1. An object is moving in 3-space according to the parametric equations $x = \cos t$, $y = \sin t$ and $z = 4t^2$. Find as functions of time $t$

   a) unit tangent vector $\vec{T}$.

   b) tangential component of acceleration $a_T$.

Now at $t = \frac{\pi}{2}$ seconds find

   c) curvature $\kappa$.

   d) normal component of acceleration $a_N$. 
2. A particle is moving in the plane. Suppose you know that at 
$t = 2$ seconds the position vector is \( \vec{r}(2) = \vec{i} + 2\vec{j} \), the velocity vector is 
\( \vec{v}(2) = 2\vec{i} - \vec{j} \) and the acceleration vector is \( \vec{a}(2) = -3\vec{i} + 4\vec{j} \). Using this 
information only, answer the following questions. Do not attempt to find \( \vec{r} \), \( \vec{v} \) 
and \( \vec{a} \) as functions of \( t \). Assume distance is measured in feet.

At \( t = 2 \) seconds

a) at which point is the particle located?

b) what is the speed?

c) what is the unit tangent vector \( \vec{T} \)?

d) what is the value of \( a_T \)?

e) what is the value of \( a_N \)?

f) is it speeding up or slowing down? Why?
3. An object is moving in the plane along the curve $y = 2 - x^2$ from left to right. It is moving at a constant speed of 3 ft/sec.

a) Find $a_T$ and $a_N$ at the point $(x, 2 - x^2)$.

b) Find the velocity vector and the acceleration vector when the object is at the point $(0, 2)$. 
4. As accurately as you can sketch the surfaces in 3-space determined by the following equations

a) \( y = x^2 \)

b) \( z = 4 - x^2 - y^2 \)

c) \( z = \sqrt{x^2 + y^2} \)
(10) 5. Find the equation of the plane which is tangent to the surface 
\[ z = 4 - x^2 - y^2 + 3xy \] at the point (2, 1, 5).
(15) 6. Find all points on the surface \( z = y(x^2 + 2x - 3) - \frac{y^2}{2} \) at which the tangent plane is horizontal.
(10) 7. Calculate all the second partial derivatives of the function \( f(x, y) = e^{xy^2} \).