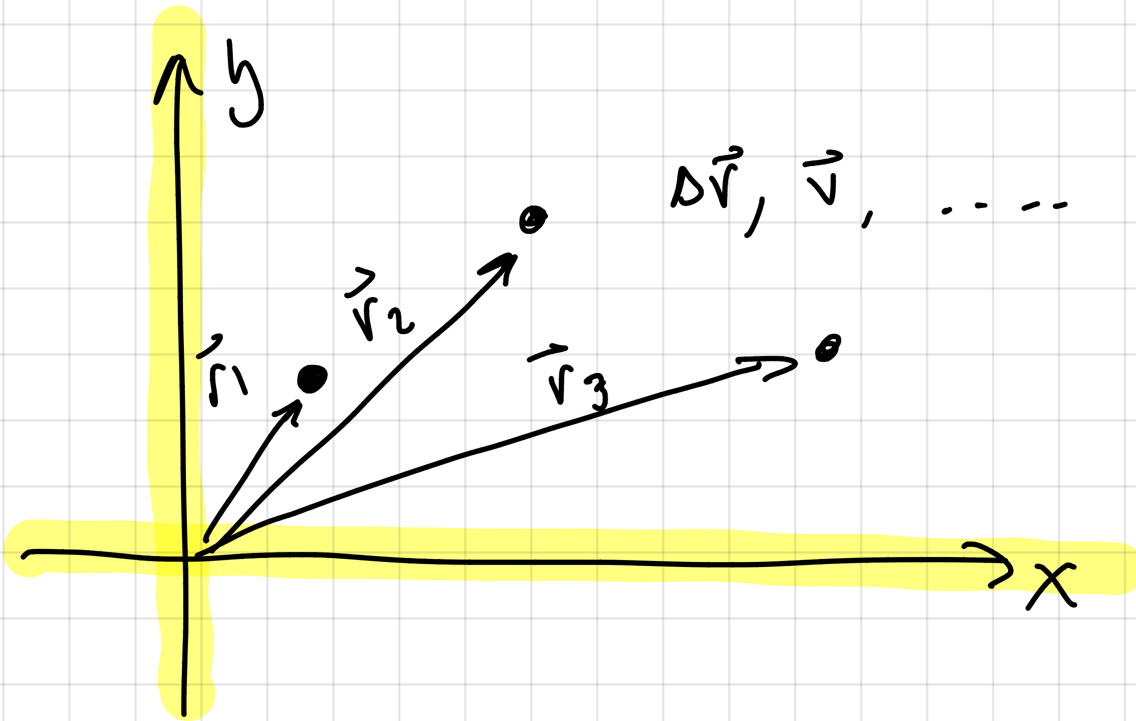
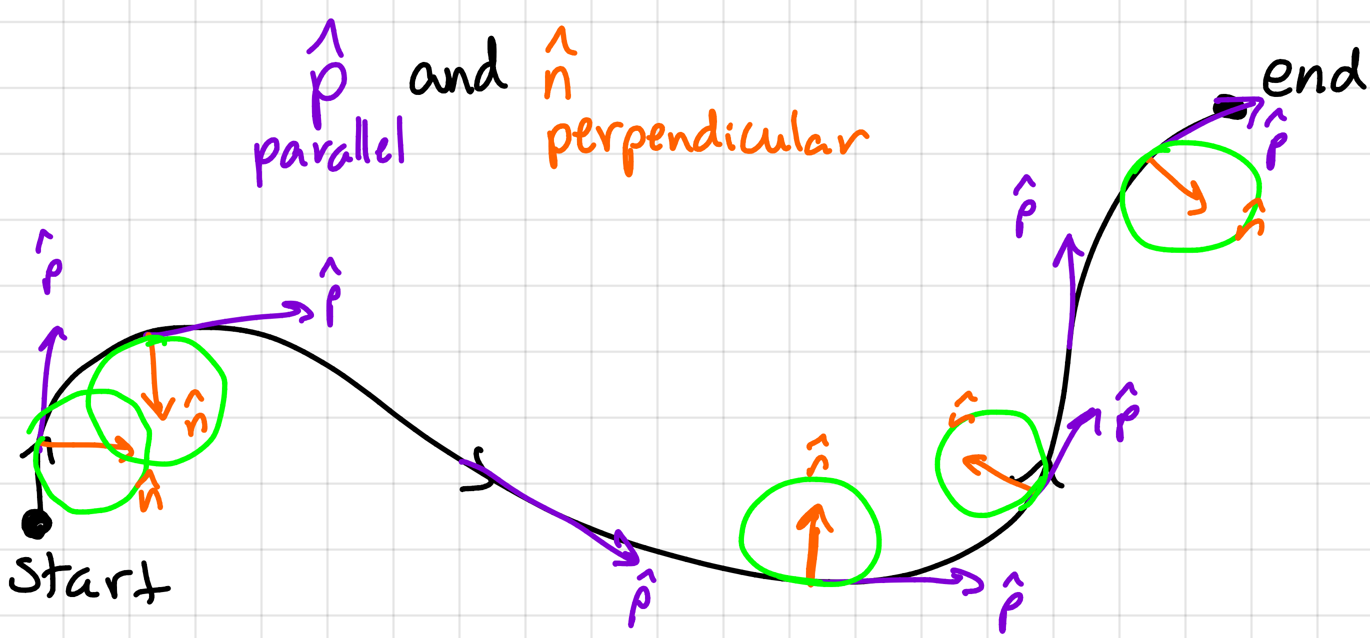
PHYS 2211, Summer 2021

Week 5: Curving Motion



$\Delta\vec{r}$, $\vec{v}$, ...

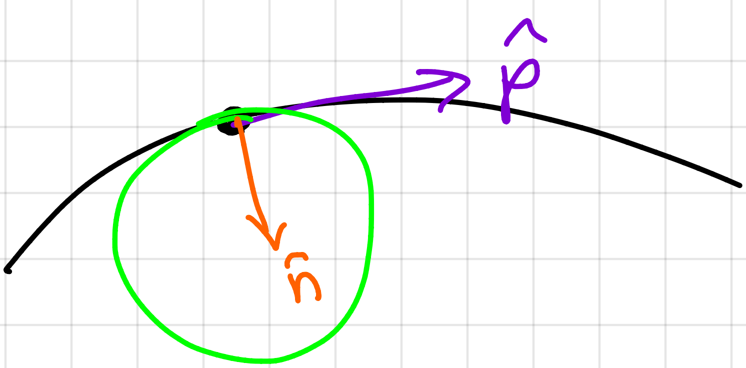


Non-Equilibrium Motion

$$\vec{F}_{net} \neq 0$$

$$\vec{F}_{net} = \vec{F}_{net_{\parallel}} + \vec{F}_{net_{\perp}} \qquad \begin{matrix} \hat{p}, & \hat{n} \\ \parallel & \perp \end{matrix}$$

$$\boxed{\frac{d\vec{p}}{dt} = \left(\frac{d\vec{p}}{dt}\right)_{\parallel} + \left(\frac{d\vec{p}}{dt}\right)_{\perp}}$$



$\left(\frac{d\vec{p}}{dt}\right)_{\parallel}$ = changing speed

$|\vec{p}|$

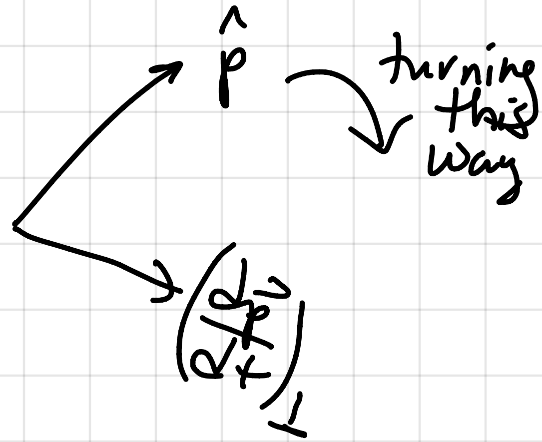
$\longrightarrow \vec{p}$

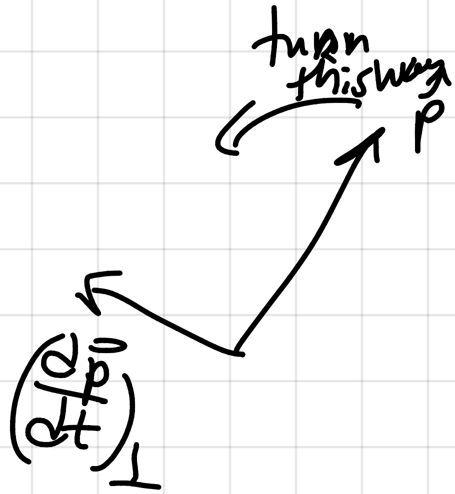
$\longrightarrow \left(\frac{d\vec{p}}{dt}\right)_{\parallel} \Rightarrow$ Speeding up

$\longrightarrow \hat{p}$

$\longleftarrow \left(\frac{d\vec{p}}{dt}\right)_{\parallel}$ $\Rightarrow$ slowing down

$$\left(\frac{d\vec{p}}{dt}\right)_{\perp} \Rightarrow \text{changing the direction } (\hat{p})$$



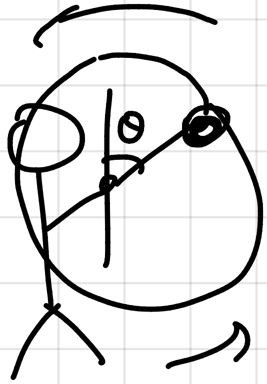


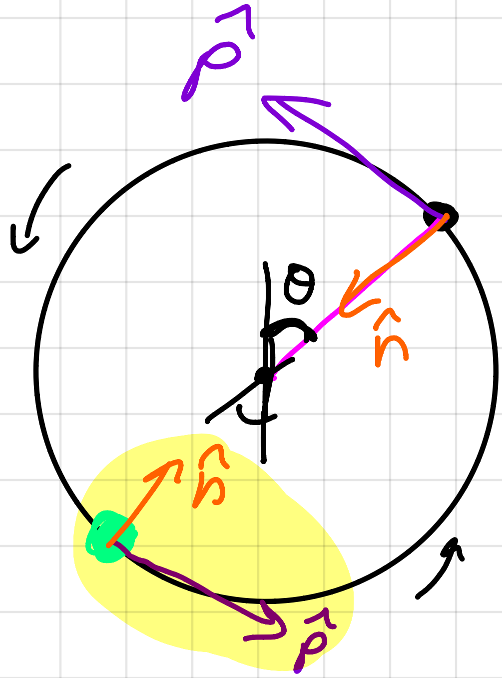
$$\boxed{\left(\frac{d\vec{p}}{dt}\right)_{\perp} = \frac{mv^2}{R}\hat{n}}$$

$\frac{v^2}{R}$ = centripetal acceleration

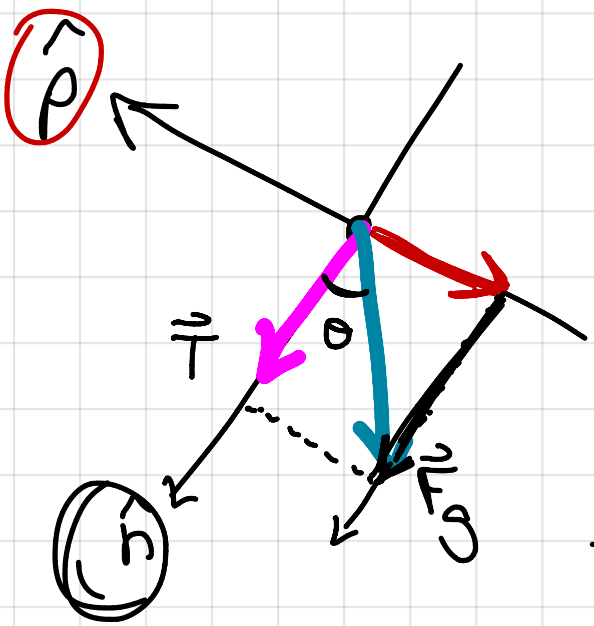
$$\vec{F}_{net_{\perp}} = \frac{mv^2}{R}\hat{n}$$

R = radius of curvature (kissing circle, turning circle)





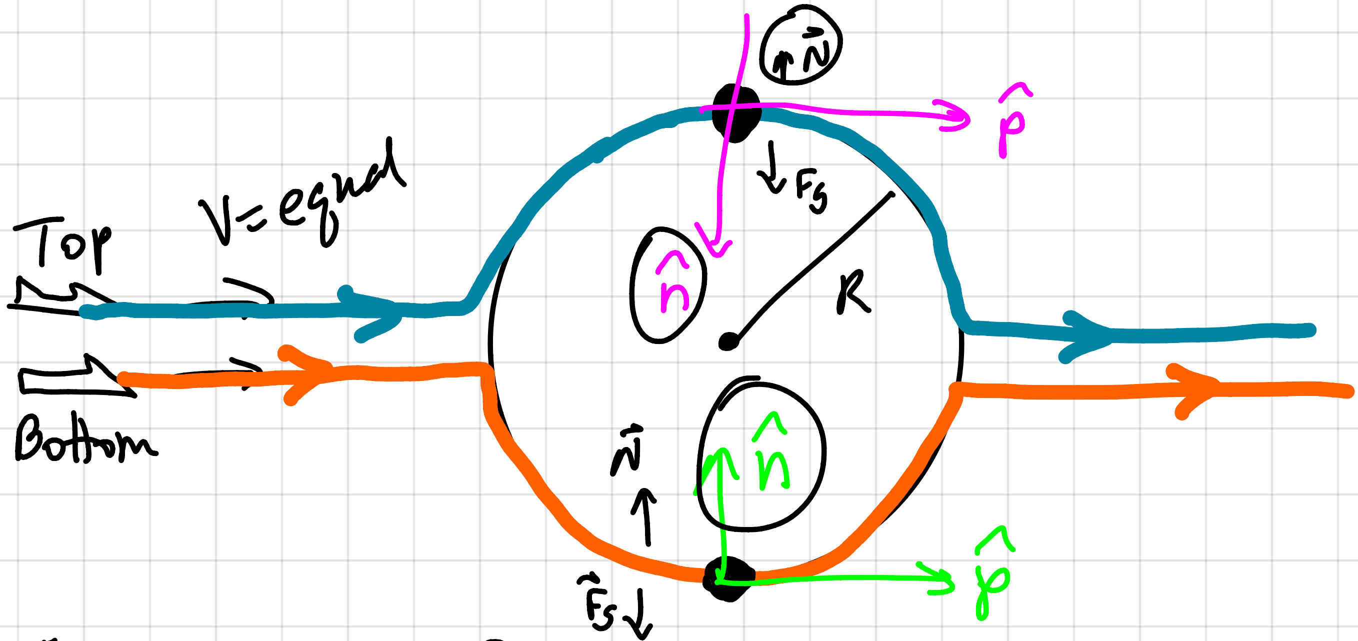
$$\vec{F}_{net} \neq 0$$



$$\vec{F}_{net_{\parallel}} = \vec{F}_{g\parallel} = mg\sin\theta\,(-\hat{p})$$

$$\vec{F}_{net_{\perp}} = \frac{mv^2}{R}\hat{n} = T\hat{n} + mg\cos\theta\,(\hat{n})$$

$$\frac{mv^2}{R} = T + mg\cos\theta$$



Top $\quad \vec{F}_{net_\perp} = \frac{mv^2}{R}\hat{n} = F_g(\hat{n}) + N(-\hat{n})$

$$\frac{mv^2}{R} = mg - N$$

$$\boxed{N = \frac{mv^2}{R} - mg}$$

top feels less N
$\Rightarrow$ lighter

Bottom $\quad \vec{F}_{net_\perp} = \frac{mv^2}{R}\hat{n} = F_g(-\hat{n}) + N(+\hat{n})$

$$\frac{mv^2}{R} = N - mg$$

$$\boxed{N = \frac{mv^2}{R} + mg}$$

bottom feels more N
$\Rightarrow$ heavier