Section 2.2

The Constant Rule and the Power Rule: The derivative of a constant function is 0. That is, if c is a real number, then

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

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.

1) Find the derivatives of the following functions:

   a) $f(x) = -3$

   b) $g(x) = x^4$

   c) $h(x) = \sqrt[3]{x^2}$

   d) $k(x) = \frac{1}{\sqrt[4]{x}}$

2) Find the equation of the tangent line to the graph of $f(x) = \sqrt{x}$ at $(4, 2)$.

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

3) Find the derivatives of the following functions:

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

b) $g(x) = \frac{2x^3}{7}$

c) $h(x) = \frac{3\sqrt{x}}{(2x)^2}$

The Sum and Difference Rules: The sum (or difference) of two differentiable functions f and g is itself differentiable. Moreover, the derivative of $f + g$ (or $f - g$) is the sum (or difference) of the derivatives of f and g.

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

4) Find the derivatives of the following functions:

a) $f(x) = 3x^3 - 2x^2 + 1$

b) $g(x) = 4\sqrt{x} - \frac{x^2}{3} + 10x$

Derivatives of Sine and Cosine Functions:

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

5) Find the derivatives of the following functions:

a) $f(x) = 3\cos x$

b) $g(x) = -\frac{\sin x}{3}$

c) $h(x) = 2x^3 - 3\cos x$

Velocity: If $s = s(t)$ is the position function for an object moving along a straight line, then the **velocity** of the object at time t is

$$v(t) = \lim_{\Delta t \to 0} \frac{s(t + \Delta t) - s(t)}{\Delta t} = s'(t).$$

6) If a hammer is dropped on the surface of the moon from a height of 50 feet, its height s at time t is given by the position function

$$s = -2.65t^2 + 50$$

where s is measured in feet and t is measured in seconds. Find the average velocity of the hammer over each of the following time intervals.

a) $[1, 2]$

b) $[1, 1.5]$

c) $[1, 1.1]$

d) Find the instantaneous velocity of the hammer at $t = 1$ (how fast is the hammer falling when exactly one second has passed?).

7) A cannonball is shot straight up from a cannon on a 24 foot tall platform. The position of the cannonball is given by

$$s(t) = -16t^2 + 92t + 24$$

where s is measured in feet and t is measured in seconds.

a) When does the cannonball hit the ground?

b) What is the velocity of the cannonball when it hits the ground?

Homework for this section: Read the section and watch the videos/tutorials. Then do these problems in preparation for the quiz #17, 24, 29, 35, 46, 55, 57, 67, 95, 98, 115