The position vector for the motion of a ball along a path at time \( t \) is given as,

\[
\vec{r} = 2(1 + 3t^2)\hat{e}_r
\]

The motion has an angular speed of \( \omega = \dot{\theta} = 1 \text{ rad/s} \).

a) Derive an equation for the velocity of the ball at time \( t \).

\[
\vec{v} = \vec{r}' = \dot{r}\hat{e}_r + r\dot{\theta}\hat{e}_\theta
\]

\[
\vec{v} = 12t\hat{e}_r + 2(1 + 3t^2)\hat{e}_\theta
\]

b) Calculate the angle between \( \vec{r} \) and \( \vec{v} \) at the time \( t = 1 \text{ s} \).

at \( t = 1 \)

\[
\vec{r} = 8\hat{e}_r
\]

\[
\vec{v} = 12\hat{e}_r + 8\hat{e}_\theta
\]

\[
\cos\theta = \frac{\vec{r} \cdot \vec{v}}{|\vec{r}| |\vec{v}|} = \frac{96}{(8)(14.4)} = 0.83
\]

\[
\theta = 33.7^\circ
\]