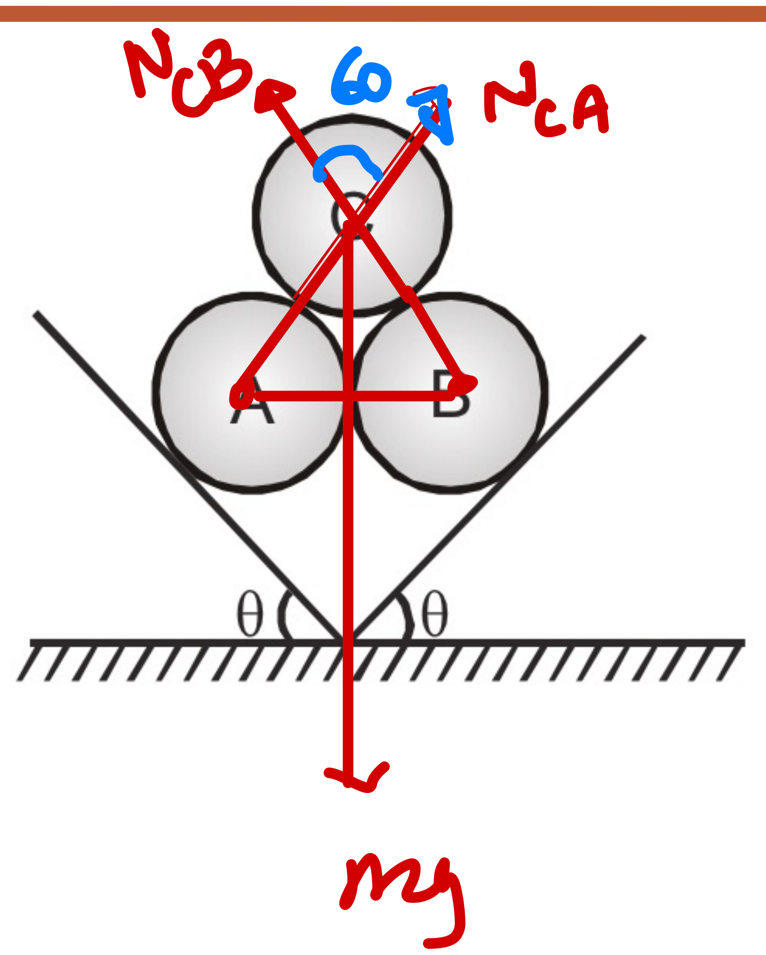
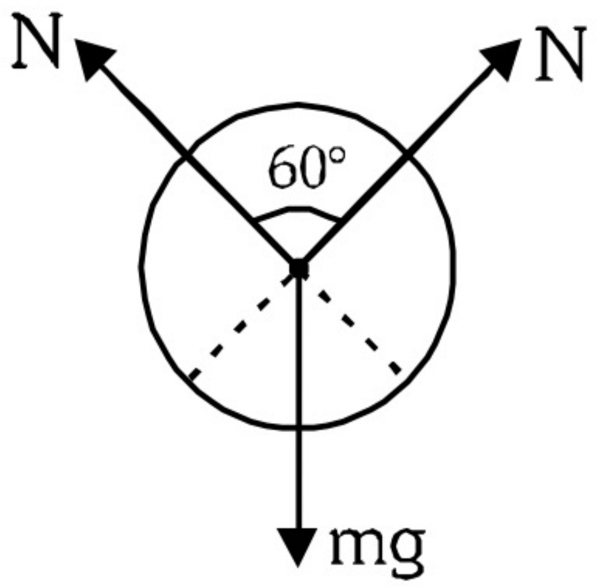
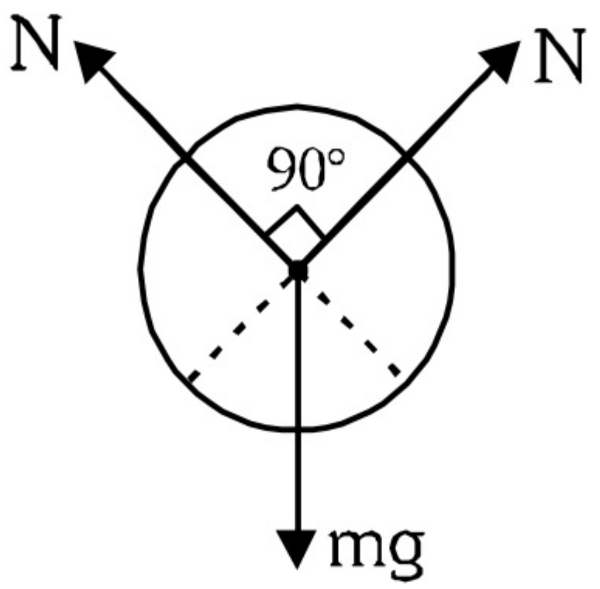
1. A, B & C are three identical smooth sphere placed on frictionless inclined plane as shown in figure then F.B.D. of sphere C is



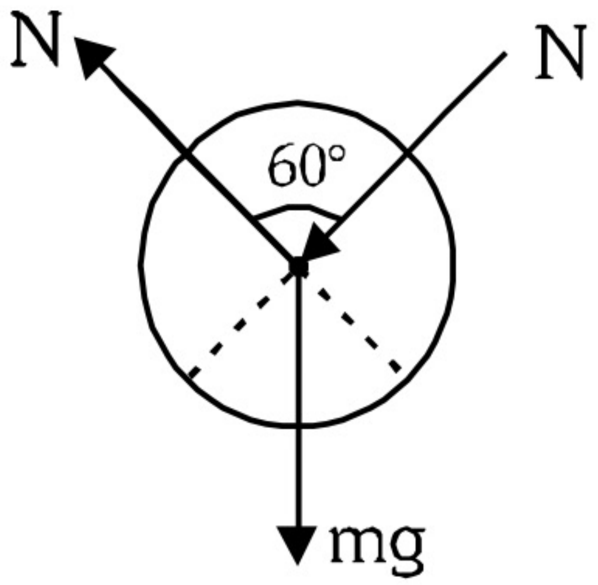
(A)



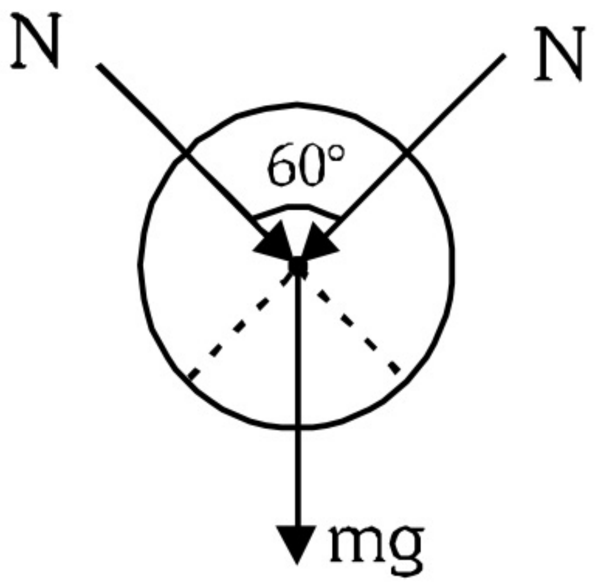
(B)



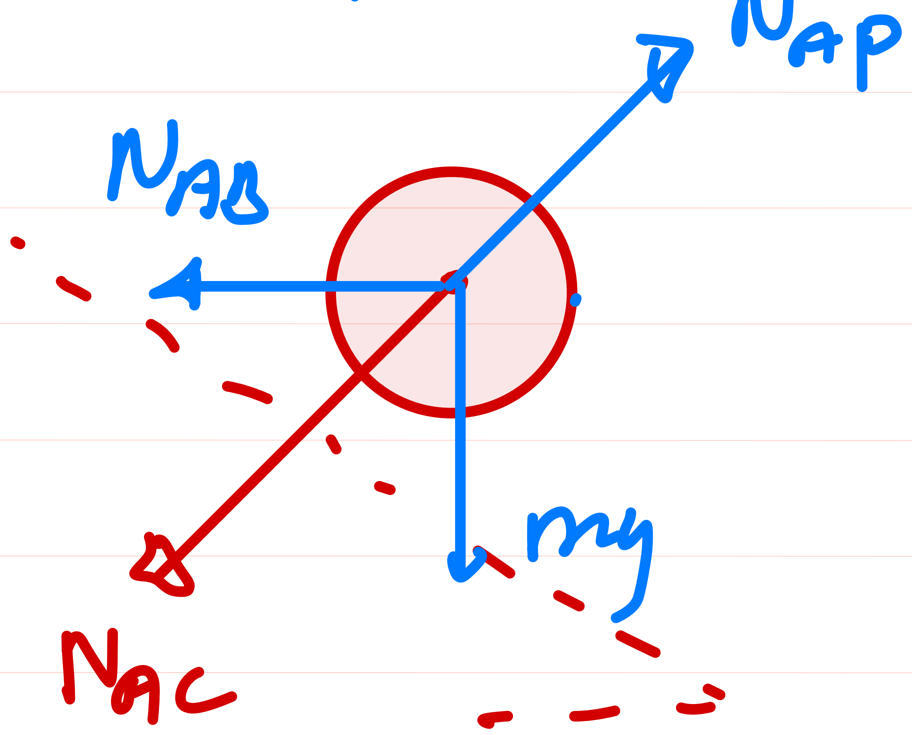
(C)



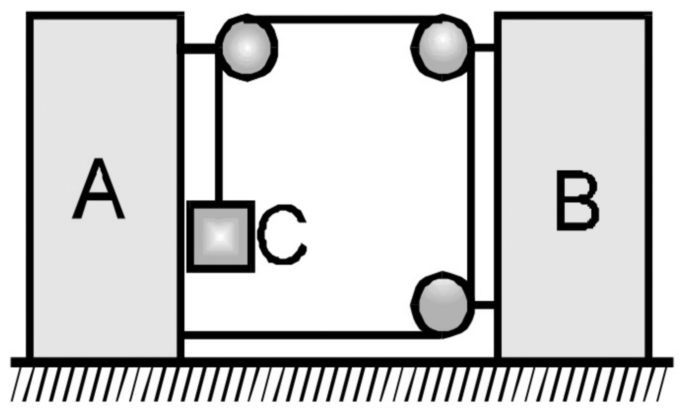
(D)

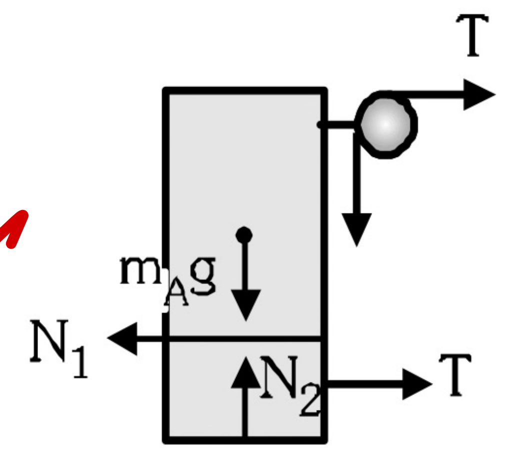


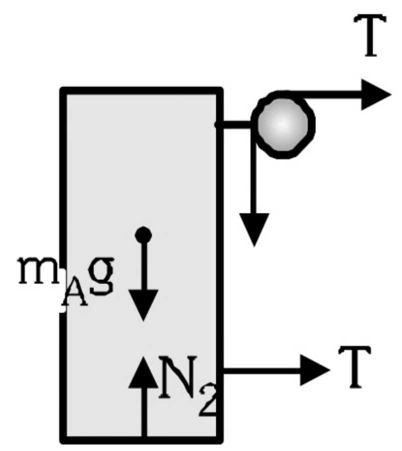
F.B.D of A

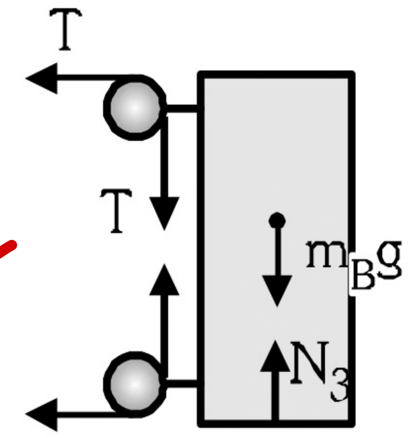


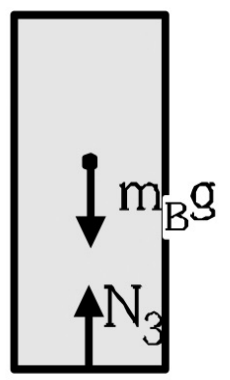
9. Block A and B are connected by light string as shown in figure. All surface are frictionless then which is the correct F.B.D. of block B and block A.



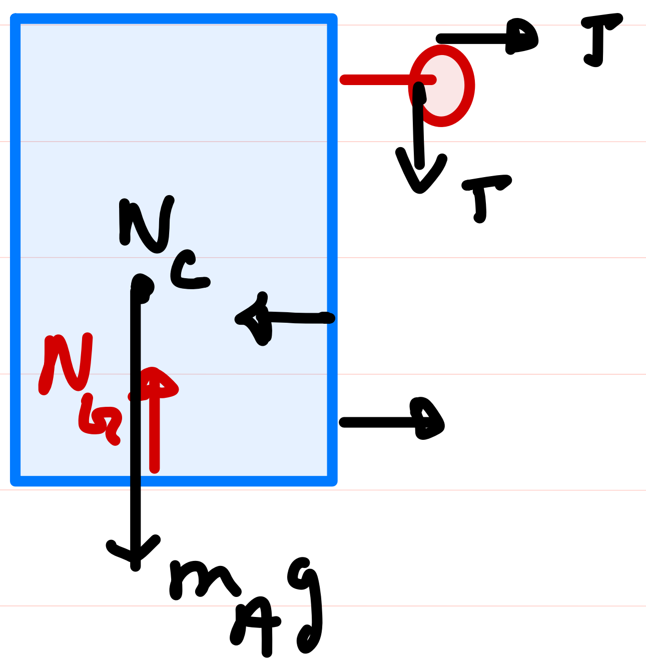
(A) 

(B) 

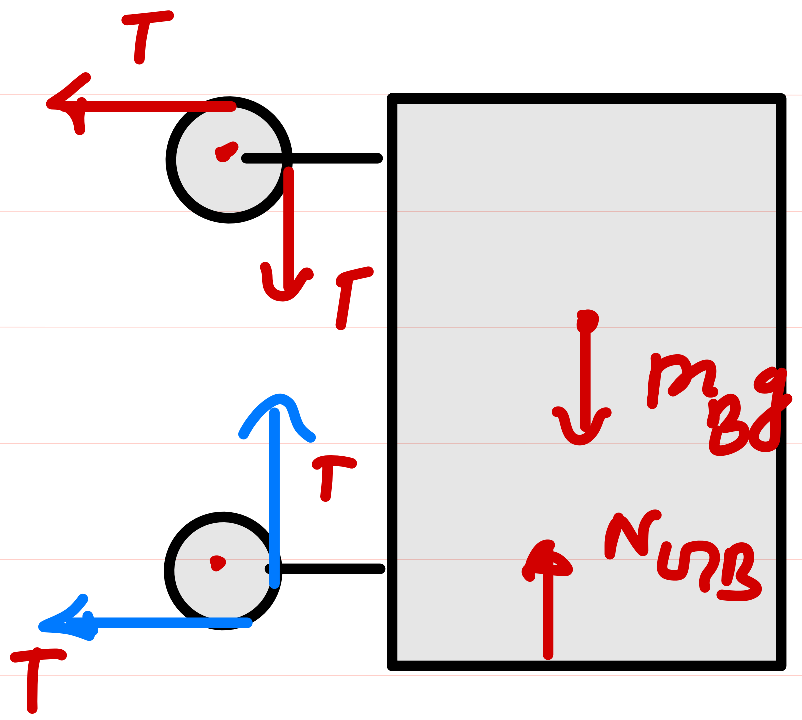
(C) 

(D) 

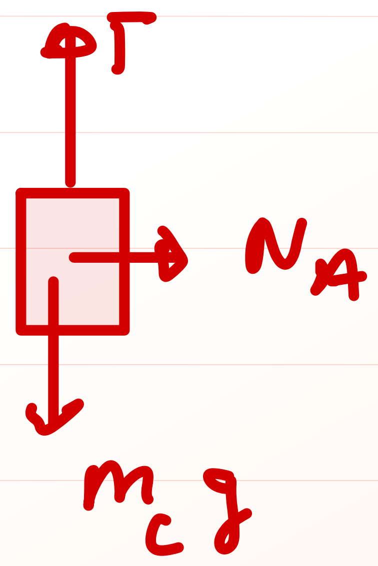
F.B.D of A



F.B.D of B



F.B.D of C



B.B # 1

H.W

TRANSLATIONAL EQUILIBRIUM :→

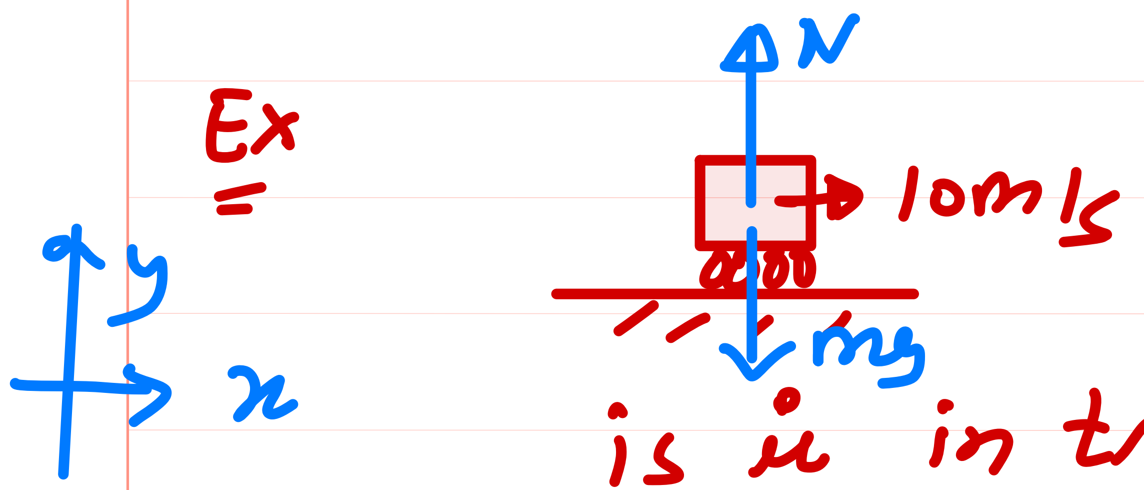
A body in state of rest or moving with constant velocity is said to be in translational equilibrium. Thus if a body is in translational equilibrium in a particular inertial frame of reference, it must have no linear acceleration. When it is at rest, it is in *static equilibrium*, whereas if it is moving at constant velocity it is in *dynamic equilibrium*.

Conditions for translational equilibrium :→

For a body to be in translational equilibrium, no net force must act on it i.e. vector sum of all the forces acting on it must be zero.

$$\boxed{\sum F_{ix} = 0 \qquad \sum F_{iy} = 0 \qquad \sum F_{iz} = 0}$$

Ex



is it in translational Eq.

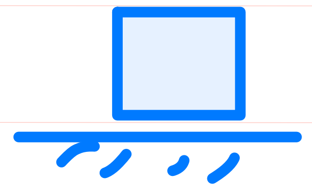
Yes

dynamic Eq

$\Sigma F_y = 0$

$N = mg$

Ex



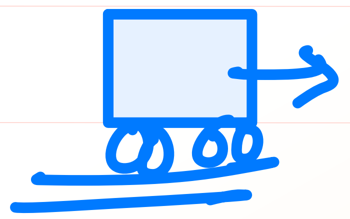
Yes

Static Eq.

$\Sigma F_y = 0$

Ex

$m = 2kg$



$a = 2 m/s^2$

No

$\Sigma F_x \neq 0$

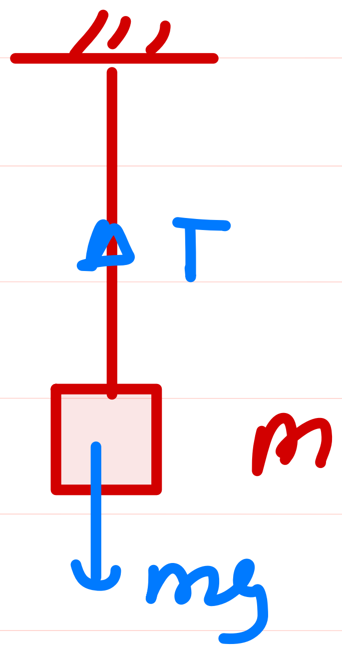
$\Sigma F_y = 0$

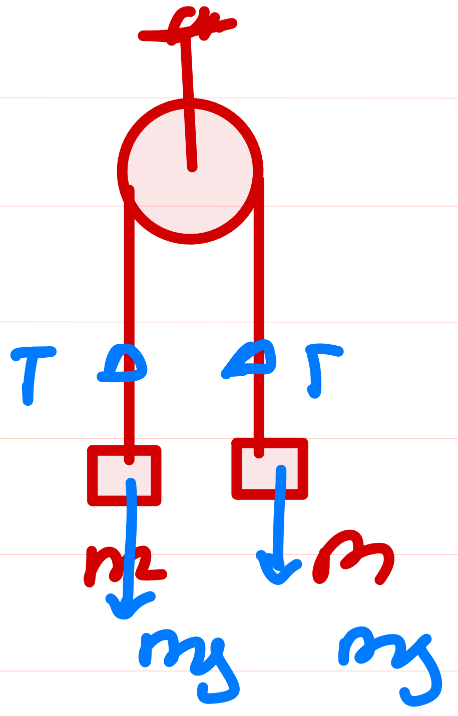
$F_x = ma_x$

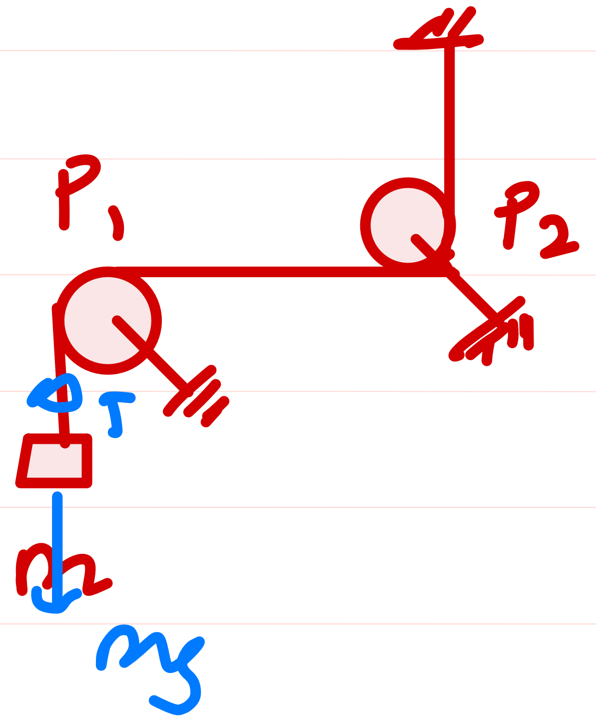
$= 2 \times 2$

$\boxed{F_x = 4N}$

Ex







All are in static equ

$\Sigma F_y = 0$

$T = mg$

$\Sigma F_y = 0$

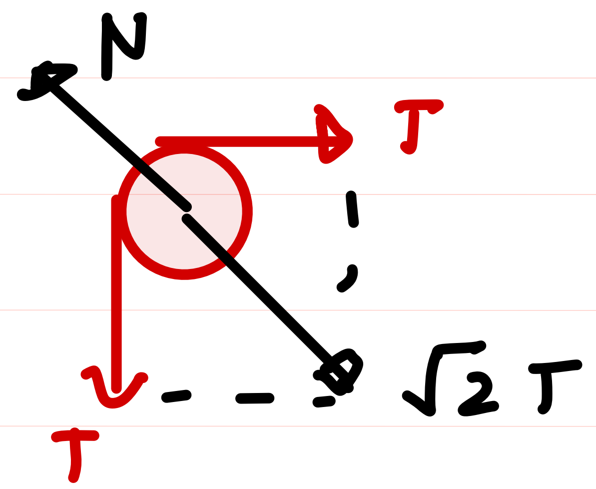
$\boxed{T = mg}$

$\Sigma F_y = 0$

$T = mg$

F.B.D of P_1 & P_2

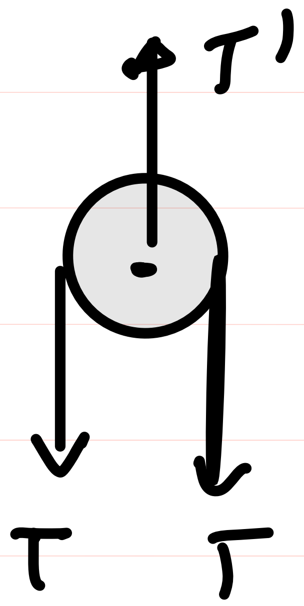
$\underline{P_1}$



N = Force by ground

$N = \sqrt{2}\,T = \sqrt{2}\,mg$

F.B.D of pulley



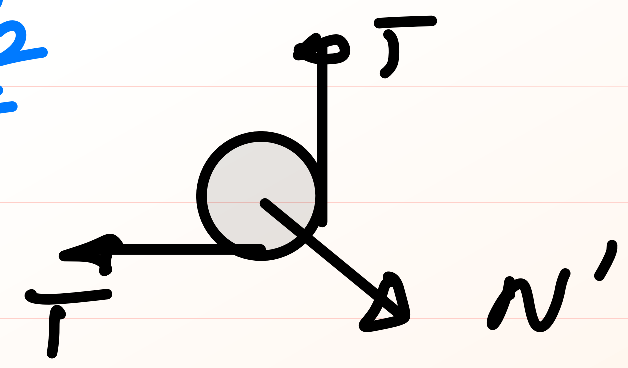
$\Sigma F_y = 0$

$T' - 2T = 0$

$T' = 2T$

$\boxed{T' = 2mg}$

$\underline{P_2}$



$N' = \sqrt{2}\,T = \sqrt{2}\,mg$

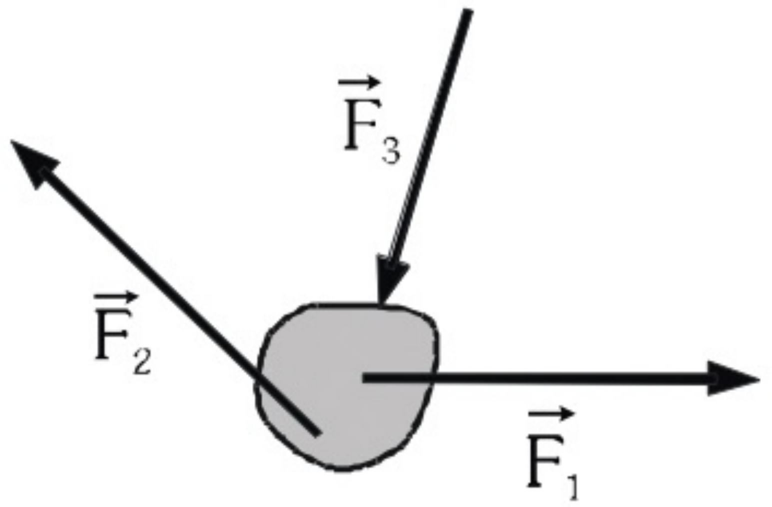
CONCEPT

Dirn of Tension of String always away from connected object

(only For 3- Forces acting on object)

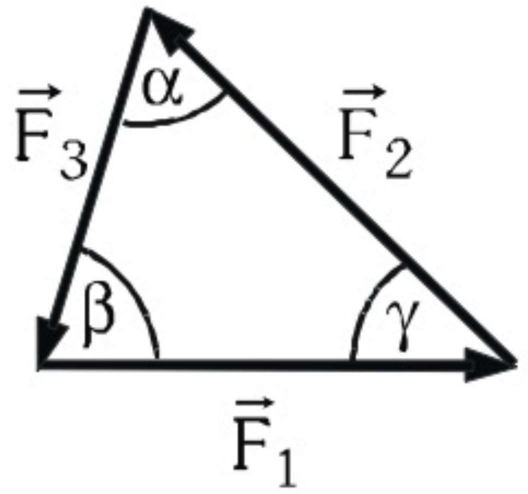
Lamis Theorem :⇒

If a body is in equilibrium under action of three forces, their resultant must be zero; therefore, according to the triangle law of vector addition they must be coplanar and make a closed triangle.



If

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

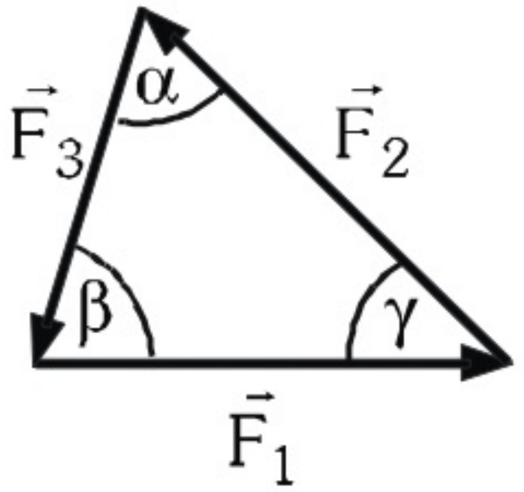


The situation can be analyzed by either graphical method or analytical method.

- Graphical method makes use of sine rule or Lami's theorem.

Sine rule : $\boxed{\dfrac{F_1}{\sin\alpha} = \dfrac{F_2}{\sin\beta} = \dfrac{F_3}{\sin\gamma}}$ then

$$\boxed{\text{Lami's theorem : } \dfrac{F_1}{\sin A} = \dfrac{F_2}{\sin B} = \dfrac{F_3}{\sin C}}$$



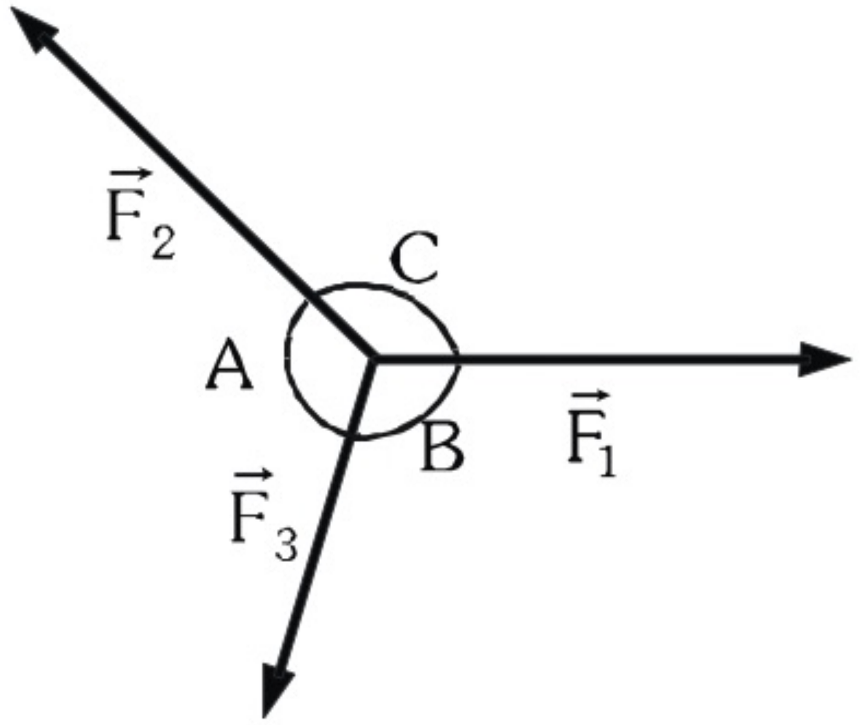


Illustration 3. (a) A box of weight $10\sqrt{3}$ N is held in equilibrium with the help of two strings OA and OB as shown in figure-I. The string OA is horizontal. Find the tensions in both the strings.

Fig. I

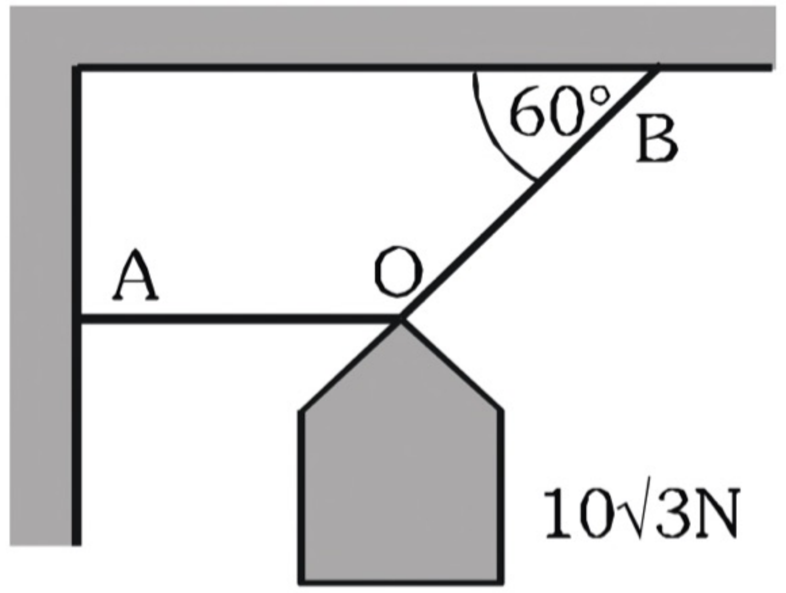
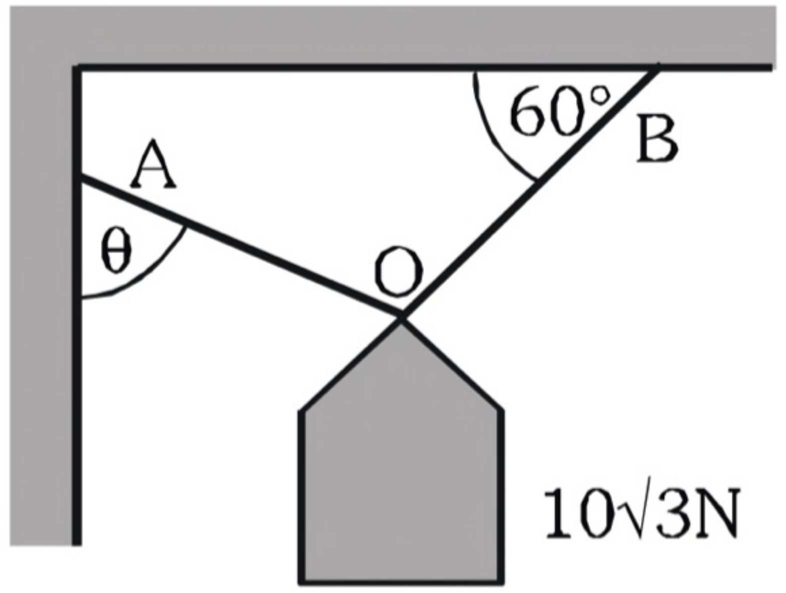
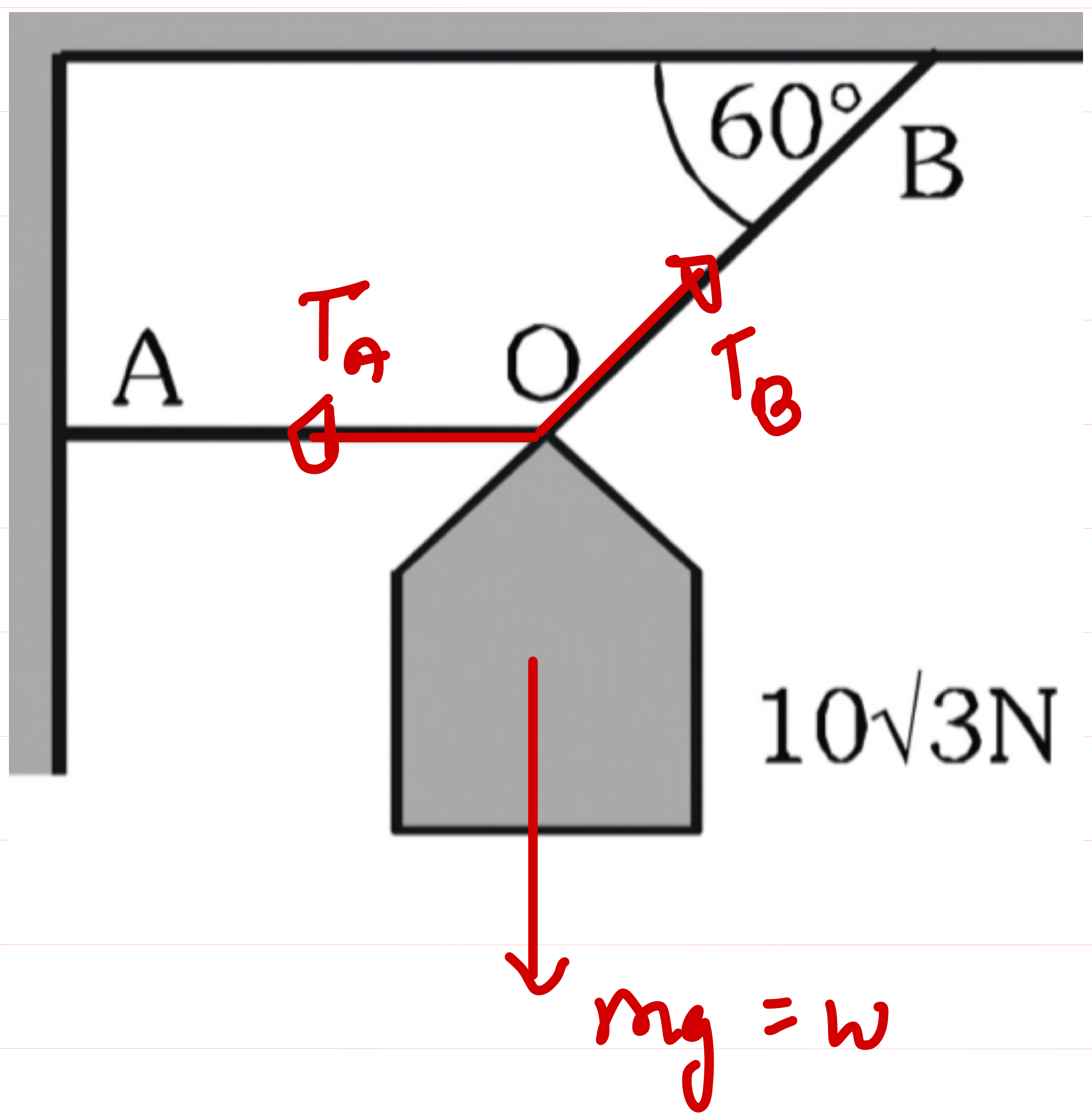


Fig. II

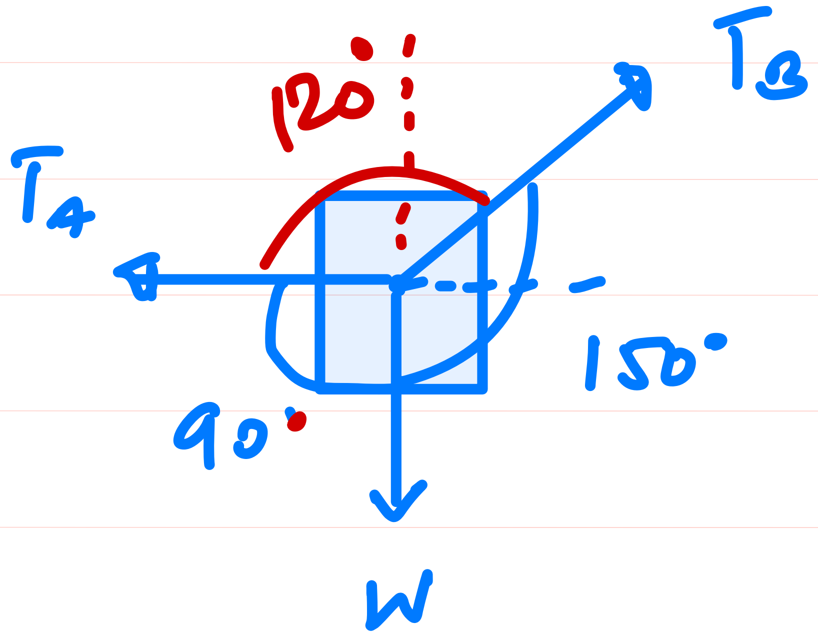


(b) If you can change location of the point A on the wall and hence the orientation of the string OA without altering the orientation of the string OB as shown in figure-II. What angle should the string OA make with the wall so that a minimum tension is developed in it?

Fig-1



$$\boxed{\vec{T_A}+\vec{T_B}+\vec{W}=0}$$



$$\frac{W}{\sin(120)} = \frac{T_A}{\sin(150)} = \frac{T_B}{\sin(90)}$$

$$\frac{10\sqrt{3}}{\sin(90+30)} = \frac{T_A}{\sin(90+60)} = \frac{T_B}{1}$$

$$\frac{10\sqrt{3}}{\cos 30} = \frac{T_A}{\cos 60} = T_B$$

$$\frac{10\sqrt{3}}{\frac{\sqrt{3}}{2}} = \frac{T_A}{\frac{1}{2}} = T_B$$

$$20 = 2T_A = T_B$$

$$\boxed{\begin{aligned} T_B &= 20\ N \\ T_A &= 10\ N \end{aligned}}$$

Ans

m-1

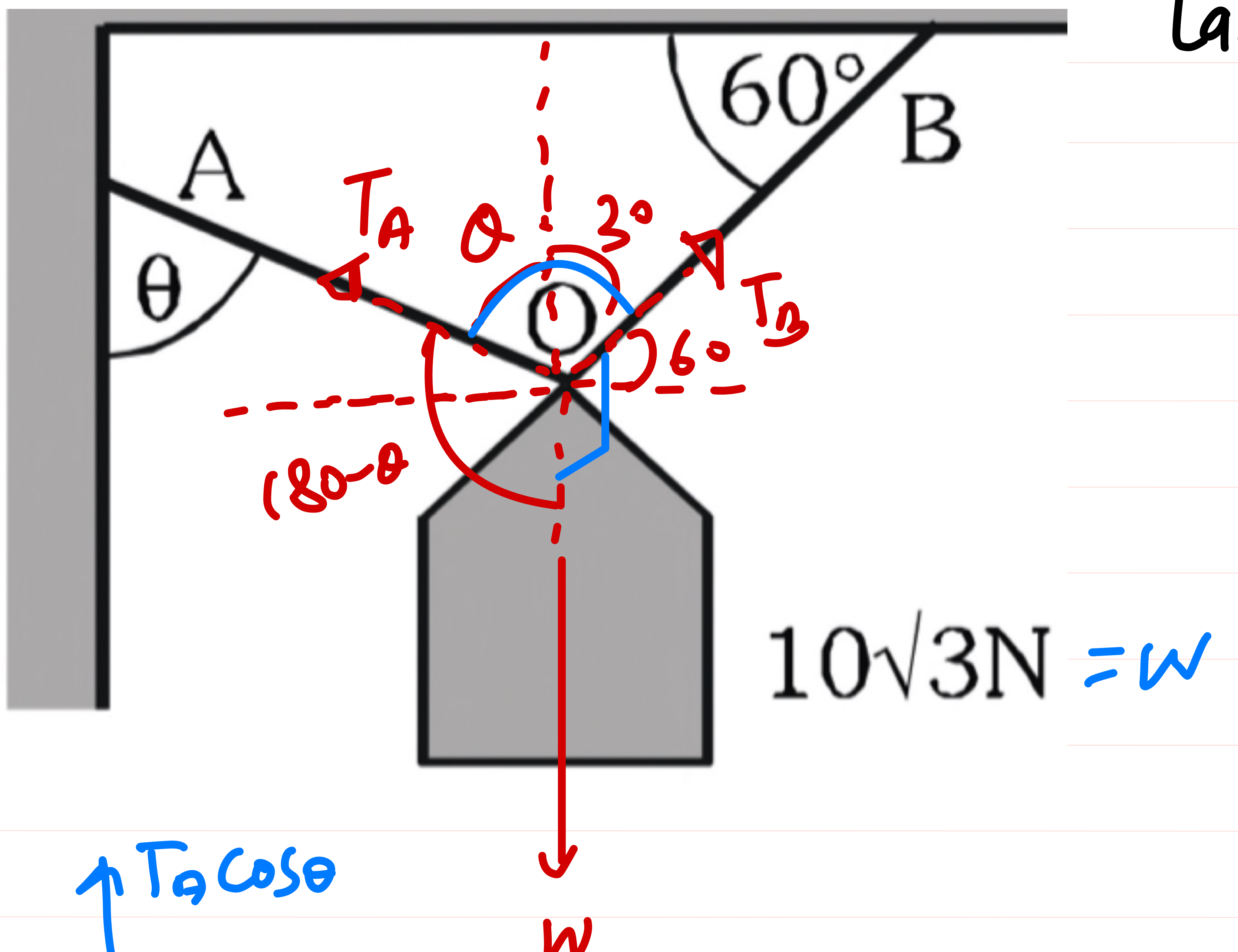


Fig. II

Lami's theorem

$$\frac{W}{\sin(\theta+30)} = \frac{T_A}{\sin(90+60)} = \frac{T_B}{\sin(180-\theta)} = K$$

$$T_A = \frac{W\cos 60}{\sin(\theta+30^\circ)} = \frac{10\sqrt{3}\times\frac{1}{2}}{\sin(\theta+30)} = \frac{5\sqrt{3}}{\sin(\theta+30^\circ)}$$

for $T_A \rightarrow$ minimum $\quad \sin(\theta+30)=1$

$\theta+30^\circ = 90^\circ$

$\boxed{\theta = 60^\circ}$ Ans

m.2

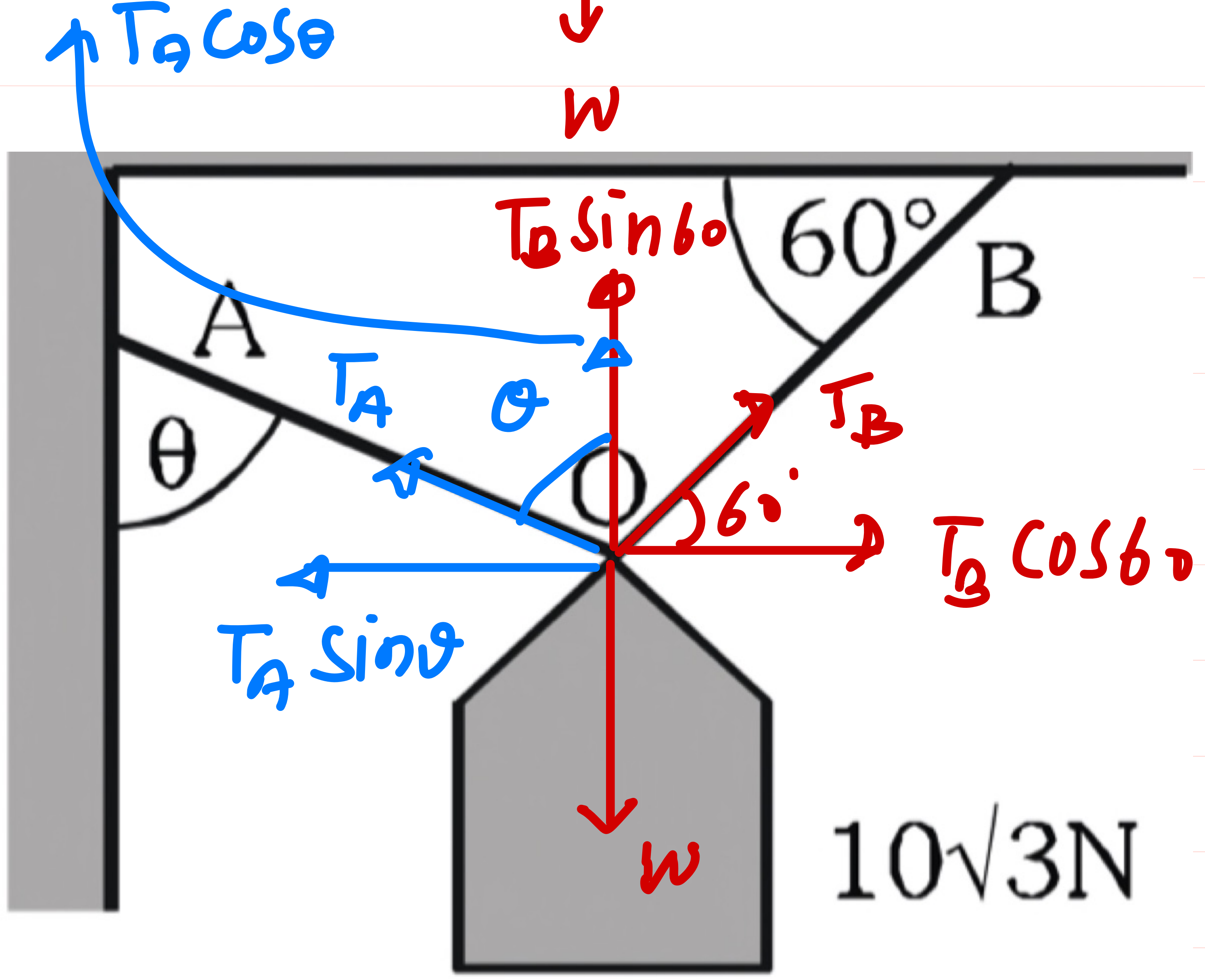


Fig. II

$\Sigma F_x = 0$

$T_B\cos 60 - T_A\sin\theta = 0$

$\frac{T_B}{2} = T_A\sin\theta$ — (1)

$T_B = 2T_A\sin\theta$

$\Sigma F_y = 0$

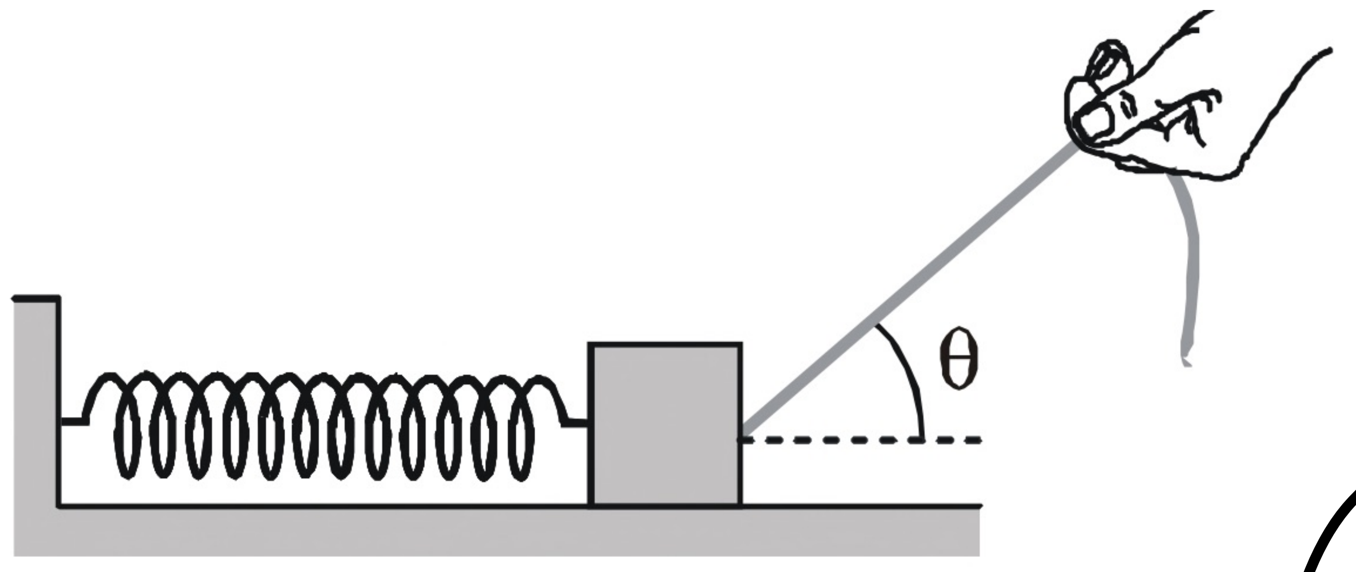
$T_B\sin 60 + T_A\cos\theta = W$

$T_B\frac{\sqrt{3}}{2} + T_A\cos\theta = 10\sqrt{3}$ — (2)

$\sqrt{3}T_A\sin\theta + T_A\cos\theta = 10\sqrt{3}$

$$T_A = \frac{10\sqrt{3}}{\sqrt{3}\sin\theta + \cos\theta}$$

Illustration 7. A block of mass m placed on a smooth floor is connected to a fixed support with the help of a spring of force constant k. It is pulled by a rope as shown in the figure. Tension force T of the rope is increased gradually without changing its direction, until the block losses contact from the floor. The increase in rope tension T is so gradual that acceleration in the block can be neglected.

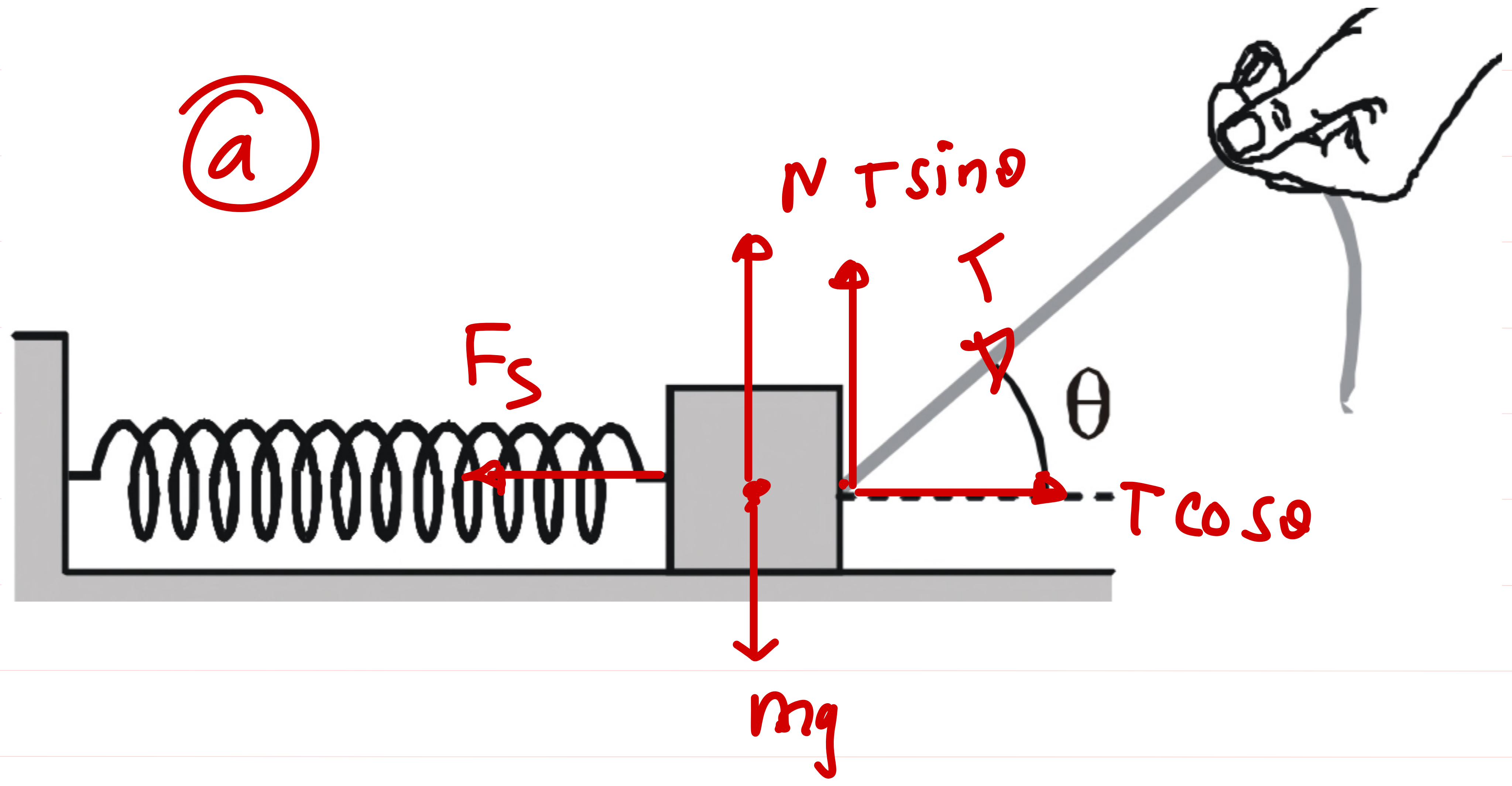


(a) Well before the block losses contact from the floor, draw its free body diagram.

(b) What is the necessary tension in the rope so that the block looses contact from the floor?

(c) What is the extension in the spring, when the block looses contact with the floor?

(a)



$\Sigma F_x = 0$ $\qquad$ $\Sigma F_y = 0$

$T\cos\theta = F_s$ $\qquad$ $N + T\sin\theta = mg$

When block losses the contact

$N = 0$

$T\sin\theta = mg$

$T = \dfrac{mg}{\sin\theta}$

(b) $\boxed{T = mg\,\mathrm{cosec}\,\theta}$

Ans

$mg\,\mathrm{cosec}\,\theta \times \cos\theta = kx$

$mg\cot\theta = kx$

(c) $\boxed{x = \dfrac{mg}{k}\cot\theta}$ Elongation in spring

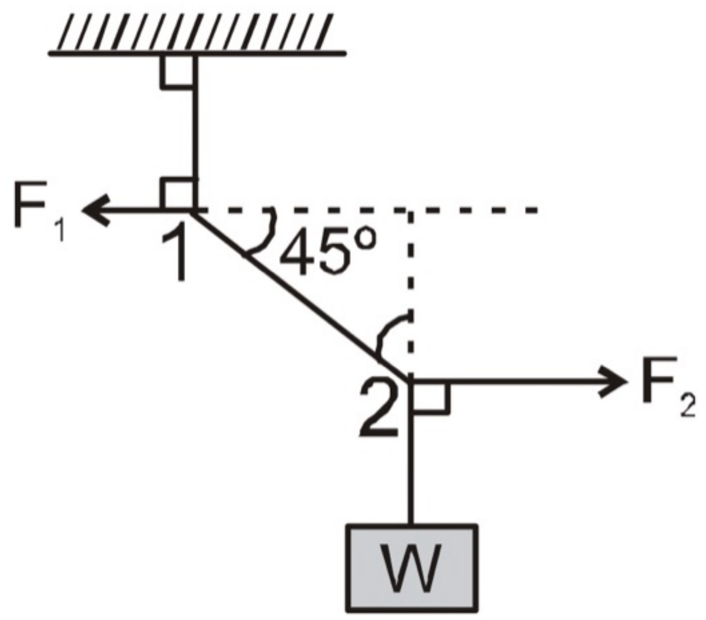
5. In the figure the tension in the string between 1 and 2 is $\overset{T}{60}$ N. Find the magnitude of the horizontal force $\vec{F}_1$ and $\vec{F}_2$ that must be applied to hold the system in the position shown.

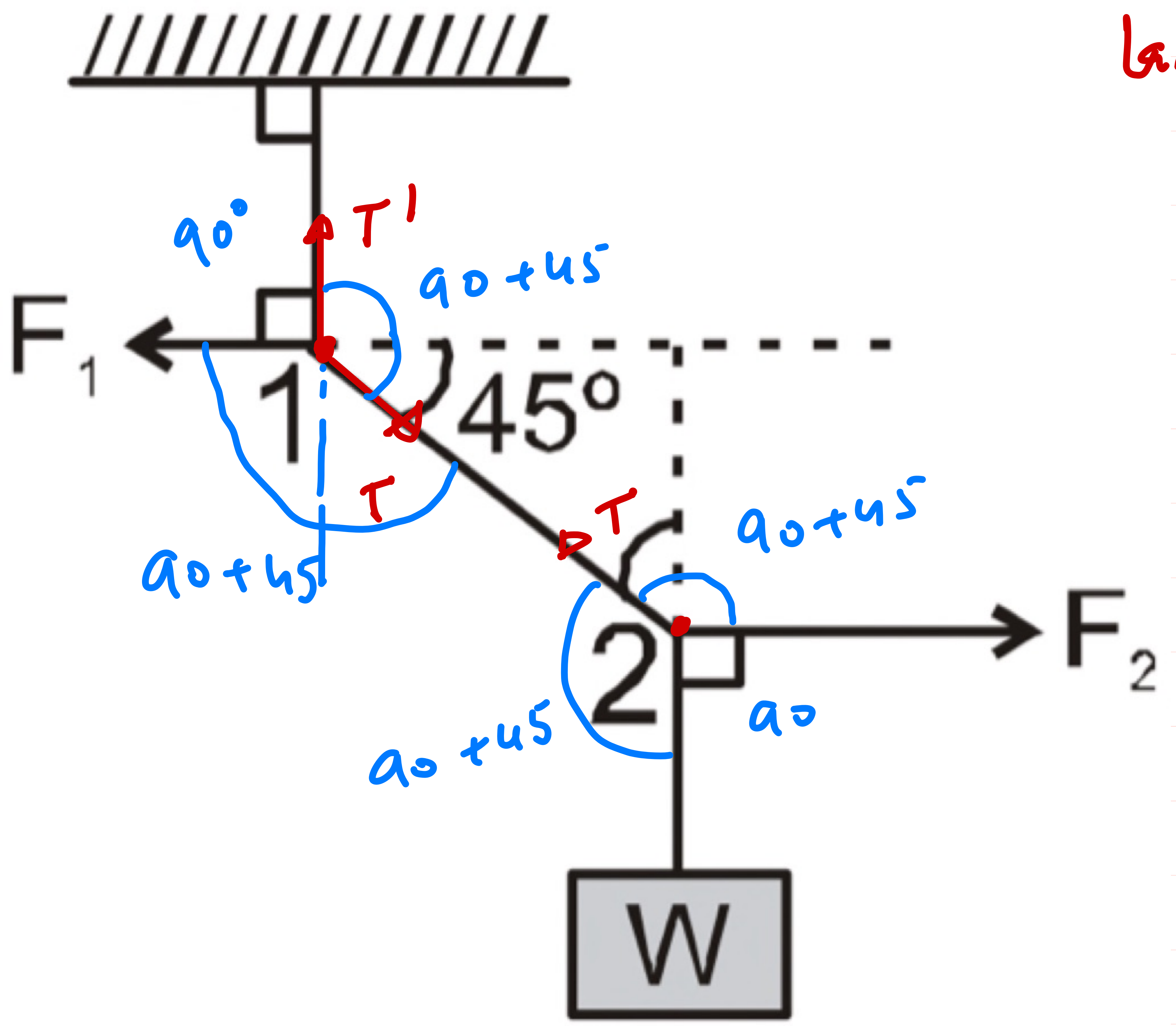
(A) $|\vec{F}_1| = |\vec{F}_2| = 40\sqrt{2}$ N

(B) $|\vec{F}_1| = |\vec{F}_2| = 30\sqrt{2}$ N

(C) $|\vec{F}_1| = |\vec{F}_2| = 10\sqrt{2}$ N

(D) $|\vec{F}_1| = |\vec{F}_2| = 20\sqrt{2}$ N





Lami's at Point 1

$$\frac{F_1}{\sin(90+45)} = \frac{T'}{\sin(90+45)} = \frac{T}{\sin 90}$$

$$\frac{F_1}{\cos 45} = \frac{T'}{\cos 45} = T$$

$$\boxed{\sqrt{2}F_1 = \sqrt{2}T' = T}$$

$$\sqrt{2}F_1 = \sqrt{2}T' = 60$$

$$\boxed{F_1 = T' = 30\sqrt{2}}$$

Lami's at Point 2

$$\frac{W}{\sin(90+45)} = \frac{F_2}{\sin(90+45)} = \frac{T}{\sin 90}$$

$$\sqrt{2}W = \sqrt{2}F_2 = T$$

$$\sqrt{2}W = \sqrt{2}F_2 = 60$$

$$W = F_2 = \frac{60}{\sqrt{2}}$$

$$\boxed{= 30\sqrt{2}\text{ N}}$$