

SAT II Math Formula Reference

MATH LEVEL IIC 1.3ver

CHAPTER 1 INTRODUCTION TO FUNCTIONS

$$(f+g)(x)=f(x)+g(x)$$

$$(f \cdot g)(x)=f(x) \cdot g(x)$$

$$(f/g)(x)=f(x)/g(x)$$

$$(f \circ g)(x)=f(x) \circ g(x)=f(g(x))$$

CHAPTER 2 POLYNOMIAL FUNCTIONS**Linear Functions**

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

$$\text{Distance}=\frac{|Ax_1+By_1+C|}{\sqrt{A^2+B^2}}$$

$$\tan \theta = \frac{m_1 - m_2}{1 + m_1 m_2} \quad (\text{m is the slope of l.})$$

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

$$\text{Sum of zeros (roots)} = -\frac{b}{a}$$

$$\text{Product of zeros (roots)} = \frac{c}{a}$$

CHAPTER 3 TRIGONOMETRIC FUNCTIONS**Graphs:**

$$y = A \bullet f(Bx + C)$$

$$\left\{ \begin{array}{l} |A| \text{ is the amplitude} \\ \frac{f}{B} \text{ is the period of the graph} \\ -\frac{C}{B} \text{ is the phase shift} \end{array} \right.$$

$$\sin \theta \bullet \csc \theta = 1$$

$$\cos \theta \bullet \sec \theta = 1$$

$$\tan \theta \bullet \cot \theta = 1$$

$$\tan \theta = \frac{\sin \theta}{\cos \theta}$$

$$\cot \theta = \frac{\cos \theta}{\sin \theta}$$

Quadrant	I	II	III	IV
Function: sin, csc	+	+	-	-
cos, sec	+	-	-	+
tan, cot	+	-	+	-

Arcs and Angles

$$s = r\theta$$

$$A = \frac{1}{2}r^2\theta$$

Special Angles

	0	$\frac{\pi}{2}$	π	$\frac{3\pi}{2}$	2
sine	0	1	0	-1	0
cosine	1	0	-1	0	1
tangent	0	und	0	und	0
cotangent	und	0	und	0	und
secant	1	und	-1	und	1
cosecant	und	1	und	-1	und

*und: means that the function is undefined because the definition of the function necessitates division by zero.

	$\frac{\pi}{6}$ or 30°	$\frac{\pi}{4}$ or 45°	$\frac{\pi}{3}$ or 60°
sine	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$
cosine	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$
tangent	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$
cotangent	$\sqrt{3}$	1	$\frac{\sqrt{3}}{2}$

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secant	$\frac{2\sqrt{3}}{3}$	$\sqrt{2}$	2
cosecant	2	$\sqrt{2}$	$\frac{2\sqrt{3}}{3}$

Formulas:

1. $\sin^2 x + \cos^2 x = 1$

2. $\tan^2 x + 1 = \sec^2 x$

3. $\cot^2 x + 1 = \csc^2 x$

4. $\sin(A + B) = \sin A \bullet \cos B + \cos A \bullet \sin B$

5. $\sin(A - B) = \sin A \bullet \cos B - \cos A \bullet \sin B$

6. $\cos(A + B) = \cos A \bullet \cos B - \sin A \bullet \sin B$

7. $\cos(A - B) = \cos A \bullet \cos B + \sin A \bullet \sin B$

8. $\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A \bullet \tan B}$

9. $\tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A \bullet \tan B}$

10. $\sin 2A = 2 \sin A \cos A$

11. $\cos 2A = \cos^2 A - \sin^2 A$

12. $\cos 2A = 2 \cos^2 A - 1$

13. $\cos 2A = 1 - 2 \sin^2 A$

14. $\tan 2A = \frac{2 \tan A}{1 - \tan^2 A}$

15. $\sin \frac{1}{2} A = \pm \sqrt{\frac{1 - \cos A}{2}}$

16. $\cos \frac{1}{2} A = \pm \sqrt{\frac{1 + \cos A}{2}}$

17. $\tan \frac{1}{2} A = \pm \sqrt{\frac{1 - \cos A}{1 + \cos A}}$

18. $= \frac{1 - \cos A}{\sin A}$

19. $= \frac{\sin A}{1 + \cos A}$

*The correct sign for Formulas 15 through 17 is determined by the quadrant in which angle $\frac{1}{2} A$ lies.

Triangles

Law of sines: $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Law of cosines: $b^2 = a^2 + c^2 - 2ac \cos B$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$\text{Area} = \frac{1}{2} bc \sin A$$

Area of a Δ : $\text{Area} = \frac{1}{2} ac \sin B$

$$\text{Area} = \frac{1}{2} ab \sin C$$

CHAPTER 4 MISCELLANEOUS RELATIONS AND FUNCTIONS

The general quadratic equation

$$Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$$

If $B^2 - 4AC < 0$ and $A = C$, the graph is a circle.

If $B^2 - 4AC < 0$ and $A \neq C$, the graph is an ellipse.

If $B^2 - 4AC = 0$, the graph is a parabola.

If $B^2 - 4AC > 0$, the graph is a hyperbola.

Circle:

$$(x - h)^2 + (y - k)^2 = r^2$$

Ellipse:

if $C > A$, $\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$, transverse axis horizontal

if $C < A$, $\frac{(x - h)^2}{b^2} + \frac{(y - k)^2}{a^2} = 1$, transverse axis vertical, where $a^2 = b^2 + c^2$

Vertices: $\pm a$ units along major axis from center

Foci: $\pm c$ units along major axis from center

Length=2b

Eccentricity = $\frac{c}{a} < 1$

Length of latus rectum = $\frac{2b^2}{a}$

Parabola:

if $C=0$, $(x - h)^2 = 4p(y - k)$ opens up and down---axis of symmetry is vertical

if $A=0$, $(y-k)^2 = 4p(x-h)$ opens to the side---axis of symmetry is horizontal

Equation of axis of symmetry:

$x=h$ if vertical

$y=k$ if horizontal

Focus: p units along the axis of symmetry from vertex

Equation of directrix:

$y=-p$ if axis of symmetry is vertical

$x=-p$ if axis of symmetry is horizontal

$$\text{Eccentricity} = \frac{c}{a} = 1$$

Length of latus rectum $= 4p$

Hyperbola:

$$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1, \text{ transverse axis horizontal}$$

$$\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1, \text{ transverse axis vertical, where } c^2 = a^2 + b^2$$

Vertices: $\pm a$ units along the transverse axis from center

Foci: $\pm c$ units along the transverse from center

$$\text{Length of latus rectum} = \frac{2b^2}{a}$$

$$\text{Eccentricity} = \frac{c}{a} > 1$$

the slopes of the asymptotes are $\pm \frac{a}{b}$ (vertical) or $\pm \frac{b}{a}$ (horizontal).

Exponential and Logarithmic Functions

$$x^a \bullet x^b = x^{a+b}$$

$$x^0 = 1$$

$$\frac{x^a}{x^b} = x^{a-b}$$

$$x^{-a} = \frac{1}{x^a}$$

$$(x^a)^b = x^{ab}$$

$$x^a \bullet y^a = (xy)^a$$

$$\log_b(p \bullet q) = \log_b p + \log_b q$$

$$\log_b 1 = 0$$

$$b^{\log_b p} = p$$

$$\log_b \left(\frac{p}{q} \right) = \log_b p - \log_b q$$

$$\log_b b = 1$$

$$\log_b(p^x) = x \bullet \log_b p$$

$$\log_b p = \frac{\log_a p}{\log_a b}$$

Greatest Integer Functions:

$$[x] = i, \text{ where } i \text{ is an integer and } i \leq x < i + 1$$

Polar Coordinates:

$$x = r \bullet \cos \theta$$

$$y = r \bullet \sin \theta$$

$$x^2 + y^2 = r^2$$

De Moivre's Thorem:

$$z_1 = x_1 + y_1 i = r_1 (\cos \theta_1 + i \bullet \sin \theta_1) = r_1 \text{cis} \theta_1$$

and

$$z_2 = x_2 + y_2 i = r_2 (\cos \theta_2 + i \bullet \sin \theta_2) = r_2 \text{cis} \theta_2 :$$

$$1. z_1 \bullet z_2 = r_1 \bullet r_2 [\cos(\theta_1 + \theta_2) + i \bullet \sin(\theta_1 + \theta_2)]$$

$$\text{If } 2. \frac{z_1}{z_2} = \frac{r_1}{r_2} [\cos(\theta_1 - \theta_2) + i \bullet \sin(\theta_1 - \theta_2)]$$

$$3. z^n = r^n (\cos n\theta_2 + i \bullet \sin n\theta_2) = r^n \text{cis} n\theta$$

$$4. z^{1/n} = r^{1/n} \left(\cos \frac{\theta + 2\pi k}{n} + i \sin \frac{\theta + 2\pi k}{n} \right) = r^{1/n} \text{cis} \frac{\theta + 2\pi k}{n}$$

where k is an integer taking on values from 0 to n-1.

CHAPTER 5 MISCELLANEOUS TOPICS

$$n! = n(n-1)(n-2)...3 \bullet 2 \bullet 1$$

Permutations:

Circular permutation (e.g., around a table) of n elements = $(n-1)!$

Circular permutation (e.g., beads on a bracelet) of n elements = $\frac{(n-1)!}{2}$

Permutations of n elements with a repetitions and with b repetitions = $\frac{n!}{a!b!}$

$${}_nP_r = \frac{n!}{(n-r)!}$$

$$\binom{n}{r} = \frac{{}_nP_r}{r!} = \frac{\text{the product of the largest r factors of n!}}{r!}$$

The number of combinations of n things taken r at a time is denoted by ${}_nC_r$ or C(n,r) or $\binom{n}{r}$.

$$\binom{n}{r} = \binom{n}{n-r}$$

Binomial Theorem:

$$T_{r+1} = {}_nC_r a^{n-r} b^r$$

Probability:

Independent events: $P(A \cap B) = P(A) \cdot P(B)$

Mutually exclusive events: $P(A \cap B) = 0$
and $P(A \cup B) = P(A) + P(B)$

Sequences and Series

In general, an arithmetic sequence is denoted by

$$t_1, t_1 + d, t_1 + 2d, t_1 + 3d, \dots, t_1 + (n-1)d$$

$$S_n = \frac{n}{2}(t_1 + t_n)$$

or

$$S_n = \frac{n}{2}[2t_1 + (n-1)d]$$

In general, a geometric sequence is denoted by

$$t_1, t_1 r, t_1 r^2, t_1 r^3, \dots, t_1 r^{n-1}$$

$$S_n = \frac{t_1(1-r^n)}{1-r}$$

$$\lim_{n \rightarrow \infty} S_n = \frac{t_1}{1-r}$$

Geometry and Vectors

If $\vec{V}(v_1, v_2)$ and $\vec{U}(u_1, u_2)$,

$$\vec{U} + \vec{V} = (u_1 + v_1, u_2 + v_2)$$

$$\|\vec{V}\| = \sqrt{(v_1)^2 + (v_2)^2}$$

$$\vec{V} \bullet \vec{U} = v_1 u_1 + v_2 u_2$$

Two vectors are perpendicular if and only if $\vec{V} \bullet \vec{U} = 0$

Logic:

conjunction = $(A \cap B)$

disjunction = $(A \cup B)$

implication = $(A \rightarrow B)$, *negation*, $A \cap B'$

If $A \rightarrow B$ is true, then $B' \rightarrow A'$ is also true.

Determinates:

$$\begin{vmatrix} a & c \\ b & d \end{vmatrix} = ad - bc$$

$$\text{If } \begin{cases} ax + by = c \\ dx + ey = f \end{cases}$$

$$x = \frac{\begin{vmatrix} c & b \\ f & e \end{vmatrix}}{\begin{vmatrix} a & b \\ d & e \end{vmatrix}}, \quad y = \frac{\begin{vmatrix} a & c \\ d & f \end{vmatrix}}{\begin{vmatrix} a & b \\ d & e \end{vmatrix}}$$

Geometry:**Distance between two points with coordinates**

(x_1, y_1, z_1) and $(x_2, y_2, z_2) =$

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

The distance between a point and a plane:

$$\text{Distance} = \frac{|Ax_1 + By_1 + Cz_1 + D|}{\sqrt{A^2 + B^2 + C^2}}$$

Triangle:**Heron's formula:**

$\sqrt{s(s-a)(s-b)(s-c)}$; a, b, c are the three sides of the triangle,

$$A = \frac{1}{2}(a + b + c)$$

Rhombus:

$$\text{Area} = bh = \frac{1}{2}d_1d_2; b = \text{base}, h = \text{height}, d = \text{diagonal}$$

Cylinder

$$\text{Volume} = \pi r^2 h$$

$$\text{Later surface area} = 2\pi rh$$

$$\text{Total surface area} = 2\pi rh + 2\pi r^2$$

Cone:

The volume of the cone:

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

$$\text{Later surface area} = \pi r \sqrt{r^2 + h^2} = \frac{1}{2}cl$$

$$\text{Total surface area} = \pi r \sqrt{r^2 + h^2} + \pi r^2$$

Sphere

$$\text{Volume} = \frac{4}{3}\pi r^3$$

$$\text{Surface area} = 4\pi r^2$$