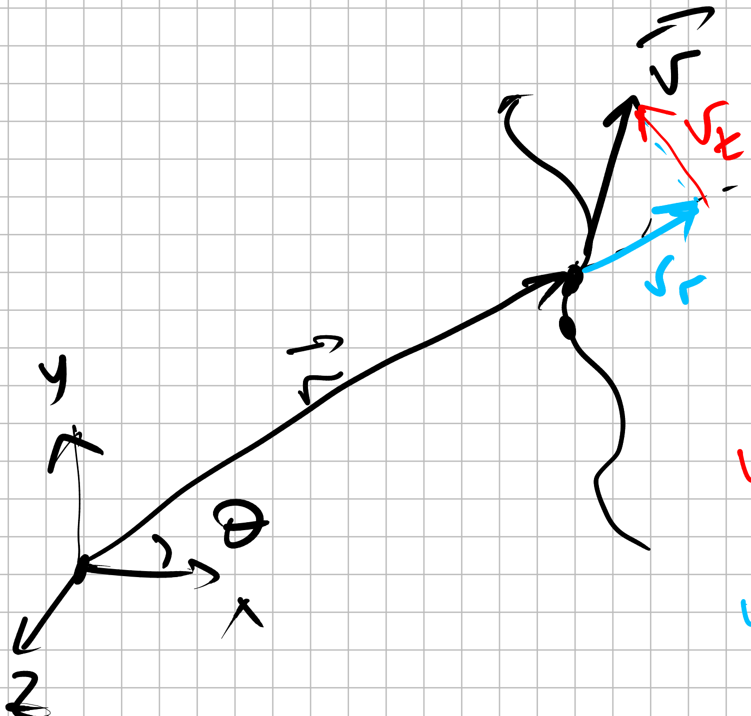
$$\vec{F}_{\substack{net \\ ext}} = \frac{d\vec{P}}{dt} = \frac{d}{dt}\left(\sum_i m_i \vec{v}_i\right) =$$

$$= \frac{d}{dt}\left(\sum_i m_i \frac{d\vec{r}_i}{dt}\right) =$$

$$= \frac{d}{dt}\cdot\frac{d}{dt}\underbrace{\left(\sum_i m_i \vec{r}_i\right)\frac{M_{tot}}{M_{tot}}}_{\vec{r}_{CM}} =$$

$$= M_{tot}\cdot\frac{d^2}{dt^2}\vec{r}_{CM} =$$

$$\boxed{\vec{F}_{\substack{net \\ ext}} = M_{tot}\,\vec{a}_{CM}}$$



Decart's system of coordinate

$$\vec{v} = \{v_x, v_y, \cancel{v_z}\}$$

$$\vec{r} = \{x, y, \cancel{z}\}$$

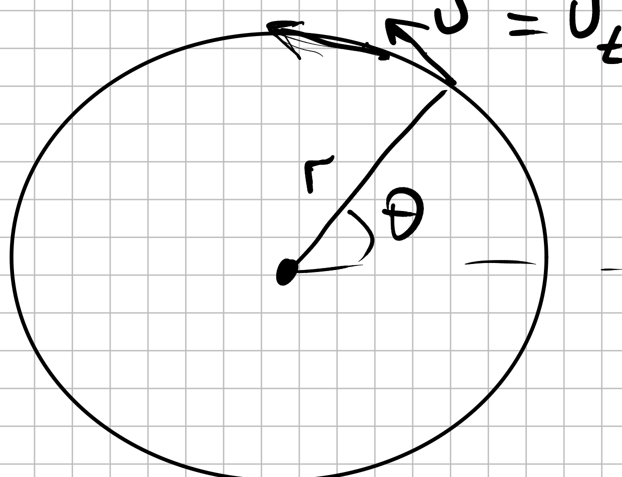
Polar

$$\vec{r} = \{r, \theta\}$$

v_t ← tangential

v_r ← radial

$$\vec{v} = \vec{v}_t$$



$$\begin{array}{cc} r & t \\ \end{array}$$

$$\vec{v} = \{0, v_t\} =$$

$$= \{0, \omega \cdot r\}$$

$$\vec{a} = \{\_\_, \frac{d}{dt}(\omega r)\}$$

α - angular acceleration

artificial b/s this is not inertial reference frame

$$\vec{a} = \{-\omega^2 r, \left(\frac{d\omega}{dt}\right) \cdot r\}$$

$$= \{-\omega^2 r, \alpha \cdot r\}$$

$\vec{v}_t$

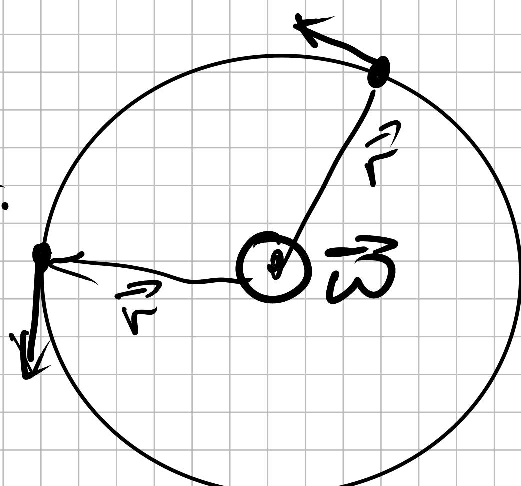
$x \longleftrightarrow \theta$

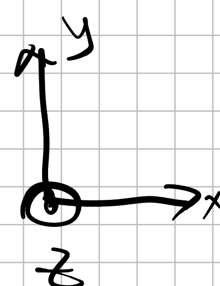
$$\vec{v}_t = \vec{\omega} \times \vec{r}$$

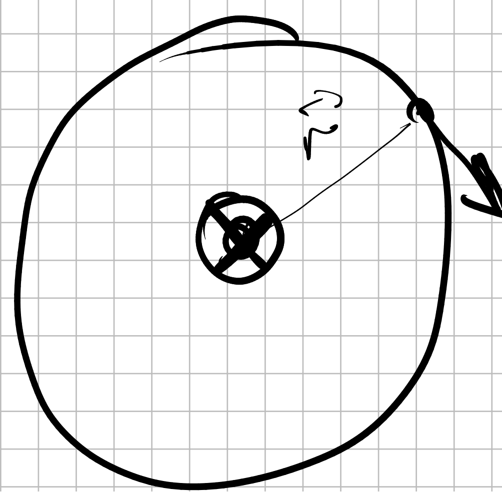
$$\vec{a}_t = \vec{\alpha} \times \vec{r}$$

$x = x_0 + v_0 t + \frac{at^2}{2}$	$\theta = \theta_0 + \omega_0 t + \frac{\alpha t^2}{2}$
v	ω
a	α

$\omega = \text{const.}$







$$\vec{v}_t = \vec{\omega} \times \vec{r} = \det \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ x & y & z \\ \omega_x & \omega_y & \omega_z \\ r_x & r_y & r_z \end{vmatrix} =$$

$$= \hat{i}\,(\omega_y \cdot r_z - \omega_z \cdot r_y) +$$

$$+ \hat{j}\,(\omega_z \cdot r_x - \omega_x r_z)$$

$$+ \hat{k}\,(\omega_x r_y - \omega_y r_x)$$

in physics 100 $\vec{\omega} = \{ \overset{x}{0}, \overset{y}{0}, \overset{z}{\omega} \}$