

Name: \_\_\_\_\_

Mark: \_\_\_\_\_ / 16

**Mini-math Div 3/4: Friday, January 16, 2026 (9.6-9.9) - (24 minutes)**

**Calculator active**

1. (4 points) The velocity vector of a particle moving in the plane is given by

$$\langle 5 - 2 \cos(t^2), 8 \sin(t^2) \cos(e^t) \rangle, \text{ for } 0 \leq t \leq 2$$

At time  $t = 0$ , the particle is at position  $(3, -1)$ . Write an equation for the line tangent to the path of the particle at  $t = 1$ .

2. (4 points) Where does the graph  $r = 1 - \sin \theta$ ,  $0 \leq \theta \leq 2\pi$ , have a vertical tangent?

3. (4 points) Find the area of the inner loop of  $r = 4\sqrt{3} - 8\cos\theta$

4. (4 points) Find the area of the region common to  $r = 1 - \sin\theta$  and  $r = 2\sin\theta$ .