Case – II: Equilibrium under three forces

$$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$$

According to law of triangle of vector a body can be equilibrium under action of three force only if the forces can be represented by three sides of a triangle in a order.

Example.

Figure shows a mass of 6 kg is suspended by a rope of length 2 m from the ceiling. A force of 50 N in the horizontal direction is applied at midpoint point P of the rope, as shown. What is the angle of the rope makes with vertical in equilibrium (take g = 10 m/s^2) neglect the mass of the rope.

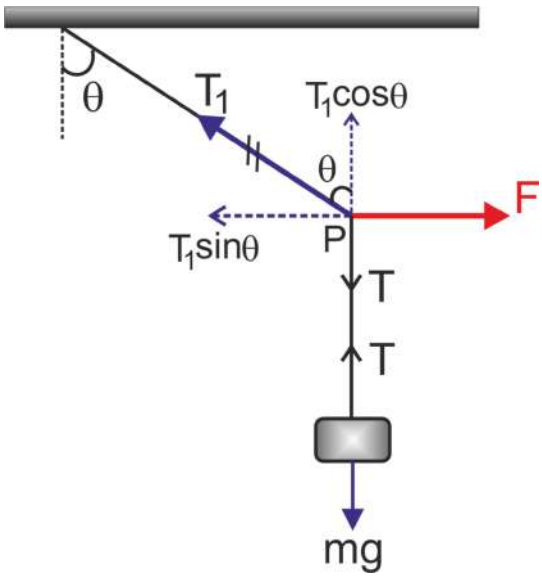
SOLUTION:

For the block:

$$\sum F_y = ma_y$$

$$T - mg = 0$$

$$T = mg = 6 \times 10 = 60\ N$$



For equilibrium of Point – P : -

$$\sum \vec{F} = 0$$

In terms of component

$$\sum F_x = 0, \quad \sum F_y = 0$$

$$\therefore \sum F_x = 0 \Rightarrow \quad T_1 sin\theta - F = 0$$

$$T_1 sin\theta = F \Rightarrow \quad T_1 sin\theta = 50\ N \qquad \ldots\ldots\ldots\ldots \text{(i)}$$

$$\sum F_y = 0 \quad \Rightarrow \quad T_1 cos\theta - T = 0 \quad \Rightarrow \quad T_1 cos\theta = T = 60\ N \qquad \ldots\ldots\ldots\ldots \text{(ii)}$$

By eq. (i)/(ii)

$$\frac{T_1 sin\theta}{T_1 cos\theta} = \frac{50}{60} \quad \Rightarrow \quad tan\theta = \frac{5}{6} \quad \Rightarrow \quad \theta = tan^{-1}\frac{5}{6}$$