SAT & PSAT Must-Know Math Formulas
LOTLOUISCHO STEM CLUB

1. Algebra – Linear Equations and Functions

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{(Slope formula)}$$

$$y = mx + b \quad \text{(Slope-intercept form)}$$

$$y - y_1 = m(x - x_1) \quad \text{(Point-slope form)}$$

$$y_1 = m_1 x + b_1$$
$$y_2 = m_2 x + b_2$$

$m_1 = m_2$ **for parallel lines**, $\quad m_1 \cdot m_2 = -1$ **for perpendicular lines.**

Average rate of change between (a,f(a)) and (b, f(b)): $\frac{f(b) - f(a)}{b - a}$

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2. Quadratics and Polynomials

$$y = ax^2 + bx + c \quad \text{(Standard form)}$$
$$y = a(x - h)^2 + k \quad \text{(Vertex form, vertex} = (h, k))$$
$$y = a(x - r_1)(x - r_2) \quad \text{(Factored form, roots } r_1, r_2)$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{(Quadratic formula)}$$
$$b^2 - 4ac > 0 \textbf{ TWO Real Solutions}$$
$$b^2 - 4ac = 0 \textbf{ ONE Real Solution}$$
$$b^2 - 4ac < 0 \textbf{ NO Real Solutions}$$
$$\textbf{Sum of solutions } = \frac{-b}{a}, \textbf{ Product of Solutions } = \frac{c}{a}$$
$$a^2 + 2ab + b^2 = (a + b)^2, a^2 - 2ab + b^2 = (a - b)^2, \quad a^2 - b^2 = (a - b)(a + b)$$

Explanation of determining the minimum/maximum of $y = ax^2 + bx + c$

$$y = ax^2 + bx + c \tag{1}$$
$$\frac{dy}{dx} = 2ax + b \tag{2}$$
$$\textbf{Let } \frac{dy}{dx} = 0 \tag{3}$$
$$\frac{dy}{dx} = 2ax + b = 0 \tag{4}$$
$$2ax = -b \tag{5}$$
$$x = \frac{-b}{2a} \tag{6}$$

Thus the minimum/maximum of $f(x) = ax^2 + bx + c$ is at $(\frac{-b}{2a}, f(\frac{-b}{2a}))$.

3. Exponential and Radical Functions

$$y = a(1 \pm r)^t \quad \text{(Growth/decay model)}$$
$$A = P\Big(1 + \frac{r}{n}\Big)^{nt} \quad \text{(Compound interest)}$$
$$A = Pe^{rt} \quad \text{(Continuous growth/decay)}$$
$$a^m \cdot a^n = a^{m+n}, \quad \frac{a^m}{a^n} = a^{m-n}, \quad a^{1/n} = \sqrt[n]{a}, \quad a^{m/n} = \sqrt[n]{a^m}$$

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4. Geometry – Plane Figures

$$A_{\triangle} = \frac{1}{2}bh, \quad A_{\text{circle}} = \pi r^2, \quad C = 2\pi r$$
$$A_{\text{rect}} = bh, \quad A_{\text{trap}} = \frac{1}{2}(b_1 + b_2)h$$
$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}, \quad M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$
$$a^2 + b^2 = c^2 \quad \text{(Pythagorean theorem)}$$
$$\text{45-45-90 triangle: } x, x, x\sqrt{2}; \quad \text{30-60-90: } x, x\sqrt{3}, 2x$$
$$s = \frac{\theta}{360}(2\pi r), \quad A_{\text{sector}} = \frac{\theta}{360}(\pi r^2)$$

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5. Solid Geometry

$$V_{\text{rect prism}} = lwh, \quad V_{\text{cyl}} = \pi r^2 h$$
$$V_{\text{cone}} = \frac{1}{3}\pi r^2 h, \quad V_{\text{sphere}} = \frac{4}{3}\pi r^3$$
$$A_{\text{sphere}} = 4\pi r^2$$

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6. Statistics and Data

$$\bar{x} = \frac{\text{sum of data}}{\text{number of data points}} \quad \text{(Mean)}$$

Median = middle value, Mode = most frequent value, Range = Max - Min

$$\text{Line of best fit: } y = mx + b, \quad \text{Percent change: } \frac{\text{new} - \text{old}}{\text{old}} \times 100\%$$

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7. Probability and Counting

$$P = \frac{\text{favorable outcomes}}{\text{total outcomes}}$$
$$P(A \cap B) = P(A)P(B) \text{ (independent)}, \quad P(A \cup B) = P(A) + P(B) \text{ (mutually exclusive)}$$
$${}_nC_r = \frac{n!}{r!(n-r)!}, \quad {}_nP_r = \frac{n!}{(n-r)!}$$

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8. Conversions and Constants

$$1 \text{ in} = 2.54 \text{ cm}, \quad 1 \text{ ft} = 12 \text{ in}, \quad 1 \text{ yd} = 3 \text{ ft}$$
$$\pi \approx 3.1416, \quad e \approx 2.718$$

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Bonus: Quick Test Tips

- Memorize special right triangle ratios.
- Know how to use the built-in Desmos calculator efficiently.
- Check units for geometry problems.
- For variables, plug in easy numbers.
- Estimate magnitude to spot unreasonable answers.