## Higher Order Derivatives

Sometimes we need to find the derivative of the derivative. Since the derivative is a function, this is something we can readily do. The derivative of the derivative is called the second derivative, and is denoted $f^{\prime \prime}(x)$.

To find the second derivative, we will apply whatever rule is appropriate given the first derivative.

Similarly, the third derivative is the derivative of the second derivative, the fourth derivative is the derivative of the third derivative, the fifth derivative is the derivative of the fourth derivative, etc.

The second, third, fourth, fifth, . . . derivatives of a function are collectively called higher order derivatives. In application, we will mostly use the second derivative. If the derivative represents a rate of change, the second derivative can be used to determine how fast the rate of change is increasing or decreasing. For example, if costs are rising, the first derivative will give the rate of change of the costs, and the second derivative will give the rate of change of increase or decrease.

Example 1: Find the second derivative: $f(x)=4 x^{6}+5 x^{3}-8 x^{2}+10 x+5$.

Example 2: Find the second derivative: $f(x)=\frac{9}{(x+4)^{6}}$.

Example 3: Find the second derivative: $f(x)=\left(x^{3}-5\right)^{3}$.

Example 4: Find the third derivative: $f(x)=\frac{1}{x-1}$.

Example 5: Find the second derivative: $f(x)=e^{4 x^{2}}$

Example 6: Find the second derivative: $f(x)=\ln \left(x^{3} e^{-2 x}\right)$

From this lesson you should be able to
Find a higher order derivative of a function

