

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. $\frac{d}{dx}(a^u) = a^u \ln a \frac{du}{dx}$ **
6. $\frac{d}{dx}(\log_a u) = \frac{1}{u \ln a} \frac{du}{dx}$
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. $\frac{d}{dx}(\text{arcsec } u) = \frac{1}{|u|\sqrt{u^2-1}} \frac{du}{dx}$
16. $\frac{d}{dx}(\sinh u) = \cosh u \frac{du}{dx}$
17. $\frac{d}{dx}(\cosh u) = \sinh u \frac{du}{dx}$
18. $\frac{d}{dx}(\tanh u) = \operatorname{sech}^2 u \cdot \frac{du}{dx}$
19. $\frac{d}{dx}(\sinh^{-1} u) = \frac{1}{\sqrt{u^2+1}} \frac{du}{dx}$
20. $\frac{d}{dx}(\cosh^{-1} u) = \frac{1}{\sqrt{u^2-1}} \frac{du}{dx}$

$$21. \frac{d}{dx}(\tanh^{-1} u) = \frac{1}{1-u^2} \frac{du}{dx}$$

** can use log diff to solve

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. $\frac{d}{dx}(f(u(x))) = f'(u(x))u'(x)$

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

$$\frac{dy}{dx} = f'(x), \quad \frac{d^2y}{dx^2} = f''(x), \quad \frac{d^3y}{dx^3} = f'''(x), \dots$$

9. Use the definition of derivatives to find

$$\frac{dy}{dx} = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}.$$

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