1. Let $\Delta$ be the triangle having the vertices $P(-1,1,-1)$, $Q(1,1,1)$, and $R(1,2,3)$. Let $\Pi$ be the plane containing $\Delta$.

a) Find a unit vector which is normal to $\Pi$.

b) Find the area of $\Delta$.

c) Find an equation for $\Pi$.

d) Find parametric equations for the line $\ell$ perpendicular to $\Pi$ and containing $Q$.

e) Find the angle in $\Delta$ at the vertex $P$. 
2. A point is moving along a curve $C$ in 3-space, according to the parametric equations

\[ x = t, \quad y = \sin t, \quad z = t^2. \]

a) Determine (as functions of $t$) the position vector $\vec{r}(t)$, velocity vector $\vec{v}(t)$, and acceleration $\vec{a}(t)$ for the above parametrization of $C$.

b) Are there any values of $t$ for which the parametrization is not smooth? Why?

c) Find the tangential component of the acceleration as a function of $t$.

d) Find the curvature $\kappa$ when $t = 0$.

e) Find the normal component of the acceleration when $t = 0$. In plain English, what does the result say about the relationship between $\vec{a}(0)$ and $\vec{v}(0)$?
3. A point is moving along a curve in 3-space, in such a way that the acceleration vector is
\[ \vec{a}(t) = \langle 0, 1, e^t \rangle. \]
Suppose that \( \vec{v}(0) = \langle 1, 1, 1 \rangle \) and \( \vec{r}(0) = \langle 0, 0, 1 \rangle \).

a) Find the position vector \( \vec{r}(t) \).

b) Find parametric equations for the tangent line to the curve when \( t = 1 \).

4. Find the arc-length of the elliptical spiral
\[ a = A \cos t, \quad y = A \sin t, \quad z = Bt \]
as \( t \) goes from 0 to \( 2\pi \).
(11) 5. Find an equation for the circle of curvature for the graph of $y = \sin x$ at the point $(\pi/6, 1/2)$. (If time is running out, at least find the radius of this circle.)