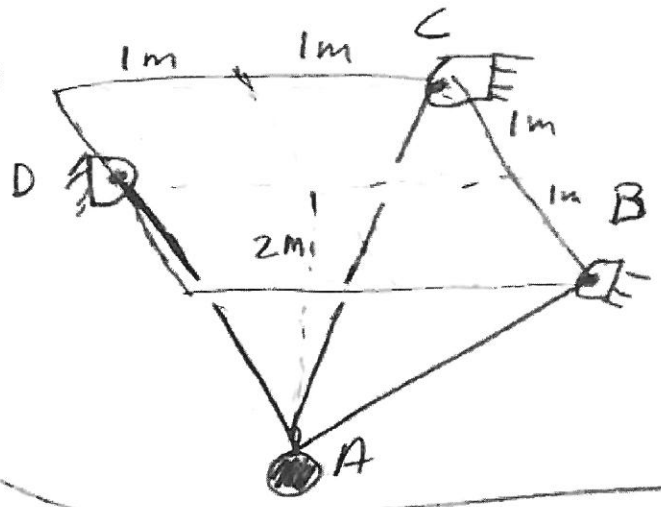
"Homework" exam, TAM 2020, Dec 4, 2010 "SOLUTIONS"

1) RP 4,1,23

Find tension in AC.



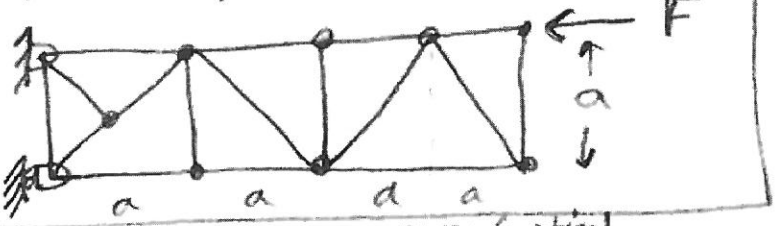
$m = 1\ kg$

$g = 10\ N/kg$

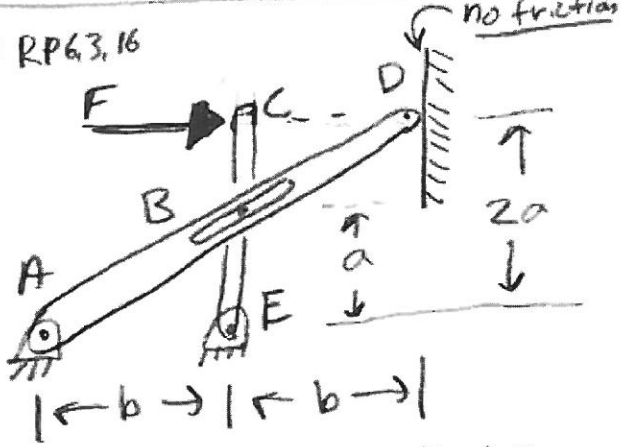
2) RP 5,1,13

a) Find & clearly mark all of the zero force members.

b) Find the tension or compression in any non-zero force member (you choose).



3) RP 6,3,16

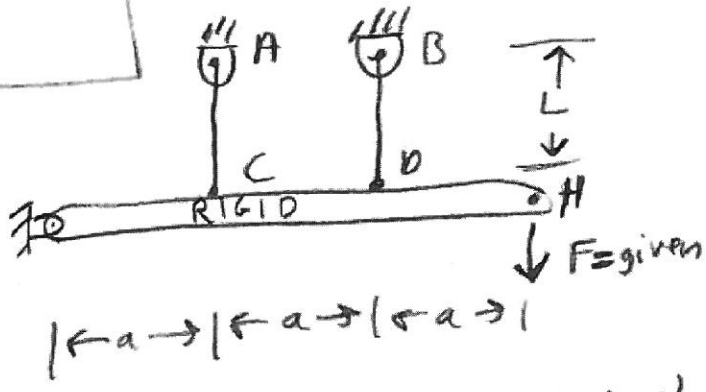


Find force at wall at D

(Given a, b, F)

4) BJ 9,34

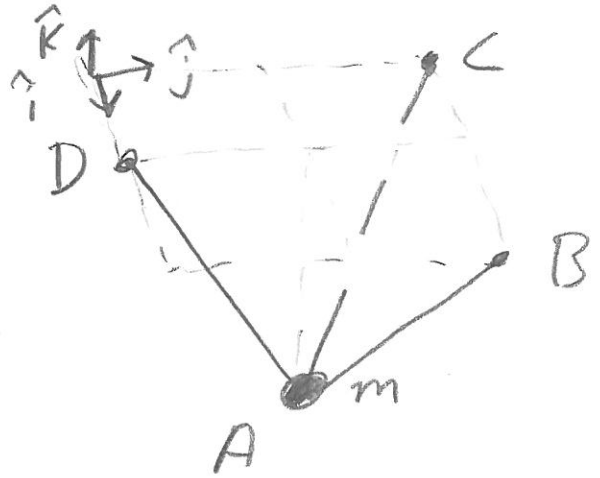
Deflection at H = ?



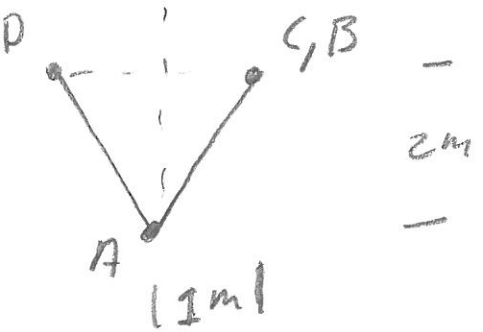
AC & BD cross section

A, E, G, α, ν given

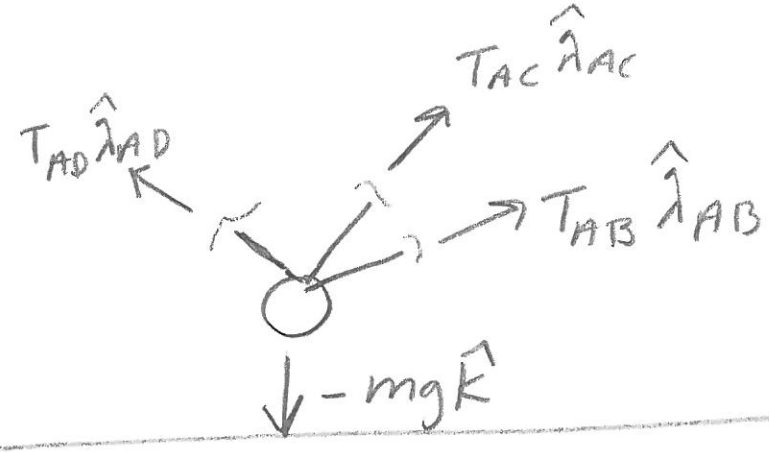
1)



Looking down $\hat{i}$ axis



FBD



Quick (advanced) intuitive soln.:

By symmetry ⇒ prob. would be same if there were 4 cables, one to each corner. ⇒ Each carries 1/4 of weight.

$$\Rightarrow \frac{T_{AC}/4}{mg} = \frac{2}{\sqrt{6}} \Rightarrow T_{AC} = \frac{\sqrt{6}}{8}mg = \frac{\sqrt{6}}{8}10N = 3.06\ N$$

Real Soln!

$$\sum M_{DB} = 0 \Rightarrow \underbrace{\overrightarrow{DB}}_{(2\hat{j}+\hat{i})/\sqrt{5}} \cdot \left[\overrightarrow{DA} \times \left(-mg\hat{k} + T_{AC}\hat{\lambda}_{AC}\right)\right] = 0$$

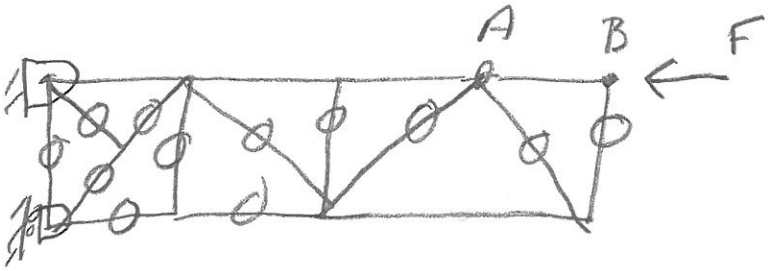
$\hat{\lambda}_{AC} = (-\hat{i}+\hat{j}+2\hat{k})/\sqrt{6}$, $\overrightarrow{DA} = (\hat{j}-2\hat{k})/\sqrt{5}$

$$\Rightarrow (2\hat{j}+\hat{i}) \cdot \left[-mg\hat{i} + \frac{T_{AC}}{\sqrt{6}}\left(\hat{k} + 2\hat{i} + 2\hat{j} + 2\hat{i}\right)\right] = 0$$

$$\Rightarrow -mg + \frac{T_{AC}}{\sqrt{6}}[4+4] = 0$$

$$\Rightarrow T_{AC} = \frac{\sqrt{6}}{8}mg = \frac{\sqrt{6}}{8}10N = \boxed{3.06\ N}$$

2)

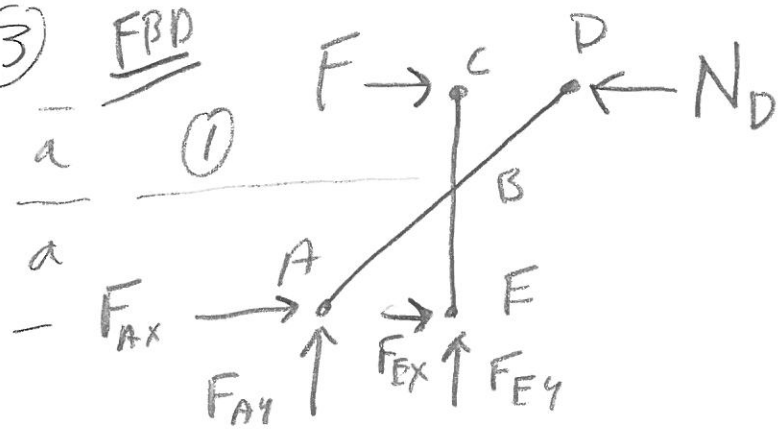


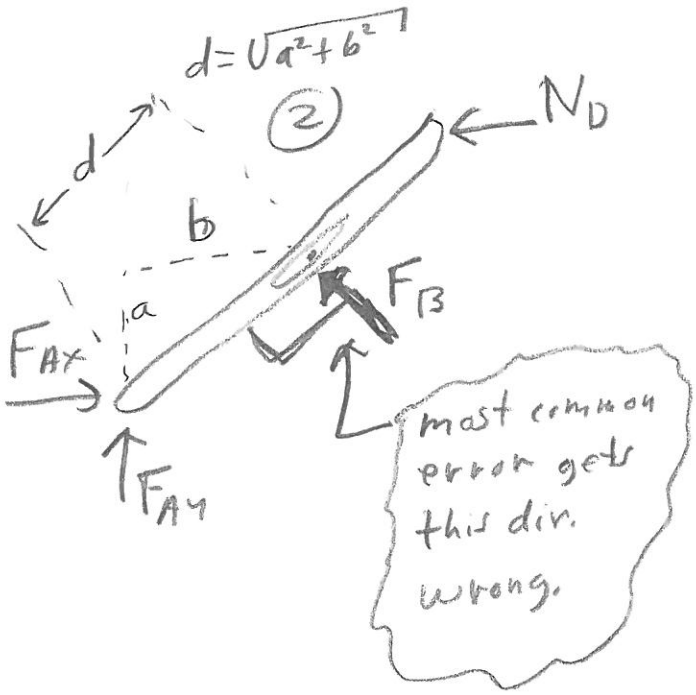
joint B

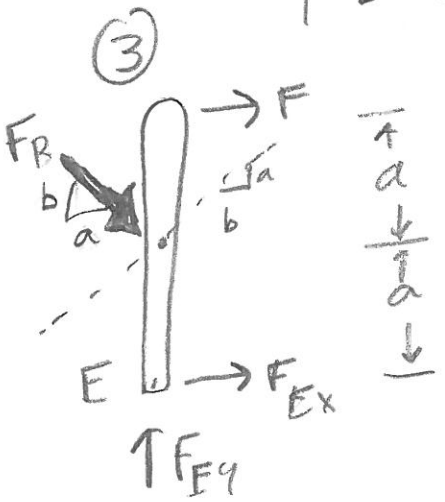
$\sum F_x = 0 \Rightarrow$ $\boxed{T_{AB} = -F}$

If $F > 0 \Rightarrow$ compression

③ FBD







$\hat{j}$ ↺ $\hat{i}$

③, $+\circlearrowleft \sum M_{/E} = 0 \Rightarrow -2aF - \left(\frac{a}{d} F_B\right) a = 0$

$\Rightarrow F_B = \frac{-2d}{a} F = \frac{-2\sqrt{a^2+b^2}}{a} F$

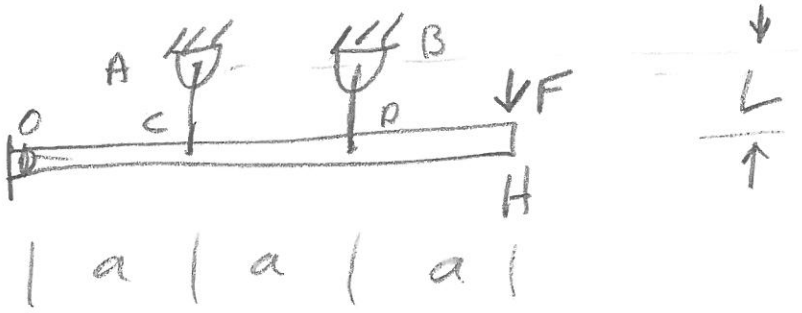
②, $+\circlearrowleft \sum M_{/A} = 0 \Rightarrow 2aN_D + F_B d = 0$

$\Rightarrow N_D = \frac{-d}{2a} F_B = \frac{-d}{2a}\left(\frac{-2\sqrt{a^2+b^2}}{a} F\right)$

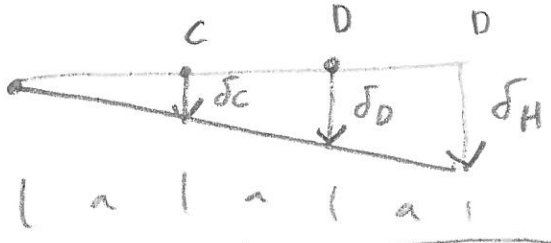
$= \frac{a^2+b^2}{a^2} F$

$$\boxed{N_D = F\left(1+\frac{b^2}{a^2}\right)}$$

4)

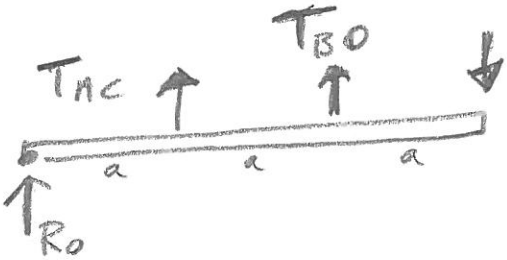


Geometry



$\delta_C = \frac{\delta_H}{3}$, $\delta_D = \frac{2\delta_H}{3}$ (1)

FBD



$\curvearrowleft \sum M_O = 0 \Rightarrow T_{AC} + 2T_{BD} = 3F$ (2)

Mat Prop

$T_{AC} = \delta_{AC} EA/L$, $T_{BC} = \frac{\delta_{BD} EA}{L}$ (3)

(1) → (3) → (2)

$$\Rightarrow (\delta_H/3)\frac{EA}{L} + 2\left(\frac{2\delta_H}{3}\right)\frac{EA}{L} = 3F$$

$$\Rightarrow \delta_H \frac{EA}{L}\left[\frac{1}{9} + \frac{4}{9}\right] = F$$

$$\Rightarrow \boxed{\delta_H = \frac{9}{5}\frac{FL}{EA}}$$