**Review Problems (I)**

1. Find the vertex and focus for the parabola

   \[ y = -\frac{1}{2} x^2 - x + \frac{1}{2}. \]

2. (a) Find and sketch the domain of the functions; (b) Find the first partial derivatives of the functions.
   
   (i) \( f(x, y) = \sqrt{4 - x^2 - 4y^2} + \sqrt{xy} \)
   
   (ii) \( g(x, y) = \sqrt{x + y - 1} + \ln(1 - x^2 - y^2) \)
   
   (iii) \( h(x, y) = x e^{x^2 y} \)

3. The Cartesian coordinates of the point \( P \) is \( (x, y, z) = (-2, 2\sqrt{3}, 4) \). Find the spherical coordinates \( (\rho, \phi, \theta) \) of \( P \).

4. Show that the limit \( \lim_{(x,y) \to (0,0)} \frac{xy}{x^2 + 2y^2} \) does not exist.

5. Find an equation for the tangent plane to the surface

   \[ xy^2 - 3xz + y^2 + yz - z^2 = -4 \]

   at \( (1, 2, 3) \).