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Algebra Master Cheat Sheet

1. Exponents and Logarithms

Exponent Rules:

$$a^m \cdot a^n = a^{m+n} \quad \frac{a^m}{a^n} = a^{m-n}$$

$$(a^m)^n = a^{mn} \quad (ab)^n = a^n b^n$$

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

Logarithm Properties:

$$\log_b(xy) = \log_b x + \log_b y$$

$$\log_b\left(\frac{x}{y}\right) = \log_b x - \log_b y$$

$$\log_b(x^k) = k \log_b x$$

$$\log_b x = \frac{\log_a x}{\log_a b} \quad (\text{Change of Base})$$

2. Polynomials and Factoring

Special Products:

$$(a \pm b)^2 = a^2 \pm 2ab + b^2$$

$$a^2 - b^2 = (a - b)(a + b)$$

$$a^3 \pm b^3 = (a \pm b)(a^2 \mp ab + b^2)$$

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

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

Discriminant ($\Delta = b^2 - 4ac$): * $\Delta > 0$: Two distinct real roots. * $\Delta = 0$: One repeated real root. * $\Delta < 0$: Two complex conjugate roots.

3. Sequences and Series

Arithmetic Sequence:

$$a_n = a_1 + (n - 1)d$$

$$S_n = \frac{n}{2} (2a_1 + (n - 1)d) = \frac{n}{2} (a_1 + a_n)$$

Geometric Sequence:

$$a_n = a_1 r^{n-1}$$

$$S_n = a_1 \frac{1 - r^n}{1 - r} \quad (r \neq 1)$$

Infinite sum ($|r| < 1$):

$$S_\infty = \frac{a_1}{1 - r}$$

4. Complex Numbers

Let $z = a + bi$, where $i^2 = -1$. * **Conjugate:**

$\bar{z} = a - bi$ * **Magnitude/Modulus:** $|z| = \sqrt{a^2 + b^2}$

* **Euler's Formula:** $e^{i\theta} = \cos \theta + i \sin \theta$

5. Inequalities and Absolute Value

* $|x| < c \iff -c < x < c$ * $|x| > c \iff x > c$ or $x < -c$ * **Triangle Inequality:** $|a + b| \leq |a| + |b|$

6. Binomial Theorem

$$(a + b)^n = \sum_{k=0}^n \binom{n}{k} a^{n-k} b^k$$

where the binomial coefficient is defined as:

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$