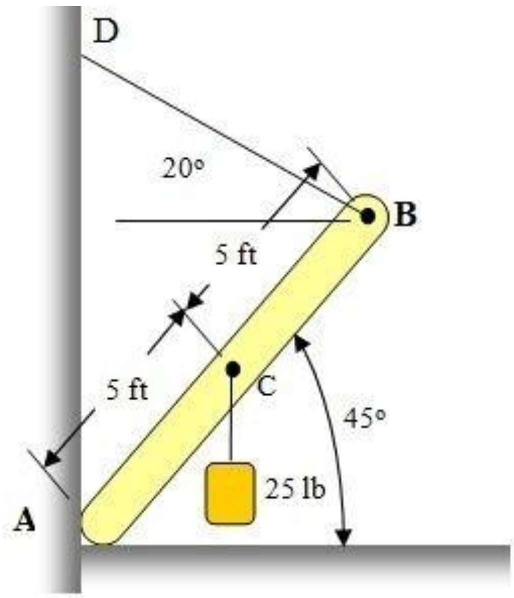
Social Club NDU

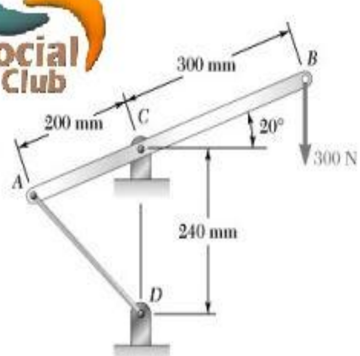
Cen 202 Exrcises For Exam 2

Problem 1 : Solution 1

For the body AB to the right, determine the reaction at point A and the tension in the cord that connect B to D.

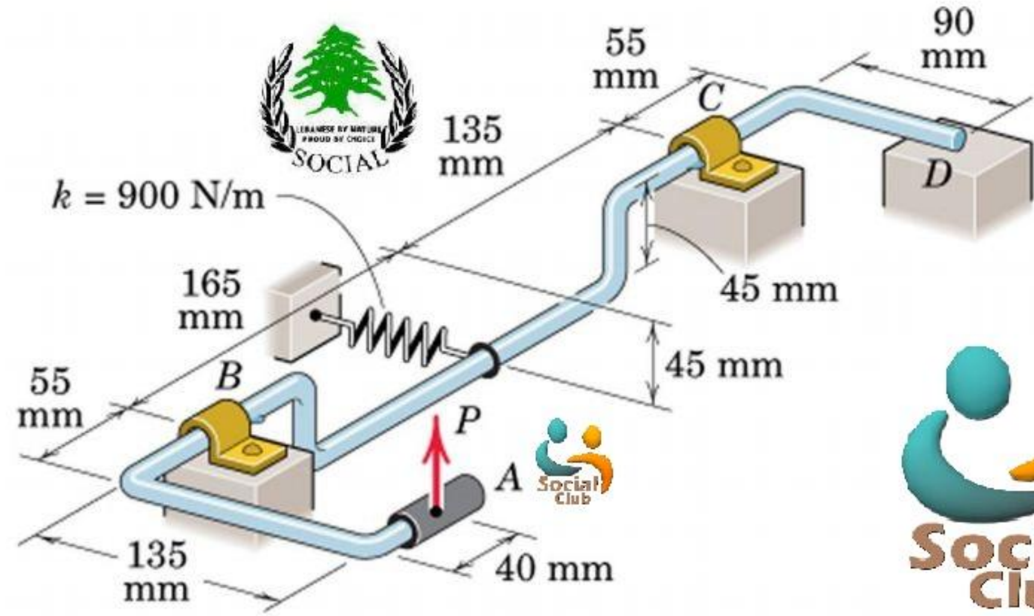


Problem 2: Solution 2 (Ex 2 Summer 2012)



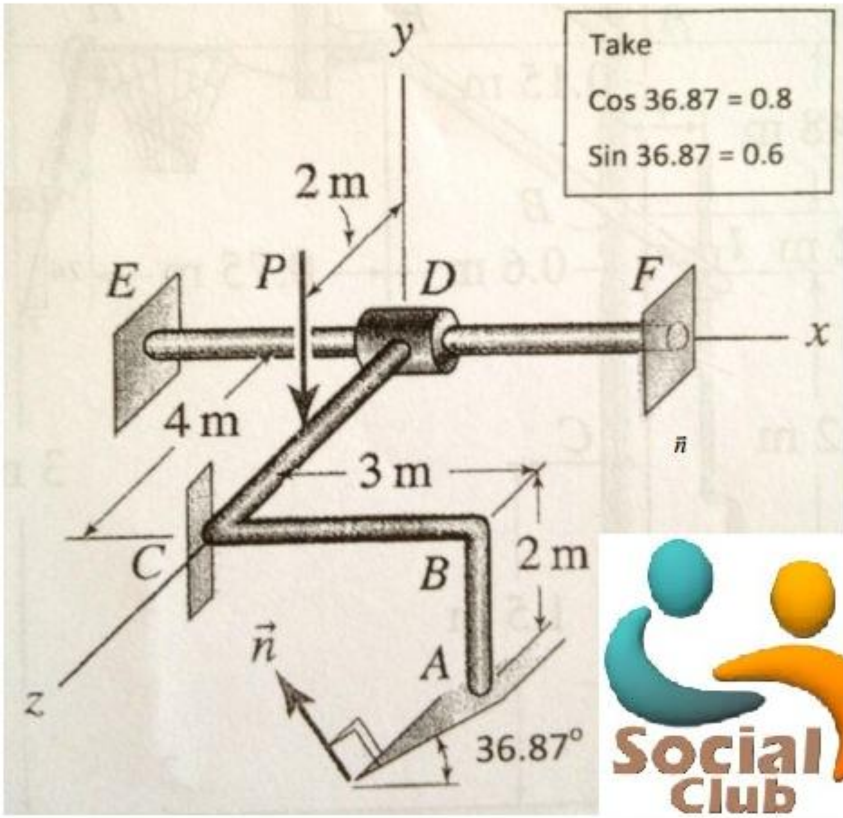
A lever *AB* is hinged at *C* and is attached to a control cable at *A*. If the lever is subjected to a 300-N vertical force at *B*, determine (a) the tension in the cable, (b) the reaction at *C*.

Problem 3: No Solution (EX2 Spring 2012)



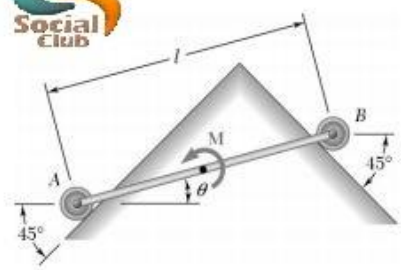
3/84 The spring of modulus k =900 N/m is stretched a distance δ= 60 mm when the mechanism is in the position shown. Calculate the force P_{min} required to initiate rotation about the hinge axis BC and determine the corresponding magnitudes of the bearing forces which are perpendicular to BC. What is the normal reaction force is $P=P_{min}/2$?

Problem 4 : No Solution



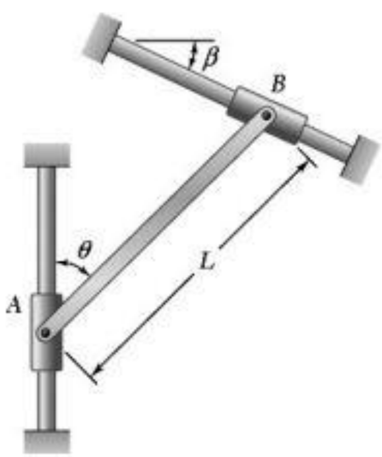
Structure ABCD is supported by a collar at D that can rotate and slide along bar EF which is fixed and frictionless. Structure ABCD makes contact with smooth surfaces at A and C where normal direction $\vec{n}$ to the surface at A lies in a plane that is parallel to the xy plane. Force P is parallel to the y axis. If P= 10 kN, determine the reactions at A, C and D. Note that collar D acts like a wide radial bearing.

Problem 5 : Solution 5



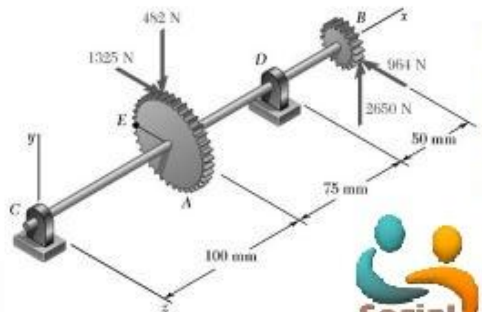
Uniform rod AB of length l and weight W lies in a vertical plane and is acted upon by a couple **M**. The ends of the rod are connected to small rollers which rest against frictionless surfaces. (*a*) Express the angle θ corresponding to equilibrium in terms of M, W, and l. (*b*) Determine the value of θ corresponding to equilibrium when $M = 1.5\ \text{lb}\cdot\text{ft}$, $W = 4\ \text{lb}$, and $l = 2\ \text{ft}$.

Problem 6 : Solution 6



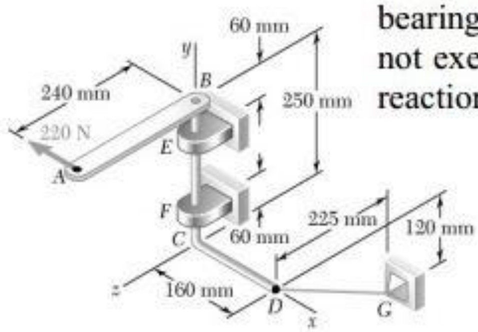
A 10-kg slender rod of length L is attached to collars which can slide freely along the guides shown. Knowing that the rod is in equilibrium and that $\beta = 25°$, determine (*a*) the angle θ that the rod forms with the vertical, (*b*) the reactions at A and B.

Problem7 : Solution 7



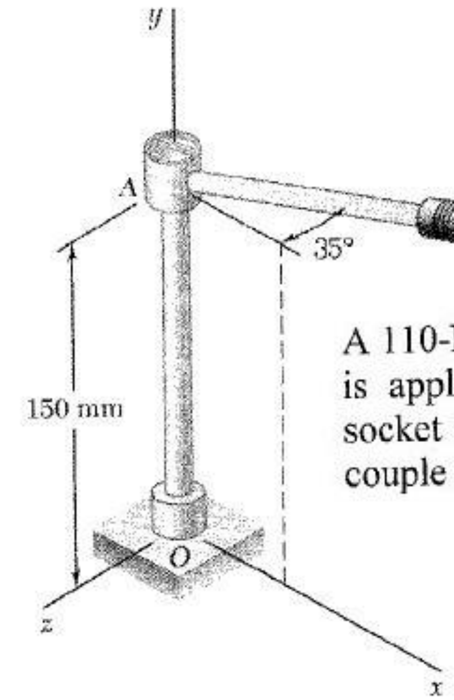
Gears *A* and *B* are attached to a shaft supported by bearings at *C* and *D*. The diameters of gears *A* and *B* are 150 mm and 75 mm, respectively, and the tangential and radial forces acting on the gears are as shown. Knowing that the system rotates at a constant rate, determine the reactions at *C* and *D*. Assume that the bearing at *C* does not exert any axial force, and neglect the weights of the gears and the shaft.

Problem 8 : Solution 8



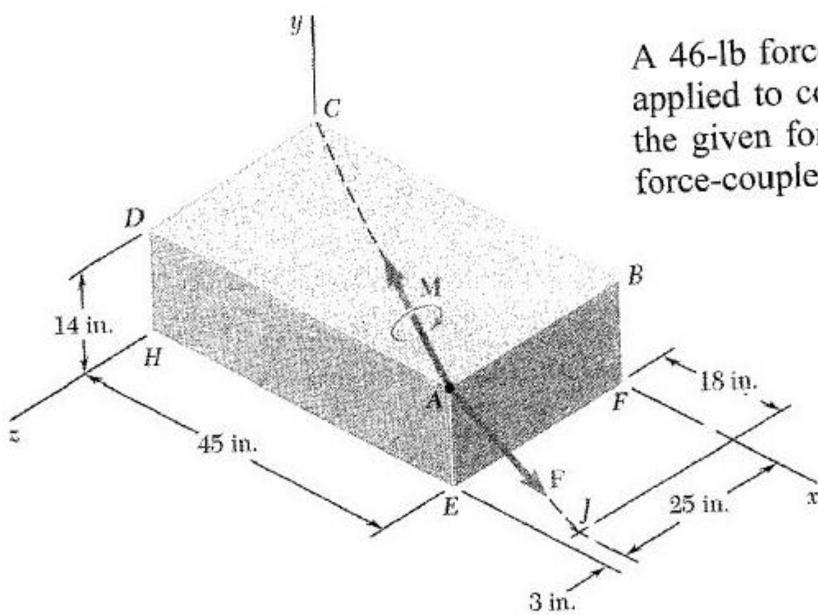
The lever *AB* is welded to the bent rod *BCD* which is supported by bearings at *E* and *F* and by cable *DG*. Knowing that the bearing at *E* does not exert any axial thrust, determine (*a*) the tension in cable *DG*, (*b*) the reactions at *E* and *F*.

Problem 9 : Solution 9



A 110-N force acting in a vertical plane parallel to the *yz* plane is applied to the 220-mm-long horizontal handle *AB* of a socket wrench. Replace the force with an equivalent force-couple system at the origin *O* of the coordinate system.

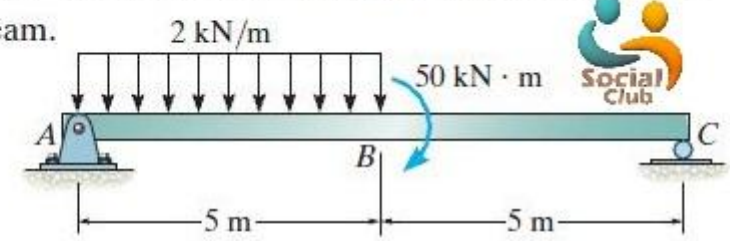
Problem 10 : Solution 10



A 46-lb force **F** and a 2120-lb · in. couple **M** are applied to corner *A* of the block shown. Replace the given force-couple system with an equivalent force-couple system at corner *H*.

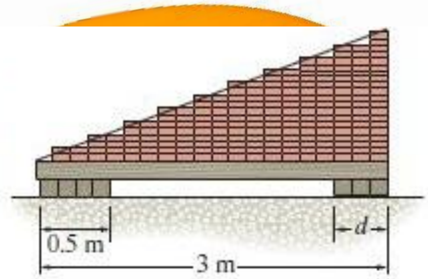
Problem 11 : Solution 11

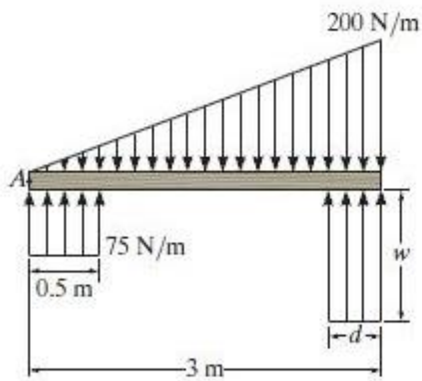
Draw the shear and moment diagrams for the beam.



Problem 12 : Solution 12

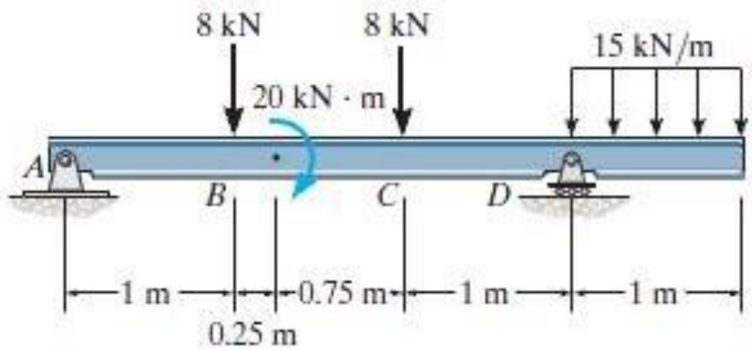
The bricks on top of the beam and the supports at the bottom create the distributed loading shown in the second figure. Determine the required intensity w and dimension d of the right support so that the resultant force and couple moment about point A of the system are both zero.



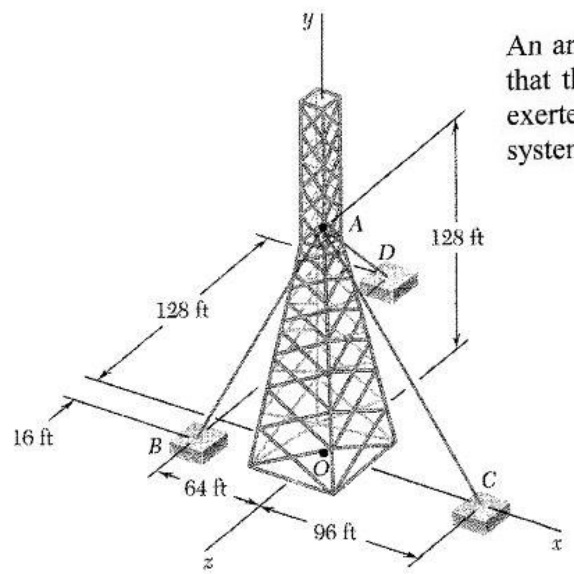


Problem 13 : Solution 13

Draw the shear and moment diagrams for the beam.

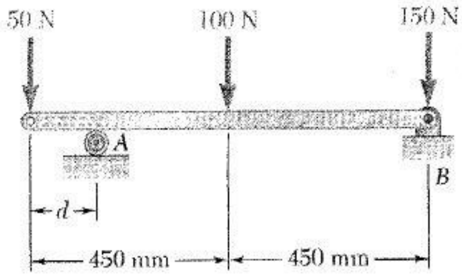


Problem 14 : Solution 14



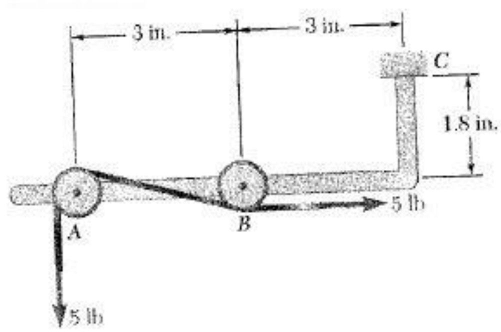
An antenna is guyed by three cables as shown. Knowing that the tension in cable *AB* is 288 lb, replace the force exerted at *A* by cable *AB* with an equivalent force-couple system at the center *O* of the base of the antenna.

Problem 15 : Solution 15



The maximum allowable value of each of the reactions is 180 N. Neglecting the weight of the beam, determine the range of the distance *d* for which the beam is safe.

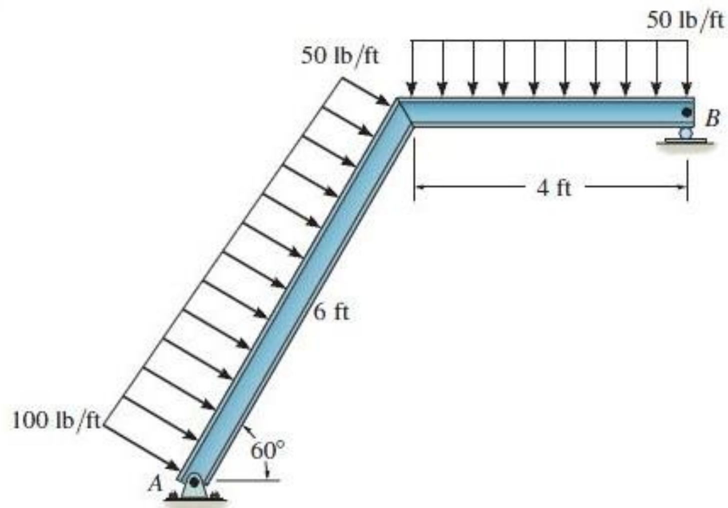
Problem 16 : Solution 16



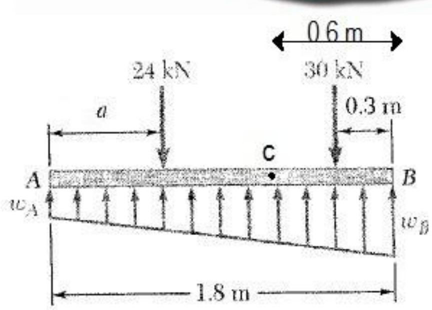
A tension of 5 lb is maintained in a tape as it passes through the support system shown. Knowing that the radius of each pulley is 0.4 in., determine the reaction at *C*.

Problem 17 : Solution 17

Replace the loading by an equivalent resultant force and couple moment at point A.



Problem 18 : Solution 18



determine

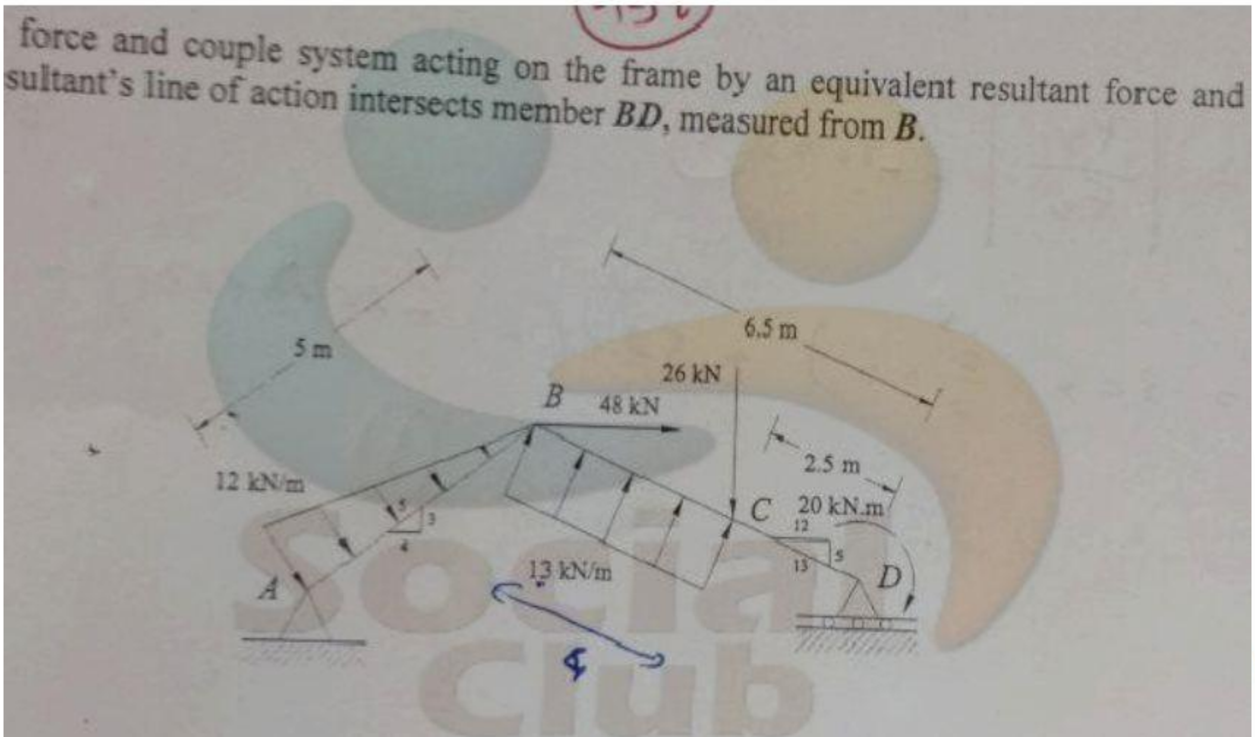
(*a*) the distance a for which $\omega_A = 20$ kN/m,

(*b*) the corresponding value of ω_B.

Exam 2 Cen 202 Summer 2012 (No Solution)

Problem 1 (30 pts)

Replace the force and couple system acting on the frame by an equivalent resultant force and specify where the resultant's line of action intersects member **BD**, measured from **B**

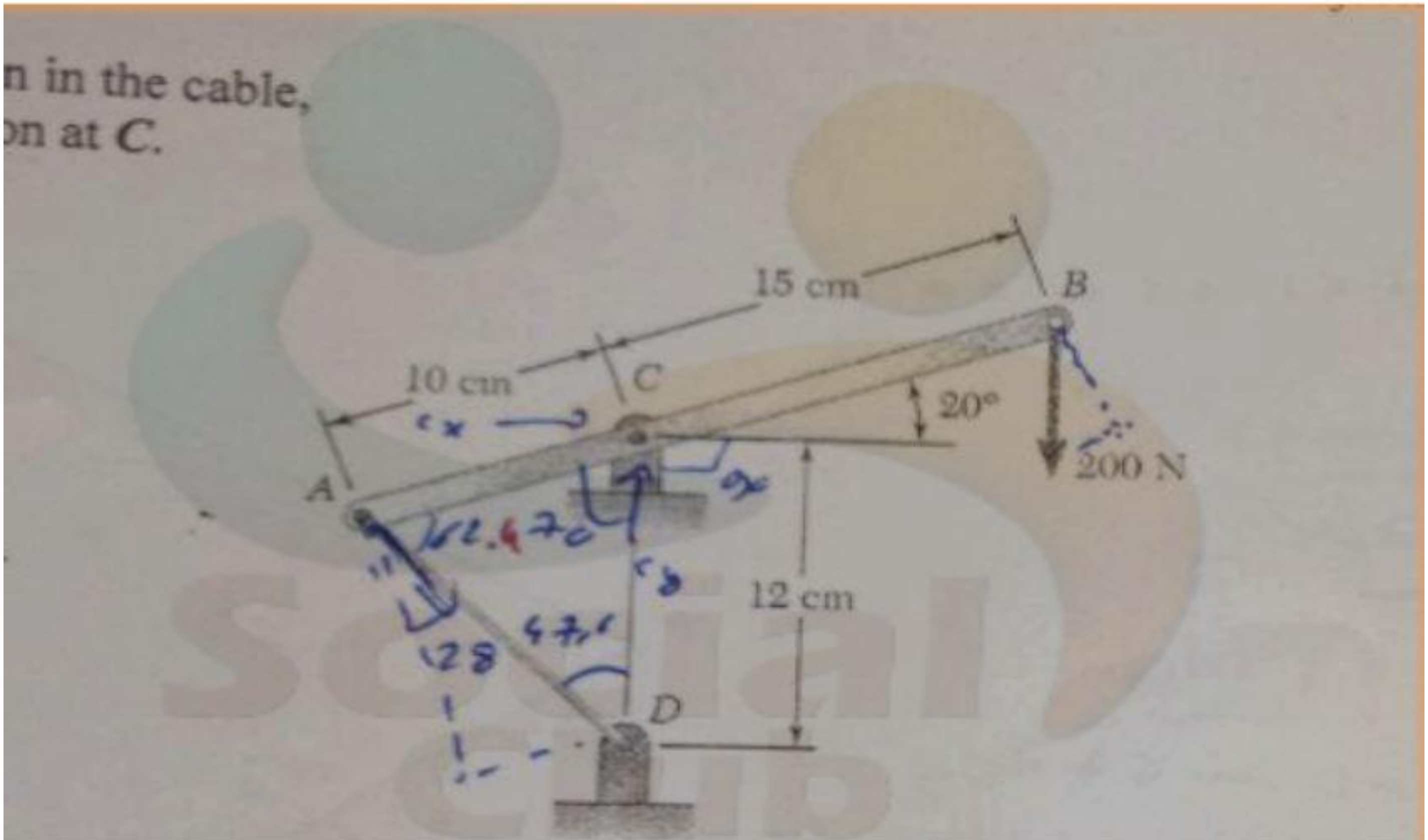


<u>Problem 2 (30 pts)</u>

A lever AB is hinged at C and is attached to a control cable at A. If the lever is subjected to a 200-N vertical force at B, determine.

(a) the tension in the cable

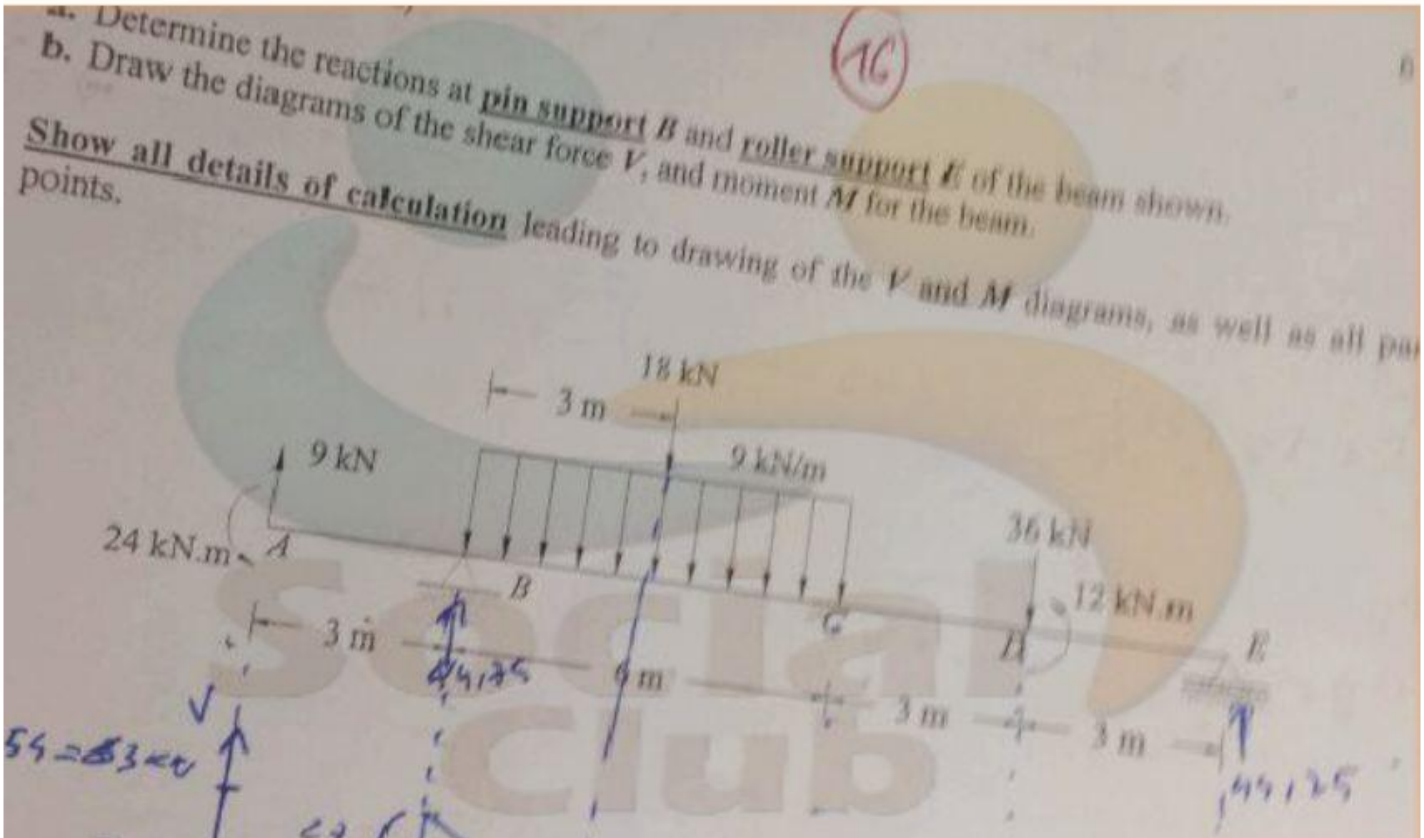
(b) the reaction at C



Problem 3 (40 pts)

a. Determine the reaction **at pin support B** and **roller support E** of the beam shown

b. Draw the diagrams of the shear force **V**, and moment **M** for the beam.



Cen 202 Exam 2 Spring 2012

The spring is stretched a distance d= 30 mm when the mechanism is in the

position shown

1- calculate the force P_{min} required to initiate rotation about the hinge axis **BC** , and determine the corresponding magnitude of the bearing forces which are perpendicular to **BC**. Hint : Look at what happens to the mechanism at **D** , when the force P_{min} is applied

2- What is the normal reaction force at **D** if P= $P_{min}/2$

N.B: points A, B ,C and D are located in the x-y plane and **k=900 N/m**

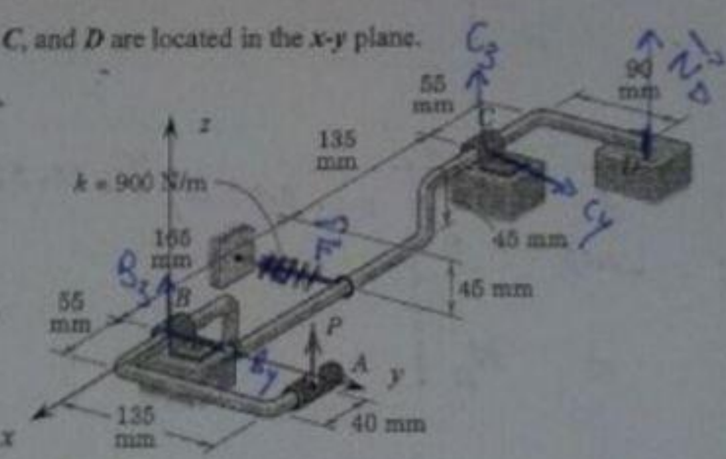
PROBLEM 3: (30 points)

The spring of stiffness $k = 900$ N/m is stretched a distance $\delta = 30$ mm when the mechanism is in the position shown.

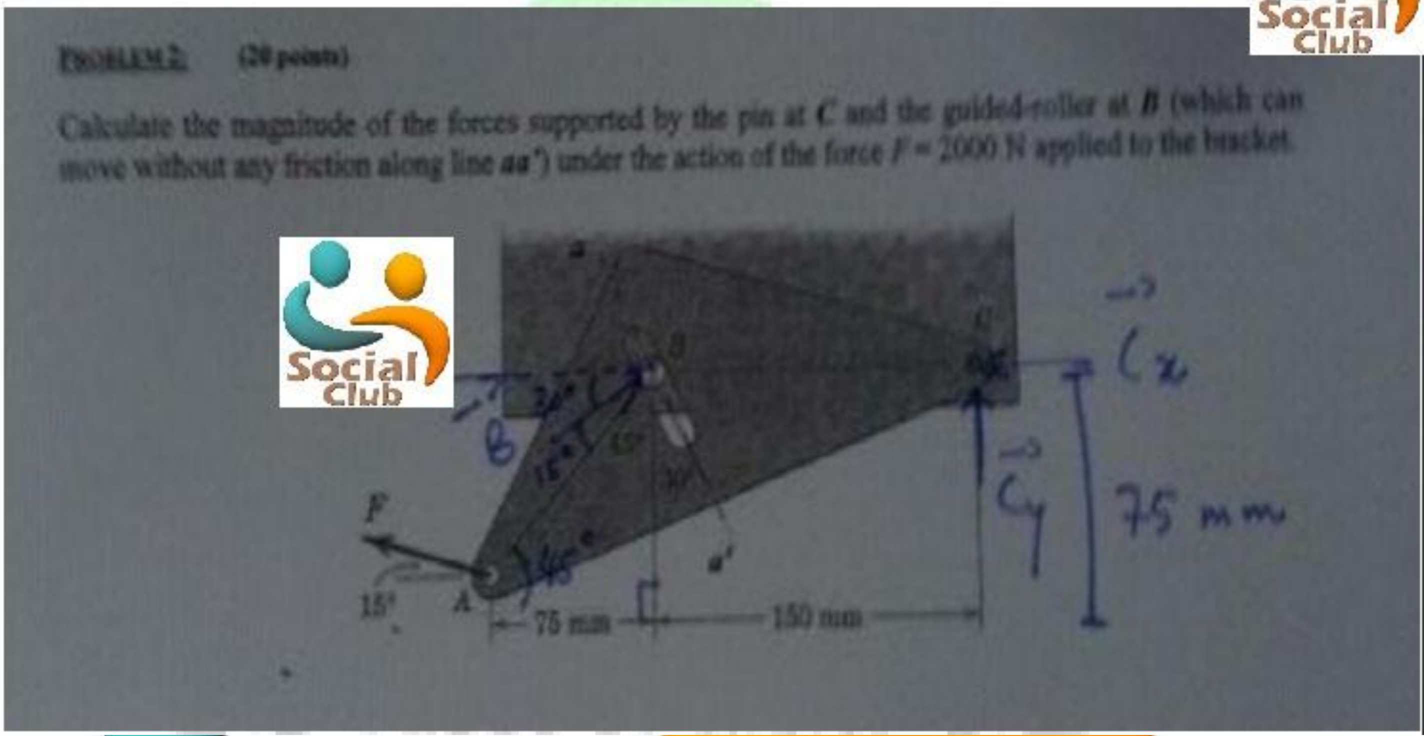
1. Calculate the force P_{min} required to initiate rotation about the hinge axis *BC*, and determine the corresponding magnitudes of the bearing forces which are perpendicular to *BC*. *Hint*: Look at what happens to the mechanism at *D*, when the force P_{min} is applied.

2. What is the normal reaction force at *D* if $P = P_{min}/2$.

N.B.: points *A*, *B*, *C*, and *D* are located in the *x*-*y* plane.



Calculate the magnitude of the forces supported by the pin at C ant the guided roller at B (which can move without any friction along line aa') under the action of force F = 2000 N applied to the bracket

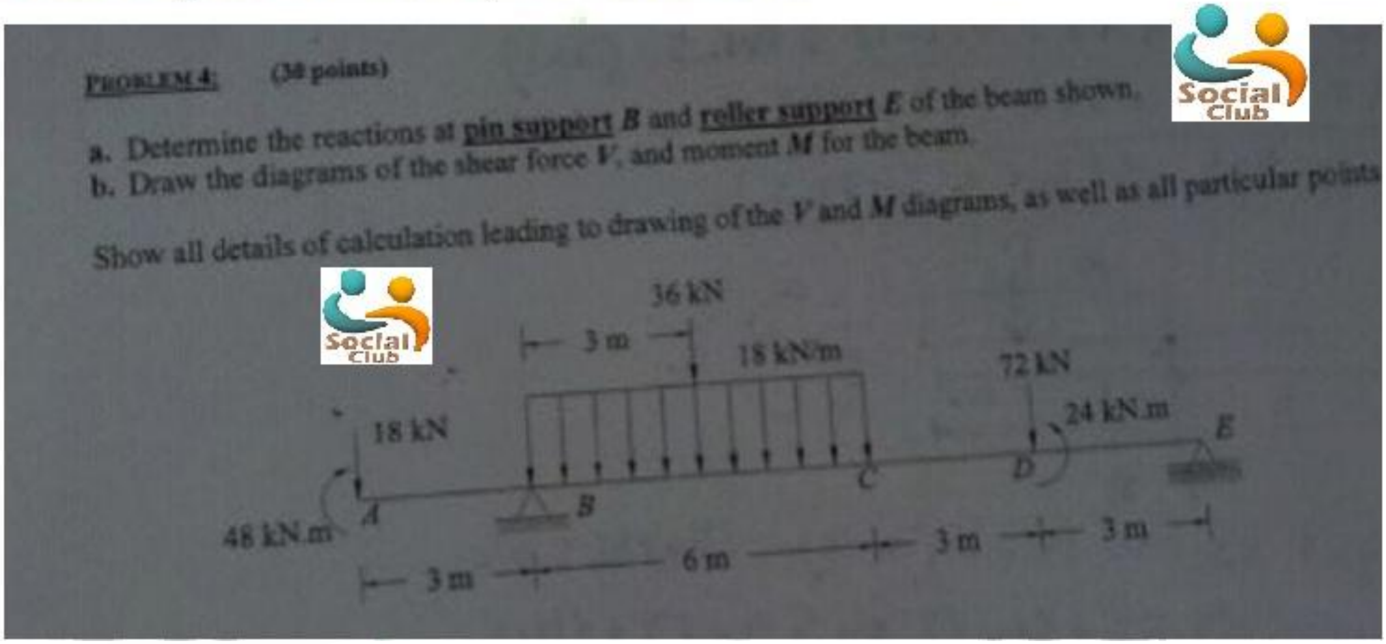


PROBLEM 2: (20 points)

Calculate the magnitude of the forces supported by the pin at *C* and the guided-roller at *B* (which can move without any friction along line *aa'*) under the action of the force *F* = 2000 N applied to the bracket.

a- Determine the reaction at **pin support B** and **roller support E** of the beam shown

b- Draw the diagrams of the shear force **V** , and moment **M** for the beam



PROBLEM 4: (30 points)

a. Determine the reactions at pin support *B* and roller support *E* of the beam shown.

b. Draw the diagrams of the shear force *V*, and moment *M* for the beam.

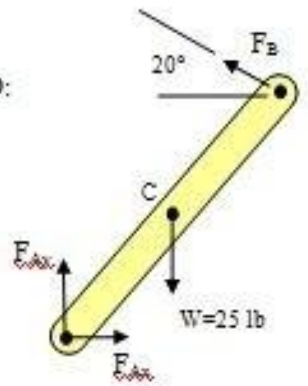
Show all details of calculation leading to drawing of the *V* and *M* diagrams, as well as all particular points

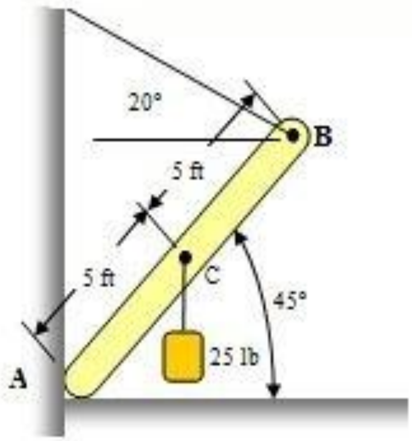
Solution

Sol Prob 1--back to ex 1

Solution:

1) Draw the FBD:





Vector List:

$$\vec{F}_A = F_{Ax}\,\hat{\mathbf{i}} + F_{Ay}\,\hat{\mathbf{j}}$$

$$\vec{F}_B = -F_B\cos 20^\circ\,\hat{\mathbf{i}} + F_B\sin 20^\circ\,\hat{\mathbf{j}}$$

$$\vec{W} = -25\,\hat{\mathbf{j}}\,lb$$

Apply Equilibrium: $\sum \vec{\mathbf{F}} = 0$

$\sum \mathbf{F}_x = 0$

i: $0 = F_{Ax} - F_B\cos 20^\circ$

$F_{Ax} = F_B\cos 20^\circ$

$\sum \mathbf{F}_y = 0$

j: $0 = F_{Ay} + F_B\sin 20^\circ - 25$

$F_{Ay} = 25 - F_B\sin 20^\circ$

and

$$\sum \vec{\mathbf{M}}_{about\ A} = 0$$

$$0 = \Sigma \vec{M}_{conc} + \Sigma \vec{r}\times\vec{F}$$

$$0 = \vec{r}_{AA}\times\vec{F}_A + \vec{r}_{AB}\times\vec{F}_B + \vec{r}_{AC}\times\vec{W}$$

$$0 = 0\times(\vec{F}_A) + (5\cos 45^\circ\,\hat{\mathbf{i}} + 5\sin 45^\circ\,\hat{\mathbf{j}})\times(-25\,\hat{\mathbf{j}}) + (10\cos 45^\circ\,\hat{\mathbf{i}} + 10\sin 45^\circ\,\hat{\mathbf{j}})\times(-F_B\cos 20^\circ\,\hat{\mathbf{i}} + F_B\sin 20^\circ\,\hat{\mathbf{j}})$$

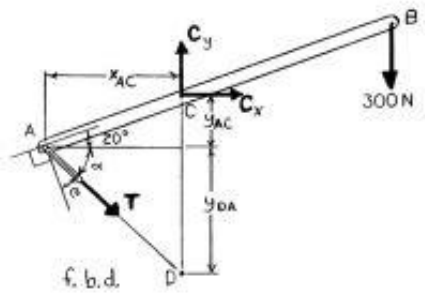
$$0 = -88.4\hat{\mathbf{k}} + 2.418F_B\hat{\mathbf{k}} + 6.645F_B\hat{\mathbf{k}}$$

k: $2.418F_B + 6.645F_B = 88.4$

$$F_B = \frac{88.4}{9.063} = 9.75\,lb \quad \rightarrow \quad F_{Ax} = F_B\cos 20^\circ = 9.165\,lb$$

$$F_{Ay} = 25 - F_B\sin 20^\circ = 21.66\,lb$$

Sol Prob 2--back to ex 2



First

$$x_{AC} = (0.200 \text{ m})\cos 20° = 0.187\,939 \text{ m}$$

$$y_{AC} = (0.200 \text{ m})\sin 20° = 0.068\,404 \text{ m}$$

Then

$$y_{DA} = 0.240 \text{ m} - y_{AC}$$

$$= 0.240 \text{ m} - 0.068404 \text{ m}$$

$$= 0.171596 \text{ m}$$

and

$$\tan\alpha = \frac{y_{DA}}{x_{AC}} = \frac{0.171\,596}{0.187\,939}$$

$$\therefore \quad \alpha = 42.397°$$

and

$$\beta = 90° - 20° - 42.397° = 27.603°$$

(*a*) From f.b.d. of lever *AB*

$$+\circlearrowleft \Sigma M_C = 0: \quad T\cos 27.603°(0.2 \text{ m}) - 300 \text{ N}\left[(0.3 \text{ m})\cos 20°\right] = 0$$

$$\therefore \quad T = 477.17 \text{ N} \qquad \text{or } T = 477 \text{ N} ◀$$

(*b*) From f.b.d. of lever *AB*

$$\xrightarrow{+} \Sigma F_x = 0: \quad C_x + (477.17 \text{ N})\cos 42.397° = 0$$

$$\therefore \quad C_x = -352.39 \text{ N}$$

or

$$\mathbf{C}_x = 352.39 \text{ N} \leftarrow$$

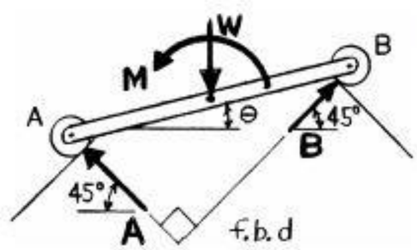
$$+\uparrow \Sigma F_y = 0: \quad C_y - 300 \text{ N} - (477.17 \text{ N})\sin 42.397° = 0$$

$$\therefore \quad C_y = 621.74 \text{ N}$$

or

$$\mathbf{C}_y = 621.74 \text{ N} \uparrow$$

Sol Prob 5--back to ex 5



(*a*) From f.b.d. of uniform rod *AB*

$$\xrightarrow{+} \Sigma F_x = 0: \quad -A\cos 45° + B\cos 45° = 0$$

$$\therefore -A + B = 0 \quad \text{or} \quad B = A \qquad (1)$$

$$+\uparrow \Sigma F_y = 0: \quad A\sin 45° + B\sin 45° - W = 0$$

$$\therefore A + B = \sqrt{2}W \qquad (2)$$

From Equations (1) and (2)

$$2A = \sqrt{2}W$$

$$\therefore A = \frac{1}{\sqrt{2}}W$$

From f.b.d. of uniform rod *AB*

$$+\circlearrowleft \Sigma M_B = 0: \quad W\left[\left(\frac{l}{2}\right)\cos\theta\right] + M$$

$$-\left(\frac{1}{\sqrt{2}}W\right)\left[l\cos(45° - \theta)\right] = 0 \qquad (3)$$

From trigonometric identity

$$\cos(\alpha - \beta) = \cos\alpha\cos\beta + \sin\alpha\sin\beta$$

Equation (3) becomes

$$\left(\frac{Wl}{2}\right)\cos\theta + M - \left(\frac{Wl}{2}\right)(\cos\theta + \sin\theta) = 0$$

or

$$\left(\frac{Wl}{2}\right)\cos\theta + M - \left(\frac{Wl}{2}\right)\cos\theta - \left(\frac{Wl}{2}\right)\sin\theta = 0$$

$$\therefore \sin\theta = \frac{2M}{Wl}$$

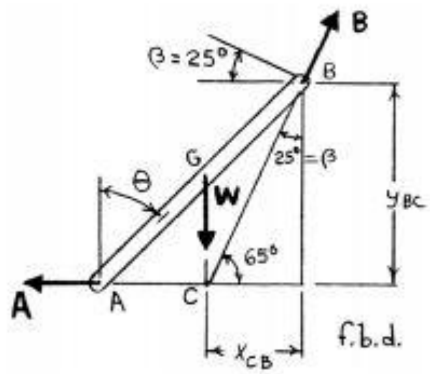
$$\text{or} \quad \theta = \sin^{-1}\left(\frac{2M}{Wl}\right) \blacktriangleleft$$

(*b*)

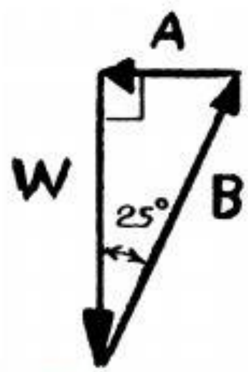
$$\theta = \sin^{-1}\left[\frac{2(1.5\text{ lb}\cdot\text{ft})}{(4\text{ lb})(2\text{ ft})}\right] = 22.024°$$

$$\text{or} \quad \theta = 22.0° \blacktriangleleft$$

Sol Prob 6--back to ex 6



f.b.d.



(*a*) As shown in the f.b.d. of the slender rod *AB*, the three forces intersect at *C*. From the geometry of the forces

$$\tan\beta = \frac{x_{CB}}{y_{BC}}$$

where

$$x_{CB} = \frac{1}{2}L\sin\theta$$

and

$$y_{BC} = L\cos\theta$$

$$\therefore\quad \tan\beta = \frac{1}{2}\tan\theta$$

or

$$\tan\theta = 2\tan\beta$$

For

$$\beta = 25°$$

$$\tan\theta = 2\tan 25° = 0.93262$$

$$\therefore\quad \theta = 43.003°$$

or $\theta = 43.0°$ ◀

(*b*)

$$W = mg = (10\text{ kg})(9.81\text{ m/s}^2) = 98.1\text{ N}$$

From force triangle

$$A = W\tan\beta$$

$$= (98.1\text{ N})\tan 25°$$

$$= 45.745\text{ N}$$

or $\mathbf{A} = 45.7\text{ N} \longleftarrow$ ◀

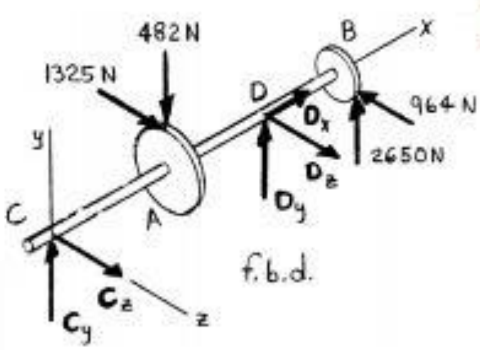
and

$$B = \frac{W}{\cos\beta} = \frac{98.1\text{ N}}{\cos 25°} = 108.241\text{ N}$$

or $\mathbf{B} = 108.2\text{ N} \measuredangle 65.0°$ ◀

Sol Prob 7--back to ex 7

SOLUTION



Assume moment reactions at the bearing supports are zero. From f.b.d. of shaft

$$\Sigma F_x = 0: \quad \therefore \quad D_x = 0$$

$$\Sigma M_{D(z\text{-axis})} = 0: \quad -C_y(175 \text{ mm}) + (482 \text{ N})(75 \text{ mm}) + (2650 \text{ N})(50 \text{ mm}) = 0$$

$$\therefore \quad C_y = 963.71 \text{ N}$$

or $$\mathbf{C}_y = (964 \text{ N})\mathbf{j}$$

$$\Sigma M_{D(y\text{-axis})} = 0: \quad C_z(175 \text{ mm}) + (1325 \text{ N})(75 \text{ mm}) + (964 \text{ N})(50 \text{ mm}) = 0$$

$$\therefore \quad C_z = -843.29 \text{ N}$$

or $$\mathbf{C}_z = (843 \text{ N})\mathbf{k}$$

$$\text{and } \mathbf{C} = (964 \text{ N})\mathbf{j} - (843 \text{ N})\mathbf{k} \blacktriangleleft$$

$$\Sigma M_{C(z\text{-axis})} = 0: \quad -(482 \text{ N})(100 \text{ mm}) + D_y(175 \text{ mm}) + (2650 \text{ N})(225 \text{ mm}) = 0$$

$$\therefore \quad D_y = -3131.7 \text{ N}$$

or $$\mathbf{D}_y = -(3130 \text{ N})\mathbf{j}$$

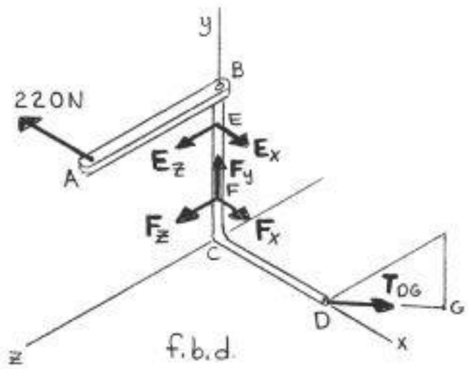
$$\Sigma M_{C(y\text{-axis})} = 0: \quad -(1325 \text{ N})(100 \text{ mm}) - D_z(175 \text{ mm}) + (964 \text{ N})(225 \text{ mm}) = 0$$

$$\therefore \quad D_z = 482.29 \text{ N}$$

or $$\mathbf{D}_z = (482 \text{ N})\mathbf{k}$$

$$\text{and } \mathbf{D} = -(3130 \text{ N})\mathbf{j} + (482 \text{ N})\mathbf{k} \blacktriangleleft$$

Sol Prob 8--back to ex 8



(*a*) From f.b.d. of assembly

$$\mathbf{T}_{DG} = \boldsymbol{\lambda}_{DG}T_{DG} = \left[\frac{-(0.12\text{ m})\mathbf{j} - (0.225\text{ m})\mathbf{k}}{\sqrt{(0.12)^2 + (0.225)^2}\text{ m}}\right] = \frac{T_{DG}}{0.255}\left[-(0.12)\mathbf{j} - (0.225)\mathbf{k}\right]$$

$$\Sigma M_y = 0: \quad -(220\text{ N})(0.24\text{ m}) + \left[T_{DG}\left(\frac{0.225}{0.255}\right)\right](0.16\text{ m}) = 0$$

$$\therefore \quad T_{DG} = 374.00\text{ N}$$

or $T_{DG} = 374\text{ N}$ ◀

(*b*) From f.b.d. of assembly

$$\Sigma M_{F(z\text{-axis})} = 0: \quad (220\text{ N})(0.19\text{ m}) - E_x(0.13\text{ m}) - \left[374\text{ N}\left(\frac{0.120}{0.255}\right)\right](0.16\text{ m}) = 0$$

$$\therefore \quad E_x = 104.923\text{ N}$$

$$\Sigma F_x = 0: \quad F_x + 104.923\text{ N} - 220\text{ N} = 0$$

$$\therefore \quad F_x = 115.077\text{ N}$$

$$\Sigma M_{F(x\text{-axis})} = 0: \quad E_z(0.13\text{ m}) + \left[374\text{ N}\left(\frac{0.225}{0.255}\right)\right](0.06\text{ m}) = 0$$

$$\therefore \quad E_z = -152.308\text{ N}$$

$$\Sigma F_z = 0: \quad F_z - 152.308\text{ N} - (374\text{ N})\left(\frac{0.225}{0.255}\right) = 0$$

$$\therefore \quad F_z = 482.31\text{ N}$$

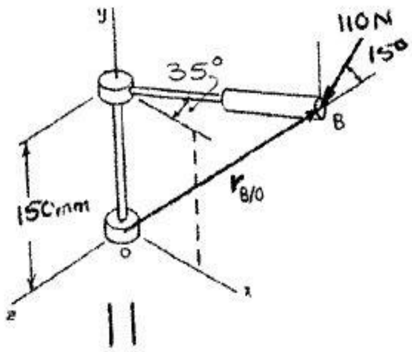
$$\Sigma F_y = 0: \quad F_y - (374\text{ N})\left(\frac{0.12}{0.255}\right) = 0$$

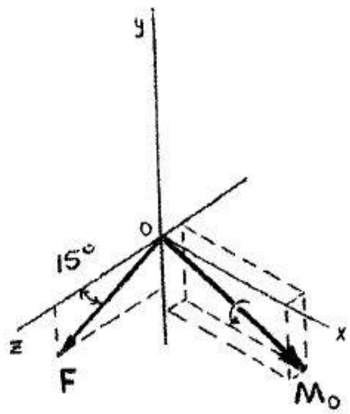
$$\therefore \quad F_y = 176.0\text{ N}$$

$\mathbf{E} = (104.9\text{ N})\mathbf{i} - (152.3\text{ N})\mathbf{k}$ ◀

$\mathbf{F} = (115.1\text{ N})\mathbf{i} + (176.0\text{ N})\mathbf{j} + (482\text{ N})\mathbf{k}$ ◀

Sol Prob 9--back to ex 9





We have $\Sigma \mathbf{F}: \quad \mathbf{P}_B = \mathbf{F}$

where $\mathbf{P}_B = 110\text{ N}[-(\sin 15°)\mathbf{j} + (\cos 15°)\mathbf{k}]$

$= -(28.470\text{ N})\mathbf{j} + (106.252\text{ N})\mathbf{k}$

or $\mathbf{F} = -(28.5\text{ N})\mathbf{j} + (106.3\text{ N})\mathbf{k}$ ◀

We have $\Sigma M_O: \quad \mathbf{r}_{B/O} \times \mathbf{P}_B = \mathbf{M}_O$

where $\mathbf{r}_{B/O} = [(0.22\cos 35°)\mathbf{i} + (0.15)\mathbf{j} - (0.22\sin 35°)\mathbf{k}]\text{m}$

$= (0.180213\text{ m})\mathbf{i} + (0.15\text{ m})\mathbf{j} - (0.126187\text{ m})\mathbf{k}$

$$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0.180213 & 0.15 & 0.126187 \\ 0 & -28.5 & 106.3 \end{vmatrix} \text{N}\cdot\text{m} = \mathbf{M}_O$$

$\mathbf{M}_O = [(12.3487)\mathbf{i} - (19.1566)\mathbf{j} - (5.1361)\mathbf{k}]\text{N}\cdot\text{m}$

or $\mathbf{M}_O = (12.35\text{ N}\cdot\text{m})\mathbf{i} - (19.16\text{ N}\cdot\text{m})\mathbf{j} - (5.13\text{ N}\cdot\text{m})\mathbf{k}$ ◀

Sol Prob 10--back to ex 10

We have $d_{AJ} = \sqrt{(18)^2 + (-14)^2 + (-3)^2} = 23 \text{ in.}$

Then
$$\mathbf{F} = \frac{46 \text{ lb}}{23}(18\mathbf{i} - 14\mathbf{j} - 3\mathbf{k})$$
$$= (36 \text{ lb})\mathbf{i} - (28 \text{ lb})\mathbf{j} - (6 \text{ lb})\mathbf{k}$$

Also $d_{AC} = \sqrt{(-45)^2 + (0)^2 + (-28)^2} = 53 \text{ in.}$

Then
$$\mathbf{M} = \frac{2120 \text{ lb}\cdot\text{in.}}{53}(-45\mathbf{i} - 28\mathbf{k})$$
$$= -(1800 \text{ lb}\cdot\text{in.})\mathbf{i} - (1120 \text{ lb}\cdot\text{in.})\mathbf{k}$$

Now $\mathbf{M}' = \mathbf{M} + \mathbf{r}_{A/H} \times \mathbf{F}$

where $\mathbf{r}_{A/H} = (45 \text{ in.})\mathbf{i} + (14 \text{ in.})\mathbf{j}$

Then
$$\mathbf{M}' = (-1800\mathbf{i} - 1120\mathbf{k}) + \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 45 & 14 & 0 \\ 36 & -28 & -6 \end{vmatrix}$$
$$= (-1800\mathbf{i} - 1120\mathbf{k}) + \{[(14)(-6)]\mathbf{i} + [-(45)(-6)]\mathbf{j} + [(45)(-28) - (14)(36)]\mathbf{k}\}$$
$$= (-1800 - 84)\mathbf{i} + (270)\mathbf{j} + (-1120 - 1764)\mathbf{k}$$
$$= -(1884 \text{ lb}\cdot\text{in.})\mathbf{i} + (270 \text{ lb}\cdot\text{in.})\mathbf{j} - (2884 \text{ lb}\cdot\text{in.})\mathbf{k}$$
$$= -(157 \text{ lb}\cdot\text{ft})\mathbf{i} + (22.5 \text{ lb}\cdot\text{ft})\mathbf{j} - (240 \text{ lb}\cdot\text{ft})\mathbf{k}$$

The equivalent force-couple system at H is
$$\mathbf{F}' = (36.0 \text{ lb})\mathbf{i} - (28.0 \text{ lb})\mathbf{j} - (6.00 \text{ lb})\mathbf{k} \blacktriangleleft$$
$$\mathbf{M}' = -(157 \text{ lb}\cdot\text{ft})\mathbf{i} + (22.5 \text{ lb}\cdot\text{ft})\mathbf{j} - (240 \text{ lb}\cdot\text{ft})\mathbf{k} \blacktriangleleft$$

Sol Prob 11--back to ex 11

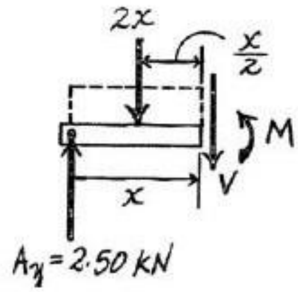
$0 \le x < 5$ m:

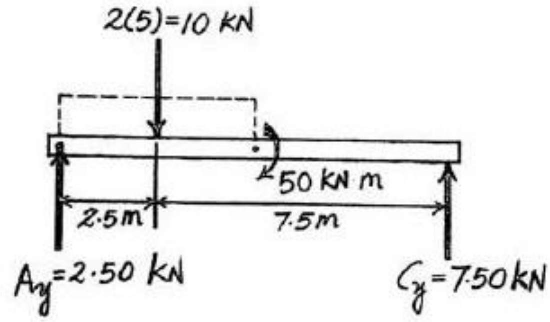
$+\uparrow \Sigma F_y = 0; \quad 2.5 - 2x - V = 0$

$V = 2.5 - 2x$

$\circlearrowleft + \Sigma M = 0; \quad M + 2x\left(\frac{1}{2}x\right) - 2.5x = 0$

$M = 2.5x - x^2$





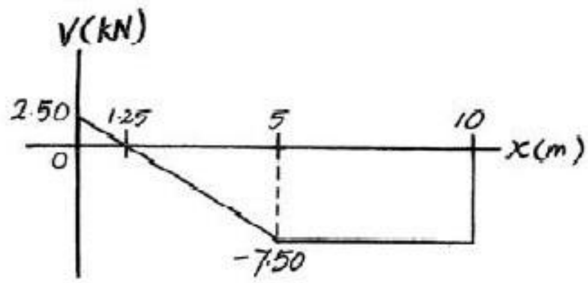
$5 \text{ m} < x < 10 \text{ m}$:

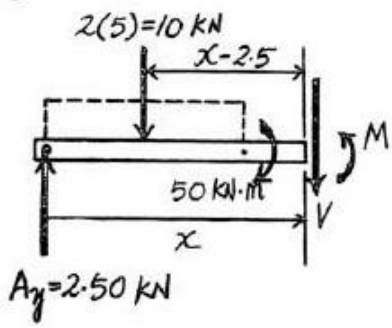
$+\uparrow \Sigma F_y = 0; \quad 2.5 - 10 - V = 0$

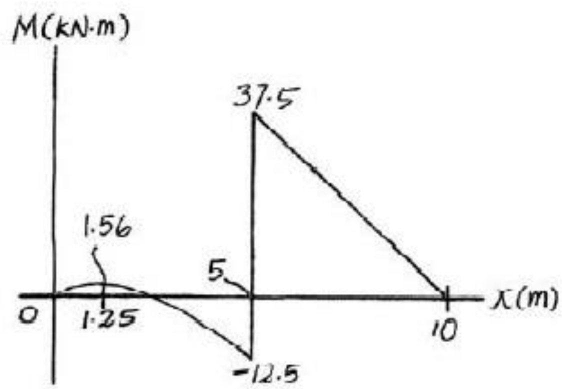
$V = -7.5$

$\circlearrowleft + \Sigma M = 0; \quad M + 10(x - 2.5) - 2.5x - 50 = 0$

$M = -7.5x + 75$







Sol Prob 12--back to ex 12

Require $F_R = 0$.

$$+\uparrow F_R = \Sigma F_y; \quad 0 = wd + 37.5 - 300$$

$$wd = 262.5 \qquad [1]$$

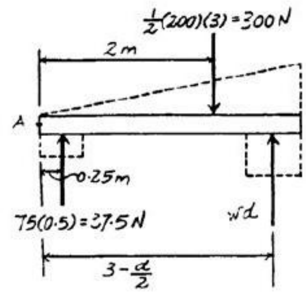
Require $M_{R_A} = 0$.

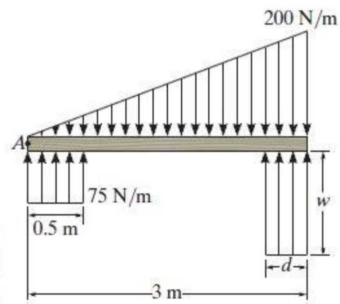
$$\circlearrowleft + M_{R_A} = \Sigma M_A; \quad 0 = 37.5(0.25) + wd\left(3 - \frac{d}{2}\right) - 300(2)$$

$$3wd - \frac{wd^2}{2} = 590.625 \qquad [2]$$

Solving Eqs. [1] and [2] yields

$d = 1.50$ m $\qquad w = 175$ N/m $\qquad$ **Ans**





Sol Prob 13--back to ex 13

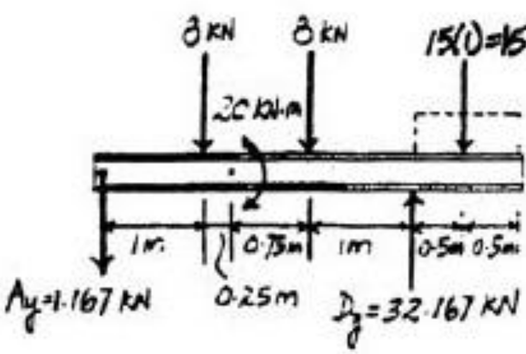
Support Reactions :

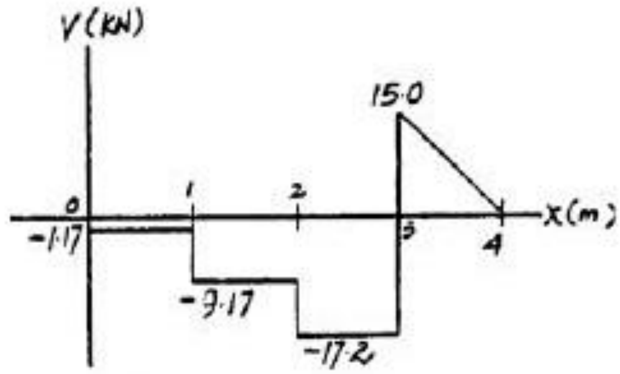
$$\circlearrowleft + \Sigma M_A = 0; \quad D_y(3) - 8(1) - 8(2) - 15.0(3.5) - 20 = 0$$

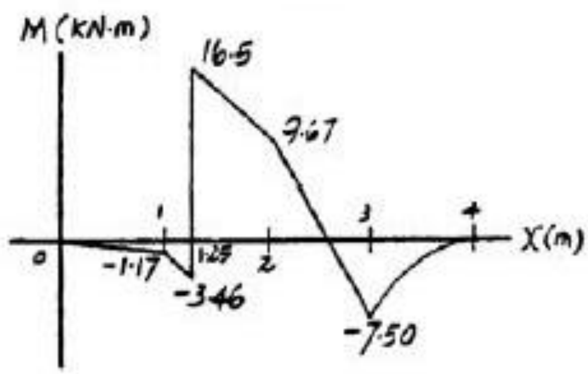
$$D_y = 32.167 \text{ kN}$$

$$+\uparrow \Sigma F_y = 0; \quad 32.167 - 8 - 8 - 15.0 - A_y = 0$$

$$A_y = 1.167 \text{ kN}$$







Sol Prob 14--back to ex 14

We have $d_{AB} = \sqrt{(-64)^2 + (-128)^2 + (16)^2} = 144 \text{ ft}$

Then $\mathbf{T}_{AB} = \frac{288 \text{ lb}}{144}(-64\mathbf{i} - 128\mathbf{j} + 16\mathbf{k})$

$= (32 \text{ lb})(-4\mathbf{i} - 8\mathbf{j} + \mathbf{k})$

Now $\mathbf{M} = \mathbf{M}_O = \mathbf{r}_{A/O} \times \mathbf{T}_{AB}$

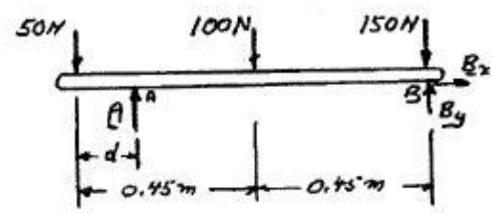
$= 128\mathbf{j} \times 32(-4\mathbf{i} - 8\mathbf{j} + \mathbf{k})$

$= (4096 \text{ lb} \cdot \text{ft})\mathbf{i} + (16{,}384 \text{ lb} \cdot \text{ft})\mathbf{k}$

The equivalent force-couple system at O is $\mathbf{F} = -(128.0 \text{ lb})\mathbf{i} - (256 \text{ lb})\mathbf{j} + (32.0 \text{ lb})\mathbf{k}$ ◀

$\mathbf{M} = (4.10 \text{ kip} \cdot \text{ft})\mathbf{i} + (16.38 \text{ kip} \cdot \text{ft})\mathbf{k}$ ◀

Sol Prob 15--back to ex 15



$$\Sigma F_x = 0: \quad B_x = 0$$

$$B = B_y$$

$$+\circlearrowright \Sigma M_A = 0: \quad (50\text{ N})d - (100\text{ N})(0.45\text{ m} - d) - (150\text{ N})(0.9\text{ m} - d) + B(0.9\text{ m} - d) = 0$$

$$50d - 45 + 100d - 135 + 150d + 0.9B - Bd$$

$$d = \frac{180\text{ N}\cdot\text{m} - (0.9\text{ m})B}{300A - B} \qquad (1)$$

$$+\circlearrowright \Sigma M_B = 0: \quad (50\text{ N})(0.9\text{ m}) - A(0.9\text{ m} - d) + (100\text{ N})(0.45\text{ m}) = 0$$

$$45 - 0.9A + Ad + 45 = 0$$

$$d = \frac{(0.9\text{ m})A - 90\text{ N}\cdot\text{m}}{A} \qquad (2)$$

Since $B \le 180$ N, Eq. (1) yields.

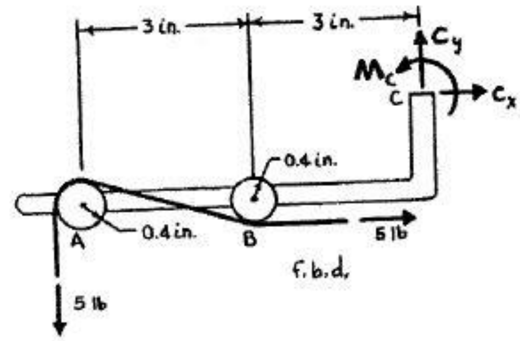
$$d \ge \frac{180 - (0.9)180}{300 - 180} = \frac{18}{120} = 0.15\text{ m} \qquad d \ge 150.0\text{ mm} \ \triangleleft$$

Since $A \le 180$ N, Eq. (2) yields.

$$d \le \frac{(0.9)180 - 90}{180} = \frac{72}{180} = 0.40\text{ m} \qquad d \le 400\text{ mm} \ \triangleleft$$

Range: $150.0\text{ mm} \le d \le 400\text{ mm}$ ◀

Sol Prob 16--back to ex 16



From f.b.d. of system

$$\xrightarrow{+} \Sigma F_x = 0: \quad C_x + (5 \text{ lb}) = 0$$

$$C_x = -5 \text{ lb}$$

$$+\uparrow \Sigma F_y = 0: \quad C_y - (5 \text{ lb}) = 0$$

$$C_y = 5 \text{ lb}$$

Then

$$C = \sqrt{(C_x)^2 + (C_y)^2}$$
$$= \sqrt{(5)^2 + (5)^2}$$
$$= 7.0711 \text{ lb}$$

and

$$\theta = \tan^{-1}\left(\frac{+5}{-5}\right) = -45^\circ$$

or $\mathbf{C} = 7.07$ lb ⦪ 45.0° ◀

$$+\circlearrowleft \Sigma M_C = 0: \quad M_C + (5 \text{ lb})(6.4 \text{ in.}) + (5 \text{ lb})(2.2 \text{ in.}) = 0$$

$$M_C = -43.0 \text{ lb} \cdot \text{in}$$

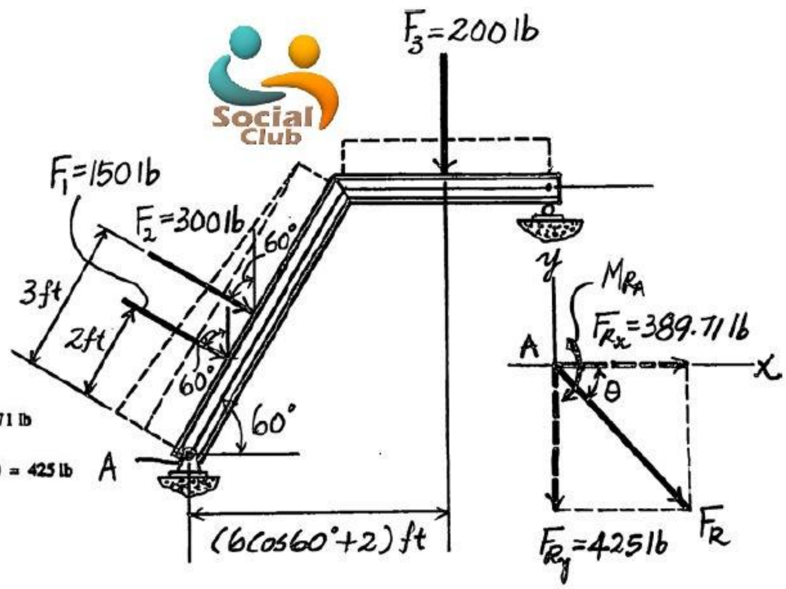
or $\mathbf{M}_C = 43.0 \text{ lb} \cdot \text{in.}$ ↻ ◀

Sol Prob 17--back to ex 17

$$F_1 = \frac{1}{2}(6)(50) = 150 \text{ lb}$$

$$F_2 = (6)(50) = 300 \text{ lb}$$

$$F_3 = (4)(50) = 200 \text{ lb}$$



$$\xrightarrow{+} F_{Rx} = \Sigma F_x; \quad F_{Rx} = 150 \sin 60° + 300 \sin 60° = 389.71 \text{ lb}$$

$$+\downarrow F_{Ry} = \Sigma F_y; \quad F_{Ry} = 150 \cos 60° + 300 \cos 60° + 200 = 425 \text{ lb}$$

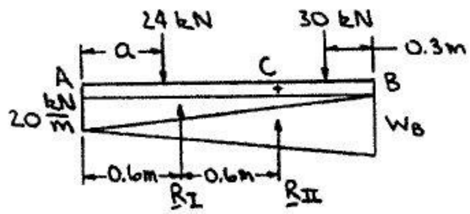
$$F_R = \sqrt{(389.71)^2 + (425)^2} = 577 \text{ lb} \quad \textbf{Ans}$$

$$\theta = \tan^{-1}\left(\frac{425}{389.71}\right) = 47.5° \quad \textbf{Ans}$$

$$\circlearrowright + M_{RA} = \Sigma M_A; \quad M_{RA} = 150(2) + 300(3) + 200(6\cos 60° + 2)$$

$$= 2200 \text{ lb} \cdot \text{ft} = 2.20 \text{ kip} \cdot \text{ft} \quad \textbf{Ans}$$

Sol Prob 18--back to ex 18



We have

$$R_{\mathrm{I}} = \frac{1}{2}(1.8\ \mathrm{m})(20\ \mathrm{kN/m}) = 18\ \mathrm{kN}$$

$$R_{\mathrm{II}} = \frac{1}{2}(1.8\ \mathrm{m})(\omega_B\ \mathrm{kN/m}) = 0.9\omega_B\ \mathrm{kN}$$

(a) $+\circlearrowright \Sigma M_C = 0$: $(1.2 - a)\mathrm{m} \times 24\ \mathrm{kN} - 0.6\ \mathrm{m} \times 18\ \mathrm{kN} - 0.3\ \mathrm{m} \times 30\ \mathrm{kN} = 0$

or $a = 0.375\ \mathrm{m}$ ◀

(b) $+\uparrow \Sigma F_y = 0$: $-24\ \mathrm{kN} + 18\ \mathrm{kN} + (0.9\omega_B)\ \mathrm{kN} - 30\ \mathrm{kN} = 0$

or $\omega_B = 40.0\ \mathrm{kN/m}$ ◀