

**Definition of the Derivative [the Limit Definition]**

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

$$\lim_{x \rightarrow a} \frac{f(x) - f(a)}{x - a} = f'(a)$$

$$\lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h} = f'(a)$$

Based on our vast knowledge of the Power Rule, find the value of the following:  
[First re-write as a derivative]

Example:  $\lim_{h \rightarrow 0} \frac{(x+h)^2 - x^2}{h} = \frac{d}{dx}(x^2) = 2x$

Another example:  $\lim_{x \rightarrow 5} \frac{x^2 - 25}{x - 5} = \frac{d}{dx}(x^2) \Big|_{x=5} = 2x \Big|_{x=5} = 10$

Now you try:

1.  $\lim_{h \rightarrow 0} \frac{(5+h)^2 - 25}{h}$

2.  $\lim_{x \rightarrow 3} \frac{x^3 - 27}{x - 3}$

$$3. \quad \lim_{h \rightarrow 0} \frac{3(x+h) - 2 - (3x - 2)}{h}$$

$$4. \quad \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

$$5. \quad \lim_{h \rightarrow 0} \frac{2(x+h)^4 - 3(x+h)^2 - 2x^4 + 3x^2}{h}$$

$$6. \quad \lim_{x \rightarrow 5} \frac{x^4 - 625}{x - 5}$$

$$7. \quad \lim_{x \rightarrow a} \frac{x^3 - a^3}{x - a}$$

$$8. \quad \lim_{h \rightarrow 0} \frac{[-(x+h)^2 + (x+h)] - (-x^2 + x)}{h}$$