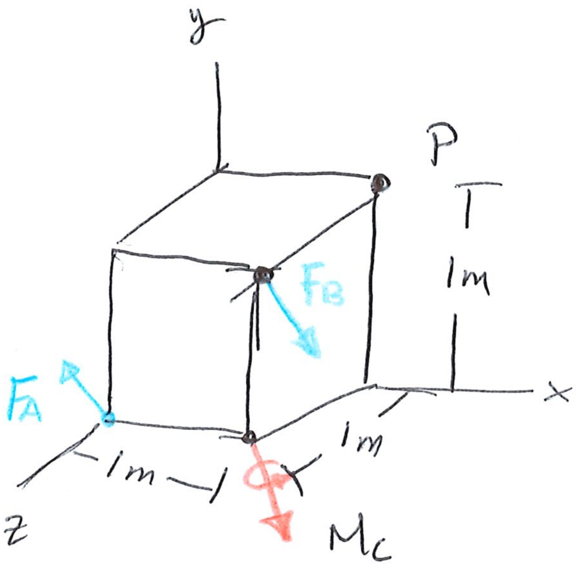
Problem 4.159

Homework 5

Raul Marrero Rosa

Find: Equivalent force $\vec{F}$ at P and couple moment $\vec{M}$?

FBD



$$F_A = -1\vec{i} + 1\vec{j} + 1\vec{k} \ [kN]$$

$$F_B = 2\vec{i} - 1\vec{j} + 0\vec{k} \ [kN]$$

$$M_C = 4\vec{i} - 4\vec{j} + 4\vec{k} \ [kN \cdot m]$$

A(0, 0, 1) P(1, 1, 0)

B(1, 1, 1)

System 1

$$\sum \vec{F_1} = \vec{F_A} + \vec{F_B} = 1\vec{i} + 0\vec{j} + 1\vec{k} \ [kN]$$

$$\sum \vec{F_1} = \vec{F_1} = 1\vec{i} + 0\vec{j} + 1\vec{k}$$

Moment of $\vec{F_A}$ around P

$$\vec{M}_{P_{FA}} = \vec{r_{PA}} \times \vec{F_A}$$

$$\vec{r_{PA}} = -1\vec{i} - 1\vec{j} + 1\vec{k}$$

$$\vec{r_{PA}} \times \vec{F_A} = \begin{vmatrix} i & j & k \\ -1 & -1 & 1 \\ -1 & 1 & 1 \end{vmatrix}$$

$$\vec{M}_{P_{FA}} = \left((-1)(1) - (1)(1)\right)\vec{i}$$
$$- \left((-1)(1) - (1)(-1)\right)\vec{j}$$
$$+ \left((-1)(1) - (-1)(-1)\right)\vec{k}$$

$$\vec{M}_{P_{FA}} = -2\vec{i} + 0\vec{j} - 2\vec{k} \quad [kN \cdot m]$$

Moment of $\vec{F_B}$ around P

$$\vec{M}_{P_{FB}} = \vec{r}_{PB} \times \vec{F_B}$$

$$\vec{r}_{PB} = 0\vec{i} + 0\vec{j} + 1\vec{k}$$

$$\vec{r}_{PB} \times \vec{F_B} = \begin{vmatrix} i & j & k \\ 0 & 0 & 1 \\ 2 & -1 & 0 \end{vmatrix}$$

$$= \left(0(0) - (1)(-1)\right)\vec{i}$$
$$- \left(0(0) - (1)(2)\right)\vec{j}$$
$$+ 0\vec{k}$$

$$\vec{M}_{P_{FB}} = 1\vec{i} + 2\vec{j} + 0\vec{k}$$

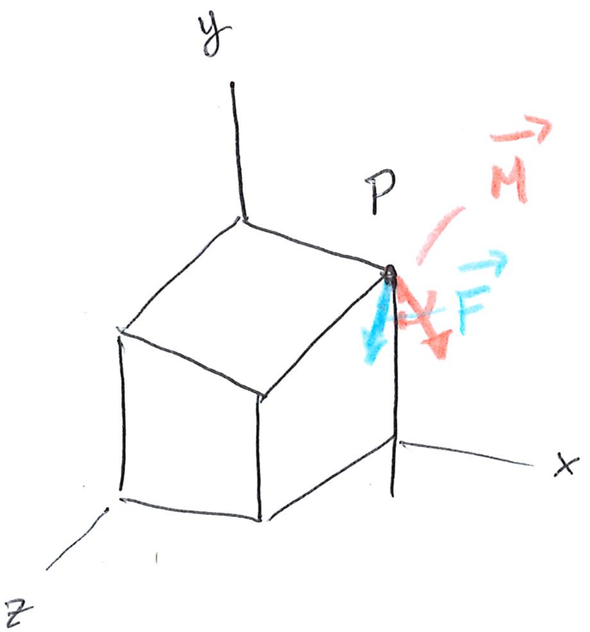
$$\sum \vec{M}_{P_1} = \vec{M}_c + \vec{M}_{PFA} + \vec{M}_{PFB}$$

$$= (4\vec{i} - 4\vec{j} + 4\vec{k}) + (-2\vec{i} + 0\vec{j} - 2\vec{k})$$

$$+ (1\vec{i} + 2\vec{j} + 0\vec{k})$$

$$\sum \vec{M}_{P_1} = 3\vec{i} - 2\vec{j} + 2\vec{k} \quad [kN \cdot m]$$

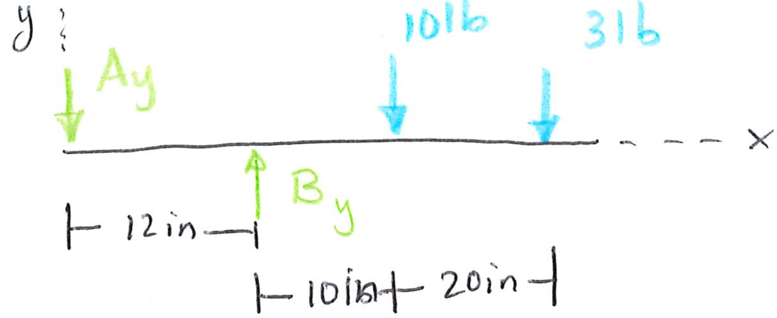
$$\boxed{\begin{aligned} \vec{F} &= 1\vec{i} + 0\vec{j} + 1\vec{k} \quad [kN] \\ \vec{M} &= 3\vec{i} - 2\vec{j} + 2\vec{k} \quad [kN \cdot m] \end{aligned}}$$



Problem 5.7

Homework 5 W1 24
Raul Marrero Rosa

ⓐ FBD



ⓑ Determine Reaction A and B
Equilibrium

$$+\circlearrowleft \sum M_A = 0$$

$$B_y(12in) - (10lb)(22in) - (3lb)(42in) = 0$$

$$B_y = \frac{346 \text{ lb}\cdot\text{in}}{12 in}$$

$$\boxed{B_y = 28.8 \text{ lb}} \uparrow$$

$$+\uparrow \sum F_y = 0$$

$$B_y - A_y - 10 lb - 3 lb = 0$$

$$A_y = B_y - 13 lb$$

$$\boxed{A_y = 15.8 \text{ lb} \downarrow}$$

Check (No needed for the solution)

$$+\circlearrowright \sum M_B = 0$$

$$(15.8\ \text{lb})(12\ \text{in}) - (10\ \text{lb})(10\ \text{in}) - (3\ \text{lb})(30\ \text{in}) \approx -0.4$$

$$-0.4 \approx 0 = 0 \quad \text{OK}$$

approximate zero
error due to rounding

Homework W124
Raul Marrero Rosa

Problem 5.20

Given:

$L_0 = 0.350\ m$

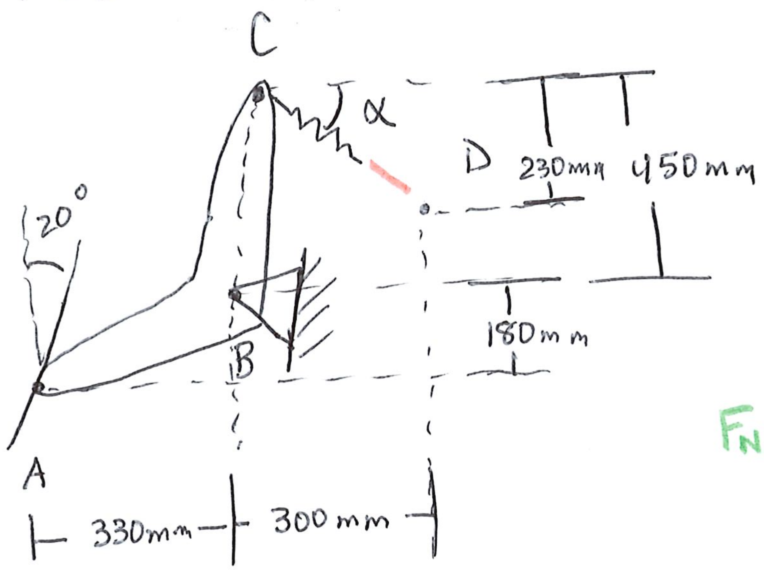
$|F_{N_A}| = 120\ N$

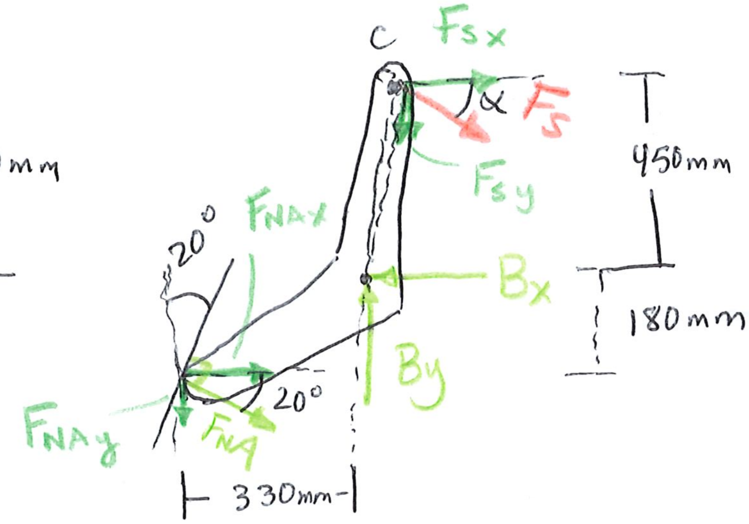
Find

$K = ?$

Reaction at B

FBD





$$L_{f_s} = \sqrt{(300mm)^2 + (230mm)^2} = 378.02\ mm$$

$$F_s = K\left(0.37802\ m - 0.350\ m\right) = 0.02802\ K$$

It is streched ~~so~~ it is a tension in the springs.

$$\alpha = \tan^{-1}\left(\frac{0.230\ m}{0.300\ m}\right) = 37.48^\circ$$

$F_{NAx} = F_{NA} \cos(20)$

$F_{NAy} = F_{NA} \sin(20)$

$F_{sx} = F_s \cos(37.48^\circ)$

$F_{sy} = F_s \sin(37.48^\circ)$

$\circlearrowright^{+}\ \sum M_B = 0$

$$F_{NA}\cos(20)(0.180\,m) + F_{NA}\sin(20)(0.330\,m)$$

$$- F_S\cos(37.48)(0.450\,m) = 0$$

$$F_{NA}(0.28201\,m) = (0.02802\,K)(0.450\,m)\cos(37.48)$$

$$F_{NA}(0.28201\,m) = K(0.01001\,m^2)$$

$$K = \frac{(0.28201\,\cancel{m})}{(0.01001\,m^{\cancel{2}})}(120\,N)$$

$$\boxed{K = 3381\ N/m}$$

$$F_S = (3381\ N/\cancel{m})(0.02802\,\cancel{m})$$

$$\boxed{F_S = 94.7\ N}$$

$\xrightarrow{+}\ \sum F_x = 0$

$$F_{NAx} + F_{Sx} - B_x = 0$$

$$(\overset{120\,N}{\cancel{94.7\,N}})\cos(20) + (94.7\,N)\cos(37.48^\circ) = B_x$$

$$\boxed{B_x = 187.9\ N \leftarrow}$$

$+\uparrow \sum F_y = 0$

$$-F_{NAy} - F_{sy} + B_y = 0$$

$$B_y = (120N)\sin(20) + (94.7\,N)\sin(37.48)$$

$$\boxed{B_y = 98.7\ N \uparrow}$$

Problem 5.47

Homework W124
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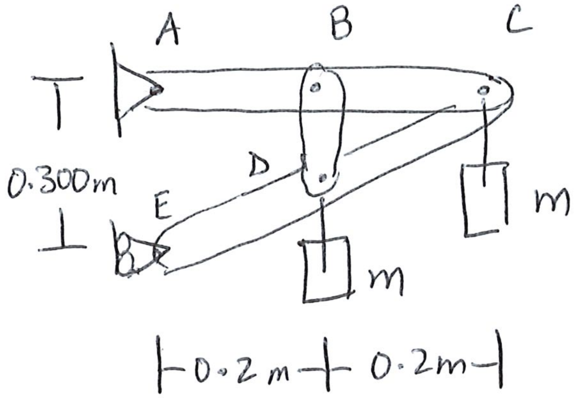
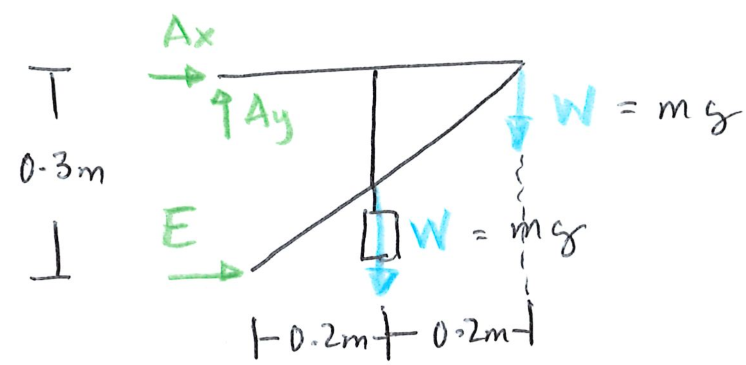


FBD



Equilibrium

$$\circlearrowleft^{+}\ \Sigma M_A = 0$$

$$E(0.3m) - W(0.2m) - W(0.4m) = 0$$

$$E(0.3m) = (0.6m)W$$

$$E = \frac{(0.6m)}{(0.3m)} W$$

$$E = 2W \quad (1)$$ Equation (1)

$$+\uparrow \ \Sigma F_y = 0$$

$$A_y - W - W = 0$$

$$A_y = 2W$$

$\sum F_x = 0$

$A_x + E = 0$

$A_x = -2W$

Resultant

$A = \sqrt{(2W)^2 + (-2W)^2}$

$A = 2.828\ W$ ② equation

Maximum magnitude 6KN

Option 1 $A = 6KN$

$W_1 = \frac{6KN}{2.828} = 2.12\ KN$

$$\boxed{m_1 = \frac{2{,}120\ N}{9.81\ m/s^2} = 216.1\ Kg}$$

This is the maximum mass

Option 2 $E = 6KN$

$E = 2W$

$W_2 = \frac{E}{2} = \frac{6KN}{2} = 3\ KN$

$m_2 = \frac{3000\ N}{9.81\ m/s^2} = 305.8\ Kg$

Problem 5.60

Homework W1 24

Raul Marrero Rosa

Given:

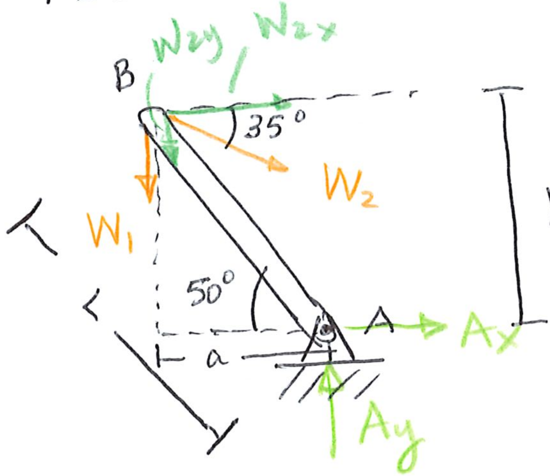
$W_1 = 1000 \text{ lb}$

Find:

$W_2 = ?$

Reaction at A

FBD



$$W_{2x} = W_2 \cos(35)$$

$$W_{2y} = W_2 \sin(35)$$

$$a = L\cos(50)$$

$$b = L\sin(50)$$

Equilibrium

$$+\circlearrowleft \sum M_A = 0$$

$$W_1 \cancel{L} \cos(50) + W_2 \sin(35)(\cancel{L}\cos(50)) - W_2\cos(35)(\cancel{L}\sin(50)) = 0$$

$$W_1 \cos(50) = W_2\left[\cos(35)\sin(50) - \sin(35)\cos(50)\right]$$

$$W_1 \cos(50) = W_2 (0.25882)$$

$$W_2 = \frac{0.64279}{0.25882} W_1$$

$$W_2 = 2.4835\ W_1$$

$$\boxed{W_2 = 2{,}484\ \text{lb}}$$

$$W_{2x} = (2{,}484\ \text{lb})\cos(35) = 2035\ \text{lb}$$

$$W_{2y} = (2{,}484\ \text{lb})\sin(35) = 1425\ \text{lb}$$

$$\xrightarrow{+} \Sigma F_x = 0$$

$$A_x + W_{2x} = 0$$

$$\boxed{A_x = -2035\ \text{lb}} \qquad \leftarrow \quad A_x = 2035\ \text{lb}$$

$$+\uparrow \Sigma F_y = 0$$

$$A_y - 1000\ \text{lb} - 1425\ \text{lb} = 0$$

$$\boxed{A_y = 2425\ \text{lb}\ \uparrow}$$

Problem 5-75

Homework W1 24
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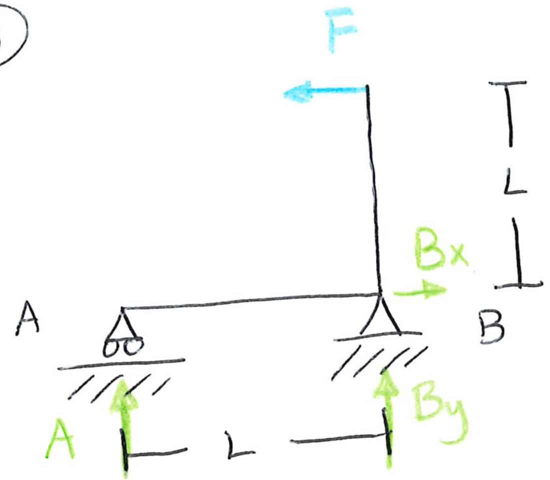
(1)



Properly supported

Equilibrium

$+\circlearrowleft \sum M_B = 0$

$F(L) - A(L) = 0$

$\boxed{A = F} \uparrow$

$+\uparrow \sum F_y = 0$

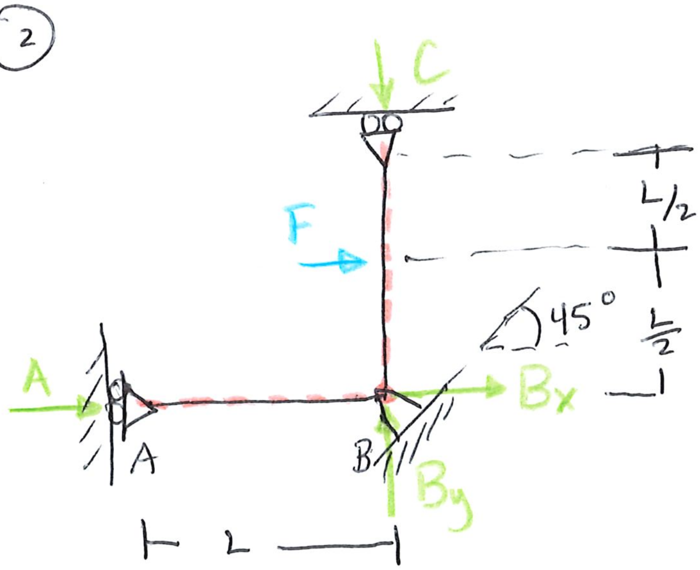
$A + B_y = 0$

$\boxed{B_y = -F}$

$\overset{+}{\rightarrow} \sum F_x = 0$

$\boxed{B_x = F}$

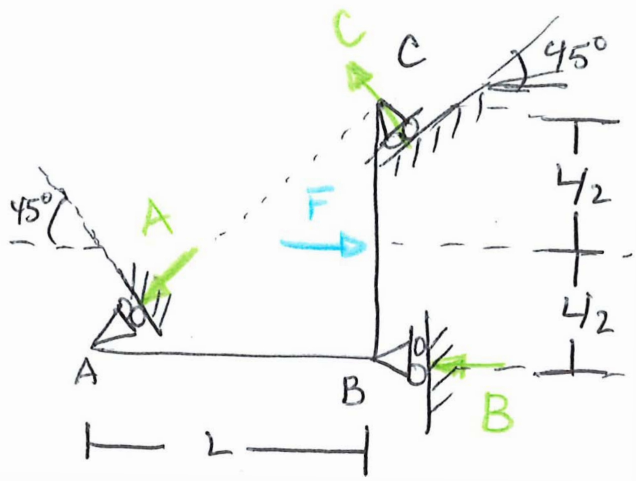
(2)

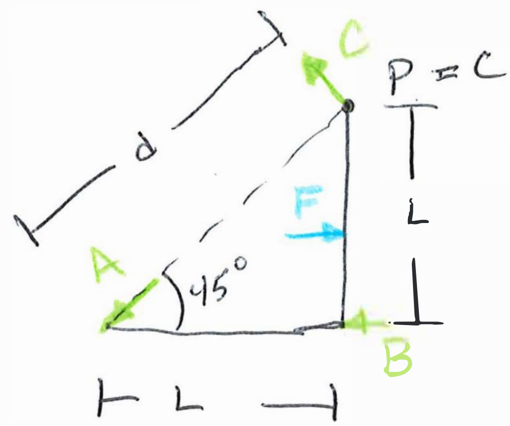


All lines of action of the reaction forces intersect in point B.

Improperly supported.

③





Properly Supported

Reaction A and C Intersect at Point P
They don't generate moment around point P

Equilibrium

$+\circlearrowleft \sum M_C = 0$

$$F\left(\frac{L}{2}\right) - B(L) = 0$$

$$\boxed{B = \frac{F}{2}}$$

$$d = \sqrt{(L)^2 + (L)^2}$$

$$d = 1.414\ L$$

$+\circlearrowleft \sum M_A = 0$

$$C(1.414\cancel{L}) - F\left(\frac{\cancel{L}}{2}\right) = 0$$

$$\boxed{C = 0.354\ F}$$

$+\uparrow \sum F_y = 0$

$$-A\sin(45) + C\sin(45) = 0$$

$$\boxed{A = C = 0.354\ F}$$