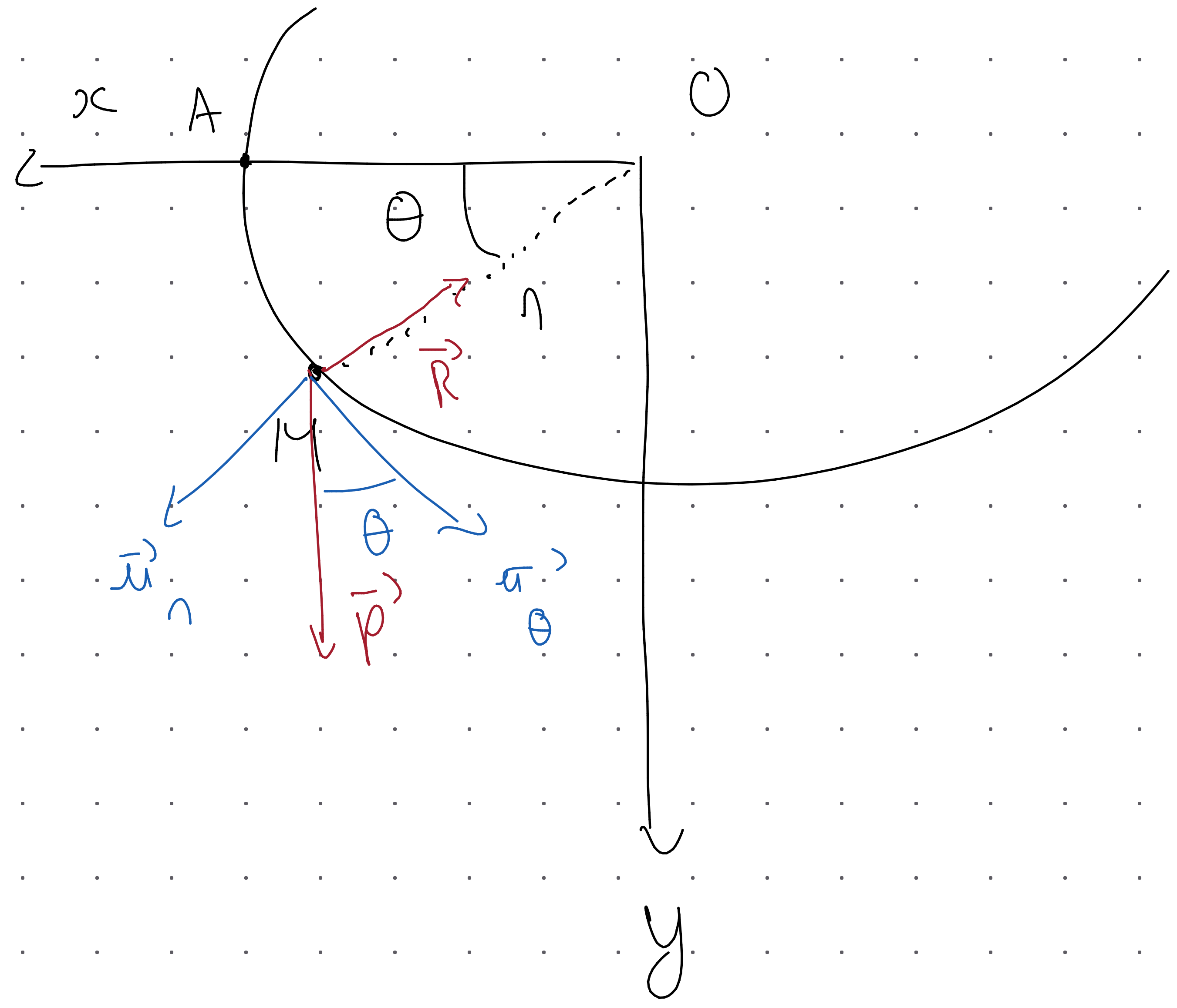
E_x 3



PFD : $m\vec{a} = \sum F_{ext}$

$m\vec{a} = \vec{P} + \vec{R}$

$\vec{OM} = r\,\vec{u}_r$

$\vec{V} = r\dot{\theta}\,\vec{u}_\theta$

$\vec{a} = r\ddot{\theta}\,\vec{u}_\theta - r\,\vec{u}_r\,\dot{\theta}^2$

$\vec{R} = -R\,\vec{u}_r$

$\vec{P} = P\,\vec{u}_\theta \cos\theta + P\sin\theta\,\vec{u}_r$

$= mg\cos\theta\,\vec{u}_\theta + mg\sin\theta\,\vec{u}_r$

$ma = -R\,\vec{u}_r + mg\cos\theta\,\vec{u}_\theta + mg\sin\theta\,\vec{u}_r$

$m r\ddot{\theta}\,\vec{u}_\theta - m r\,\vec{u}_r\,\dot{\theta}^2 = -R\,\vec{u}_r + mg\cos\theta\,\vec{u}_\theta + mg\sin\theta\,\vec{u}_r$

$$m\left|\begin{array}{l} -r\dot{\theta}^2 \\ r\ddot{\theta} \end{array}\right. = \left|\begin{array}{l} -R \\ 0 \end{array}\right. + mg\left|\begin{array}{l} \sin\theta \\ \cos\theta \end{array}\right.$$

$$m\left|\begin{array}{l} -r\dot{\theta}^2 \\ r\ddot{\theta} \end{array}\right. - mg\left|\begin{array}{l} \sin\theta \\ \cos\theta \end{array}\right. = \left|\begin{array}{l} -R \\ 0 \end{array}\right.$$

$$m\left|\begin{array}{l} -r\dot{\theta}^2 - g\sin\theta \\ r\ddot{\theta} - \cos\theta \end{array}\right. = \left|\begin{array}{l} -R \\ 0 \end{array}\right.$$

$$\left| \begin{array}{l} R = m r \dot{\theta}^2 + mg \sin\theta \\ r\ddot{\theta} = \cos\theta \end{array} \right.$$

$$\Delta E_c = \Delta W(F_{ext})$$

$$dW = \vec{F} \cdot \vec{dl}$$

$$W_{AB} = \int_A^B dW = \int_A^B \vec{F} \cdot \vec{dl} \quad \text{avec } \vec{dl} = \underbrace{dr \vec{u}_r}_{\text{cste}} + r d\theta \vec{u}_\theta + \underbrace{d_y \vec{u}_y}_{=0}$$

$$\vec{dl} = r d\theta \vec{u}_\theta$$

$$= r\dot{\theta} \vec{u}_\theta$$

$$W_{AB} = \int_A^B \vec{F} \vec{u}_\theta d_\theta$$

$$dW_R = \vec{R} \cdot r\dot{\theta}\vec{u}_\theta = -R r \dot{\theta} \vec{u}_\theta \vec{u}_r = 0$$

$$dW_P = \vec{P} r d\theta \vec{u}_\theta = mg \sin\theta \, r\dot{\theta}$$

$$\Delta W(\vec{F}_{Ext}) = \int_A^M mg \sin\theta \, r \, d\theta = mg \sin\theta$$

$$E_C = \frac{1}{2} m V^2$$

$$\Delta E_C = \frac{1}{2} m V_y^2 - \frac{1}{2} m V^2 = \frac{1}{2} m V_y^2 = \frac{1}{2} m r^2 \cdot \dot{\theta}^2$$

$$\frac{1}{2} m r^2 \dot{\theta}^2 = mgr \sin\theta$$

$$\dot{\theta}^2 = \frac{2g \sin\theta}{r}$$

$$R = mg \sin\theta + mr \, 2g \sin\theta \, \frac{1}{r} = 3mg \sin\theta$$