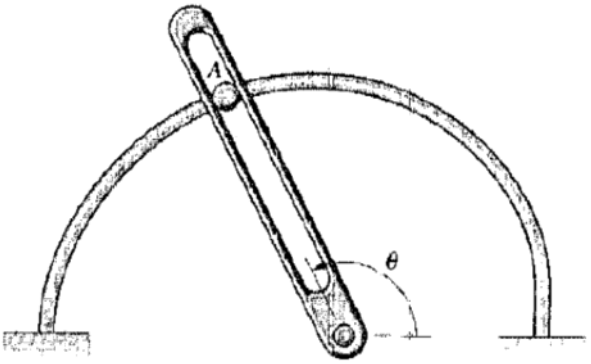
Dynamics midterm q2

Thursday, December 2, 2021 5:47 PM

The 1 kg slider A is pushed along the curved bar by the slotted bar. The curved bar lies *in the vertical plane,* and its profile is described by $r = 2(\theta/2\pi+1)$ m, where θ is in radians. The angular position of the slotted bar is $\theta = 2t$ rad, Determine the radial and transverse components of the total external force exerted on the slider when $\theta = 120^\circ$.



$$\begin{cases} r = 2\left(\frac{\theta}{2\pi}+1\right) m \text{ and } \theta \text{ (rad)} \\ \theta = 2t \text{ (rad)} \end{cases} \quad @\ \theta = 120^\circ = \frac{2}{3}\pi \text{ rad}$$

$$\begin{cases} \dot{r} = 2\frac{\dot{\theta}}{2\pi} = \frac{\dot{\theta}}{\pi} \\ \dot{\theta} = 2 \ \frac{rad}{s} \end{cases} \Rightarrow \begin{cases} \ddot{r} = 0 \\ \ddot{\theta} = 0 \end{cases} \quad \dot{\theta} = \text{constant}$$

polar coordinate $\begin{cases} a_r = \ddot{r} - r\dot{\theta}^2 \\ a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta} \end{cases} \Rightarrow$

$$\begin{cases} a_r = 0 - 2\left(\frac{\theta}{2\pi}+1\right)\times(2)^2 = -8\left(\frac{\theta}{2\pi}+1\right) \ \frac{m}{s^2} \\ a_\theta = 2\left(\frac{\theta}{2\pi}+1\right)\times 0 + 2\times\frac{\dot{\theta}}{\pi}\times 2 = 4\frac{\dot{\theta}}{\pi} \xrightarrow{\dot{\theta}=2} \frac{8}{\pi} \ \frac{m}{s^2} \end{cases}$$

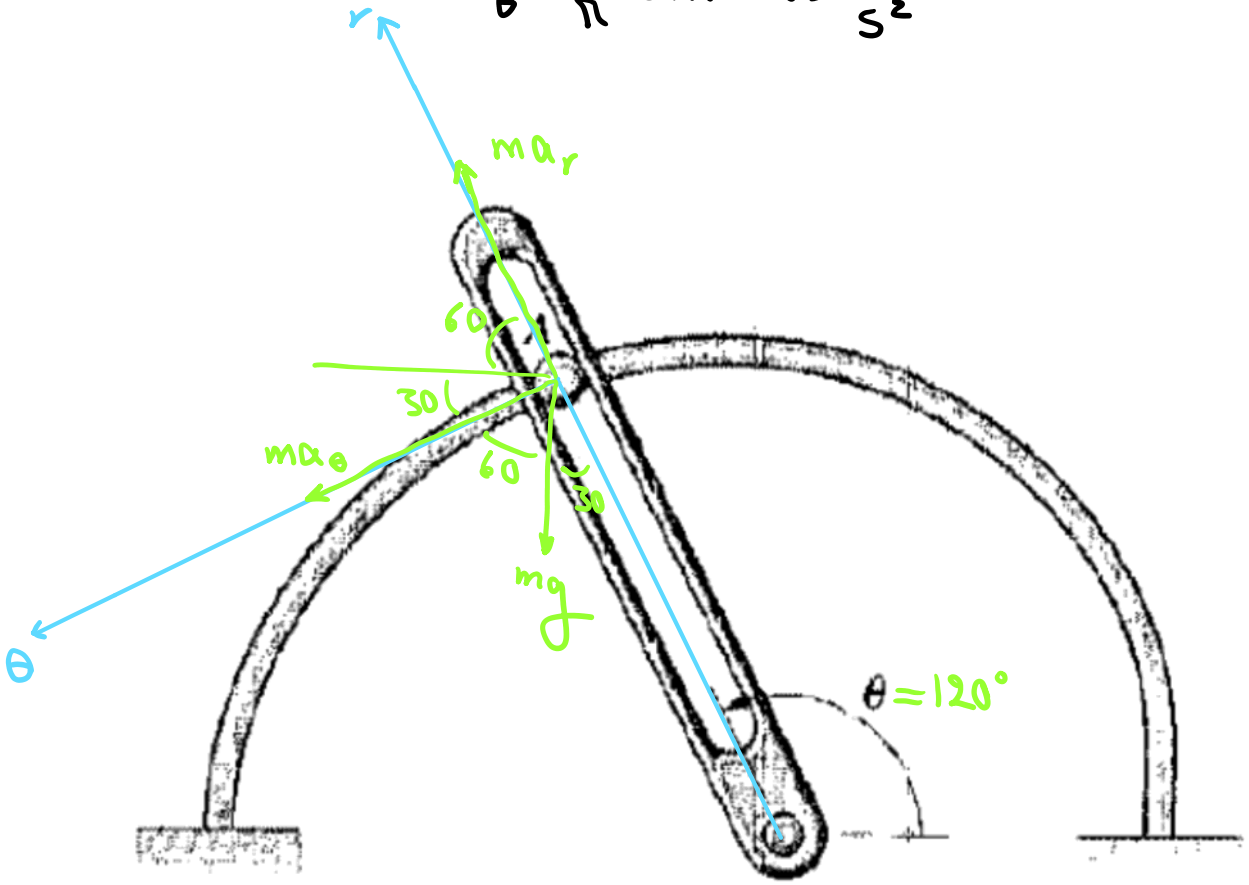
$$a_r = -8\left(\frac{\theta}{2\pi}+1\right) \ \frac{m}{s^2}$$

$$a_\theta = \frac{8}{\pi} \ \frac{m}{s^2}$$

@ $\theta = 120^\circ = \frac{2}{3}\pi$ rad

$\hookrightarrow$ @ $\theta = 120^\circ = \frac{2}{3}\pi \Rightarrow a_r\Big|_{\theta=120^\circ} = -8\left(\frac{\frac{2}{3}\pi}{2\pi} + 1\right) = -10.6667 \frac{m}{s^2}$

@ $\theta = 120^\circ \Rightarrow a_\theta = \frac{8}{\pi} = 2.5465 \frac{m}{s^2}$



$ma_r = 1 \times (-10.6667) = -10.6667\ N$

$ma_\theta = 1 \times (2.5465) = 2.5465\ N$

$mg = 1 \times 9.81 = 9.81\ N$

$\Sigma F = (-10.6667 - 9.81\sin 60)\,\hat{e}_r + (2.5465 + 9.81\cos 60)\,\hat{e}_\theta \quad (N)$

$\Rightarrow \boxed{\Sigma F = -19.1624\,\hat{e}_r + 7.4515\,\hat{e}_\theta \quad (N)}$