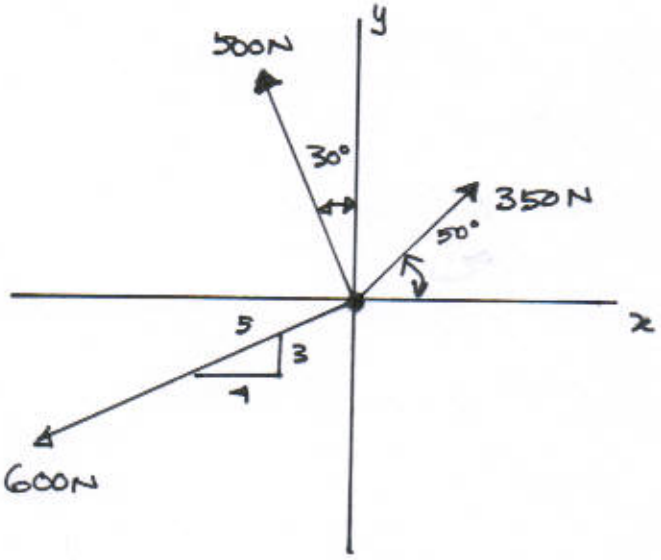
ENGINEERING MECHANICS - STATICS

ADDITION OF SEVERAL VECTORS

1) DETERMINE THE MAGNITUDE OF THE RESULTANT FORCE AND ITS DIRECTION, MEASURED COUNTERCLOCKWISE FROM THE POSITIVE X-AXIS.



FIND THE RESULTANT FORCE IN THE X-DIRECTION:

$$F_{Rx} = \overset{+}{\rightarrow} \sum F_x = 350\cos 50^\circ - 500\sin 30^\circ - 600\left(\frac{4}{5}\right)$$

$$F_{Rx} = -505.02\ \text{N}$$

FIND THE RESULTANT FORCE IN THE Y- DIRECTION:

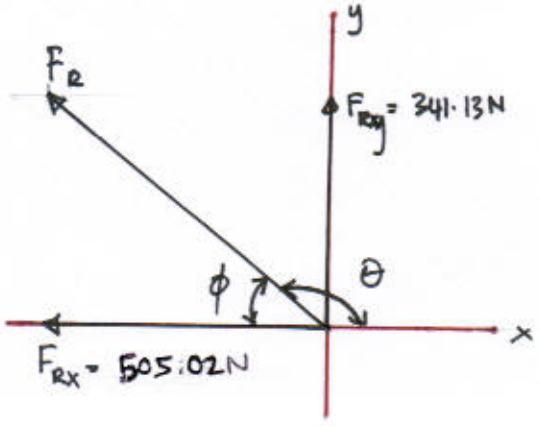
$$F_{Ry} = +\uparrow \sum F_y = 350\sin 50^\circ + 500\cos 30^\circ - 600\left(\frac{3}{5}\right)$$

$$F_{Ry} = 341.13\ \text{N}$$

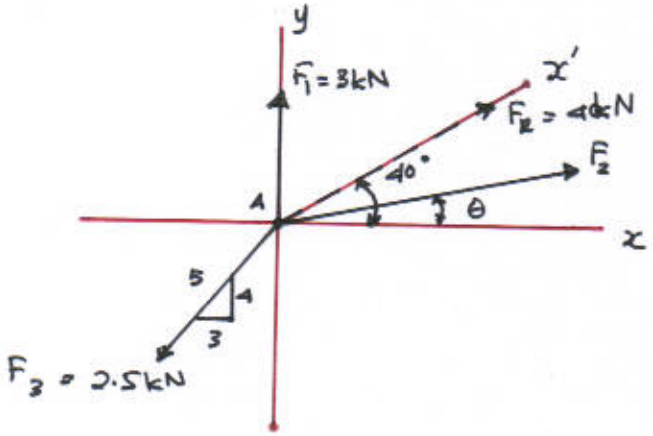
$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2}$$

$$= \sqrt{(-505.02)^2 + (341.13)^2}$$

$$F_R = 609.\ \text{N}$$



2) THREE FORCES ACT ON THE POINT A. DETERMINE THE MAGNITUDE AND DIRECTION θ OF F_2 SO THAT THE RESULTANT IS DIRECTED ALONG THE POSITIVE x'-AXIS AND HAS A MAGNITUDE OF 4 kN.



- SUM THE FORCES IN THE X DIRECTION:

$$\stackrel{+}{\rightarrow} F_{Rx} = \sum F_x :$$

$$4\cos 40^\circ = F_{2x} - 2.5\left(\frac{3}{5}\right)$$

$$\therefore F_{2x} = 4.5642 \text{ kN}$$

- SUM THE FORCES IN THE Y DIRECTION:

$$+\uparrow F_{Ry} = \sum F_y :$$

$$4\sin 40^\circ = F_{2y} + 3 - 2.5\left(\frac{4}{5}\right)$$

$$\therefore F_{2y} = 1.5712 \text{ kN}$$

- DETERMINE F_2 FROM ITS COMPONENT FORCES F_{2x} & F_{2y}:

$$F_2 = \sqrt{F_{2x}^2 + F_{2y}^2}$$

$$= \sqrt{4.5642^2 + 1.5712^2}$$

$$\therefore F_2 = 4.83 \text{ kN}$$

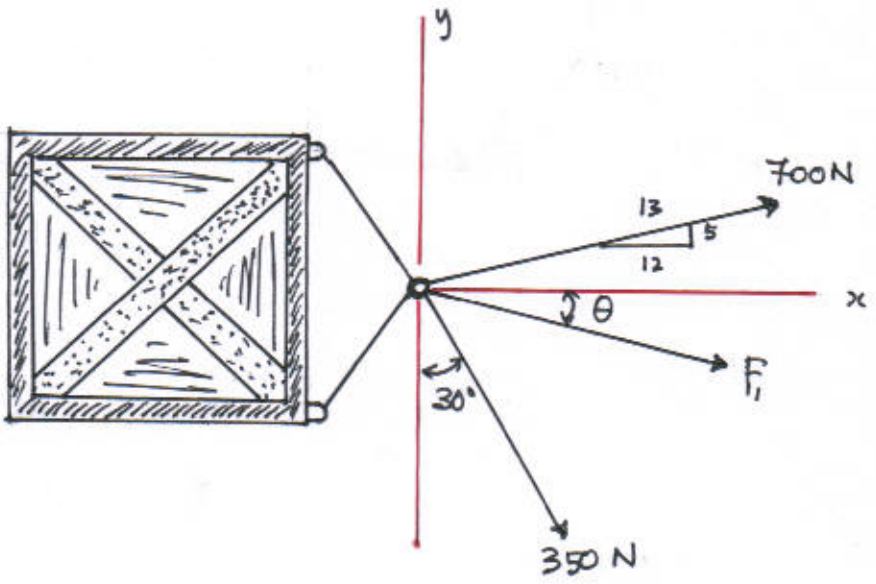
DETERMINE THE ANGLE θ :

$$\theta = \tan^{-1}\left|\frac{F_{2y}}{F_{2x}}\right|$$

$$= \tan^{-1}\left|\frac{1.5712}{4.5642}\right|$$

$$\underline{\underline{\theta = 19^\circ}}$$

3) DETERMINE THE MAGNITUDE AND DIRECTION θ OF F_1 SO THAT THE RESULTANT FORCE IS DIRECTED HORIZONTALLY TO THE RIGHT AND HAS A MAGNITUDE OF 1 kN.



SUM THE FORCES IN THE X-DIRECTION:

$$\overset{+}{\rightarrow} F_{Rx} = \sum F_x : \quad 700\left(\frac{12}{13}\right) + 350 \sin 30^\circ + F_{1x} = 1000$$

$$\therefore F_{1x} = 178.8 \text{ N}$$

SUM THE FORCES IN THE Y-DIRECTION:

$$+\uparrow F_{Ry} = \sum F_y : \quad 700\left(\frac{5}{13}\right) - 350 \cos 30^\circ - F_{1y} = 0$$

$$\therefore F_{1y} = -33.9 \text{ N}$$

FIND F_1 FROM ITS COMPONENT FORCES F_{1x} & F_{1y}:

$$F_1 = \sqrt{F_{1x}^2 + F_{1y}^2}$$

$$= \sqrt{178.8^2 + (-33.9)^2}$$

$$\underline{\underline{F_1 = 182 \text{ N}}}$$

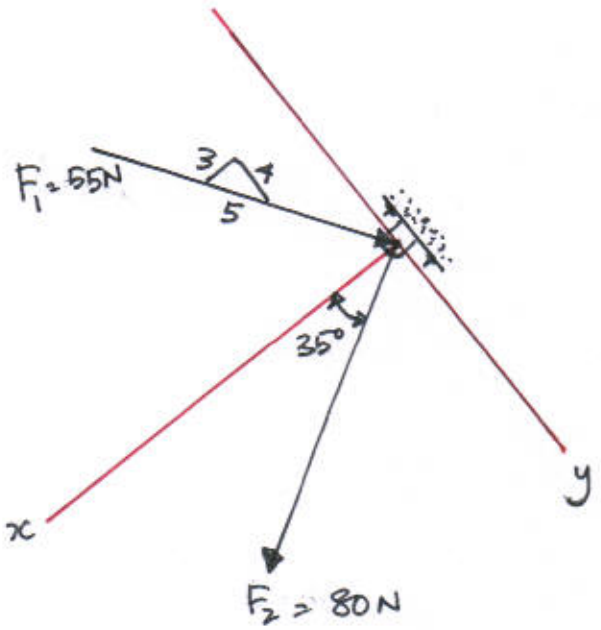
DETERMINE THE ANGLE θ:

$$\theta = \tan^{-1}\left|\frac{F_{1y}}{F_{1x}}\right|$$

$$= \tan^{-1}\left|\frac{33.9}{178.8}\right|$$

$$\underline{\underline{\theta = 10.7^\circ}}$$

*) DETERMINE THE x AND y COMPONENTS OF F_1 AND F_2



SOLVE THE COMPONENTS OF F_1 :

$\overset{+}{\swarrow} F_{1x} = -55\left(\frac{3}{5}\right) = \underline{\underline{-33\,N}}$

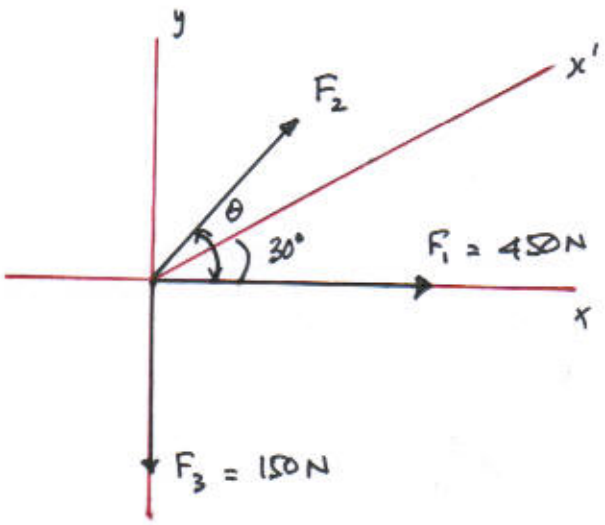
$\overset{+}{\searrow} F_{1y} = 55\left(\frac{4}{5}\right) = \underline{\underline{44\,N}}$

SOLVE THE COMPONENTS OF F_2 :

$\overset{+}{\swarrow} F_{2x} = 80 \cos 35° = \underline{\underline{65.5\,N}}$

$\overset{+}{\searrow} F_{2y} = 80 \sin 35° = \underline{\underline{45.9\,N}}$

6) EXPRESS EACH OF THE THREE FORCES ACTING ON THE POINT IN CARTESIAN VECTOR FORM WITH RESPECT TO THE x AND y AXES. DETERMINE THE MAGNITUDE AND DIRECTION θ OF F_2 SO THAT THE RESULTANT FORCE IS DIRECTED ALONG THE POSITIVE x' AXIS AND HAS THE MAGNITUDE $F_R = 800\,N$.



FORCES IN CARTESIAN VECTOR FORM:

$$\vec{F}_1 = \{450\,i\}\ N$$

$$\vec{F}_2 = \{F_2 \cos\theta\, i + F_2 \sin\theta\, j\}\ N$$

$$\vec{F}_3 = \{-150\,j\}\ N$$

IF $F_R = 800\ N$:

$$\vec{F}_R = 800\cos 30\, i + 800 \sin 30\, j$$

$$= \{692.8\,i + 400\,j\}\ N$$

EQUATE THE i & j COMPONENTS:

$$450 + F_2 \cos\theta = 692.8$$

$$F_2 \cos\theta = 242.8 \quad \text{——} \quad (1)$$

$$F_2 \sin\theta - 150 = 400$$

$$F_2 \sin\theta = 550 \quad \text{——} \quad (2)$$

$$\frac{(2)}{(1)} : \quad \frac{F_2 \sin\theta}{F_2 \cos\theta} = \frac{550}{242.8}$$

$$\tan\theta = 2.265$$

$$\therefore \theta = 66.2^\circ$$

SUBSTITUTE θ INTO (1):

$$F_2 \cos(66.2) = 242.8$$

$$\therefore F_2 = 601.7 \text{ N}$$