1. Label each expression as a scalar quantity, a vector quantity or undefined, if $f$ is a scalar function and $\mathbf{F}$ is a vector field.
   a. $\nabla \cdot (\nabla f)$
   b. $\nabla \times (\nabla \cdot \mathbf{F})$
   c. $\nabla (\nabla \times \mathbf{F})$
   d. $\nabla (\nabla \cdot \mathbf{F})$
   e. $\nabla \times (\nabla f)$
2. \( \mathbf{F} = (z^2 + 2xy)\mathbf{i} + x^2\mathbf{j} + 2xz\mathbf{k} \). (a): Determine whether the vector field is conservative; (b): Evaluate \( \int_C \mathbf{F} \cdot d\mathbf{r} \), where \( C \) runs from \((2, 3, 1)\) to \((4, -1, 0)\).
3. Evaluate \( \int_C (y + e^{\sqrt{x}})dx + (2x + \cos y^2)dy \), where \( C \) is the boundary of the region enclosed by the parabolas \( y = x^2 \) and \( x = y^2 \), and \( C \) is positively oriented.
4. Evaluate \( \int_S (x - z) \, dS \), where \( S \) is the portion of the cylinder \( x^2 + z^2 = 1 \) above the \( xy \)-plane between \( y = 1 \) and \( y = 2 \).
5. Evaluate the flux integral \( \iint_S \mathbf{F} \cdot n \, dS \), where \( \mathbf{F} = \langle y, -x, z \rangle \), \( S \) is the portion of \( z = \sqrt{x^2 + y^2} \) below \( z = 4 \). (n downward).