1. **Chain Rule:** Let $z = \arctan\left(\dfrac{x}{y}\right)$, $\quad x = \ln(u - v)$, $\quad$ and $\quad y = u^2 v$. Find $\dfrac{\partial z}{\partial v}$ and $\dfrac{\partial z}{\partial u}$.

2. You are standing on a hill whose shape is give by the equation: $z = 1000 - 0.01x^2 - 0.02y^2$ where x, y, and z are given in feet. You are standing at the point with coordinates $(50, 80, 847)$. The positive x axis points east and the positive y axis points north.
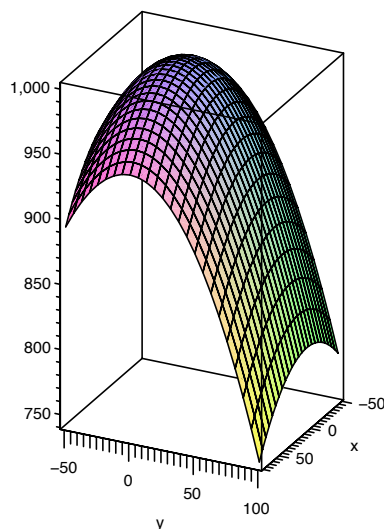
   (a) **Partial Derivatives**: If you walk due north or due east, will you start to ascend or descend? At what rate?

   (b) **Directional Derivatives:** If you walk due south or due northwest, will you start to ascend or descend? At what rate?

   (c) **Gradient:** In which direction (as a 2 dimensional vector) is the slope largest? What is the rate of ascent in that direction?

   (d) **Angle between Vectors:** At what angle above the horizontal will you be heading if you head in the direction from part (c)?

   (e) In which directions in 3 dimensional space would you be heading if you started at your present location and walked in the compass directions from part (c) ?

   (f) **Normal Vector:** Find a vector perpendicular to the surface of the hill at $(50, 80, 847)$ by thinking of this surface as a level surface for $f(x, y, z) = 1000 - 0.01x^2 - 0.02y^2 - z$. Verify that this vector and the vector from part (e) are perpendicular.