

$\text{curl } \mathbf{F} = (xe^{-y} - 6x)\mathbf{i} - (ye^{-y} - y)\mathbf{j} + (6z - z)\mathbf{k}$ and we take S to be the disk $x^2 + y^2 \leq 4$, $z = 2$. Since \mathbf{F} is oriented counterclockwise (from above), we orient S upward.

The normal vector is \mathbf{k} and $\text{curl } \mathbf{F} \cdot \mathbf{k} = 6z - z$ on S , where $z = 2$. Thus

$$\begin{aligned} \mathbf{F} \cdot d\mathbf{r} &= \iint_S \text{curl } \mathbf{F} \cdot \mathbf{k} \, dS = \iint_S (6z - z) \, dS = \iint_S (12 - 2) \, dS \\ &= 10(\text{area of } S) = 10(\pi \cdot 2) = 40\pi. \end{aligned}$$