Consider the surface (paraboloid) \( \Sigma \) given by \( x^2 + y^2 - z = 0 \), \( 0 \leq z \leq 1 \).

1) Parametrize \( \Sigma \) using cylindrical coordinates (that is, viewing it as the surface obtained by rotating \( z = y^2 \) around the \( z \)-axis). Compute the flow of \( \mathbf{r} \) in two ways:

   A) by going through the following steps:

   - Compute the unit normal vector \( \mathbf{n}_\Sigma \) separately by normalizing the gradient of \( g(x, y, z) = x^2 + y^2 - z \). Make sure your unit normal vector is pointing outwards.
   - Compute \( \mathbf{r} \cdot \mathbf{n}_\Sigma \).
   - Compute the area element \( dS \).
   - Integrate \( \int \int_{\Sigma} (\mathbf{r} \cdot \mathbf{n}_\Sigma) dS \).

   B) by going through the following steps (assume one has parametrization \( x = x(u, v) \), etc. . . ):

   - Use the determinant formula \( \mathbf{F} \cdot dS = \begin{vmatrix} F_1 & F_2 & F_3 \\ \frac{\partial x}{\partial u} & \frac{\partial y}{\partial u} & \frac{\partial z}{\partial u} \\ \frac{\partial x}{\partial v} & \frac{\partial y}{\partial v} & \frac{\partial z}{\partial v} \end{vmatrix} dudv \) (provided \( T_u \times T_v \) point in the direction of \( \mathbf{n}_\Sigma \)).
   - Compute the flow as \( \int \int_{\Sigma} \mathbf{F} \cdot dS = \int \int (\text{determinant}) dudv \).

2) Do the same thing as in 1), this time parametrizing \( \Sigma \) as a graph surface: \( x = x, y = y, z = x^2 + y^2 \) so the parameters are \( (x, y) \in D \), the unit disk in \( \mathbb{R}^2 \).

3) Put a lid on \( \Sigma \) to enclose a solid region \( W \). Use Gauss divergence theorem to compute the flow of \( \mathbf{r} \) through \( \Sigma \). Compare your result with 1) and 2).