(20) 1. An object is moving in 3-space according to the parametric equations 
\( x = t, \ y = t, \ z = t^2 \). Find as functions of the time \( t \)

a) the position vector \( \vec{r} = \)

b) the velocity vector \( \vec{v} = \)

c) the acceleration vector \( \vec{a} = \)

d) the speed \( \frac{ds}{dt} = \)

e) the tangential component of acceleration \( a_T = \)

f) The curvature \( \kappa = \)

g) the normal component of acceleration \( a_N = \)
2. An object is moving in the plane in such a way that its acceleration vector as a function of time \( t \) is \( \vec{a} = (\cos t)\vec{i} + \vec{j} \). Suppose at time \( t = 0 \), the velocity vector is \( \vec{v}(0) = \vec{j} \) and the position vector is \( \vec{r}(0) = \vec{i} + \vec{j} \). Find the velocity vector and the position vector as functions of \( t \) and then give the parametric equations for the motion.
3. An object is moving along a curve in 3-space at a constant speed of 4 ft/sec. Suppose the curve is not a straight line and the curvature as a function of time is $\kappa(t) = \frac{1}{1 + t^2}$.

a) Explain why the acceleration vector $\vec{a}$ is not $\vec{0}$, even though the speed is constant, and find $|\vec{a}|$ as a function of $t$.

b) Show that the velocity vector is perpendicular to the acceleration vector at each instant.

Note: This is just like two of the practice problems.
4. Given the points $P(1, 1, 0)$, $Q(2, 2, 2)$, $R(3, 4, 0)$, let $\Delta$ denote the triangle having $P$, $Q$ and $R$ as its vertices.

a) Find the angle of $\Delta$ at the vertex $P$.

b) Find the area of the triangle $\Delta$.

c) Find the equation of the plane which contains $\Delta$. 
5. Find parametric equations for the following lines:

a) The line through \( P(2, 1, 0) \) and \( Q(1, 3, 4) \).

b) The line through \( P(1, 3, 2) \) and perpendicular to the plane 
\[ 2x - 4y + 3z = 2. \]

c) The line of intersection of the planes \( x + y + z = 0 \) and \( 2x + 3y + z = 6 \).
(15) 6. Let \( \vec{a} = 2\vec{i} - \vec{j} + \vec{k} \)
\( \vec{b} = 2\vec{i} + \vec{j} + 2\vec{k} \)

a) \( \text{comp}_b \vec{a} = \)

b) Find vectors \( \vec{a}_\parallel \) and \( \vec{a}_\perp \) such that \( \vec{a} = \vec{a}_\parallel + \vec{a}_\perp \), \( \vec{a}_\parallel \) is parallel to \( \vec{b} \) and \( \vec{a}_\perp \) is perpendicular to \( \vec{b} \).