(20) 1) Given the points $P(1, 0, 1), Q(1, 1, 0)$ and $R(0, 1, 4)$ in 3-space.
   a) Find the angle, in degrees, at the vertex $P$ of the triangle having vertices $P, Q, R$.

   b) Find the area of the triangle having vertices $P, Q$ and $R$.

   c) Find the equation of the plane containing the points $P, Q$ and $R$. 
2.a) Find the equation of the plane which contains the point $P(2, 3, -1)$ and is perpendicular to the line $x = 1 + 4t, y = 2 - t, z = 3t$

b) Find the parametric equations for the line through $P(2, 3, -1)$ which is perpendicular to the plane $3x + 4y - 6z = 24$. 
(20) 3) An object is moving in 3-space according to the parametric equations \( x = t^2 + 1, \ y = t^3, \ z = t \) where \( t \) is the time. Find, as functions of \( t \)

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

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

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

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

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

f) curvature \( \kappa = \)

g) normal component of acceleration \( a_N = \)
4) An object is moving in 3-space in such a way that its acceleration vector as a function of the time $t$ is $\vec{a} = 2\vec{i} + (\cos t)\vec{j}$. Suppose you know that at time $t = 0$ its velocity vector is $\vec{v}(0) = \vec{i} + \vec{k}$ and its position vector is $\vec{r}(0) = \vec{i} + \vec{j} + \vec{k}$. Find the velocity vector and the position vector as functions of $t$. Now give the parametric equations for the motion.
5) An object is moving in the plane along the curve $y = \frac{1}{x}$, $x > 0$. It is moving from left to right at a constant speed of 4 ft/sec.

a) Find $a_T$ and $a_N$ when the object is at the point $\left( x, \frac{1}{x} \right)$.

b) Find the velocity vector and the acceleration vector when the object is at the point $(1, 1)$. 
(20) 6) Carefully sketch the following surfaces.

a) \( x^2 - y + z^2 + 1 = 0 \)

b) \( x^2 - y^2 + z^2 = 0 \)

c) \( y^2 + z = 1 \)

d) \( x + y + 2z = 4 \)