1. (10 points) Find an equation for the tangent line to the curve $y = 3(x+1)^2$ at the point (-2, 3).

2. (10 points) Newton's law of gravitation states that the gravitational force F between two bodies of mass m_1 and m_2, respectively, is given by the equation $F(r) = G\frac{m_1 m_2}{r^2}$, where r is the distance between the centers of mass of the bodies and G is the gravitational constant (G is positive). Compute $\frac{dF}{dr}$, and explain the physical significance of the sign of the derivative.

3. (12 points) Let $f(x) = e^{2x}$.

a) Is *f(x)* increasing or decreasing at *x*=1? How do you know?

a) Is $f'(x)$ increasing or decreasing at *x*=1? How do you know?

a) Let *n* be a positive integer (e.g., 1, 2, or 3). What is $\frac{d^n f}{dx^n}$?

4. (12 points) USE THE DEFINITION OF DERIVATIVE to compute the derivative of the function $f(x) = x^2$.

5. (12 points) Compute the derivatives of the following functions. YOU DON'T NEED TO SIMPLIFY YOUR ANSWERS.

a) $f(x) = \dfrac{\sin x}{x+1}$

b) $f(x) = (3x^{21} - x^{-7.2}) \cdot 4^x$

c) $f(x) = \ln(\cos(x^2))$

d) $f(x) = x^x$

6. (12 points) Each of the graphs above shows the position of a particle moving along the x-axis as a function of time, $0 \le t \le 5$. During this time interval, which particle has:

a) Constant velocity?

b) The greatest initial velocity?

c) The greatest average velocity?

d) Zero average velocity?

e) Zero acceleration?

f) Positive acceleration throughout?

7. (10 points) For each of the following statements, explain whether it's true or false. If it's false, give an example showing that it's false.

a) If $f'(x_0) = 0$, then $f''(x_0) = 0$ as well.

b) If f and g are differentiable at x_0, then $\frac{f}{g}$ is differentiable at x_0 as well.

c) If f is differentiable, then it's continuous.

d) If $f'(x) = g'(x)$ for every x, then $f(x) = g(x)$ for every x.

e) If $f(x) = g(x)$ for every x, then $f'(x) = g'(x)$ for every x.

8. (12 points) Uncle Ant is flying a kite. The kite is at a constant altitude of 400 feet, being blown away from Uncle Ant horizontally at a constant speed. If it's directly over his head at 9:00 am, and it's moved 800 feet horizontally by 1:00 pm, how fast is the string being payed out at the time when 500 feet of string is already out? (Assume that the string is perfectly taut, so that it forms a straight line, and that Uncle Ant's height is 0.)

9. (10 points) DO ONLY ONE of the following problems. I will grade only one of them, so if you try both, be sure to tell me which one you want graded.

a) Prove the quotient rule. (You may use any other rules that we've learned.)

b) State the definition of the derivative of the function *f(x)* at the point x_0. Using a picture, explain (in words) why the slope of the tangent line to the graph *y=f(x)* at the point x_0 is given by that definition. Be sure to label your picture well.