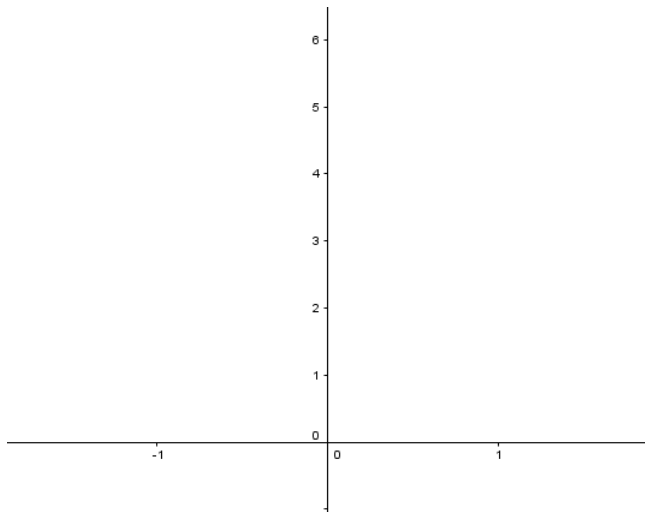Show all work for full credit.

1. Let $x = \sin(\pi t)$ and $y = 4t^2 + 2t$, $-1 \le t \le 1$

   (a) (10 points) Sketch the graph of the parametric equations on the interval $[-1, 1]$. Start with $t = -1$ and increase by $1/2$.
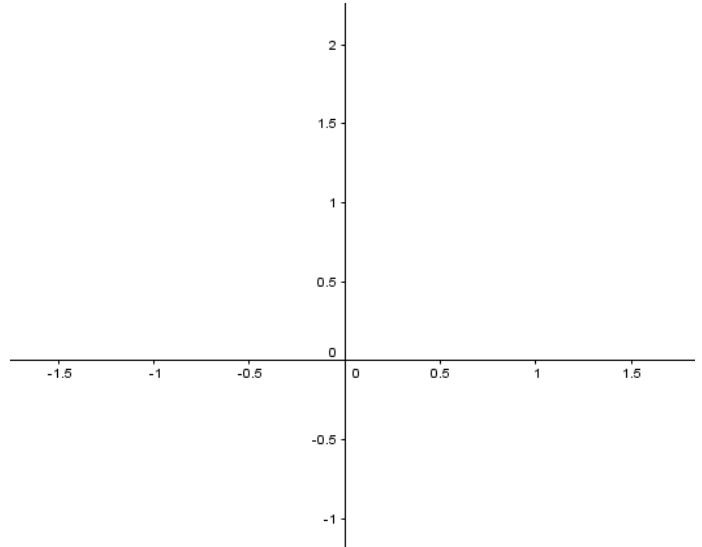
   (b) (10 points) Find the equation of the tangent line at $t = 0$. Draw the line in the graph above.

   (c) (5 points) Set up the integral for the arc length.

2. Let $r_1(\theta) = 1$ and $r_2(\theta) = 1 + \sin(\theta)$.

   (a) (10 points) Sketch r_1 and r_2.

   (b) (15 points) Evaluate the integral that represents the area inside $r_2 = 1 + \sin(\theta)$ outside $r_1 = 1$ and

3. Let Let $P(3,1,2)$, $Q(6,0,5)$, and $R(8,9,0)$ be three points.

    (a) (6 points) Find the vectors $\vec{a} = \vec{PQ}$ and $\vec{b} = \vec{PR}$

    (b) (10 points) Find the vector equation, parametric equations, and symmetric equations of the line L through P and Q.

    (c) (6 points) At what point does the line L intersect the yz-plane?

    (d) (6 points) Find $\vec{a} \times \vec{b}$

(e) (6 points) Are vectors $\vec{a}$ and $\vec{b}$ orthogonal, parallel, or neither? Explain.

(f) (5 points) Find the area of the triangle formed by the points P, Q, and R.

(g) (6 points) Find the equation of the plane through the points $P(3, 1, 2)$, $Q(6, 0, 5)$, and $R(8, 9, 0)$

(h) (5 points) Find the angle between the vectors $\vec{a}$ and $\vec{b}$.