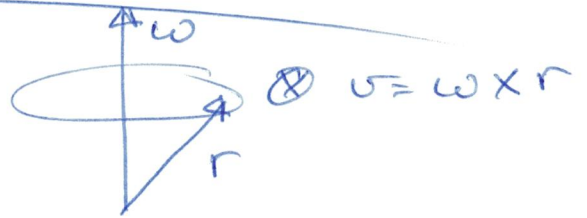


Non-Inertial Frames

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



$$\underbrace{\frac{d}{dt} \vec{r}}_{\text{Inertial}} = \underbrace{\frac{d}{dt} \vec{r} + \vec{\omega} \times \vec{r}}_{\text{Non-inertial}}$$

$$\frac{d}{dt} \boxed{\vec{r} = \frac{d}{dt} \vec{r} + \vec{\omega} \times \vec{r}}$$

$$F = ma = m(\frac{d^2}{dt^2} \vec{r})$$

$$\frac{d^2}{dt^2} \vec{r} = \left[\frac{d}{dt} + \vec{\omega} \times \right] \left[\frac{d}{dt} + \vec{\omega} \times \right] \vec{r} \quad \text{Non-Inertial}$$

$$\begin{aligned} &= \frac{d^2}{dt^2} \vec{r} + \frac{d}{dt} [\vec{\omega} \times \vec{r}] + \vec{\omega} \times (d\vec{r}) + \vec{\omega} \times \vec{\omega} \times \vec{r} \\ &= \frac{d^2}{dt^2} \vec{r} + (d\vec{\omega}) \times \vec{r} + \vec{\omega} \times (d\vec{r}) + \vec{\omega} \times (d\vec{r}) + \vec{\omega} \times \vec{\omega} \times \vec{r} \end{aligned}$$

$$\boxed{= \frac{d^2}{dt^2} \vec{r} + \vec{\omega} \times \vec{r} + 2\vec{\omega} \times \dot{\vec{r}} + \vec{\omega} \times \vec{\omega} \times \vec{r}}$$

Time-dep.
 ω

Coriolis

$$2\vec{\omega} \times \vec{v}$$

Centrifugal

$$\vec{\omega} \times \vec{\omega} \times \vec{r} = -\frac{v^2}{r} \hat{r}$$