## Derivatives

$\frac{d}{dx}(c) = 0$

$\frac{d}{dx}(cx) = c$

$\frac{d}{dx}(cx^n) = c \cdot nx^{n-1}$

$\frac{d}{dx}(uv) = u\frac{dv}{dx} + v\frac{du}{dx}$

$= (1st)(D{:}2nd) + (2nd)(D{:}1st)$

$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2} =$

$\frac{(low)(D{:}high) - (high)(D{:}low)}{(low)^2}$

$\frac{d}{dx}(u)^n = n(u)^{n-1}\frac{du}{dx}$

(der - OUT)(IN - same)(der - IN)

* Don't be greedy...1 derivative at a time. Use with any complicated trig. function.

## Logarithmic/Exponential

Change of Base Formula

$\log_b a = \frac{\log a}{\log b} = \frac{\ln a}{\ln b}$

$\frac{d}{dx}(\ln u) = \frac{1}{u}\frac{du}{dx}$

$\frac{d}{dx}(e^u) = e^u\frac{du}{dx}$

$\frac{d}{dx}(a^u) = a^u \ln a \frac{du}{dx}$

## Trigonometric Functions

$\frac{d}{dx}(\sin u) = \cos u\frac{du}{dx}$

$\frac{d}{dx}(\cos u) = -\sin u\frac{du}{dx}$

$\frac{d}{dx}(\tan u) = \sec^2 u\frac{du}{dx}$

$\frac{d}{dx}(\cot u) = -\csc^2 u\frac{du}{dx}$

$\frac{d}{dx}(\sec u) = \sec u \tan u\frac{du}{dx}$

$\frac{d}{dx}(\csc u) = -\csc u \cot u\frac{du}{dx}$

## Implicit Differentiation

Step 1: Differentiate both sides w.r.t. "x"
Always label dy/dx... show respect.
Step 2: Collect dy/dx on 1 side of equation
Step 3: Factor out dy/dx
Step 4: Solve for dy/dx by dividing

$x^2 + 2xy + y^3 = 24$

$2x + 2\left(x\frac{dy}{dx}(label) + y\right) + 3y^2\frac{dy}{dx}(label) = 0$

$2x + 2x\frac{dy}{dx} + 2y + 3y^2\frac{dy}{dx} = 0$

$(2x + 3y^2)\frac{dy}{dx} = -2x - 2y$

$\frac{dy}{dx} = -\frac{2x + 2y}{2x + 3y^2}$

## Inverse Trigonometric Functions

$\frac{d}{dx}(\sin^{-1} u) = \frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$

$\frac{d}{dx}(\cos^{-1} u) = -\frac{1}{\sqrt{1-u^2}}\frac{du}{dx}$

$\frac{d}{dx}(\tan^{-1} u) = \frac{1}{1+u^2}\frac{du}{dx}$

$\frac{d}{dx}(\cot^{-1} u) = -\frac{1}{1+u^2}\frac{du}{dx}$

$\frac{d}{dx}(\sec^{-1} u) = \frac{1}{|u|\sqrt{u^2-1}}\frac{du}{dx}$

$\frac{d}{dx}(\csc^{-1} u) = -\frac{1}{|u|\sqrt{u^2-1}}\frac{du}{dx}$

## Formal Definition of Derivative

$\lim_{h\to 0}\frac{f(x+h) - f(x)}{h}$

## Limits

$\lim_{x\to 0}\frac{\sin(ax)}{ax} = 1 \qquad \lim_{x\to\pm\infty}\frac{\#}{(\text{var})} = 0$

When taking the limit as $x \to \pm\infty$, divide every term by the largest degree of the variable in the denominator OR think about the function in terms of H.A.

## Derivatives of Inverse Functions

If $g = f^{-1}$ & $f^{-1}(g(a)) \neq 0$ , then

$g'(a) = \frac{1}{f'(g(a))}$

## Integrals

$\int(cu)du = c\int udu$

$\int u^n du = \frac{u^{n+1}}{n+1} + C$

$\int\frac{1}{u}du = \ln|u| + C$

$\int e^u du = e^u + C$

$\int a^u du = \frac{a^u}{\ln a} + C$

$\int(\sin u)du = -\cos u + C$

$\int(\cos u)du = \sin u + C$

$\int(\tan u)du = \ln|\sec u| + C$

$= -\ln|\cos u| + C$

$\int(\cot u)du = -\ln|\csc u| + C$

$= \ln|\sin u| + C$

$\int(\sec u)du = \ln|\sec u + \tan u| + C$

$\int(\csc u)du = -\ln|\csc u + \cot u| + C$

$\int(\sec^2 u)du = \tan u + C$

$\int(\csc^2 u)du = -\cot u + C$

$\int(\sec u \tan u)du = \sec u + C$

$\int(\csc u \cot u)du = -\csc u + C$

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

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

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

## Integration by Parts

$\int(u)dv = uv - \int(v)du$ "Vorro"

Find:

$\int(x^2 \ln x)dx$

$u = \ln x \quad dv = x^2dx$

$du = \frac{1}{x} \leftarrow v = \frac{x^3}{3}$

$\therefore \int(x^2 \ln x)dx = \frac{x^3}{3}\ln x - \int\left(\frac{x^3}{3}\cdot\frac{1}{x}\right)dx$

# Math Facts Sheet

### Triangle
Area = ½ bh

### Law of Sines
$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

### Law of Cosines
$c^2 = a^2 + b^2 - 2ab\cos\theta$

### Equilateral Triangle
$h = \frac{\sqrt{3}}{2}s$; Area $= \frac{\sqrt{3}}{4}s^2$

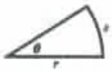
### Parallelogram
Area = bh

### Circle
Circumference = $2\pi r = \pi d$

Area = $\pi r^2$

### Sector of Circle
Area = ½ $(\theta r^2)$

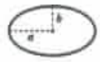
Arc length = $r\theta$



### Trapezoid
Area = $\frac{h}{2}(b_1 + b_2)$

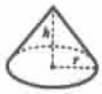
### Ellipse
Area = $\pi ab$

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



### Right Circular Cone
Volume = $\frac{1}{3}(\pi r^2 h)$

Lateral Surface Area = $\pi r\sqrt{r^2 + h^2}$



### Right Circular Cylinder
Volume = $\pi r^2 h$

Lateral Surface Area = $2\pi rh$

Surface Area = $2\pi rh + 2\pi r^2$

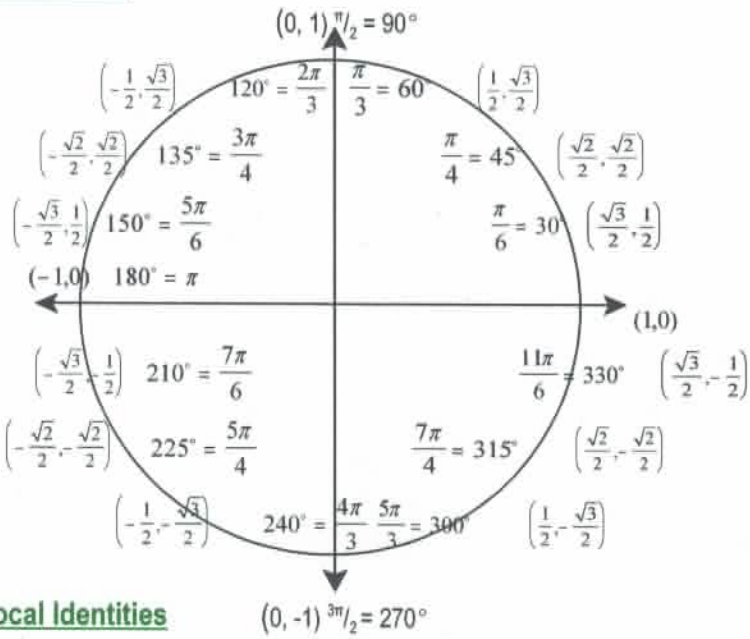
### Sphere
Volume = $\frac{4}{3}\pi r^3$

Surface Area = $4\pi r^2$

Position function: $s(t) = \frac{1}{2}gt^2 + V_o t + S_o$ Velocity Function: $v(t) = s'(t)$ Acceleration Function: $a(t) = v'(t) = s''(t)$

| | maximum | minimum | increasing | decreasing | concave up | concave down | point of inflection |
|---|---|---|---|---|---|---|---|
| $f(x)$ | mountain | valley | + slope | - slope | | | c-up to c-down (vice versa) |
| $f'(x)$ | $f'(c) = 0$ + to - | $f'(c) = 0$ - to + | $f'(x) > 0$ | $f'(x) < 0$ | $f'(x)$ is increasing | $f'(x)$ is decreasing | max. min. |
| $f''(x)$ | $f''(c) < 0$ | $f''(c) > 0$ | | | $f''(x) > 0$ | $f''(x) < 0$ | $f''(c) = 0$ + to - or - to + |

## The Unit Circle




## Right Triangle Definitions

$\sin\theta = \frac{opp}{hyp}$ $\cos\theta = \frac{adj}{hyp}$ $\tan\theta = \frac{opp}{adj}$

$\csc\theta = \frac{hyp}{opp}$ $\sec\theta = \frac{hyp}{adj}$ $\cot\theta = \frac{adj}{opp}$

## Pythagorean Identities

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

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

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

## Double-Angle Formulas

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

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

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

## Power-Reducing Formulas

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

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

## Reciprocal Identities

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

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

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

## Sum & Difference Identities

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

$\cos(u \pm v) = \cos u\cos v \mp \sin u\sin v$

$\tan(u \pm v) = \frac{\tan u \pm \tan v}{1 \mp \tan u\tan v}$