1. Consider the set of parametric equations \( x = 5t^3 + 1, y = \ln t, t > 0 \).
   a. Find its rectangular (Cartesian) equation.
   b. Determine \( \frac{dy}{dx} \) in terms of \( t \).
   c. Determine \( \frac{dy}{dx} \) in terms of \( x \).
   d. Make a sketch of the curve. Label the direction as \( t \) increases. Label any horizontal or vertical tangent lines.

2. Consider the curves \( r = 1 - \sin \theta, \, r = 1 + \cos \theta \)
   a) Graph both curves
   b) Find all the intersection points
   c) Find the area of the region inside the cardioid \( r = 1 + \cos \theta \) and outside the cardioid \( r = 1 - \sin \theta \)

3. Find the Cartesian equation of the given polar equation \( r - 3 \cos \theta = 0 \)

4. Consider the two vectors \( \mathbf{u} = \langle 2, 3, 1 \rangle \) and \( \mathbf{v} = \langle 2, 4, -5 \rangle \)
   a) Find the angle between the vectors.
   b) Find \( \text{proj}_v \mathbf{u} \)
   c) Express \( \mathbf{u} \) as the sum \( \mathbf{u} = \mathbf{p} + \mathbf{n} \) where \( \mathbf{p} \) is parallel to \( \mathbf{v} \) and \( \mathbf{n} \) is orthogonal (perpendicular) to \( \mathbf{v} \).

5. Find the area of the triangle with vertices \( A = (0,1,2), \, B = (6,2,1), \, C = (4,0,5) \)

6. Consider the pair of lines \( \mathbf{r}(t) = \langle 4t, 1 + 2t, 3t \rangle \) and \( \mathbf{R}(s) = \langle -1 + s, -7 + 2s, -12 + 3s \rangle \)
   a) Find the point of intersection.
   b) Determine the equation of the line that is perpendicular to these two lines and passes through the point of intersection.
   c) Determine the equation of the line that is parallel to \( \mathbf{R}(s) \) and passes through \( (0,0,0) \)

7. Re-parameterize the curve with respect to arc length, \( s \), measured from the point where \( t = 0 \) in the direction of increasing \( t \). \( \mathbf{R}(t) = 2t \mathbf{i} + (1 - 3t) \mathbf{j} \)

8. Let \( \mathbf{r}(t) = t \mathbf{i} + \cos t \mathbf{j} + \sin t \mathbf{k}, \, 0 \leq t \leq 4\pi \). Find the tangent line to \( \mathbf{r}(t) \) at the point \( (\pi, -1, 0) \).

9. If the acceleration of a particle is \( \mathbf{a}(t) = -9.8 \mathbf{k} \) and the particle starts at the point \( (1, 2, 3) \) with the initial velocity \( \mathbf{v}(t) = \mathbf{i} + 2 \mathbf{k} \), find \( \mathbf{r}(t) \) and the speed of the particle for time \( t \).

10. What force is required so that a particle of mass \( m \) has position function \( \mathbf{R}(t) = t^3 \mathbf{i} + t^2 \mathbf{j} \)?