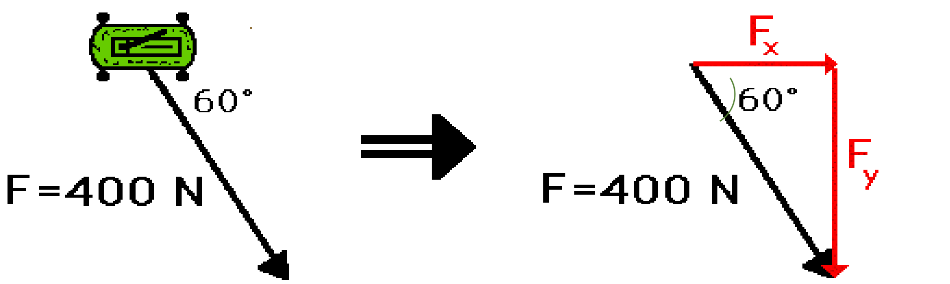
Resultant of Concurrent Force system:

2. Resolution of forces method:

- More than two concurrent forces.

Earlier, the method of resolving a vector into its components was thoroughly discussed. it was said that any vector that is directed at an angle to one of the coordinate axis can be considered to have two parts - each part being directed along one of the axes - either horizontally or vertically. The parts of the single vector are called components and describe the influence of that single vector in that given direction.



$$\sin 60° = \frac{F_y}{400\ N} \qquad \cos 60° = \frac{F_x}{400\ N}$$

$$F_y = 400\ N * \sin 60° \qquad F_x = 400\ N * \cos 60°$$

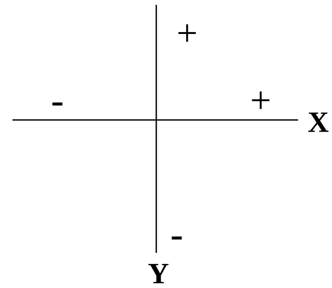
$$F_y = 346\ N \qquad F_x = 200\ N$$

Steps to solve the problems of resolution of forces method:

1. **Resolve the forces acting at an angle, along X & Y axis.**
2. **Add all horizontal forces to get** ΣF_X.
3. **Add all vertical forces to get** ΣF_Y.
4. **Find the magnitude of the resultant:**
   $R = \sqrt{(\Sigma F_X^2 + \Sigma F_Y^2)}$.
5. $\theta = \tan^{-1} \frac{\Sigma Fy}{\Sigma Fx}$ (neglect the negative sign).

6. ΣF_X ΣF_Y

ΣF_X	ΣF_Y	
+	+	I
-	+	II
-	-	III
+	-	IV



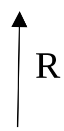
Notes:

1. **If the resultant force equals zero that's mean that,**

   $\Sigma F_X = 0$ & $\Sigma F_Y = 0$

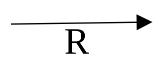
2. **If the resultant force is vertical this means that,**

   $\Sigma F_X = 0$ & $R = \Sigma F_Y$



3. **If the resultant force is horizontal this means that,**

   $\Sigma F_Y = 0$ & $R = \Sigma F_X$



4. **If the resultant is directed at an angle to one of the coordinate axis, it can be resolved to its horizontal and vertical components.**

   $R_x = \Sigma F_X$

   $R_Y = \Sigma F_Y$

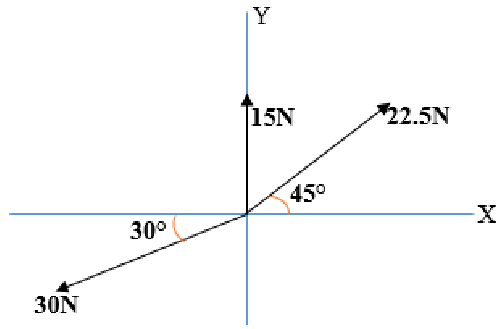
5. **cos (a + b) = cos a cos b - sin a sin b**

   cos (a - b) = cos a cos b + sin a sin b

   sin (a + b) = sin a cos b + cos a sin b

   sin (a - b) = sin a cos b - cos a sin b

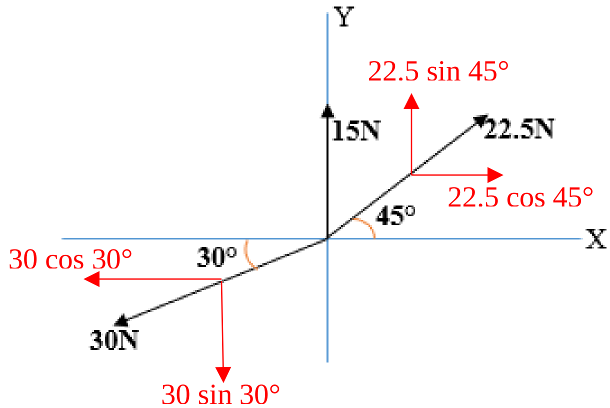
Example 1: Find the resultant force and its direction for the figure below



Sol.:

$\Sigma F_X = 22.5 \cos 45° - 30 \cos 30°$

$= -10.071$ N



$\Sigma F_Y = 15 + 22.5 \sin 45° - 30 \sin 30°$

$= 15.9$ N

$R = \sqrt{(\Sigma F_X^2 + \Sigma F_Y^2)}$

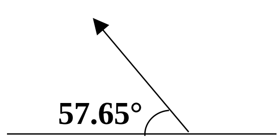
$= \sqrt{(-10.071^2 + 15.9^2)}$

$= 18.83$

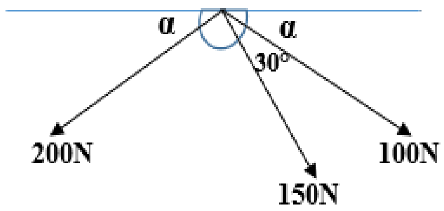
$\theta = \tan^{-1} \frac{\Sigma Fy}{\Sigma Fx}$

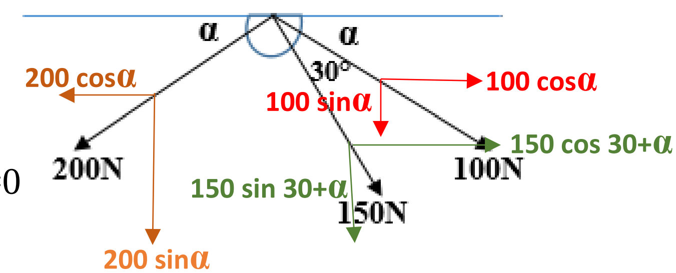
$= \tan^{-1} \frac{15.9}{10.071} = 57.65°$

R= 18.83, θ = 57.65°



Example 2: Find the value of angle α if the resultant is vertical. Also, find the magnitude of the resultant





Sol.:

$\Sigma F_X = o$ (the resultant is vertical)

$\Sigma F_X =$ 100 cosα + 150 cos (30+α) - 200 cosα =0

= 100 cosα + 150 (cos30 . cos α - sin30 . sin α) - 200 cosα =0

=100 cosα + 150 cos30 . cos α – 150 sin30 . sin α - 200 cosα =0] divided by cosα

$=100 + 150 \cos 30 - 150 \sin 30 . \frac{\sin \alpha}{\cos \alpha} - 200 = 0$

=100 + 150 cos30 – 150 sin30 . tan α - 200 =0

= 100 + 150 cos30 -200 = 150 sin30 . tan α

$\tan \alpha = \frac{100 + 150 \cos 30 - 200}{150 \sin 30} = 0.3987$

$\alpha = \tan^{-1} 0.3987 = 21.74°$

The resultant, $R = \Sigma F_Y$ [the resultant is vertical]

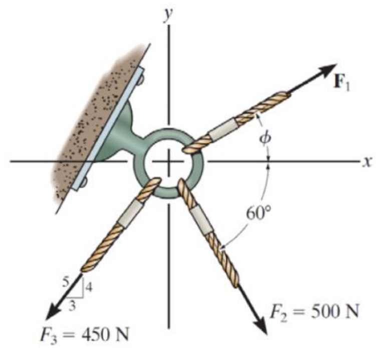
R= -200 sinα -150 sin (30+α) -100 sin α

= -200 sin21.74 -150 sin (30+21.74) -100 sin21.74

= -200 sin21.74 -150 sin 51.74 -100 sin21.74

R= -228.89 N ↓

Example 3: If the magnitude of the resultant force acting on the eyebolt is 600N and its direction measured clockwise from the positive x-axis is **θ** = 30° determine the magnitude of F1 and the angle **ϕ**?

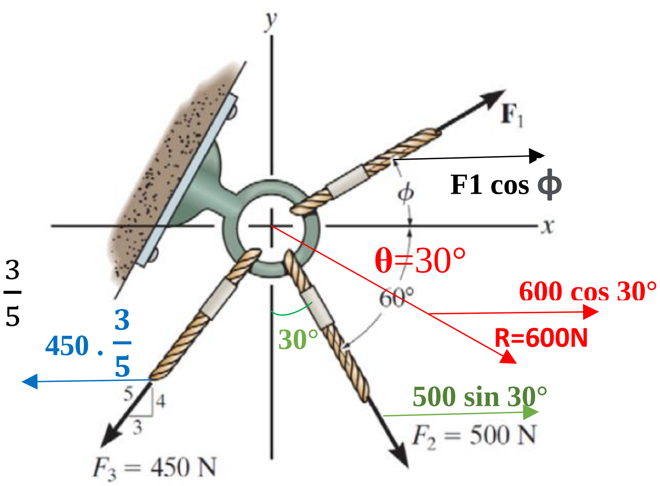


Sol.:

$R_X = \Sigma F_X$

$600 \cos 30° = F1 \cos \phi + 500 \sin 30° - 450 \cdot \frac{3}{5}$

$F1 \cos \phi = 539.62$ N … (1)



$R_Y = \Sigma F_Y$

$-600 \sin 30° = F1 \sin \phi - 500 \cos 30° - 450 \cdot \frac{4}{5}$

$F1 \sin \phi = 493.01$N … (2)

Divided (2) / (1)

$$\frac{F1 \sin \varphi}{F1 \cos \varphi} = \frac{493.01}{539.62}$$

$\tan \phi = 0.91$

$\phi = \tan^{-1} 0.91 = 42.3°$ sub. In (1)

$F1 \cos 42.3° = 539.62$ N

$F1 = 729.57$ N