3.33 Transform the vector

$$\mathbf{A} = \hat{\mathbf{R}} \sin^2\theta \cos\phi + \hat{\boldsymbol{\theta}} \cos^2\phi - 3\hat{\boldsymbol{\phi}} \sin\phi$$

into cylindrical coordinates and then evaluate it at $P = (2, \pi/2, \pi/2)$.

Solution: From Table 3-2,

$$\begin{aligned}\mathbf{A} &= (\hat{\mathbf{r}} \sin\theta + \hat{\mathbf{z}} \cos\theta) \sin^2\theta \cos\phi + (\hat{\mathbf{r}} \cos\theta - \hat{\mathbf{z}} \sin\theta) \cos^2\phi - 3\hat{\boldsymbol{\phi}} \sin\phi \\ &= \hat{\mathbf{r}} (\sin^3\theta \cos\phi + \cos\theta \cos^2\phi) - \hat{\boldsymbol{\phi}} \sin\phi + \hat{\mathbf{z}} (\cos\theta \sin^2\theta \cos\phi - \sin\theta \cos^2\phi)\end{aligned}$$

At $P = (2, \pi/2, \pi/2)$,

$$\mathbf{A} = -3\hat{\boldsymbol{\phi}}.$$