

1. Exponents and Logarithms

$$\begin{aligned}
 a^m \cdot a^n &= a^{m+n} & \log_b(xy) &= \log_b x + \log_b y \\
 \frac{a^m}{a^n} &= a^{m-n} & \log_b\left(\frac{x}{y}\right) &= \log_b x - \log_b y \\
 (a^m)^n &= a^{mn} & \log_b(x^k) &= k \log_b x \\
 a^{-m} &= \frac{1}{a^m} & \log_b x &= \frac{\log_c x}{\log_c b}
 \end{aligned}$$

2. Quadratic Equations

For $ax^2 + bx + c = 0$, the roots are given by the quadratic formula:

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

* **Discriminant (Δ):** $\Delta = b^2 - 4ac$ * $\Delta > 0$: Two distinct real roots. * $\Delta = 0$: One repeated real root. * $\Delta < 0$: Two complex conjugate roots.
 * **Vieta's Formulas:** Sum of roots: $r_1 + r_2 = -\frac{b}{a}$, Product of roots: $r_1 r_2 = \frac{c}{a}$.

3. Polynomials and Binomial Theorem

* **Binomial Expansion:**

$$(x + y)^n = \sum_{k=0}^n \binom{n}{k} x^{n-k} y^k$$

* **General Term (r -th term):**

$$T_{r+1} = \binom{n}{r} x^{n-r} y^r$$

* **Sum of Cubes / Squares:**

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

4. Sequences and Series

* **Arithmetic Progression (AP):**

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

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

* **Geometric Progression (GP):**

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

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

Sum to infinity ($|r| < 1$):

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

5. Complex Numbers

Let $z = x + iy = r(\cos \theta + i \sin \theta) = re^{i\theta}$.

* **Magnitude:** $|z| = \sqrt{x^2 + y^2}$ * **Conjugate:** $\bar{z} = x - iy$ * **De Moivre's Theorem:**

$$(r(\cos \theta + i \sin \theta))^n = r^n(\cos(n\theta) + i \sin(n\theta))$$

6. Matrices and Determinants

For a 2×2 matrix $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$:

* **Determinant:**

$$\det(A) = ad - bc$$

* **Inverse Matrix:**

$$A^{-1} = \frac{1}{ad - bc} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$