

# Derivative Rules

## Product Rule

$$y = f(x) \cdot g(x)$$

$$y' = f'(x) \cdot g(x) + f(x) \cdot g'(x)$$

**Ex**  $y = x^4 \cdot \sin(x)$

$$f(x) = x^4 \quad g(x) = \sin(x)$$

$$f'(x) = 4x^3 \quad g'(x) = \cos(x)$$

$$y' = 4x^3 \cdot \sin(x) + x^4 \cdot \cos(x)$$

**Ex**  $y = 2x^2 \cdot \ln(x)$

$$f(x) = 2x^2 \quad g(x) = \ln(x)$$

$$f'(x) = 4x \quad g'(x) = \frac{1}{x}$$

$$y' = 4x \cdot \ln(x) + 2x^2 \cdot \frac{1}{x}$$

$$y' = 4x \cdot \ln(x) + 2x$$

## Quotient Rule

$$y = \frac{f(x)}{g(x)} = \frac{hi}{lo}$$

$$y' = \frac{lo \cdot dhi - hi \cdot dlo}{(lo)^2}$$

**Ex**  $y = \frac{e^x}{4x^3}$

$$hi = e^x \quad lo = 4x^3$$

$$dhi = e^x \quad dlo = 12x^2$$

$$y' = \frac{4x^3 \cdot e^x - e^x \cdot 12x^2}{(4x^3)^2}$$

**Ex**  $y = \frac{5x}{\sin(x)}$

$$hi = 5x \quad lo = \sin(x)$$

$$dhi = 5 \quad dlo = \cos(x)$$

$$y' = \frac{\sin(x) \cdot 5 - 5x \cdot \cos(x)}{(\sin(x))^2}$$

## Chain Rule

$$y = f(g(x))$$

$$y' = f'(g(x)) \cdot g'(x)$$

**Ex**  $y = \cos(3x^2)$

$$f(g(x)) = \cos(3x^2) \quad g(x) = 3x^2$$

$$f'(g(x)) = -\sin(3x^2) \quad g'(x) = 6x$$

$$y' = -\sin(3x^2) \cdot 6x$$

**Ex**  $y = e^{2x^3+4}$

$$f(g(x)) = e^{2x^3+4} \quad g(x) = 2x^3 + 4$$

$$f'(g(x)) = e^{2x^3+4} \quad g'(x) = 6x^2$$

$$y' = e^{2x^3+4} \cdot 6x^2$$