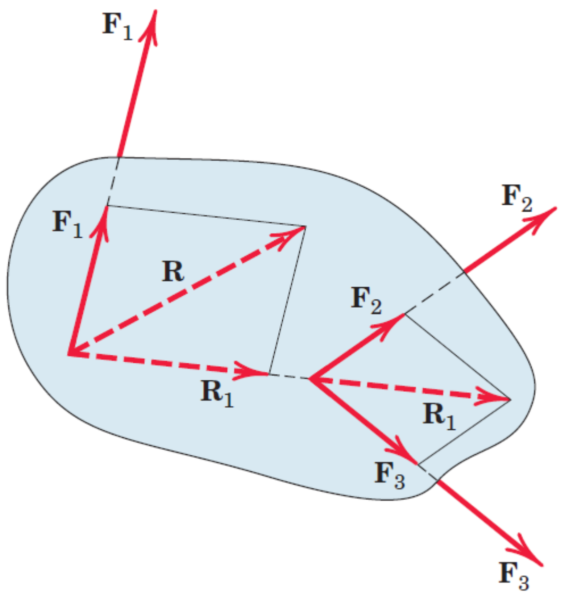
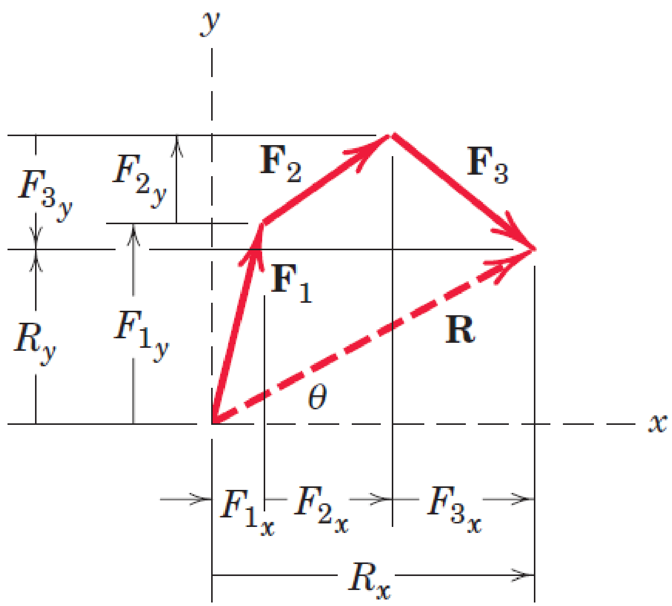
FORCE SYSTEMS

2/6 RESULTANT

The most common type of force system occurs when the forces all act in a single plane, say, the *x-y* plane, as illustrated by the system of three forces **F**1, **F**2, and **F**3 in Fig. 2/13*a*. We obtain the magnitude and direction of the resultant force **R** by forming the *force polygon* shown in part *b* of the figure, where the forces are added head-to-tail in any sequence. Thus, for any system of coplanar forces we may write





FORCE SYSTEMS

Thus, for any system of coplanar forces we may write

$$\mathbf{R} = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \cdots = \Sigma\mathbf{F}$$

$$R_x = \Sigma F_x \qquad R_y = \Sigma F_y \qquad R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$$

$$\theta = \tan^{-1}\frac{R_y}{R_x} = \tan^{-1}\frac{\Sigma F_y}{\Sigma F_x}$$

Also. For the principle of moments. The process is summarized in equation form by

$$\mathbf{R} = \Sigma\mathbf{F}$$

$$M_O = \Sigma M = \Sigma(Fd)$$

$$Rd = M_O$$

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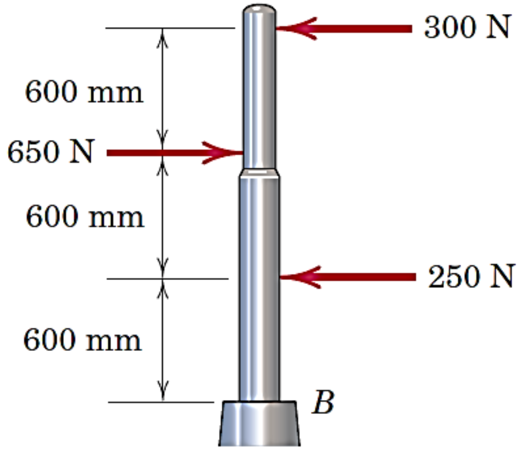
Ex:- Determine the height *h* above the base ***B*** at which the resultant of the three forces acts.



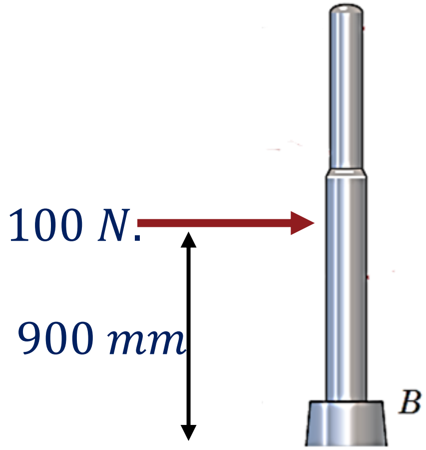
$$[\ Rx = \Sigma Fx]$$

$$\overrightarrow{Rx} = 650 - 300 - 250 = 100N.$$

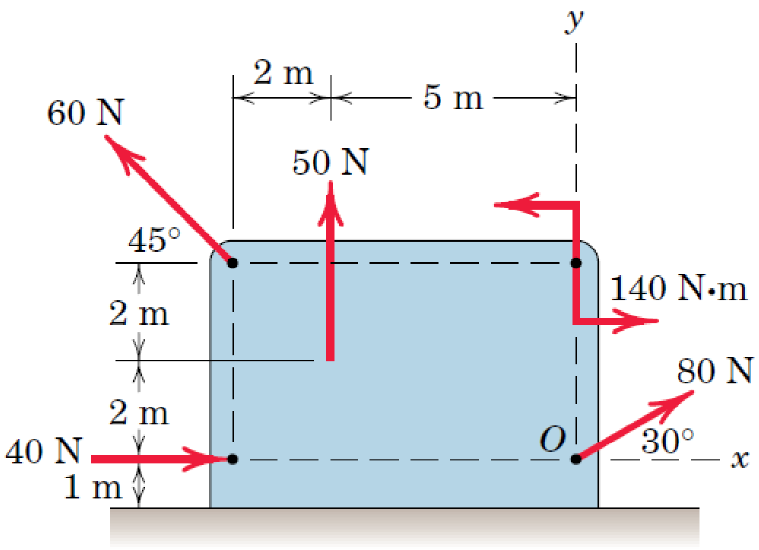
$$\sum M_B = R.h$$

$$-650 * 1200 + 300 * 1800 + 250 * 600 = -100 * h$$

$$h = \frac{-90000}{-100} = 900\ mm$$



Ex:- Determine the resultant of the four forces and one couple which act on the plate shown.



solution

[$Rx = \Sigma Fx$]

$\overrightarrow{Rx}$ = 40 + 80 cos 30 - 60 cos 45

= $\overrightarrow{66.9}$ N.

[$Ry = \Sigma Fy$]

$\uparrow Ry$ = 50 + 80 sin 30 + 60 cos 45

= ↑ 132.4 N

[$R = \sqrt{Rx^2 + Ry^2}$

$R = \sqrt{(66.9)^2 + (132.4)^2}$ = 148.3 N

$$\left[\theta = \tan^{-1}\frac{Ry}{Rx}\right]$$

$$\theta = \tan^{-1}\frac{132.4N}{66.9N} = 63.2$$

$$[MO = \Sigma(F.\,d)]$$

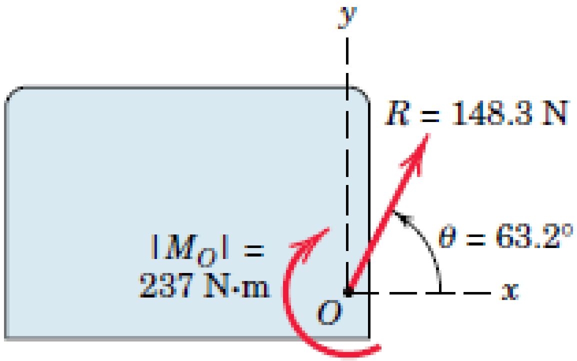
$$+\ MO = 140 - 50(5) + 60\cos 45(4) - 60\sin 45(7)$$

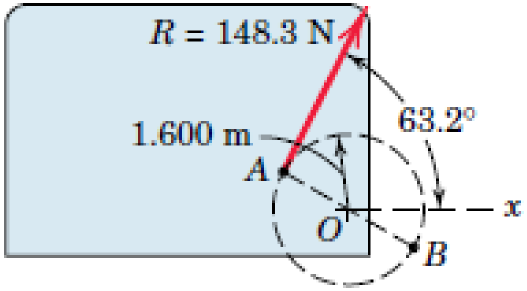
$$= -237\ \text{N.m.} = 237\ \text{N.n}\ +$$

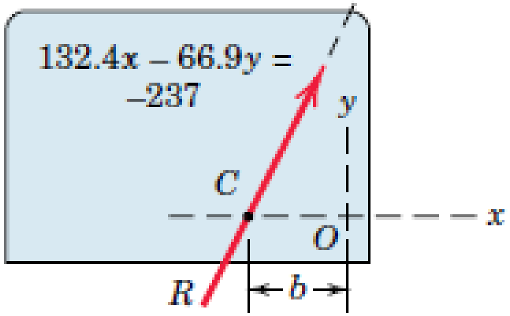
$[Rd = MO]$ 148.3 d = 237 d = 1.600 m

$Ry\,b = MO$ and

$$b = \frac{\mathbf{237}}{\mathbf{132.4}} = 1.792\ \text{m}$$



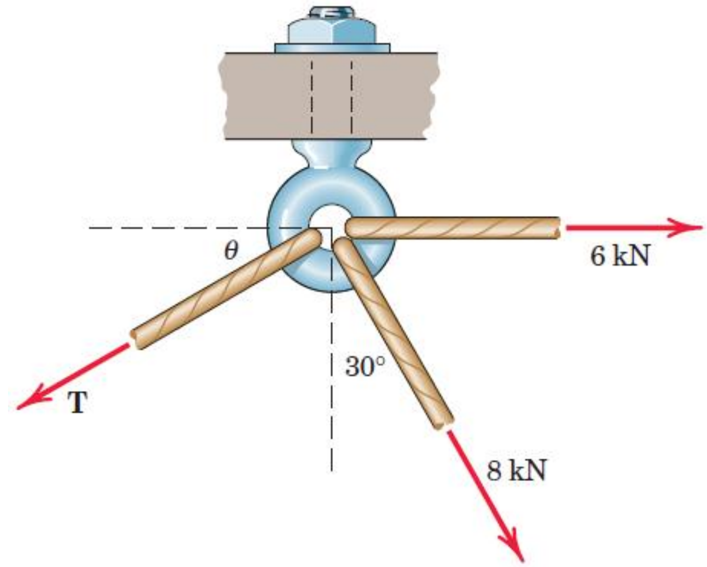




FORCE SYSTEMS

H.w.

Q1:- Calculate the magnitude of the tension **T** and the angle for which the eye bolt will be under a resultant downward force of **15 kN**.



Q2:- Determine and locate the resultant **R** of the two forces and one couple acting on the I-beam.