1) (20 pts) Consider the polar curve $r = e^{\theta}$, running from $\theta = 0$ to $\theta = \pi$.
   a) Find the slope of a line tangent to this curve at $\theta = \pi/2$.
   b) Find the arc-length of this curve.
   c) Find the area between this curve and the x-axis.

2. (20 points) Let $C$ be a conic section with ellipticity $e = 1/2$, focus at the origin, and whose directrix is the line $x = -2$.
   a) Find the equation of $C$ in polar coordinates.
   b) Find an equation of $C$ in cartesian coordinates.
   c) If $C$ is an ellipse or a hyperbola, find the location of the center and the parameters $a$ and $b$. If $C$ is a parabola, find the location of the vertex.

3. (20 pts) Sequences. Evaluate the following limits. Show your work!
   a) $\lim_{n \to \infty} \frac{n^3}{e^n}$
   b) $\lim_{n \to \infty} \frac{2n^2 + n + 5e^{-n}}{n^2 + e^{-n}}$
   c) $\lim_{n \to \infty} \frac{2n^2 + n + 5e^n}{n^2 + e^n}$
   d) $\lim_{n \to \infty} (3n^2 + 7) \sin(1/n)$

4. (2 pages, 40 points) For each of the following series, indicate whether the series converges absolutely, converges conditionally, or diverges, and why. (E.g. “converges absolutely by the ratio test with $R = 1/2$” or “converges by comparison to $\sum 2^n$” or “converges absolutely by limit comparison to $\sum 1/n^5$”)
   a) $\sum_{n=1}^{\infty} \frac{n^2 + n - 7}{n^4 - n^3 + 1}$
   b) $\sum_{n=1}^{\infty} (-1)^n \frac{\ln(n)}{n}$
   c) $\sum_{n=1}^{\infty} (-1)^n \frac{n!}{10^n}$
   d) $\sum_{n=1}^{\infty} \left(1 - \frac{1}{n}\right)^{n^2}$
   e) $\sum_{n=1}^{\infty} \frac{n^{100}100^n}{n!}$. 