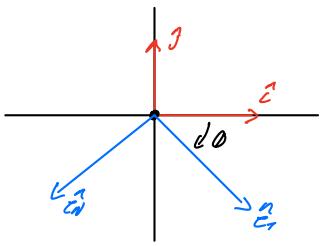
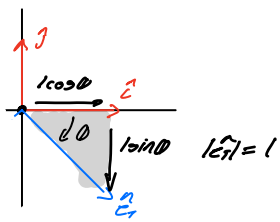
Quiz 1 Solution

1) Consider the two sets of unit vectors shown for Cartesian and path coordinates.

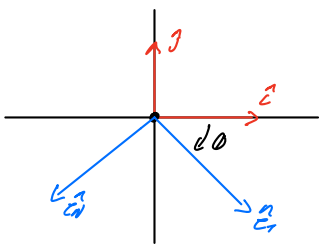


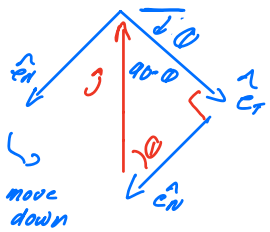
$\hat{e}_T$ in terms of the Cartesian unit vectors i and j

$$\hat{e}_T = \cos\theta\, i - \sin\theta\, j$$



Cartesian unit vector j in terms of the path unit vectors $\hat{e}_T$ and $\hat{e}_N$



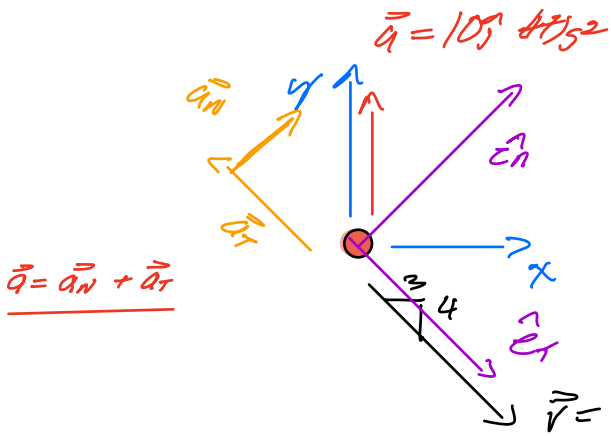


$$j = -\sin\theta\, \hat{e}_T - \cos\theta\, \hat{e}_N$$

② A particle P moves with a velocity and acceleration vectors of:

$\vec{v} = (30\hat{i} - 40\hat{j})$ ft/s and $\vec{a} = 10\hat{j}$ ft/s^2

respectively, in terms of Cartesian components. Is the change of speed P increasing, decreasing, or constant.



$\vec{a} = \vec{a}_N + \vec{a}_T$

By inspection the tangential components of acceleration, $\vec{a}_T$, points in the opposite direction of $\vec{v}$.

The particle is slowing down.

Find unit vector to analyze mathmatically

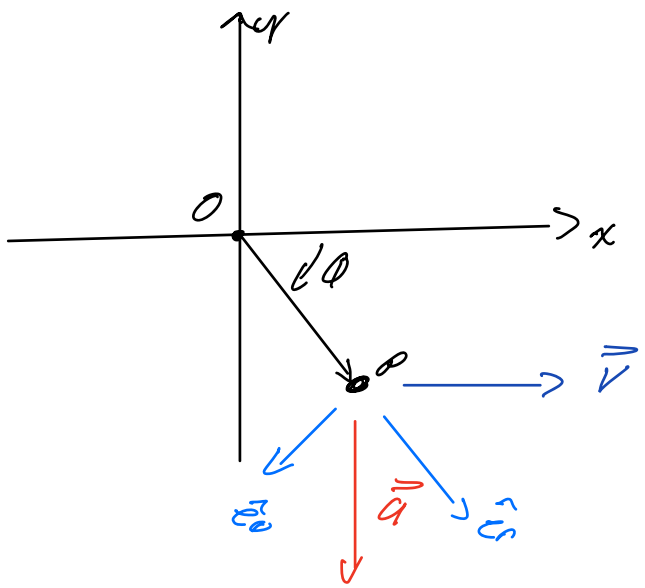
$$\hat{e}_T = \frac{\vec{v}}{|v|} \qquad |\vec{v}| = \sqrt{30^2 + 40^2} = 50$$

$$\hat{e}_T = \frac{(30\hat{i} - 40\hat{j})}{50} = 3/5\,\hat{i} - 4/5\,\hat{j}$$

$$\dot{v} = \hat{e}_T \cdot \vec{a} = (3/5\,\hat{i} - 4/5\,\hat{j}) \cdot (10\hat{j}) = -40/5 \text{ ft/s}^2$$

$\dot{v}$ is negative thus P is slowing down

③ At the instant shown, the velocity of point P is in the positive x-direction and the acceleration of point P is in the negative y-direction. The angle θ lies in the range $0 < \theta < 90°$.



By inspection $\vec{v}$ has a positive $\hat{e}_r$ component

$\dot{r} > 0$

By inspection $\vec{a}$ has a positive $\hat{e}_r$ component

$\ddot{r} > 0$