ROHININ COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF THE SUBJECT: ENGINEERING MECHANICS

SUBJECT CODE : ME3351

REGULATION 2021

UNIT II: STATICS OF RIGID BODIES IN TWO DIMENSIONAL

Non current coplander force system:

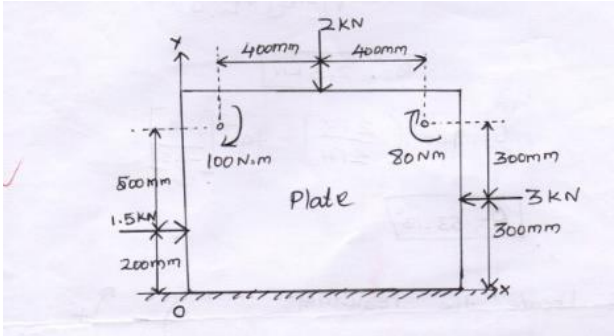
1. Resolve the given forces, if they are inclined to reference x and y Axis.
2. Find the sum of horizontal component of forces $\sum FH$
3. Find the sum of vertical component of forces $\sum FV$
4. 4.Calculate the resultant force R = $\sqrt{(\sum(F_H)^2 + (\sum(F_V)^2}$
5. Angle of inclination of resultant θ = $\tan^{-1}[\frac{\sum FV}{\sum FH}]$
6. If the force moment system is converted into a single force, coordinate position is given by

$$\sum M_o = R \times x$$

$$\sum M_o = \sum F_v \times x$$

$$\sum M_o = \sum F_H \times y$$

A plate os acted upon by three force and two couple as shown in fig. determine the resultant of these force couple system and find co-ordinate x of the point on the x axis through which the resultant is passed



Given

Three force $1.5KN, 2KN, 3KN$

Two couple $100N.m\ 80\ N.m$

To find

Resultant force, location

Soln:

Resultant force R = $\sqrt{(\sum(F_H)^2 + (\sum(F_V)^2}$

Sum of horizontal

$$\sum F_H = 0$$

$$\sum F_H = 1.5 - 3$$

$$\sum F_H = -1.5KN1$$

Sum of vertical force $\sum Fv$ =0

$$\sum F_V = -2\ KN$$

Resultant $R = \sqrt{(\sum(F_H)^2 + (\sum(F_V)}$

$$R = \sqrt{[-1.5]^2[-2]^2}$$

$$R = 2.5KN$$

$$\theta = tan^{-1}\left[\frac{\sum F_V}{\sum F_V}\right] = tan^{-1}\left[\frac{-2}{-1.5}\right]$$

$$\theta = 53.13°$$

To locate the resultant

By varigon's Thorem $\downarrow +\uparrow -$

$\sum M_o = R \times x \; and \sum M_o = \sum F_y \times x$

$\sum M_O = [3 \times 0.3] + [-2 \times 0.5] + [-1.5 \times 0.2] + [-0.1] + [-0.08] = 0$

$\sum M_o = -0.58 \; KN.M$

$\sum Mo = 0.58 \; KN.M$ [clock wise]

The co-ordinate x of the point through which the resulted passes is given by

$\sum$Mo= $\sum FY \times x$ $x = \frac{0.58}{2}$

$0.58 = 2 \times x$

$x = 0.29m$

$x = 290mm$

we want to find the intersection

$\sum M_o = \sum F_H \times y$

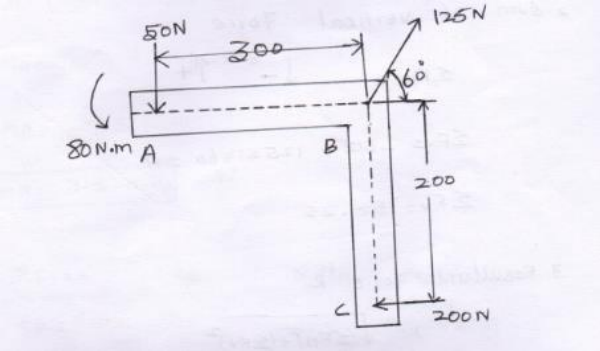
$0.581.5 \times y$

$y = 0.387 \; m$

The three forces and a couple shown below are applied to an angel bracket

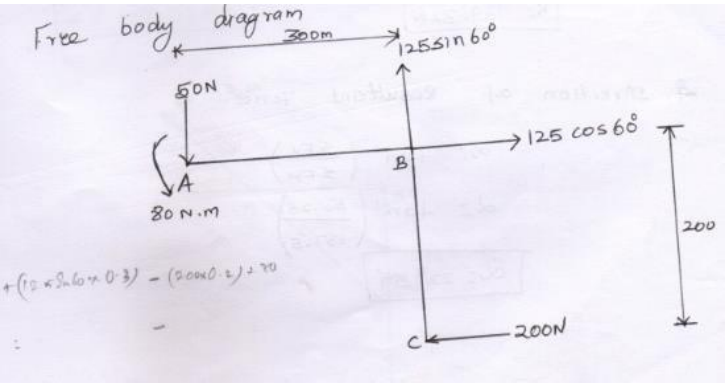
(i) Find he Resultant of this system of forces

(ii) Locate the points where the line o action of the resultant intersects line AB and the line BC



Soln

Free body diagram



1. Sum of Horizontal force

$$\sum F_H = 0 \qquad \overset{+}{\rightarrow\leftarrow}_{-}$$

$$\sum F_H = +125\cos 60 - 200 = 0$$

$$\sum F_H = -137.5N$$

2. Sum of Vertical Force

$$\sum F_V = 0 \downarrow - \uparrow +$$

$$\sum F_V = -50 + 125\sin 60 = 0$$

$$\sum F_V = 58.25$$

3. Resultant force' R'

$$R = \sqrt{(\sum(F_H)^2 + (\sum(F_V)^2}$$

$$R = \sqrt{[-137.5]^2 + [58.23]^2}$$

$$R = 149.32N$$

4. Direction of Resultant force α

$$\alpha = \tan^{-1}(\frac{\sum FV}{\sum FV})$$

$$\alpha = \tan^{-1}(\frac{58.25}{137.5})$$

$$\alpha = 22°57'$$

Location of Resultant Force:

By Varigon's Theorem

$$\sum M_A = \sum F_V \times x \; and \sum M_A = \sum F_H \times y$$

$$\sum M_A = (200 \times 0.2) + (-125 \sin 60 \times 0.3) - 80{:}0$$

$$\sum M_A = 40 - 32.47 - 80$$

$$\sum M_A = -7.5 \, N.m$$

$$\sum M_A = \sum F_V \times x$$

$$7.5 = 58.25 \times x$$

$$x = 7.5/58.25 = 0.12\ m$$

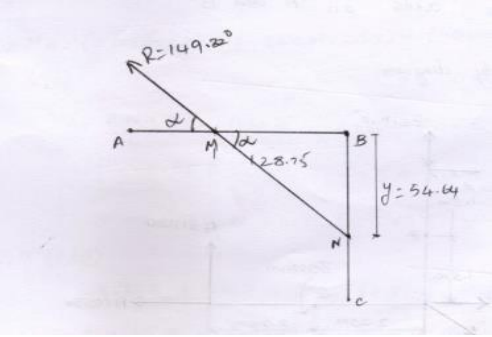
$$x = 128.75mm$$

$$\sum M_A = \sum F_v \times y$$

$$7.5 = 137.25 \times y$$

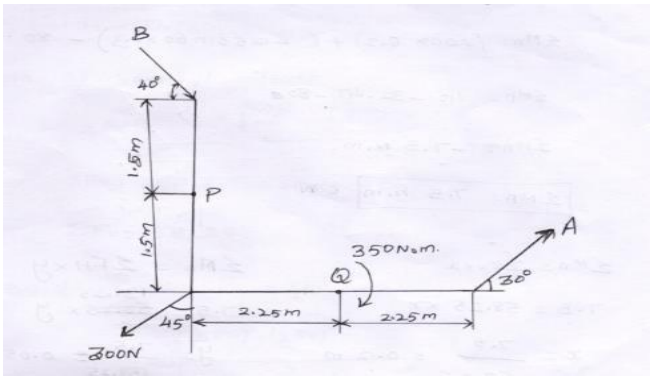
$$y = 7.5/137.25 = 0.05m$$

$$y = 54.64\ mm$$



Problem:

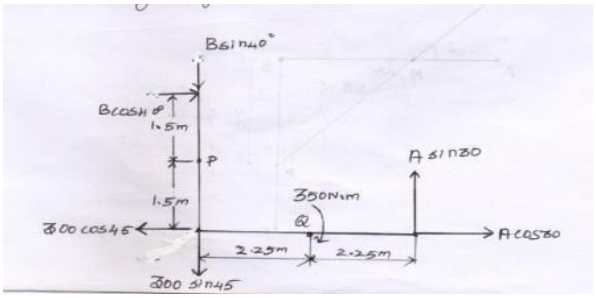
A system of forces acts as shown in fig.find the magnitude of A and B so that resultant of the force system passes through P and Q



To Find:

Forces acts on A and B

Soln: Free body diagram



The resultant forces passes through P and Q is moment About pis zero and also moment about Q=0

It only means that the algebraic sum of moment about P and Q is equal to zero

$\sum M_P = 0$ $\downarrow +\ \uparrow -$

$$\sum M_P = (+B\ \cos 40 \times 1.5) + (300\cos 45 \times 1.5) + 350 + (-A \sin 30 \times 4.5) + (-A \cos 30 \times 1.5) = 0$$

$$\sum M_P = 1.149\,B + 318.19350 - 2.25A - 1.29$$

$$\Sigma M_P = 1.49B + 668.19 - 3.54A = 0$$

$$-3.54A + 1.149B = -668.19 \quad \text{>(1)}$$

$\sum M_Q = 0 \quad \downarrow + \uparrow -$

$\sum M_Q = (B\,cos40 \times 3) + (-B\,sin40 \times 2.25) + (-300sin\,45 \times 2.25) + 350 + (-A\,sin$
$30 \times 2.25) = 0$

$2.29\,B - 1.44B - 477 + 350 - 1.125A = 0$

$0.85B - 127 - 1.125A = 0$

$-1.25A + 0.85B = 127 - - - - - - - - - - > (2)$

Solve 1&2

$-3.54A + 1.149B = -668.19$ (1)

$-1.125A + 0.85B = 127$ (2)

$(1) \times 1.25 \Rightarrow -3.982A + 1.292B = -751.7$

$(2) \times 3.54 \Rightarrow 3.982A + (-)\,3.009B = < -> 449.58$

$$-171B = -1201.29$$

$$B = (-1201.29)/(-1.71)$$

$$B = 702.508N$$

B Value substituting in Eqn (1)

$-3.54A + 1.149 \times 702.508 = -668.19$

$-3.54A + 807.182 = -668.19$

$-3.54A = -668.19 - 807.182$

$-3.54A = -1475.37$

$A = (-1475.37)/(-3.54)$

$A = 416.77\ N$

Result:-

$Force\ on\ A = 416.77N$

$Force\ on\ B = 702.508N$

Take moment about 'A'

$\sum M_A$=0

$\sum M_A = (500 \times 11) + (-200 \times 7) + (1200 \times 5) + (-300 \times 2)$

$\sum M_A = 5500 = 1400 + 6000 - 600$

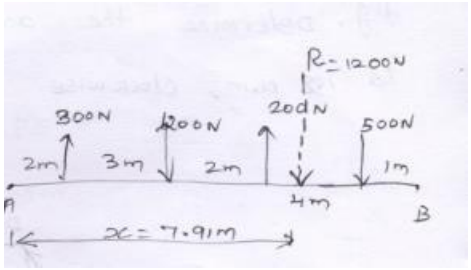
$\sum M_A = 9500\ N.m$

By varignon's theorem

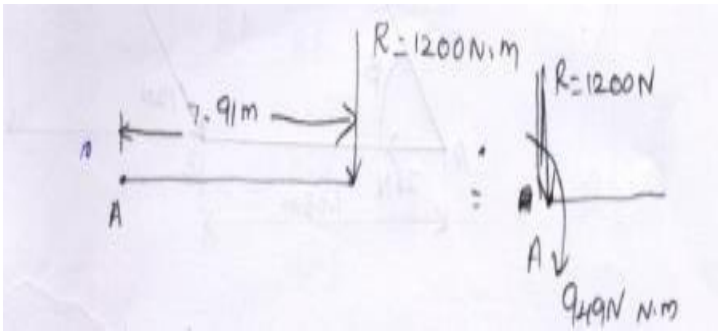
$\sum M_A = R \times x$

$9500 = 1200 \times x$

$x = 7.91m$



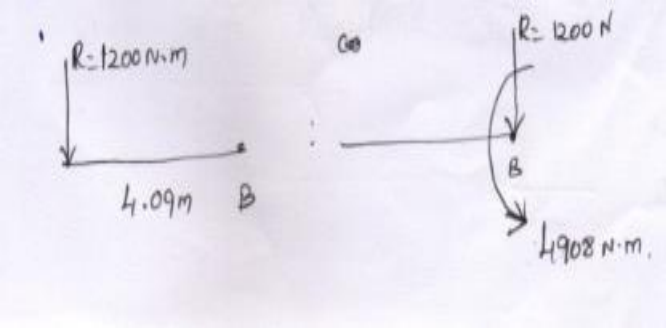
Force couple systemant 'A'



$Couple\ at\ A = 1200 \times 7.91$

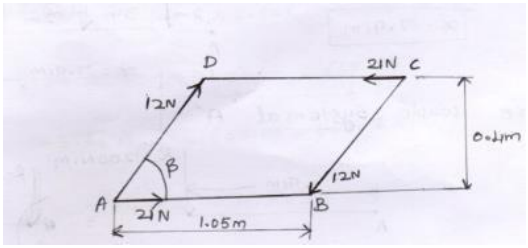
$A = 9492\ N.m$

Couple system at B



Problem:

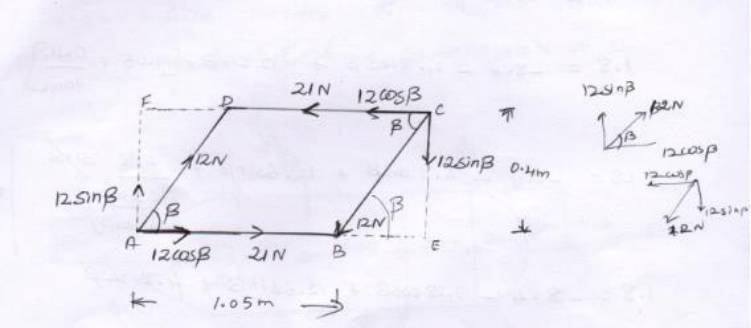
A plate ABCD in the shape of parallelogram is acted upon the two couples, as shown in the fig. Determine the angle B if the resultant couple is 1.8 N.m clockwise



Given:

Resultant couple =1.8N. m

Free body diagram



$Distance\ of\ AE = AB + BE$

$AB = 1.05\ m$

To find BE

$$tan\beta = \frac{CE}{BE} = \frac{0.4}{BE}$$

$$BE = \ 0.4/tan\ \beta$$

$$AE = AB + BE$$

$$AE = 1.05 + \frac{0.4}{tan\,\beta}$$

Given the resultant couple $\sum M_A = 1.8N.M$

Take moment about A

$$\sum M_A = [-21 \times 0.4] + [-12\ cos\beta \times 0.4] + [12 sin\beta \times AE]$$

$$\sum M_A = 1.8\ N.M$$

$$1.8 = -8.4\ - 4.8cos\beta + 12\ sin\beta \times [1.05 + \frac{0.4}{tan\beta}]$$

$$1.8 = -8.4\ - 4.8cos\beta + 12.6\ sin\beta + \frac{4.8}{\frac{sin\beta}{cos\beta}}\ sin\,\beta \qquad tan\,\theta = \frac{sin\,\theta}{cos\,\theta}$$

$$1.8 = -8.4 - 4.8\,cos\beta\ + 12.6\,sin\,\beta + 4.8\,cos\,\beta$$

$$1.8 + 8.4 = -4.8\,cos\beta + \ 12.6\,sin\beta\ + 4.8cos\,\beta$$

$$10.2\ = 12.6sin\beta$$

$$Sin\beta = \frac{10.2}{12.6}$$

$$B = sin - 1\left(\frac{10.2}{12.6}\right) \qquad B = 54°$$