

$$\begin{aligned}\mathbf{r}(t) &= t \sin t \mathbf{i} + t \cos t \mathbf{j} + 4t^2 \mathbf{k} \quad \Rightarrow \\ \mathbf{v}(t) = \mathbf{r}'(t) &= (\sin t + t \cos t) \mathbf{i} + (\cos t - t \sin t) \mathbf{j} + 8t \mathbf{k}, \\ \mathbf{a}(t) = \mathbf{v}'(t) &= (2 \cos t - t \sin t) \mathbf{i} + (-2 \sin t - t \cos t) \mathbf{j} + 8 \mathbf{k}, \\ |\mathbf{v}(t)| &= \sqrt{(\sin^2 t + 2t \sin t \cos t + t^2 \cos^2 t) + (\cos^2 t - 2t \sin t \cos t + t^2 \sin^2 t) + 64t^2} \\ &= \sqrt{65t^2 + 1}.\end{aligned}$$