This lab is due in class on Friday. You can choose your own groups for this lab. Remember that there will be a quiz in class tomorrow. You should know the basic differentiation rules, from last week's lab, as well as the derivatives of sin(x) and cos(x). You do not have to know the chain rule or the derivatives of the other trigonometric functions at this time.

1. For practice on derivatives of trigonometric functions, compute the following derivatives:

a) $\dfrac{d}{dt}(\tan(t) + 5\cos(t))$ **b)** $\dfrac{d}{dx}\dfrac{1}{2+\sin(x)}$ **c)** $\dfrac{d}{d\theta}\dfrac{1+\sec(\theta)}{1+\csc(\theta)}$

d) $\dfrac{d}{dx}(x\sec(x)\tan(x))$ **e)** $\dfrac{d}{dx}\left(\dfrac{5\tan(x)+3x^3\sin(x)}{(x^2+1)\sec(x)}\right)$

2. Remember that the poor notation $\sin^2(x)$ really means $(\sin(x))^2$!

a) Compute $\frac{d}{dx}\sin^2(x)$. (This can be done using the chain rule or by applying the product rule to $\sin(x)\cdot\sin(x)$.)

b) Compute $\frac{d}{dx}\cos^2(x)$.

c) Now, compute $\frac{d}{dx}(\sin^2(x)+\cos^2(x))$, and explain why the answer is so simple.

3. If a and b are constants, then $\frac{d}{dx}\sin(ax+b) = a\cos(ax+b)$ and $\frac{d}{dx}\cos(ax+b) = -a\sin(ax+b)$. This can be shown using the chain rule.

Suppose that an object moves along a line and that its position at time t is $s(t)$. Suppose that the acceleration, $s''(t)$, of the object has the property that $s''(t) = -ks(t)$ for some positive constant k. (The equation $s''(t) = -ks(t)$ is an example of a *differential equation*, and this particular equation is the differential equation for a physical system called a *harmonic oscillator*.) Show that for any constants A and B, the function $s(t) = A\sin(\sqrt{k}\cdot t + B)$ satisfies $s''(t) = -ks(t)$. The motion of any harmonic oscillator can be given by a function of this form.

4. A function $f(x)$ is defined to be **even** if $f(-x) = f(x)$ for all x. And a function $f(x)$ is defined to be **odd** if $f(-x) = -f(x)$ for all x, For example, x^2 and $\cos(x)$ are even functions, while x^3 and $\sin(x)$ are odd functions. What happens when you take the derivative of an even or odd function? Try some specific examples! Invent a theorem about the derivatives of odd and even functions, and show that your theorem is true. (You will need the fact that $\frac{d}{dx}g(cx) = cg'(cx)$ for a constant c. This fact follows from the chain rule.)

5. Angles are more commonly measured in degrees instead of radians. We know that $x^\circ = \frac{\pi}{180}x$ radians (where x° means x degrees). This means that we could write $\sin(x^\circ) = \sin\left(\frac{\pi}{180}x\right)$ and $\cos(x^\circ) = \cos\left(\frac{\pi}{180}x\right)$, where on the right, angles are properly measured in radians. Find formulas for the derivatives of sine and cosine when angles are measured in degrees. That is, find $\frac{d}{dx}\sin(x^\circ)$ and $\frac{d}{dx}\cos(x^\circ)$. Angles should also be measured in degrees in the answers. (This problem shows one reason why angles in calculus are measured in radians!)

6. For review: Is the following function continuous at $x = -2$? at $x = 0$? at $x = 2$? Is it differentiable at $x = -2$? at $x = 0$? at $x = 2$?

$$f(x) = \begin{cases} 4 - x^2, & \text{if } x < -2 \\ 4x, & \text{if } -2 \le x < 0 \\ x^2, & \text{if } 0 \le x < 2 \\ 4x - 4, & \text{if } x \ge 2 \end{cases}$$

7. Shown here is the graph of a function $f(x)$. Based on this graph, draw a graph of the derivative function $f'(x)$. The derivative graph can't be perfect, but you should try to make it reasonably accurate.