Instructions: Each group will get half the chalkboard. For each problem, choose a person to be the primary writer. Your group will discuss the problem together, and the writer will write the work up carefully on the board. Other group members can help, but be sure each person gets a turn to be the primary writer. When you have finished writing all your work for one problem on the board, stop and show it to the teacher for comments and discussion. Once the teacher approves, you can erase it and go on to the next problem.

1. Let $y = sin^{-1}(x)$. (Notation: recall that $sin^{-1}(x)$ is defined to be the inverse function of $sin(x)$. It is pronounced "sine inverse" and it is also known as $arcsin(x)$. It is not the same as $1/sin(x)$.)
   (a) Solve the equation $y = sin^{-1}(x)$ for $x$.
   (b) Use implicit differentiation and the derivative rules we already know to find an expression for $\frac{dy}{dx}$.
   (c) Use trig identities to write your derivative expression in terms of $x$ only. (Check that this matches the derivative of $sin^{-1}(x)$ given in the back of your book.)
   (d) Use the same technique to find the derivative of $tan^{-1}(x)$.
2. Use the same technique as in the previous problem to find a general expression for the derivative of an inverse function, that is, set $y = f^{-1}(x)$, assume $f$ is differentiable and invertible, and find an expression for the derivative of $f^{-1}(x)$.
3. (a) Let $f(x) = \sqrt{x^3 + 1}$. Find $(f^{-1})'(3)$ in two ways: by using the above formula without finding $f^{-1}(x)$, and by finding $f^{-1}(x)$ and then taking its derivative.
   (b) Let $f(x) = x^3 + 2x + 3$. Find $(f^{-1})'(0)$. Is it practical to use both of the methods in the previous problem? Why or why not? You may assume that this $f(x)$ passes the horizontal line test. (Why do you need that assumption?)
   (c) Show that if a function $f$ with the property $f'(x) = f(x)$ has inverse $g$, then $g'(x) = \frac{1}{x}$. (Hint: what is $g(f(x))$? And if you prefer, you can equivalently write $f^{-1}$ throughout instead of $g$.) Use this to show that the derivative of $\ln x$ is $1/x$.
4. (a) You are standing at the end of Navy Pier. A plane is traveling in a straight line directly overhead towards Michigan, maintaining a constant altitude of $h$ feet. Assume that the sun is directly above the plane, so the shadow cast by the plane on the lake is always directly below the plane. Write an expression for the angle of elevation of the plane when the shadow is $w$ feet away from the end of Navy Pier.
   (b) In the situation above, suppose that the plane is flying at an altitude of 35,000 feet at 830 feet per second. How fast is the angle of elevation changing if it passed overhead three seconds ago?