Math 163 **The Velocity Vector**

1. Prove that the tangent lines to the helix $\mathbf{r} = < 3\cos 2t, 3\sin 2t, 3t >$ make a constant angle with the xy-plane and find that angle.

2. A force acting on a particle causes the particle to move in a curve. The position of the particle at time t seconds is given by the function $\mathbf{r} = < t^2, 4t, t^3 >$, $0 \le t \le 1$. If the force is removed at time $t = 1$ second (so that the net force on the particle is zero), find the position of the particle three seconds later.

3. A particle moves with a constant velocity. At time $t = 0$ seconds it passes the point $(2, 1, 5)$ and at time $t = 4$ seconds it passes the point $(3, 0, 2)$. Find parametric equations that give the position of the particle at time t seconds.

4. The position of a particle at time t seconds is given by the function

$$\vec{r}(t) =< t^2 - 4t + 4, 6t - 24, t^2 - 3t >$$

a. When is the particle moving parallel to the plane $x + 2y - 3z = 6$?
b. When is the particle moving directly toward the origin? When is it moving directly away from the origin?

5. The position of a particle at time t seconds is given by the function

$$\vec{r}(t) =< t^2 - 4t + 1, 6t - 10, t^2 + 4t - 25 >$$

a. When is the particle moving directly away from the plane $x + 3y + 5z = 5$? When is it moving directly toward this plane?

6. Sketch the logarithmic spiral $\mathbf{r} = < e^t \cos t, e^t \sin t >$, $t \in \mathcal{R}$. Prove that the curve intersects the lines through the origin at a constant angle and find that angle.