1.3.8 Find the surface area of a cylindrical surface by setting up and evaluating the integral $\oint \mathbf{A} \bullet \mathbf{ds}$ where $\mathbf{A} = \mathbf{u}_\rho + 2\mathbf{u_z}$. *Note: Diagram not shown.*

The radius of the cylinder is a.

$$\begin{aligned}
\oint \mathbf{A} \bullet \mathbf{ds} &= \int_{\phi=0}^{2\pi} \int_{z=0}^{\mathscr{L}} (\mathbf{u}_\rho + 2\mathbf{u_z}) \bullet (\rho \mathrm{d}\phi \mathrm{d}z \mathbf{u}_\rho + \rho \mathrm{d}\rho \mathrm{d}\phi \mathbf{u_z}) \\
&= \int_{\phi=0}^{2\pi} \int_{z=0}^{\mathscr{L}} \rho \mathrm{d}z \mathrm{d}\phi + \int_{\phi=0}^{2\pi} \int_{z=0}^{\mathscr{L}} 2\rho \mathrm{d}\rho \mathrm{d}\phi \\
&= \int_{\phi=0}^{2\pi} \rho z|_{z=0}^{\mathscr{L}} \mathrm{d}\phi \\
&= \int_{\phi=0}^{2\pi} \rho \mathscr{L} \mathrm{d}\phi \\
&= \rho \mathscr{L} \phi|_{\phi=0}^{2\pi} \\
&= 2\pi\rho\mathscr{L} \\
&= 2\pi a \mathscr{L}
\end{aligned}$$