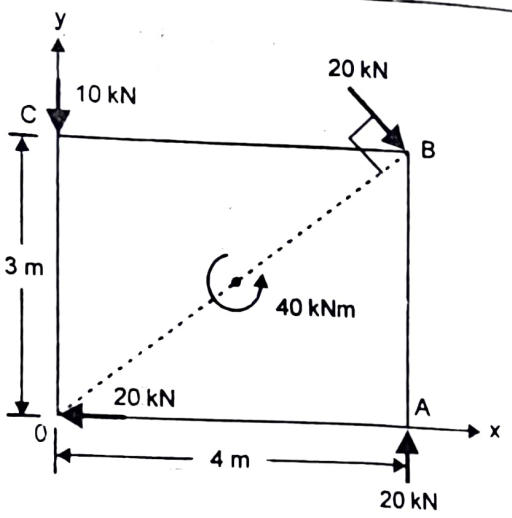
Ex. 2.17 Find the resultant of the force system acting on a body OABC shown in figure.
Find the distance of the resultant from O. Also find the points where the resultant will cut the x and y axis.



Solution: This is a general force system of four forces and a couple of 40 kNm acting on the body OABC.

$\Sigma F_x \quad \rightarrow$ + ve

$= 20 \cos 53.13 - 20$

$= -8$

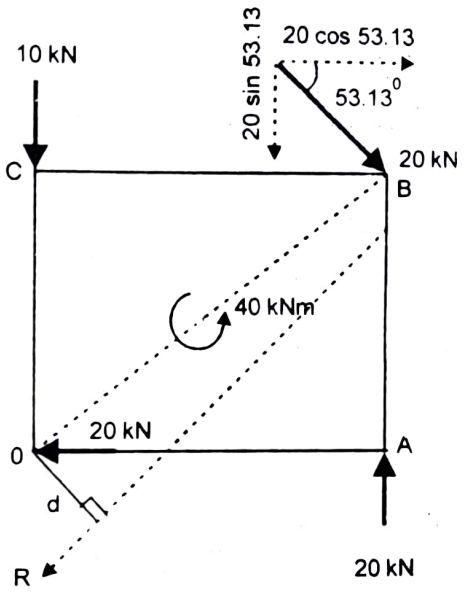
$= 8$ kN $\leftarrow$

$\Sigma F_y \uparrow$ + ve

$= -10 - 20 \sin 53.13 + 20$

$= -6$

$= 6$ kN $\downarrow$



Using $R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$= \sqrt{8^2 + 6^2}$

$= 10$ kN

also $\tan\theta = \dfrac{\Sigma F_y}{\Sigma F_x} = \dfrac{6}{8} = 0.75$

$\theta = 36.86°$

$\therefore$ R = 10 kN at $\theta = 36.86°$ ↙

Location of resultant force

Let the resultant force be located at a ⊥ distance 'd' to the right of O as shown in the figure.

Using Varignon's theorem

$\Sigma M_O^F = M_O^R$ ↺ + ve

$40 - (20 \sin 53.13) \times 4 - (20 \cos 53.13) \times 3 + 20 \times 4 = -10 \times d$

$d = -2$ m

$= 2$ m (left of O)

$\therefore$ The resultant R = 10 kN at $\theta = 36.86°$ ↙ lies at ⊥ distance d = 2 m to the left of O. ..... **Ans.**

also $\tan\theta = \dfrac{\Sigma F_y}{\Sigma F_x} = \dfrac{20.72}{18.93}$

$= 47.58°$

$R = 28.06$ kN at $\theta = 47.58°$ ↘

Location of resultant force

Let the resultant force be located at a ⊥ distance 'd' to the right of O as shown in the figure.

Using Varignon's theorem

$\Sigma M_O^F = M_O^R$ ↺ + ve

$-3.5 \times 1000 - (8.5 \cos 45) \times 400 - (8.5 \sin 45) \times 200 - (5 \cos 26.56) \times 600$
$+ (5 \sin 26.56) \times 800 - (7 \cos 45) \times 400 - (7 \sin 45) \times 800 - 12 \times 600 = - 28.06 \times d$

$\therefore \quad 21141 = 28.06\ d$

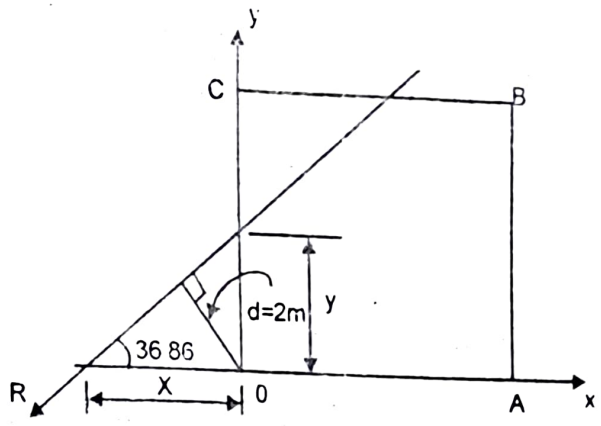
$\therefore \quad d = 753.4$ mm

Hence Resultant force $R = 28.06$ kN at $\theta = 47.58°$ ↘ lies at a ⊥ distance $d = 753.4$ mm to the right of O.

..... **Ans.**

Point of intersection with x and y axis

Let the resultant cut the x-axis and the y-axis at a distance x and y as shown.



From geometry

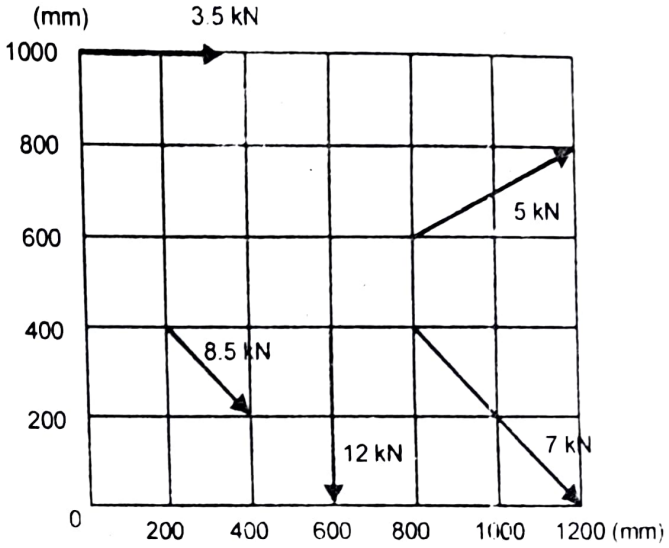
$\sin 36.86 = {}^{2}/_{x}$

$\therefore \quad x = 3.34$ m (on the – ve x-axis)

Also $\cos 36.86 = {}^{2}/_{y}$

$\therefore \quad y = 2.5$ m (on the + ve y-axis)

Ex. 2.18 A set of five forces are acting on a plate as shown. Determine the resultant force of the force system from point O.



Solution: This is a general force system of five forces acting on the plate.

$\Sigma F_x \rightarrow$ + ve

$= 3.5 + 8.5 \cos 45 + 5 \cos 26.56 + 7 \cos 45$

$= 18.93$ kN $\rightarrow$

$\Sigma F_y \uparrow$ + ve

$= -12 - 8.5 \sin 45 + 5 \sin 26.56 - 7 \sin 45$

$= -20.72$ kN

$= 20.72$ kN $\downarrow$

Using $R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$= \sqrt{18.93^2 + 20.72^2}$

$= 28.06$ kN