# 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 $y_1 = m_1x + b_1$ and $y_2 = m_2x + b_2$. 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 & Radicals

**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**

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

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

$$y = y_0 b^t$$
$$y = y_0(1 \pm r)^t \quad \text{(Growth/decay model)}$$
$$A = P\left(1 + \frac{r}{n}\right)^{nt} \quad \text{(Compound interest)}$$
$$A = Pe^{rt} \quad \text{(Continuous growth/decay)}$$

## 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!**

$b^2 - 4ac > 0$ **TWO Real Solutions**

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

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

$$\textbf{Sum of solutions } = \frac{-b}{a}, \textbf{ Product of Solutions } = \frac{c}{a}$$

**DISCLAIMER: If you are currently enrolled in AP Calculus, then you will know what this part is about. For those of you not enrolled in AP Calculus, this is a quick shortcut to determine the minimum or the maximum points on the quadratic equation $y = ax^2 + bx + c$.**

$$\begin{gathered} y = ax^2 + bx + c \\ \tfrac{dy}{dx} = 2ax + b \\ \tfrac{dy}{dx} = 0 \\ \tfrac{dy}{dx} = 2ax + b = 0 \\ 2ax = -b \\ x = -\tfrac{b}{2a} \end{gathered}$$

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

# 4 Factoring

$$\begin{gathered} a^2 + 2ab + b^2 = (a + b)^2 \\ a^2 - 2ab + b^2 = (a - b)^2 \\ a^2 - b^2 = (a - b)(a + b) \end{gathered}$$

# 5 Complex Numbers

The canonical form for complex numbers is $a + bi$ where $a$ is the real number and $b$ is in the imaginary axis. The patterns shown below will repeat after four cycles.

$$\begin{gathered} i = \sqrt{-1} \\ i^2 = -1 \\ i^3 = -i \\ i^4 = 1 \end{gathered}$$

Now look what happens after we pass $i^4$:

$$\begin{gathered} i^5 = \sqrt{-1} \\ i^6 = -1 \\ i^7 = -i \\ i^8 = 1 \end{gathered}$$

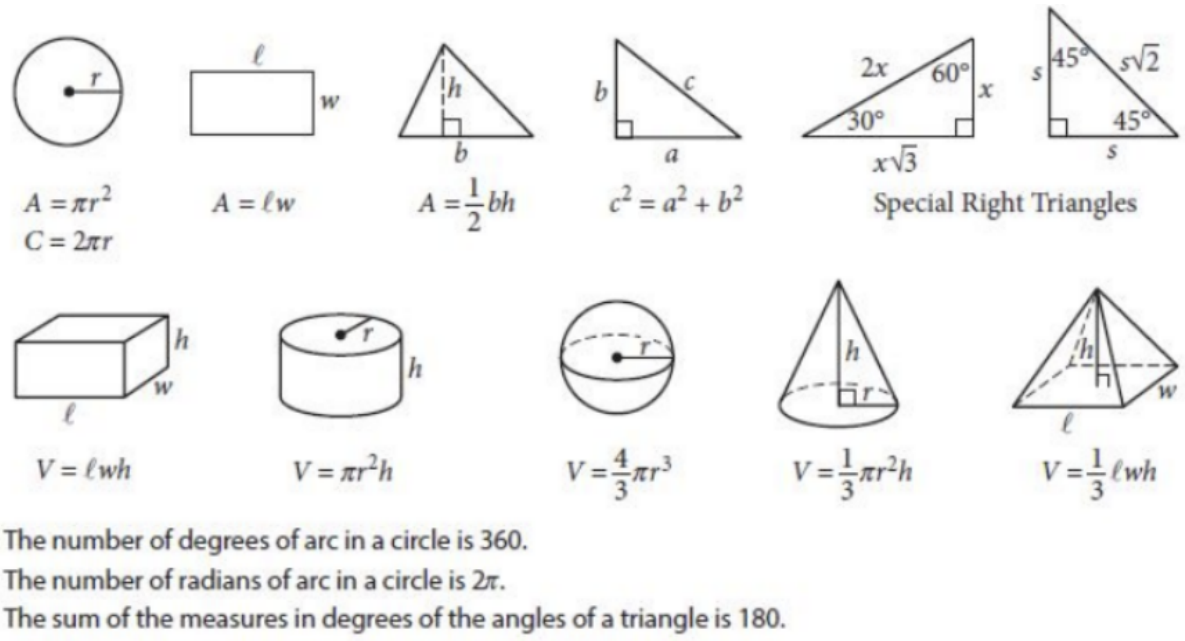
# 6 Geometry

## 6.1 Triangle Theorems

The inequality theorem states that when you have sides $a$, $b$ and $c$, then $a + b > c$.

Equilateral Triangle: ALL sides are EQUAL
Isosceles Triangle: Two sides are EQUAL
Scalene Triangle: ALL unequal sides
Acute angle means less than 90°
Right angle means 90°
Obtuse angle means greater than 90°

## 6.2 Shapes




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

Figure 1: Geometry Formulas from Official College Board SAT and PSAT Exams.

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

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

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

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

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

# 8 Statistics and Data

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

# 9 Probability and Counting

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

# 10 Conversions and Constants

1 in = 2.54 cm, 1 ft = 12 in, 1 yd = 3 ft

$\pi \approx 3.1416, \quad e \approx 2.718$

—

# 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.