1. \( x = \sin t - \cos t , \ y = \sin t + \cos t \) is a parametric curve in the plane.

a) Find \( \frac{dy}{dx} \) as a function of \( t \).

b) Find the equation of the tangent line to the curve when \( t = 0 \).

c) Find the equation of the tangent line to the curve when \( t = \frac{\pi}{2} \).

d) Find the arc length of the piece of the curve obtained when \( 0 \leq t \leq \frac{\pi}{2} \).
2. The three points in space \( A(1,0,1) \), \( B(4,2,1) \), \( C(0,1,2) \) determine a triangle with the points as vertices.

a) Find the angle of the triangle at the vertex \( A \).

b) Calculate the area of the triangle.

c) Find the equation of the plane which contains the triangle.

d) Give parametric equations for the line which passes through the point \( C \) and is perpendicular to the triangle.
3. Given the three vectors $\vec{a} = \vec{i} + \vec{j} + 2\vec{k}$, $\vec{b} = 2\vec{i} - 6\vec{k}$, $\vec{c} = \vec{j} + \vec{k}$,

a) Calculate the volume of the parallelepiped determined when $\vec{a}$, $\vec{b}$ and $\vec{c}$ are placed with the same initial point.

b) Find $\text{comp}_\vec{b} \vec{a}$.

c) Find a vector $\vec{v}$ so that $\vec{v}$ is parallel to $\vec{b}$ and $\vec{a} - \vec{v}$ is perpendicular to $\vec{b}$. 
4. An object is moving in the plane according to the parametric equations $x = \cos t$, $y = 3 \sin t$ where $t$ is the time.

Find as functions of the time $t$,

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) sketch the path of motion

h) what is the largest value of the curvature the object encounters? The smallest value?
5. An object is moving in 3-space in such a way that its acceleration vector as a function of time is \( \vec{a} = \vec{j} + (\sin t)\vec{k} \). Suppose that at time \( t = 0 \) the velocity vector is \( \vec{v}(0) = \vec{i} - \vec{k} \) and the position vector is \( \vec{r}(0) = \vec{i} + \vec{j} \).

a) Find the velocity vector as a function of \( t \).

b) Find the position vector as a function of \( t \).

c) Write the parametric equations of motion.

d) Find the curvature when \( t = \frac{\pi}{2} \).
6. A projectile is fired from the top of a 320 foot building. Its angle of inclination with the horizontal is $30^\circ$. If its initial speed is 576 ft/sec find the horizontal distance from its launching point to the point where it hits the earth.