

SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35.

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai.

DEPARTMENT OF AUTOMOBILE ENGINEERING

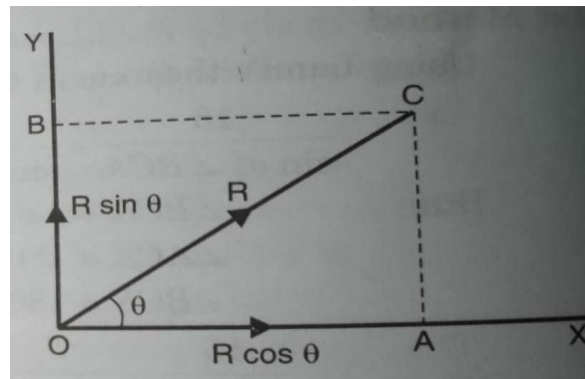
COURSE NAME : 23MET101 – ENGINEERING MECHANICS

I YEAR / I SEMESTER

Topic – Resolution and Composition of forces

RESOLUTION OF FORCES

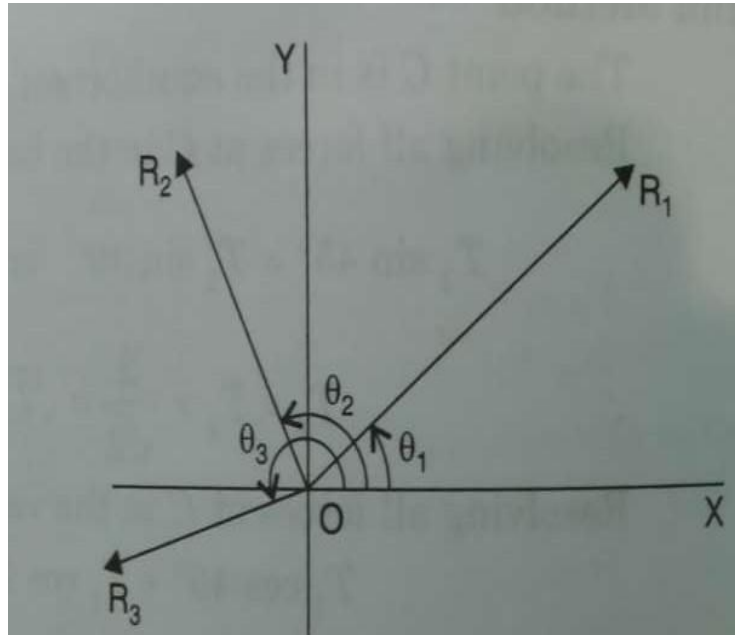
- It is defined as the process of splitting up the given force into a number of components, without changing its effect on the body is called resolution of a force.
- A force is, generally, resolved along two mutually perpendicular directions.



Components of R along x axis

Components of R along y axis

Resolution of no. Of coplanar forces.



= Sum of components of all forces along X-axis.

$$H = R_1 \cos \theta_1 + R_2 \cos \theta_2 + R_3 \cos \theta_3 + \dots$$

$$R = \sqrt{H^2 + V^2}$$

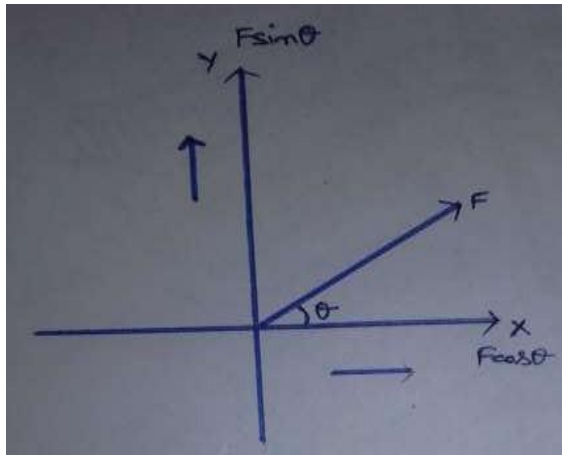
= Sum of components of all forces along Y-axis.

$$V = R_1 \sin \theta_1 + R_2 \sin \theta_2 + R_3 \sin \theta_3 + \dots$$

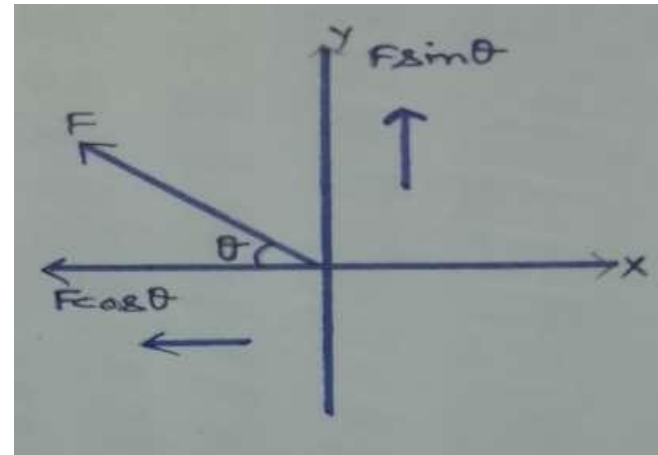
$$\tan \theta = \frac{V}{H}$$

Principle of Resolution

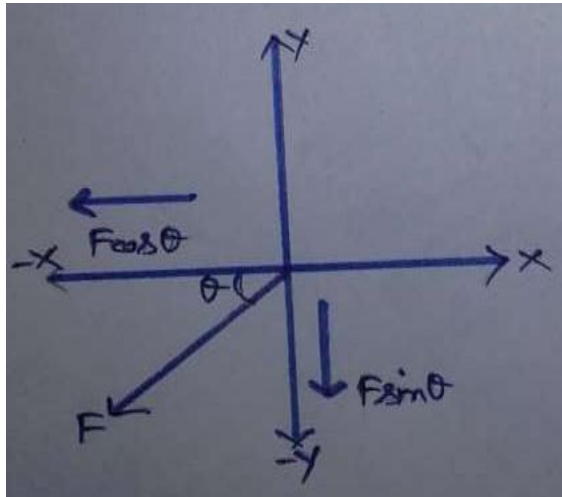
It states, “The algebraic sum of the resolved parts of a no. of forces, in a given direction, is equal to the resolved part of their resultant in the same direction.”



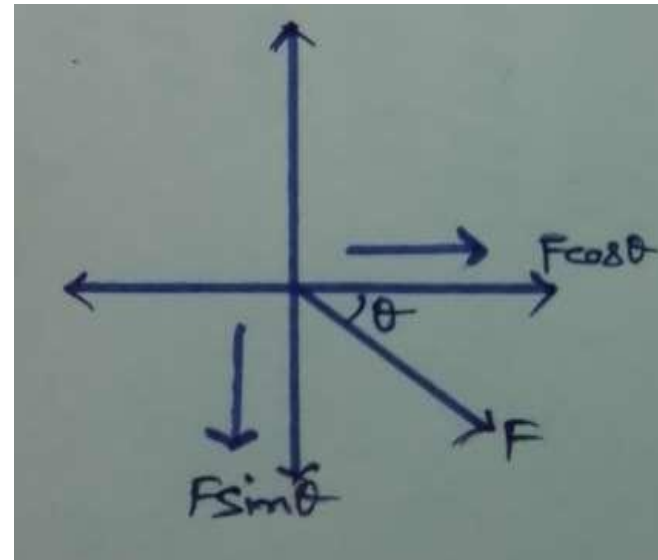
1st quadrant



2nd quadrant



3rd quadrant



4th quadrant

METHOD OF RESOLUTION FOR THE RESULTANT FORCE.

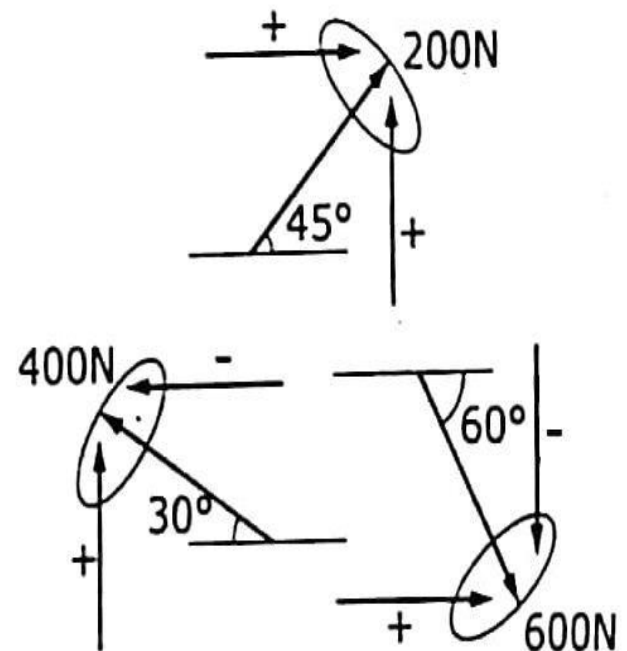
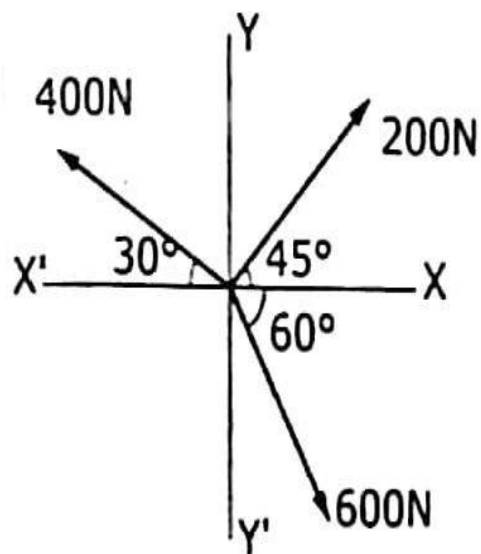
- Resolve all the forces horizontally and find the algebraic sum of the horizontal components.
- Resolve all the forces vertically and find the algebraic sum of all the vertical components.
- The resultant R of the given forces will be given by the equation :

$$R = \sqrt{(\sum H)^2 + (\sum V)^2}$$

- The resultant force will be inclined at an angle ,with the horizontal such that

$$\tan \theta = \frac{\sum V}{\sum H}$$

Three coplanar concurrent forces are acting at a point as shown in fig 2.12. Determine the resultant in magnitude and direction.



Step 1 : Algebraic sum of Horizontal forces. (i.e., ΣH)

Resolving the forces horizontally (i.e., along XX' axis) we get,

$$\begin{aligned}\Sigma H &= 200 \cos 45^\circ - 400 \cos 30^\circ + 600 \cos 60^\circ \\ &= 141.42 - 346.41 + 300 = 95.01N\end{aligned}$$

Step 2 : Algebraic sum of vertical forces. (i.e. ΣV)

Resolving the forces vertically (i.e. along YY' axis) we get,

$$\begin{aligned}\Sigma V &= 200 \sin 45^\circ + 400 \sin 30^\circ - 600 \sin 60^\circ \\ &= 141.42 + 200 - 519.62 = -178.2N\end{aligned}$$

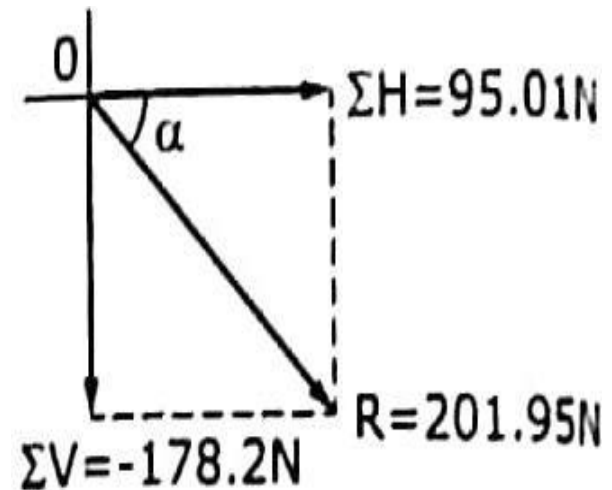
Step 3 : Magnitude of Resultant force.

$$\begin{aligned}\text{Magnitude of Resultant force, } R &= \sqrt{(\Sigma H)^2 + (\Sigma V)^2} \\ \therefore R &= \sqrt{(95.01)^2 + (-178.2)^2} \\ R &= 201.95N\end{aligned}$$

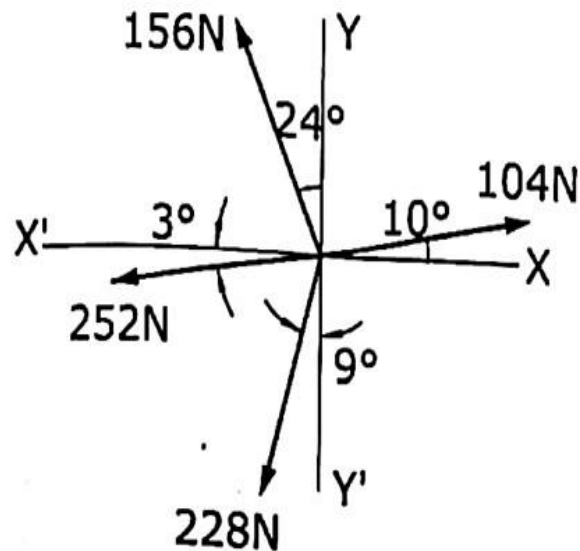
Step 4 : Direction of Resultant force.

$$\text{then, } \tan \alpha = \frac{\Sigma V}{\Sigma H}$$

$$\alpha = \tan^{-1} \left(\frac{\Sigma V}{\Sigma H} \right) = \tan^{-1} \left(\frac{178.2}{95.01} \right) = 61.93^\circ$$



The four coplanar forces are acting at a point as shown in fig 2.14. (a). Determine the resultant in magnitude and direction.



Solution.

Let $F_1 = 104N$; $F_2 = 156N$; $F_3 = 252N$ and $F_4 = 228N$

Angle of inclination of the forces 156N and 228N are given with reference to y axis. Hence θ has to be found with x axis.

Therefore,

$$\theta_1 = 10^\circ$$

$$\theta_2 = (90 - 24) = 66^\circ$$

$$\theta_3 = 3^\circ$$

$$\text{and } \theta_4 = (90 - 9) = 81^\circ$$

Resolving the forces horizontally, we get

$$\begin{aligned}\Sigma H &= 104 \cos 10^\circ - 156 \cos 66^\circ - 252 \cos 3^\circ - 228 \cos 81^\circ \\ &= 102.4 - 63.44 - 251.64 - 35.66 \\ &= -248.32N\end{aligned}$$

Resolving the forces vertically, we get.

$$\begin{aligned}\Sigma V &= 104 \sin 10^\circ + 156 \sin 66^\circ - 252 \sin 3^\circ - 228 \sin 81^\circ \\ &= 18.06 + 142.5 - 13.18 - 225.2 \\ &= -77.82\end{aligned}$$

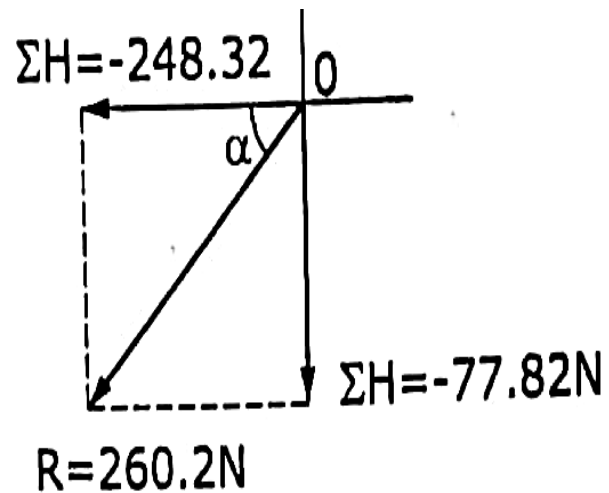
Magnitude of Resultant force, $R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2}$

$$\therefore R = \sqrt{(-248.32)^2 + (-77.82)^2} = 260.2N$$

Direction of Resultant force,

$$\tan \alpha = \frac{\Sigma V}{\Sigma H}$$

$$\alpha = \tan^{-1} \left(\frac{\Sigma V}{\Sigma H} \right) = \tan^{-1} \left(\frac{77.82}{248.32} \right) = 17.4^\circ$$



The forces 10N, 20N, 30N and 40N are acting on one of the vertices of a regular pentagon, towards the other four vertices taken in order. Find the Magnitude and direction of the resultant force R.

We know,

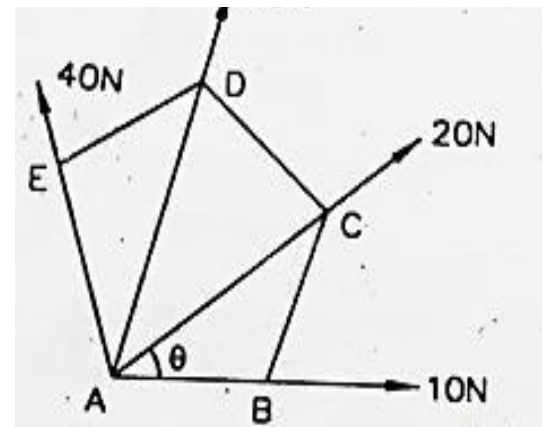
Sum of the interior angles of any regular polygon is $(2n - 4) \times 90^\circ$, where n = number of sides. So, for Regular Pentagon,

$$\text{Sum of interior angles} = (2 \times 5 - 4) \times 90 = 540^\circ$$

$$\therefore \text{Each included angle} = \frac{540}{5} = 108^\circ$$

Joining the vertices B, C, D and E with the vertex A, we get 3 equal angles θ , as shown in fig 2.15. (a).

$$\therefore \text{angle } \theta = \frac{108^\circ}{3} = 36^\circ$$



Hence the forces and their corresponding angles with x axis are designated as below

$$F_1 = 10N; \quad \theta_1 = 0^\circ$$

$$F_2 = 20N; \quad \theta_2 = 36^\circ$$

$$F_3 = 30N; \quad \theta_3 = (2 \times 36) = 72^\circ$$

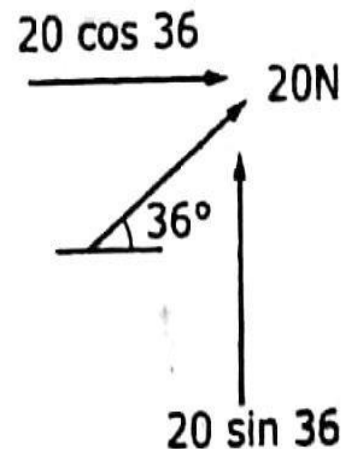
$$F_4 = 40N; \quad \theta_4 = 180 - (3 \times 36) = 72^\circ$$

Resolved components of each force are given below:



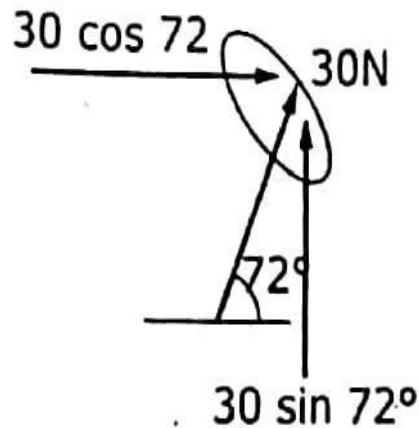
$$F_h = 10 \cos 0^\circ = 10$$

$$F_v = 10 \sin 0^\circ = 0$$



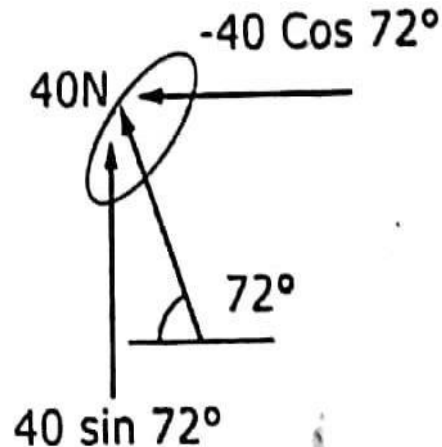
$$F_h = 20 \cos 36^\circ$$

$$F_v = 20 \sin 36^\circ$$



$$F_h = 30 \cos 72^\circ$$

$$F_v = 30 \sin 72^\circ$$



$$F_h = -40 \cos 72^\circ$$

$$F_v = 40 \sin 72^\circ$$

Resolving the forces horizontally,

$$\begin{aligned} \Sigma H &= 10 + 20 \cos 36^\circ + 30 \cos 72^\circ - 40 \cos 72^\circ \\ &= 10 + 16.18 + 9.27 - 12.36 \\ &= 23.09N \end{aligned}$$

Resolving the forces vertically,

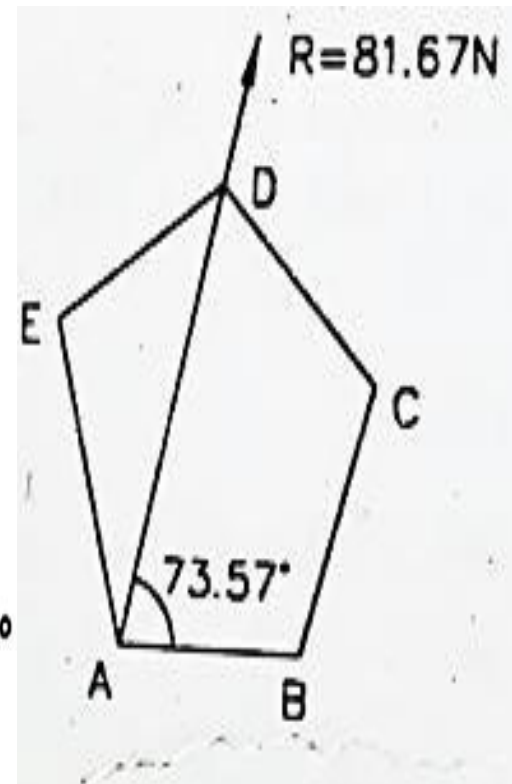
$$\begin{aligned} \Sigma V &= 0 + 20 \sin 36^\circ + 30 \sin 72^\circ + 40 \sin 72^\circ \\ &= 0 + 11.76 + 28.53 + 38.04 \end{aligned}$$

Magnitude of Resultant force, $R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2}$

$$\therefore R = \sqrt{(23.09)^2 + (78.33)^2}$$
$$= 81.67N$$

Direction of Resultant force,

$$\alpha = \tan^{-1}\left(\frac{\Sigma V}{\Sigma H}\right) = \tan^{-1}\left(\frac{78.33}{23.09}\right) = 73.57^\circ$$



Thank You..