Show all work on this sheet, including mental steps, in a clearly organized way that speaks for itself. Use proper mathematical notation/syntax. Label parts, box final short answers.

a) Show that the equation \( x^2 + y^2 + z^2 + 2x + 8y - 4z + 12 = 0 \) represents a sphere and find its center and radius.

b) Using a diagram like 
\[ \begin{array}{c}
\text{(x,y,z)} \\
\text{(-1,2,1)} \\
\end{array} \]
sketch the center point on a set of coordinate axes.

c) What is the intersection of the sphere with the x-y plane \( z = 0 \)? Describe the curve in words after deriving its equation (in a standard form). Make a rough sketch of this curve in the x-y plane.

\[ \begin{align*}
a) & \quad x^2 + 2x + y^2 + 8y + z^2 - 4z + 12 = 0 \\
& \quad (x+1)^2 - 1^2 + (y+4)^2 - 4^2 + (z-2)^2 - 2^2 + 12 = 0 \\
& \quad (x+1)^2 + (y+4)^2 + (z-2)^2 = 12 - 1 - 16 - 4 = 9 = 3^2 \\
& \quad \text{compare } (x-x_0)^2 + (y-y_0)^2 + (z-z_0)^2 = r^2 \\
& \quad \text{center } (x_0,y_0,z_0) : \quad (-1,-4,2) \\
& \quad \text{radius } r = 3 \\

b) \quad \text{circle with center } (-1,-4) , \text{ radius } r = \sqrt{9} \approx 2.24 \\
\end{align*} \]