Let $S$ be the surface formed by capping the piece of a cone $x^2 + y^2 = (4 - z)^2, 1 \leq z \leq 3$ with the upper part of the sphere $x^2 + y^2 + (z - 3)^2 = 1, z \geq 3$. The outward normals to $S$ define a smooth orientation to $S$.

1) Identify the boundary $C$ of $S$. Find a parameterization of $C$ which is positive with respect to the given orientation.

\[
r(t) = \]

2) Let $F$ be the vector field $(0, 0, 2)$. Verify that $F = \text{curl}(A)$, where $A = (P, Q, R) = (-y, x, 0)$.

\[
\text{curl}(A) = \text{curl}(P, Q, R) = (R_y - Q_z, P_z - R_x, Q_x - P_y) = \]

3) Write first down a formula which relates:

- the flux of $F$ through the surface $S$ with
- the line integral for $A$ along the boundary $C$ of $S$.

\[
\int \int_S F \cdot dS = \]

4) Find the flux of $F$ through $S$ by evaluating the line integral.

\[
\int \int_S F \cdot dS = \]