1. (10 points) Find the exact value of the volume of the solid obtained by revolving the region above the graph of \( y = x^2 \) and below the line \( y = 9 \) about the line \( y = 9 \).

2. Answer the following questions.
   
   (a) (5 points) For what values of \( p \) does the integral \( \int_{1}^{\infty} t^{-p} \, dt \) converge?
   
   (b) (5 points) For what values of \( p \) does the integral \( \int_{0}^{1} t^{-p} \, dt \) converge?
   
   (c) (5 points) Does the integral \( \int_{0}^{\infty} \frac{dy}{1 + e^y} \) converge?

3. A cylindrical form is filled with a slow curing concrete. The base of form is 10 ft in radius, and the height is 25 ft. While the concrete hardens, gravity causes the density to vary from a density of 90 lb/ft\(^3\) at the bottom to a density of 50 lb/ft\(^3\) at the top.

   (a) (5 points) By assuming that the density varies linearly from top to bottom, find the function that gives the density at height \( h \) from the bottom.

   (b) (5 points) Consider a horizontal slice of the cylindrical form with thickness \( \Delta h \) at height \( h \). Find an approximation to the weight of this slice.

   (c) (5 points) Derive a definite integral for the total weight of the resulting concrete column and then compute the total weight.

4. (10 points) Find the length of the curve given parametrically as \( x = \sin 2t \) and \( y = \cos 2t \) for \( 0 \leq t \leq 2\pi \).