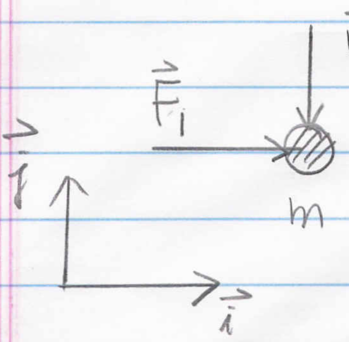
Equation of Motion of Particles

$$\sum \vec{F} = m\vec{a}$$



$$\Rightarrow \vec{a}_1 = \frac{\vec{F}_1}{m}$$

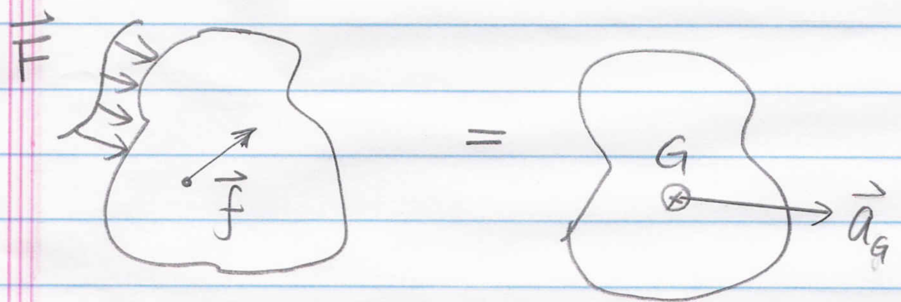
$$\left(\vec{a} = a_1\vec{i} - g\vec{j}\right)$$

Free-body diagram

$$\vec{F}_i + \vec{f}_i = m_i \times \vec{a}_i$$

$$\Rightarrow \sum_{i=1}^{n} \vec{F}_i + \sum_{i=1}^{n} \vec{f}_i = \sum m_i \times \vec{a}_i$$

($\sum \vec{F}_i$: external force; $\sum \vec{f}_i$: internal force)



* Force vectors can be computed / balanced w.r.t. each coordinate component.

Cartesian Coord.

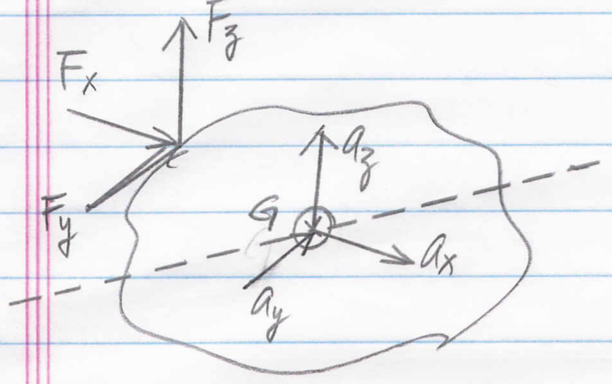
$$\Rightarrow \begin{cases} \sum F_x = m a_x \\ \sum F_y = m a_y \\ \sum F_z = m a_z \end{cases} \Rightarrow \sum F_x \vec{i} + \sum F_y \vec{j} + \sum F_z \vec{k} = m(a_x \vec{i} + a_y \vec{j} + a_z \vec{k})$$

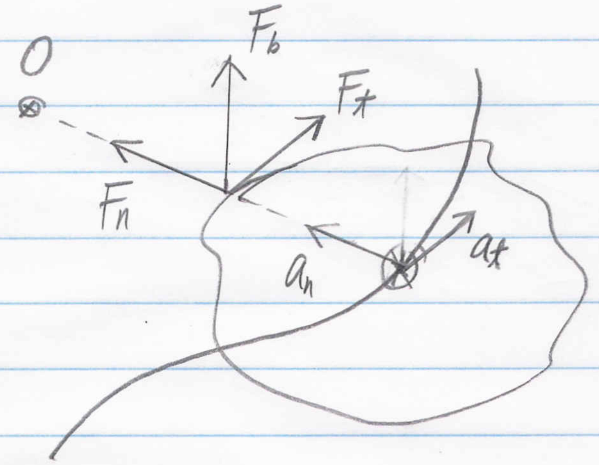
Curvilinear motion

$$\begin{cases} \sum F_t = m a_t & \text{(tangential)} \\ \sum F_n = m a_n & \text{(normal)} \\ \sum F_b = 0 & \text{(binormal)} \end{cases}$$

$a_t = \dfrac{dv}{dt}$

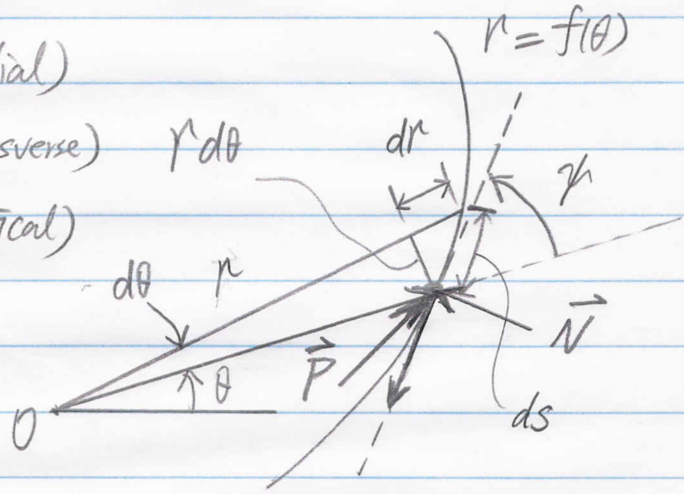
$a_n = \dfrac{v^2}{\rho}$ = centripetal force





Cylindrical Coord.

$$\begin{cases} \sum F_r = m a_r & \text{(radial)} \\ \sum F_\theta = m a_\theta & \text{(transverse)} \\ \sum F_z = m a_z & \text{(vertical)} \end{cases}$$



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With ds (actual displacement), the displacement components are

dr = radial

$r\,d\theta$ = transverse

$$\Rightarrow \tan\psi = \frac{r\,d\theta}{dr} = \frac{r}{(dr/d\theta)}$$