Algebra Cheat Sheet

Arithmetic Properties

Let $a, b, c \in \mathbb{R}$.

- **Commutative:** $a + b = b + a$, $ab = ba$
- **Associative:** $a + (b + c) = (a + b) + c$
- **Distributive:** $a(b + c) = ab + ac$

Exponents & Radicals

$$\begin{aligned} a^m a^n &= a^{m+n} \\ \frac{a^m}{a^n} &= a^{m-n} \\ (a^m)^n &= a^{mn} \\ (ab)^m &= a^m b^m \\ a^{-n} &= \frac{1}{a^n} \\ \sqrt[n]{ab} &= \sqrt[n]{a}\,\sqrt[n]{b} \end{aligned}$$

Quadratic Equation

For $ax^2 + bx + c = 0$ (where $a \neq 0$):

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Discriminant $\Delta = b^2 - 4ac$:

- $\Delta > 0$: 2 real roots
- $\Delta = 0$: 1 real root
- $\Delta < 0$: 2 complex roots

Logarithms

$$\begin{aligned} \log_b(xy) &= \log_b(x) + \log_b(y) \\ \log_b(\frac{x}{y}) &= \log_b(x) - \log_b(y) \\ \log_b(x^k) &= k \log_b(x) \\ \log_b(x) &= \frac{\ln(x)}{\ln(b)} \end{aligned}$$

Factoring Formulas

$$\begin{aligned} x^2 - y^2 &= (x - y)(x + y) \\ (x \pm y)^2 &= x^2 \pm 2xy + y^2 \\ x^3 \pm y^3 &= (x \pm y)(x^2 \mp xy + y^2) \\ (x \pm y)^3 &= x^3 \pm 3x^2 y + 3xy^2 \pm y^3 \end{aligned}$$