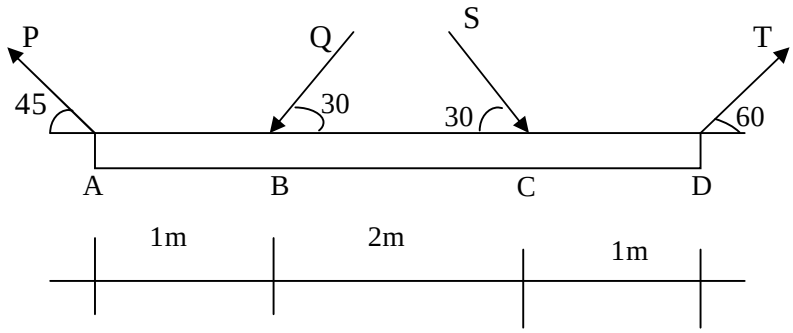
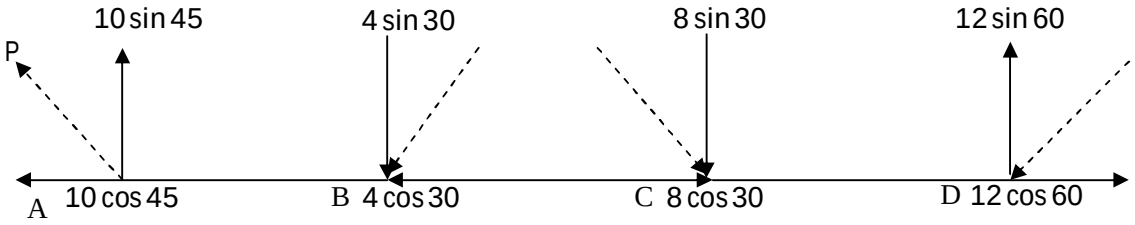


Solution:



Algebric sum of horizontal components

$$\sum H = -10\cos 45 - 4\cos 30 + 8\cos 30 + 12\cos 60$$

$$= -7.071 - 3.464 + 6.928 + 6 = 2.393N$$

Algebric sum of vertical components

$$\sum v = -10\sin 45 - 4\sin 30 - 8\sin 30 + 12\sin 60$$

$$= 11.463N$$

Magnitude of the resultant force

$$R = \sqrt{\left(\sum H\right)^2 + \left(\sum v\right)^2}$$

$$R = \sqrt{(2.393)^2 + (11.453)^2} = 11.71N$$

Direction of the resultant force

$$\alpha = \tan^{-1}\left(\frac{\sum H}{\sum v}\right) = \tan^{-1}\left(\frac{11.463}{2.393}\right) = 78.2$$

Location of resultant force

Let us locate the resultant from the point A. Z-Perpendicular distance of resultant force from A.

$$\sum m_A = R \times Z$$

Algebric sum of the moments about A

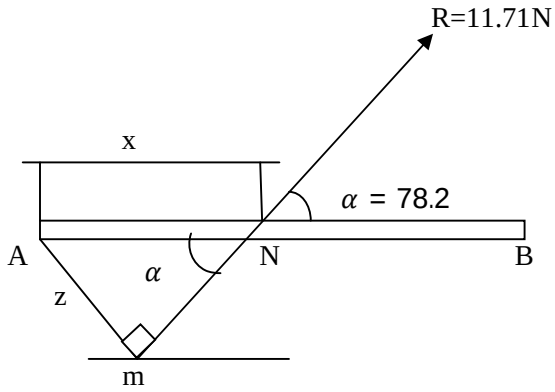
$$\sum m_A = (-10\sin 45 \times 0) + (4\sin 30 \times 1) + (8\sin 30 \times 2) - (12\sin 60 \times 3)$$

$$\sum m_A = -21.176Nm$$

(Moments of all other forces about the point A are zero, as they are passing through it).

(-) sign,

Hence, resultant force should also produce anticlockwise moment about A. Hence R should be taken on the right side A.



$$\sum m_A = R \times Z$$

$$21.176 = 11.71 \times Z$$

$$Z = 1.808m$$

To find x

In triangle AMN

$$AMN = 90$$

$$AMN = 78.2(\alpha)$$

$$\sin 78.2 = \frac{Am}{AN} = \frac{Z}{x}$$

$$x = \frac{Z}{\sin 78.2} = \frac{1.808}{\sin 78.2} = 1..847m$$

Alternate method

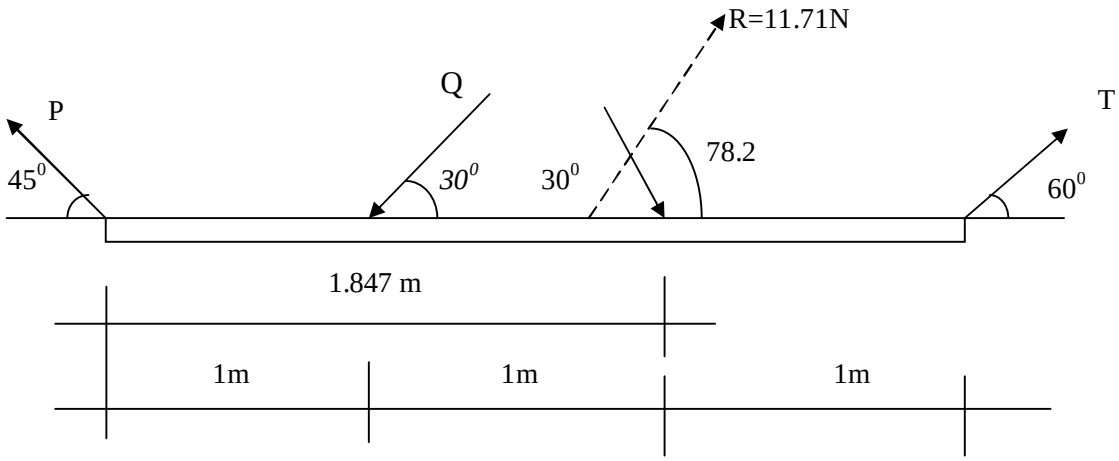
$$\sum M_A = R \times x$$

$$\sum M_A = \left(\sqrt{\left(\sum H\right)^2 + \left(\sum v\right)^2}\right) \times x$$

(moment of $\sum H$ about A is zero)

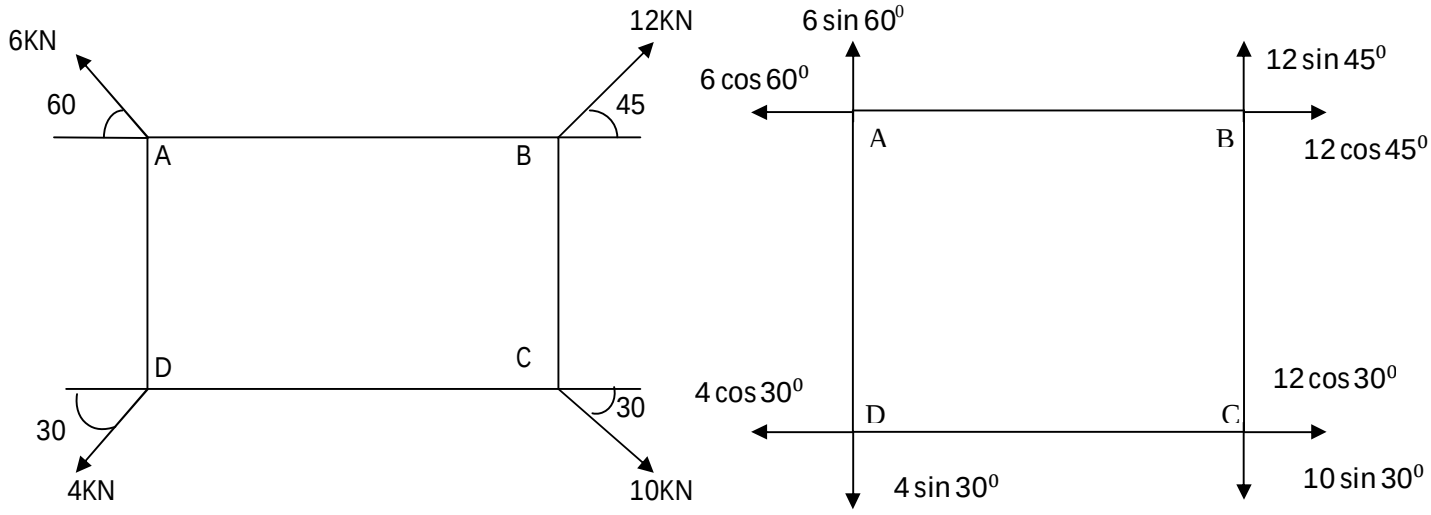
$$\sum M_A = \sum v \times x$$

$$x = \frac{\sum M_A}{\sum v} = \frac{21.176}{11.463} = 1.847m$$



Problem 4:

Four forces of magnitude and direction acting on a square ABCD of side 2m one shown in fig. calculate the resultant in magnitude and direction and also locate its point of application with respect to the sides AB and AD



Solution:

Algebric sum of horizontal forces

$$\sum H = 12\cos 45 + 10\cos 30 - 4\cos 30 - 60\cos 60 = 10.681KN$$

Algebric sum of vertical forces

$$\sum v = 12\sin 45 - 10\sin 30 - 4\sin 30 + 60\sin 60$$

$$= 6.681KN$$

Magnitude of the resultant force

$$R = \sqrt{\left(\sum H\right)^2 + \left(\sum v\right)^2} = \sqrt{(10.681)^2 + (6.681)^2} = 12.598KN$$

Direction of the resultant force

$$\alpha = \tan^{-1}\left(\frac{\sum v}{\sum H}\right) = \tan^{-1}\left(\frac{6.681}{10.681}\right) = 32$$

Location of the resultant force