Section 3.3 & 3.4:
Rules for Differentiation
&
Velocity and Other Rates of Change

Quick Review: "Derivative" means ___________________.

Now, I know you loved the limit definition of the derivative, but let's go ahead and learn some shortcuts to finding derivatives. The rest of this chapter is dedicated to those shortcuts. To be successfull in this course, you MUST learn these rules. That means a lot of memorizing and practicing! Are you ready. . .

The Constant Rule: The derivative of a constant function is 0.

$$\frac{d}{dx}[c] = 0$$

(1) $y = 7$

$y' =$ _______

(2) $f(x) = 0$

$f'(x) =$ _______

(3) $g(x) = \pi^2$

$g'(x) =$ _______

The Single Variable Rule: The derivative of a single variable is 1.

$$\frac{d}{dx}[x] = 1$$

(1) $y = x$

$y' =$ _______

(2) $f(y) = y$

$f'(y) =$ _______

(3) $s(t) = t$

$g'(t) =$ _______

The Power Rule: If n is a rational number, then

$$\frac{d}{dx}\left[x^n\right] = nx^{n-1}$$

(1) $y = x^6$

$y' =$ ______

(2) $f(x) = \sqrt{x}$

$f'(x) =$ ______

(3) $f(x) = \dfrac{1}{x}$

$f'(x) =$ ______

(4) $f(x) = \dfrac{1}{x^3}$

$f'(x) =$ ______

(5) $f(t) = \dfrac{1}{\sqrt[3]{t}}$

$f'(t) =$ ______

(6) $f(t) = \dfrac{1}{t^{3/4}}$

$f'(t) =$ ______

The Constant Multiple Rule: If f is differentiable and c is a real number, then

$$\frac{d}{dx}\left[c \cdot f(x)\right] = c \cdot f'(x)$$

(1) $y = 3x^2$

$y' =$ ________

(2) $f(x) = 4\sqrt{x}$

$f'(x) =$ ________

(3) $f(x) = \dfrac{2}{x^3}$

$f'(x) =$ ________

The Sum/Difference Rule: The derivative of a sum/difference is the sum/difference of the derivatives.

$$\frac{d}{dx}\left[f(x) \pm g(x)\right] = f'(x) \pm g'(x)$$

(1) $y = x^2 + 5x - 3$

$y' =$ ________

(2) $f(x) = 6\sqrt{x}\left(\sqrt[3]{x} - 2x + 6\right)$

$f'(x) =$ ________

(3) $f(x) = (2x-3)^2$

$f'(x) =$ ________

<u>The Product Rule</u>: The derivative of the product of two function is the first times the derivative of the second plus the second times the derivative of the first.

$$\frac{d}{dx}\left[f(x)\cdot g(x)\right]=f(x)\cdot g'(x)+g(x)\cdot f'(x)$$

(1) $y=\left(4x-2x^2\right)(3x-5)$

$y'=$ ____________________

(2) $y=\left(3x^2-2x+5\right)\left(-5x^4+2x^3-7x^2+x+2\right)$

$y'=$ ____________________

The Quotient Rule: The derivative of the quotient of two function can be found by

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)\cdot f'(x) - f(x)\cdot g'(x)}{[g(x)]^2}$$

(1)

$$y = \frac{5x+2}{x^2-1}$$

$y' =$ ________________

(2)

$$y = \frac{5x+3}{x^2+4x-2}$$

$y' =$ ________________

Use the chart to find $f'(3)$.

$g(3)$	$g'(3)$	$h(3)$	$h'(3)$
4	-2	3	π

(1) $f(x) = 4g(x) - \frac{1}{2}h(x) + 1$

(2) $f(x) = g(x)h(x)$

(3) $f(x) = \frac{g(x)}{4h(x)}$

(4) $f(x) = \frac{g(x) - h(x)}{g(x)}$

Use the defintion of the derivative and your derivative rules to evaluate the following limits.

$$\lim_{x\to 3}\frac{x^2-9}{x-3} = \_\_\_\_\_\_\_$$

$$\lim_{h\to 0}\frac{\sqrt{4+h}-2}{h} = \_\_\_\_\_\_\_$$

$$\lim_{\Delta x\to 0}\frac{\frac{1}{x+\Delta x}-\frac{1}{x}}{\Delta x} = \_\_\_\_\_\_\_$$

Determine if the function is differentiable at $x = 2$.

$$f(x) = \begin{cases} 2x^2 & x < 2 \\ 3x + 2 & x \geq 2 \end{cases}$$

$$f(x) = \begin{cases} x^3 - 4x^2 + 2 & x \leq 2 \\ -4x + 2 & x > 2 \end{cases}$$