1. Write down the chain rule three ways: in Newton's notation (using primes), in Liebniz notation (using differentials), and as a sentence about inner and outer functions.

2. Assume that $f(x)$ is a differentiable function and that the values of $f(x)$ and its derivative at the points $x = 0, 1, 2$, and 3 are given by:

x	$f(x)$	$f'(x)$
0	3	-1
1	5	0
2	-2	3
3	6	1

Let $g(x) = x^2 - 3x + 2$. For each function below, calculate the derivative at the given point.

(a) $f(x)g(x)$; $x = 2$ (b) $\frac{f(x)}{g(x)}$; $x = 1$
(c) $f(g(x))$; $x = 0$ (d) $f(g(x))$; $x = 1$

3. (a) Imagine a road on which the speed limit is specified at every single point. In other words, there is a certain function L such that the speed limit x miles from the beginning of the road is $L(x)$. Two cars A and B, are driving along this road; car A's position at time t is $a(t)$, and car B's is $b(t)$.

(b) What equation expresses the fact that the car A always travels at the speed limit? (Hint: the answer is *not* $a'(t) = L(t)$.)

(c) Suppose that A always goes at the speed limit, and that B's position at time t is A's position at time $t - 1$. Show that B is also going at the speed limit at all times.

(d) Suppose B always stays at a constant distance behind A. Under what circumstances will B still always travel at the speed limit?

4. Differentiate the following.

(a) $f(x) = (1 + \sqrt{x})^{\frac{1}{2}}$ (b) $g(x) = [(x^2 + 1)^2 + (x^2 + 1) + 1]^2$
(c) $f(x) = [x - \frac{2}{x + \sin x}]^{-1}$ (d) $f(x) = \sin(\frac{\cos x}{x})$

5. Let $S(x)$ =sine of x radians (the usual $sin(x)$ function we've been using).
Let $G(x)$ = sine of x **degrees**.
Similarly, let $C(x)$ =cosine of x radians, and let $H(x)$=cosine of x degrees.

(a) Are S and G the same function? For what values of x is $S(x) = G(x)$? What about $C(x)$ and $H(x)$?

(b) Express $G(x)$ and $H(x)$ in terms of $S(x)$ and $C(x)$.

(c) What is $\dfrac{dG}{dx}$? What is $\dfrac{dH}{dx}$? (Hint: Use part a) and the chain rule.)

(d) Express $\dfrac{dG}{dx}$ and $\dfrac{dH}{dx}$ in terms of $G(x)$ and $H(x)$. (No mention of sin or S or cos or C allowed.)

(e) Is it still true that $(G(x))^2 + (H(x))^2 = 1$?

(f) Why don't we use the unit of degrees in calculus?

6. Find $f'(x)$ in terms of $g(x)$ and $g'(x)$, where $g(x) > 0$ for all x. *(Recall: If c is a constant, then $g(c)$ is a constant.)*

   (a) $f(x) = g(x)(x - a)$ (b) $f(x) = g(a)(x - a)$ (c) $f(x) = g(x + g(x))$

   (d) $f(x) = \sqrt{g(x)^2}$ (e) $f(x) = \sqrt{g(x^2)}$ (f) $f(2x + 3) = g(x^2)$

   Hint for 5f: You can write x as $x = 2\frac{(x-3)}{2} + 3$.