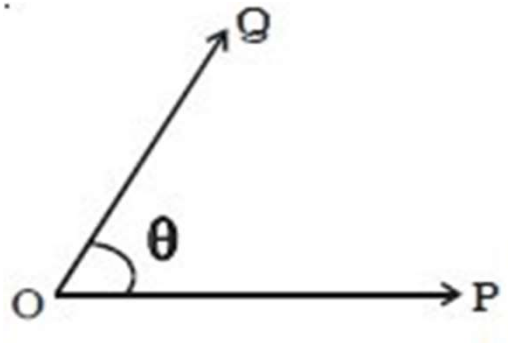
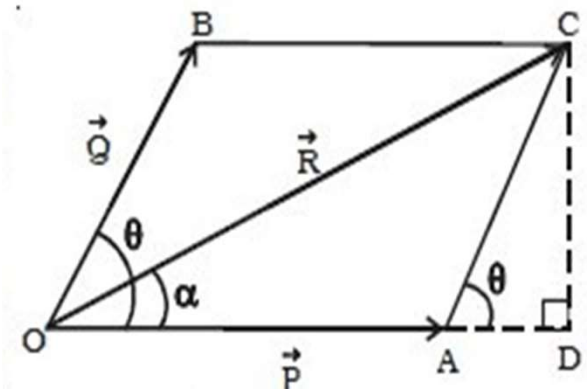
Law of mechanics

- Newton’s first law
- Newton’s second law
- Newton’s third law
- Law of parallelogram
- Principle of Transmissibility.

PARALLELOGRAM LAW OF FORCES

- It states, “If two forces, acting simultaneously on a particle, be represented in magnitude and direction by the two adjacent sides of a parallelogram ; their resultant may be represented in magnitude and direction by the diagonal of the parallelogram, which passes through their point of intersection.”





Conti...

Mathematically, resultant force,

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

and

$$\tan\alpha = \frac{F_2\sin\theta}{F_1 + F_2\cos\theta}$$

where F_1 and F_2 = Forces whose resultant is required to be found out,

θ = Angle between the forces F_1 and F_2, and

α = Angle which the resultant force makes with one of the forces (say F_1).

Questions..

Q. Two forces of 100 N and 150 N are acting simultaneously at a point. What is the resultant of these two forces, if the angle between them is 45°?

Q. Find the magnitude of the two forces, such that if they act at right angles, their resultant is 10 N . But if they Act at 60°, their resultant is 13 N .

Q. Two forces of 100 N and 150 N are acting simultaneously at a point. What is the resultant of these two forces, if the angle between them is 45°?

Given : First force (*F*1) = 100 N; Second force (*F*2) = 150 N and angle between *F*1 and *F*2 (q) = 45°.

We know that the resultant force

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

$$= \sqrt{(100)^2 + (150)^2 + 2\times100\times150\cos45^\circ}\ \text{N}$$

$$= \sqrt{10\,000 + 22\,500 + (30\,000\times0.707)}\ \text{N}$$

$$= 232\ \text{N} \quad \textbf{Ans.}$$

Q. Find the magnitude of the two forces, such that if they act at right angles, their resultant is √10 N . But if they Act at 60°, their resultant is √13 N .

Solution. Given : Two forces = F_1 and F_2.

First of all, consider the two forces acting at right angles. We know that when the angle between the two given forces is 90°, then the resultant force (R)

$$\sqrt{10} = \sqrt{F_1^2 + F_2^2}$$

or $$10 = F_1^2 + F_2^2 \qquad \text{...(Squaring both sides)}$$

Similarly, when the angle between the two forces is 60°, then the resultant force (R)

$$\sqrt{13} = \sqrt{F_1^2 + F_2^2 + 2F_1 F_2 \cos 60^\circ}$$

$\therefore$ $$13 = F_1^2 + F_2^2 + 2F_1 F_2 \times 0.5 \qquad \text{...(Squaring both sides)}$$

or $$F_1 F_2 = 13 - 10 = 3 \qquad \text{...(Substituting } F_1^2 + F_2^2 = 10\text{)}$$

Conti..

We know that $(F_1 + F_{2]})^2 = F_1^2 + F_2^2 + 2F_1F_2 = 10 + 6 = 16$

$$\therefore \quad F_1 + F_2 = \sqrt{16} = 4 \qquad \ldots(i)$$

Similarly $(F_1 - F_2)^2 = F_1^2 + F_2^2 - 2F_1F_2 = 10 - 6 = 4$

$$\therefore \quad F_1 - F_2 = \sqrt{4} = 2 \qquad \ldots(ii)$$

Solving equations (i) and (ii),

$F_1 = 3\ \text{N}$ and $F_2 = 1\ \text{N}$ **Ans.**