

# Engineering Mechanics

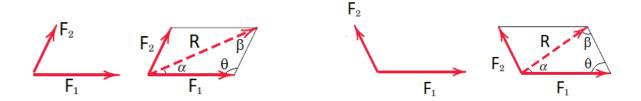


#### Al-Mustaqbal University College

## 1.2 Composition & Resolution of Forces

**Composition** is the process of replacing a force system by its resultant.

#### a. Parallelogram Law



#### b. Triangle Law



The resultant of a pair of concurrent forces can be determined by:

$$R = \sqrt{{F_1}^2 + {F_2}^2 - 2F_1F_2\cos\theta}$$

Also, it can be found the direction of R or unknown one of forces by:

$$\frac{R}{\sin \theta} = \frac{F_1}{\sin \beta} = \frac{F_2}{\sin \alpha}$$

**Resolution** is the process of replacing a single force by its components.

If a force (F) lies in the x - y plane. The force (F) may be resolved into two rectangular components. The component of a force parallel to the x-axis is called the Horizontal component (Fx), and parallel to y-axis the is called Vertical component (Fy).

### For Example:

$$\cos \theta = \frac{Fx}{F} \rightarrow Fx = F \cos \theta \rightarrow$$

$$\sin\theta = \frac{Fy}{F} \rightarrow Fy = F\sin\theta \uparrow$$

$$\mathbf{F}_{y}$$
 $\mathbf{F}_{x}$ 
 $\mathbf{F}_{x}$ 

$$F = \sqrt{Fx^2 + Fy^2}$$

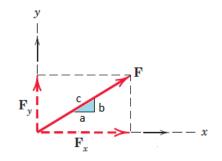
$$\theta_x = \tan^{-1}\left(\frac{Fy}{Fx}\right)$$

The direction of F can also be defined using a small "slope" triangle. Given the slope of the line of action of the force as

$$c = \sqrt{a^2 + b^2}$$

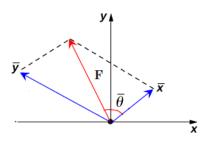
$$Fx = F\cos\theta \rightarrow Fx = F \cdot \frac{a}{c} \rightarrow$$

$$Fy = F \sin \theta \rightarrow Fy = F \cdot \frac{b}{c} \uparrow$$

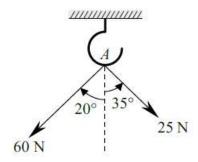


$$F\bar{x} = F\cos\bar{\theta}$$

$$F\bar{y} = F\sin\bar{\theta}$$



**Example No. 1:** Two forces are applied at the point A of a hook support as shown in Figure. Determine the magnitude and direction of the resultant force by using (i) parallelogram law, and (ii) triangle law.



#### **Solution:**

#### Parallelogram law

$$F_1 = 25 N$$
,  $F_2 = 60 N$   
 $\theta = 70 + 55 = 125^{\circ}$ 

To find the value of resultant:

$$R = \sqrt{{F_1}^2 + {F_2}^2 - 2F_1F_2\cos\theta}$$

$$R = \sqrt{25^2 + 60^2 - 2 \times 25 \times 60 \times \cos 125} = 77.11 \, N$$

To find the direction of resultant:

$$\frac{R}{\sin \theta} = \frac{F_2}{\sin \alpha}$$

$$\frac{77.11}{\sin 125} = \frac{60}{\sin \alpha} \quad \to \quad \sin \alpha = \frac{60 \times \sin 125}{77.11} = 0.637$$

$$\alpha = \sin^{-1} 0.637 = 39.597^{\circ}$$

The direction of R from the vertical axis =  $39.597 - 35 = 4.597^{\circ}$ 

#### ii. Triangle Law

by the same above equations to get:

 $R = 77.11 \, N$  inclined 4.597° with vertical direction

