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ALGEBRA

ANALYTIC GEOMETRY

EXPONENTS AND RADICALS

$$a^m a^n = a^{m+n} \quad a^{m/n} = \sqrt[n]{a^m} = (\sqrt[n]{a})^m$$

$$(a^m)^n = a^{mn} \quad \sqrt[n]{ab} = \sqrt[n]{a} \sqrt[n]{b}$$

$$(ab)^n = a^n b^n \quad \sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$$

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \quad \sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a}$$

$$\frac{a^m}{a^n} = a^{m-n} \quad a^{-n} = \frac{1}{a^n}$$

ABSOLUTE VALUE ($d > 0$)

$$|x| < d \text{ if and only if } -d < x < d$$

$$|x| > d \text{ if and only if either } x > d \text{ or } x < -d$$

$$|a + b| \leq |a| + |b| \quad (\text{Triangle inequality})$$

$$-|a| \leq a \leq |a|$$

INEQUALITIES

$$\text{If } a > b \text{ and } b > c, \text{ then } a > c$$

$$\text{If } a > b, \text{ then } a + c > b + c$$

$$\text{If } a > b \text{ and } c > 0, \text{ then } ac > bc$$

$$\text{If } a > b \text{ and } c < 0, \text{ then } ac < bc$$

QUADRATIC FORMULA

$$\text{If } a \neq 0, \text{ the roots of } ax^2 + bx + c = 0 \text{ are}$$

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

LOGARITHMS

$$y = \log_a x \text{ means } a^y = x \quad \log_a 1 = 0$$

$$\log_a xy = \log_a x + \log_a y \quad \log_a a = 1$$

$$\log_a \frac{x}{y} = \log_a x - \log_a y \quad \log x = \log_{10} x$$

$$\log_a x^r = r \log_a x \quad \ln x = \log_e x$$

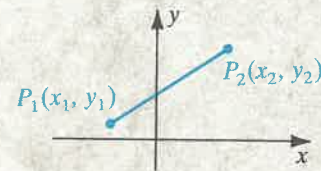
BINOMIAL THEOREM

$$(x + y)^n = x^n + \binom{n}{1} x^{n-1} y + \binom{n}{2} x^{n-2} y^2 + \dots + \binom{n}{k} x^{n-k} y^k + \dots + y^n,$$

$$\text{where } \binom{n}{k} = \frac{n!}{k!(n-k)!}$$

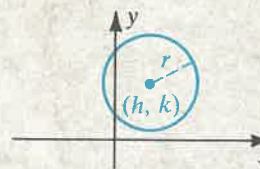
DISTANCE FORMULA

$$d(P_1, P_2) = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$



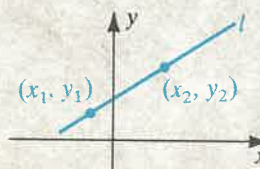
EQUATION OF A CIRCLE

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



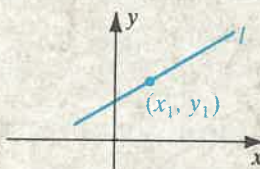
SLOPE m OF A LINE

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$



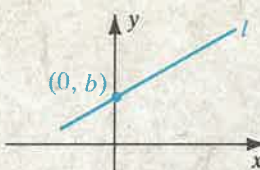
POINT-SLOPE FORM

$$y - y_1 = m(x - x_1)$$



SLOPE-INTERCEPT FORM

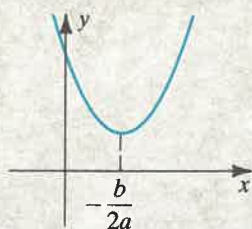
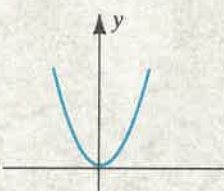
$$y = mx + b$$



GRAPH OF A QUADRATIC FUNCTION

$$y = ax^2, a > 0$$

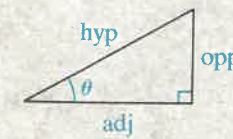
$$y = ax^2 + bx + c, a > 0$$



TRIGONOMETRY

TRIGONOMETRIC FUNCTIONS

OF ACUTE ANGLES



$$\sin \theta = \frac{\text{opp}}{\text{hyp}}$$

$$\csc \theta = \frac{\text{hyp}}{\text{opp}}$$

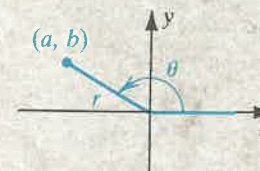
$$\cos \theta = \frac{\text{adj}}{\text{hyp}}$$

$$\sec \theta = \frac{\text{hyp}}{\text{adj}}$$

$$\tan \theta = \frac{\text{opp}}{\text{adj}}$$

$$\cot \theta = \frac{\text{adj}}{\text{opp}}$$

OF ARBITRARY ANGLES



$$\sin \theta = \frac{b}{r}$$

$$\csc \theta = \frac{r}{b}$$

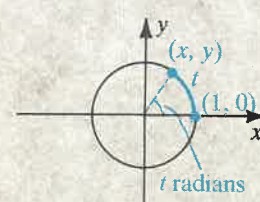
$$\cos \theta = \frac{a}{r}$$

$$\sec \theta = \frac{r}{a}$$

$$\tan \theta = \frac{b}{a}$$

$$\cot \theta = \frac{a}{b}$$

OF REAL NUMBERS



$$\sin t = y$$

$$\csc t = \frac{1}{y}$$

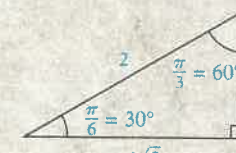
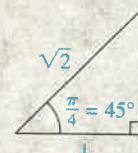
$$\cos t = x$$

$$\sec t = \frac{1}{x}$$

$$\tan t = \frac{y}{x}$$

$$\cot t = \frac{x}{y}$$

SPECIAL TRIANGLES



SPECIAL VALUES OF TRIGONOMETRIC FUNCTIONS

θ (degrees)	θ (radians)	$\sin \theta$	$\cos \theta$	$\tan \theta$	$\cot \theta$	$\sec \theta$	$\csc \theta$
0°	0	0	1	0	—	1	—
30°	$\frac{\pi}{6}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$	$\sqrt{3}$	$\frac{2\sqrt{3}}{3}$	2
45°	$\frac{\pi}{4}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	1	1	$\sqrt{2}$	$\sqrt{2}$
60°	$\frac{\pi}{3}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$	$\frac{\sqrt{3}}{3}$	2	$\frac{2\sqrt{3}}{3}$
90°	$\frac{\pi}{2}$	1	0	—	0	—	1

TRIGONOMETRIC IDENTITIES

$$\csc t = 1/\sin t$$

$$\tan t = \sin t/\cos t$$

$$\sec t = 1/\cos t$$

$$\cot t = \cos t/\sin t$$

$$\cot t = 1/\tan t$$

$$\sin^2 t + \cos^2 t = 1$$

$$\sin(-t) = -\sin t$$

$$1 + \tan^2 t = \sec^2 t$$

$$\cos(-t) = \cos t$$

$$1 + \cot^2 t = \csc^2 t$$

$$\tan(-t) = -\tan t$$

$$\sin(u + v) = \sin u \cos v + \cos u \sin v$$

$$\cos(u + v) = \cos u \cos v - \sin u \sin v$$

$$\tan(u + v) = \frac{\tan u + \tan v}{1 - \tan u \tan v}$$

$$\sin(u - v) = \sin u \cos v - \cos u \sin v$$

$$\cos(u - v) = \cos u \cos v + \sin u \sin v$$

$$\tan(u - v) = \frac{\tan u - \tan v}{1 + \tan u \tan v}$$

$$\sin 2u = 2 \sin u \cos u$$

$$\cos 2u = \cos^2 u - \sin^2 u = 1 - 2 \sin^2 u = 2 \cos^2 u - 1$$

$$\tan 2u = \frac{2 \tan u}{1 - \tan^2 u}$$

$$\left| \sin \frac{u}{2} \right| = \sqrt{\frac{1 - \cos u}{2}} \quad \left| \cos \frac{u}{2} \right| = \sqrt{\frac{1 + \cos u}{2}}$$

$$\tan \frac{u}{2} = \frac{1 - \cos u}{\sin u} = \frac{\sin u}{1 + \cos u}$$

$$\sin^2 u = \frac{1 - \cos 2u}{2} \quad \cos^2 u = \frac{1 + \cos 2u}{2}$$

$$\sin u \cos v = \frac{1}{2} [\sin(u + v) + \sin(u - v)]$$

$$\cos u \sin v = \frac{1}{2} [\sin(u + v) - \sin(u - v)]$$

$$\cos u \cos v = \frac{1}{2} [\cos(u + v) + \cos(u - v)]$$

$$\sin u \sin v = \frac{1}{2} [\cos(u - v) - \cos(u + v)]$$

INVERSE TRIGONOMETRIC FUNCTIONS

Function	Domain	Range
$y = \sin^{-1} x$	$-1 \leq x \leq 1$	$-\frac{\pi}{2} \leq y \leq \frac{\pi}{2}$
$y = \cos^{-1} x$	$-1 \leq x \leq 1$	$0 \leq y \leq \pi$
$y = \tan^{-1} x$	$\mathbb{R}$	$-\frac{\pi}{2} < y < \frac{\pi}{2}$
$y = \cot^{-1} x$	$\mathbb{R}$	$0 < y < \pi$
$y = \sec^{-1} x$	$ x \geq 1$	$\left[0, \frac{\pi}{2}\right) \cup \left[\pi, \frac{3\pi}{2}\right)$
$y = \csc^{-1} x$	$ x \geq 1$	$\left[-\frac{\pi}{2}, 0\right) \cup \left(0, \frac{\pi}{2}\right]$

Nature's power and the elegance of its creations are visible in the drifting sand dunes of the Sahara Desert. The wind causes these mountains of sand to change their shape and to shift their positions, forming smooth curves of varying complexity along their ridges.

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