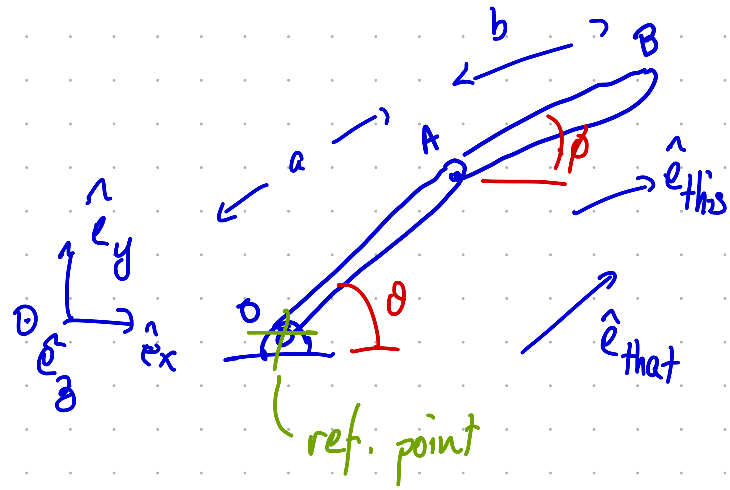
$$\vec{r}_{OA} = a\,\hat{e}_{that}$$

$$+ \quad \vec{r}_{AB} = b\,\hat{e}_{this}$$



$$\vec{r}_{OB} = \vec{r}_{OA} + \vec{r}_{AB}$$

$$= a\,\underbrace{\hat{e}_{that}}_{} + b\,\overbrace{\hat{e}_{this}}^{\cos\phi\,\hat{e}_x + \sin\phi\,\hat{e}_y}$$

$$\hat{e}_{that} = (\cos\theta)\,\hat{e}_x + (\sin\theta)\,\hat{e}_y$$

$$\dot{\vec{r}}_{OB} = a\,\dot{\hat{e}}_{that} + b\,\dot{\hat{e}}_{this}$$

$$\dot{\hat{e}}_{that} = \vec{\omega}\times\hat{e}_{that}, \quad \vec{\omega} = \dot{\theta}\,\hat{e}_z$$

$$\hat{e}_x \to \hat{e}_y \to \hat{e}_z \to \hat{e}_x$$

$$\dot{\theta}\,\hat{e}_z \Rightarrow \vec{\omega}\times\hat{e}_{that} = \dot{\theta}\,\hat{e}_z \times \left[\cos\theta\,\hat{e}_x + \sin\theta\,\hat{e}_y\right]$$

$$= \dot{\theta}\cos\theta\,(\hat{e}_z\times\hat{e}_x) + \dot{\theta}\sin\theta\,(\hat{e}_z\times\hat{e}_y)$$

$$= \dot{\theta}\left[\cos\theta\,\hat{e}_y - \sin\theta\,\hat{e}_x\right]$$

D'lambert: $\sum\vec{F} = m\ddot{\vec{r}} \Rightarrow \left(\sum\vec{F} - m\ddot{\vec{r}}\right) = \vec{0}$

$$[I_c] = \frac{2}{5}mR^2\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$$ for a sphere of radius R.

$$[I_{c,s\text{-}ball}] = \frac{2}{5}m(2R)^2\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix} \qquad [I_{c',cavity}] = \frac{2}{5}mR^2\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$$

$$= \frac{8mR^2}{5}\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$$

$$[I_{C,\text{cavity}}] = \underbrace{\frac{2}{5}\left(\frac{m}{8}\right)R^2 \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}}_{[I_{C',\text{cavity}}]} + \frac{m}{8}\begin{bmatrix} 0 & 0 & 0 \\ 0 & R^2 & 0 \\ 0 & 0 & R^2 \end{bmatrix} \quad \text{with } a = R$$

$b = 0$

$c = 0$

$$[I_{c,\text{ball}}] - [I_{c,\text{cavity}}] \cdots$$