1. a. (10 points) Find an equation of the sphere with center \((-2, 1, -4)\) that is tangent to the xy-plane.

b. (10 points) Find an equation of the plane that passes through the point \((3, -2, 1)\) and is perpendicular to the line \(x = 6, y = 2 + 4t, z = 3t\).
2. (20 points) Determine whether the following two lines are parallel, skew, or intersect. If they intersect, find the point of intersection.

\[ L_1 : x = 7 - 6t_1, \quad y = 4, \quad z = 5 + 2t_1 \]

\[ L_2 : x = -2 - t_2, \quad y = 1 + t_2, \quad z = -2 + 5t_2 \]
3. a. (10 points) Find the tangent line to the graph of \( \mathbf{r}(t) = e^{2t} \mathbf{i} + \sqrt{t} \mathbf{j} - (\sin t) \mathbf{k} \) at the point where \( t = \pi \). You may write your answer either in the form of a vector equation or as parametric equations.

b. (10 points) Given that \( \mathbf{v} = \langle 2, -1, 3 \rangle \) and \( \mathbf{b} = \langle 1, 2, 2 \rangle \), find the vector component of \( \mathbf{v} \) along \( \mathbf{b} \) and the vector component of \( \mathbf{v} \) orthogonal to \( \mathbf{b} \). Clearly indicate which one is along \( \mathbf{b} \) and which one is orthogonal to \( \mathbf{b} \).
4. (20 points) Consider the parallelepiped with adjacent edges:
\[
\vec{u} = \langle -1, 1, 2 \rangle, \vec{v} = \langle 0, 2, 1 \rangle, \vec{w} = \langle 1, 3, -1 \rangle
\]

a. Find the area of the face determined by \( \vec{v} \) and \( \vec{w} \).
b. Find the volume of the parallelepiped.
c. Find the angle between \( \vec{u} \) and the plane containing the face determined by \( \vec{v} \) and \( \vec{w} \). You may leave your answer in terms of an inverse trigonometric function.
5. (20 points) Consider the function \( z = f(x, y) = \sqrt{x^2 + y^2} - 4 \)
   
   a. On the given axes sketch the domain of \( f \).

   b. Evaluate \( f(3\sin t, 3\cos t) \)

   c. On the given axes sketch and label the level curves of \( z = k \) for values of \( k = 0, \sqrt{5}, \sqrt{12} \)
6. (bonus) (3 points)

Find the plane thru the point \((-1,4,2)\) which contains the line of intersection for the planes:

\[ 8x - 2y + 2z - 4 = 0 \quad \text{and} \quad 4x + 2y - 4z - 6 = 0 \]