# 2.2 Basic Differentiation Rules and Rates of Change

- Find the derivative of a function using the Constant Rule.
- Find the derivative of a function using the Power Rule.
- Find the derivative of a function using the Constant Multiple Rule.
- Find the derivative of a function using the Sum and Difference Rules.
- Find the derivatives of the sine function and of the cosine function.
- Use derivatives to find rates of change.

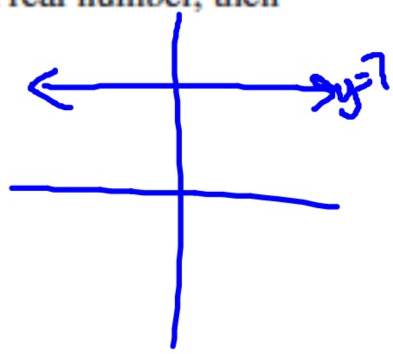
**THEOREM 2.2 THE CONSTANT RULE**

The derivative of a constant function is 0. That is, if $c$ is a real number, then

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

$f(x) = 7$

$f'(x) = 0$




$g(x) = \pi$

$g'(x) = 0$

$f(x) = 2x^1 - 1$

$f'(x) = 2$

$g(x) = 2 - x$

$g'(x) = -1$

$f(x) = x^2 - 5x$

$f'(x) = 2x - 5$

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

power rule

ex.

① $y = x^4 - x^3 + x^2 + x + 7$

$y' = 4x^3 - 3x^2 + 2x + 1 + 0$

$y' = 4x^3 - 3x^2 + 2x + 1$

② $y = 7x - x^3 + x^2 - 2$

$y' = 7 - 3x^2 + 2x$

**Findf"(x)**

**#1** $f(x) = x^2$ **#2** $f(x) = x^{-5}$

**THEOREM 2.3 THE POWER RULE**

If $n$ is a rational number, then the function $f(x) = x^n$ is differentiable and

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

For $f$ to be differentiable at $x = 0$, $n$ must be a number such that $x^{n-1}$ is defined on an interval containing 0.

Find y'. Rewrite the function to make it 'derivative ready' if necessary. Rewrite

**#3**

$$y = x^{16}$$

$$y' = 16x^{15}$$

**#4**

$$y = \frac{1}{x^8}$$

$$y = x^{-8}$$

$$y' = -8x^{-9}$$

$$y' = \frac{-8}{x^9}$$

**#5**

$$g(x) = \sqrt[4]{x}$$

$$g(x) = x^{1/4}$$

$$g'(x) = \frac{1}{4}x^{-3/4}$$

$$g'(x) = \frac{1}{4x^{3/4}}$$

**THEOREM 2.4 THE CONSTANT MULTIPLE RULE**

If $f$ is a differentiable function and $c$ is a real number, then $cf$ is also differentiable and $\frac{d}{dx}[cf(x)] = cf'(x)$.

**#6**

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

$f'(x) = 2 \cdot 3x^2 - 2x + 3$

$= 6x^2 - 2x + 3$

**#7**

$$g(x) = 6(x^2 - 5x + 3)$$

$g'(x) = 6(2x - 5)$

$g(x) = 6x^2 - 30x + 15$

$g'(x) = 12x - 30$

**#8**

$$f(t) = 3 - \frac{3}{5t}$$

$$f(t) = 3 - \frac{3}{5}t^{-1}$$

$$f'(t) = 0 + \frac{3}{5}t^{-2}$$

$$\boxed{f'(t) = \frac{3}{5t^2}}$$

**#9**

$$f(x) = \frac{x^3 - 6}{x^2}$$

$$f(x) = \frac{x^3}{x^2} - \frac{6}{x^2}$$

$$f(x) = x - 6x^{-2}$$

$$f'(x) = 1 + 12x^{-3}$$

$$= 1 + \frac{12}{x^3}$$

**#10**

$$f(x) = 3(5 - x)^2$$

$$f(x) = 3(25 - 10x + x^2)$$

$$f'(x) = 3(-10 + 2x)$$

$$= +3(2x - 10)$$

**THEOREM 2.6 DERIVATIVES OF SINE AND COSINE FUNCTIONS**

$$\frac{d}{dx}[\sin x] = \cos x \qquad \frac{d}{dx}[\cos x] = -\sin x$$

Show Geogebra demonstration...

$$\frac{d}{dx}[\sin x] = \cos x$$

$$\frac{d}{dx}[\cos x] = -\sin x$$

**#11**

$f(x) = x + 7 - \sin x$

$f'(x) = 1 - \cos x$

**#12**

$f(x) = 7x + 3\sin x - 6\cos x$

$f'(x) = 7 + 3\cos x + 6\sin x$