Review

Kinetics $F = ma$

Kinematics r, v, a

method assumed motion : $\vec{a} \rightarrow \vec{F}$

forces : $\vec{F} \rightarrow \vec{a}$

Newton : ① $\vec{F} = 0 \Rightarrow \vec{a} = 0 \Rightarrow \vec{v} = \text{const}$

② $\vec{F} = m\vec{a}$

③ equal and opposite.

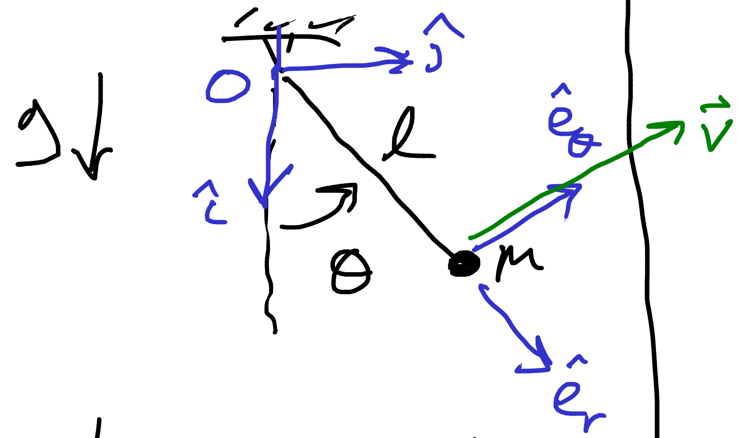
Method : ① FBD

② kinematics $\rightarrow \vec{a}$

③ $F = ma$

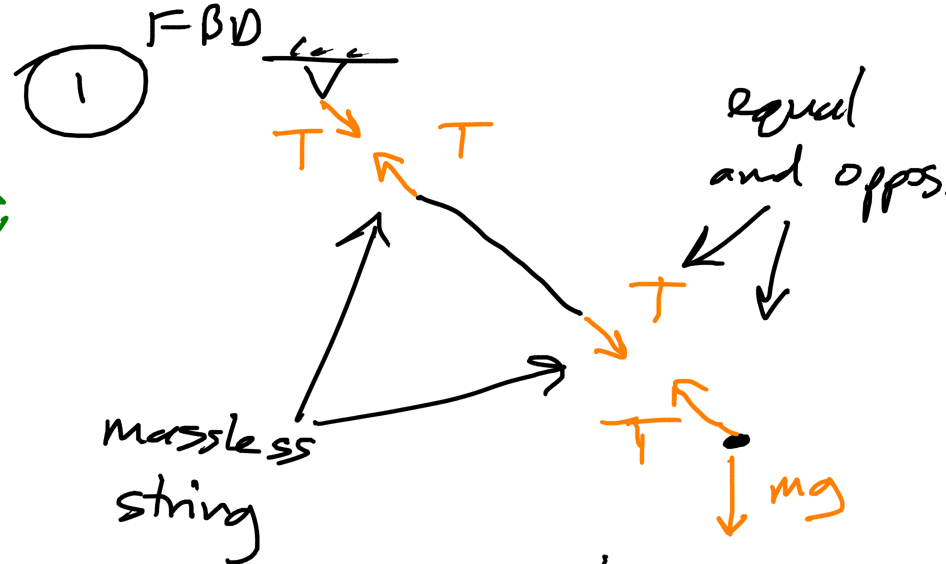
④ solve

Ex pendulum



Find angular acceleration and string tension.

1 FBD



$\sum F = \underbrace{\cancel{m}}_{0}a$ for string

Massless objects have force balance

Static objects have force balance

2 Kinematics

$$\vec{a} = (\cancel{\ddot{r}} - r\dot{\theta}^2)\,\hat{e}_r + (r\ddot{\theta} + \cancel{2\dot{r}\dot{\theta}})\,\hat{e}_\theta$$

$$= -\ell\dot{\theta}^2\,\hat{e}_r + \ell\ddot{\theta}\,\hat{e}_\theta$$

3 Newton:

$$\vec{F}_T = -T\hat{e}_r$$

$$\vec{F}_g = mg\,\hat{i}$$

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

$$-T\hat{e}_r + mg\,\hat{i} = -m\ell\dot{\theta}^2\,\hat{e}_r + m\ell\ddot{\theta}\,\hat{e}_\theta$$

④ solving

$\hat{c} = \cos\theta\,\hat{e}_r - \sin\theta\,\hat{e}_\theta$

$\hat{c}$ $\hat{e}_\theta$ $\hat{e}_r$

θ small

$$(-T + mg\cos\theta)\,\hat{e}_r - mg\sin\theta\,\hat{e}_\theta = -ml\dot{\theta}^2\hat{e}_r + ml\ddot{\theta}\,\hat{e}_\theta$$

$\hat{e}_\theta \Longrightarrow \quad ml\ddot{\theta} = -mg\sin\theta$

$$\alpha = \boxed{\ddot{\theta} = -\frac{g}{l}\sin\theta}$$

$\hat{e}_r \Longrightarrow \quad -T + mg\cos\theta = -ml\dot{\theta}^2$

$$\boxed{T = mg\cos\theta + ml\dot{\theta}^2}$$

$\dot{\theta}, \theta = 0 \Rightarrow T = mg$

swinging, at bottom $\Rightarrow$ T $> mg$ A.

$= mg$ B.

$< mg$ C.