3) case: 1.

$\theta = 90^\circ$

$R = \sqrt{40}$

$R^2 = 40$

case: 2

$\theta = 60^\circ$

$R = \sqrt{52}$

$R^2 = 52$

$$R^2 = P^2 + Q^2 + 2PQ\cos\theta$$

when $\theta = 90^\circ$

$40 = P^2 + Q^2 + 2PQ\cos 90^\circ$

$\therefore 40 = P^2 + Q^2$ ----- (1)

when $\theta = 60^\circ$

$52 = P^2 + Q^2 + 2PQ\cos 60^\circ$

$\therefore 52 = (P^2 + Q^2) + 2PQ \times 0.5$

from eqn (1)

$52 = 40 + PQ$

$PQ = 12$ ------- (2)

$(P+Q)^2 = P^2 + Q^2 + 2PQ$

$= 40 + (2 \times 12)$

$(P+Q)^2 = 64$

$P + Q = 8$ ---------- (3)

$(P-Q)^2 = P^2 + Q^2 - 2PQ$

$= 40 - (2 \times 12)$

$= 16$

$P - Q = 4$ ---------- (4)

from eqn (3) & (4)

$P + Q = 8$

$P - Q = 4$

$2P = 12$ $\Rightarrow$ $\boxed{P = 6\ kN}$

from eqn (3)

$\boxed{Q = 2\ kN}$

4) $P = P$, $Q = P$, $R = P$

As per law of triangle of Forces,

(2)

$$R = \sqrt{P^2 + Q^2 - 2PQ\cos\beta}$$

$$P = \sqrt{P^2 + P^2 - 2PP\cos\beta}$$

$$P^2 = 2P^2 - 2P^2\cos\beta$$

$$P^2 = 2P^2(1 - \cos\beta)$$

$$\therefore \frac{1}{2} = 1 - \cos\beta$$

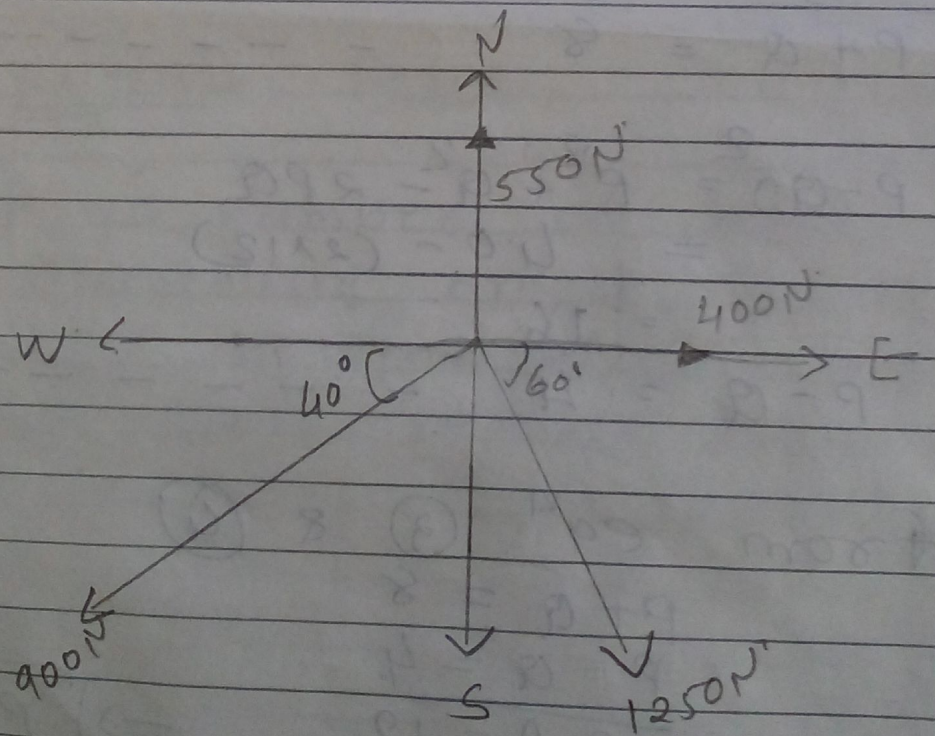
$$\therefore \cos\beta = 0.5 \implies \boxed{\beta = 60^\circ}$$

$$\theta = 180^\circ - 60^\circ$$

$$= 120^\circ$$

5)

(3)



$$\Sigma H = 400 - 900\cos 40^\circ + 1250\cos 60^\circ$$

$$= 335.56\ N$$

$$\Sigma V = 500 - 900\sin 40^\circ - 1250\sin 60^\circ$$

$= -1111.04\ kN$

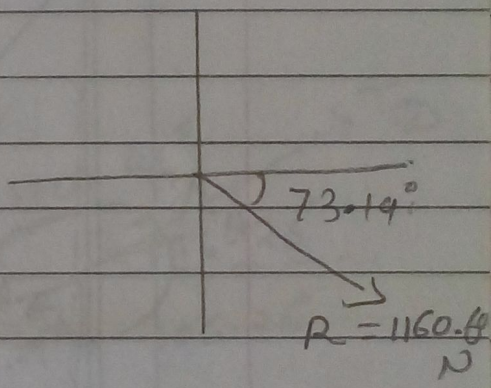
$R = \sqrt{\Sigma H^2 + \Sigma V^2}$

$= \sqrt{(335.56)^2 + (-1111.04)^2}$

$= 1160.60\ N$

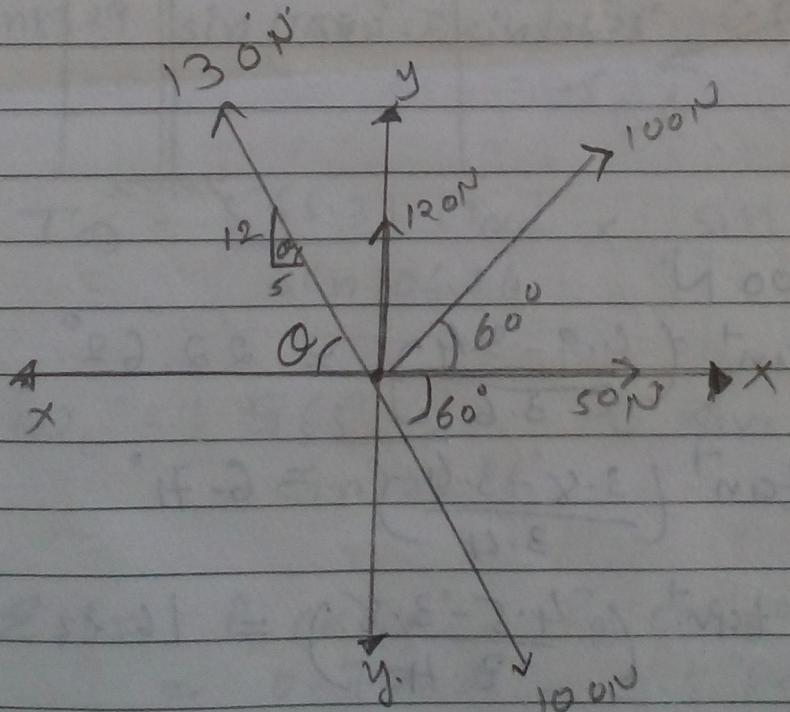
$\tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{1111.04}{335.56} = 3.31$

$\therefore \boxed{\theta = 73.19^\circ}$



6)

4)



$\tan\theta = 12/5 = 2.4 \Rightarrow \boxed{\theta = 67.38^\circ}$

$\Sigma H = 50\cos 0^\circ + 100\cos 60^\circ - 130\cos 67.38^\circ$

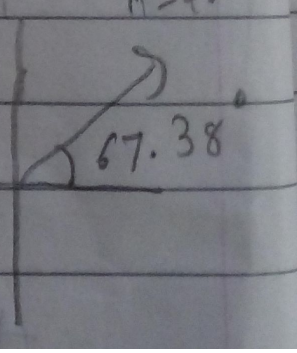
$= 100\ N$

$$\Sigma V = 120 + 100\sin 60 + 130 \sin 67.38^\circ - 100\sin 60^\circ$$

$$= 240\ N$$

$$\tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{240}{100} = 2.40$$

$$\theta = 67.38^\circ$$



8) $\Sigma H = P_1 \cos 45^\circ - P_2 \cos 60^\circ + 6 \cos 60^\circ$

$= 0.707 P_1 - 0.5 P_2 + 3 \quad \text{---} (1)$

5

$\Sigma V = P_1 \sin 45^\circ - P_2 \sin 60 - 6 \sin 60$

$= 0.707 P_1 - 0.866 P_2 - 5.196$

$\text{----} (2)$

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Sum of resolution of forces about an axis is equal to the resolution of resultant about the same axis.

$$\Sigma P_{xL} = R_x \cos\alpha$$

$$\therefore 0.707P_1 - 0.5P_2 + 3 = 20\cos 20^\circ$$

$$\therefore 0.707P_1 - 0.5P_2 = 15.794 \quad \text{----} (3)$$

Similarly

$$\Sigma P_y = R \cdot \sin\alpha$$

$$\therefore 0.707P_1 - 0.866P_2 - 5.196 = 20\sin 20^\circ$$

$$\therefore 0.707P_1 - 0.866P_2 = 12.036 \quad \text{----} (4)$$

from eqn (3) & (4)

$$0.707P_1 - 0.5P_2 = 15.794$$

$$0.707P_1 - 0.866P_2 = 12.036$$

$$\boxed{P_2 = 10.26 \text{ kN}}$$

from eqn (1) $\boxed{P_1 = 29.59 \text{ kN}}$

Co-planer Non-concurrent forces:-

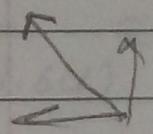
1) $\Sigma H = 0.5\cos 60^\circ + 1.2 - 2.1\cos 45^\circ$

$= 0.25 + 1.2 - 1.485$

$= -0.035\ kN$ ←

$\Sigma V = 1.1 + 0.5\sin 60^\circ + 2.1\sin 45^\circ$

$= 3.02\ kN$ ↑



$R = \sqrt{\Sigma H^2 + \Sigma V^2}$

$= \sqrt{(0.035)^2 + (3.02)^2} = 3.02\ kN$

$\therefore \tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{3.02}{0.035} = 86.28$

$\theta = 89.33^\circ$

Location of resultant:-

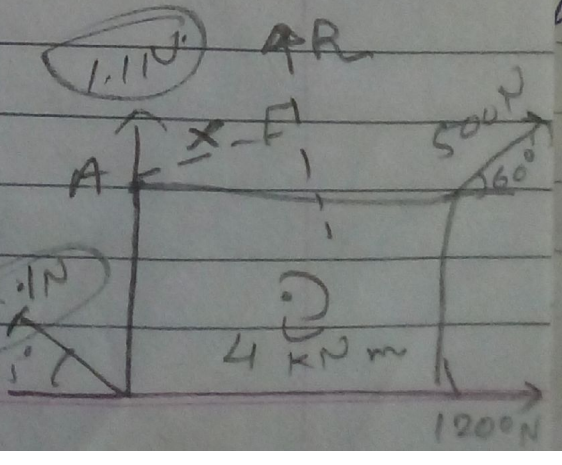
1 Let R is at perpendicular distance x from A.

Taking moment @ A:

$R.x + (1.2 \times 1.5) + 0.5\sin 60^\circ \times 2 - 4.0 - 2.1\cos 45 \times 1.5 = 0$

$\therefore 3.02x = 3.564$

$x = 1.18\ m$



12) $\Sigma H = 30\cos 30 + 40\cos 45 - 50$

$= 4.26$ kN

(2)

$\Sigma V = 30\sin 30 - 40\sin 45 + 60$

$= 46.72$ kN

$R = \sqrt{\Sigma H^2 + \Sigma V^2}$

$= \sqrt{(4.26)^2 + (46.72)^2}$

$\boxed{R = 46.91 \text{ kN}}$

$\tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{46.72}{4.26} = 10.96$

$\boxed{\theta = 84.79^\circ}$

Let R be at perpendicular distance x from 'O'.

$Rx = 60\times 2 + 30\cos 30\times 1 - 30\sin 30\times 1 + 50\times 2.$

$\therefore 46.91x = 230.98$

$\boxed{x = 4.92 \text{ m}}$

15) ③ $\Sigma H = 1000 + 500\cos 45 - 800\cos 30$

$= 660.73\ N$

$\Sigma V = 850 + 800\sin 30 - 500\sin 45$

$= 896.45\ N$

$R = \sqrt{\Sigma H^2 + \Sigma V^2}$

$= \sqrt{(660.73)^2 + (896.45)^2}$

$\boxed{R = 1113.63\ N}$

$\tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{896.45}{660.73} = 1.356$

$\boxed{\theta = 53.59^\circ}$

R is at perpendicular distance x from A

$R \cdot x = 400 + 800 \sin 30 \times 1.8 + 850 \times 1.5 + 500 \cos 45 \times 1.4$

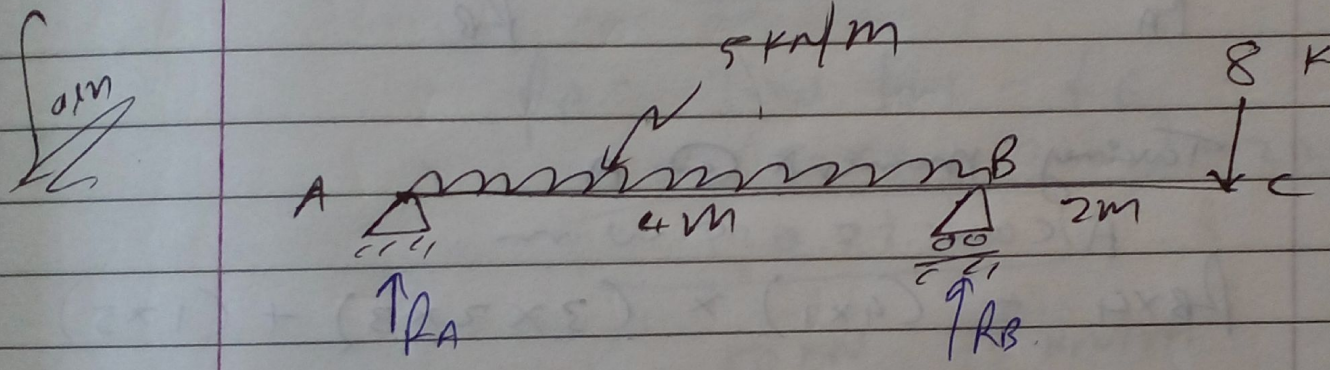
$1113.63\, x = 3144.97$

$\boxed{x = 2.82\ m}$

DATE: / /

Ex·14

A beam ABC is 6 m long. End A is hinged and end B is supported on rollers. AB is 4 m and portion BC is overhanging. Load on span AB is 5 kN/m. U.d.l. and point load of 8 kN acting at point C, find the reactions at A and B.



Taking moment @ A,

A.C.M = C.W.M

$\therefore R_B \times 4 = (5 \times 4 \times 2) + 8 \times 6$

$R_B \times 4 = 88$

$\boxed{R_B = 22 \text{ kN} \uparrow}$

$\therefore R_A$ = Total load − R_B

$= (5 \times 4 + 8) - 22$

$\boxed{= 6 \text{ kN} \uparrow}$

Solution :

Q.5

A આગળ મોમેન્ટ લેતાં,

$\therefore \quad R_B \times 4 = 5 \times 1 + 8 \times 3 + (2 \times 2) \times 5$

$\therefore \quad R_B \times 4 = 5 + 24 + 20$

$\therefore \quad R_B = \frac{49}{4}$

$\therefore \quad \boxed{R_B = 12.25 \text{ kN}}$

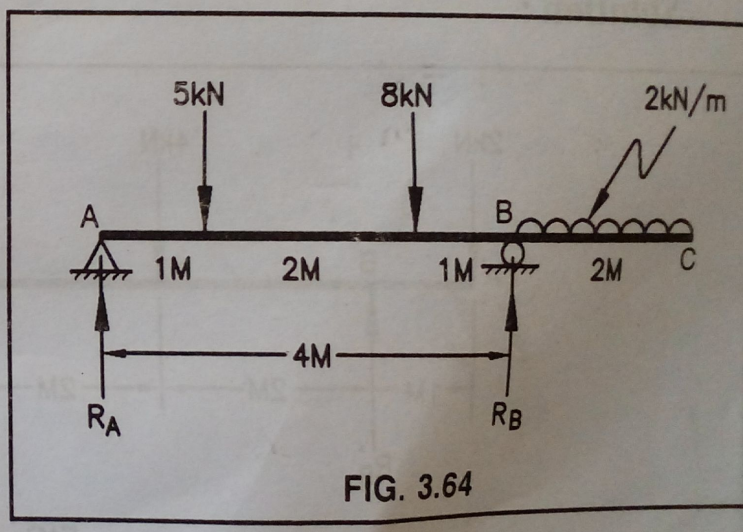


FIG. 3.64

R_A = Total load - R_B

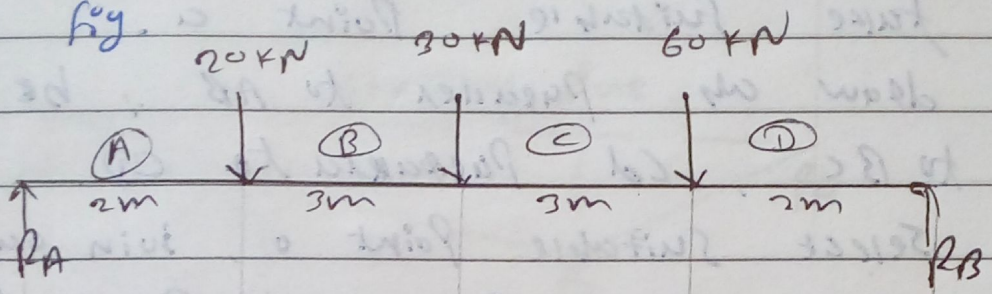
= 5 + 8 + (2×2) - 12.25

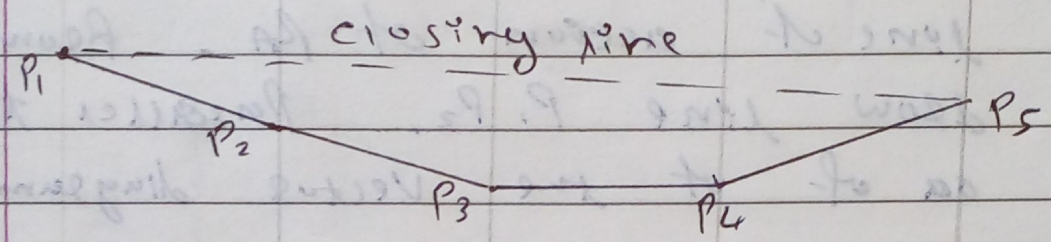
= 4.75 KN

Ex 6

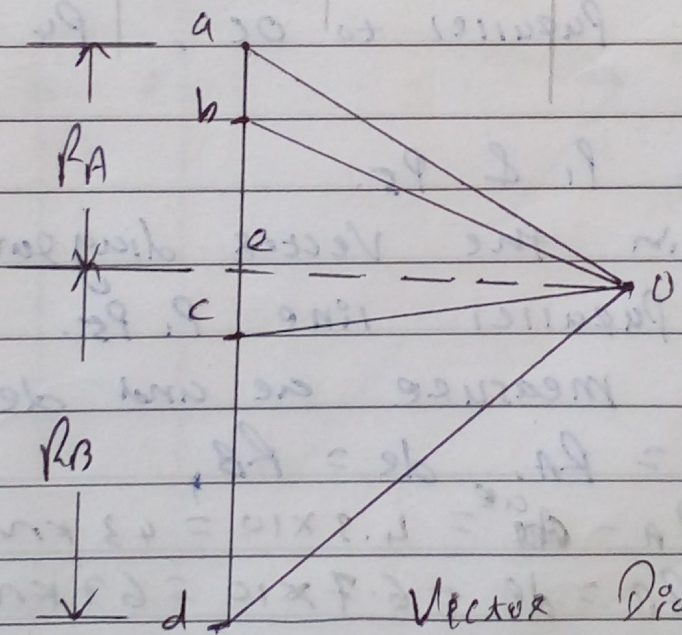
Soln.

Consider a beam loaded as shown in fig.





Space diagram:



Vector Diagram scale

1 cm = 10 KN.

Procedure:-

→ First draw space diagram to some scale.
Extend the lines of action of forces downwards

→ To the right side of space diagram, take suitable point a. From a draw ab parallel to AB, bc parallel to BC, cd parallel to CD.

→ Select suitable point o, join oa, ob, oc, od

→ Now take suitable point P_1 on the line of action of RA. From P_1 draw line P_1P_2, parallel to line oa of the vector diagram.

Similarly, draw P_2P_3 parallel to ob, P_3P_4 parallel to oc, P_4P_5 parallel to od.

→ Join P_1 & P_5.

→ Now in the vector diagram draw line oe, parallel line P_1P_5.

→ Now, measure ae and de.

ae = RA, de = RB,

$R_A = ae = 4.3 \times 10 = 43$ KN

$R_B = de = 6.7 \times 10 = 67$ KN