Differentiation Rules

$\frac{d}{dx}x^n = nx^{n-1}$ (power rule)

$\frac{d}{dx}[u^n] = nu^{n-1}u'$

$\frac{d}{dx}[c] = 0$

$\frac{d}{dx}[cu] = cu'$

$\frac{d}{dx}[u \pm v] = u' \pm v'$

$\frac{d}{dx}[uv] = uv' + vu'$ (product rule)

$\frac{d}{dx}\left[\frac{u}{v}\right] = \frac{vu'-uv'}{v^2}$ (quotient rule)

$g'(x) = \frac{1}{f'(g(x))}$ where $g(x)$ is the inverse of $f(x)$

Trigonometric Functions:

$\frac{d}{dx}[\sin u] = \cos(u)u'$ $\quad$ $\frac{d}{dx}[\cos u] = -\sin(u)u'$

$\frac{d}{dx}[\tan u] = \sec^2(u)u'$ $\quad$ $\frac{d}{dx}[\cot u] = -\csc^2(u)u'$

$\frac{d}{dx}[\sec u] = (\sec u \tan u)u'$ $\quad$ $\frac{d}{dx}[\csc u] = -(\csc u \cot u)u'$

Inverse Trigonometric Functions:

$\frac{d}{dx}[\sin^{-1} u] = \frac{u'}{\sqrt{1-u^2}}$ $\quad$ $\frac{d}{dx}[\csc^{-1} u] = -\frac{u'}{|u|\sqrt{u^2-1}}$

$\frac{d}{dx}[\cos^{-1} u] = -\frac{u'}{\sqrt{1-u^2}}$ $\quad$ $\frac{d}{dx}[\sec^{-1} u] = \frac{u'}{|u|\sqrt{u^2-1}}$

$\frac{d}{dx}[\tan^{-1} u] = \frac{u'}{1+u^2}$ $\quad$ $\frac{d}{dx}[\cot^{-1} u] = -\frac{u'}{1+u^2}$

Exponential & Logarithmic Functions:

$\frac{d}{dx}[e^u] = e^u u'$ $\quad$ $\frac{d}{dx}[a^u] = (\ln a)a^u u'$

$\frac{d}{dx}[|u|] = \frac{u}{|u|}(u'), u \neq 0$ $\quad$ $\frac{d}{dx}[\log_a u] = \frac{u'}{(\ln a)u}$

Properties of Definite Integrals:

$\int_a^a f(x)dx = 0$ $\quad$ $\int_a^b f(x) = \int_a^c f(x)dx + \int_c^b f(x)dx$

$\int_b^a f(x) = -\int_a^b f(x)dx$

Integration Rules

$\int x^n dx = \frac{x^{n+1}}{n+1} + C$

$\int cf(x)dx = c\int f(x)dx$

$\int [f(x) + g(x)]dx = \int f(x)dx + \int g(x)dx$

Trigonometric Functions:

$\int \sin x dx = -\cos x + C$

$\int \cos x dx = \sin x + C$

$\int \tan x\, dx = -\ln|\cos x| + C$

$\int \cot x\, dx = \ln|\sin x| + C$

$\int \sec x\, dx = \ln|\sec x + \tan x| + C$

$\int \csc x\, dx = -\ln|\csc x + \cot u| + C$

$\int \sec^2 x dx = \tan x + C$

$\int \csc^2 x dx = -\cot x + C$

$\int \sec x \tan x dx = \sec x + C$

$\int \csc x \cot x dx = -\csc x + C$

Inverse Trigonometric Functions:

$\int \frac{du}{\sqrt{a^2-u^2}} = \sin^{-1}\frac{u}{a} + C$

$\int \frac{du}{a^2+u^2} = \frac{1}{a}\tan^{-1}\frac{u}{a} + C$

$\int \frac{du}{u\sqrt{u^2-a^2}} = \frac{1}{a}\sec^{-1}\frac{|u|}{a} + C$

Exponential & Logarithmic Functions:

$\int e^x dx = e^x + C$

$\int a^x dx = \left(\frac{1}{\ln a}\right)a^x + C$

$\int \frac{1}{x}dx = \ln|x| + C$

FORMULAS FROM GEOMETRY

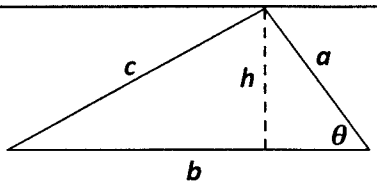
Triangle

$h = a \sin\theta$

$A = \frac{1}{2}bh$

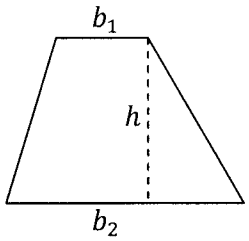
Law of Cosines

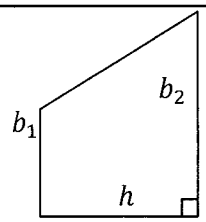
$c^2 = a^2 + b^2 - 2ab\cos\theta$



Trapezoid

$A = \frac{h}{2}(b_1 + b_2)$

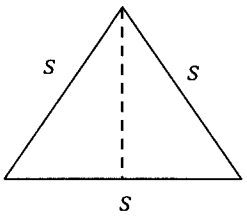




Equilateral Triangle

$h = \frac{s\sqrt{3}}{2}$

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

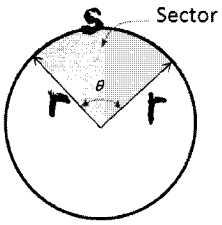


Area of a Sector

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

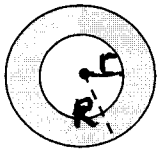
$s = r\theta$

(θ in radians)



Circular Ring

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

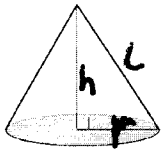


Cone

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

$L.A. = \pi r l$

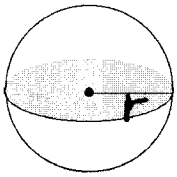
$S.A. = \pi r l + \pi r^2$



Sphere

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

$S.A. = 4\pi r^2$

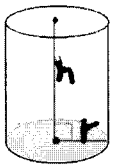


Cylinder

$V = \pi r^2 h$

$L.A. = 2\pi r h$

$S.A. = 2\pi r h + 2\pi r^2$



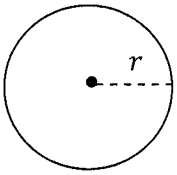
Conic Sections

Circle

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

$A = \pi r^2$

$C = 2\pi r$

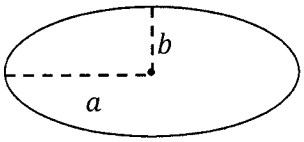


Ellipse

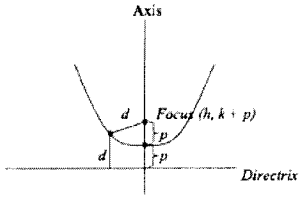
$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$

$A = \pi a b$

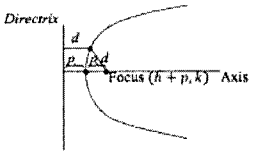
$C = 2\pi\sqrt{\frac{a^2+b^2}{2}}$



Parabola

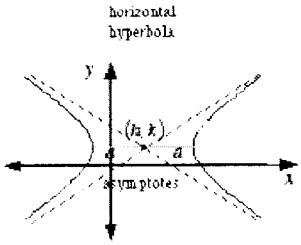


Vertex (h, k)
Directrix: $y = k - p$ (horizontal)
Focus $(h, k + p)$
Equation of a parabola:
$(x-h)^2 = 4p(y-k)$

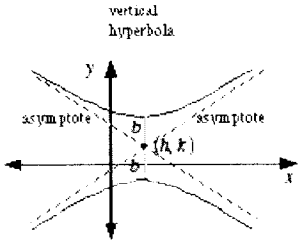


Vertex (h, k)
Directrix: $x = h - p$ (vertical)
Focus $(h + p, k)$
Equation: $(y-k)^2 = 4p(x-h)$

Hyperbola



$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$



$\frac{(y-k)^2}{b^2} - \frac{(x-h)^2}{a^2} = 1$

For both horizontal and vertical hyperbolas,

slopes of asymptotes $= \pm\frac{b}{a}$