IQRA NATIONAL UNIVESTY
OF PESHAWAR

I D 12430

BATCH 2015

B.tech CIVIL

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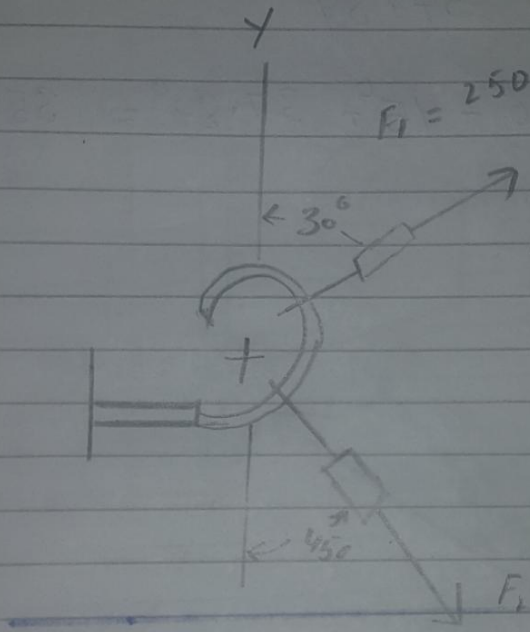
Final term

PAPER APPLIED MECHANIC.

Question No 1

PART "A"

Determine the magnitude of the resultant force $F_R = F_1 + F_2$ and its direction measured Counter clockwise from the positive X axis.



Solution:-

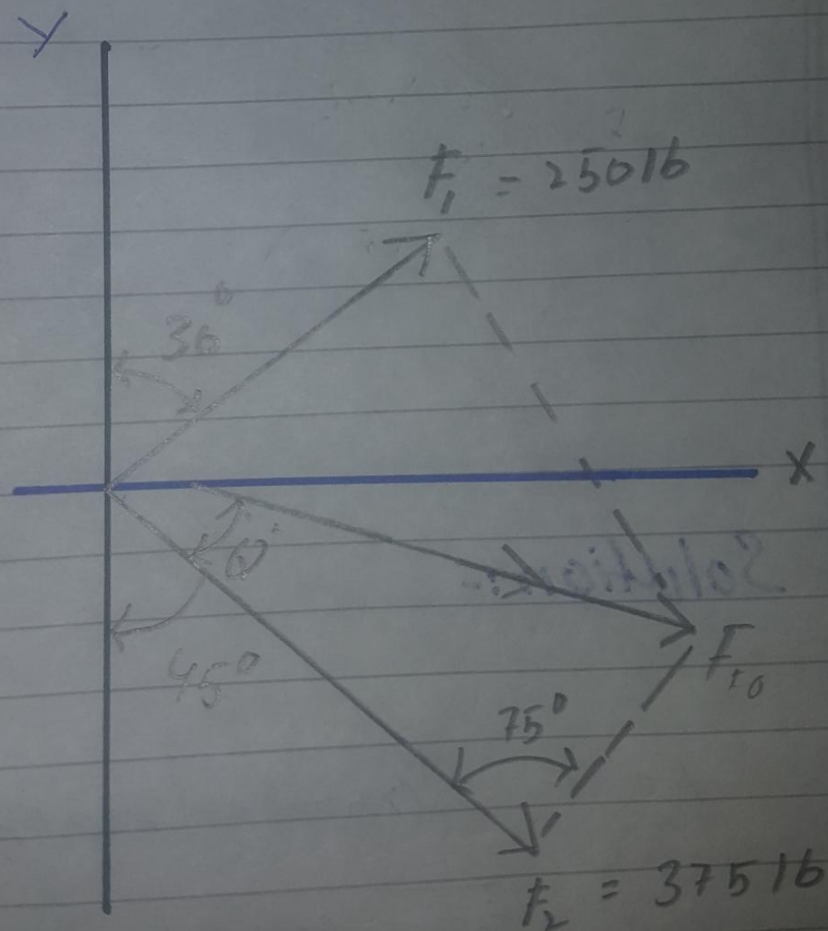
$$F_R = \sqrt{(250)^2 + (375)^2 - 2(250)(375)\cos 75^\circ} = 393.2$$

$$= 393lb$$

$$\frac{393.2}{\sin 75^\circ} = \frac{250}{\sin \theta}$$

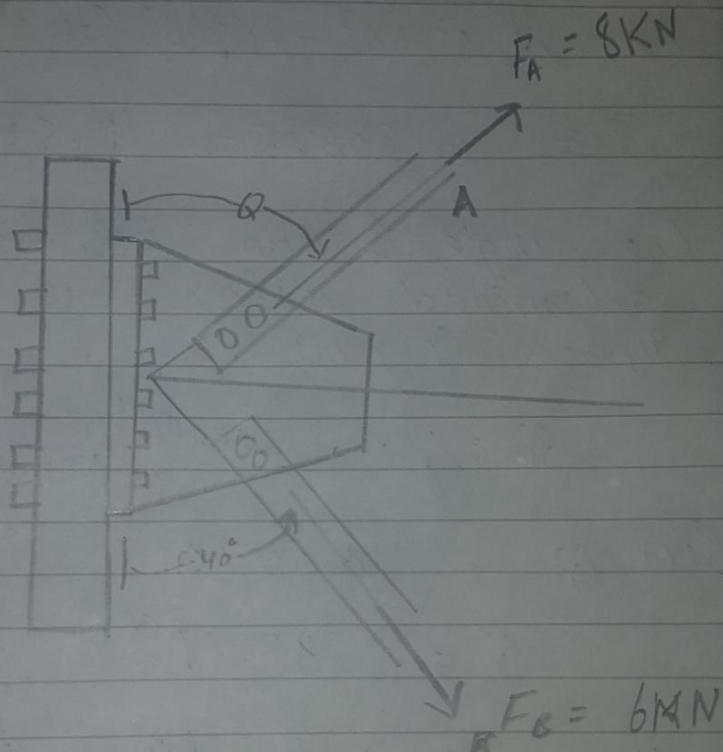
$\theta = 37.89^\circ$

$\varphi = 360^\circ - 45^\circ + 37.89^\circ = 353^\circ$



PART B

The plate is subjected to the two forces at A and B shown. If determine magnitude of the resultant of these two force and the direction measured clockwise from the horizontal. $Q = 60°$



Solution:-

parallelogram law:

The parallelogram law of addition is show in the fig. a.

Trigonometry :-

Using law of Cosines (Fig. b) we have.

$$F_R = \sqrt{8^2 + 6^2 - 2(8)(6)\cos 100^\circ}$$

$$= 10.80\,KN = 10.8\,KN$$

The angle θ can be be determined using law of Sines (fig. b)

$$\sin\theta / 6 = \sin 100^\circ / 10.80$$

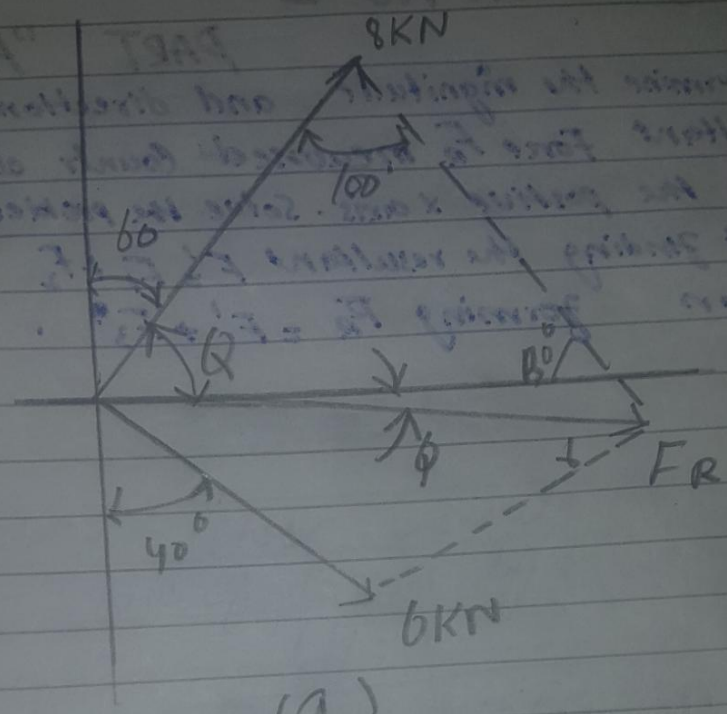
$$\sin\theta = 0.5470$$

$$\theta = 33.16^\circ$$

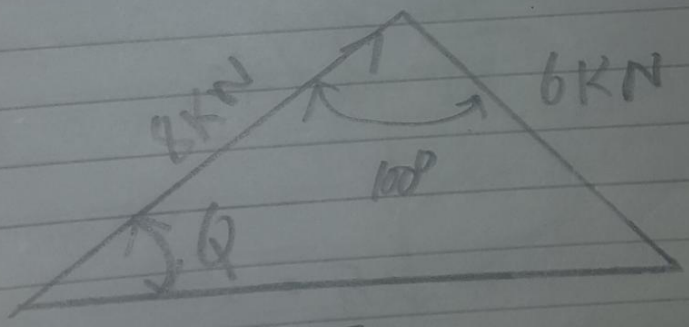
Thus the direction ϕ of F_R measured from the x axis is

$$\theta = 33.16^\circ - 30^\circ$$

$$= 3.16^\circ$$



(a)

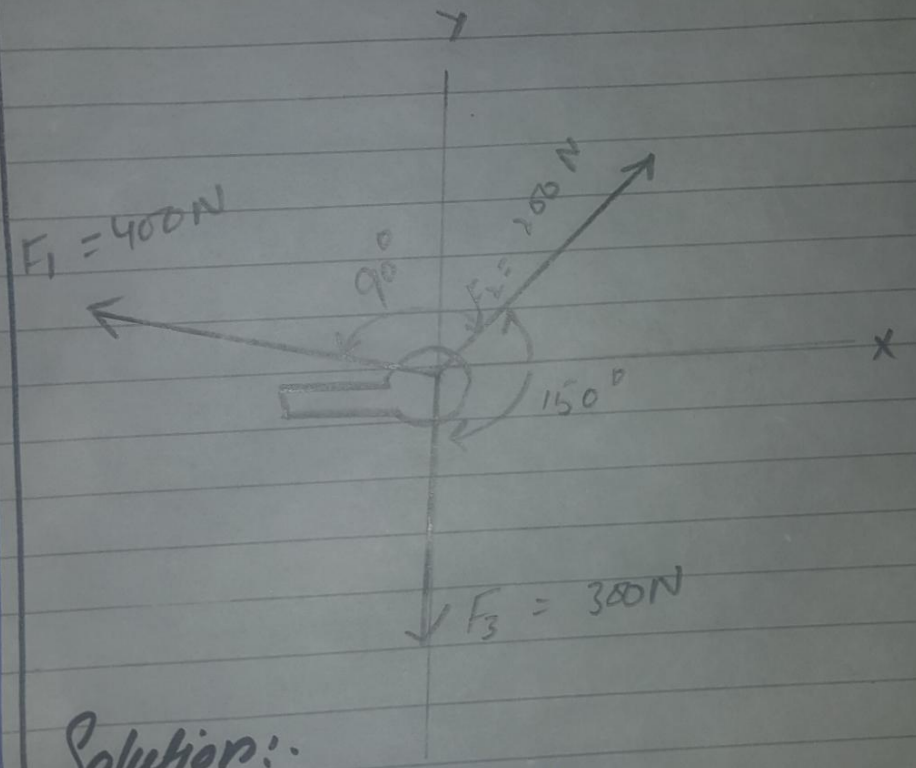


(b)

Question No 2

PART "A"

Determine the magnitude and direction of the resultant Force F_R measured Countr clockwise from the postive x axis. Solve the problem by first finding the resultant $F' = F_1 + F_2$ and then forming $F_R = F' + F_3$.



Solution:

Parallelogram law.

The parallelogram law of addition for F_1 and F_2 and their resultan F' and F_3 are show on figs. a and b, respectively.

Trigonomtry.

Reffering to Fig c

$F' = \sqrt{200^2 + 400^2} = 447.21$

$\theta = \tan^{-1}(200/400) = 26.57^\circ$

thus $\phi' = 90^\circ - 30^\circ - 26.57^\circ =$

33.43°

using these result to apply the law of cosines by referring to Fig. d.

$F_R = \sqrt{300^2 + 447.21^2 - 2(300)(447.21)\cos 33.43^\circ}$

$= 257.05\,N = 257\,KN$ Ans.

Then apply the law of sines

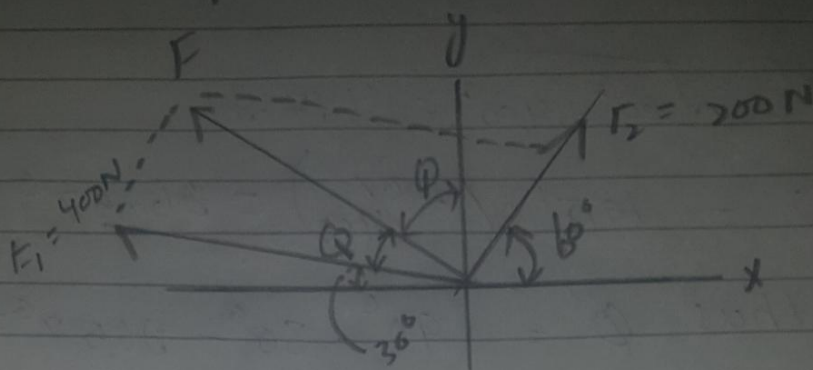
$\sin\phi / 300 = \sin 33.43^\circ / 257.05$

$\phi = 46.02^\circ$

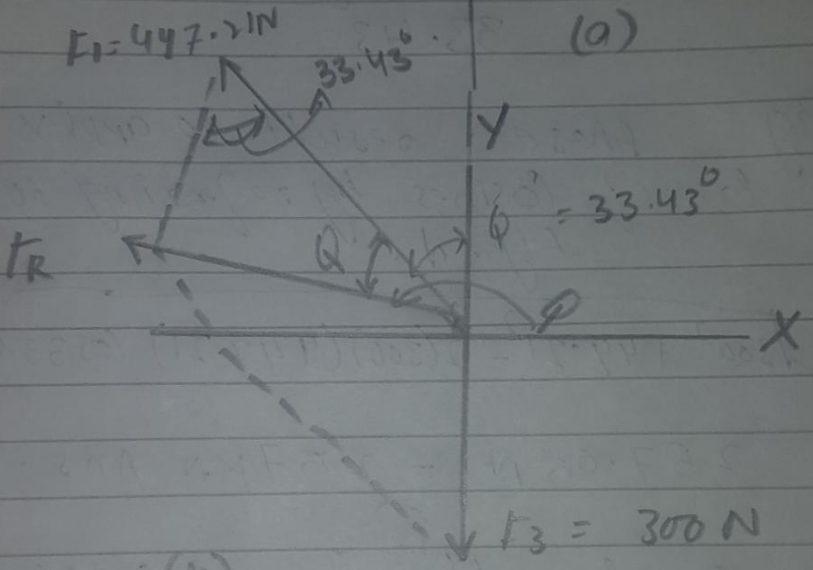
Thus, the direction ϕ of F_R measured counterclockwise from the postive x axis is

$\phi = 90^\circ + 33.43^\circ + 46.02^\circ =$

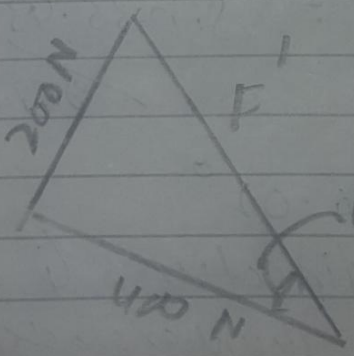
$163.45^\circ = 163^\circ$.


F'
y
$F_3 = 300\,N$
$F_1 = 400\,N$
P
Q
60°
x
30°

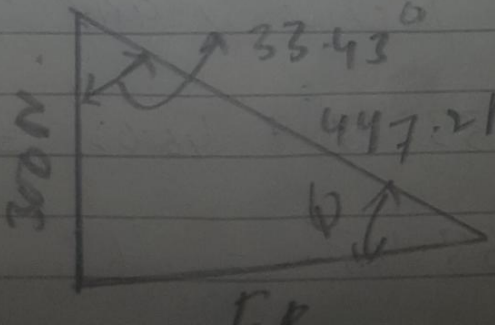
(a)


$F_1 = 447.2\,N$
33.43°
y
$\theta = 33.43°$
F_R
Q
P
x
$F_3 = 300\,N$

(b)


300 N
F'
θ'
400 N

(c)


33.43°
300 N
447.2 N
θ
F_R

PART "B"

Define equilibrium :-

As any point where the total amount of external force or torque is zero. This point may be anywhere near the centre mass. External force in translational motion of the rigid body changes the liner momentum of that bod.

equilbritum of rigid body.

→ Force and moment acting on a rigid body could be external force/moment or external force/moments.

→ Force acting from one body to another body direct physical contant or from the earth are example of external force.

→ Fluid pressure acting to the wall of water tank or force exerted by the tire of truck to the road is all external force.

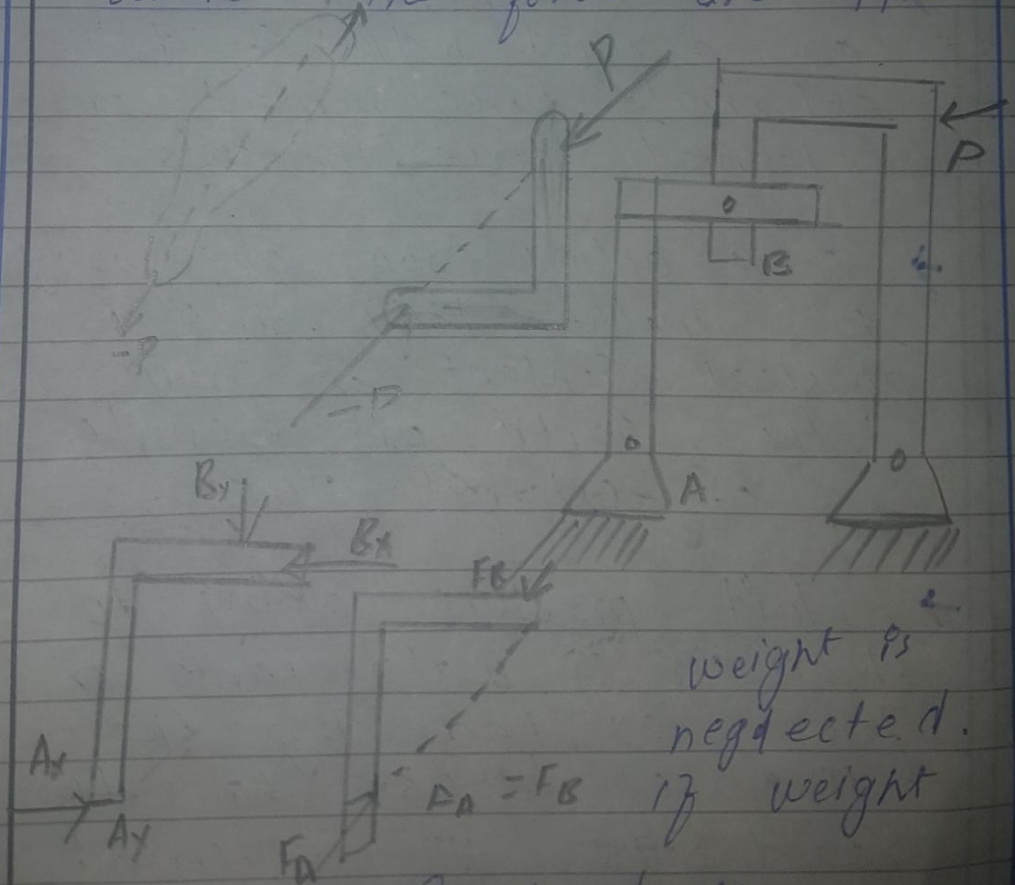
Question No 3

PART "A"

what is meant by two force member and three force members?

Two Force members.

Members which are to only two forces are named as "two force members" Force acting on those members are equal in the magnitude, opposite in direction and directed along the line joining the two point where the force are applied.

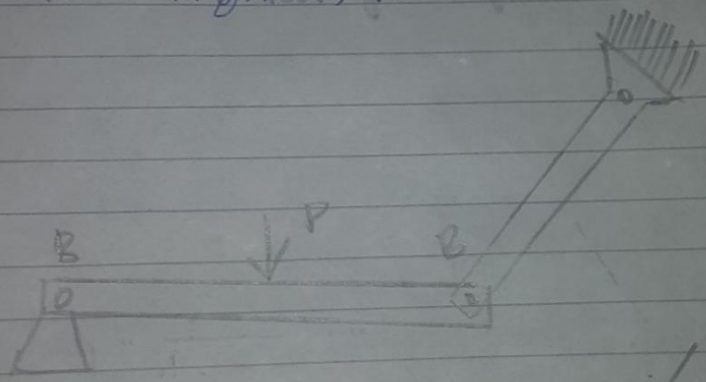


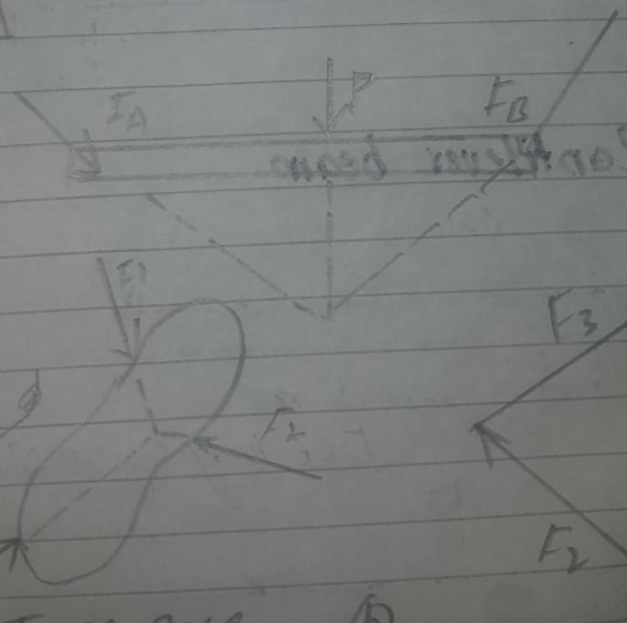
weight is neglected.

$F_A = F_B$ if weight is considered the member will not be

THRE-FORCE MEMBER

In rigid bodies acted on by only three force the line section of the force must be concurrent otherwise the body will rotate about the intersection point of two force due to the third force which is not concurrent. If the force acting on the body are parallel, then the point of concurrency is assumed to be





(a) Three force members

(b) closed polygon statistics

$\sum F = 0$

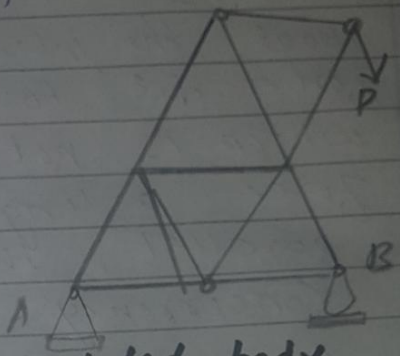
PART "B"

FREE BODY DIAGRAM

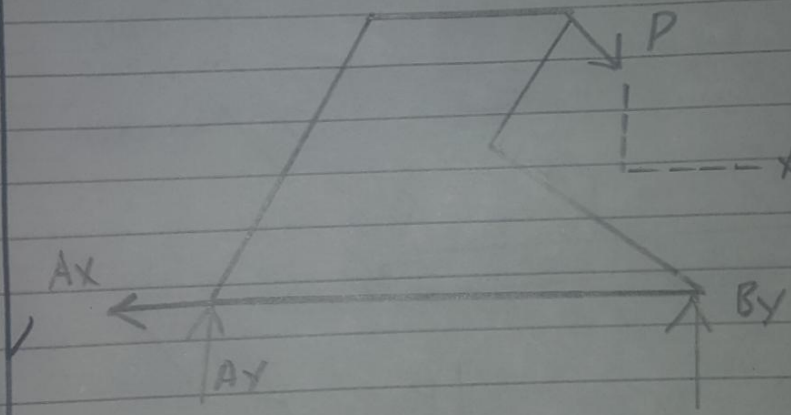
Mechanical system

1. **plan furss**

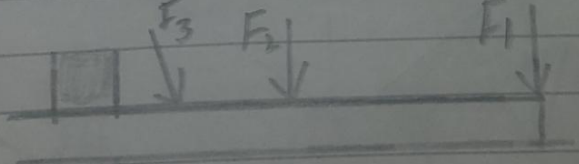
wight of furss assumbed neglibiglbe Camposed with P.



Free - Body Digram of Isolated body

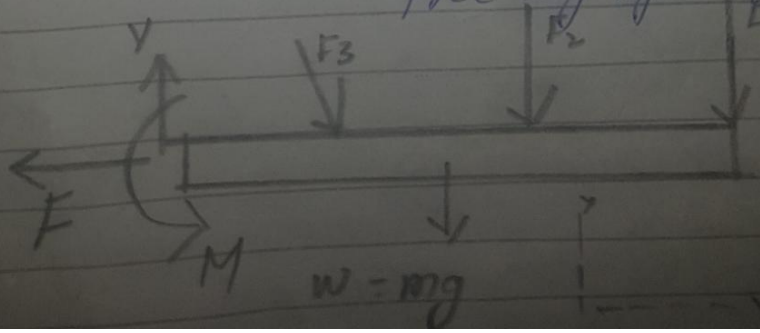


2. **Cantilever beam**



A mass m

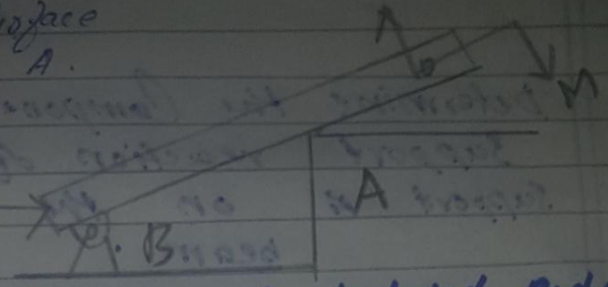
Free body digram of Isolated body -



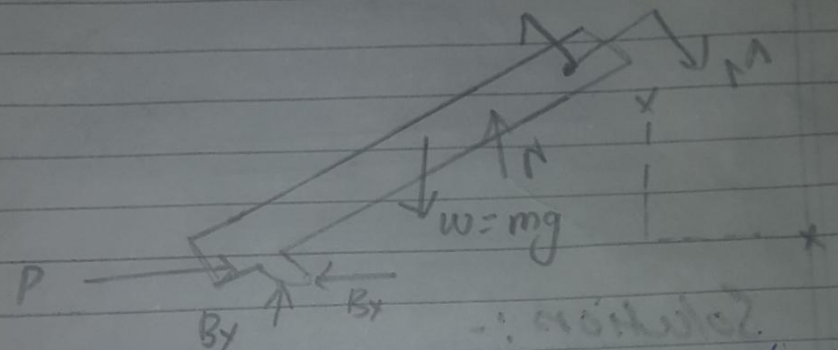
Mechanical System

3. **Beam**

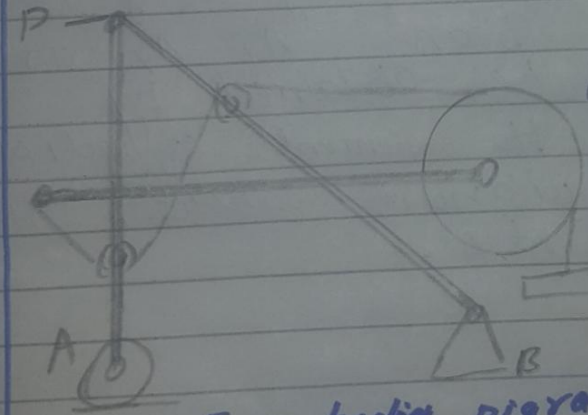
Smooth Surface
Contact at A.
Mass: m



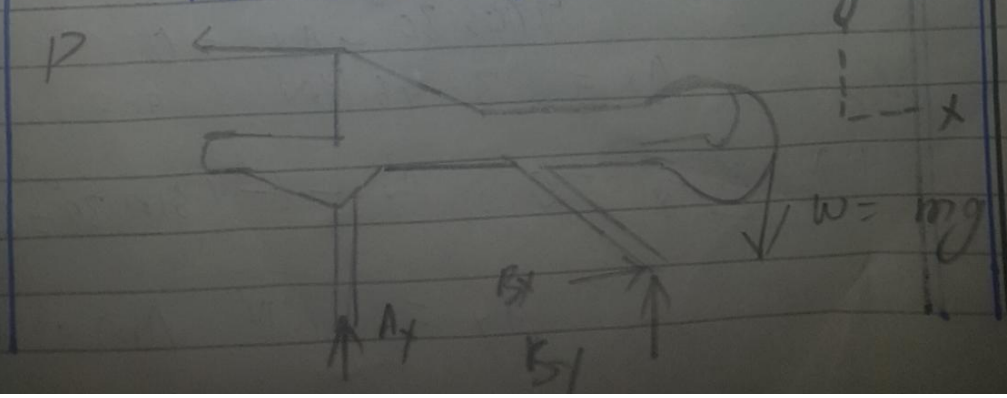
Free-Body Digram of Isolated Body



4:- Right system of interconnected bodies analzed as a single unit.

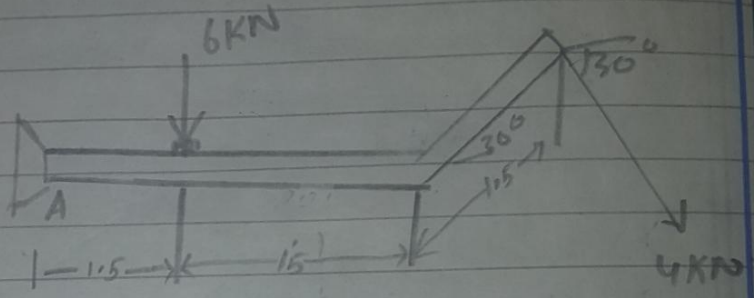


Free bodies Digram of Isolated Body.



Question No 4 PAR "A"

Determine the Component of the Support reaction of the fixed Support A on the Cantilevered beam.



Solution :-

Equation of Equilibrium :-

From the free body diagram of the Cantilever beam A_x A_y and M_A can be obtained by writing the moment equation of equilibrium about point A.

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

$$4\cos 30^\circ - A_x = 0$$

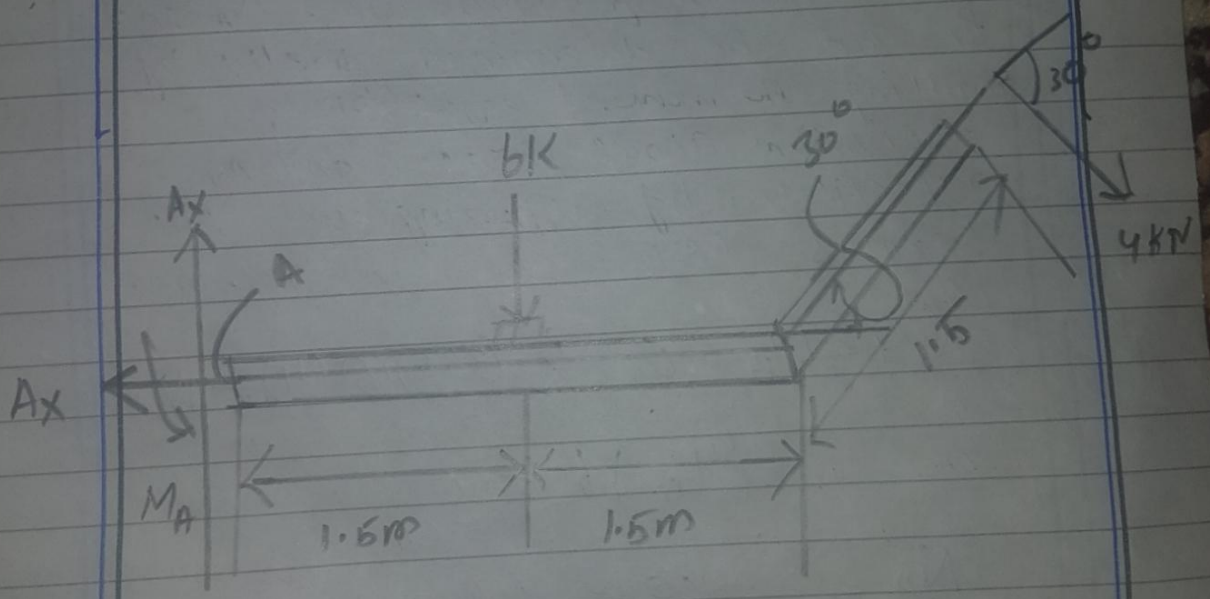
$$A_x = 3.46\ KN \quad \text{Ans}$$

$$+\uparrow \sum F_x = 0 : A_y - 6 - 4\sin 30^\circ = 0$$

$$A_x = 8\ KN \quad \text{Ans}$$

$\circlearrowleft + \sum M_A = 0 : M_A - 6(1.5) + 4\cos 30^\circ (1.5 \sin 30^\circ) - 4\sin 30^\circ (3 + 1.5\cos 30^\circ) = 0$

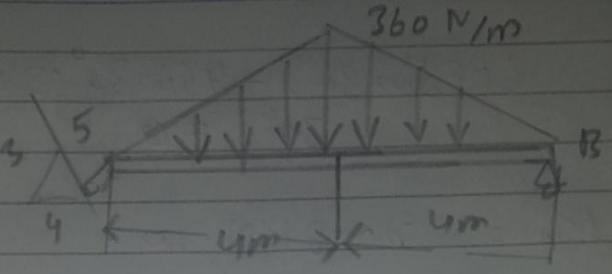
$M_A = 20.2\ KN \cdot m$



(a)

PART "B"

Determine the reaction at the supports.



Solution:-

Equation of Equilibrium. N_A and B_y can be determined direlty by writting the moment equation of equilibrium about point B and A, respectively, by referring to the Beam's FBD show in Fig. a.

$$\circlearrowleft + \Sigma M_B = 0 : \quad \tfrac{1}{2}(360)(8)(\tfrac{4}{5}) - N_A$$

$$(4/5)\,6 = 0$$

$$N_A = 900\,N$$

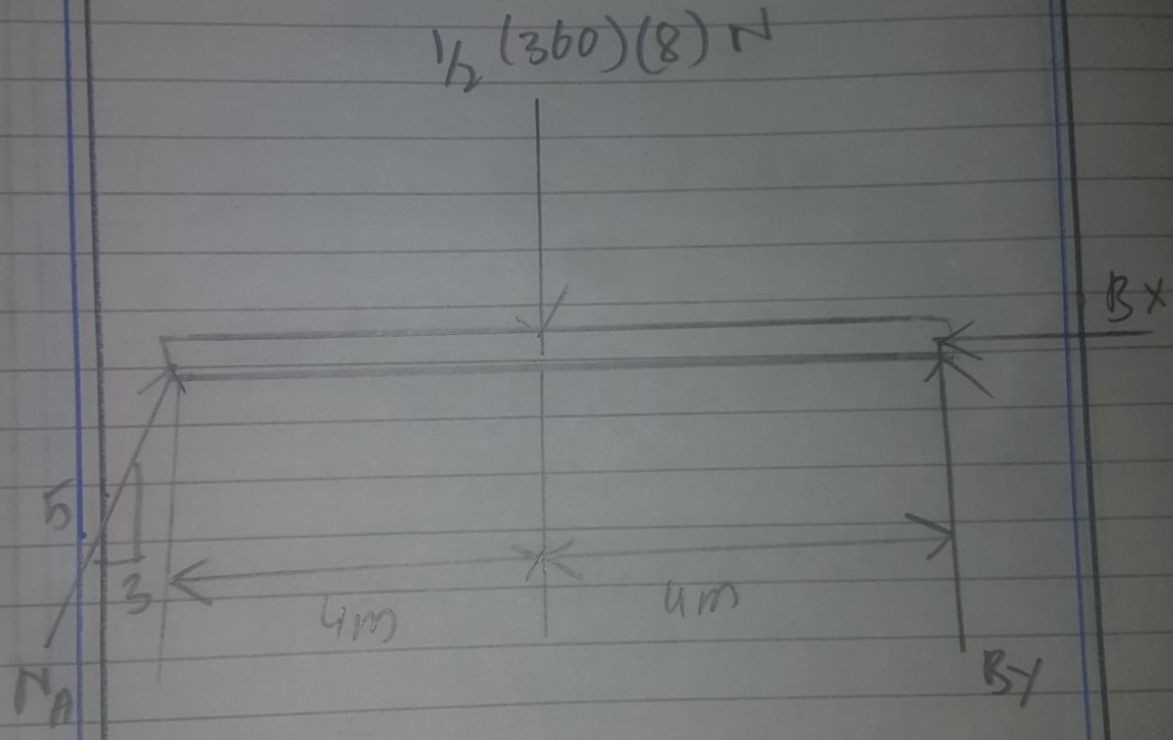
$$\circlearrowleft + \Sigma M_A = 0 \quad B_6(8) - \tfrac{1}{2}(360)(8)(4)$$

$$B_y = 780\,N$$

using the result of N_A to write the force equation of equilibrium along the axis

$\pm \rightarrow \sum F_x = 0: \quad 900\left(\frac{3}{5}\right) - B_x = 0$

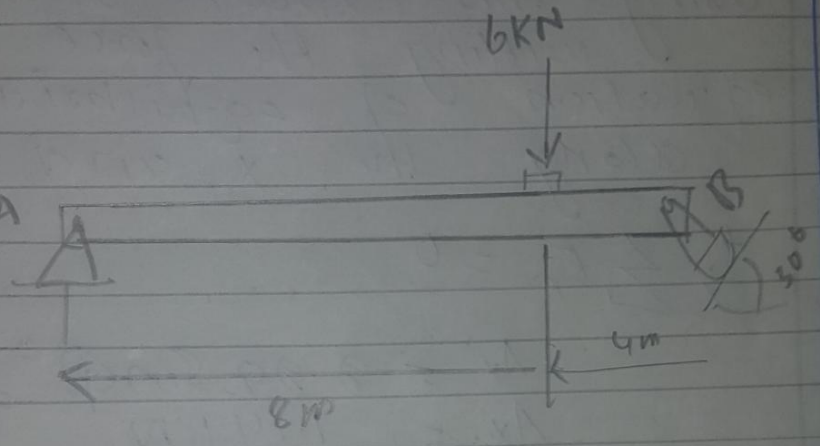
$B_x = 540\ N$



(a)

Question No 5
PART "A"

Determine the horizontal and vertical Components of reaction at the pin A and the reaction of rocker B on the Beam.



Solution:-

Equation of equilibrium:

From the free body diagram of the the beam Fig. a N_B Can be obtained by writing the moment equation of equilibrium about point A.

$$\curvearrowleft \Sigma M_A = 0$$

$$N_B \cos 30^\circ (12) - 4(8) = 0$$

$$N_B = 2.99\ KN$$

using this result and writing the force equation of equilibrium along the x and

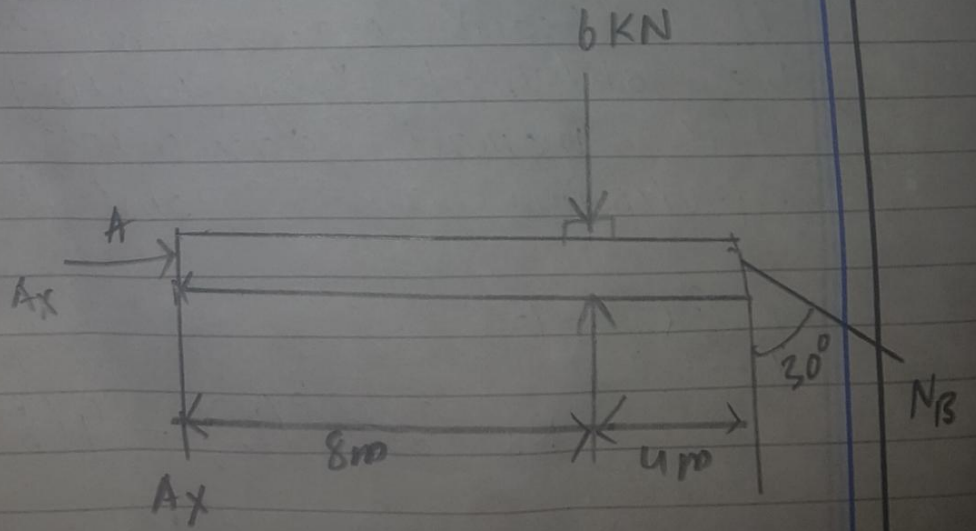
$$\xrightarrow{+} \sum F_x = 0$$

$$A_x = 2.29 \sin 60^\circ =$$

$$A_x = 1.14\ KN$$

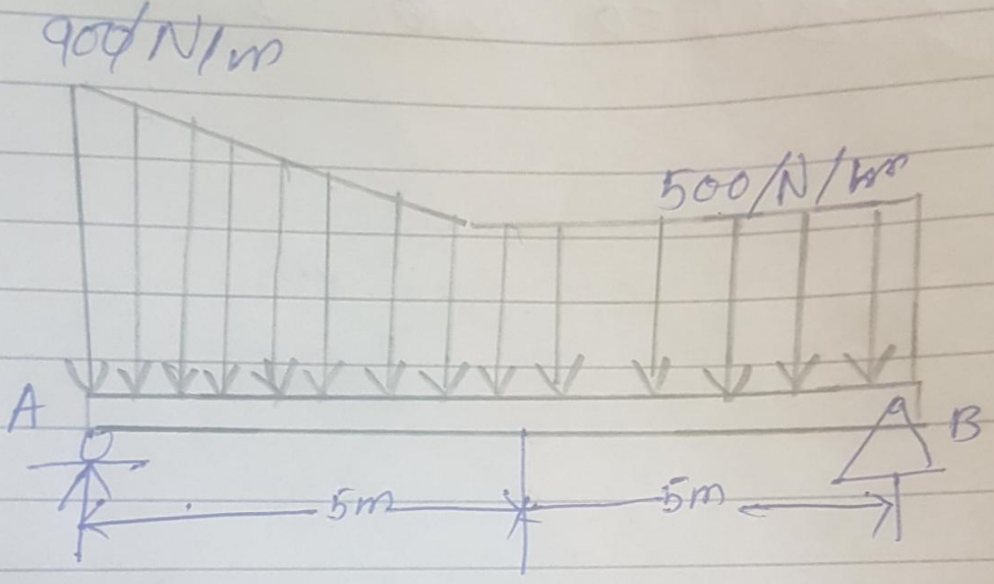
$$+\uparrow \sum F_y = 0 \quad A_y + 2.29 \cos 60^\circ - 4 = 0$$

$$A_y = 2.02\ KN$$



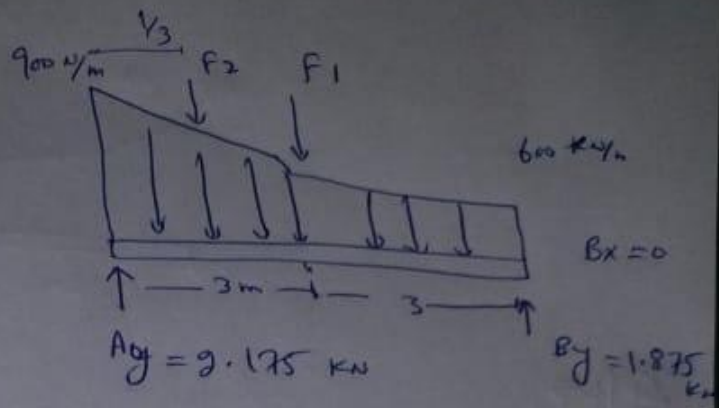
Part "B"

Determine the reaction at the support.



Solution:-

Equation of equilibrium N_A and B_x can be determined directly by working the moment equilibrium equation about point B and A respectively by referring to FBD of the beam shown in Fig. a.



Sol:

$$F_1 = 600\,(6) = 3600\ N$$

$$F_2 = \frac{300\,(3)}{2} = 450\ N$$

$$\Sigma m_B = 0 \quad +\circlearrowleft$$

$$F_1(3) + F_2(3) - A_y(6) = 0$$

$$\boxed{A_y = 2.175\ KN}$$

$$\Sigma F_y = 0$$

$$-F_1 - F_2 + A_y + B_y = 0$$

$$\boxed{B_y = 1.875\ KN}$$