1. Suppose $D_{\vec{u}}f(7, 9) = 4$ for $\vec{u} =< 2, 3 >$. Find the value of each of the following. If it is not possible to calculate the value say so.
a. $D_{\vec{v}}f(7, 9)$ for $\vec{v} =< 200, 300 >$.
b. $D_{\vec{v}}f(7, 9)$ for $\vec{v} =< -200, -300 >$.
c. $D_{\vec{v}}f(7, 9)$ for $\vec{v} =< -3, 2 >$.

2. Say whether each of the following statements is true or false. If false, change a couple of words in the statement to make it true.
a. If $z = f(x, y)$ is a function of two variables and $\vec{u} =< 6, 1 >$ is a vector such that the directional derivative of f at the point $(2, 5)$ in the direction of $\vec{u}$ is as large as possible, then $\nabla f(2, 5) =< 6, 1 >$.
b. If $z = f(x, y)$ is a function of two variables, then the vector $\nabla f(a, b)$ is perpendicular to the surface $z = f(x, y)$ at the point $(a, b, f(a, b))$.
c. If $w = f(x, y, z)$ is a function of three variables, then the vector $\nabla f(a, b, c)$ is perpendicular to the surface $f(a, b, c) = f(x, y, z)$ at the point (a, b, c).

3. Suppose the temperature (in C°) at a point (x, y, z) in space is given by the function $T(x, y, z) = 3x^2 + 2y^2 + z^2$.
a. Describe the isotherms - that is, describe as precisely as possible the set of points where the temperature is constant.
b. In which direction from the point $(1, 1, 1)$ does the temperature increase at the fastest rate? What is the rate of temperature increase in this direction?
c. Suppose a particle passes through the point $(1, 1, 1)$ as it moves in a straight line toward the point $(2, 1, 0)$ at the constant speed of 10 units/sec. Find the rate at which the temperature of the surrounding environment of the particle is changing at the instant it passes through the point $(1, 1, 1)$.

4. Find a parameterization of the steepest tangent line to the surface $z = f(x, y) = \sqrt{9 - x^2 - y^2}$ at the point $(2, 1, 2)$.