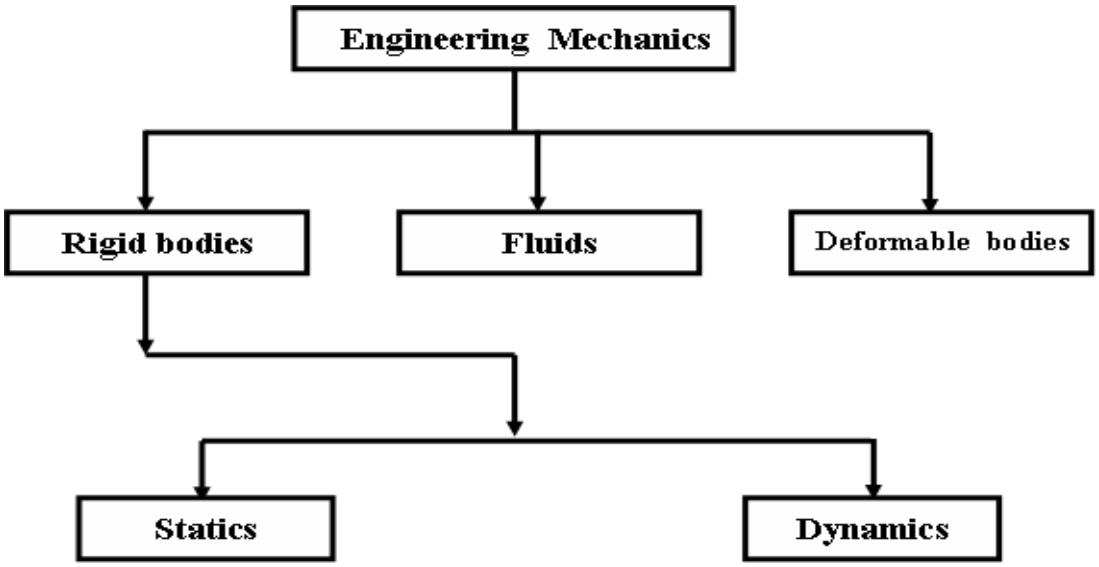
*By : Eng . YOUNIS FAKHER*

# Resolution & Composition of a force

**Engineering Mechanics : may be defined as a science which describes and predicts the condition of rest or motion of bodies under the action of forces.**




## Vector & Scalar quantities :

**Vector quantities : are the quantities which have magnitude and direction .such as:**
**Force , weight , distance , speed , displacement , acceleration ,velocity .**
**Scalar quantities : are the quantities which have only magnitude , such as :**
**Time , size , sound , density , light , volume .**

## Force :

**A "force" is an action that changes, or tends to change, the state of motion of the body upon which it acts. It is a vector quantity that can be represented either mathematically or graphically**

**A complete description of a force MUST include its:**

1. **MAGNITUDE**
2. **DIRECTION and SENSE**
3. **POINT OF ACTION**

## Resolution & Composition of a force :

**Let the force ( F) shown in fig.(1) with the direction (θ )**

**We can resolve this force into two components :**

1- **horizontal component ( Fx ) which lies on x- axis**

2- **vertical component ( Fy ) which lies on y- axis**

**as shown in fig.(2)**

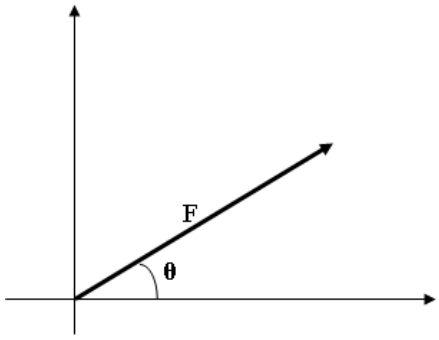



**fig.(1 )**

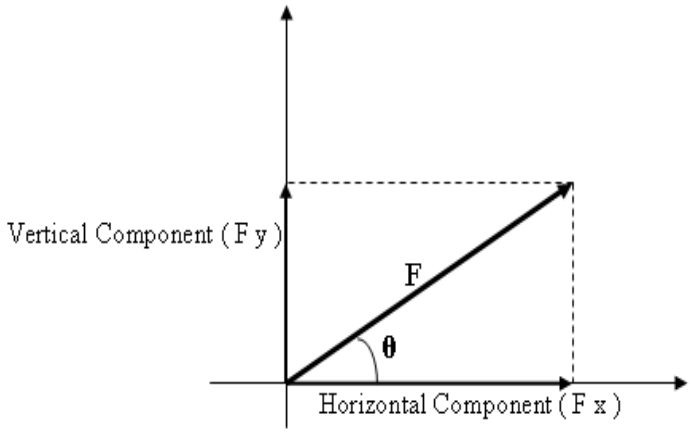
**from fig.(2) :**

**The horizontal component may be determined as :**

**Fx = F . cos θ**

**The vertical component may be determined as :**

**Fy = F . sin θ**




$$F_x = F\cos\theta \qquad F = \sqrt{F_x^2 + F_y^2}$$

$$F_y = F\sin\theta \qquad \theta = \tan^{-1}\frac{F_y}{F_x}$$

**EX (1 ) :**

**Find the two components of the force ( 100 N ) if : θ = 30° , 120° , 270° fig. ( 2 )**

**Solution :**

**θ = 30° :**

**Fx = F . cos θ**

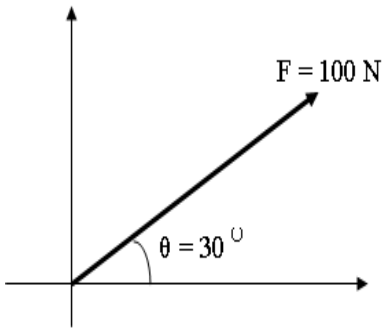
**= 100 * cos 30**

**= 100 * $\frac{\sqrt{3}}{2}$ = 50$\sqrt{3}$ N**

**Fy = F . sin θ**

**= 100 * sin 30**

**= 100 * 0.5 = 50 N**




**θ = 120° :**

**Fx = F . cos θ**

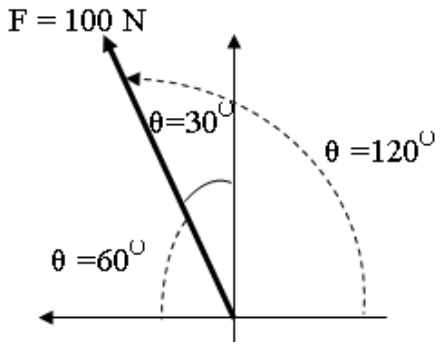
**= 100 * cos 120**

**= 100 * (- 0.5 ) = - 50 N**

**Fy = F . sin θ**

**= 100 * sin 120**

**= 100 * $\frac{\sqrt{3}}{2}$ = 50$\sqrt{3}$ N**




**θ = 270° :**

**Fx = F . cos θ**

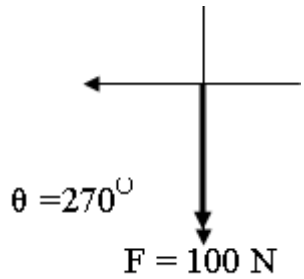
**= 100 * cos 270**

**= 100 * ( 0 ) = 0**

**Fy = F . sin θ**

**= 100 * sin 270**

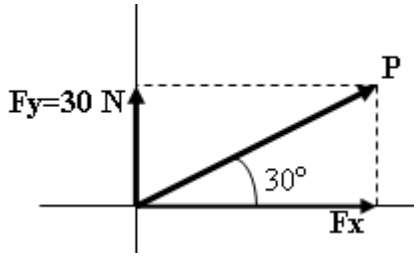
**= 100 * ( - 1 ) = - 100 N**



**EX ( 2 ) :**

**The direction of the force ( P ) is ( 30° ) , Find the horizontal component if the vertical component is ( 30 N ) ?**

**Solution :**




**From the diagram shown :**

**Fy = 30 N**

**Fy = F . sin θ**

**30 = P * sin 30**

**30 = P * 0.5**

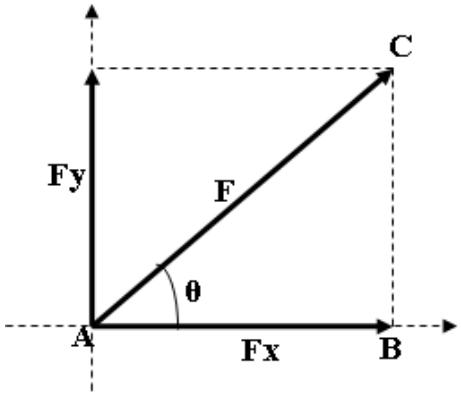
**P = 30 / 0.5 = 60 N**

**Fx = F . cos θ**

**= 60 * cos 30 = 60 *** $\frac{\sqrt{3}}{2}$ **= 30** $\sqrt{3}$ **N**

## Composition of a force :

**Let we have ( Fx ) is the horizontal component and ( Fy ) is the vertical component for the force ( F ) shown in fig.**




**From the shape ABC we get :**

**$AC^2 = AB^2 + BC^2$**

**$F^2 = Fx^2 + Fy^2$**

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

## Determination of the direction of a force :

**The direction of a force can be determined by :**

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

**EX ( 3 ) :**

**Determine the magnitude and direction of a force ( P ) , if the horizontal and vertical components are ( 20 N ) , ( 40 N ) respectively ?**

**Solution :**

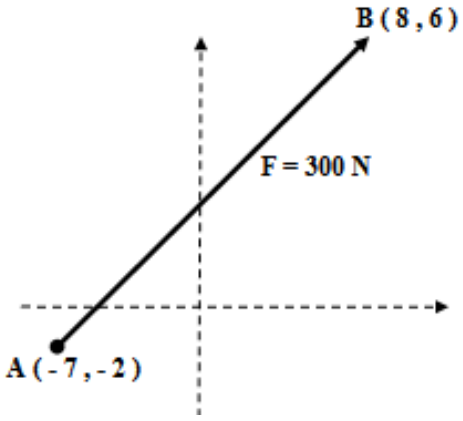
**We have : Fx = 20 N , Fy = 40 N ,** $F = \sqrt{(Fx)^2 + (Fy)^2}$

$$F = \sqrt{(20)^2 + (40)^2} = \sqrt{400 + 1600} = \sqrt{20000} = 44.72 \quad \text{N}$$

$$\theta = \tan^{-1}\left(\frac{Fy}{Fx}\right) = \tan^{-1}\left(\frac{40}{20}\right) = 63.43^\circ$$

**EX ( 4 ) :**

**The line of action of the ( 300 N ) force runs through the points ( A ) and ( B ) as shown in fig . Determine the ( X ) and ( Y ) scalar components of ( F ) .**




**Solution :**

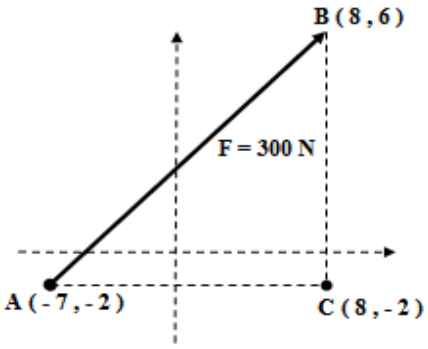
$$L_{AB} = \sqrt{(-7-8)^2 + (-2-6)^2} = 17$$

$$L_{AC} = \sqrt{(-7-8)^2} = 15$$

$$L_{BC} = \sqrt{(6+2)^2} = 8$$

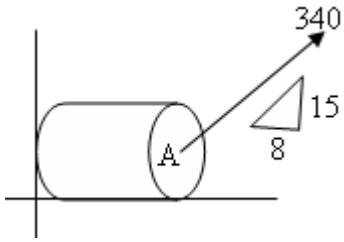
$$F_x = F.\cos\theta = 300 * \frac{15}{17} = 264.7N$$

$$F_y = F.\sin\theta = 300 * \frac{8}{17} = 141.2N$$

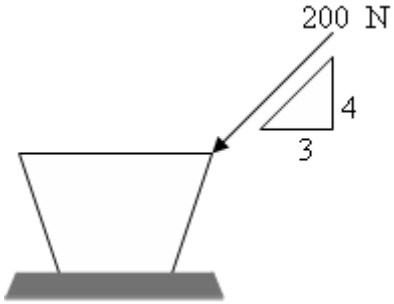



**PROBLEMS**

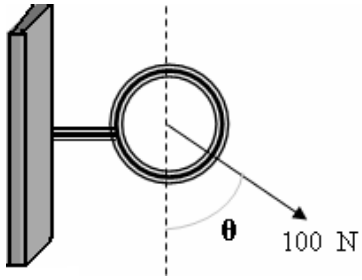
**1 - Determine a pair of horizontal and vertical components of the ( 340 N ) force ?**



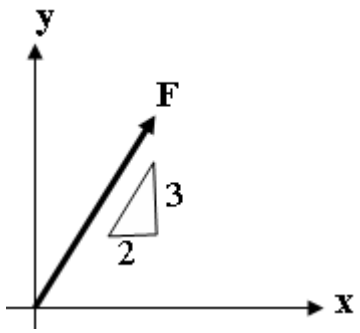

**2 - Determine the horizontal & vertical components of the force ( 200 N ) ?**



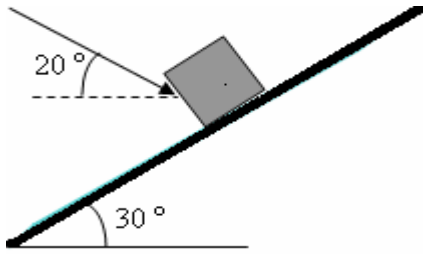
**3 - Resolve the ( 100 N ) force into horizontal and vertical components for each of the following values of ( θ ):**
**a- 20° b- 80° c- 240° d- 210°**




**4 - The horizontal component of the force ( F ) is ( 60 N ) to the right through the original point . Determine the vertical component and the magnitude of ( F ) ?**

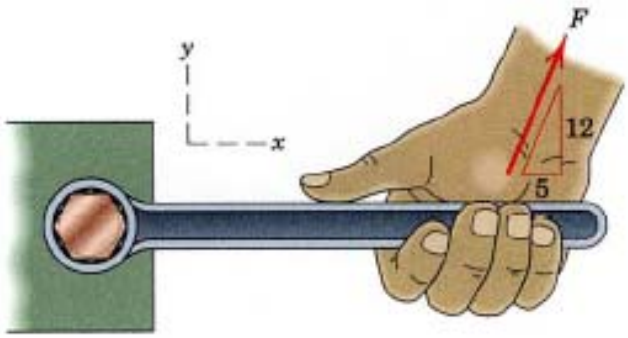



**5 - The body on the ( 30° ) incline is acted upon by a force ( P ) inclined at ( 20° ) with the horizontal . if ( P ) is resolved into components parallel and perpendicular to the incline and the value of the parallel component is ( 300 N ) , Compute the value of the perpendicular , and of ( P ) ?**

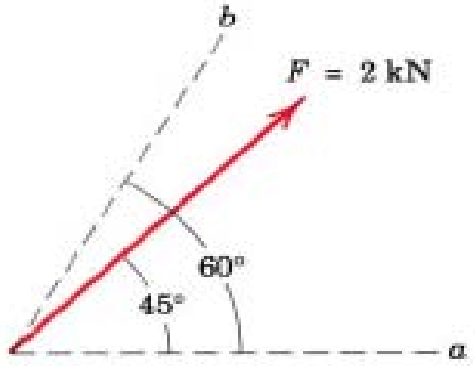



**6 – The Y – component of the force ( F ) which a person exerts on the handle of the box wrench is known to be ( 70 N ) .Determine the ( X ) component , and the magnitude of ( F ) .**

**Ans : Fx = 29.5 N , F= 75.8 N**

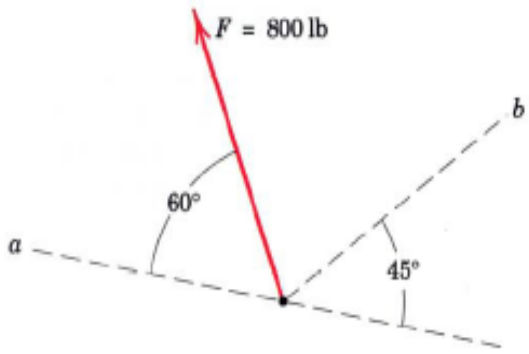


**7 – Determine the components of the ( 2 KN ) force along the oblique axes ( a ) and ( b ) . Determine the projections of ( F ) onto the a – and b- axes .**

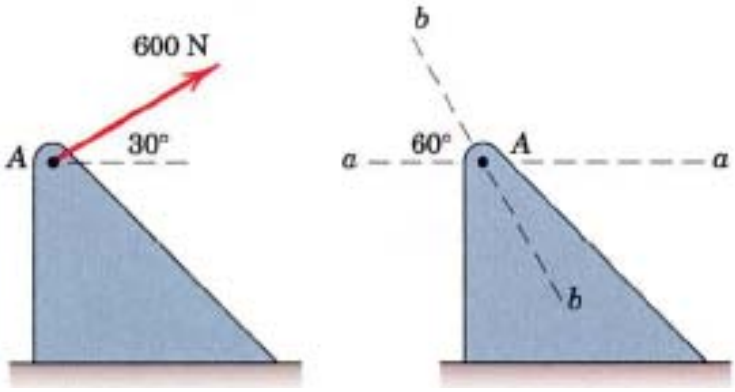



**8 -** Determine the components of the 800-lb force **F** along the oblique axes $a$ and $b$. Also, determine the projections of **F** onto the $a$- and $b$-axes.

*Ans.* Components: $F_a = 1093$ lb, $F_b = 980$ lb
Projections: $F_a = 400$ lb, $F_b = 207$ lb




**9 -** The 600-N force applied to the bracket at $A$ is to be replaced by two forces, $F_a$ in the $a$-$a$ direction and $F_b$ in the $b$-$b$ direction, which together produce the same effect on the bracket as that of the 600-N force. Determine $F_a$ and $F_b$.




**10 : Write whether the following quantities are vectors or scalars :**
**Force , sound , density , velocity , weight , time , mass , acceleration , light , area**

**11 : Determine the angle ( θ ) and locate the force on the coordinates when :**
**Fx = Fy , Fx = - Fy , - Fx = - Fy , - Fx = Fy**