a^m}{a^n} = \frac{1}{a^{n-m}}, \quad n > m$ $\qquad\qquad$ $a^{b+c} = a^b a^c$

$(a^b)^c = a^{b \cdot c}$ $\qquad\qquad$ $a^{bx} = (a^b)^x$

$\left(\frac{a}{b}\right)^c = \frac{a^c}{b^c}$ $\qquad\qquad$ $a^c \cdot b^c = (a \cdot b)^c$

Radical Rules

$\sqrt{1} = 1$ $\qquad\qquad$ $\sqrt{0} = 0$

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

$\sqrt{n}\sqrt{a} = a$ $\qquad\qquad$ $\sqrt[n]{a^a} = a, \quad a \geq 0$

$\sqrt[n]{n} = |a|, \quad n \text{ is even}$ $\qquad\qquad$ $\sqrt[n]{a^n} = a, \quad n \text{ is odd}$

$\sqrt[n]{ab} = \sqrt[n]{a}\,\sqrt[n]{b}, \quad a, b \geq 0$ $\qquad\qquad$ $\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}, \quad a, b \geq 0$

Factor Rules

$$x^2 - y^2 = (x - y)(x + y)$$
$$x^3 + y^3 = (x + y)(x^2 - xy + y^2)$$
$$x^n - y^n = (x + y)(x^{n-1} + x^{n-2}y + \ldots + xy^{n-2} + y^{n-1})$$
$$x^n + y^n = (x + y)(x^{n-1} + x^{n-2}y + \ldots + xy^{n-2} + y^{n-1}), \quad n \text{ is odd}$$
$$ax^{(2n)} - b = (\sqrt{a}x^n + \sqrt{b})(\sqrt{a}x^n - \sqrt{b})$$
$$ax^{(4)} - b = (\sqrt{a}x^n + \sqrt{b})(\sqrt{a}x^2 - \sqrt{b})$$
$$ax^{(2n)} - by^{(2m)} = (\sqrt{a}x^n + \sqrt{b}y^m)(\sqrt{a}x^n - \sqrt{b}y^m)$$
$$ax^{(4)} - by^{(4)} = (\sqrt{a}x^2 + \sqrt{b}y^2)(\sqrt{a}x^2 - \sqrt{b}y^2)$$

Factorial Rules

$\frac{n!}{(n+m)!} = \frac{1}{(n+1) \cdot (n+2) \cdots (n+m)}$ $\qquad\qquad$ $\frac{n!}{(n-m)!} = n \cdot (n-1) \cdot (n-2) \cdots (n - m + 1), \quad n > m$

$0! = 1$ $\qquad\qquad$ $n! = 1 \cdot 2 \cdots (n-2) \cdot (n-1) \cdot n$

Logarithmic Rules

$\log(0) = -\infty$

$\log(1) = 0$

$\log_a(a) = 1$

$\log_a(x^b) = b \cdot \log_a(x)$

$\log_{a^b}(x) = \frac{1}{b}\log_a(x)$

$\log_a(\frac{1}{x}) = -\log_a(x)$

$\log_{\frac{1}{a}}(x) = -\log_a(x)$

$\log_{x^n}(x) = \frac{1}{n}$

$\log_e(x) = \ln(x)$

$\log_a(b) = \frac{\ln(b)}{\ln(a)}$

$\log_x((\frac{1}{x})^n) = -n$

$\log_x(x^n) = n$

$a^{\log_a(b)} = b$

Undefined

$0^0 = $ undefined

$\frac{x}{0} = $ Undefined

$\log_a(b) = $ Undefined, $\quad a \leq 0$

$\log_a(b) = $ Undefined, $\quad b \leq 0$

$\log_1(a)$ Undefined

Complex Number Rules

$i^2 = -1$

$\sqrt{-1} = i$

$\sqrt{-a} = \sqrt{-1}\sqrt{a}$