A. Same Qs

B. Diff Qs

$\vec{v} = -3\hat{i} + 2\hat{j}$

$\vec{a} = \hat{i} - 6\hat{j}$

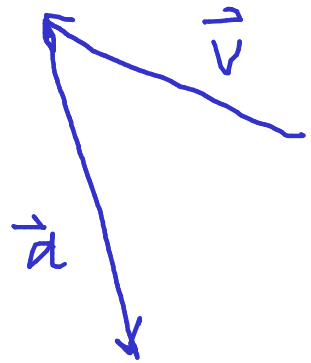
of particle

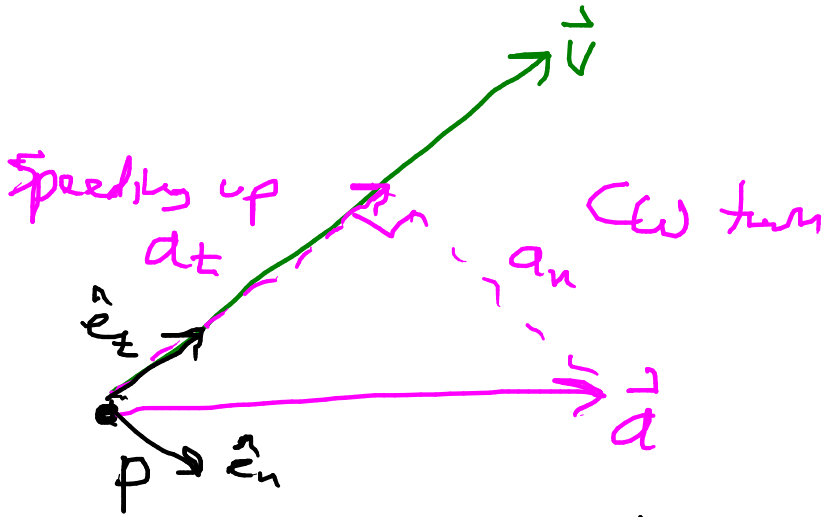
A. speeding up

B. slowing down

A. CW turn

B. CCW turn





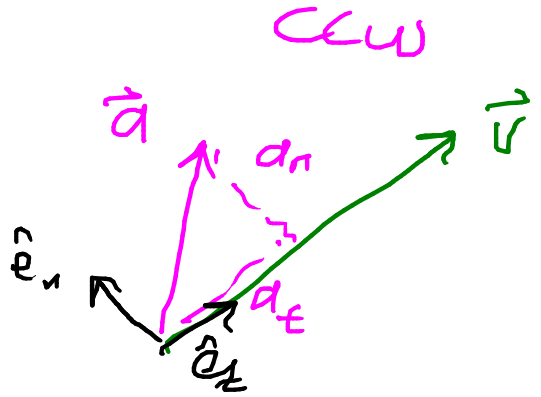
$$\vec{a} = \underbrace{\ddot{s}\hat{e}_t}_{\vec{a}_t} + \underbrace{\frac{\dot{s}^2}{\rho}\hat{e}_n}_{\vec{a}_n}$$

$$a_t = \vec{a} \cdot \hat{v}$$

ρ = radius of curvature

K = curvature

$$\rho = \frac{1}{K}$$



$\vec{v} \times \vec{a}$ → $+\hat{k}$ CCW, $-\hat{k}$ CW

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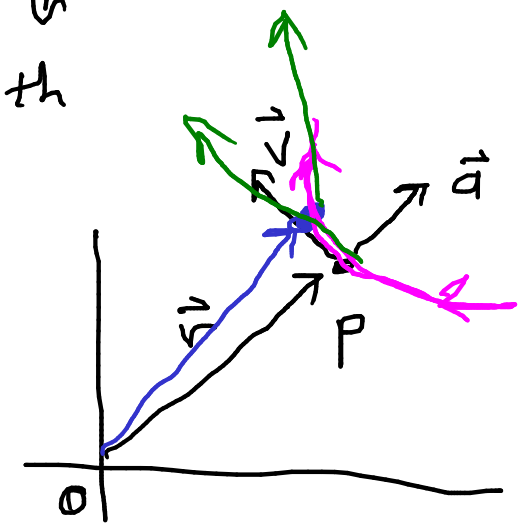
turning vs rotating

T/W → path

polar → about an axis / point

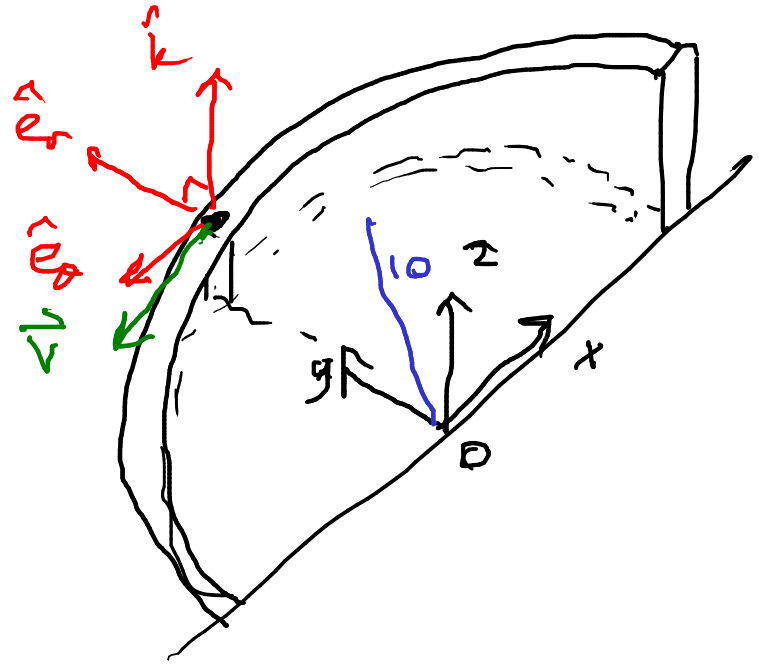


rotating about O

A. CW
B. CCW

turning

A. CW
B. CCW



$\vec{v}$?

$$z(\theta) = 2(1 + \cos\theta)$$

$R = 10\,m$ from z axis

$\theta = \frac{\pi}{2}$

$\dot{\theta} = 4\ rad/s$

$\hat{e}_t$ is below horiz by angle ϕ

ϕ ?

$\hat{e}_t = \hat{v}$

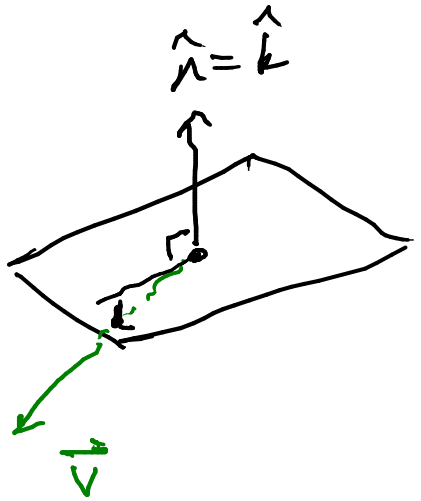
$$\vec{v} = \dot{r}\hat{e}_r + r\dot{\theta}\hat{e}_\theta + \dot{z}\hat{k}$$

$r\dot{\theta} = 40$

$\theta = \frac{\pi}{2}$

$$\dot{z} = \frac{d}{dt}z(\theta) = z'(\theta)\,\dot{\theta} = -2\sin\theta \cdot 4 = -8$$

$$\vec{v} = 40\hat{e}_\theta - 8\hat{k} = -40\hat{i} + 0\,\hat{j} + (-8)\hat{k}$$



$$\angle(\vec{v}, \hat{k}) = \phi + 90^\circ$$

$$\cos(\phi + 90^\circ) = \frac{\vec{v} \cdot \hat{k}}{\|v\| \, \|k\|} = \hat{v} \cdot \hat{k}$$

$$s = v = \|\vec{v}\| = \|\dot{\vec{r}}\| = \left\| \frac{d}{dt} \vec{r} \right\|$$

$$\ddot{s} = \dot{v} = \left\| \frac{d}{dt} \vec{v} \right\| = \|\vec{a}\| = a$$

$\neq$

$$a \neq \ddot{s}$$

$$\dot{v} = \frac{d}{dt} v = \frac{d}{dt} \|\vec{v}\| \neq \left\| \frac{d}{dt} \vec{v} \right\|$$