SAT & PSAT Must-Know Math Formulas
LOTLOUISCHO STEM CLUB

1 Algebra – Linear Equations and Functions

y: Function or Graph
m: Slope
x: Variable
b: Y-Intercept

NOTE: X-intercept means when $y = 0$. Y-intercept means $x = 0$.

Standard Form $Ax + By = C$
Slope $= -\frac{A}{B}$
Slope m $= \frac{y_2 - y_1}{x_2 - x_1}$
Slope-Intercept Form: $y = mx + b$
Point-slope Form: $y - y_1 = m(x - x_1)$

Average rate of change between (a,f(a)) and (b, f(b)) can be determined by

$$m = \frac{f(b) - f(a)}{b - a}$$

Let's say we have two lines $y_1 = m_1 x + b_1$ and $y_2 = m_2 x + b_2$. We can say that:

$m_1 = m_2$ **PARALLEL LINES (SAME SLOPE)**
$m_1 \cdot m_2 = -1$ **PERPENDICULAR LINES**

When you are given something like this:

$$ax + by = c_1$$
$$ax + by = c_2$$

If $c_1 = c_2$, then there are infinite many solutions. If $c_1 \neq c_2$, then there are no solutions to the system of linear equations above.

Distance a vehicle or a person travels can be determined by

$$\textbf{Distance} = \textbf{Velocity} \times \textbf{Time}$$

The distance d between two points (x_1, y_1) and (x_2, y_2) can be computed by

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

and the midpoint M between two points can be determined by

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

2   Exponent Rules

Be aware of MADSPM or in other words Mad Steve Pours Milkshake. What does this mean and what do we do with the exponents?

Multiplying Exponents mean **ADD**
Dividing Exponents mean **SUBTRACT**
Powering Exponents mean **MULTIPLY**

$$a^m \cdot a^n = a^{m+n}$$
$$\frac{a^m}{a^n} = a^{m-n}$$
$$(a^m)^n = a^{m \cdot n}$$
$$(ab)^m = a^m \cdot b^m$$
$$a^{-m} = \frac{1}{a^m}$$
$$a^{1/n} = \sqrt[n]{a}$$
$$a^{m/n} = \sqrt[n]{a^m}$$
$$\sqrt{a} \cdot \sqrt{b} = \sqrt{ab}$$

3   Quadratics and Polynomials

$$y = ax^2 + bx + c \quad \text{(Standard form)}$$

$$y = a(x - h)^2 + k \quad \text{(Vertex form, vertex} = (h, k))$$

$$y = a(x - r_1)(x - r_2) \quad \text{(Factored form, roots } r_1, r_2)$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{(Quadratic formula)}$$

NOTE: These kind of questions shown below **ALWAYS** appear on the exam!

$$b^2 - 4ac > 0 \text{ **TWO** Real Solutions}$$

$$b^2 - 4ac = 0 \text{ **ONE** Real Solution}$$

$$b^2 - 4ac < 0 \text{ **NO** Real Solutions}$$

Sum of solutions $= \dfrac{-b}{a}$, **Product of Solutions** $= \dfrac{c}{a}$

4   Factoring

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

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 $\left(\frac{-b}{2a}, f\left(\frac{-b}{2a}\right)\right)$.

5 Exponential and Radical Functions

$$y_0: \text{ Initial value}$$
$$b: \text{ Growth/Decay Factor}$$
$$t: \text{ Time}$$
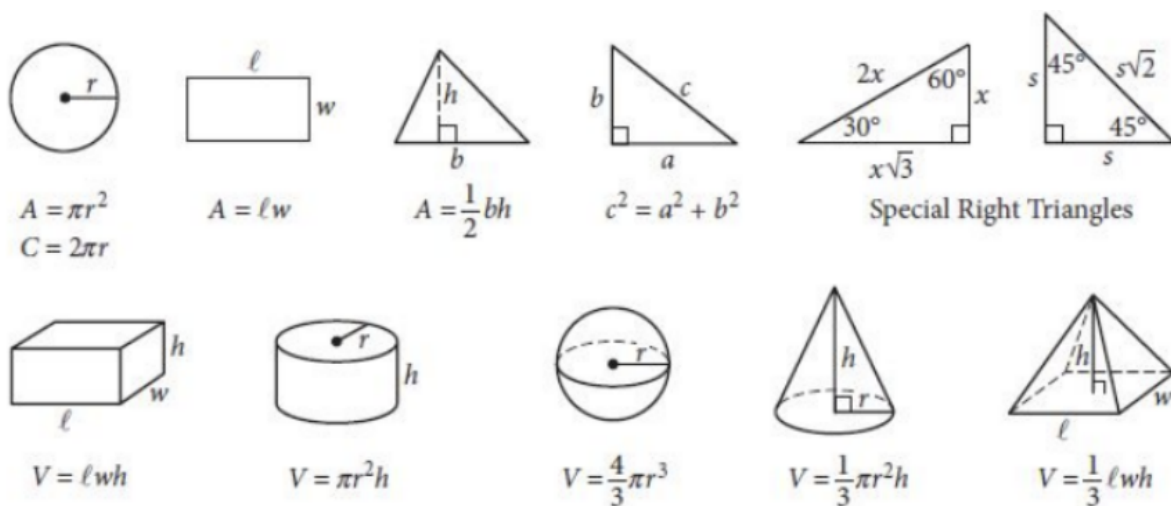$$r: \text{ Rate}$$
$$n: \text{ Time period}$$

$$y = y_0 b^t$$

$$y = y_0(1 \pm r)^t \quad \text{(Growth/decay model)}$$

$$A = P\left(1 + \frac{r}{n}\right)^{nt} \quad \text{(Compound interest)}$$

$$A = Pe^{rt} \quad \text{(Continuous growth/decay)}$$

6   Geometry – Plane Figures

$A = \pi r^2$ $A = \ell w$ $A = \frac{1}{2} bh$ $c^2 = a^2 + b^2$ Special Right Triangles
$C = 2\pi r$

$V = \ell wh$ $V = \pi r^2 h$ $V = \frac{4}{3}\pi r^3$ $V = \frac{1}{3}\pi r^2 h$ $V = \frac{1}{3}\ell wh$

The number of degrees of arc in a circle is 360.
The number of radians of arc in a circle is 2π.
The sum of the measures in degrees of the angles of a triangle is 180.

Figure 1: Geometry Formulas from College Board

$$A_\triangle = \frac{1}{2}bh, \quad A_{\text{circle}} = \pi r^2, \quad C = 2\pi r$$

$$A_{\text{rect}} = bh, \quad A_{\text{trap}} = \frac{1}{2}(b_1 + b_2)h$$

$$a^2 + b^2 = c^2 \quad \text{(Pythagorean theorem)}$$

45-45-90 triangle: $x, x, x\sqrt{2}$;   30-60-90: $x, x\sqrt{3}, 2x$

$$s = \frac{\theta}{360}(2\pi r), \quad A_{\text{sector}} = \frac{\theta}{360}(\pi r^2)$$

7   Solid Geometry

$$V_{\text{rect prism}} = lwh, \quad V_{\text{cyl}} = \pi r^2 h$$

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

$$A_{\text{sphere}} = 4\pi r^2$$

4

8 Statistics and Data

$$\text{Mean (Average) } \mu = \frac{\text{Sum of Data}}{\text{Number of Data Points}}$$
$$\text{Median} = \text{Middle value}$$
$$\text{Mode} = \text{Most Frequent Value}$$
$$\text{Range R} = \text{Max - Min}$$
$$\text{Standard Deviation } \sigma = \text{Spread of data and how far apart from mean value}$$
$$\text{Line of best fit:} \quad y = mx + b$$
$$\text{Percent} = \frac{Part}{Whole} \times 100$$
$$\text{Percent change:} \quad \frac{\text{new}-\text{old}}{\text{old}} \times 100\%$$

9 Probability and Counting

$$\text{P} = \frac{\text{favorable outcomes}}{\text{total outcomes}}$$
$$P(A \cap B) = P(A)P(B) \textbf{ (Independent Events)}$$
$$P(A \cup B) = P(A) + P(B) \textbf{ (Mutually Exclusive Events)}$$

10 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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11 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.