Scalars & Vectors

Scalar - only magnitude e.g. mass length

Vector - magnitude & direction e.g. position velocity force

represented by letter with arrow $\vec{A}$

Vector may be expressed by multiplying magnitude F with unit vector U_F whose magnitude is 1.

x axis $\rightarrow$ $\hat{i}$

y axis $\rightarrow$ $\hat{j}$

z axis $\rightarrow$ $\hat{k}$

Force

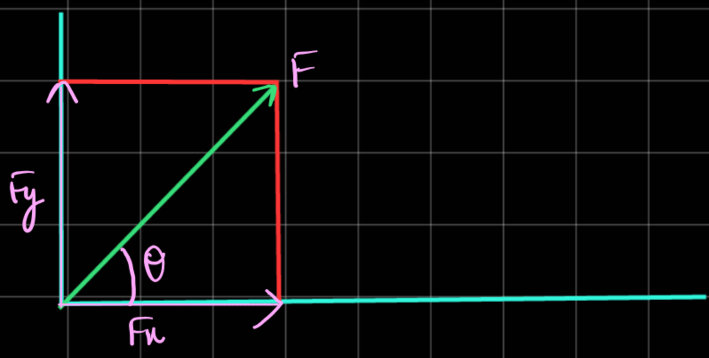
Vector quantity

Unit - Newton (N)

Has Rectangular components and

Rectangular components

When vector components are mutually $\perp$ to each other they are called rectangular components of that vector



Scalar Notation

$F_x = F\cos\theta$ $F_y = F\sin\theta$

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

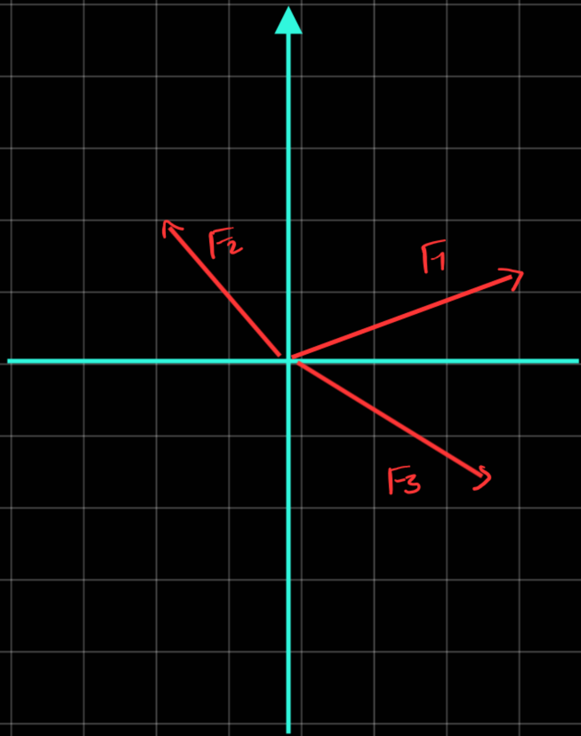
$\theta = \tan^{-1} \dfrac{F_x}{F_y}$

Cartesian Vector Notation

$$\vec{F} = \vec{F_x} + \vec{F_y}$$

$=$

Coplanar Force Results



$$\sum F_x = F_{1x} - F_{2x} + F_{3x}$$

$$\sum F_y = F_{1y} + F_{2y} - F_{3y}$$

Cartesian vector notation

$$F_1 = F_{1x}\,i + F_{1y}\,j$$

$$F_2 = -F_{2x}\,i + F_{2y}\,j$$

$$F_3 = F_{3x}\,i - F_{3y}\,j$$

Vector Resultant

$$F_R = F_1 + F_2 + F_3$$

$$= (F_{Rx})\,i + (F_{Ry})\,j$$

In all cases

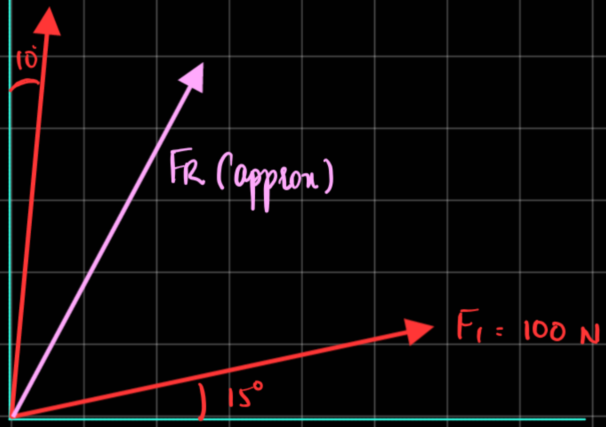
$$F_{Rx} = \sum F_x$$

$$F_{Ry} = \sum F_y$$

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

$$\theta = \tan^{-1}\left|\frac{F_{Ry}}{F_{Rx}}\right|$$

$F_2 = 150\,N$



Moment of a force

$M_O = Fd$ (Nm)

↳ perpendicular distance from O to its line of action of force

Direction → using right hand rule

Moment of Force

$M_O = r \times F$

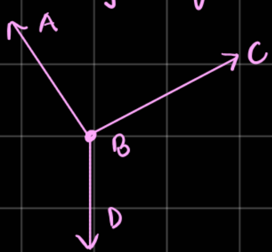
For magnitude

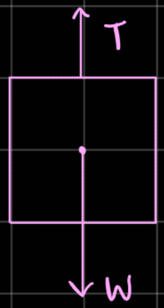
$d = r \sin\theta$

$M_O = Fd$

$= Fr \sin\theta$

Free Body Diagram





Tutorial Questions

1. $F_{1x} = F_1 \cos\theta$

$= 800 \cos 60^\circ$

$= 400\ N$

$F_{1y} = F_1 \sin\theta$

$= 800 \sin 60^\circ$

$= 693\ N$

$F_1 = 400\hat{i} + 693\hat{j}\ N$

$F_{2x} = F_2 \cos\theta$

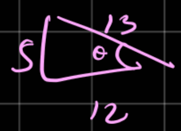
$= 424\ N$

$F_{2y} = F_2 \sin\theta$

$= 424\ N$

$F_2 = -424\hat{i} + 424\hat{j}\ N$

$\theta =$



$\cos = \frac{12}{13}$ $\quad \sin\theta = \frac{5}{13}$

$F_{3x} = F_3 \cos\theta$

$= \frac{\cancel{650}^{5} \times 12}{\cancel{13}}$

$= 600\ N$

$F_{3y} = F_3 \sin\theta$

$= \frac{-\cancel{650}^{5} \times 5}{\cancel{13}}$

$= 250\ N$

$F_3 = 600\hat{i} - 250\hat{j}\ N$

2. $F_1 = 900\hat{i}$

$F_2 = 530\hat{i} + 530\hat{j}$

$F_3 = 520\hat{i} - 390\hat{j}$

$F_R = 1950\hat{i} + 140\hat{j}\ N$

$$|F_R| = \sqrt{1950^2 + 140^2}$$

$$= 1955.02 \text{ N}$$

$$\theta = \tan^{-1}\left|\frac{140}{1950}\right|$$

$$= 4.106^\circ$$

$$F_{AC_x} = F_{AC}\cos\theta = \frac{F_{AC}}{\sqrt{2}}$$

$$F_{AC_y} = F_{AC}\sin\theta = \frac{F_{AC}}{\sqrt{2}}$$

$$F_{AB_x} = F_{AB}\cos\theta = \frac{4F_{AB}}{5}$$

$$F_{AB_y} = F_{AB}\sin\theta = \frac{3F_{AB}}{5}$$