

Since we went counterclockwise around loop looking down z axis, area element $d\vec{a} = da \hat{z}$, so we only need

$$(\nabla \times \vec{A})_{\hat{z}} = \hat{z} \left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y} \right) = \hat{z} (1 - (-1)) = 2\hat{z}$$

$$\oint_S (\nabla \times \vec{A}) \cdot d\vec{a} = 2 \oint_S da = 2(3)(4) = \underline{24}$$

They are equal!