Please answer the following questions. Your answers will be evaluated on their correctness, completeness, and use of mathematical concepts we have covered. Please show all work and write out your work neatly. Answers without supporting work will receive no credit. The point values of the problems are given in parentheses.

1. (10 points) Find the equation for the parabola with focus at the point with Cartesian coordinates \((1, -1)\) and directrix \(y = 5\). Express the parabola in standard form.
2. (4 points each) Consider the curve given in parametric form

\[
\begin{align*}
  x &= t^3 - 3t \\
  y &= 3t^2 - 9.
\end{align*}
\]

(a) Find the slope of the tangent line to the curve as a function of \( t \).

(b) Find the points on the curve where the tangent line is horizontal (if any).

(c) Find the points on the curve where the tangent line is vertical (if any).
3. (10 points) Consider curve given in parametric form

\[ \begin{align*}
    x &= \frac{t}{1+t} \\
    y &= \ln(1+t),
\end{align*} \]

where \( 0 \leq t \leq 2 \). Find the arc length of the curve. You may approximate the arc length numerically.

4. (10 points) Find the exact area enclosed by the curve \( r^2 = 4 \cos 2\theta \).
5. (10 points) Find the exact arc length of the curve \( r = \theta^2 \) for \( 0 \leq \theta \leq 2\pi \).

6. (2 points each) Identify by name each of the following conic sections.

   (a) \( \frac{(x - 1)^2}{a^2} + \frac{y + 1}{b^2} = 1 \), where \( a > b > 0 \).

   (b) \( r = \frac{2d}{1 - 2 \cos \theta} \), where \( d \neq 0 \).

   (c) \( \frac{(x - 1)^2}{a^2} + \frac{(y + 1)^2}{b^2} = 1 \), where \( a > b > 0 \).

   (d) \( r = \frac{3d}{2 + 3 \sin \theta} \), where \( d \neq 0 \).
7. (10 points) If the point $P$ has Cartesian coordinates $(2\sqrt{3}, -2)$ find its polar coordinates such that $r > 0$ and $0 \leq \theta \leq 2\pi$.

8. (10 points) Find a Cartesian equation for the polar equation $r^2 = \sin 2\theta$. 
9. (10 points) Find a polar equation for the Cartesian equation \( y = 2x - 1 \).

10. (10 points) Find the slope of the tangent line to the polar curve \( r = 1/\theta \) where \( \theta = \pi \).