

Derivatives to KNOW:

1.  $\frac{d}{dx} c = 0$
2.  $\frac{d}{dx} u^n = nu^{n-1} \frac{du}{dx}$
3.  $\frac{d}{dx} e^u = e^u \frac{du}{dx}$
4.  $\frac{d}{dx} \ln u = \frac{1}{u} \frac{du}{dx}$
5.  $\frac{d}{dx} a^u = \frac{d}{dx} e^{u \ln a} = e^{u \ln a} \ln a \frac{du}{dx} = a^u \ln a \frac{du}{dx}$
6.  $\frac{d}{dx} \log_a u = \frac{d}{dx} \left( \frac{\ln u}{\ln a} \right) = \frac{1}{u \ln a} \frac{du}{dx}$
7.  $\frac{d}{dx} \sin u = \cos u \frac{du}{dx}$
8.  $\frac{d}{dx} \cos u = -\sin u \frac{du}{dx}$
9.  $\frac{d}{dx} \tan u = \sec^2 u \frac{du}{dx}$
10.  $\frac{d}{dx} \sec u = \sec u \tan u \frac{du}{dx}$
11.  $\frac{d}{dx} \csc u = -\csc u \cot u \frac{du}{dx}$
12.  $\frac{d}{dx} \cot u = -\csc^2 u \frac{du}{dx}$
13.  $\frac{d}{dx} \arcsin u = \frac{1}{\sqrt{1-u^2}} \frac{du}{dx}$
14.  $\frac{d}{dx} \arctan u = \frac{1}{1+u^2} \frac{du}{dx}$
15.  $\frac{d}{dx} \operatorname{arcsec} u = \frac{1}{|u| \sqrt{u^2-1}} \frac{du}{dx}$

Rules:

Suppose  $u = f(x)$  and  $v = g(x)$

1.  $\frac{d}{dx} cf(x) = c \frac{d}{dx} f(x)$
2.  $\frac{d}{dx} (u+v) = \frac{du}{dx} + \frac{dv}{dx}$
3.  $\frac{d}{dx} uv = \frac{du}{dx} \cdot v + u \frac{dv}{dx}$
4.  $\frac{d}{dx} \left( \frac{u}{v} \right) = \frac{\frac{du}{dx} \cdot v - u \frac{dv}{dx}}{v^2}$
5.  $\frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$
6. Log Differentiation:
  - a. Natural log of both sides
  - b. Simplify
  - c. Derivative of both sides with respect to  $x$
  - d. Solve for  $\frac{dy}{dx}$ .
7. Implicit Differentiation
8. Derivatives of higher orders
 
$$\frac{dy}{dx} = f'(x), \frac{d^2y}{dx^2} = f''(x), \frac{d^3y}{dx^3} = f'''(x), \dots$$
9. Use the definition of derivatives to find  $\frac{dy}{dx}$ .

Tangent lines:

Find the slope  $m_{\tan} = \left. \frac{dy}{dx} \right|_{x=a}$ , a point on the

line is  $(a, f(a))$  and the tan line is

$$y - f(a) = m_{\tan} (x - a)$$

Solve related rates problems: