

CE 201 Statics (Sec 485) [071]

H.W 5 by solution

Problem 1 :-

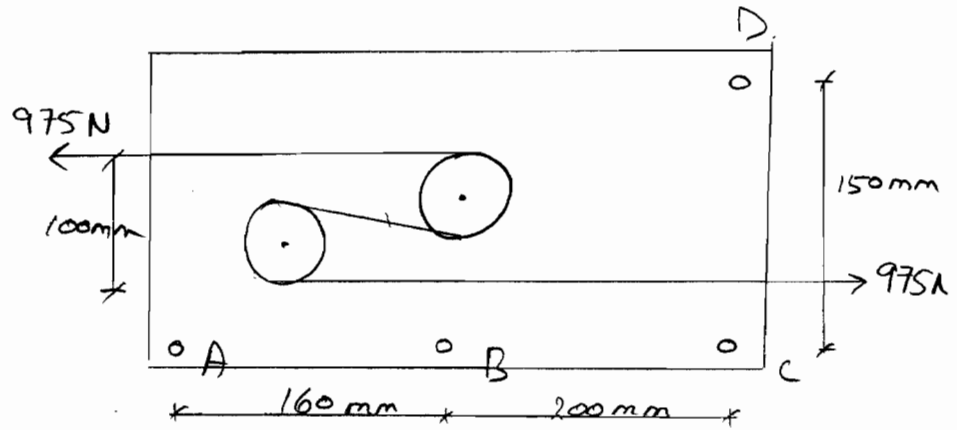
Given :-

$$F = 975 \text{ N}$$

Fig P.

Required :-

- vertical forces acting at A and C
- The smallest possible forces acting at B & D
- Smallest possible force attached to the assembly



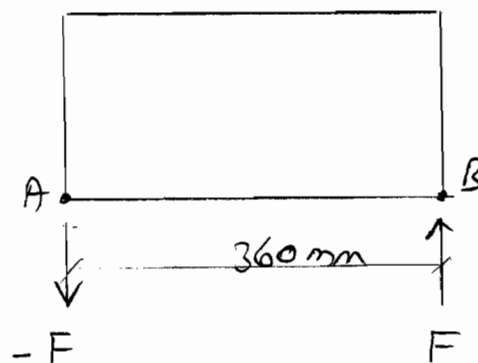
Solution :-

$$a) \quad M = Fd$$

$$\uparrow \downarrow M = (975)(100) = 97500 \text{ N}\cdot\text{mm}$$

$$97500 = F(360)$$

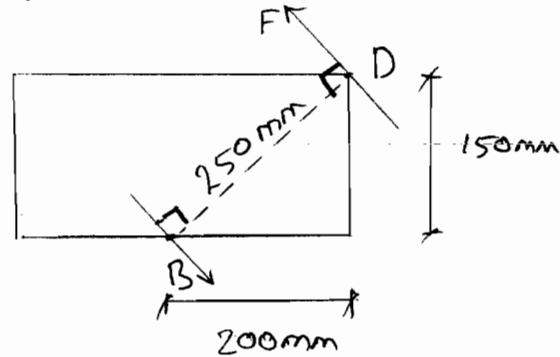
$$F = 270.8 \text{ N} \text{ as shown}$$



$$b) \quad M = Fd$$

$$F = M/d$$

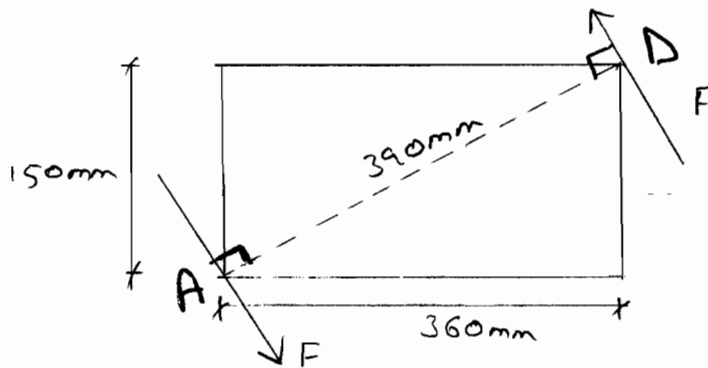
To get min forces at B & D we have to find max distance between them $\Rightarrow d \perp$ to F



$$F = \frac{97500}{250} = 390 \text{ N}$$

$$\boxed{F = 390 \text{ N}}$$

c)



Forces applied
at A and D
(why?)
 $F \perp$ to AD

$$F = M/d$$

$$F = \frac{97500}{390} = 250 \text{ N}, \quad \boxed{F = 250 \text{ N}}$$

Problem 2:-

Given:- Fig P2

Required:-

- a) Single equivalent couples.
- b) Check results.

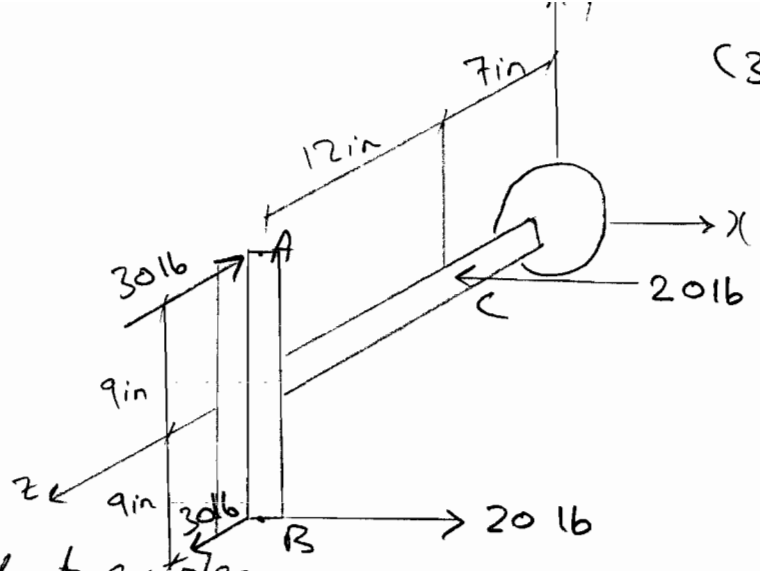


Fig P2

Solution.

$F \equiv 30 \text{ lb}$
 $P \equiv 20 \text{ lb}$

$A(0, 9, 19)$
 $B(0, -9, 19); C(0, 0, 7)$
 $D(0, 0, 7)$

$\vec{F}_B = 30 \vec{k} \text{ (lb)}$

$\vec{r}_{AB} = (B-A) = 0i - 18j + 0k$
 $\vec{r}_{AB} = -18\vec{j}$

$\vec{M}_F = \vec{r}_{AB} \times \vec{F}_B = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & -18 & 0 \\ 0 & 0 & 30 \end{vmatrix}$

$= -(18)(30)\vec{i} = -540\vec{i}$

$\vec{M}_F = -540\vec{i} \text{ (lb.in)}$

(4)

$$\vec{P}_B = 20\vec{i} \text{ (lb)}$$

$$\vec{r}_{CB} = (C - D) = -9\vec{i} + 12\vec{k}$$

$$\vec{r}_{CB} = -9\vec{i} + 12\vec{k}$$

$$\vec{M}_P = \vec{r}_{CB} \times \vec{P}_B = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & -9 & 12 \\ 20 & 0 & 0 \end{vmatrix}$$

$$= (12 \times 20)\vec{j} + (9 \times 20)\vec{k}$$

$$\vec{M}_P = 240\vec{j} + 180\vec{k}$$

$$\vec{M}_R = \vec{M}_F + \vec{M}_P$$

$$\boxed{\vec{M}_R = -540\vec{j} + 240\vec{j} + 180\vec{k}} \quad (\text{lb}\cdot\text{in})$$

Note: You may take \vec{M} about point B for both. \Rightarrow easier

$$b) \quad M_x = -(30)(9) - (30)(9) = -540 \text{ lb}\cdot\text{in} \quad \curvearrowright$$

$$M_y = (-20)(9) + (20)(19) = 240 \text{ lb}\cdot\text{in} \quad \updownarrow$$

$$M_z = (20)(9) = 180 \text{ lb}\cdot\text{in} \quad \curvearrowleft$$

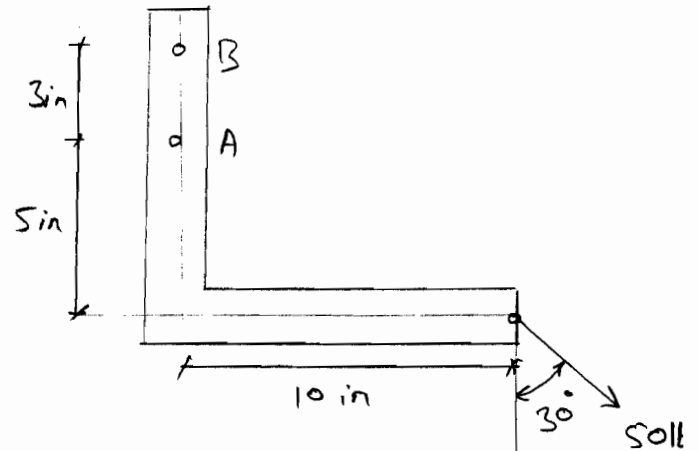
Note: You may use \vec{r}_{CB} in (b); try!

Problem 3:

Given:

$$F = 50 \text{ lb}$$

Fig P3



Required:-

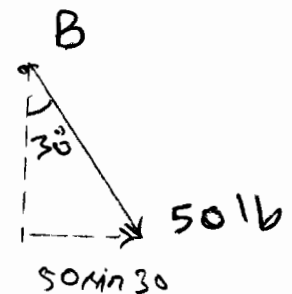
- equivalent force-couple at B
- horizontal forces at A & B forming a couple equivalent to couple at part (a)

Solution:-

$$F = 50 \text{ lb as shown}$$

$$M_B = F_x y + F_y x$$

$$-50 \cos 30$$



$$F_x = 50 \sin 30 \text{ lb}$$

$$F_y = -50 \cos 30 \text{ lb}$$

$$x = 10 \text{ in}$$

$$y = 8 \text{ in}$$

$$\begin{aligned} \overset{+}{\curvearrowright} M_B &= (50 \sin 30)(8) - (50 \cos 30)(10) \\ &= -233.013 \text{ lb} \cdot \text{in} \end{aligned}$$

$$M_B = 233.013 \text{ lb} \cdot \text{in} \downarrow$$

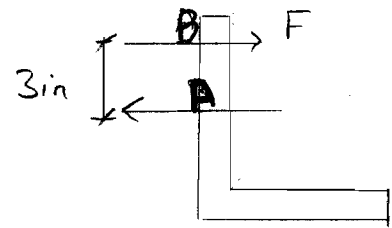
(6)

b) $M = F \cdot d$

$$233.012 = (F)(3)$$

| |
|----------------------|
| $F = 77.67 \cdot 16$ |
|----------------------|

 as shown



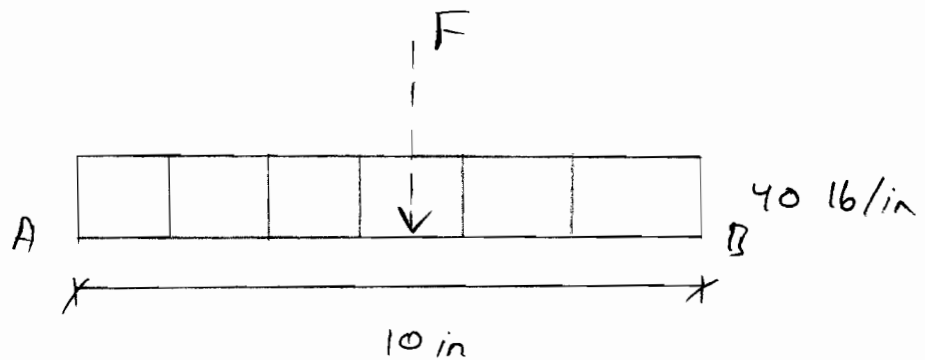
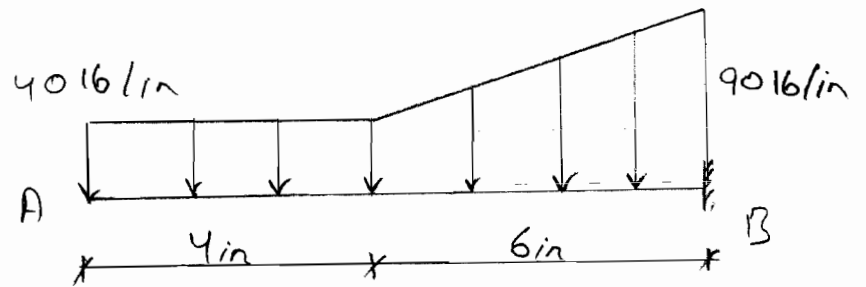
Problem 4:-

Given: Fig P₄

Required:-

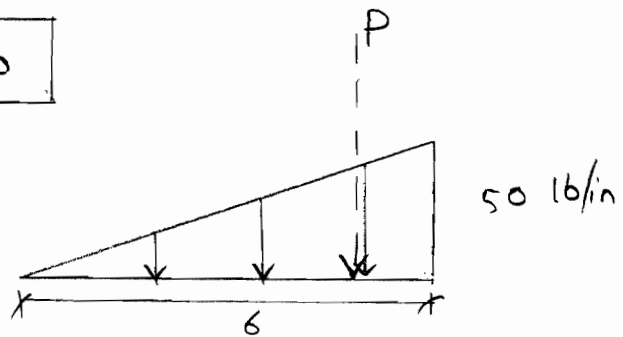
Magnitude & location of resultant

Solution:-



$$F = (40)(10) = 400 \text{ lb}$$

$$F = 400 \text{ lb}$$

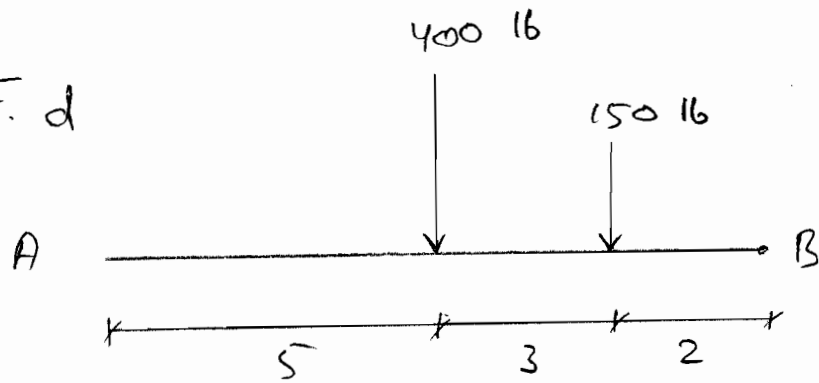


$$P = \left(\frac{1}{2}\right)(6)(50) = 150 \text{ lb}$$

$$P = 150 \text{ lb}$$

(8)

$$M_B = F \cdot d$$



$$M_B = (400)(5) + (150)(2) = 2300 \text{ lb} \cdot \text{in}$$

$$M_B = 2300 \text{ lb} \cdot \text{in}$$

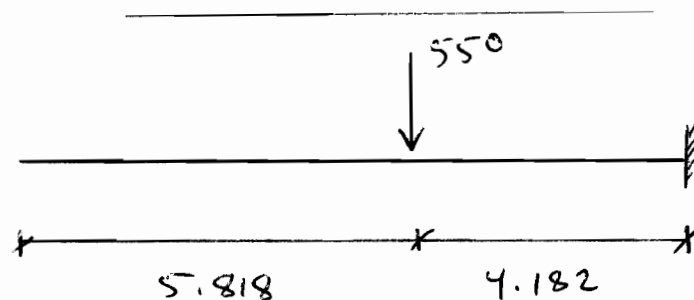
$$R = F + P$$

$$R = 400 + 150 = 550 \text{ lb}, \quad \boxed{R = 550 \text{ lb}}$$

$$M_B = R \cdot d$$

$$\therefore d = M_B / R = 2300 / 550$$

$$\boxed{d = 4.182 \text{ in}}$$

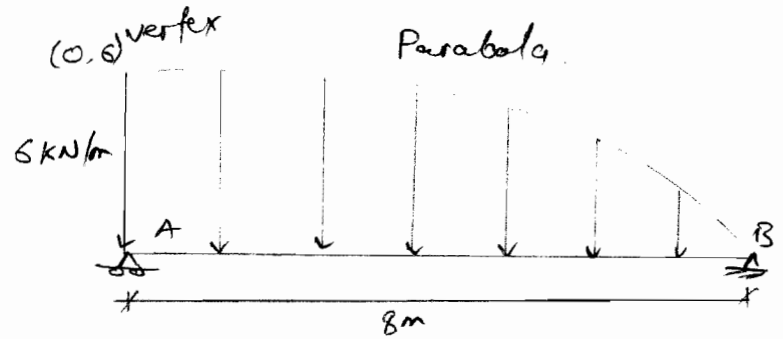


Problem 5:-

Given: Fig P5

Required:

Magnitude & location of Resultant.



Solution:-

Parabola's equation is

$$y = a(x-h)^2 + k$$

$$\text{where vertex} = (h, k) = (0, 6)$$

Using a known point at the parabola (8, 0)

$$y = a(x-h)^2 + k$$

$$0 = a(8-0)^2 + 6$$

$$a = -3/32$$

$$\therefore y = -3/32 x^2 + 6$$

(10)

$$R = \int_0^8 \left(-\frac{3}{32}x^2 + 6 \right) dx = \frac{-3}{32 \times 3} x^3 + 6x \Big|_0^8$$

$$R = -16 + 6(8) = 32 \text{ kN}$$

$$\boxed{R = 32 \text{ kN}}$$

$$\bar{x} = \frac{\int x dA}{\int dA} = \frac{\int_0^8 \left(\frac{-3}{32}x^3 + 6x \right) dx}{32}$$

$$= \frac{\frac{-3}{32 \times 4} x^4 + \frac{6x^2}{2} \Big|_0^8}{32}$$

$$= \frac{96}{32} = 3 \text{ m}$$

$$\boxed{\bar{x} = 3 \text{ m}}$$

