# Differentiation Rules Practice

Name: _____ Date: _____

## Question 1

Solve for the second derivative

I. $y = -x^2 + 3$

## Question 2

Solve for the derivative

I. $(2x + 3)(5x^2 - 4x)$

# Differentiation Rules Practice

II. $\frac{2x + 5}{3x - 2}$

III. $x^3e^x$

# Differentiation Rules Practice

IV. $2e^{-x} + e^{3x}$

V. $x^3e^x$ (Power / Natural Exponential)

# Differentiation Rules Practice

VI. $xe^{-x}$

VII. $\sqrt[7]{x^2} - x^e$

# Differentiation Rules Practice

VIII. $\frac{e^x}{x}$

# Differentiation Rules Practice

IX. $e^{x}\left(\frac{1}{x^{2}} + x^{-\pi/2}\right)$

# Differentiation Rules Practice

Name: **Key** Date: _____

## Question 1

Solve for the second derivative

I. $y = -x^2 + 3$

$$\lim_{h \to 0} \frac{(-(x+h)^2+3)-(-x^2+3)}{h} \longrightarrow \frac{-2hx-h^2}{h} \longrightarrow \frac{h(-2x-h)}{h} \longrightarrow -2x-h$$

$$-2x-(0)$$

$$-2x$$

$$\lim_{h \to 0} \frac{(-2(x+h))-(-2(x))}{h} \longrightarrow \frac{-2h}{h} \longrightarrow -2$$

## Question 2

Solve for the derivative

I. $(2x+3)(5x^2-4x)$

$(2x+3)(5x^2-4x) \longrightarrow 10x^3+7x^2-12x$

$$\lim_{h \to 0} \frac{(10(x+h)^3+7(x+h)^2-12(x+h))-(10x^3+7x^2-12x)}{h} \longrightarrow \frac{30hx^2+30h^2x+10h^3+14hx+7h^2-12h}{h}$$

$$\frac{h(30x^2+30hx+10h^2+14x+7h-12)}{h} \longrightarrow 30x^2+30hx+10h^2+14x+7h-12$$

$$30x^2+30(0)x+10(0)^2+14x+7(0)-12$$

$$30x^2+14x-12$$

# Differentiation Rules Practice

II. $\dfrac{2x+5}{3x-2}$

$$\lim_{h \to 0} \frac{\left(\frac{2(x+h)+5}{3(x+h)-2}\right) - \left(\frac{2x+5}{3x-2}\right)}{h} \longrightarrow \frac{-19h}{(3x+3h-2)(3x-2)} \longrightarrow \frac{-19\cancel{h}}{(3x+3h-2)(3x-2)} \cdot \frac{1}{\cancel{h}}$$

$$\frac{-19}{(3x+3h-2)(3x-2)} \longrightarrow \frac{-19}{(3x+3(0)-2)(3x-2)} \longrightarrow \frac{-19}{(3x-2)(3x-2)} \longrightarrow \frac{-19}{(3x-2)^2}$$

III. $x^3e^x$

$$\lim_{h \to 0} \frac{(x+h)^3 - (x)^3}{h} \longrightarrow \frac{3hx^2 + 3h^2x + h^3}{h} \longrightarrow \frac{\cancel{h}(3x^2 + 3hx + h^2)}{\cancel{h}} \longrightarrow 3x^2 + 3hx + h^2$$

$$3x^2 \longleftarrow 3x^2 + 3(0)x + (0)^2 \longleftarrow 3x^2 + 3(0)x + (0)^2$$

$$\frac{d}{dx}(e^x) \longrightarrow e^x$$

Natural Exponential Function

$$(x^3 \cdot e^x) + (e^x \cdot 3x^2) \longrightarrow x^3e^x + 3x^2e^x \longrightarrow e^x(x^3 + 3x^2)$$

Product Rule

# Differentiation Rules Practice

IV. $2e^{-x} + e^{3x}$

Product Rule (Special Natural Exponential)

$$2\frac{d}{dx}(e^{-x}) \longrightarrow (-e^{-x}) \longrightarrow (2)(-e^{-x}) \longrightarrow -2e^{-x}$$

Constant Multiple

$$\frac{d}{dx} e^{3x} \longrightarrow 3e^{3x}$$

Product Rule (Special Natural Exponential)

$$-2e^{-x} + 3e^{3x}$$

Sum Rule

V. $x^3e^x$ (Power / Natural Exponential)

$$\frac{d}{dx} x^3 \longrightarrow 3x^2$$

Power Rule

$$\frac{d}{dx} e^x \longrightarrow e^x$$

Natural Exponential Function

$$e^x \cdot 3x^2 + e^x \cdot x^3 \longrightarrow e^x(x^3 + 3x^2)$$

Product Rule

# Differentiation Rules Practice

VI. $xe^{-x}$

$$\lim_{h \to 0} \frac{(x+h)-(x)}{h} \longrightarrow \frac{h}{h} \longrightarrow 1$$

$$\frac{d}{dx}(e^{-x}) \longrightarrow -e^{-x}$$

Product Rule (Special Natural Exponential)

$$x \cdot -e^{-x} + e^{-x} \cdot 1 \longrightarrow x \cdot -e^{-x} + e^{-x} \longrightarrow -xe^{-x} + e^{-x} \longrightarrow e^{-x}(-x+1)$$

Product Rule

VII. $\sqrt[7]{x^2} - x^e \longrightarrow x^{2/7} - x^e \longrightarrow x^{2/7} + -x^e$

$$\frac{d}{dx}(x^{2/7}) \longrightarrow (2/7)x^{2/7-1} \longrightarrow (2/7)x^{-5/7}$$

Power Rule

$$\frac{d}{dx}(-x^e) \longrightarrow -ex^{e-1}$$

Power Rule

$$(2/7)x^{-5/7} + -ex^{e-1} \longrightarrow \frac{2}{7x^{5/7}} + -ex^{e-1}$$

Sum Rule

# Differentiation Rules Practice

VIII. $\frac{e^x}{x}$

$$\lim_{h \to 0} \frac{(x+h)-(x)}{h} \longrightarrow \frac{h}{h} \longrightarrow 1$$

$$\frac{d}{dx} e^x \longrightarrow e^x$$

Natural Exponential Function

$$\frac{x \cdot e^x - e^x \cdot 1}{x^2} \longrightarrow \frac{xe^x - e^x}{x^2} \longrightarrow \frac{e^x(x-1)}{x^2}$$

Quotient Rule

# Differentiation Rules Practice

IX. $e^x\left(\frac{1}{x^2} + x^{-\pi/2}\right)$

$$\frac{1}{x^2} \longrightarrow x^{-2} \longrightarrow \frac{d}{dx}(x^{-2}) \longrightarrow (-2x^{-3})$$

Power Rule

$$x^{-\pi/2} \longrightarrow \frac{d}{dx}(x^{-\pi/2}) \longrightarrow ((-\pi/2)x^{-((\pi+2)/2)})$$

Power Rule

$$-2x^{-3} + (-\pi/2)x^{-((\pi+2)/2)} \longrightarrow \frac{-2}{x^3} - \frac{\pi}{2x^{((\pi+2)/2)}}$$

Sum Rule

$$\frac{d}{dx}e^x \longrightarrow e^x$$

Natural Exponential Function

$$e^x\cdot\left(\frac{-2}{x^3} - \frac{\pi}{2x^{((\pi+2)/2)}}\right) + e^x\cdot\left(\frac{1}{x^2} + x^{-\pi/2}\right) \longrightarrow e^x\left(\frac{-2}{x^3} - \frac{\pi}{2x^{((\pi+2)/2)}} + \frac{1}{x^2} + x^{-\pi/2}\right)$$

Product Rule

$$\downarrow$$

$$e^x\left(\frac{x-2}{x^3} + \frac{2x-\pi}{2x^{((\pi+2)/2)}}\right)$$