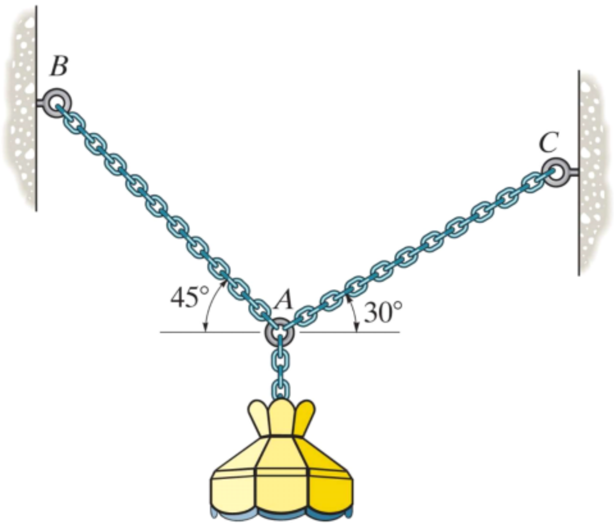
Lecture 38

Friday, December 8, 2017 12:33

To do ...

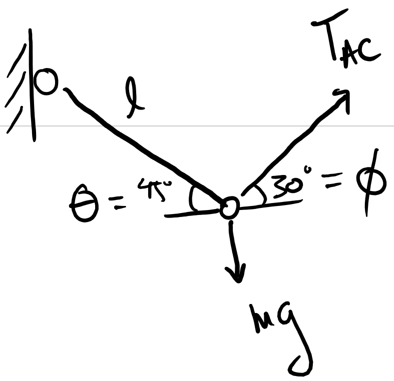
- Quiz 7 – good luck!
- Last day of office hours and piazza help: **Wed, Dec 13**
- No discussion sections next week
- TAM 211 final starts Thurs, Dec 14

- HW 27 ME due **Sat (Dec 9) – Last one!!**
- HW 26 PL due **Tues (Dec 12) – Last one!!**

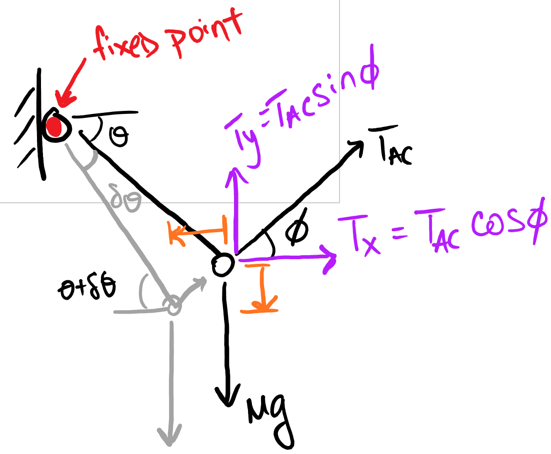


Determine the tension in the cable AC. The lamp weighs 10 lb.

FBD



VDD



Coordinates from fixed point:

$x = l\cos\theta$ $\qquad$ $y = l\sin\theta$

$\delta x = -l\sin\theta\,\delta\theta$ $\qquad$ $\delta y = l\cos\theta\,\delta\theta$

Virtual work eqn:

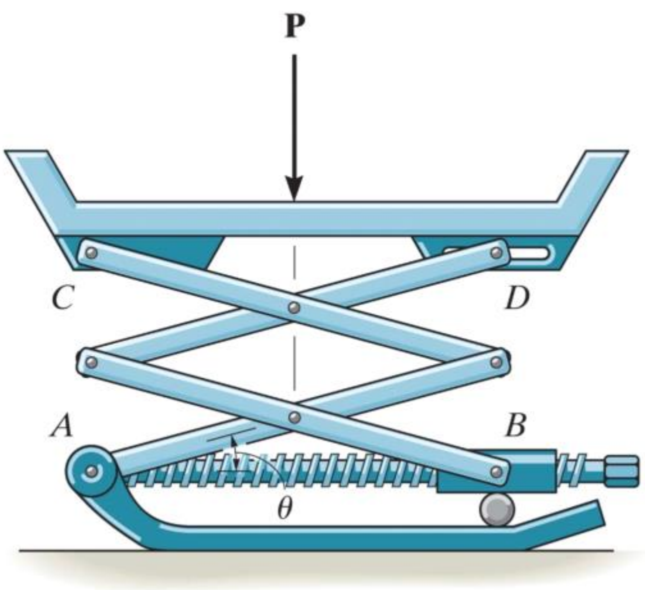
$$\delta U = W\delta y - T_y \delta y + T_x \delta x = 0$$

$$W l \cos\theta\,\delta\theta - T_{AC}\sin\phi\, l\cos\theta\,\delta\theta - T_{AC}\cos\phi\, l\sin\theta\,\delta\theta = 0$$

$$\underbrace{\left(W\cos\theta - T_{AC}\sin\phi\cos\theta - T_{AC}\cos\phi\sin\theta\right)}_{\text{solve this } = 0} l\,\delta\theta = 0$$

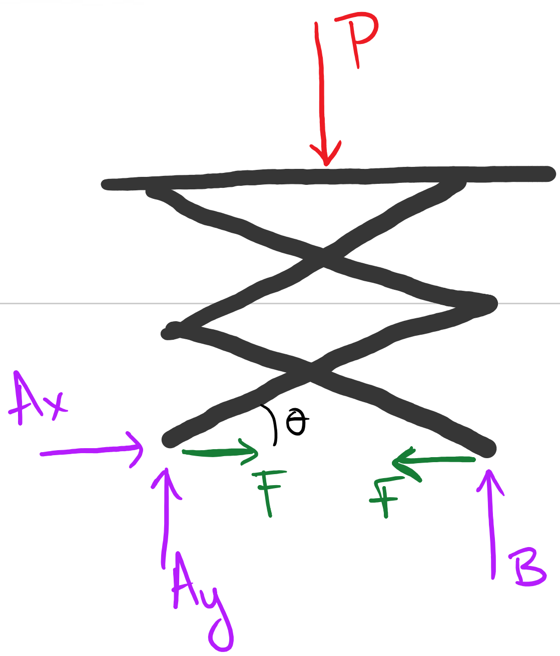
$$T_{AC}\left(\sin\phi\cos\theta + \cos\phi\sin\theta\right) = W\cos\theta$$

$$\boxed{T_{AC} = \frac{W\cos\theta}{\sin\phi\cos\theta + \cos\phi\sin\theta} \qquad \text{for } \theta = 45^\circ \text{ And } \phi = 30^\circ}$$

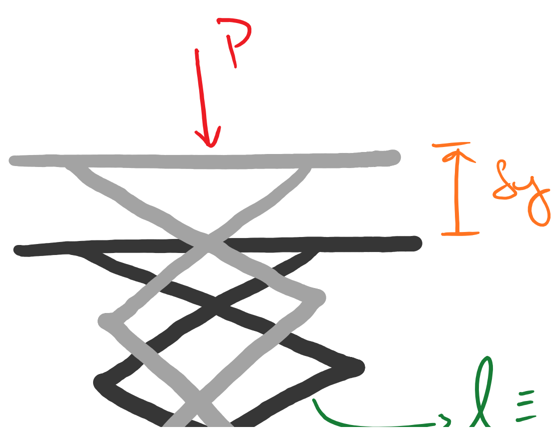


The scissors jack supports a load ***P***. Determine the axial force in the screw necessary for equilibrium when the jack is in the position theta.

FBD



VDD

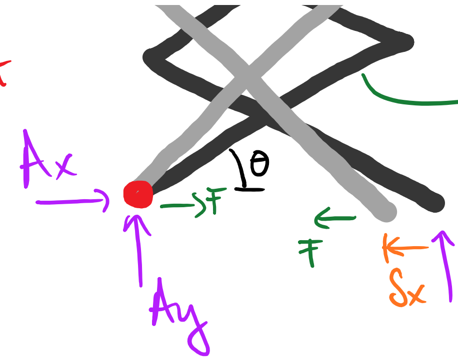


* 2 Active forces

* fixed point

l = length of member

* fixed point



$\ell \equiv$ length of member

Coordinates from fixed point:

$$x = \ell\cos\theta \qquad y = 2\ell\sin\theta$$

$$\delta x = -\ell\sin\theta\,\delta\theta \qquad \delta y = 2\ell\cos\theta\,\delta\theta$$

Virtual work Eqn:

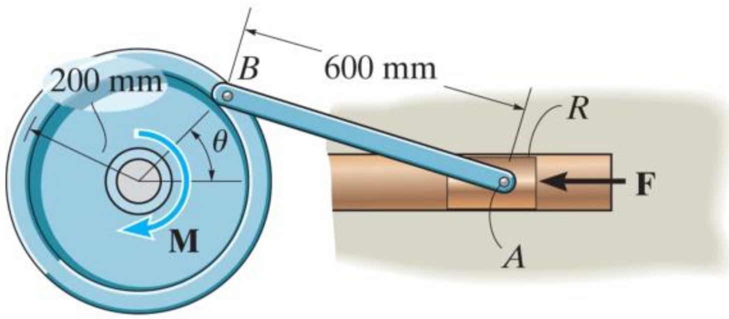
$$\delta U = -F\,\delta x - P\,\delta y = 0$$

$$-F(-\ell\sin\theta\,\delta\theta) - P(2\ell\cos\theta\,\delta\theta) = 0$$

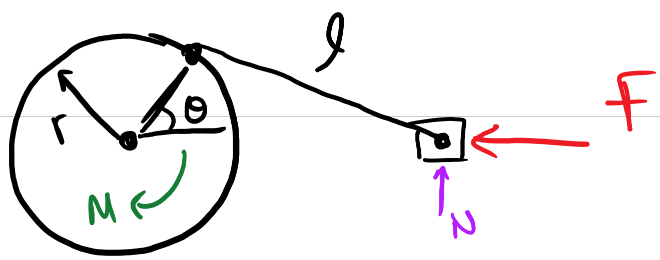
$$\underbrace{(F\sin\theta - 2P\cos\theta)}_{\text{solve for } = 0}\,\ell\,\delta\theta = 0$$

$$\boxed{F = 2P\frac{\cos\theta}{\sin\theta} = 2P\frac{1}{\tan\theta}}$$

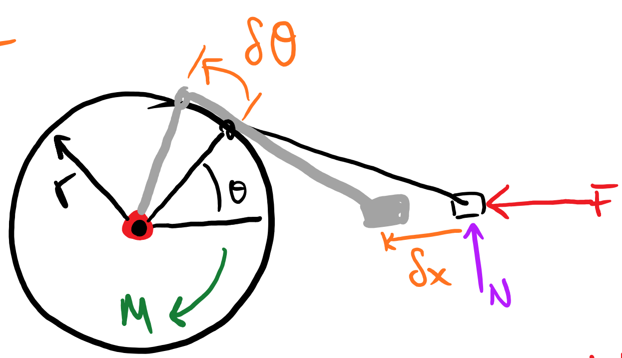
The flywheel is subjected to a torque M of 75 Nm. Determine the horizontal compressive force F and plot the result versus the equilibrium position theta.



FBD



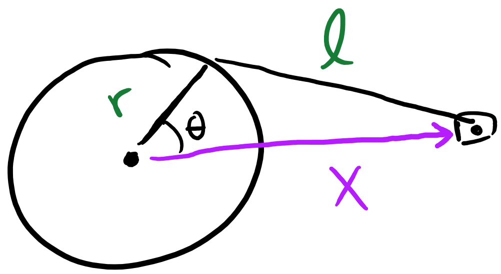
VDD



* fixed point

* 1 active force, 1 active moment.

Coordinates from fixed point:



* use law of cosines!

$$\ell^2 = r^2 + x^2 - 2rx\cos\theta$$

* use quadratic formula to solve $x(\theta)$

$$\underbrace{1}_{a}x^2 + x\underbrace{(-2r\cos\theta)}_{b} + \underbrace{(r^2-\ell^2)}_{c} = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\boxed{x(\theta) = r\cos\theta \pm \sqrt{r^2\cos^2\theta - (r^2-\ell^2)}}$$

And differentiate:

$$x^2 - 2rx\cos\theta = l^2 - r^2$$

$$2x\delta x - 2r(\cos\theta\,\delta x - x\sin\theta\,\delta\theta)$$

$$\delta x = \frac{2rx\sin\theta}{2r\cos\theta - 2x}\,\delta\theta$$

Virtual work Eqn.

$$\delta U = -F\delta x - M\delta\theta = 0$$

$$-F\left(\frac{2rx\sin\theta}{2r\cos\theta - 2x}\right)\delta\theta - M\delta\theta = 0$$

$$\boxed{F = -M\left(\frac{r\cos\theta - x(\theta)}{rx(\theta)\sin\theta}\right)}$$