

Law of Motion

H-W

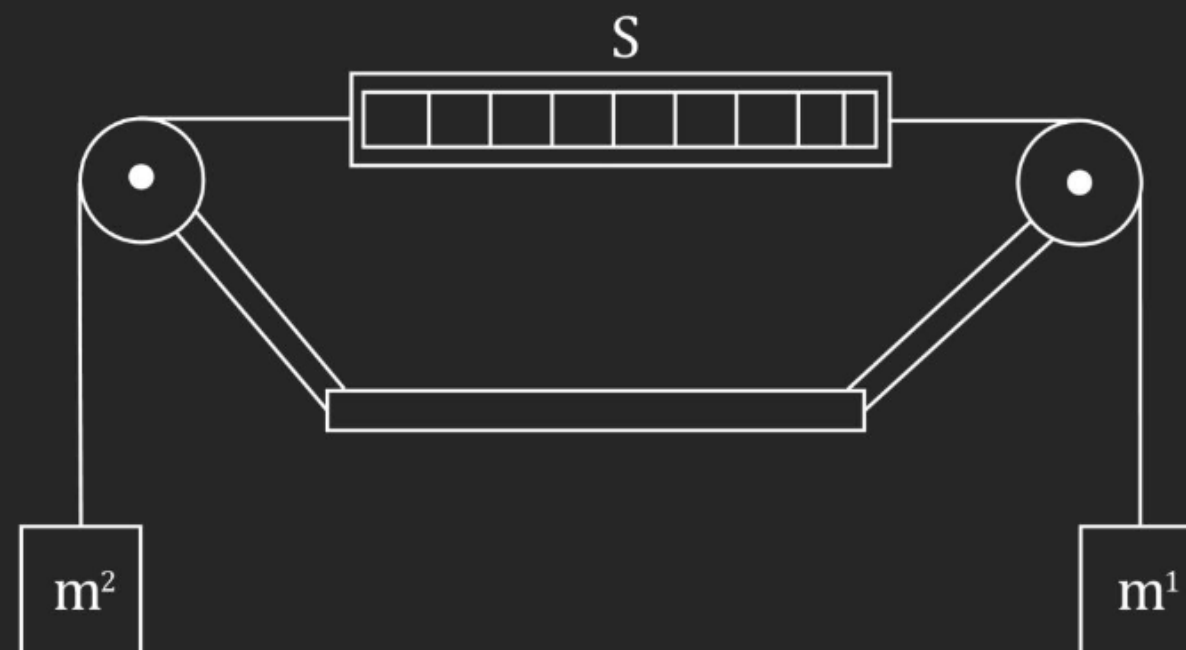
Q.2 In the arrangement shown, the pulleys are fixed and ideal, the strings are light. $m_1 > m_2$ and S is a spring balance which is itself massless. The reading of S (in unit of mass) is :

(A) $(m_1 - m_2)g$

(B) $\frac{1}{2}(m_1 - m_2)g$

(C) $\frac{m_1 m_2}{m_1 + m_2} g$

(D) $\frac{2m_1 m_2}{m_1 + m_2} g$ ✓



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Q.3 A bead of mass m is attached to one end of a spring of natural length R and spring constant $K = (\sqrt{3} + 1)mg/R$. The other end of the spring is fixed at a point A on a smooth vertical ring of radius R as shown in the figure. The normal reaction at B just after it is released to move is:

(A) $mg/2$

(B) $\sqrt{3}mg$ ✓

(C) $3\sqrt{3}mg$

(D) $3\sqrt{3}mg/2$

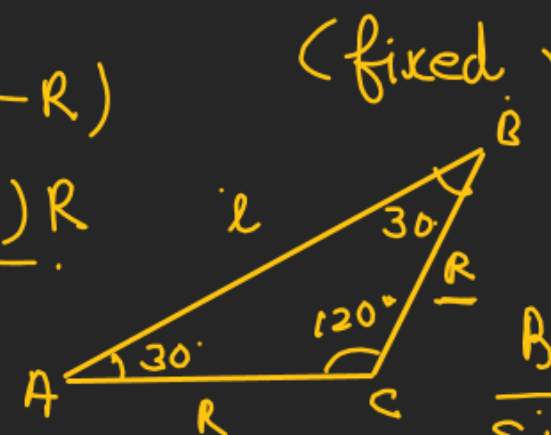
Let, x be elongation in the Spring. $x = (l_f - l_0)$

$$N = Kx \cos 30^\circ \quad \left| \quad x = (\sqrt{3}R - R) \right.$$

$$N = \left(\frac{Kx\sqrt{3}}{2} \right) \quad \left| \quad x = (\sqrt{3} - 1)R \right.$$

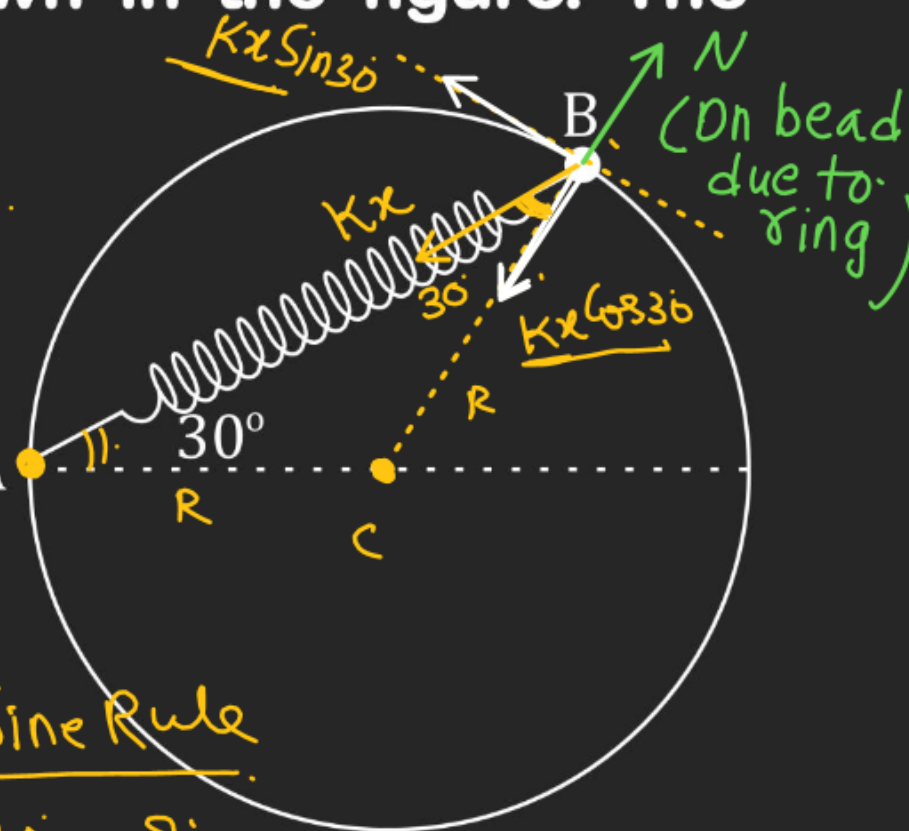
$$N = \left(\frac{\sqrt{3}}{2} \right) (\sqrt{3} - 1)R \times \frac{(\sqrt{3} + 1)mg}{R}$$

$$N = \frac{\sqrt{3}mg}{2} [(\sqrt{3})^2 - (1)^2] = \sqrt{3}mg$$



By Sine Rule
 $\frac{\sin 120^\circ}{R} = \frac{\sin 30^\circ}{l}$

$$l = \frac{R \sin 120^\circ}{\sin 30^\circ} = \frac{R(\sqrt{3}/2)}{1/2} = \sqrt{3}R$$



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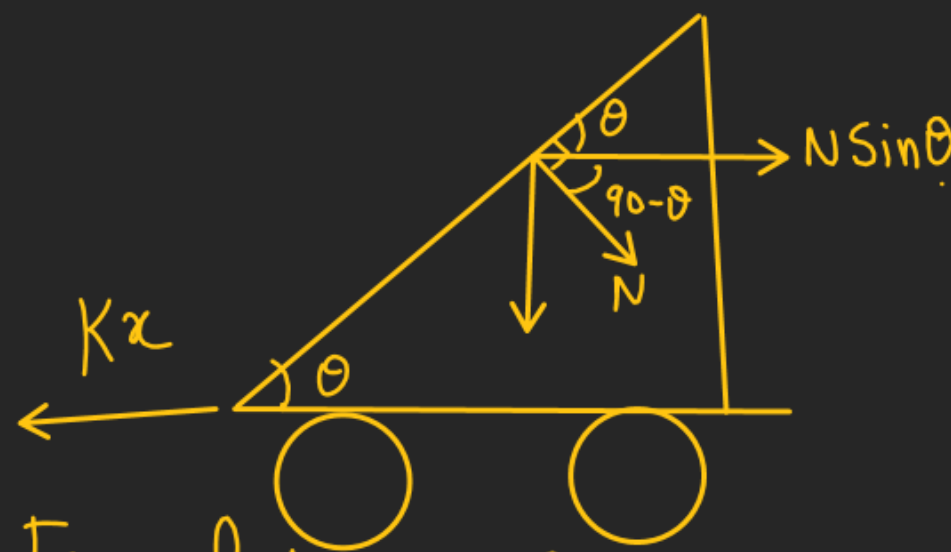
Q.4 Block B has a mass m and is released from rest when it is on top of wedge A, which has a mass $3m$. Determine the extension of the spring of force constant k while B is sliding down on A. Neglect friction: (elongation)

(A) $2mg \cos \theta / k$

(B) $\frac{mg}{2k} \cos \theta$

(C) $\frac{mg}{2k} \sin 2\theta$ ✓✓

(D) $mg \sin 2\theta / k$

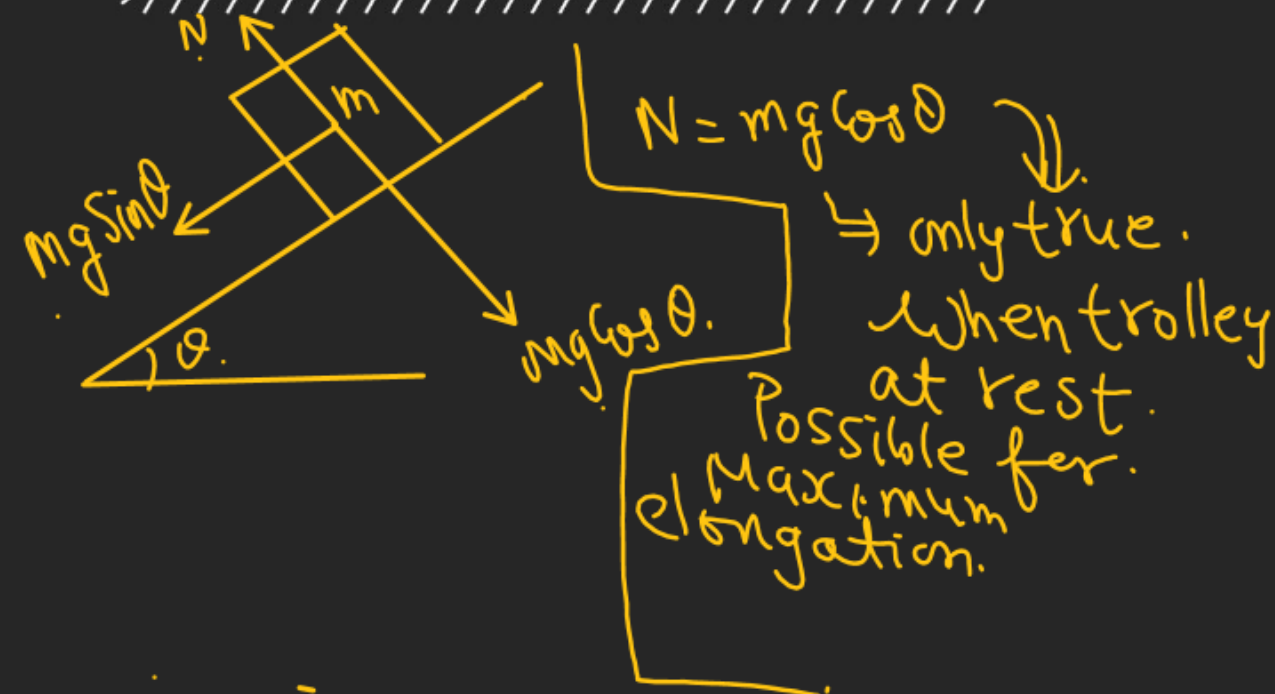
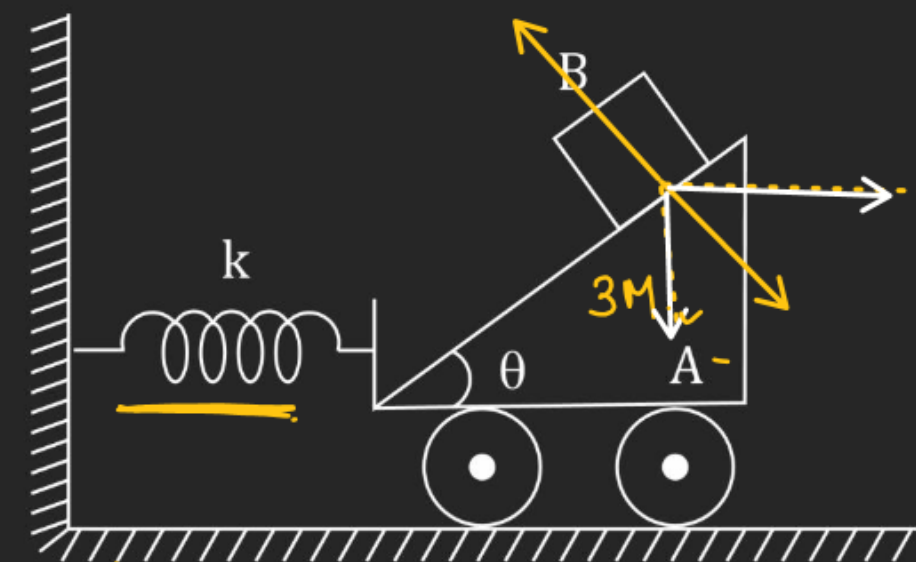


Equilibrium of trolley in

$$x = \frac{mg}{2k} (2 \sin \theta \cos \theta) \quad x - \text{direction}$$

$$N \sin \theta = Kx \quad \text{--- (1)}$$

$$x = \left[\frac{Mg}{2k} \sin 2\theta \right] \quad Mg \cos \theta \cdot \sin \theta = Kx.$$



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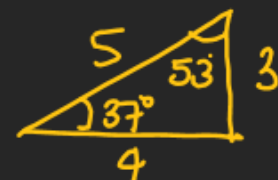
Q.6 The block shown in the figure is in equilibrium. Find the acceleration of the block just after the string burns :

(A) $\frac{3g}{5}$

(B) $\frac{4g}{5}$

(C) $\frac{4g}{3}$ ✓

(D) $\frac{3g}{4}$



Just before String is burn.
For block to be in equilibrium

$$Kx = \left(\frac{Mg}{\cos 53^\circ} \right)$$

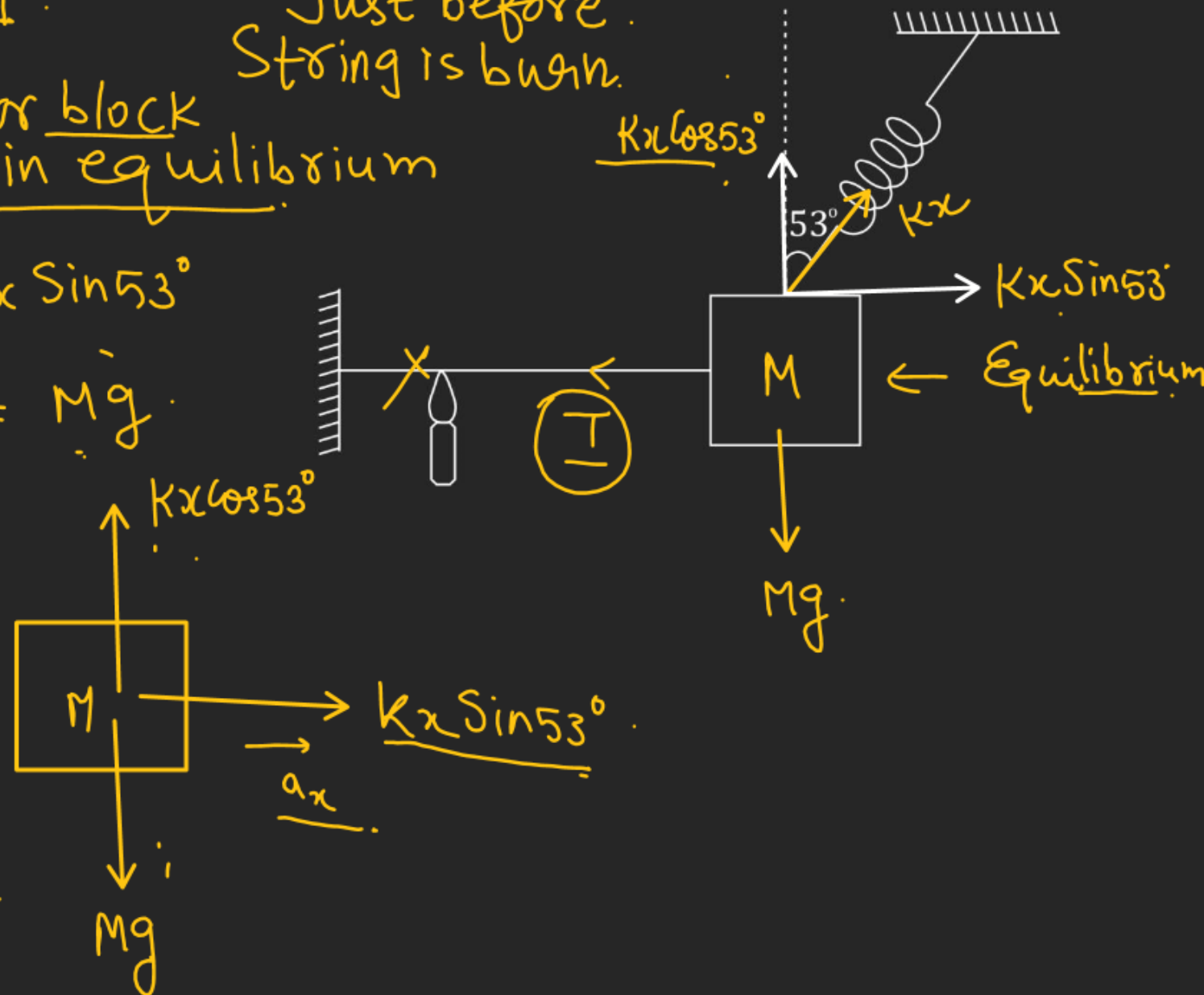
$$T = Kx \sin 53^\circ$$

$$Kx \cos 53^\circ = Mg$$

Just after String is burn.

$$a_x = \left(\frac{Kx \sin 53^\circ}{M} \right)$$

$$a_x = g \tan 53^\circ = \frac{4g}{3} \text{ m s}^{-2}$$



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Q.5 All surfaces shown in figure are smooth. System is released with the spring unstretched. In equilibrium, (compression) in the spring will be :

(A) $\frac{2mg}{k}$

(B) $\frac{(M+m)g}{\sqrt{2}k}$

(C) $\frac{mg}{\sqrt{2}k}$

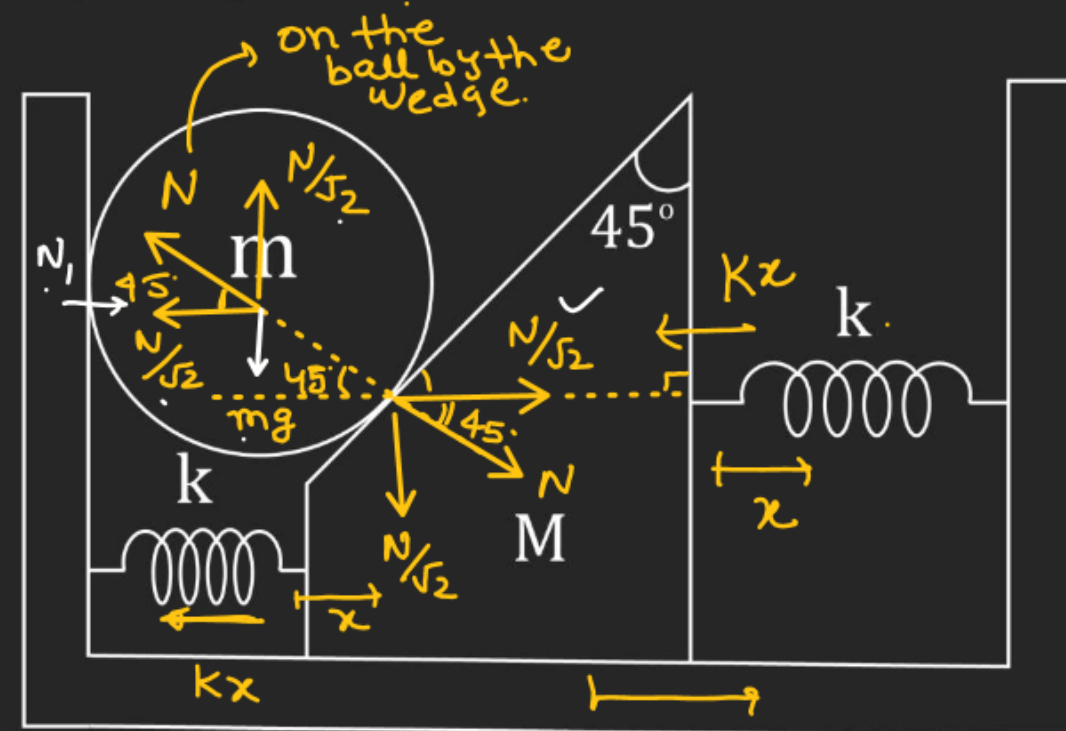
(D) $\frac{mg}{2k}$ ✓✓



(x → elongation)

(x → Compression)

F.B.D of Sphere



$$\frac{N}{\sqrt{2}} = mg$$

$$x = \frac{mg}{2k} \checkmark$$

$$N = \sqrt{2}mg \quad \text{--- (1)}$$

In x-direction

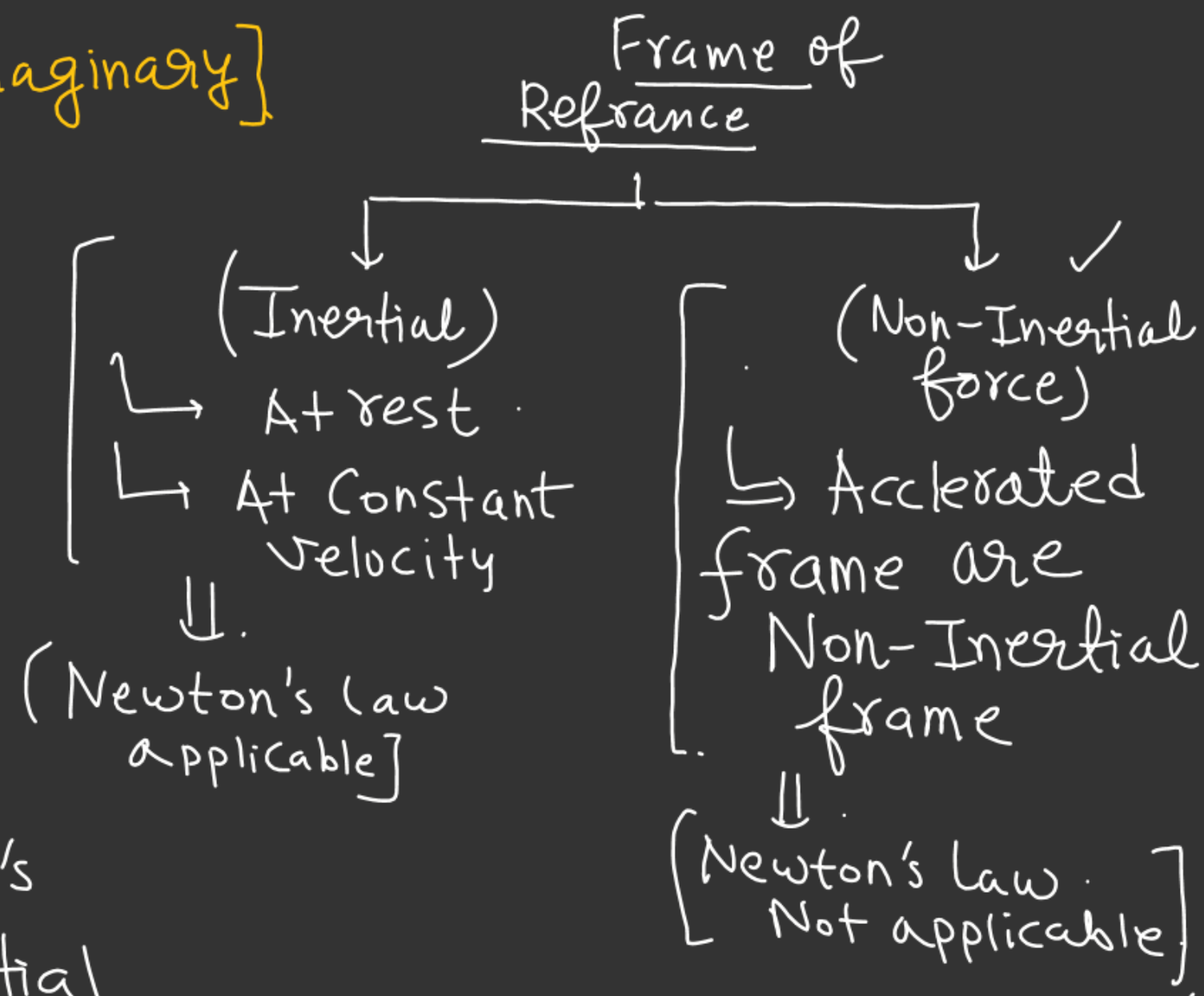
For Wedge

$$\frac{N}{\sqrt{2}} = 2kx \quad \text{--- (2)}$$

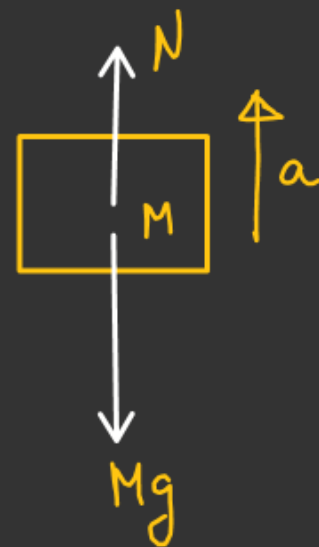
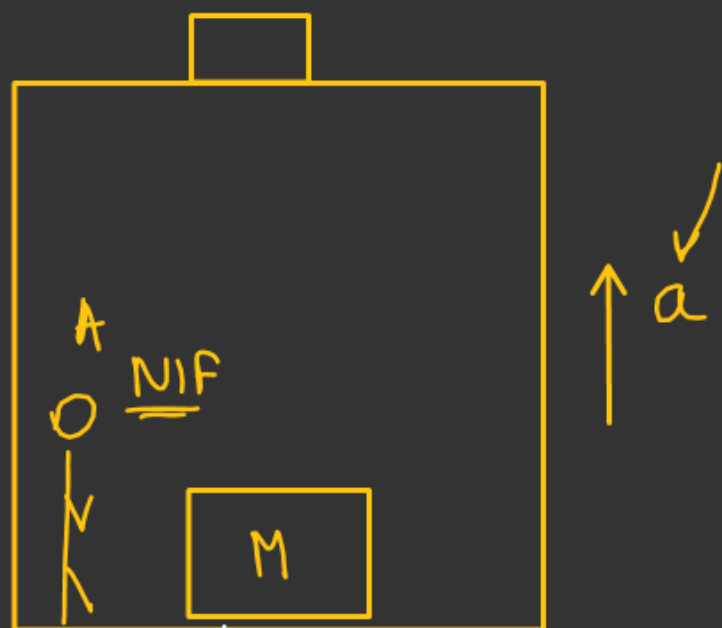
(**) Concept of Pseudo force \rightarrow \hookrightarrow झूठे \rightarrow [Imaginary]

\hookrightarrow Need of Pseudo force

\hookrightarrow In Non-Inertial frame Newton's law is not applicable. To make Newton's law applicable in Non-Inertial frame, we have to apply an imaginary force to the body, to make Newton's Law applicable in Non-Inertial frame



f.B.D w.r.t earth.

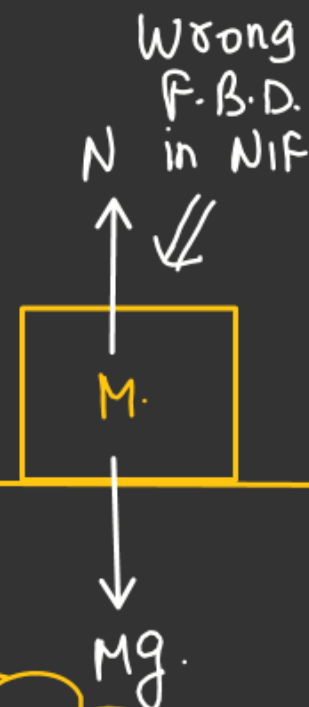


Newton's 2nd Law

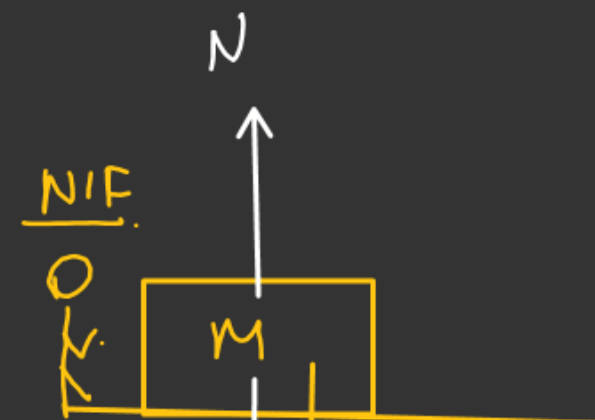
$$N - Mg = Ma$$

$$\underline{N = M(g + a)}$$

NIF



1st Law
 $N = Mg$
Wrong

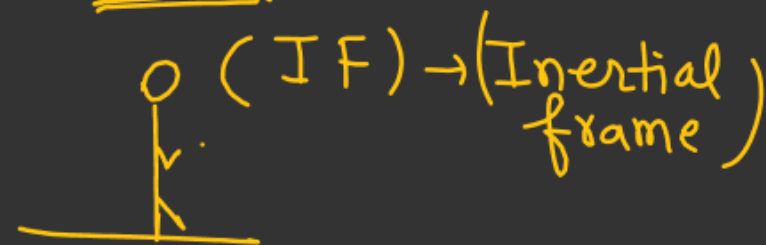


For Equilibrium of block (Newton's 1st Law)
 $N = Mg + Ma$

$$\underline{N = M(g + a)}$$

Matched

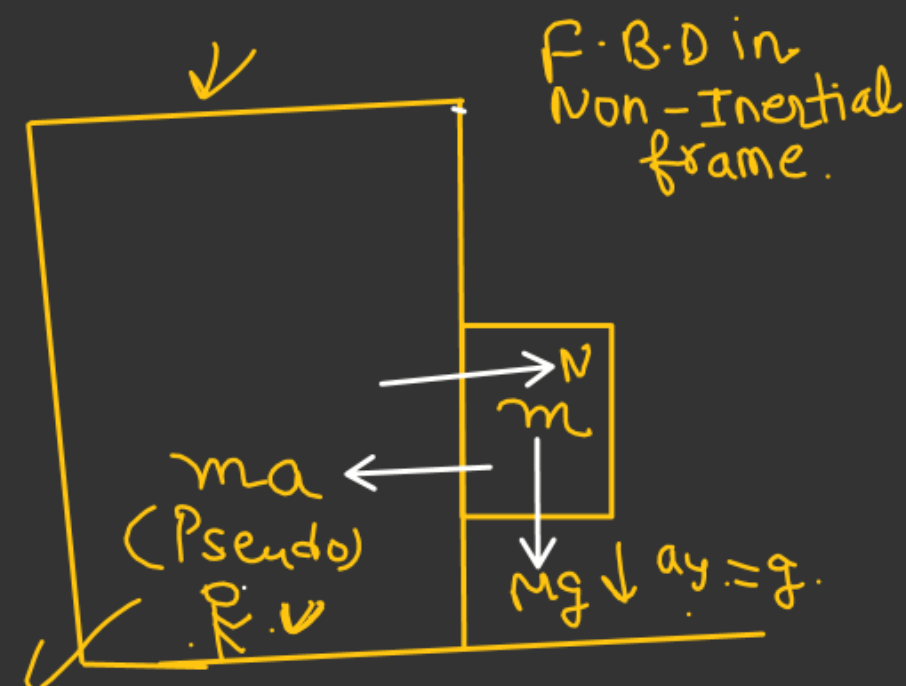
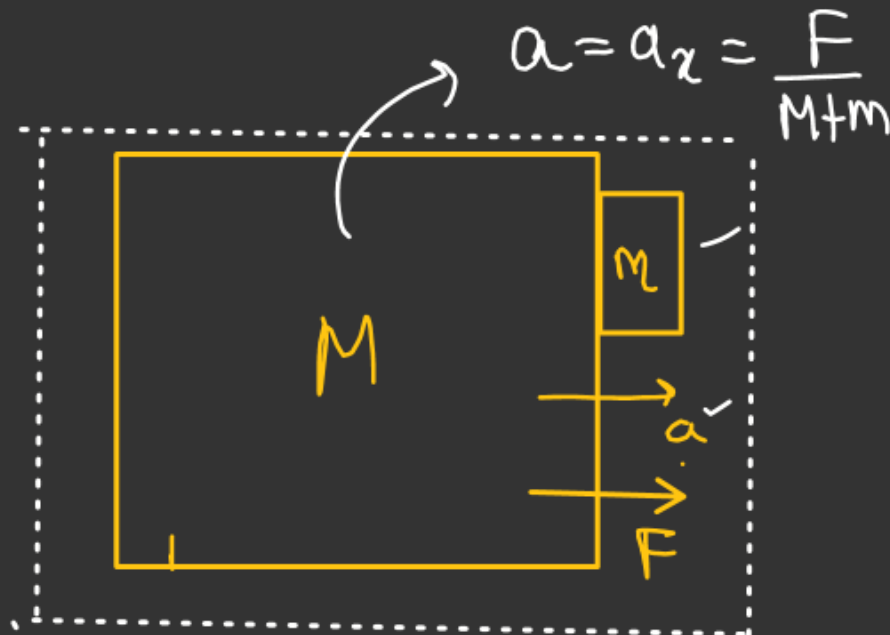
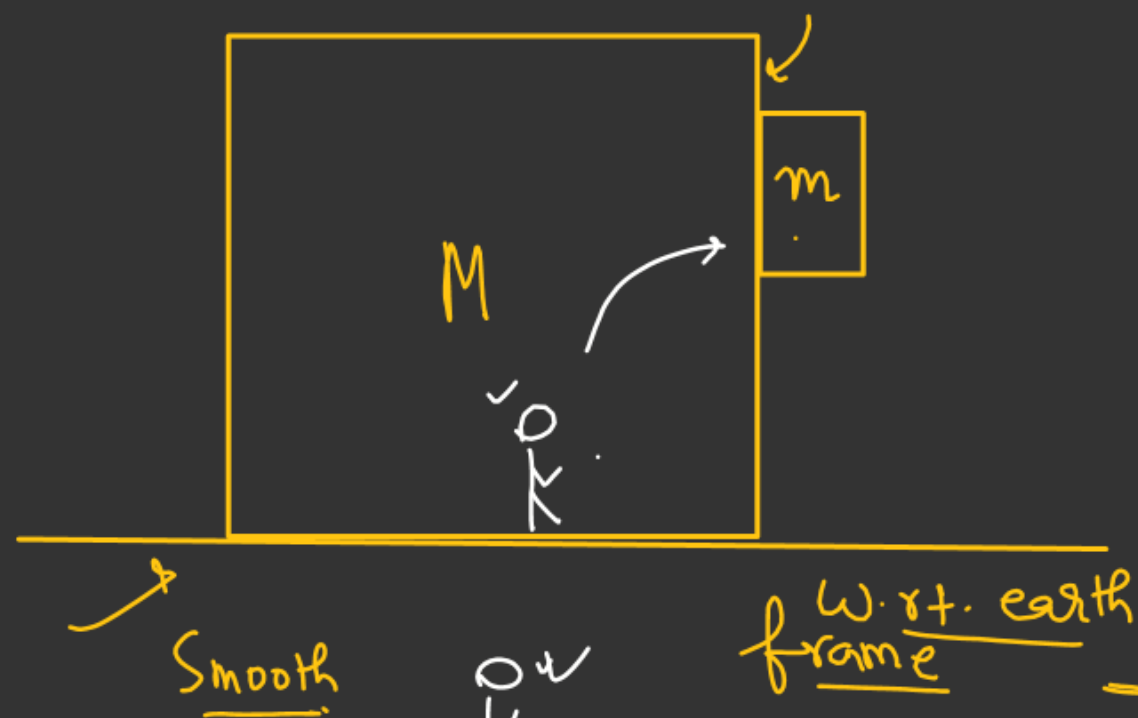
Earth



NIF \Rightarrow (Non Inertial frame)

and multiply it with mass of the body.

Smooth. # Find Normal reaction and acceleration of smaller block w.r.t earth.



In x-direction

$$N - ma = 0$$

$$N = ma = \left(\frac{mF}{M+m} \right) \Rightarrow$$

(Relative)
 $\vec{a}_{\text{block/bigger}} = (-g\hat{j})$

$\vec{a}_{\text{block/}\varepsilon} = ??$

Free Body Diagram of block m showing forces N (horizontal), Mg (vertical), and acceleration $a_y = g$. Equations derived are:
 $N = ma$
 $N = \left(\frac{mF}{M+m} \right)$

Resultant acceleration vector diagram showing components a_x and g . The magnitude of the acceleration relative to the earth is given by:
 $\Rightarrow |\vec{a}_{\text{block/}\varepsilon}| = \sqrt{g^2 + a_x^2} = \sqrt{g^2 + \left(\frac{F}{M+m} \right)^2}$