Question
A particle has a path given by $x = \cos\omega t$, $y = \sin\omega t$, $z = t$. Find its velocity and acceleration in cylindrical polar coordinates.

Answer
$\mathbf{v} = \dfrac{d}{dt}(\mathbf{i}\cos\omega t + \mathbf{j}\sin\omega t + t\mathbf{k}) = -\omega\sin\omega\mathbf{i} + \omega\cos\omega t\mathbf{j} + \mathbf{k}$
$\mathbf{r} = \mathbf{i}\cos\omega t + \mathbf{j}\sin\omega t + zt$
in cylindrical polar coordinates: $r = \sqrt{x^2 + y^2} = 1$; $\phi = \omega t$; $z = t$.
$\mathbf{v} = \dot{r}\mathbf{e}_r + r\dot{\phi}\mathbf{e}_\phi + \dot{z}\mathbf{e}_z$
$\mathbf{v} = \omega\mathbf{e}_\phi + \mathbf{e}_z$
$\mathbf{a} = (\ddot{r} - r\dot{\phi}^2)\mathbf{e}_r + \dfrac{1}{r}(\dot{r}^2\dot{\phi})\mathbf{e}_\phi + \ddot{z}\mathbf{e}_z$
$\mathbf{a} = -\omega^2\mathbf{e}_r$