1) Find the limit if it exists: $\lim\limits_{x \to 0} \dfrac{2x(\cot x - \csc x)}{\cos x - 1}$ (Hint: write all trig functions in terms of sine and cosine)

2) Is the function $f(x) = \begin{cases} x^3 + 1 & \text{when } x \leq 1 \\ 3x - 1 & \text{when } x > 1 \end{cases}$ differentiable at $x = 1$? Show the work that leads to your answer.

3) For the function in #2, find the *equation* of the tangent line at
   a) $x = 0$ b) $x = 2$

   c) $x = 1$ (if the function is differentiable at 1)

4) Given $xy^3 = 1$, use implicit differentiation to find y'.

5) Given $y^2 - x^3 - 2x = 0$, use implicit differentiation to find y''.

6) Trying to have the most creative physics project, Brendan and Sherman dangle Mr. Murphy from the top of the SLC on the end of a bungee cord. They calculate the equation for Mr. Murphy's position as being $s(t) = 75\,e^{-t/5}(\cos 2t) + 75$ over a period of 12 seconds approximating the SLC to be about 150 feet high. The diagram of the motion is displayed below.
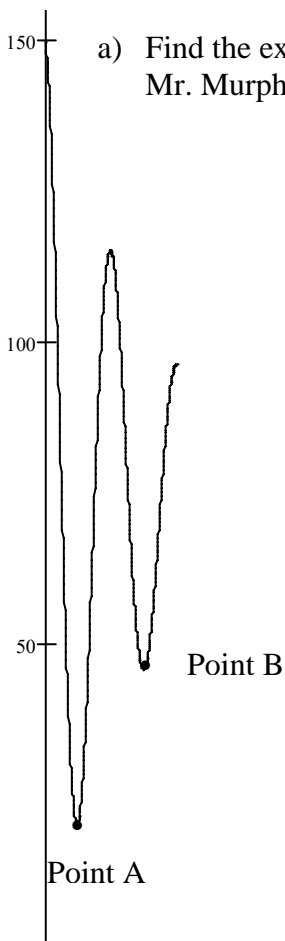
a) Find the expression for Mr. Murphy's velocity and use it and your calculator to find when and where Mr. Murphy is dangling at his lowest point (Point A)

Point B

Point A

b) Use $v(t)$ found in part a) to find out Mr. Murphy's second lowest point (Point B)

7) As they pull Mr. Murphy back up to the ledge, the cord breaks on the way up and Mr. Murphy plunges 128 feet onto a huge airbag that Herman and Evan put down to break his fall. Naomi, who is supposed to be there helping out wonders, "I wonder when his instantaneous velocity will equal his average velocity on the way down." Given that the equation for his free fall is $s(t) = 128 - 16t^2$

   a) Find the answer to Naomi's question.

   b) While Naomi is pondering this question, Gio wonders "I wonder when his instantaneous acceleration will equal his average acceleration? Find the answer to Gio's question.