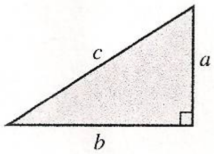
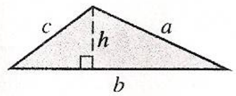
area A **perimeter** P **circumference** C **volume** V **curved surface area** S **altitude** h **radius** r

RIGHT TRIANGLE



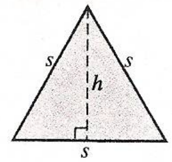
Pythagorean Theorem: $c^2 = a^2 + b^2$

TRIANGLE



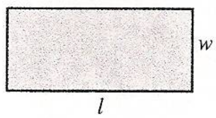
$A = \frac{1}{2}bh \qquad P = a + b + c$

EQUILATERAL TRIANGLE



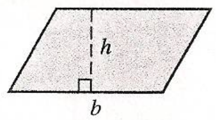
$h = \frac{\sqrt{3}}{2}s \qquad A = \frac{\sqrt{3}}{4}s^2$

RECTANGLE



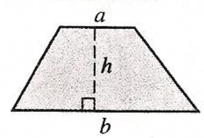
$A = lw \qquad P = 2l + 2w$

PARALLELOGRAM



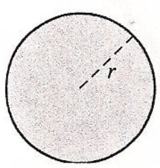
$A = bh$

TRAPEZOID



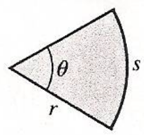
$A = \frac{1}{2}(a + b)h$

CIRCLE



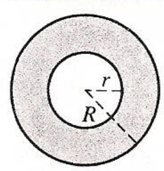
$A = \pi r^2 \qquad C = 2\pi r$

CIRCULAR SECTOR



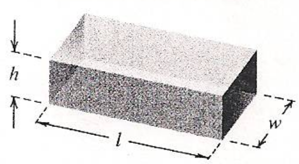
$A = \frac{1}{2}r^2\theta \qquad s = r\theta$

CIRCULAR RING



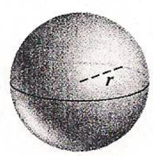
$A = \pi(R^2 - r^2)$

RECTANGULAR BOX



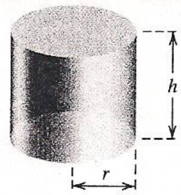
$V = lwh \qquad S = 2(hl + lw + hw)$

SPHERE



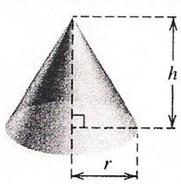
$V = \frac{4}{3}\pi r^3 \qquad S = 4\pi r^2$

RIGHT CIRCULAR CYLINDER



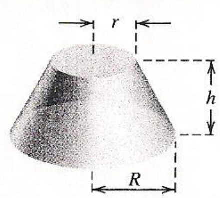
$V = \pi r^2 h \qquad S = 2\pi rh$

RIGHT CIRCULAR CONE



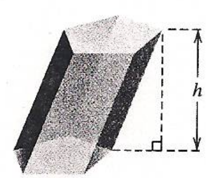
$V = \frac{1}{3}\pi r^2 h \qquad S = \pi r\sqrt{r^2 + h^2}$

FRUSTUM OF A CONE



$V = \frac{1}{3}\pi h(r^2 + rR + R^2)$

PRISM



$V = Bh$ with B the area of the base

QUADRATIC FORMULA

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

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

SPECIAL PRODUCT FORMULAS

$$(x + y)(x - y) = x^2 - y^2$$
$$(x + y)^2 = x^2 + 2xy + y^2$$
$$(x - y)^2 = x^2 - 2xy + y^2$$
$$(x + y)^3 = x^3 + 3x^2y + 3xy^2 + y^3$$
$$(x - y)^3 = x^3 - 3x^2y + 3xy^2 - y^3$$

SPECIAL FACTORING FORMULAS

$$x^2 - y^2 = (x + y)(x - y)$$
$$x^2 + 2xy + y^2 = (x + y)^2$$
$$x^2 - 2xy + y^2 = (x - y)^2$$
$$x^3 - y^3 = (x - y)(x^2 + xy + y^2)$$
$$x^3 + y^3 = (x + y)(x^2 - xy + y^2)$$

EXPONENTS AND RADICALS

$$a^m a^n = a^{m+n} \qquad a^{1/n} = \sqrt[n]{a}$$
$$(a^m)^n = a^{mn} \qquad a^{m/n} = \sqrt[n]{a^m}$$
$$(ab)^n = a^n b^n \qquad a^{m/n} = \left(\sqrt[n]{a}\right)^m$$
$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \qquad \sqrt[n]{ab} = \sqrt[n]{a}\,\sqrt[n]{b}$$
$$\frac{a^m}{a^n} = a^{m-n} \qquad \sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}$$
$$a^{-n} = \frac{1}{a^n} \qquad \sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a}$$

BINOMIAL THEOREM

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

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

INEQUALITIES

If $a > b$ and $b > c$, then $a > c$

If $a > b$, then $a + c > b + c$

If $a > b$ and $c > 0$, then $ac > bc$

If $a > b$ and $c < 0$, then $ac < bc$

ABSOLUTE VALUE ($d > 0$)

$|x| < d$ if and only if

$$-d < x < d$$

$|x| > d$ if and only if either

$$x > d \quad \text{or} \quad x < -d$$

MEANS

Arithmetic mean A of n numbers

$$A = \frac{a_1 + a_2 + \cdots + a_n}{n}$$

Geometric mean G of n numbers

$$G = (a_1 a_2 \cdots a_n)^{1/n}, \; a_k > 0$$

SEQUENCES

nth term of an arithmetic sequence with first term a_1 and common difference d

$$a_n = a_1 + (n - 1)d$$

Sum S_n of the first n terms of an arithmetic sequence

$$S_n = \frac{n}{2}(a_1 + a_n)$$

or $$S_n = \frac{n}{2}[2a_1 + (n - 1)d]$$

nth term of a geometric sequence with first term a_1 and common ratio r

$$a_n = a_1 r^{n-1}$$

Sum S_n of the first n terms of a geometric sequence

$$S_n = \frac{a_1(1 - r^n)}{1 - r}$$

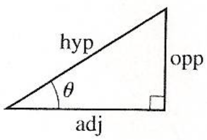
EXPONENTIALS AND LOGARITHMS

$y = \log_a x$ means $a^y = x$

$$\log_a xy = \log_a x + \log_a y$$
$$\log_a \frac{x}{y} = \log_a x - \log_a y$$
$$\log_a x^r = r \log_a x$$
$$a^{\log_a x} = x$$
$$\log_a a^x = x$$
$$\log_a 1 = 0$$
$$\log_a a = 1$$
$$\log x = \log_{10} x$$
$$\ln x = \log_e x$$
$$\log_b u = \frac{\log_a u}{\log_a b}$$

TRIGONOMETRIC FUNCTIONS

OF ACUTE ANGLES

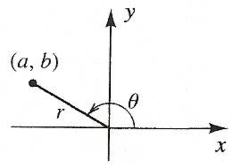


$\sin\theta = \dfrac{\text{opp}}{\text{hyp}}$ $\qquad \csc\theta = \dfrac{\text{hyp}}{\text{opp}}$

$\cos\theta = \dfrac{\text{adj}}{\text{hyp}}$ $\qquad \sec\theta = \dfrac{\text{hyp}}{\text{adj}}$

$\tan\theta = \dfrac{\text{opp}}{\text{adj}}$ $\qquad \cot\theta = \dfrac{\text{adj}}{\text{opp}}$

OF ARBITRARY ANGLES

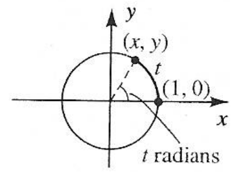


$\sin\theta = \dfrac{b}{r}$ $\qquad \csc\theta = \dfrac{r}{b}$

$\cos\theta = \dfrac{a}{r}$ $\qquad \sec\theta = \dfrac{r}{a}$

$\tan\theta = \dfrac{b}{a}$ $\qquad \cot\theta = \dfrac{a}{b}$

OF REAL NUMBERS

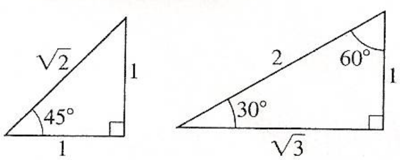


$\sin t = y$ $\qquad \csc t = \dfrac{1}{y}$

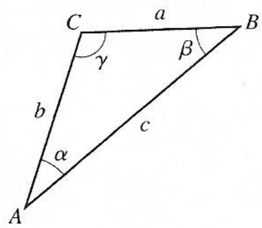
$\cos t = x$ $\qquad \sec t = \dfrac{1}{x}$

$\tan t = \dfrac{y}{x}$ $\qquad \cot t = \dfrac{x}{y}$

SPECIAL RIGHT TRIANGLES



OBLIQUE TRIANGLE



AREA

$$\mathscr{A} = \frac{1}{2}bc\sin\alpha$$

$$\mathscr{A} = \frac{1}{2}ac\sin\beta$$

$$\mathscr{A} = \frac{1}{2}ab\sin\gamma$$

$$\mathscr{A} = \sqrt{s(s-a)(s-b)(s-c)},$$

where $s = \dfrac{1}{2}(a + b + c)$ *(Heron's Formula)*

LAW OF COSINES

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

$$b^2 = a^2 + c^2 - 2ac\cos\beta$$

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

LAW OF SINES

$$\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$$

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

GREEK ALPHABET

Letter	Name	Letter	Name
Α α	alpha	Ν ν	nu
Β β	beta	Ξ ξ	xi
Γ γ	gamma	Ο ο	omicron
Δ δ	delta	Π π	pi
Ε ϵ	epsilon	Ρ ρ	rho
Ζ ζ	zeta	Σ σ	sigma
Η η	eta	Τ τ	tau
Θ θ	theta	Υ υ	upsilon
Ι ι	iota	Φ ϕ (φ)	phi
Κ κ	kappa	Χ χ	chi
Λ λ	lambda	Ψ ψ	psi
Μ μ	mu	Ω ω	omega

FUNDAMENTAL IDENTITIES

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

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

$$\cot t = \frac{1}{\tan t}$$

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

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

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

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

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

FORMULAS FOR NEGATIVES

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

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

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

$$\cot(-t) = -\cot t$$

$$\sec(-t) = \sec t$$

$$\csc(-t) = -\csc t$$

DOUBLE-ANGLE FORMULAS

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

$$\begin{aligned}\cos 2u &= \cos^2 u - \sin^2 u \\ &= 1 - 2\sin^2 u \\ &= 2\cos^2 u - 1\end{aligned}$$

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

COFUNCTION FORMULAS

$$\sin\left(\frac{\pi}{2} - u\right) = \cos u$$

$$\cos\left(\frac{\pi}{2} - u\right) = \sin u$$

$$\tan\left(\frac{\pi}{2} - u\right) = \cot u$$

$$\cot\left(\frac{\pi}{2} - u\right) = \tan u$$

$$\sec\left(\frac{\pi}{2} - u\right) = \csc u$$

$$\csc\left(\frac{\pi}{2} - u\right) = \sec u$$

ADDITION FORMULAS

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

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

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

HALF-ANGLE IDENTITIES

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

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

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

PRODUCT-TO-SUM FORMULAS

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

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

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

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

SUBTRACTION FORMULAS

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

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

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

HALF-ANGLE FORMULAS

$$\sin \frac{u}{2} = \pm\sqrt{\frac{1 - \cos u}{2}}$$

$$\cos \frac{u}{2} = \pm\sqrt{\frac{1 + \cos u}{2}}$$

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

SUM-TO-PRODUCT FORMULAS

$$\sin u + \sin v = 2 \sin\left(\frac{u + v}{2}\right) \cos\left(\frac{u - v}{2}\right)$$

$$\sin u - \sin v = 2 \cos\left(\frac{u + v}{2}\right) \sin\left(\frac{u - v}{2}\right)$$

$$\cos u + \cos v = 2 \cos\left(\frac{u + v}{2}\right) \cos\left(\frac{u - v}{2}\right)$$

$$\cos u - \cos v = -2 \sin\left(\frac{u + v}{2}\right) \sin\left(\frac{u - v}{2}\right)$$