Topics to be covered

1) Laws of Motion
2) FBD , Questions on equilibrium and Motion
3) Constraint Relation
4) Friction and questions
5) Two block systems, Circular kinematics
6) Circular dynamics
7) Pseudo force

Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points +
Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

Force, Momentum and Newton's Laws

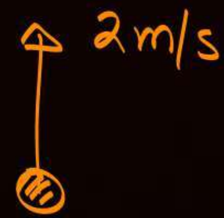
$\vec{P}$ = Momentum

$\boxed{\vec{P} = m\vec{v}}$ "Vector"

m=2kg

Case.1

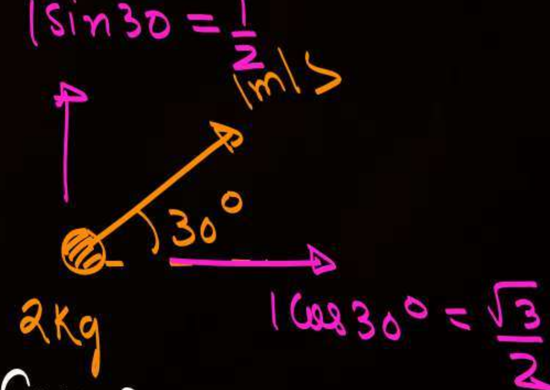
$\boxed{\vec{P} = 4\hat{i}}$



m=2kg

Case.1.

$\boxed{\vec{P} = 4\hat{j}}$



2kg

Case.3.

$\boxed{\vec{P} = 2\left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}\right)}$

Newton Laws

1. Law of Inertia

2. $\boxed{\vec{F}_{ext} = \frac{d\vec{P}}{dt}} = \frac{d}{dt} m\vec{v} = \boxed{m\frac{dv}{dt} + v\frac{dm}{dt}}$

$P = f(t)$

$\vec{F}$ = diff of $\vec{P}$

or

Slope of $P/t \Rightarrow$ Force.

$\int F \cdot dt = \int dP$

$\boxed{\int F\, dt = P_f - P_i}$

$\boxed{\circledast \text{ Area of } F/t = \Delta\vec{P}}$

If $m = \text{Const}$ $\quad \frac{dm}{dt} = 0$

$F = m\frac{dv}{dt}$

$\boxed{F = ma}$

3. For every action there is Equal & opposite Reaction

, They always act on different bodies.

Impulse

$$\boxed{\text{Change in Momentum} = \vec{P_f} - \vec{P_i} = \text{Impulse}}$$

(*) $\longrightarrow$ 1m/s. t = 2sec.

$\longrightarrow$ 5m/s.

4N for 2Sec.

2Kg 2Kg

$\longrightarrow$

$a = \frac{F}{M} = \frac{4}{2} = 2 m/s^2$

(Const).

$V = u + at$

$= 1 + 2 \times 2$

$$\boxed{V = 5 m/s}$$

(*) Impulse of Force $= \vec{P_f} - \vec{P_i}$

$= 10\hat{i} - 2\hat{i}$

$$\boxed{\vec{J} = 8\hat{i}}$$

II^{nd} Law

$$F = \frac{dP}{dt}$$

$$\int dP = \int F \cdot dt$$

$$\vec{P_f} - \vec{P_i} = \int F\,dt$$

\+ F speed ↑

$$\boxed{P_f = P_i \pm \int F\,dt}$$

− Force speed ↓

Impulse Momentum theorem

$F_{ext} = 4N$ for $t = 2sec$

$$\vec{P_f} = \vec{P_i} + \int_0^2 4\,dt$$

$$P_f = 2 + 4(t)_0^2$$

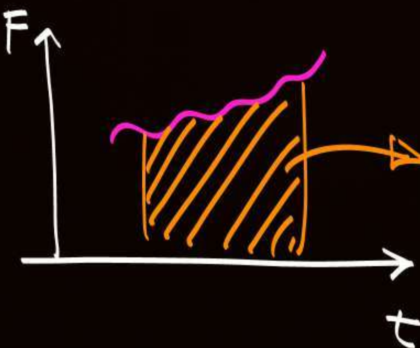
$$\boxed{P_f = 10}$$

$$\text{Impulse} = \vec{P_f} - \vec{P_i}$$

$$= \int_{t_1}^{t_2} F\,dt$$

Ex :- $F = t^2$ find Impulse $t = 0 \rightarrow t = 2$.

$=$



Area = Impulse.

QUESTION- 01

A particle of mass m strikes a wall with speed v at an angle $30°$ with the wall elastically as shown in the figure. The magnitude of impulse imparted to the ball by the wall is

(1) mv Ans

(2) $mv/2$

(3) $2\,mv$

(4) $\sqrt{3}\,mv$

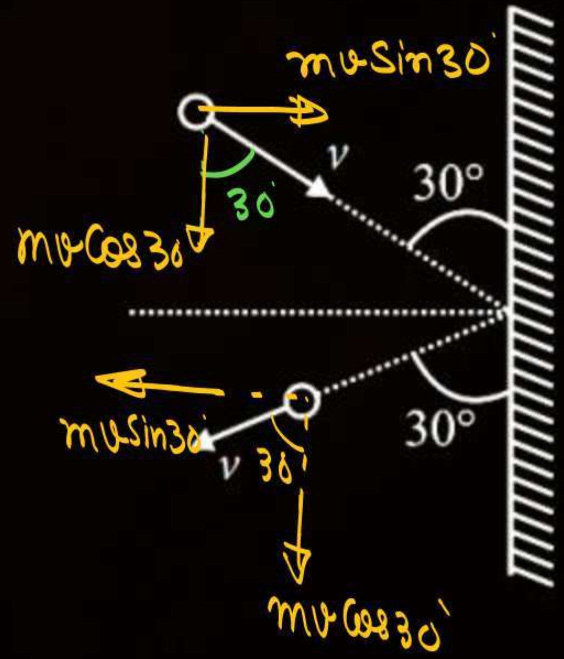
|Change in $\vec{P}$|

$$\vec{P_i} = \frac{mv}{2}\hat{i} - \frac{mv\sqrt{3}}{2}\hat{j}$$

$$\vec{P_f} = -\frac{mv}{2}\hat{i} - \frac{mv\sqrt{3}}{2}\hat{j}$$

$$\vec{P_f} - \vec{P_i} = -\frac{mv}{2}\hat{i} - \frac{mv}{2}\hat{i}$$

$$\boxed{\Delta P = -mv\hat{i}}$$



QUESTION- 02

If n balls hit elastically and normally on a surface per unit time and all balls of mass m are moving with same velocity u, then force on surface is:

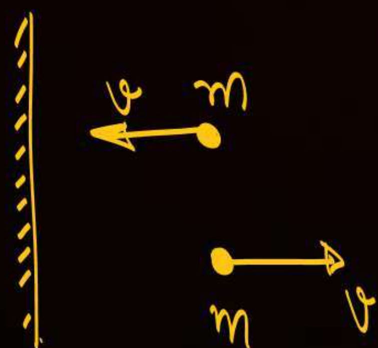
(1) mun

(2) $2\,mun$ Ans

(3) $1/2\,mu^2n$

(4) mu^2n

$n = \frac{\text{no of balls}}{\text{sec.}} = \frac{N}{\Delta T}$



$\vec{\Delta P} = \vec{P}_f - \vec{P}_i = mv\hat{i} - (-mv\hat{i})$

$= 2mv.$

ΔP for 1 ball $= 2mv.$

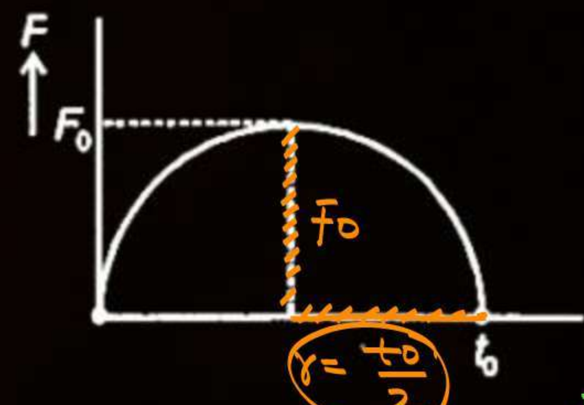
N balls $= 2Nmv.$

$F = \frac{\Delta P}{\Delta T}$

$= \frac{2Nmv}{\Delta T} = 2nmv$

QUESTION- 03

A variable force acts on a particle of mass m from $t = 0$ to $t = t_0$. the F - t plot is a semicircle. The particle is initially at rest then Velocity acquired by particle is



$t = 0 \quad u = 0$

Area of $F/t = \overline{P_f} - \overline{P_i}$

Area of Semi-Ellipse $= P_f$ $\quad \frac{\pi F_0^2}{2m}$

$$\frac{\pi F_0 \left(\frac{t_0}{2}\right)}{2} = m v_f \Rightarrow \boxed{v_f = \frac{\pi F_0 t_0}{4m}}$$

Circle $\longrightarrow$ Ellipse

$F_0 = \frac{t_0}{2}$

$a = b = r$ $\quad$ Area $= \pi ab.$

$A = \pi r^2$ $\quad$ Area of Semi $= \frac{\pi ab}{2}.$

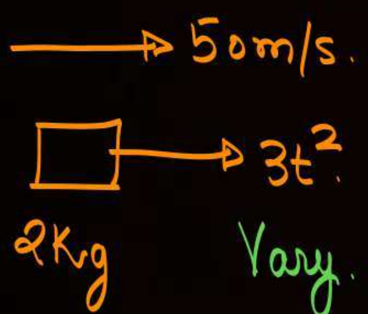
QUESTION- 04

A force $F = 3t^2$ N acts on a body of mass 2 kg. Initial velocity of body is 50 m/s along x-axis. Find velocity of body after 2s.

Case-1: If force is parallel to velocity.

Case-2: If force is anti-parallel to velocity. (HW).

Case-1



$$\boxed{\vec{P_f} = \vec{P_i} \pm \int F dt}$$

$t = 0$

$u = 50$ m/s.

$\vec{P} = m\vec{v} = 100.$

$$P_f = 100 + \int_0^2 3t^2 dt$$

$$2(v_f) = 100 + 3\int_0^2 t^3 dt = 100 + 8$$

$$v_f = \frac{108}{2}$$

$$\boxed{v_f = 54}$$

Free Body Diagram

"FBD"

Body Ko Seperately draw Karke usko force Ko banana.

$\Downarrow$

F.B.D.

Weight | Normal reaction

⇒ Force.

⇒ Pull of Earth.

⇒ Towards Earth.

⇒ $\text{Weight} = mg$.

⇒ Contact force.

⇒ Push force. (body Ko dur Karenge)

⇒ $\perp$ to Contact.

Free Body Diagram (Force in Pulley)

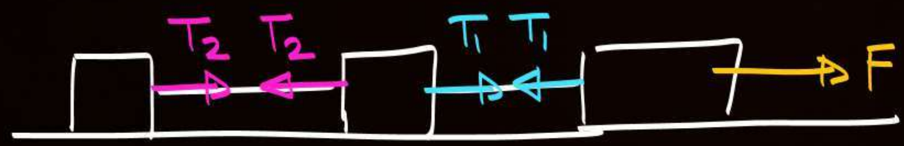
- Strings will be massless unless mentioned.
- They are inextensible {l = constant} There will be no Elongation
- When in stretched condition, force is developed in string $\rightarrow$ Tension
- One string one tension
- Always pull force.
- Tension always along thread.

String $\longrightarrow$ Dhaaga.

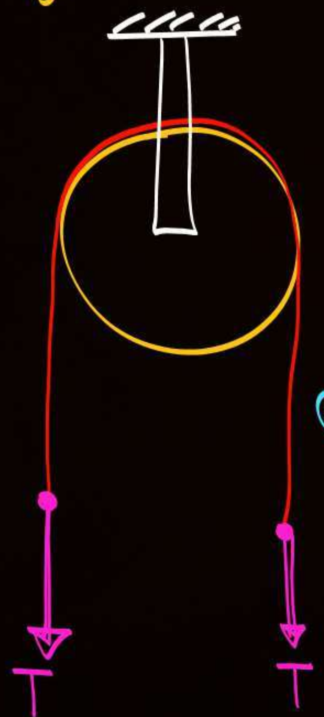
$\longrightarrow$ (Massless) & (in-extensible) (L = Constant).

$\longrightarrow$ Tension in one string $\Longrightarrow$ Same.

$\longrightarrow$ Pull force.



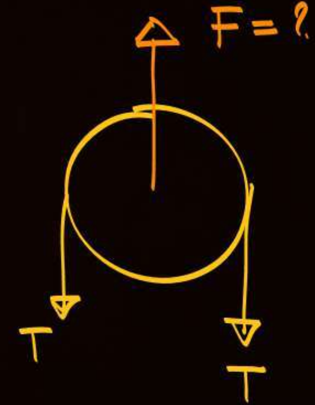
Pulley $\longrightarrow$ Massless. & frictionless. (Pulley doesnot Rotate)



Mass = 0

$F_{net} = 0$

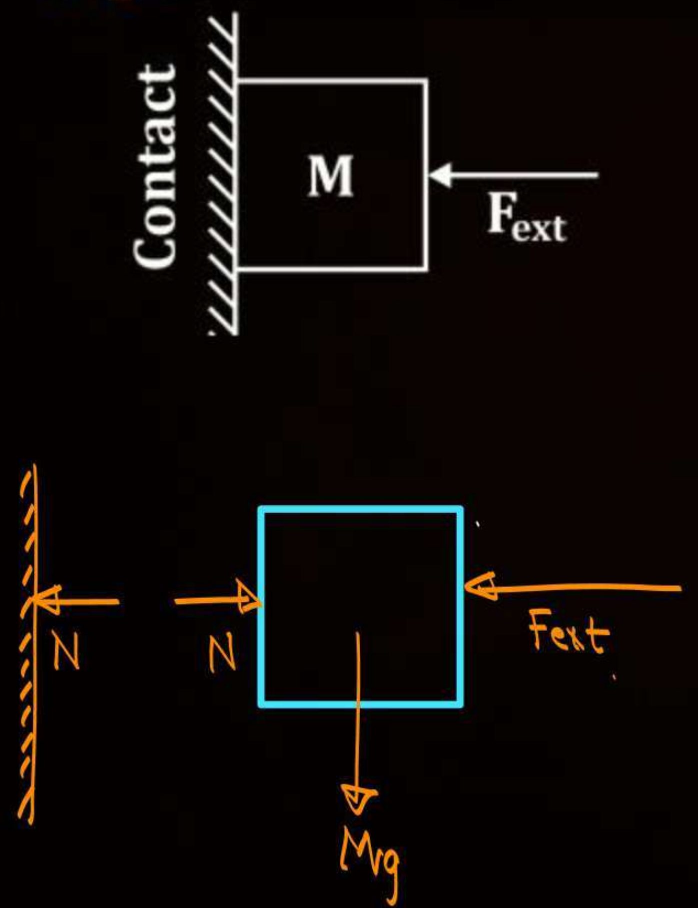
* always Even if it is accelerated.

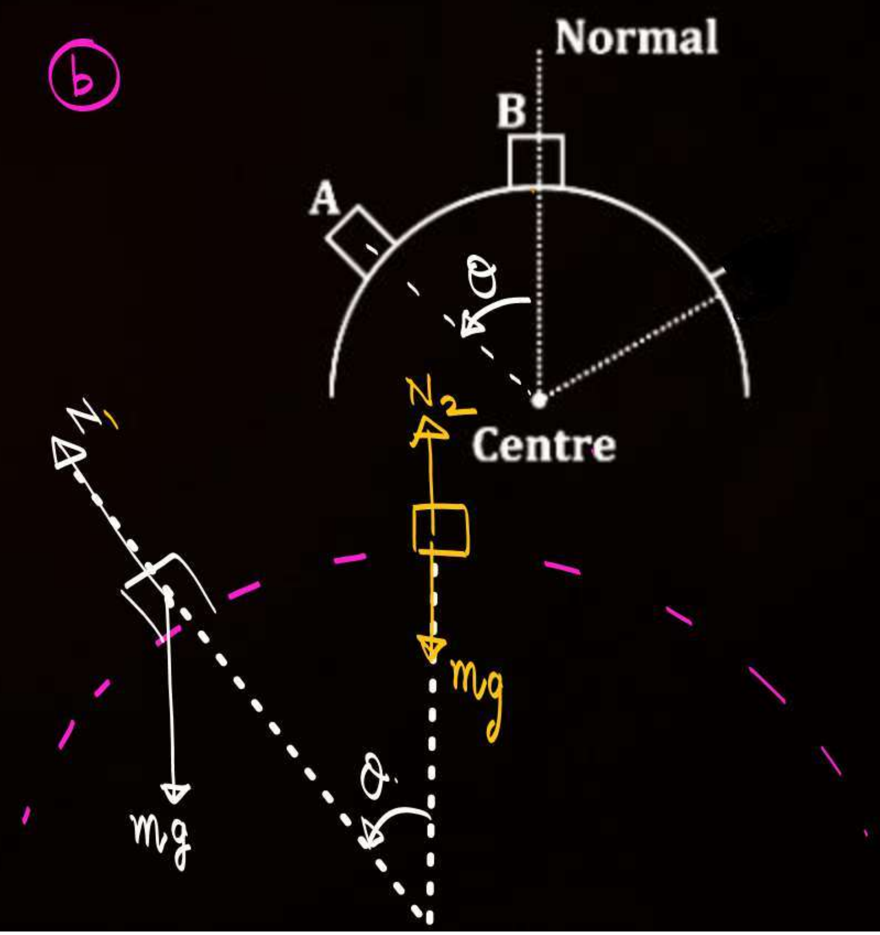


$F_{upward} = F_{downward}$

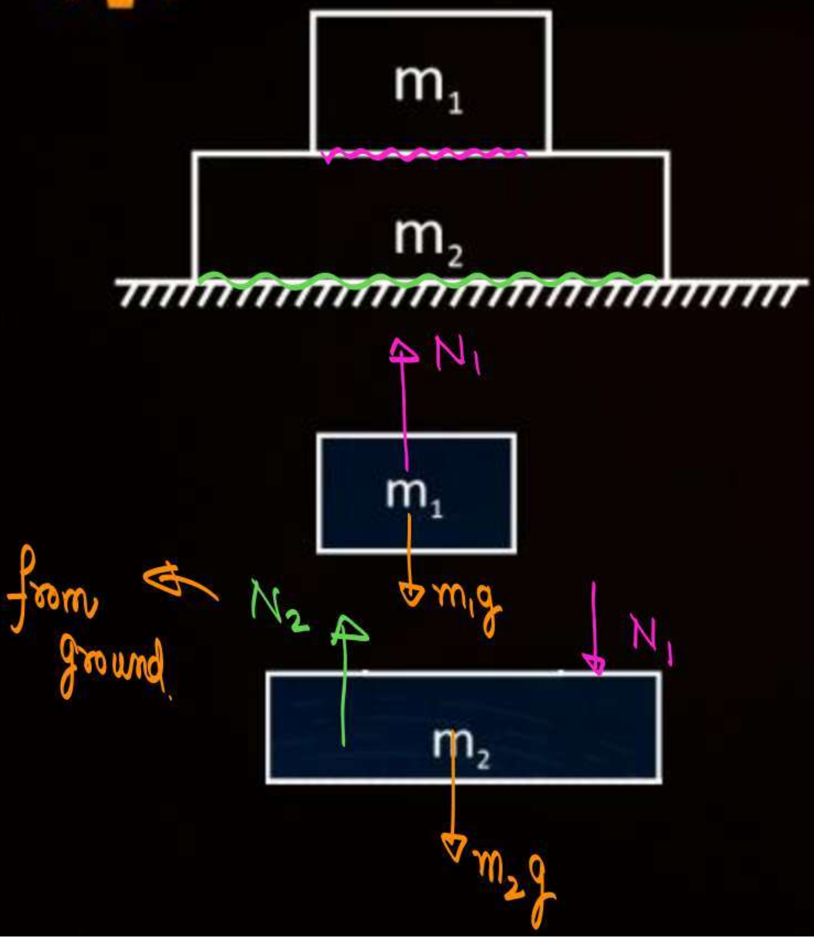
$\boxed{F = 2T}$

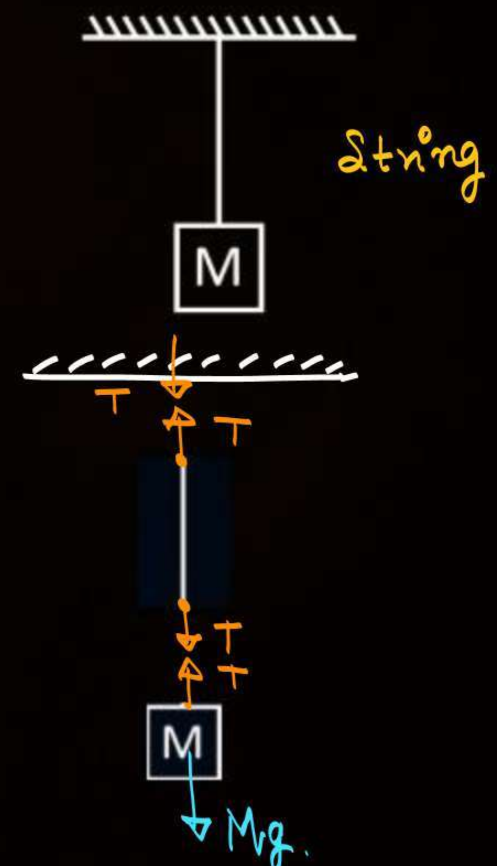
Draw Free Body Diagram



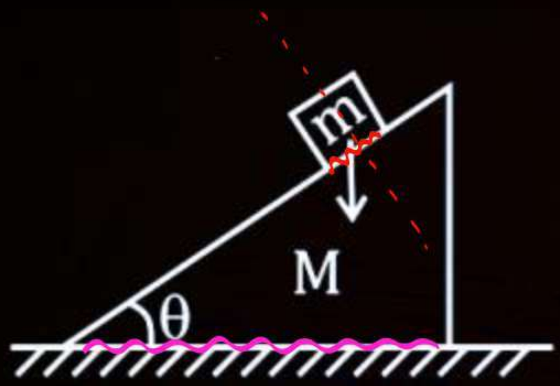


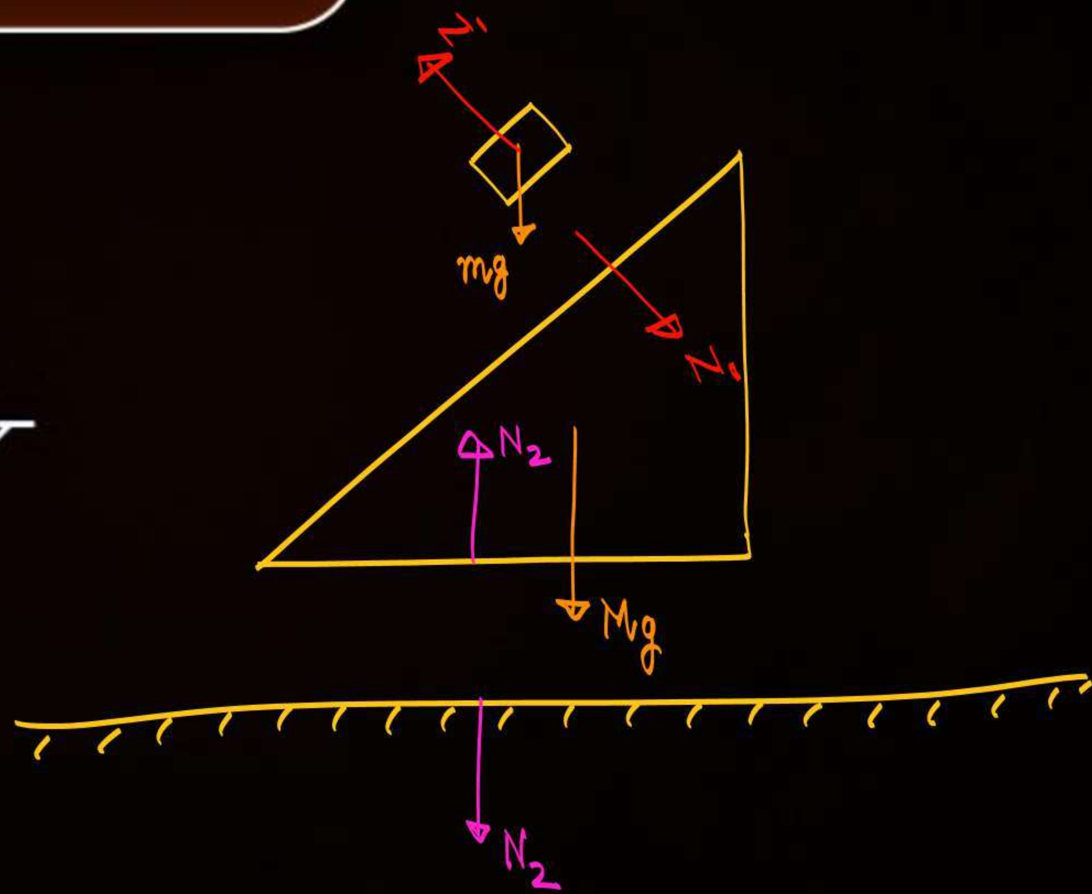
Draw Free Body Diagram



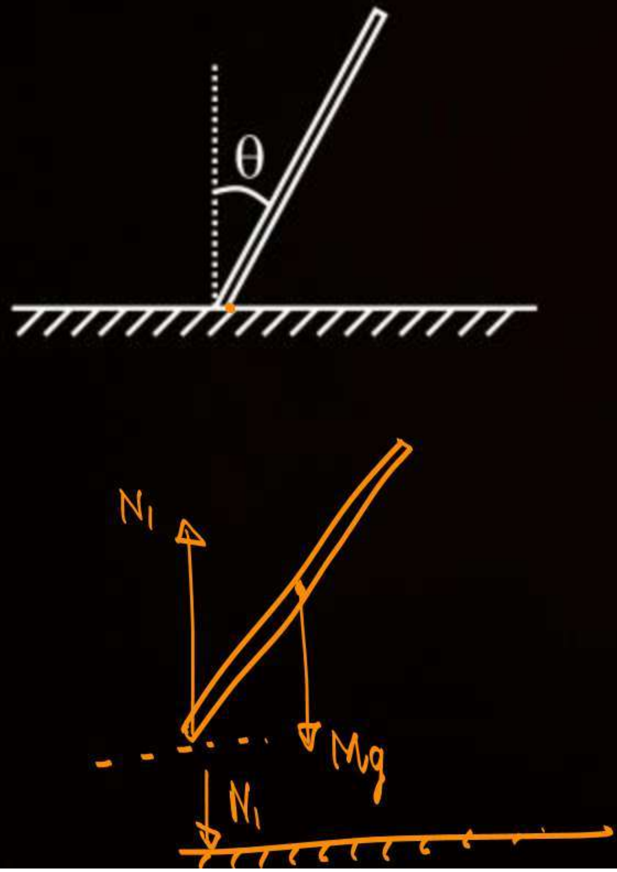


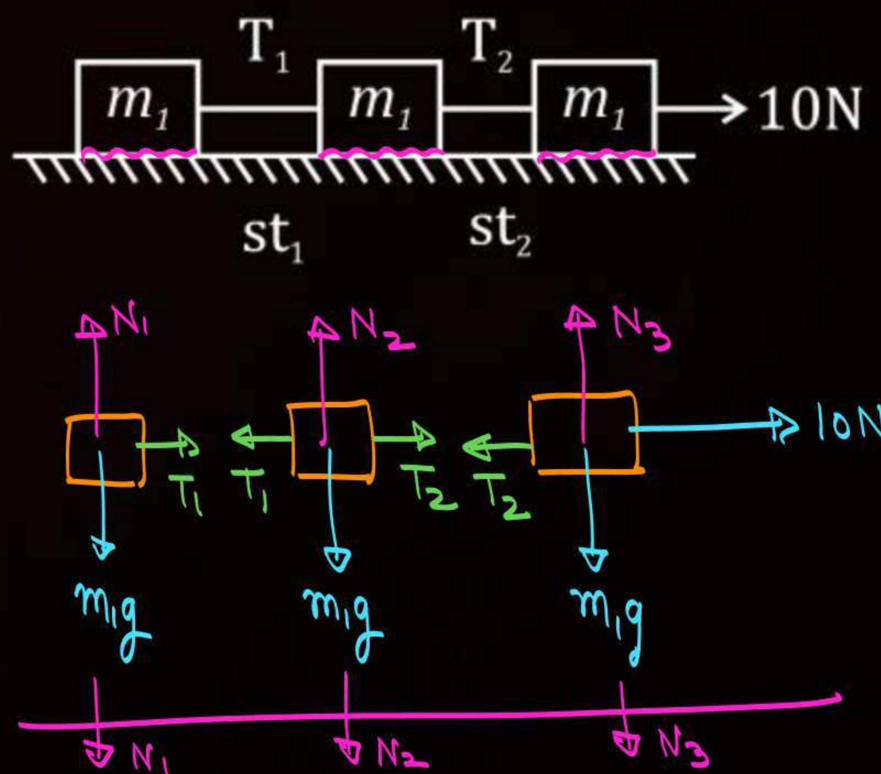
Draw Free Body Diagram



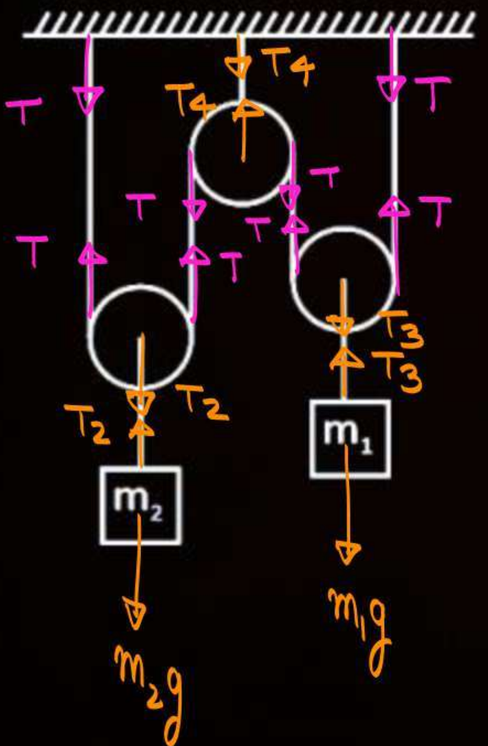


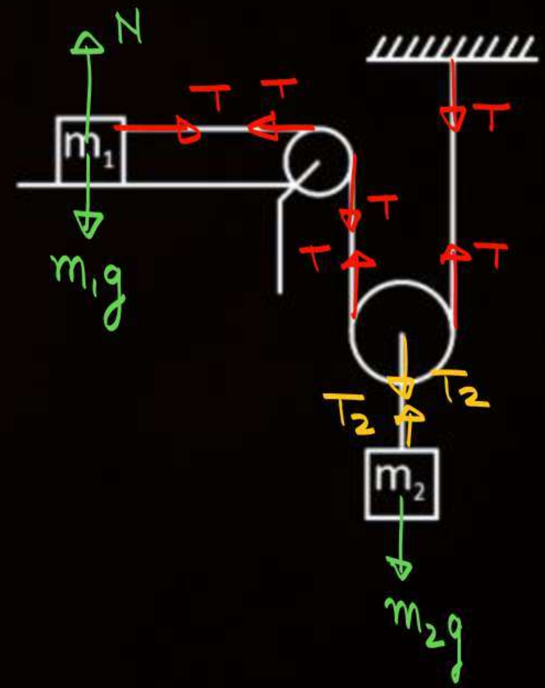
Draw Free Body Diagram





Draw Free Body Diagram





Equilibrium

State of body. $\Longrightarrow$ Rest

or

Moves with Constant Velocity.

* Draw F.B.D.
* Reslove Force along X & Y.
* $\Sigma F_{net} = 0$ along X & Y.

$$\boxed{\sum F_{net} = 0}$$

QUESTION- 05

A uniform sphere of weight w and radius 3 m is being held by a string of length 2 m, attached to a frictionless wall as shown in the figure. The tension in the string will be:

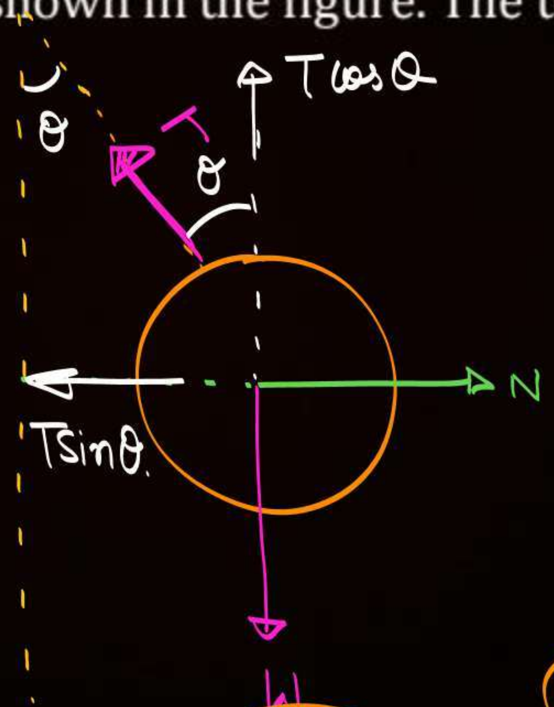
mg

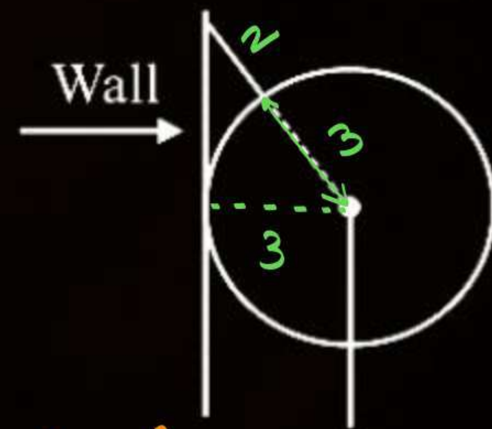
(1) $5w/4$ Ans

(2) $15w/4$

(3) $15w/16$

(4) none of these



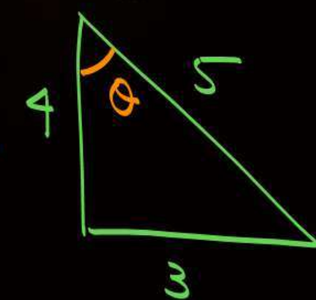


$T\sin\theta = N$

$T\cos\theta = W$

$T\cdot\left(\frac{4}{5}\right) = W$

$T = \frac{5W}{4}$



Pdf & Notes ⇒ PW app
from Manzil batch.

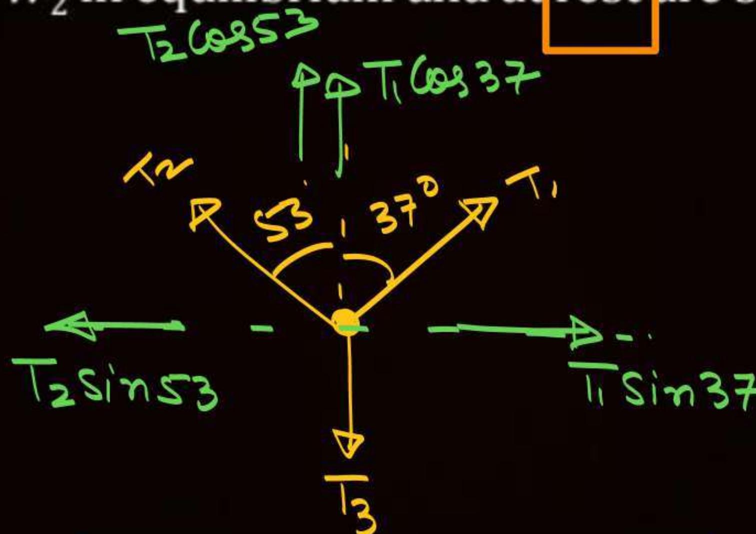
Theory → Imp points +
Formula.

Questions → Q.no
→ Solution

QUESTION- 06

Equilibrium.

Two weights W_1 and W_2 in equilibrium and at $\boxed{\text{rest}}$ are suspended as shown in figure. Then the ratio $\frac{W_1}{W_2}$ is



(1) 5/4

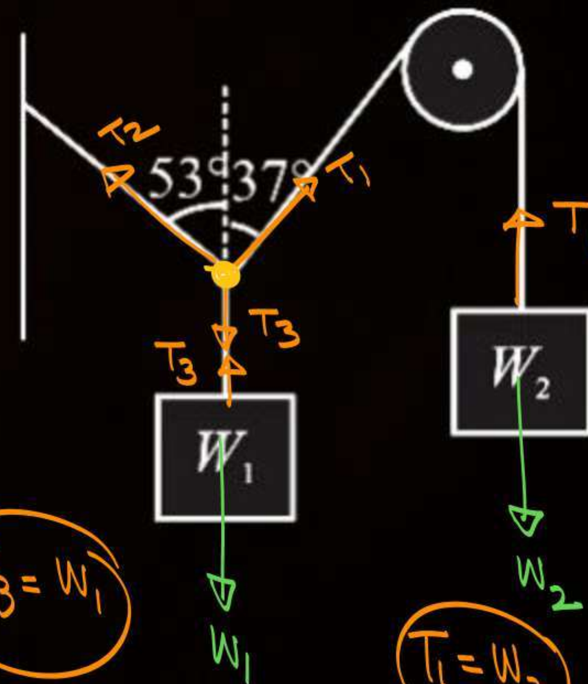
(2) 4/5

(3) 8/5

(4) None of the these

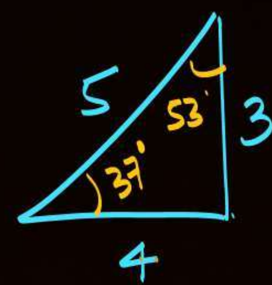
$$T_1 \sin 37 = T_2 \sin 53$$

$$T_1 \cos 37 + T_2 \cos 53 = T_3$$



$T_3 = W_1$

$T_1 = W_2$



$$T_1 = w_2$$
$$T_3 = w_1$$

$$\circledast\ T_1\left(\frac{3}{5}\right) = T_2\left(\frac{4}{5}\right)$$

$$\boxed{3T_1 = 4T_2}$$

$$T_2 = \frac{3T_1}{4}$$

$$\circledast\ T_1\left(\frac{4}{5}\right) + T_2\left(\frac{3}{5}\right) = T_3$$

$$4w_2 + 3T_2 = 5w_1$$

$$4w_2 + 3\left(\frac{3T_1}{4}\right) = 5w_1$$

$$\boxed{4w_2 + \frac{9w_2}{4} = 5w_1}$$

Solve.

QUESTION- 07

Two smooth spheres each of radius 5 cm and weight W rest one on the other inside a fixed smooth cylinder of radius 8 cm. The reactions between the spheres and the vertical side of the cylinder are:

Cylinder → $R = 8$ cm

dia $= 16$ cm.

(1) $5W/4$ and $3W/4$

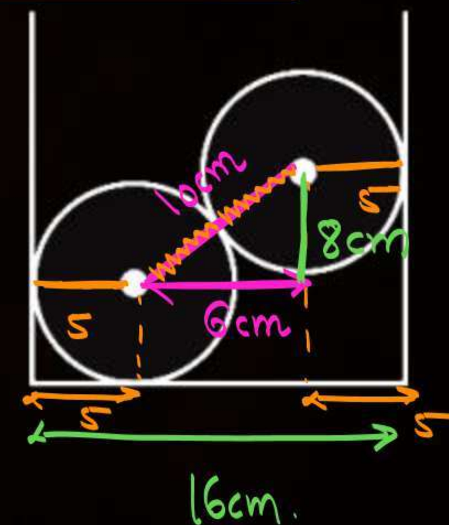
(2) $W/4$ and $W/4$

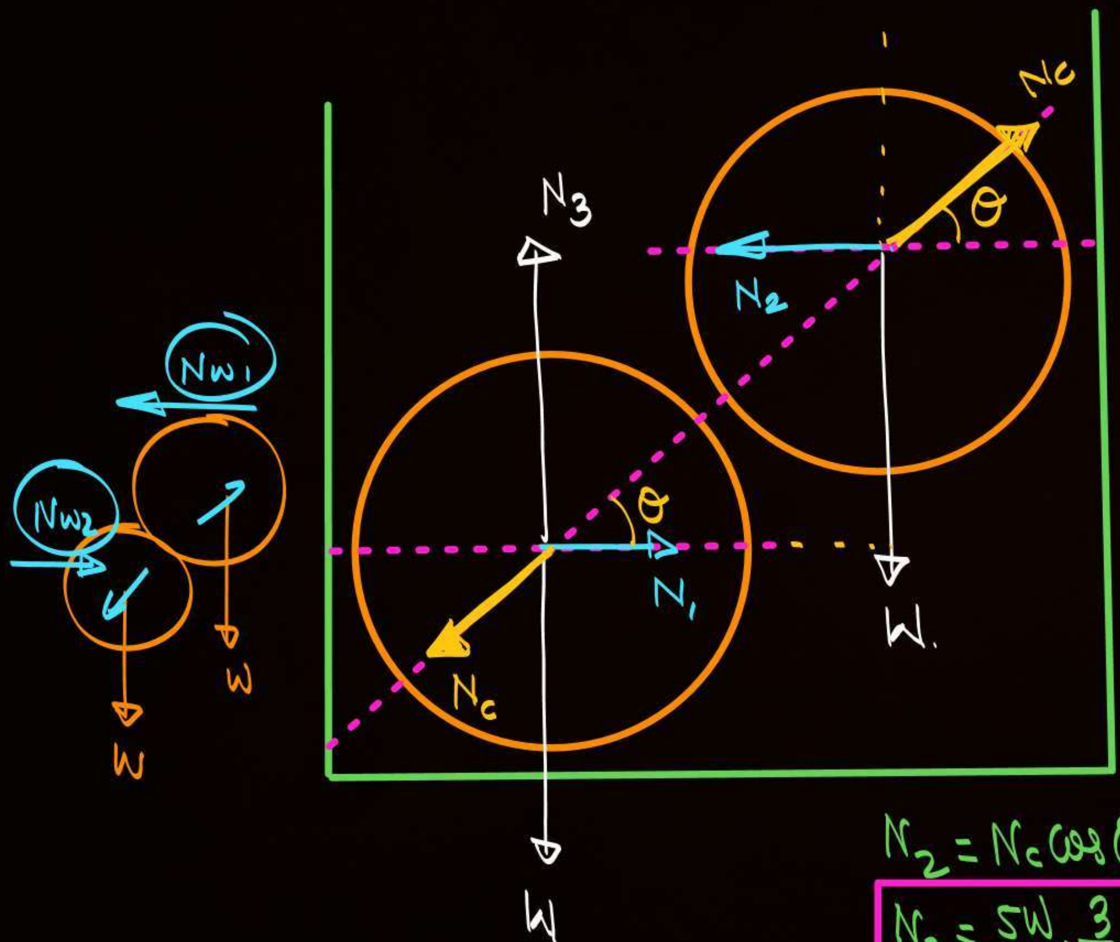
(3) $3W/4$ and $3W/4$

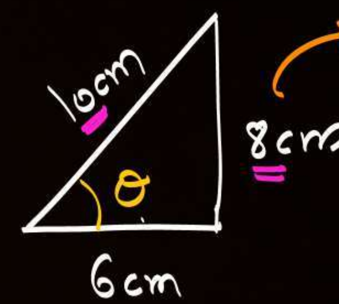
(4) W and W

$N_{wall} = \frac{3W}{4}$

$N_C = \frac{5W}{4}$.

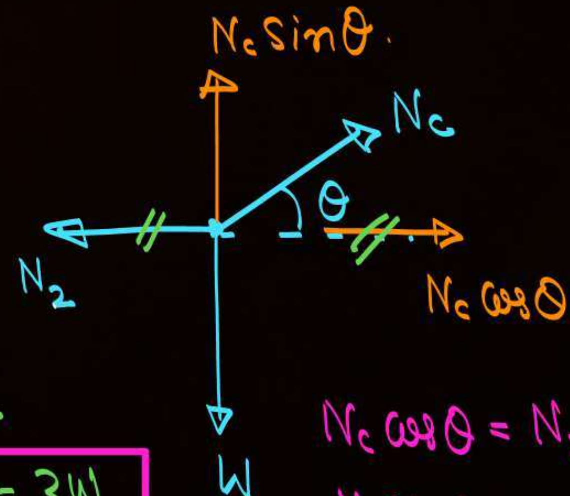






→ Pythogoras.

$$\sqrt{10^2-6^2}$$
$$= 8$$



$$N_c \cos\theta = N_2$$
$$N_c \sin\theta = W.$$

$$N_c \frac{8}{10} = W$$

$$N_c = \frac{5W}{4}$$

Ans.

$$N_2 = N_c \cos\theta$$

$$\boxed{N_2 = \frac{5W}{4} \cdot \frac{3}{5} = \frac{3W}{4}}$$

QUESTION- 08

Two masses M_1 to M_2 connected by means of a string which is made to pass over light, smooth pulley are in $\boxed{\text{equilibrium}}$ on a fixed smooth wedge as shown in figure. If $\theta = 60°$ and $\alpha = 30°$, then the ratio of M_1 to M_2 is:

(1) $1:2$

(2) $2:\sqrt{3}$

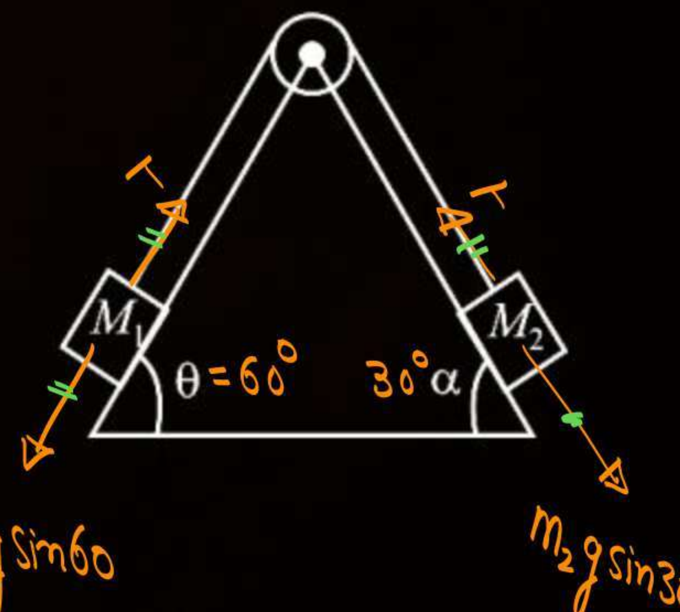
(3) $1:\sqrt{3}$ Ans.

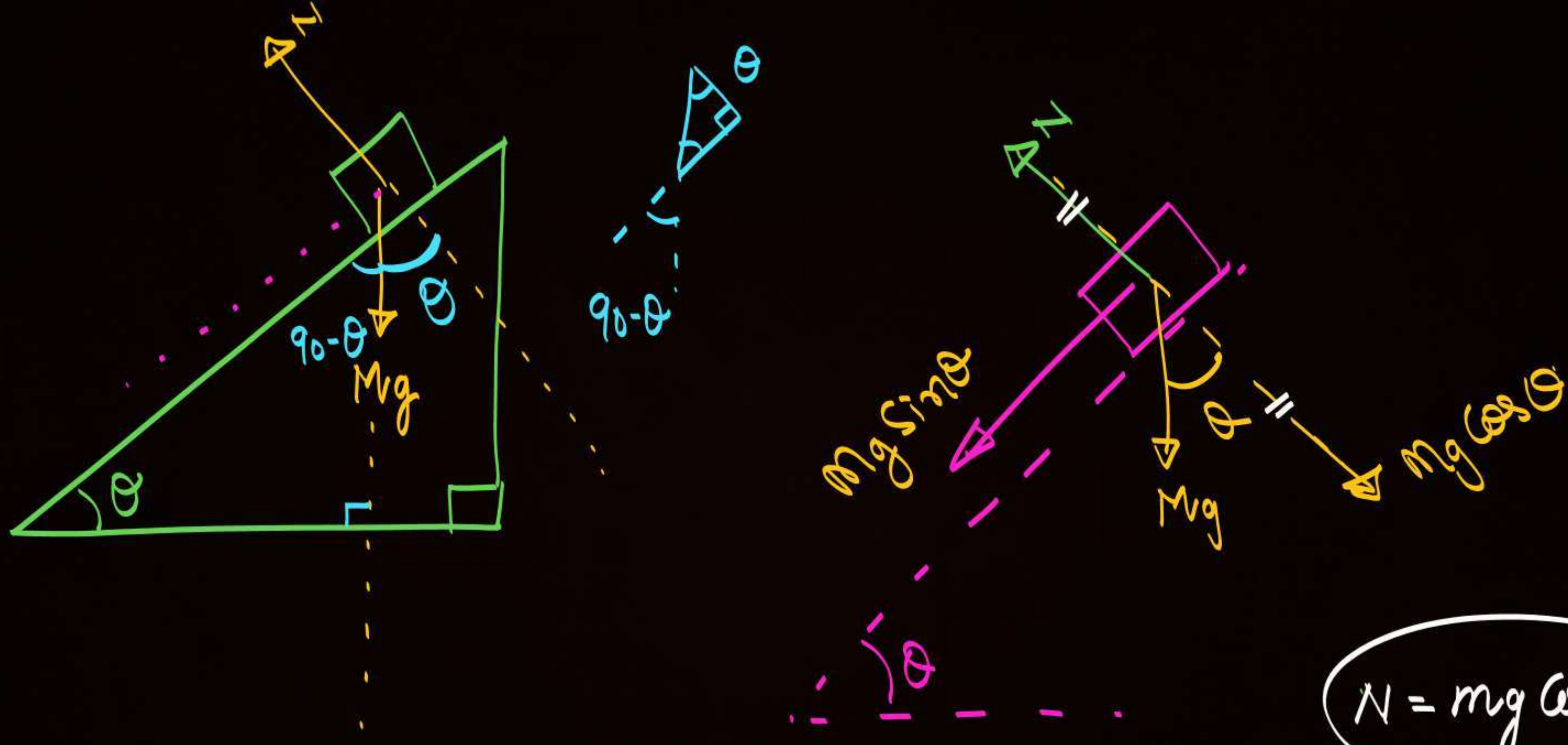
(4) $\sqrt{3}:1$

$$m_1 \cancel{g} \sin 60 = T = m_2 \cancel{g} \sin 30$$

$$\frac{m_1}{m_2} = \frac{1}{\cancel{2}} \times \frac{\cancel{2}}{\sqrt{3}}$$

$$= \frac{1}{\sqrt{3}}$$





Equili

$N = mg\cos\theta$

$Mg\sin\theta \Rightarrow$ Motion

QUESTION- 09

Figure shows a man of mass 50 kg standing on a light weighing machine kept in a box of mass 30 kg. The box is hanging from a pulley fixed to the ceiling through a light rope, the other end of which is held by the man himself. If the man manages to keep the box at rest, the weight shown by the machine is:

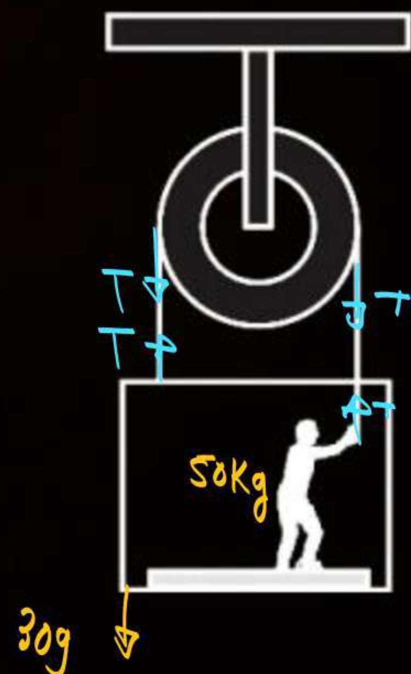
Weighing Machine ⇒ Normal Rxtn.

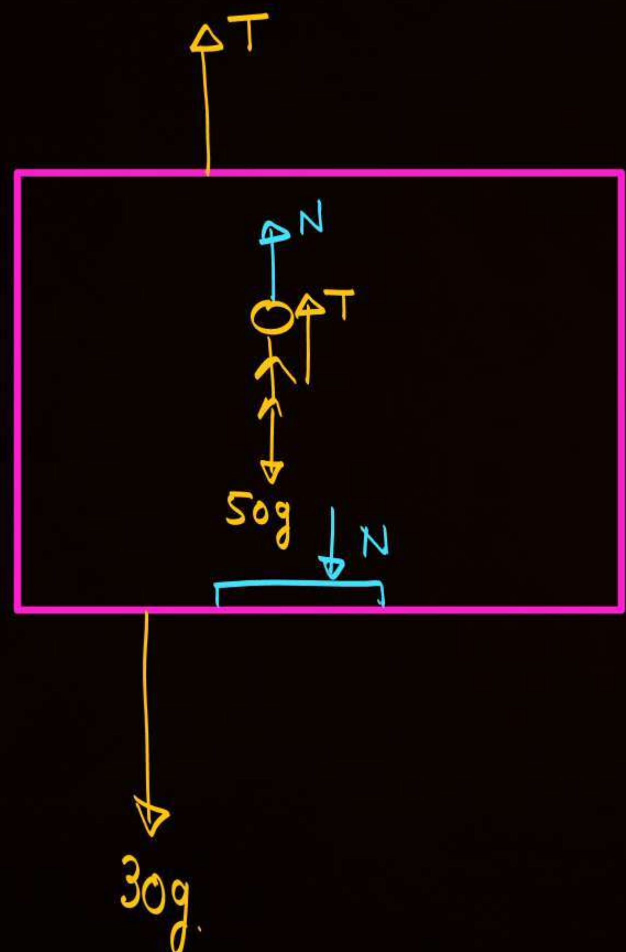
(1) 10 N

(2) 100 N

(3) 800 N

(4) 200 N





Person "Rest" = $\boxed{N+T=500}$

Box " Rest $\quad T = 300 + N.$

$$N+300+N=500$$

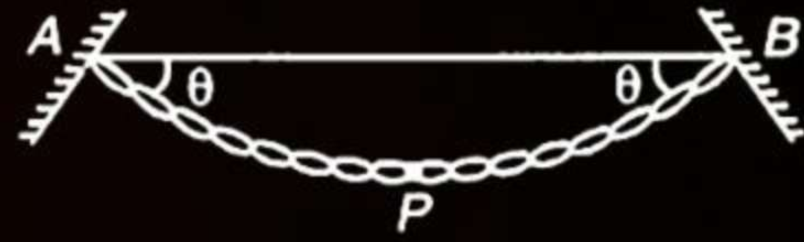
$$2N=200$$

$$N=100$$

Report $\Longrightarrow$ 10 Kg $\quad$ Weight = 100 N.

QUESTION- 10

A flexible chain of mass m hangs between two fixed points A and B at the same level. The inclination of the chain with the horizontal at the two points of support is θ. The tension at the mid point of the chain is



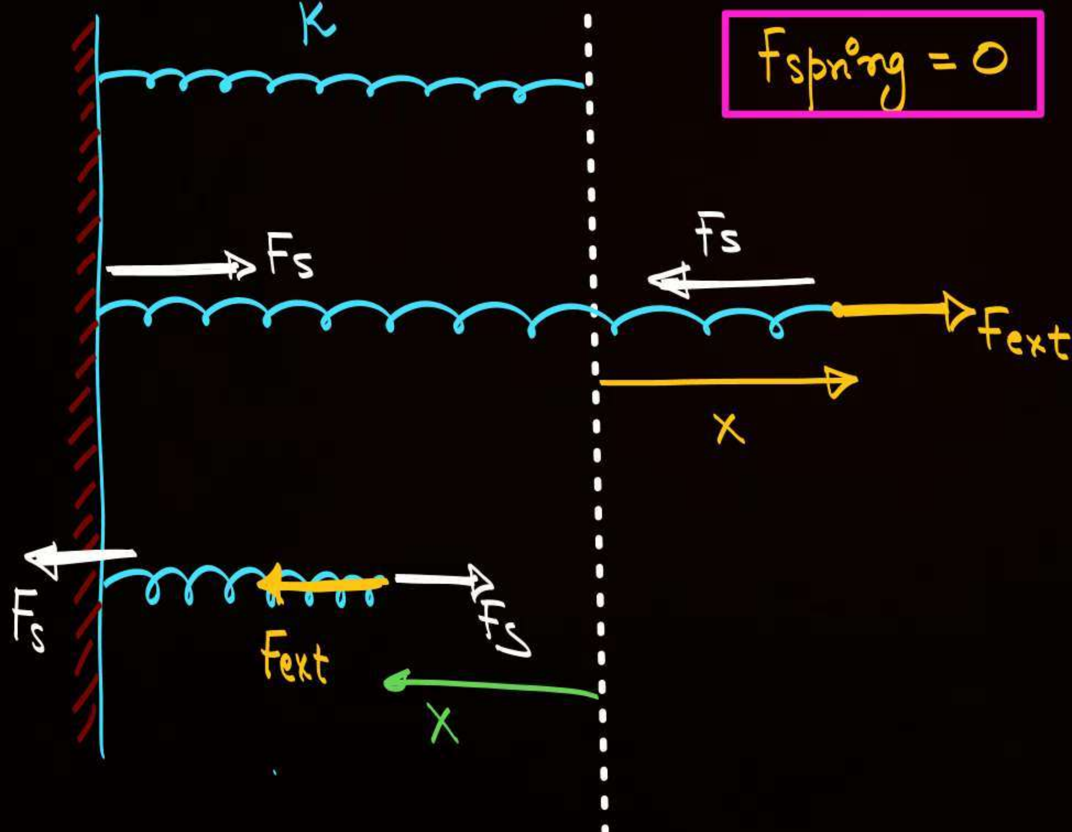
(1) $\dfrac{mg}{\tan\theta}$

(2) $\dfrac{mg}{2\tan\theta}$

(3) Zero

(4) $mg\dfrac{(\sin\theta+\cos\theta)}{2}$

Spring Force



Natural length.

Whenever Elongated/Compress

$\Downarrow$

"Restoring."

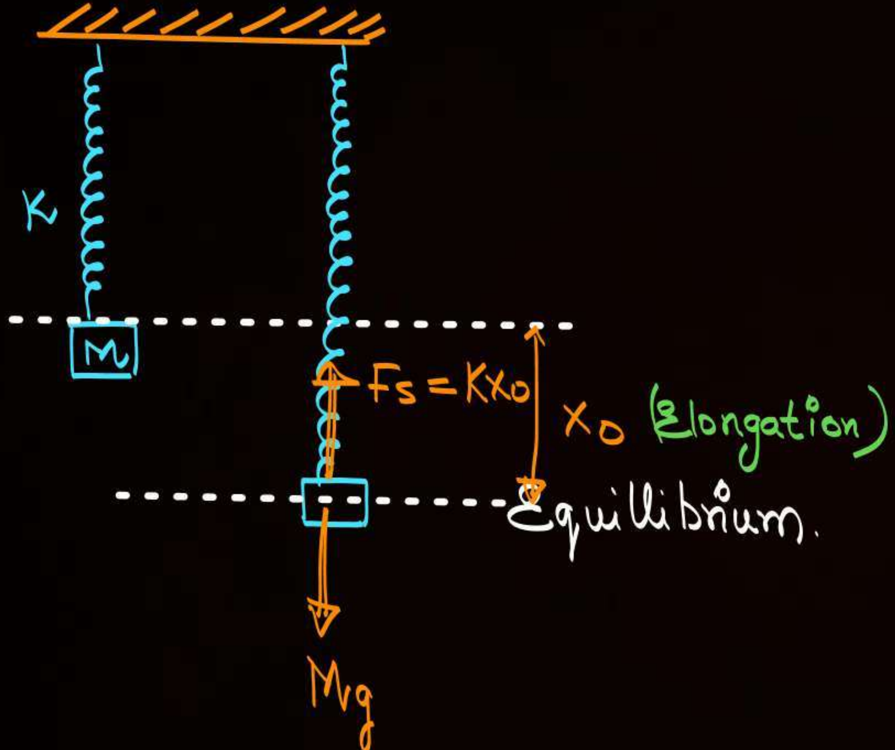
$F_s \propto -x$

$$\boxed{F_s = -Kx}$$

⊛ Spring Const = K

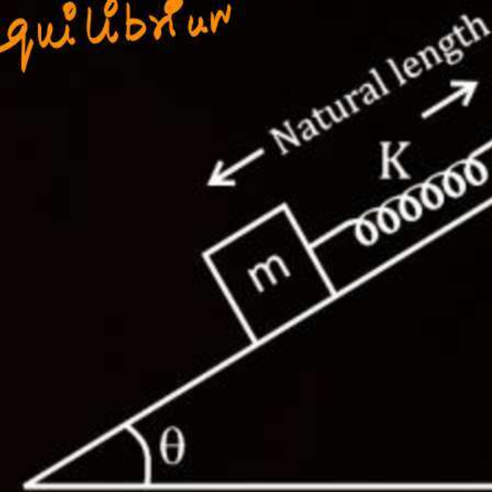
Stiffness Const.

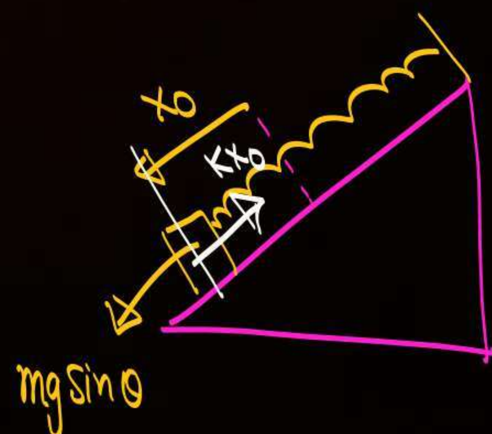
Elongation in Spring in Equilibrium



$$\text{Elongation} = Kx_0 = Mg$$

$$\boxed{x_0 = \frac{Mg}{K}}$$





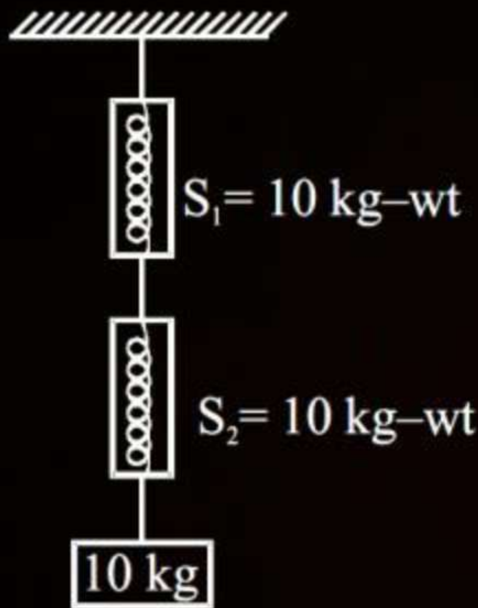
$$Kx_0 = mg\sin\theta$$

$$\boxed{x_0 = \frac{mg\sin\theta}{K}}$$

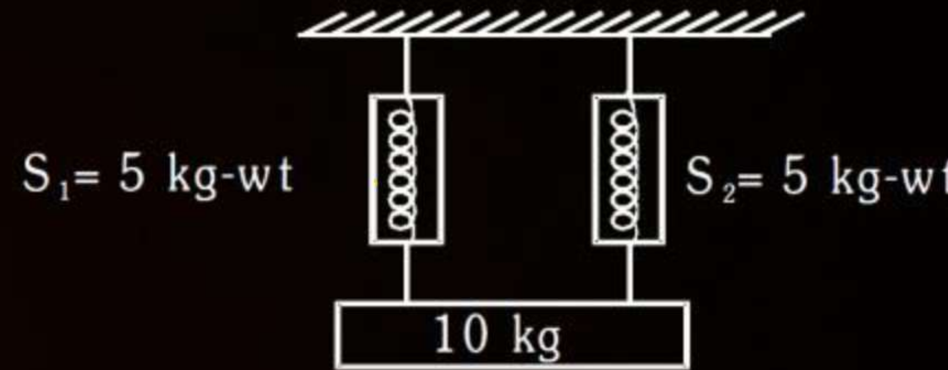
Weighing Machine Reading $\longrightarrow$ Normal Rxtn

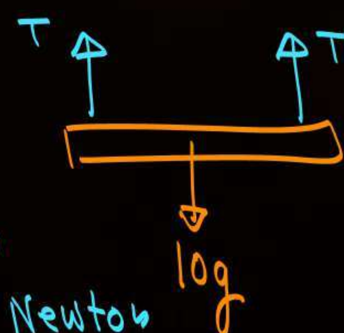
Spring balance Reading $\longrightarrow$ Tension.

No need to write



Reading = 100 N



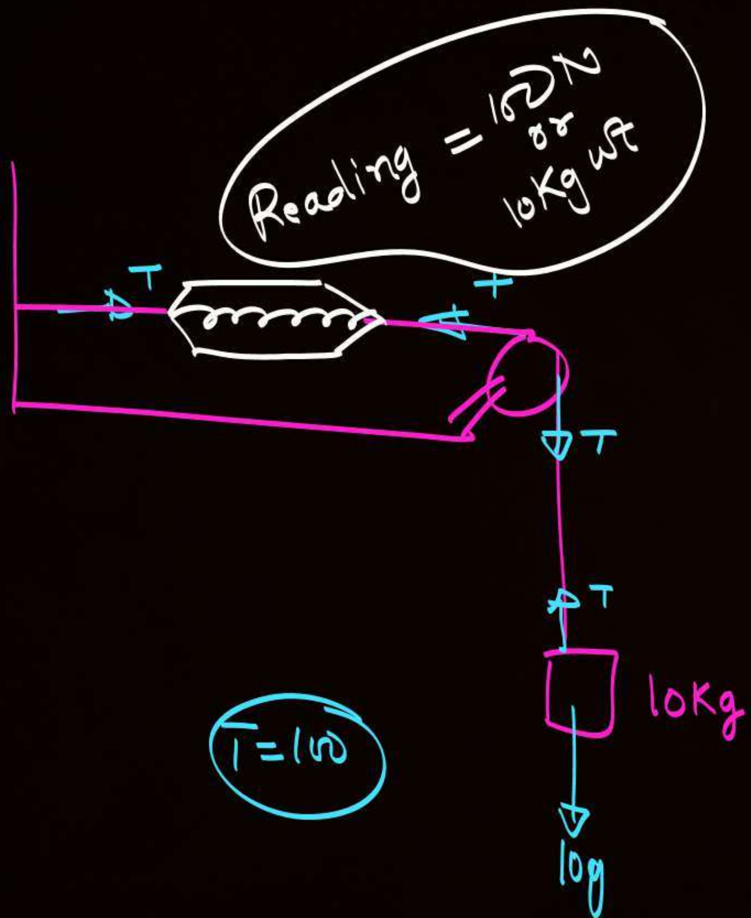


$2T = 100$

$T = 50$ Newton

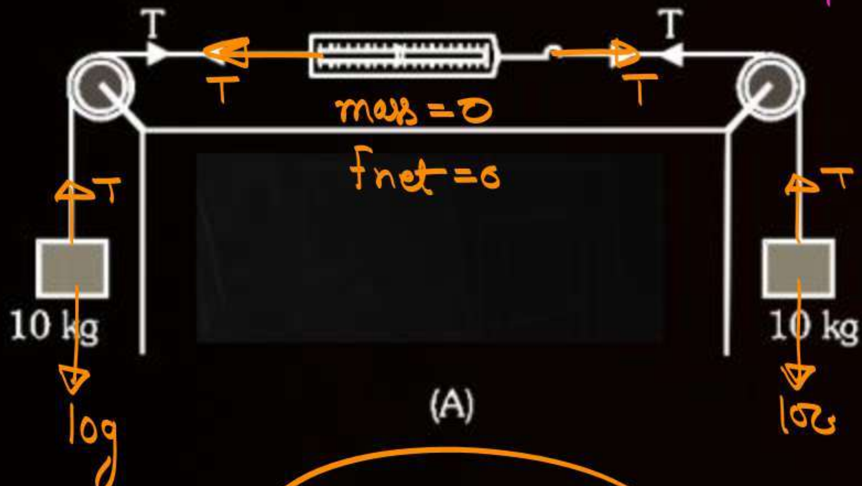
or

5 kg-wt.



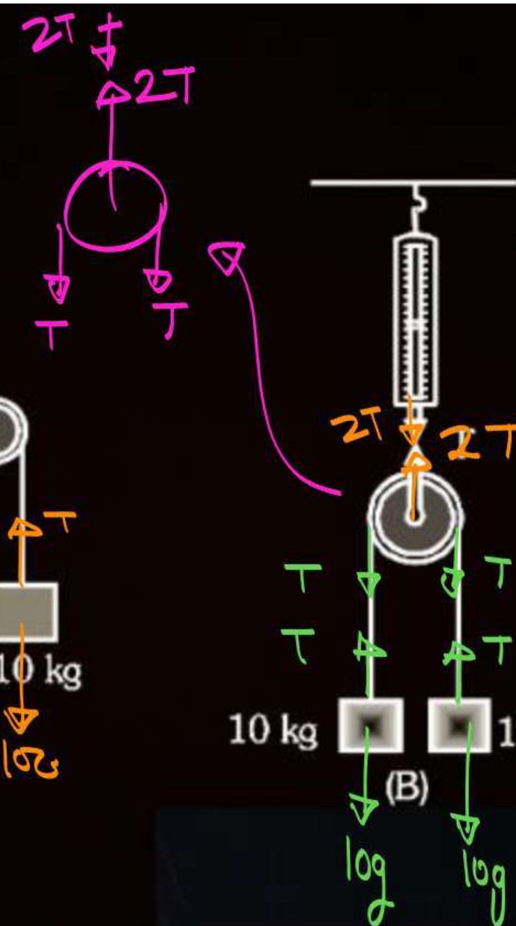
Reading = 100 N
or
10 Kg wt
T
T
T
T
10 Kg
10g
T = 100

Reading of Spring Balance



(A)

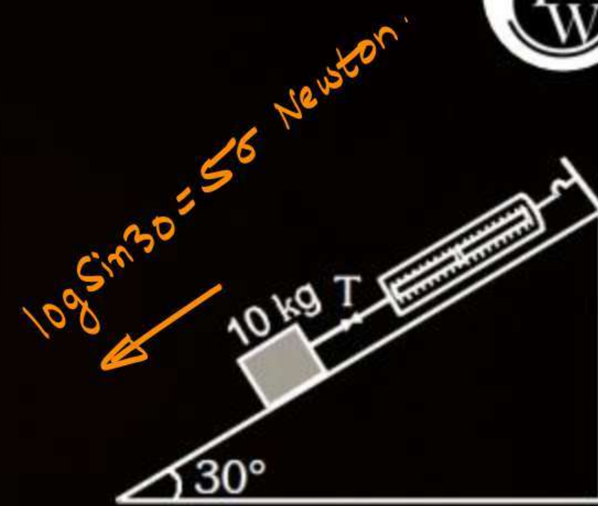
$T = 100$ Newton
$= 10$ Kg-wt



$T = 100$

(B)

Tension $= 2T = 200N$

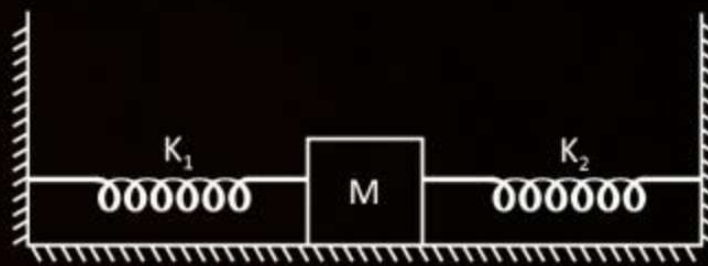


(C)

5 Kg wt

OR

50 Newton



both spring are at Natural length. Final acceleration of block when displaced towards Right by x_0 & then Released.

QUESTION- 11

A body of mass 5 kg is suspended by the strings making angles $60°$ and $30°$ with the horizontal -

(a) $T_1 = 25$ N

(b) $T_2 = 25$ N

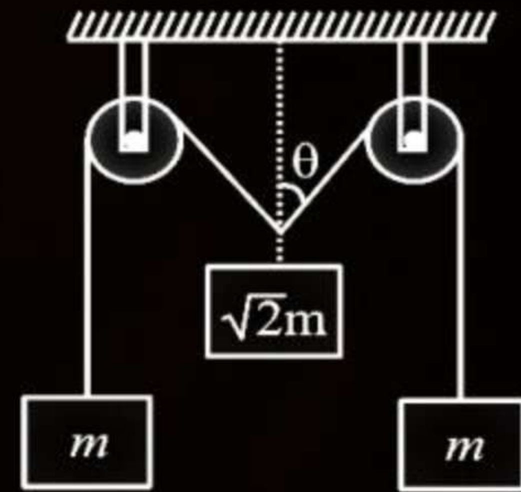
(c) $T_1 = 25\sqrt{3}$ N

(d) $T_2 = 25\sqrt{3}$ N

1. a, b
2. a, d
3. c, d
4. b, c

QUESTION- 12

The pulleys and string shown in the figure are smooth and are of negligible mass. For the system to remain in equilibrium, the angle θ should be:



(1) 0°

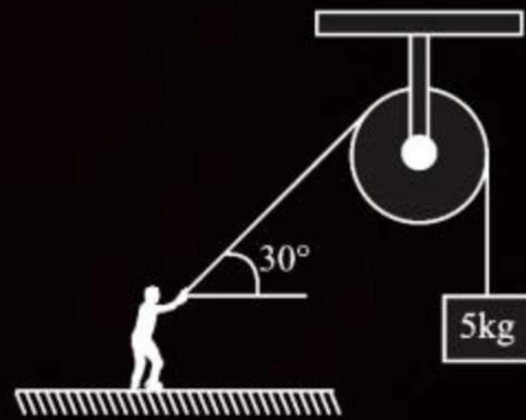
(2) 30°

(3) 45°

(4) 60°

QUESTION- 13

In the given figure a boy of mass 40 kg is just pulling a mass of 5 kg at an angle of 30° with the horizontal. While the boy is standing on a weighing machine, what would be its reading?



(1) 37.5 kg

(2) 40 kg

(3) 42.5 kg

(4) 38.5 kg

Break Tab Milega Jab Hum denge.

Jinko Pahle chaiye, Back button dabaiye.

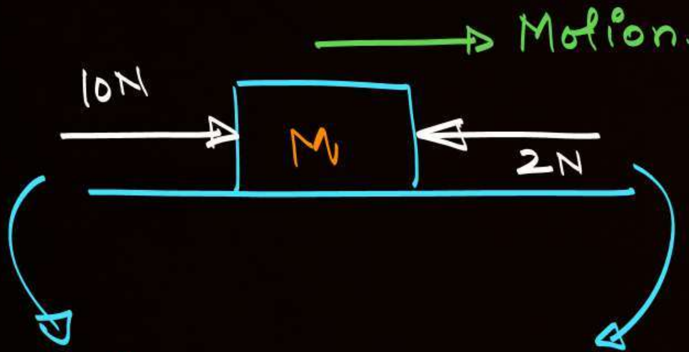
Pdf & Notes ⇒ PW app
from Manzil batch.

Theory → Imp points + Formula.

Questions → Q.no
→ Solution

accelerated Motion

Initially at Rest.



Le jane wala Force

Rokne wala.

Newton. $F_{net} = Ma$.

$10 - 2 = Ma$

$$\boxed{a = \frac{8}{M}}$$

Problems on Motion

$$a = \frac{F_{net}}{M_T} = \frac{10}{4} = 2.5\, m/s^2$$

along Y → Rest

$N_1 = 10$

$N_2 = 30$

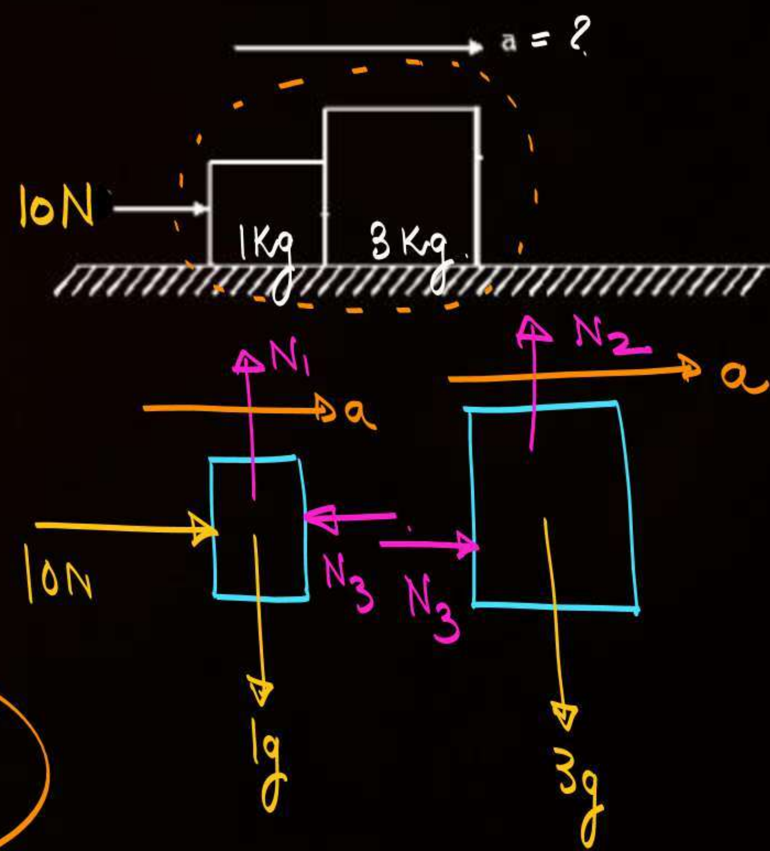
$f_{net} = Ma$

$$10 - N_3 = 1a$$
$$N_3 = 3a$$

$$10 = 4a$$

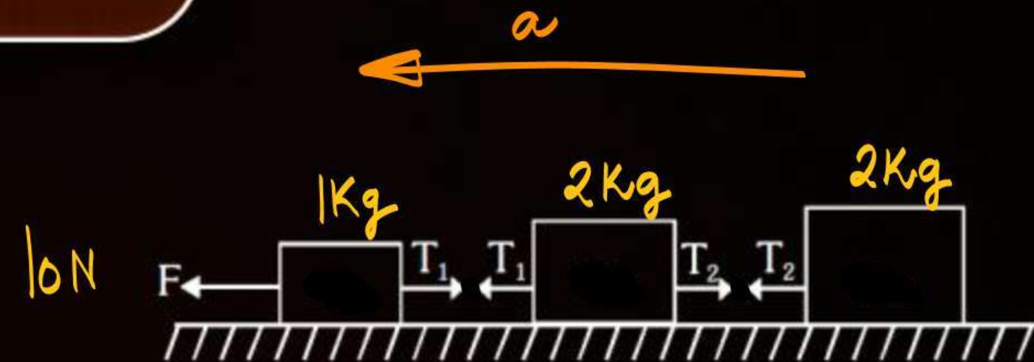
$$a = 2.5\, m/s^2$$

$N_3 = 7.5$ Newton



Three Connected Bodies

Free body diagrams :-



$$10 - \cancel{T_1} = 1a$$
$$\cancel{T_1} - \cancel{T_2} = 2a$$
$$\cancel{T_2} = 2a.$$

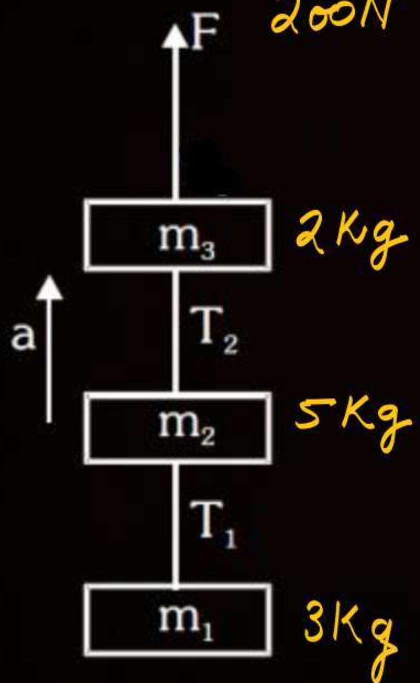
$$10 = 5a$$
$$a = 2$$

$$T_2 = 4 \text{ Newton}$$

$$T_1 = 8N$$

$$a_{net} = \frac{f_{net}}{M_{net}} = \frac{10}{5} = 2 \quad \#$$

Bodies Accelerating Vertically Upwards



Find acc & Tensions.

$$200-(20+T_2)=2a$$

$$T_2-(50+T_1)=5a$$

$$T_1-(30)=3a$$

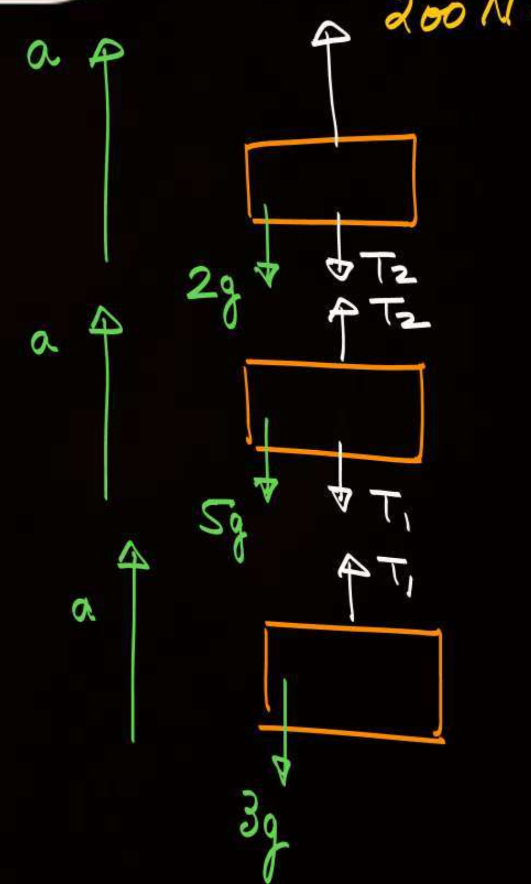
$$200-20-\cancel{T_2}=2a$$

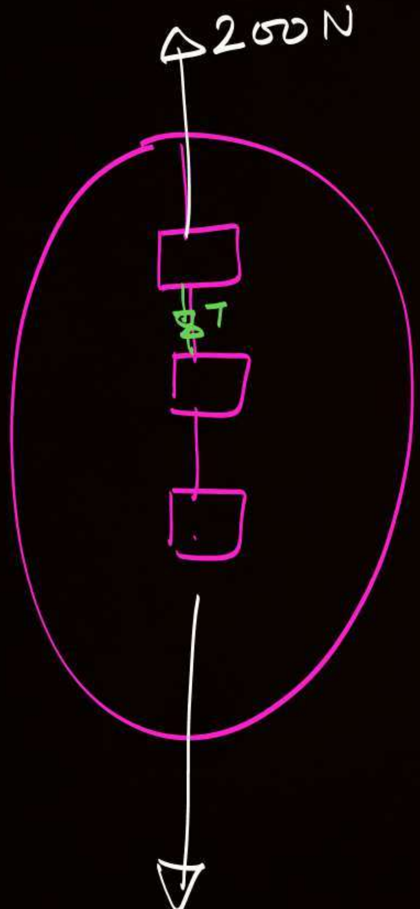
$$\cancel{T_2}-50-\cancel{T_1}=5a$$

$$\cancel{T_1}-30=3a$$

$$200-100=10a$$

$$100=10a \Rightarrow a=10\,m/s^2$$





$M_T = 10g$

100 Newton weight.

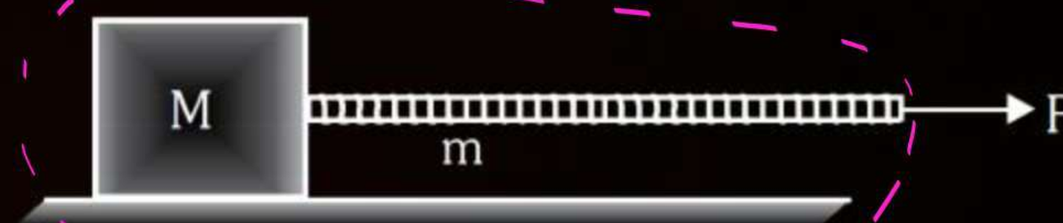
$F_{net} = 200 - 100$

$$a = \frac{F_{net}}{M_T} = \frac{100}{10} = 10$$

QUESTION- 14

* Whenever tension inside body.

A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m as shown in fig. A horizontal force F is applied to one end of the rope. Find the Tension in the rope at its mid point.



System.

$$F_{net} = F$$

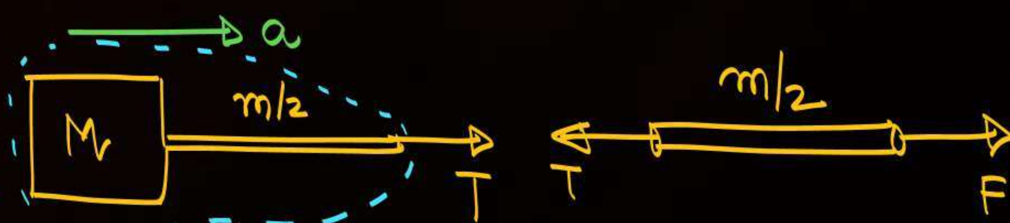
$$m_{Total} = M + m$$

$$\boxed{a = \frac{F}{M+m}}$$

$$F - T = \frac{m}{2} a$$

$$T = \left(M + \frac{m}{2}\right) a$$

$$a = \frac{F}{M+m}$$



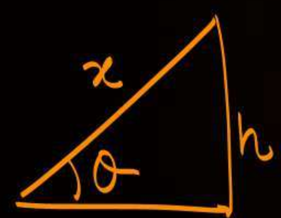
$$T = \left(M + \frac{m}{2}\right) a = \left(M + \frac{m}{2}\right) \frac{F}{(M+m)} \text{ Ans.}$$

Wedge problems

along the wedge

$\cancel{m}g\sin\theta = \cancel{m}a$

$\boxed{a = g\sin\theta}$ "Const"

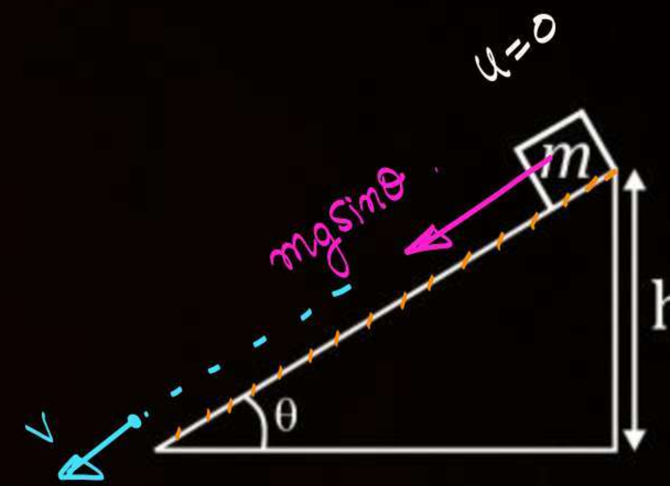


$\boxed{x = h\,\mathrm{cosec}\,\theta}$

$\sin\theta = \frac{h}{x}$

* $S = \cancel{ut}^{\,0} + \frac{1}{2}at^2$

$\sqrt{\frac{2x}{a}} = t = \sqrt{\frac{2h\,\mathrm{cosec}\,\theta}{g\sin\theta}}$



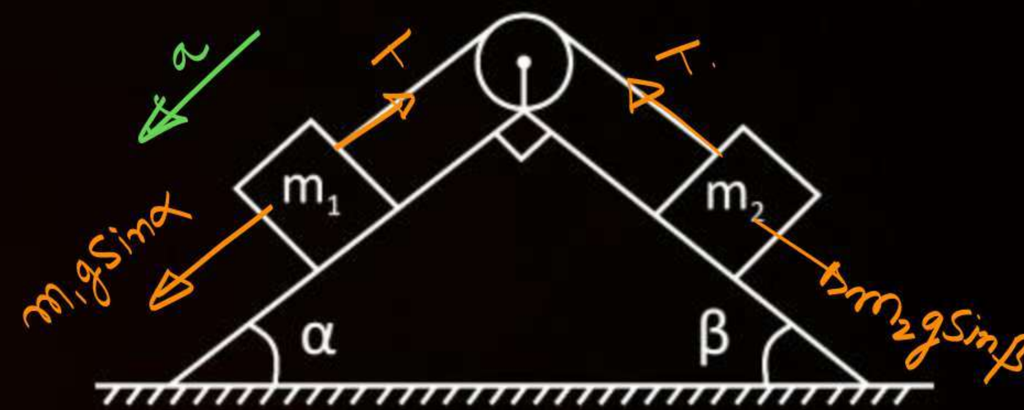
* Block is Released.
  - → Find acc of block.
* → Time to Reach ground.
  - → Velocity with which it Reaches ground.

$$v^2 - \cancel{u^2} = 2aS.$$

$$v = \sqrt{2g\sin\theta \, h \operatorname{cosec}\theta}$$

$$\boxed{v = \sqrt{2gh}}$$

$$\boxed{a = \frac{m_1 g \sin\alpha - m_2 g \sin\beta}{m_1 + m_2}}$$



$\alpha > \beta$

$m_1 > m_2$

find acceleration of blocks

$$m_1 g \sin\alpha - T = m_1 a$$

$$T - m_2 g \sin\beta = m_2 a$$

Add

$$a_{net} = \frac{|F_{net}|}{m_T} = \frac{20 + 4g\sin 30 - 1g}{7}$$

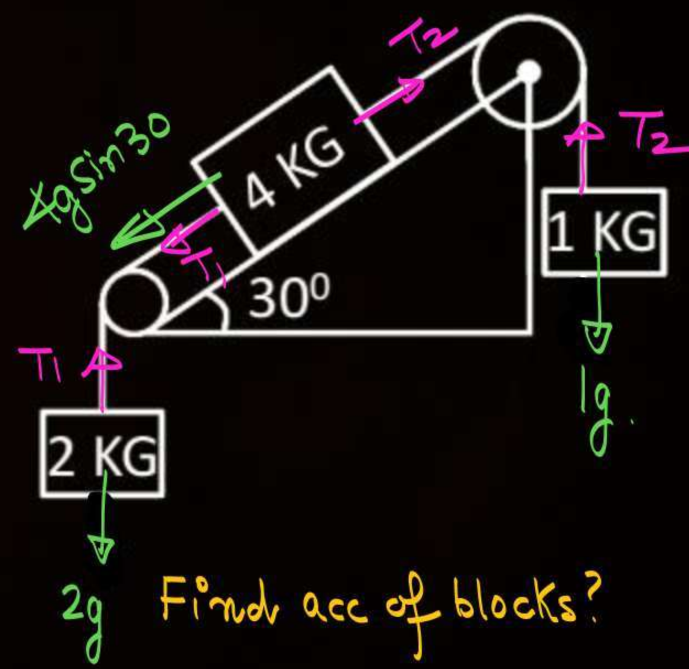
$$= \frac{20 + 20 - 10}{7} = \frac{30}{7}$$

x

$$2g - \cancel{T_1} = 2a$$

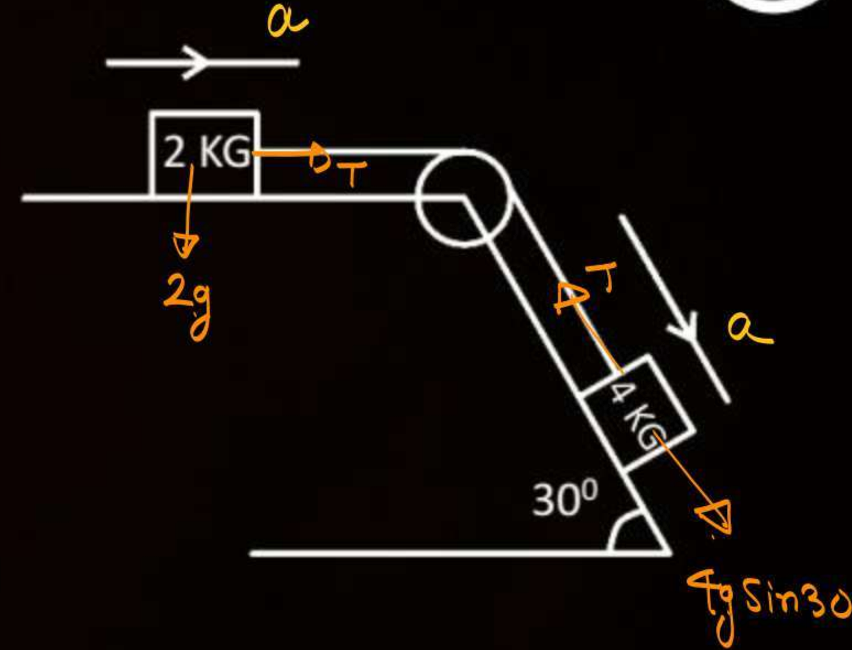
$$4g\sin 30 + \cancel{T_1} - \cancel{T_2} = 4a$$

$$\cancel{T_2} - 1g = 1a$$



Find acc of blocks?

$a_{net} =$



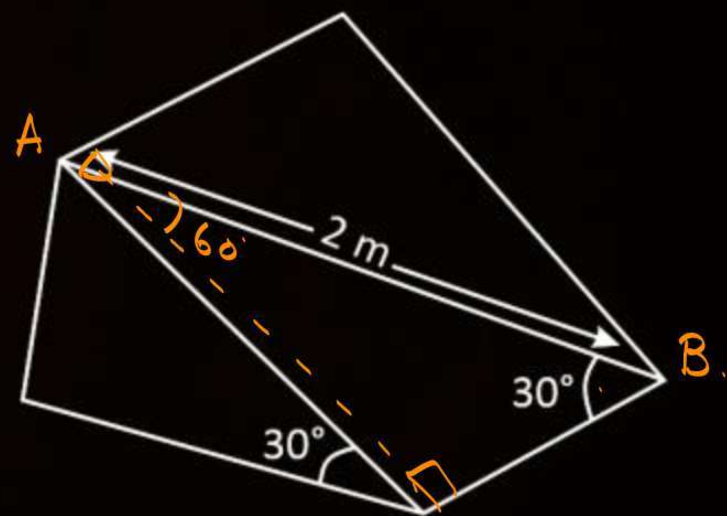
$$4g\sin 30 - T = 4a$$
$$T = 2a$$

$$4g\sin 30 = 6a$$

$$a = \frac{4g\sin 30}{6}$$

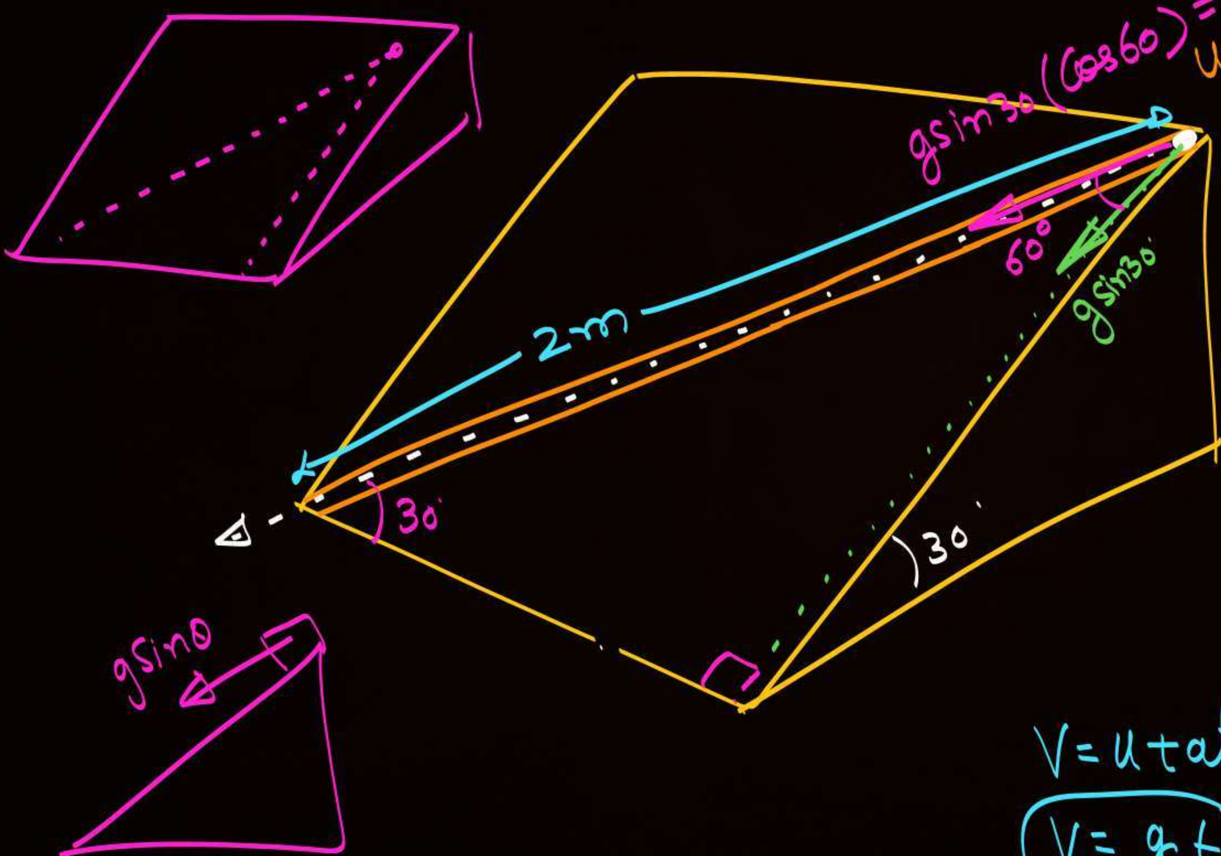
QUESTION- 15

A smooth groove is made diagonally on wedge as shown. When block is released from rest. Find time it takes to reach B.



$g\sin 30 (\cos 60) = a_{net}$ along groove

$u = 0$



$$\boxed{a = g/4}$$

const

$$v = u + at$$

$$s = \cancel{ut} + \frac{1}{2}at^2$$

$$2 = \frac{1}{2} \times \frac{g}{4} t^2$$

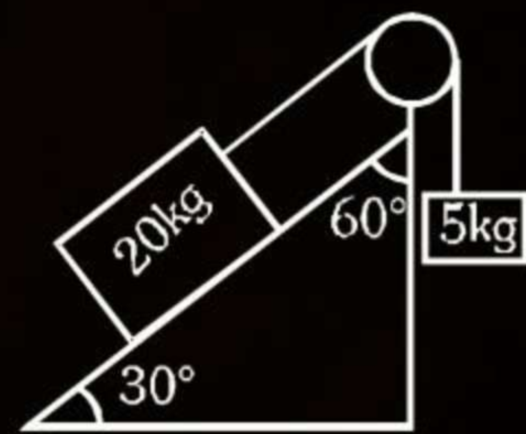
$$\sqrt{1.6} = t$$

$$V = u + at$$

$$\boxed{V = \frac{g}{4} t}$$

QUESTION- 16

Calculate the acceleration of the system and tension in the string for the situation shown in following diagram.



Break – 15 Mins.

$\boxed{8:20\ PM}$ Resume.

Pulley problems

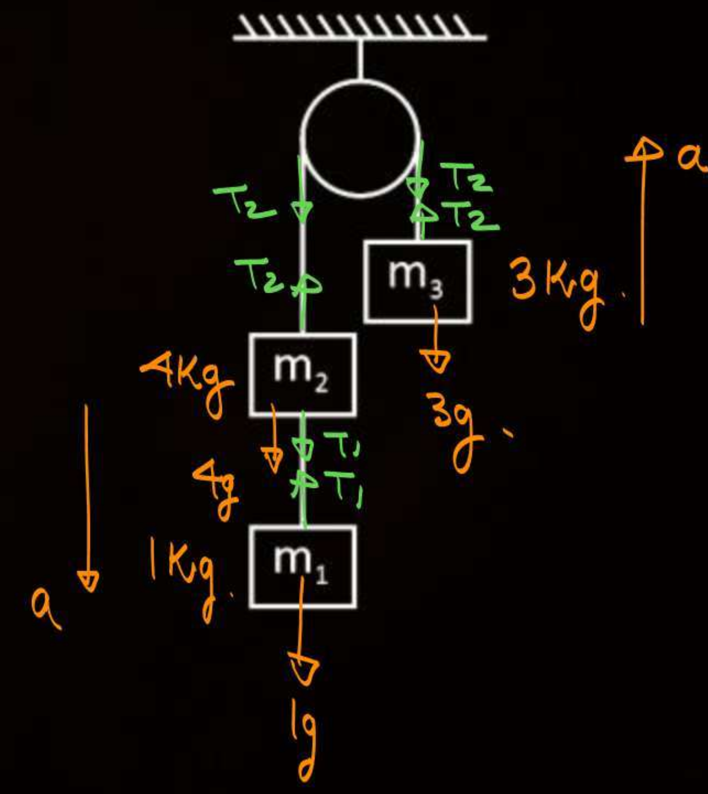
$$1g - \cancel{T_1} = 1a$$

$$4g + \cancel{T_1} - \cancel{T_2} = 4a$$

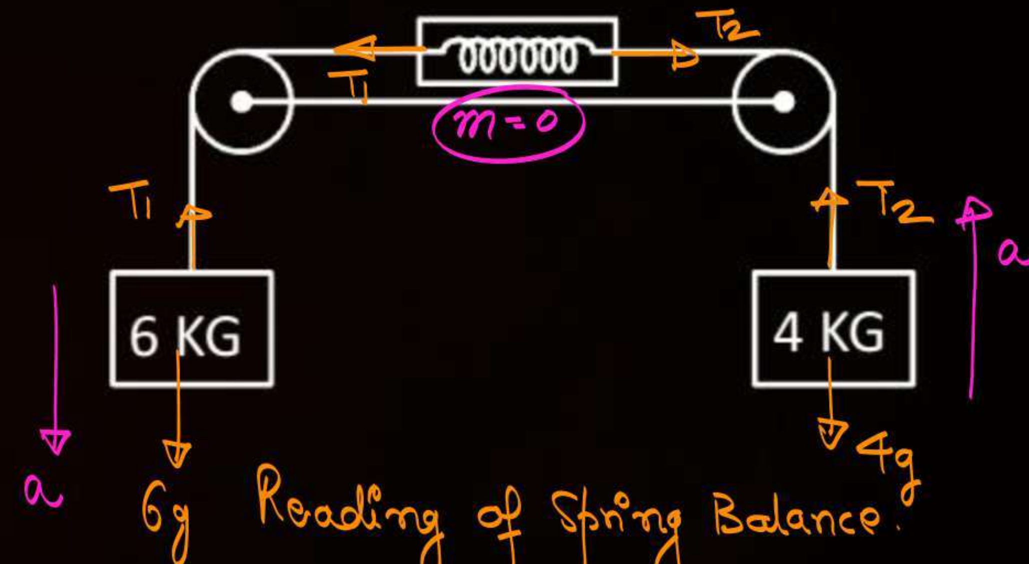
$$\cancel{T_2} - 3g = 3a$$

$$1g + 4g - 3g = 8a.$$

$$\boxed{2.5 = \frac{10}{4} = \frac{20}{8} = a}$$



Spring balance has $m = 0$.



$$60 - \cancel{T_1} = 6a$$
$$\cancel{T_1} - 40 = 4a$$
$$20 = 10a$$
$$a = 2$$

$$T_1 - 40 = 8$$
$$T_1 = 48 \Rightarrow 4.8 \text{ Kg wt.}$$

$$6g - T_1 = 6a$$
$$T_1 - T_2 = (0)a$$
$$T_1 = T_2$$
$$T_2 - 4g = 4a$$

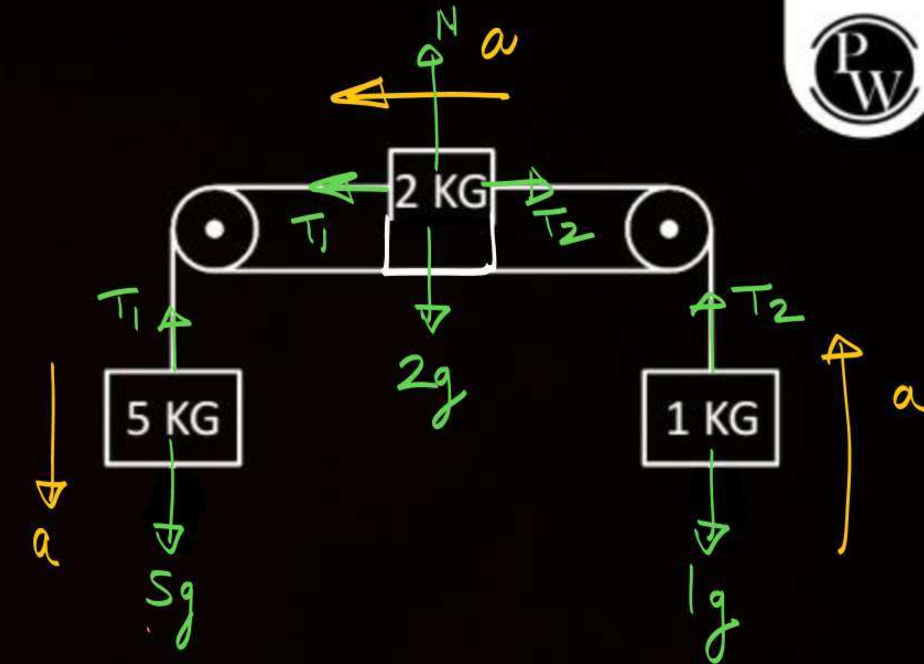
Reading of Spring Balance.

Tension

$$5g - T_1 = 5a$$

$$T_1 - T_2 = 2a$$

$$T_2 - 1g = 1a$$



$$a = \frac{5g - 1g}{5+2+1}$$

A.P

Rest

$M = 10\,Kg$

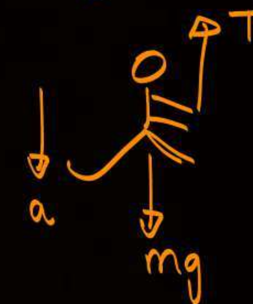
$\boxed{T = 100 \text{ Newton}}$

$a = 2\,m/s^2$

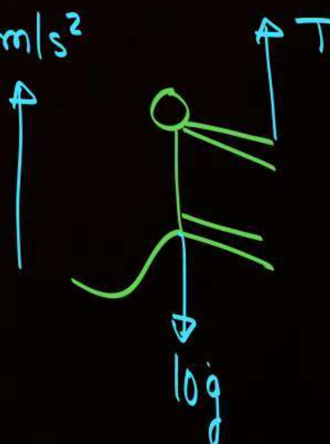
A.P

10Kg

If a = down



$a = 2\,m/s^2$



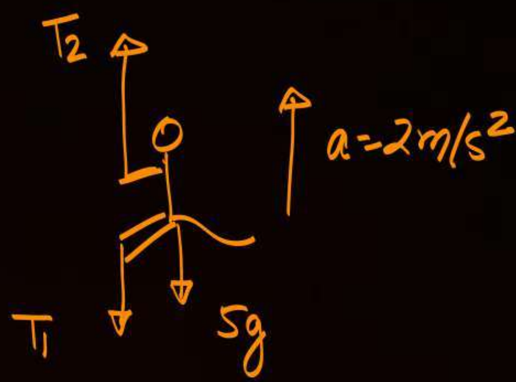
$T - 10g = 10a$

$T = 120\,N$

$T_2 - (T_1 + 50) = 5 \times 2$

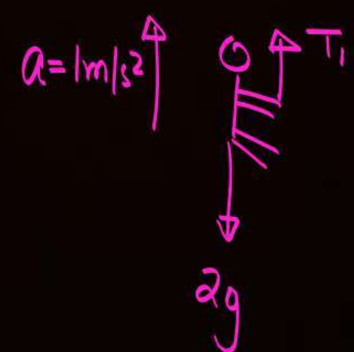
$T_2 - 22 - 50 = 10$

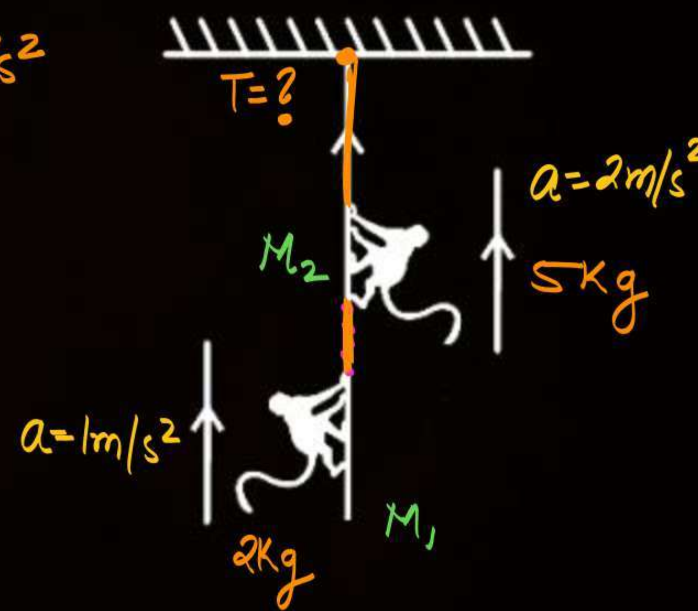
$T_2 = 82$



$T_1 - 20 = 2 \times 1$

$T = 22N$

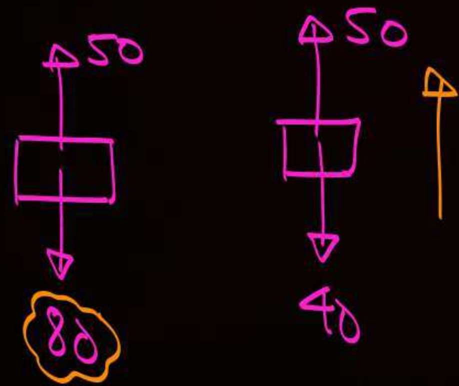




QUESTION- 17

Two blocks of masses 8 kg and 4 kg respectively are connected by a string as shown. Calculate their accelerations if they are initially $\boxed{\text{at rest}}$ on the floor, after a force of 100N is applied on the pulley in the upward direction: ($g = 10\ m/s^2$)

$a = 0$



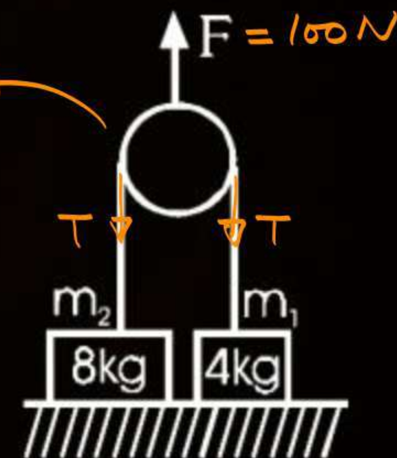
$F_{net} = 0$

mass = 0

$100 = 2T$

$T = 50$

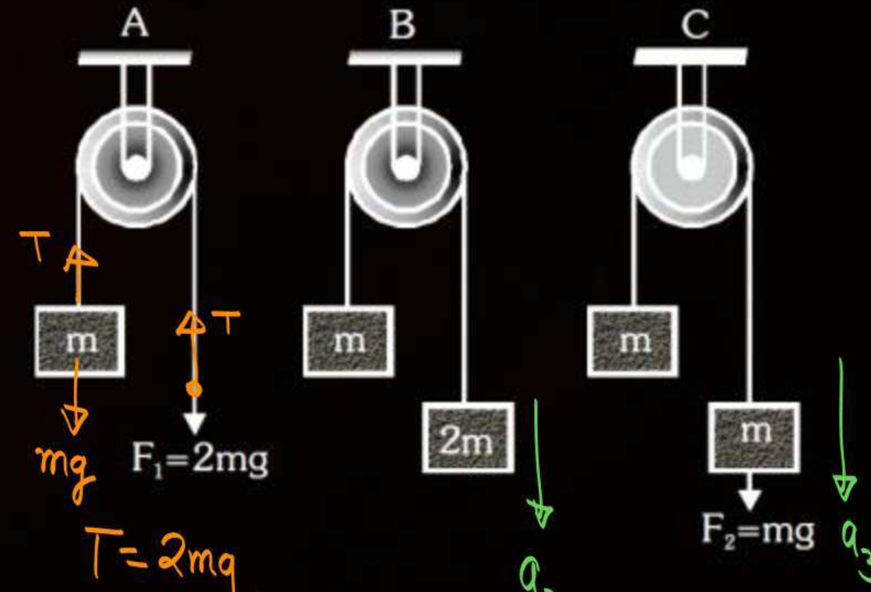
$a = \frac{50-40}{4} = \frac{10}{4} = 2.5\ m/s^2$



QUESTION- 18

In the figure blocks A, B and C have accelerations a_1, a_2 and a_3 respectively. F_1 and F_2 are external forces of magnitudes 2mg and mg respectively. Find the value of a_1, a_2 and a_3.

(B)

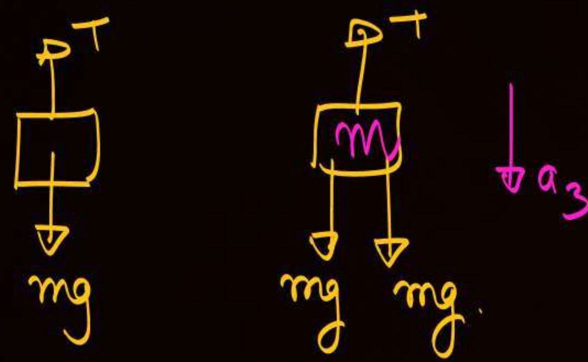


a_2, T, mg ; T, $2mg$, a_2 ; T, mg

$$2mg - T = 2ma_2$$
$$T - mg = ma_2$$
$$g/3 = a_2$$

$$T - mg = ma_1$$
$$2mg - mg = ma_1 \quad a_1 = g$$

$$T = 2mg$$



$$2mg - T = ma_3$$
$$T - mg = ma_3$$
$$mg = 2ma_3$$
$$a_3 = \frac{g}{2}$$

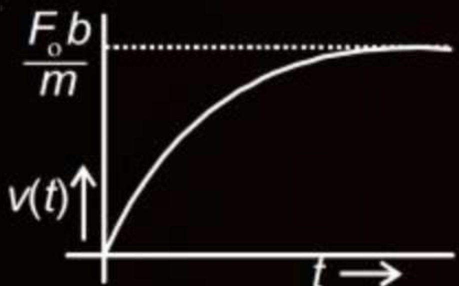
QUESTION- 19

$t=0 \quad u=0$

A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_0 e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves?

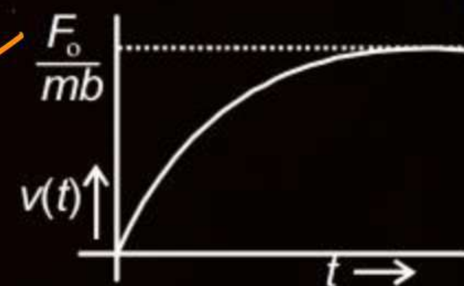
[AIEEE-2012]

(1)

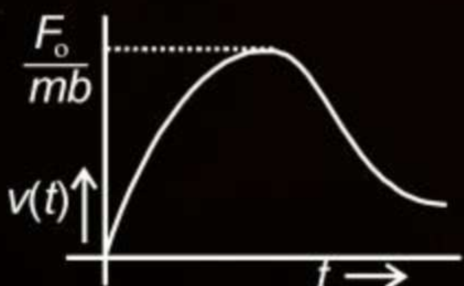


(2)

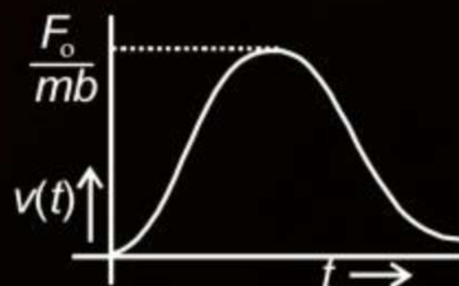
Ans



(3)



(4)



Q

mass $= m$

$t = 0$

$u = 0$

$F = F_0 e^{-bt}$

Velocity at time $= t$.

$$a = \frac{F}{m} = \frac{F_0}{m} e^{-bt}$$

$$\frac{dv}{dt} = \frac{F_0}{m} e^{-bt}$$

$$\int_0^v dv = \int_{t=0}^{t} \frac{F_0}{m} e^{-bt} dt$$

$$v = \frac{F_0}{m} \left[\frac{e^{-bt}}{-b}\right]_0^t$$

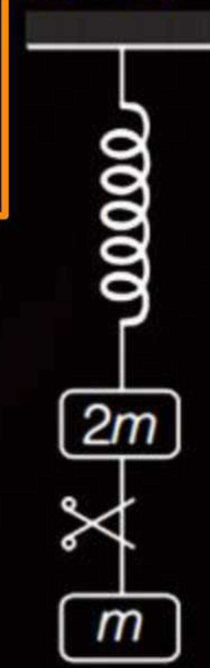
$$v = \frac{-F_0}{mb}\left[e^{-bt} - 1\right] = \frac{F_0}{mb}\left[1 - e^{-bt}\right]$$

QUESTION- 20

System shown in figure is in equilibrium and at rest. The spring and string are massless, now the string is cut. The acceleration of mass $2m$ and m just after the string is cut will be

[2006]

String Ka force achanak
Change ho Sakta hai



(1) $g/2$ upwards, g downwards

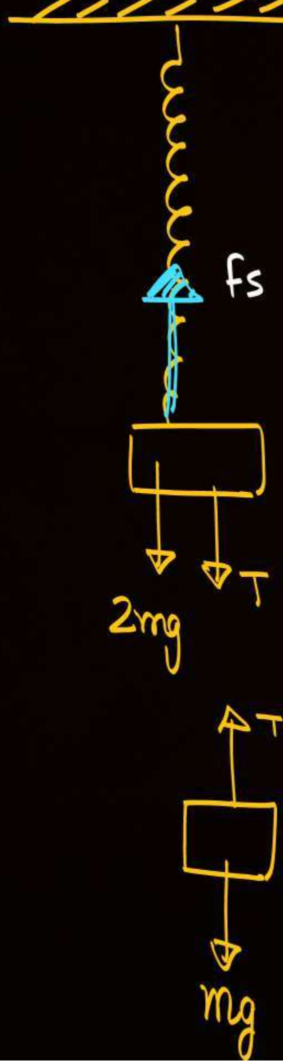
(2) g upwards, $g/2$ downwards

(3) g upwards, $2g$ downwards

(4) $2g$ upwards, g downwards

Rest

$f_s = ?$



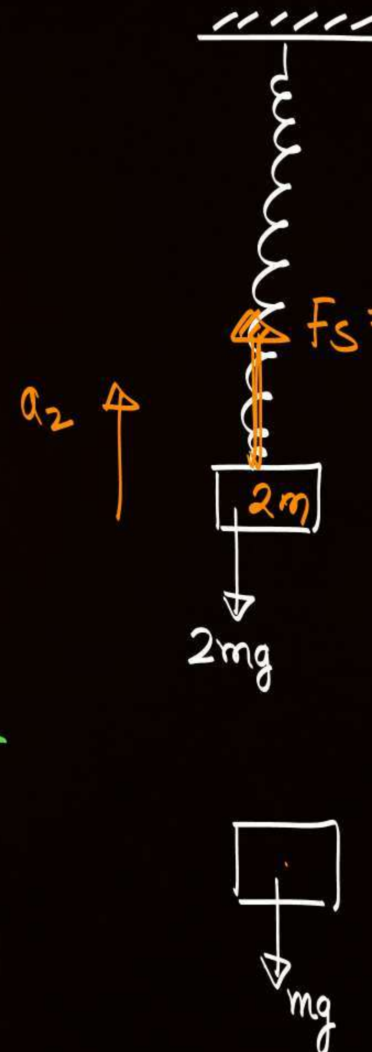
$F_s = 2mg + T$

$F_s = 3mg$

$T = mg$

Cut

$T = 0$



$F_s = 3mg$

$3mg - 2mg = 2ma_2$

$\frac{g}{2} = a_2$

$\cancel{m}g = \cancel{m}a_1$

$a = g$ ✓

QUESTION- 21

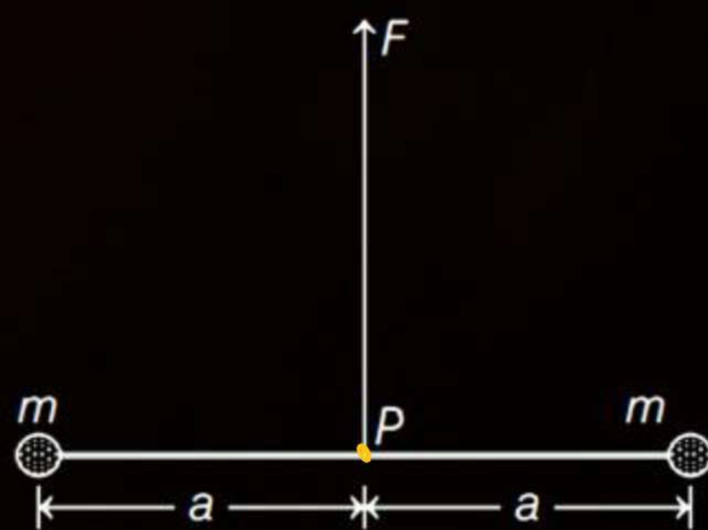
Two particles of mass m each are tied at the ends of a light string of length $2a$. The whole system is kept on a frictionless horizontal surface with the string held tight so that each mass is at a distance a from the centre P (as shown in the figure). Now, the mid-point of the string is pulled vertically upwards with a small but constant force F. As a result, the particles move towards each other on the surface. The magnitude of acceleration, when the separation between them becomes $2x$, is **[2007 adv]**

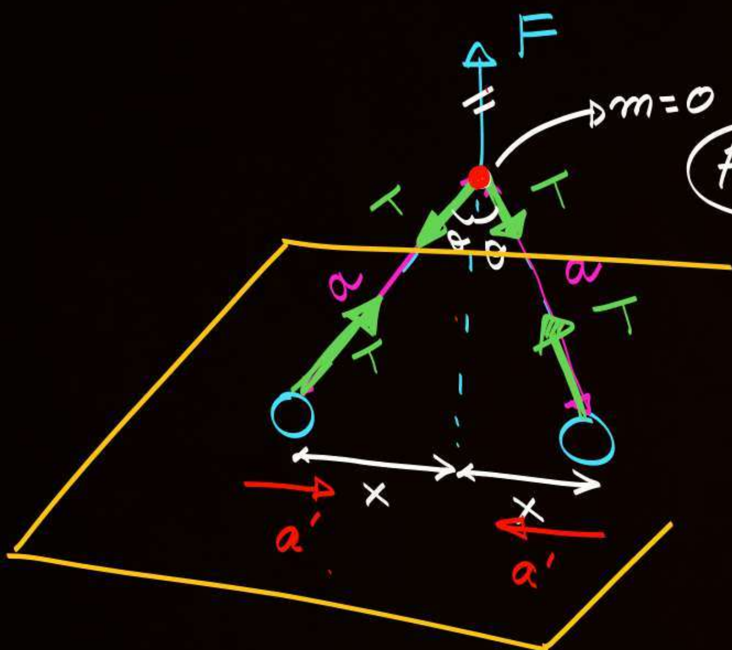
(1) $\frac{F}{2m}\frac{a}{\sqrt{a^2-x^2}}$

(2) $\frac{F}{2m}\frac{x}{\sqrt{a^2-x^2}}$ Ans

(3) $\frac{F}{2m}\frac{x}{a}$

(4) $\frac{F}{2m}\frac{\sqrt{a^2-x^2}}{x}$

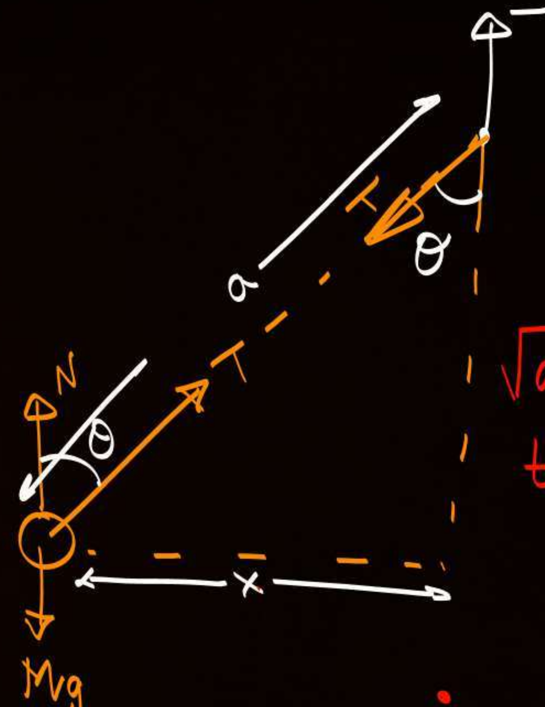




$\to m = 0 \quad f_{net} = 0$

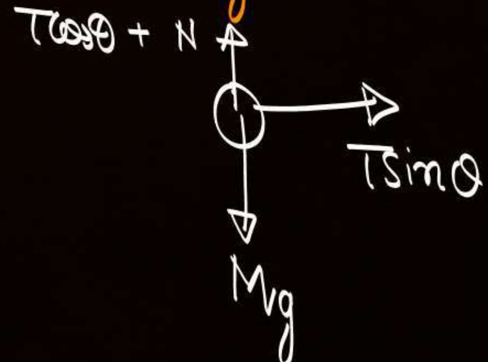
$$\boxed{F = 2T\cos\theta}$$

$$T = \frac{F}{2\cos\theta}$$



$$\sqrt{a^2 - x^2}$$

$$\tan\theta = \frac{x}{\sqrt{a^2 - x^2}}$$



$$T\sin\theta = ma'$$

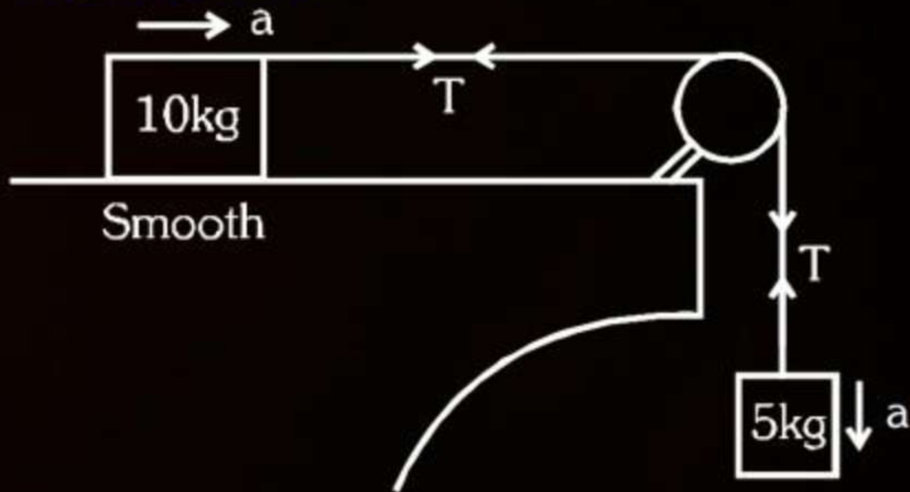
$$\frac{F\sin\theta}{2m\cos\theta} = a'$$

$$\frac{F}{2m}\tan\theta = a'$$

$$a' = \frac{F\,x}{2m\sqrt{a^2 - x^2}}$$

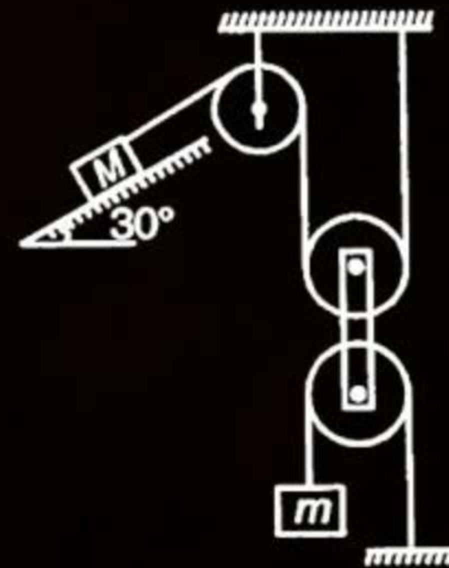
QUESTION- 20

Calculate the acceleration of the system, tension in the string and thrust on the pulley in terms of g for the situation shown in following diagram.



QUESTION- 22

In the arrangement shown, neglect the mass of the ropes and pulley. What must be the value of m to keep the system in equilibrium? There is no friction anywhere



(1) M

(2) 2 M

(3) M/2

(4) M/4

QUESTION- 23

Calculate the tension in the string shown in figure. The pulley and the string are light and all surfaces are frictionless. Take $g = 10\ m/s^2$.

QUESTION- 24

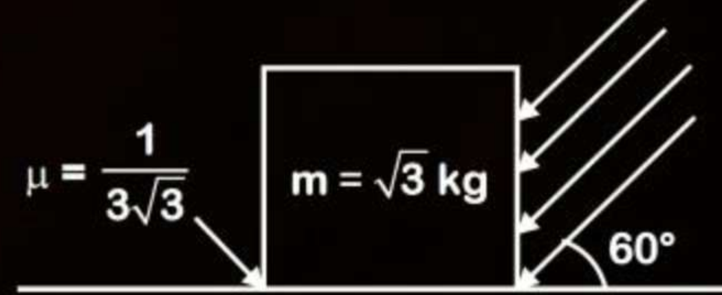
A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the roof at some point, the rope deviated at an angle of $45°$ at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is ($g = 10\ ms^{-2}$) [JEE (Main)-2019]

1. 100 N
2. 200 N
3. 70 N
4. 140 N

QUESTION- 25

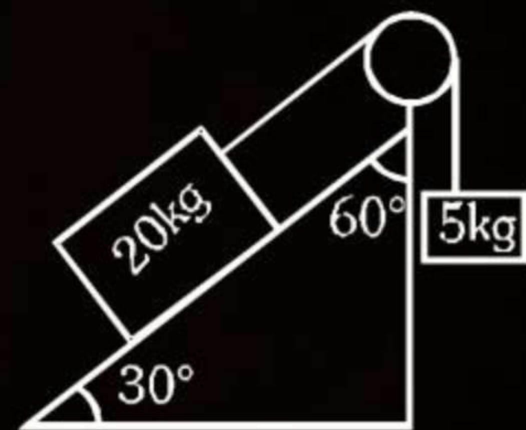
As shown in the figure, a block of mass $\sqrt{3}$ kg is kept on a horizontal rough surface of coefficient of friction $1/3\sqrt{3}$. The critical force to be applied on the vertical surface as shown at an angle $60°$ with horizontal such that it does not move, will be $3x$. The value of x will be ______.

$\left[g = 10\ \mathrm{m/s^2}; \sin 60° = \frac{\sqrt{3}}{2}; \cos 60° = \frac{1}{2}\right]$ [JEE (Main)-2021]



QUESTION- 26

Calculate the acceleration of the system and tension in the string for the situation shown in following diagram.



QUESTION- 27

A block 'A' takes 2 s to slide down a frictionless incline of $30°$ and length 'l', kept inside a lift going up with uniform velocity 'v'. If the incline is changed to $45°$, the time taken by the block, to slide down the incline, will be approximately

[JEE (Main)-2022]

(1) 2.66 s

(2) 0.83 s

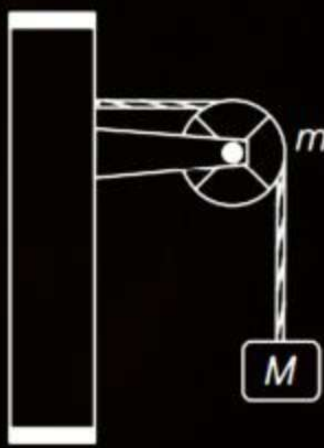
(3) 1.68 s

(4) 0.70 s

QUESTION- 28

A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by

[2001]



(1) $\sqrt{2}\,Mg$

(2) $\sqrt{2}\,mg$

(3) $g\sqrt{(M+m)^2+m^2}$

(4) $g\sqrt{(M+m)^2+M^2}$

QUESTION- 29

A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the roof at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is ($g = 10\ ms^{-2}$) [JEE (Main)-2019]

(1) 100 N

(2) 200 N

(3) 70 N

(4) 140 N

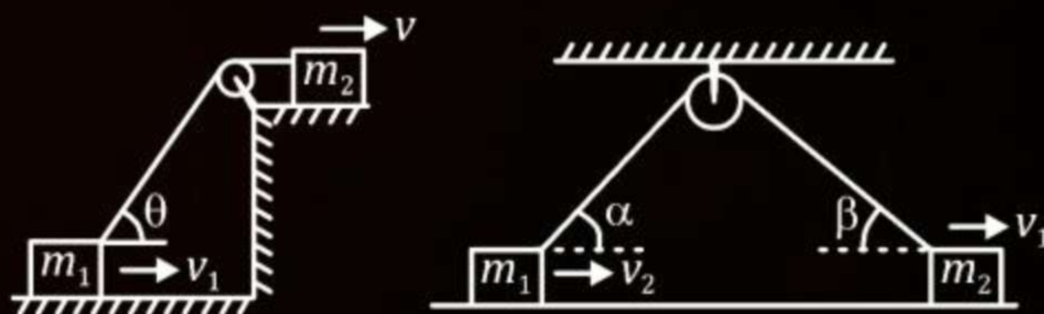
Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points + Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

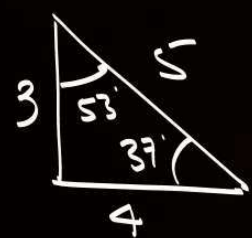
Constraint Motion

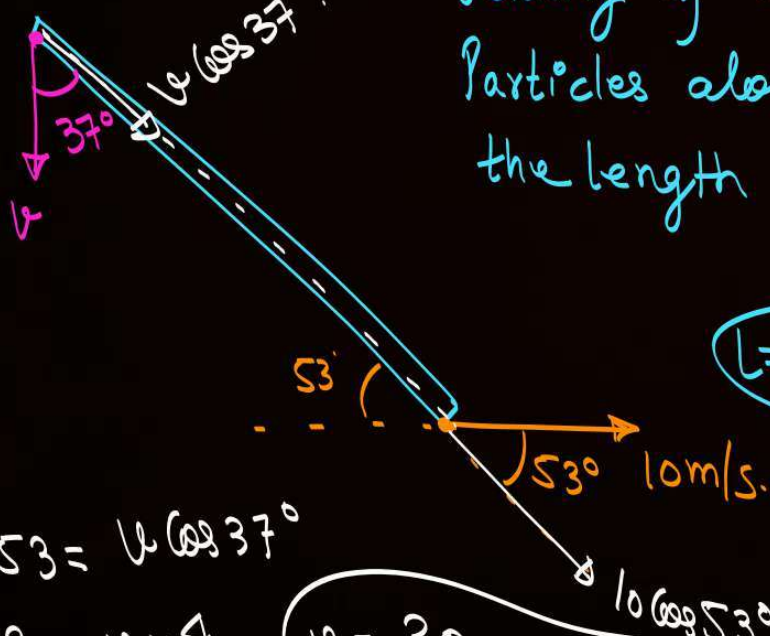
When two bodies are connected and more together in a system. Their velocities, acceleration are related. Relation between v, a for bodies is called constraint relation.



QUESTION- 30

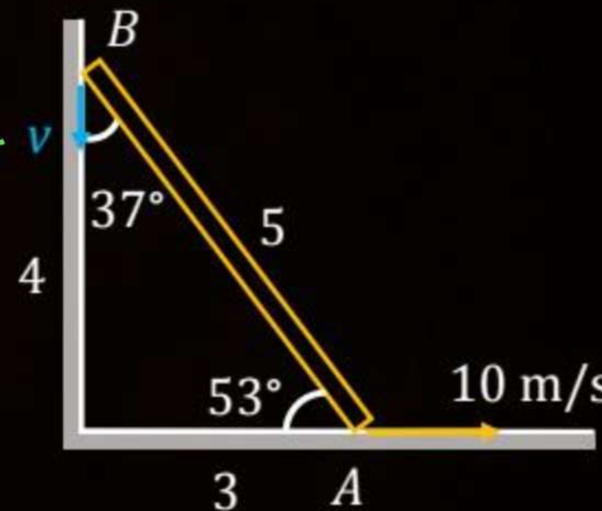
If rod starts slipping on smooth ground. Find velocity of B at this moment.





velocity of all Particles along the length of Rod = Same

$L = \text{Const}$



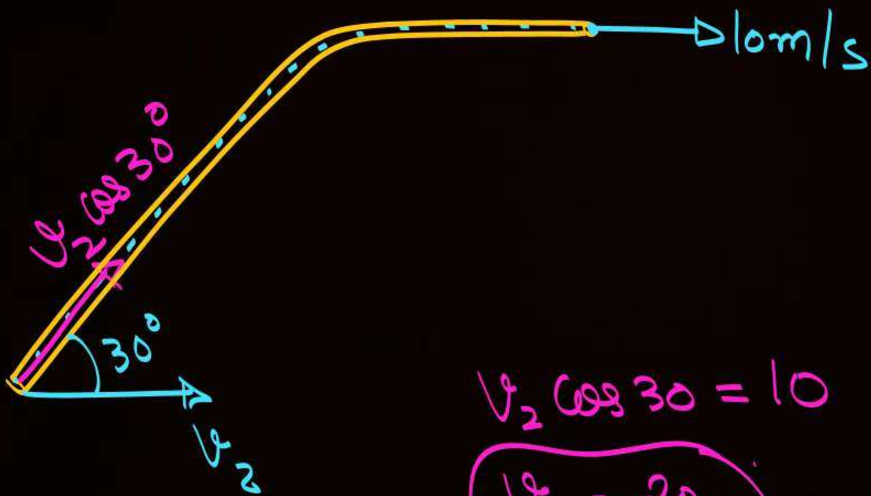
$$10 \cos 53 = v \cos 37°$$

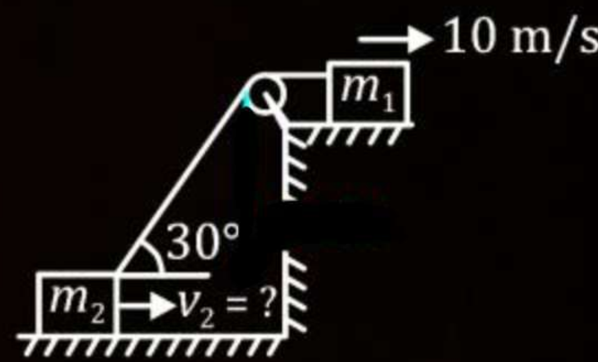
$$10 \times \frac{3}{\cancel{5}} = v \times \frac{4}{\cancel{5}}$$

$$v = \frac{30}{4} = 7.5\ m/s$$

QUESTION- 31

If m_1 is moving with 10 m/s at that instant find velocity of m_2.





$$v_2 \cos 30 = 10$$

$$\boxed{v_2 = \frac{20}{\sqrt{3}}}$$

Concept of Internal Force

$P = Fv\cos 0$

$P = Fv\cos 180$
$= -Fv$

$P = Fv\cos\theta$

$P = Fv\cos\theta$

θ = 0° θ = 180° angle = θ angle = θ

\#

$\text{Power} = \dfrac{W}{t} = \dfrac{\vec{F}\cdot\vec{S}}{t}$

$$\boxed{P = \vec{F}\cdot\vec{v}}$$

$\text{Power} = |F||v|\cos\theta$

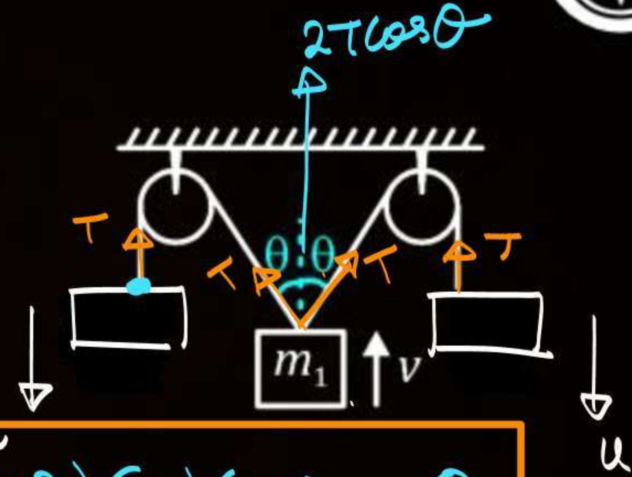
$\theta = \angle$ between $\vec{F}$ & $\vec{v}$.

⊛ Internal force $W = 0$.

$$\boxed{P_{int} = 0}$$

QUESTION- 34

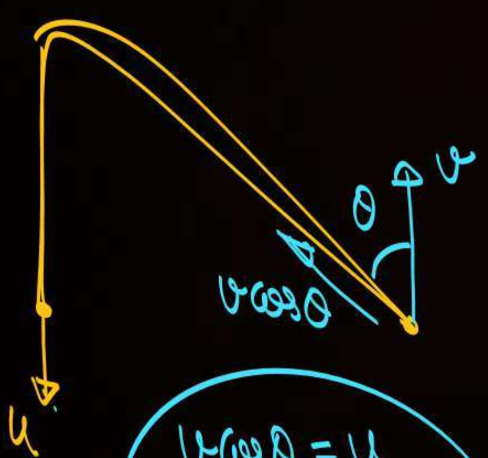
What will be $v = ?$



T= Internal.

$$\boxed{\sum P_{int} = 0}$$

$$\cancel{T}u\cos 180 + \cancel{T}u\cos 180 + (2\cancel{T}\cos\theta)(v)\cos 0 = 0$$



$$-u - u + 2v\cos\theta = 0$$

$$\cancel{2}u = \cancel{2}v\cos\theta$$

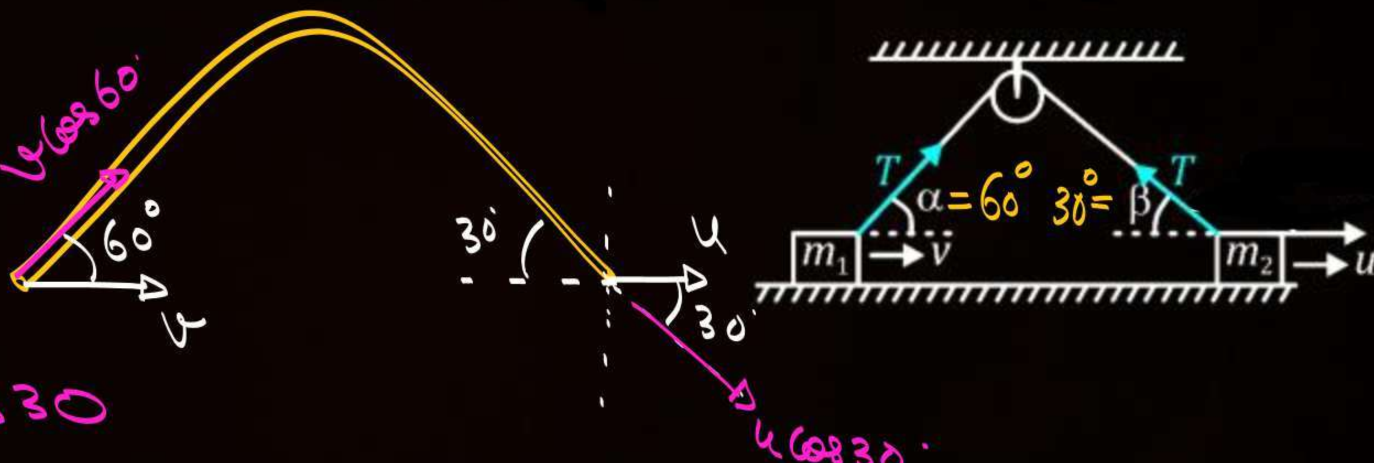
$$v = \frac{u}{\cos\theta}$$

$$v\cos\theta = u$$

$$v = u/\cos\theta$$

QUESTION- 35

Find relation between u and v. [redacted]



$$v \cos 60 = u \cos 30$$

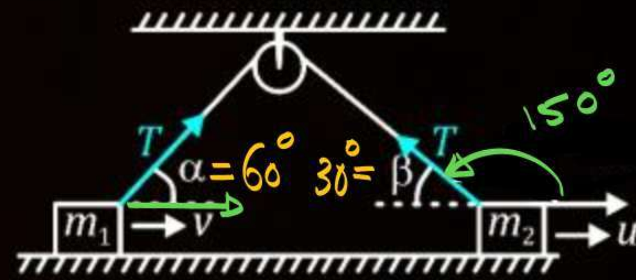
$$\frac{v}{2} = \frac{u\sqrt{3}}{2}$$

$$v = u\sqrt{3}$$

QUESTION- 35

Find relation between u and v. [redacted]ocity along [redacted]

$\boxed{\sum P_{\text{Tension}} = 0}$ system.



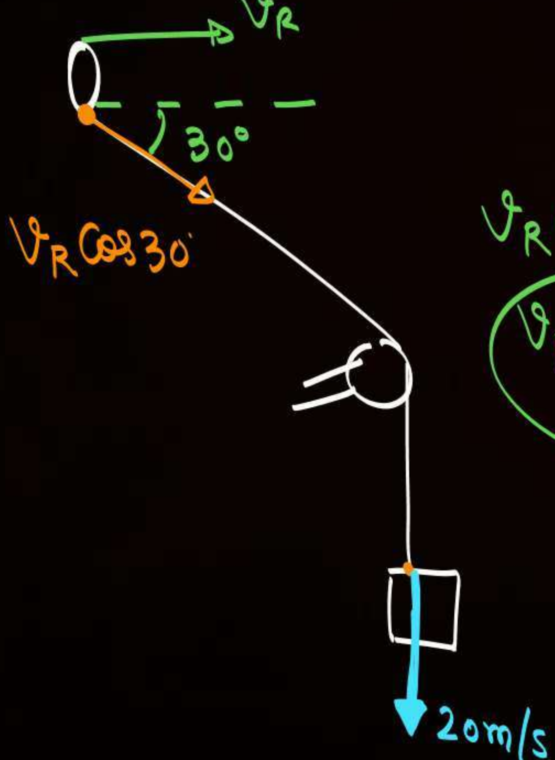
$$\cancel{T} v \cos 60 + \cancel{T} u \cos \overset{(90+60)}{150} = 0$$

$$v\left(\frac{1}{2}\right) - u\left(\frac{\sqrt{3}}{2}\right) = 0$$

$$v = u\sqrt{3}$$

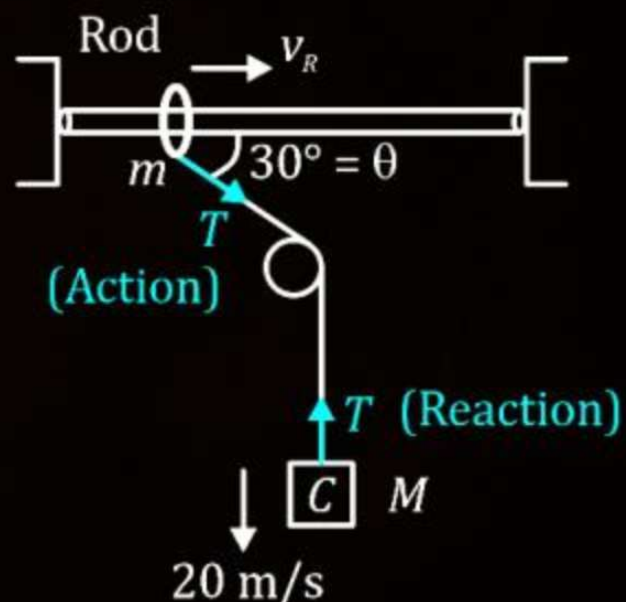
QUESTION- 36

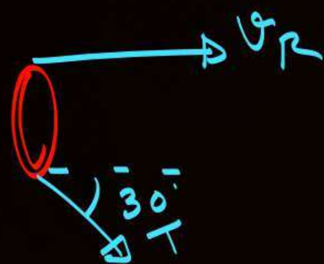
Ring can move along rod. When block m is moving with 20 m/s. Find velocity of ring when $\theta = 30°$



$v_R \cos 30 = 20$

$v_R = \frac{40}{\sqrt{3}}$



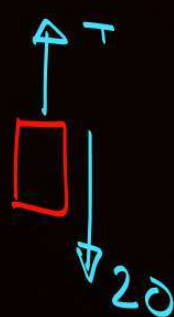


$$\Sigma P_{Int} = 0$$

$$\cancel{T}(20)\cos 180 + \cancel{T}\, v_R \cos 30 = 0$$

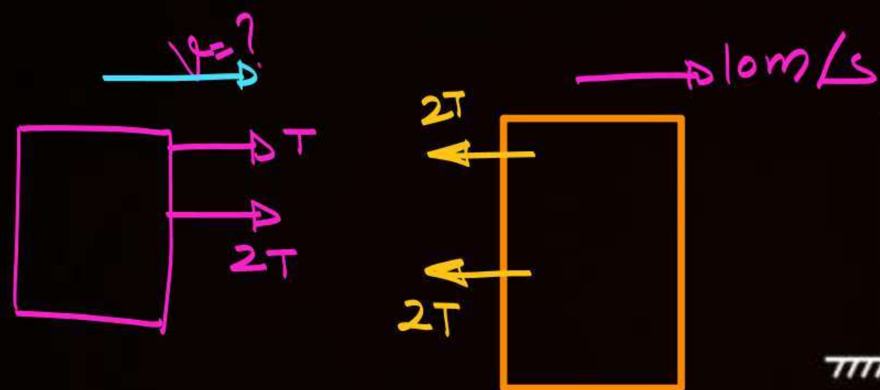
$$20 = v_R \frac{\sqrt{3}}{2}$$

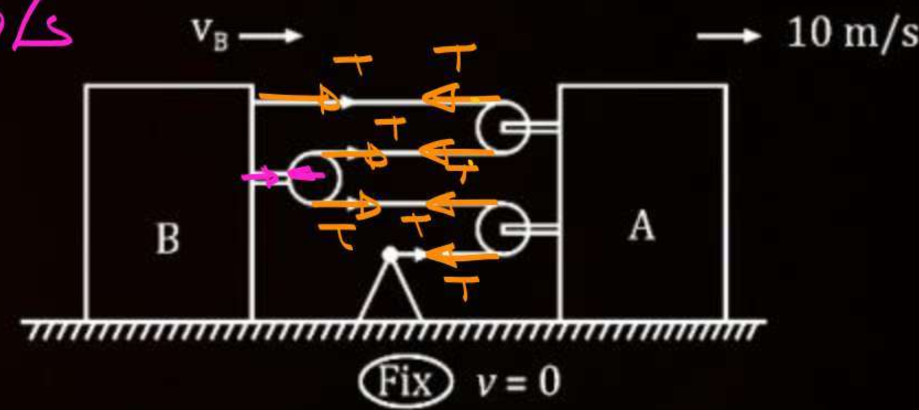
$$v_R = \frac{40}{\sqrt{3}}$$



QUESTION- 37

What is velocity of B. When multiple pulleys are there go by power method.





$$\boxed{\Sigma P_{int} = 0}$$

$$4\cancel{T}(10)\cos 180 + 3\cancel{T}v\cos 0 = 0$$

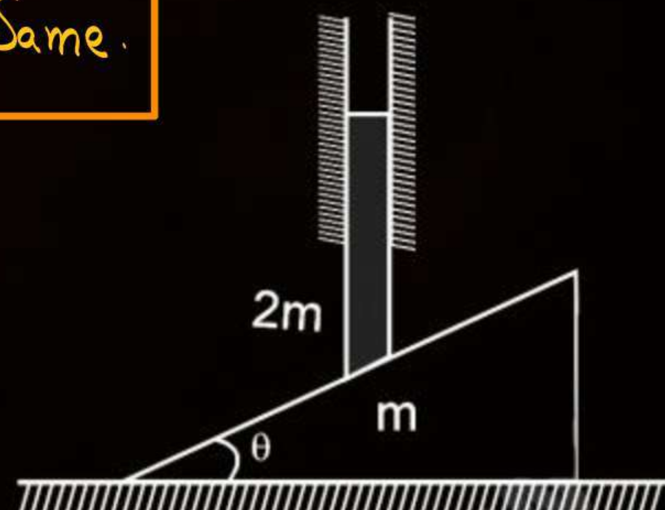
$$40 = 3v$$

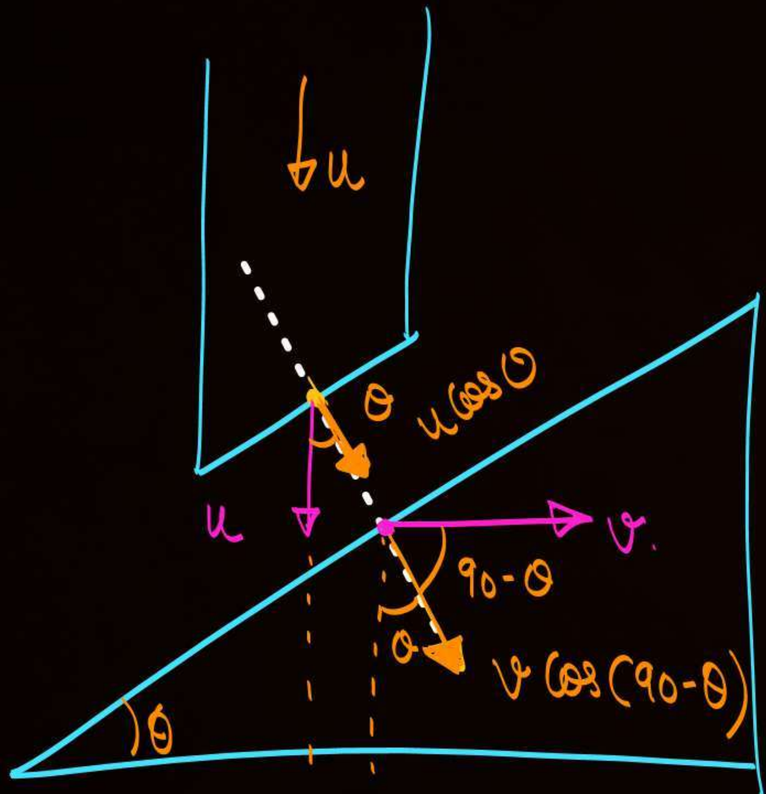
$$v = \frac{40}{3}$$

Wedge constraint

A rod of mass 2m moves vertically downward on the surface of wedge of mass as shown in figure. Find the relation between velocity of rod and that of the wedge at any instant.

Velocities along Normal = Same.





$$u\cos\theta = v\sin\theta$$

$$u = v\tan\theta$$

Find velocities along Normal & then Equate.

QUESTION- 39

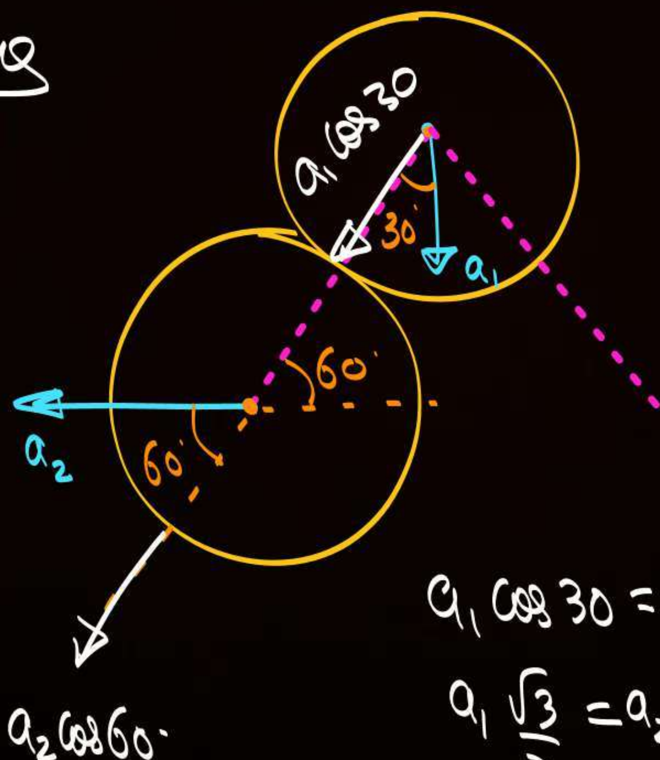
The relation between acceleration a_1 and a_2, if the radius of each sphere is equal to R.

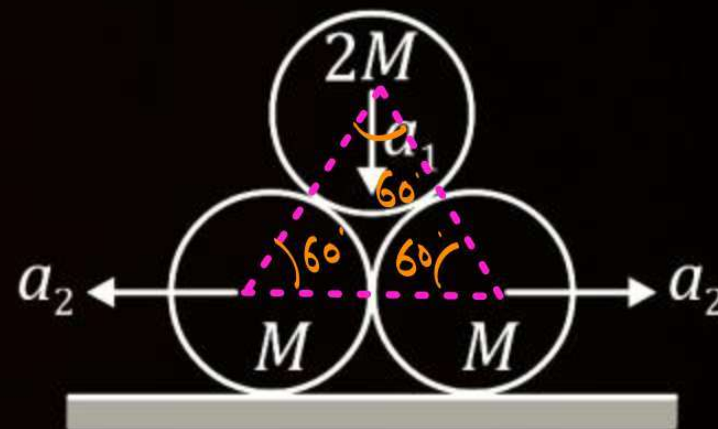
(1) $a_2 = a_1\sqrt{3}$ Ans

(2) $a_1 = a_2\sqrt{3}$

(3) $a_1 = 2a_2$

(4) $a_2 = 2a_1$





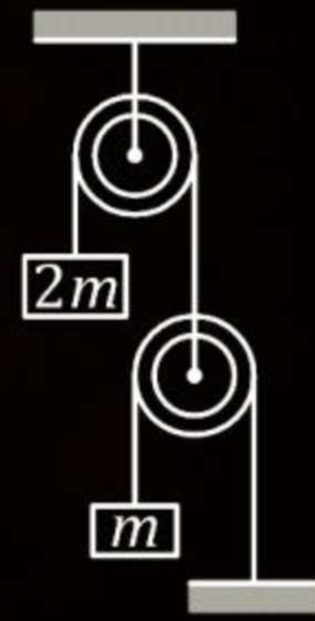
$a_1 \cos 30 = a_2 \cos 60$.

$a_1 \frac{\sqrt{3}}{2} = a_2 \frac{1}{2}$

$a_1\sqrt{3} = a_2$

QUESTION- 40

In the system shown in the figure, the friction and mass of rope is negligible then acceleration of the block of mass 2m is:



(1) $g/5$

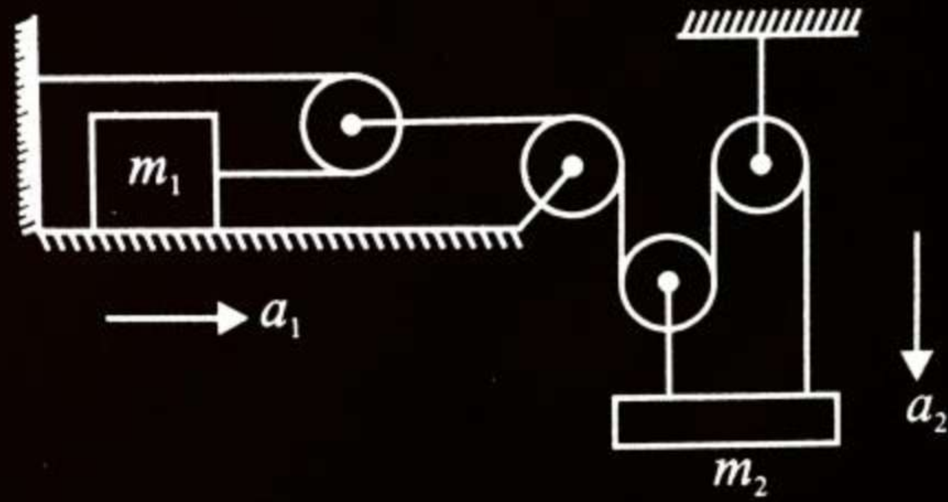
(2) $2g/5$

(3) 0

(4) $5g/2$

QUESTION- 41

Two blocks are arranged as shown in the figure. The relation between acceleration a_1 and a_2 is:



(1) $a_1 = a_2$

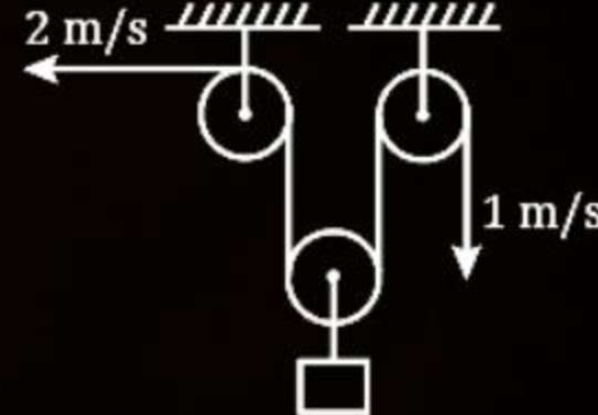
(2) $a_1 = 6a_2$

(3) $a_1 = 3a_2$

(4) $a_1 = 4a_2$

QUESTION- 42

Find the velocity of the hanging block if the velocities of the free ends of the rope are as indicated in the figure.



(1) $3/2\ \text{m/s} \uparrow$

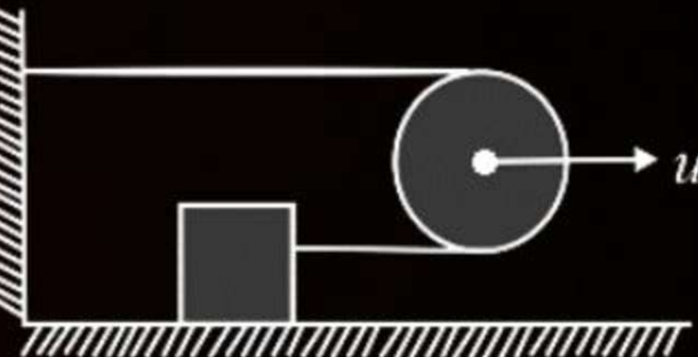
(2) $3/2\ \text{m/s} \downarrow$

(3) $1/2\ \text{m/s} \uparrow$

(4) $1/2\ \text{m/s} \downarrow$

QUESTION- 43

In the figure shown, the pulley is moving with velocity u. Calculate the velocity of the block attached with string.



(1) u

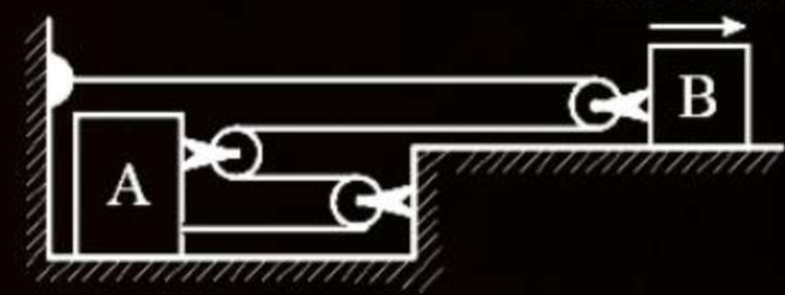
(2) $2u$

(3) $3u$

(4) $2.5u$

QUESTION- 44

If velocity of block B in the given arrangement is 300 mm/sec towards right. Then velocity of A will be



(1) 200 mm/sec

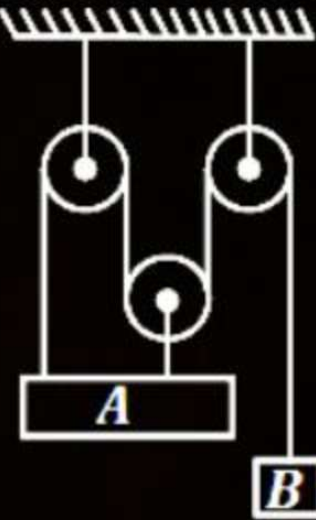
(2) 100 mm/sec

(3) 450 mm/sec

(4) 150 mm/sec

QUESTION- 45

At a given instant, A is moving with velocity of $5\ \mathrm{m/s}$ upwards. What is velocity of B at the time



(1) $15\ \mathrm{m/s} \downarrow$

(2) $15\ \mathrm{m/s} \uparrow$

(3) $5\ \mathrm{m/s} \downarrow$

(4) $5\ \mathrm{m/s} \uparrow$

Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points + Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

Friction

Contact force → which opposes Relative slipping or tendancy of slipping.

when there is tendancy of slipping

f_{static}

⊛ Self adjusting

$$\boxed{⊛\ f_{s\,max} = f_{lim} = \mu_s N.}$$

we have to check.

$$\boxed{0 \leq f_s \leq \mu_s N}$$

$f_{kinetic}$.

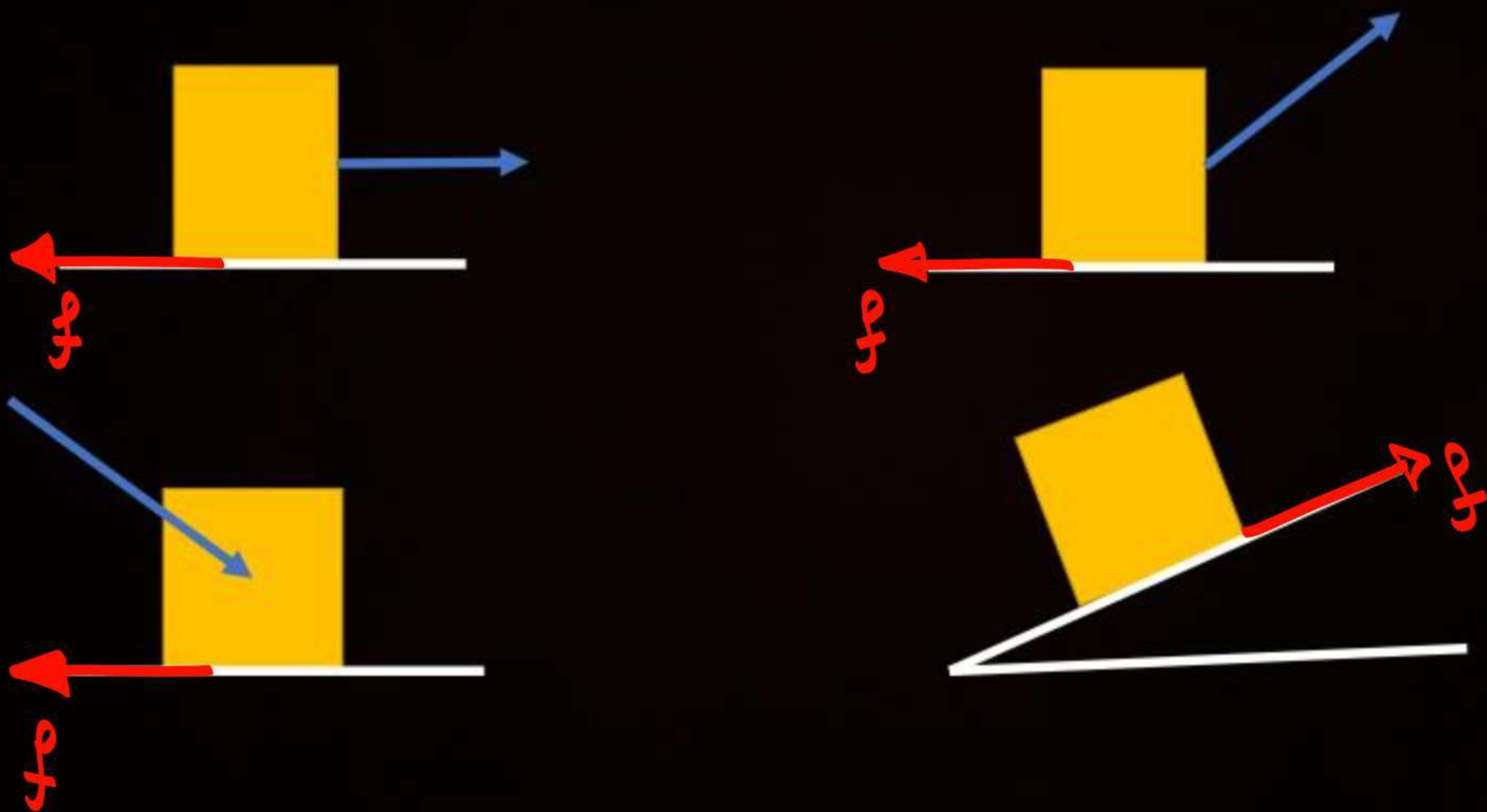
→ Relative slipping between surfaces.

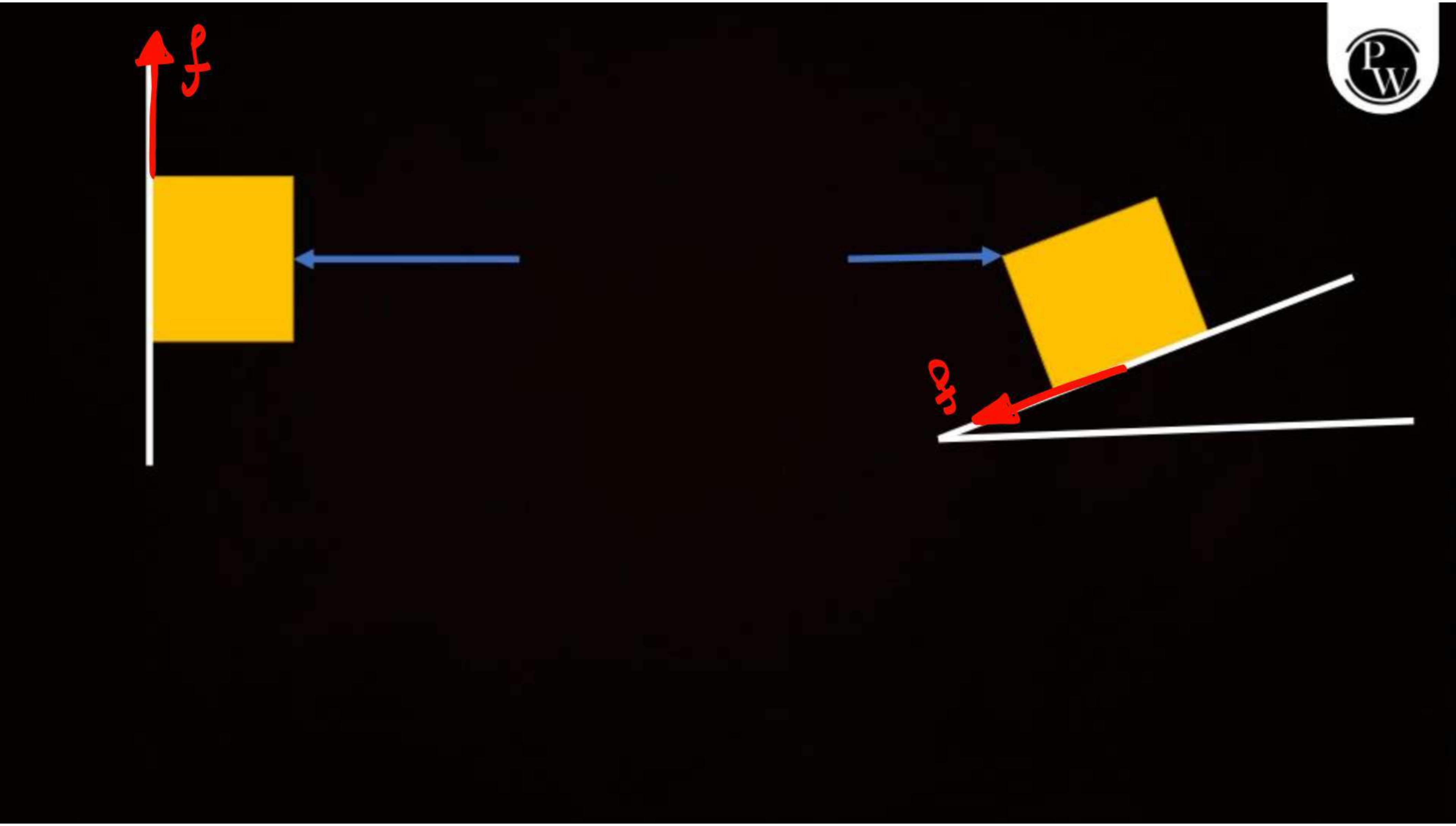
→ fix value

⇒ $f_k = \mu_k N$.

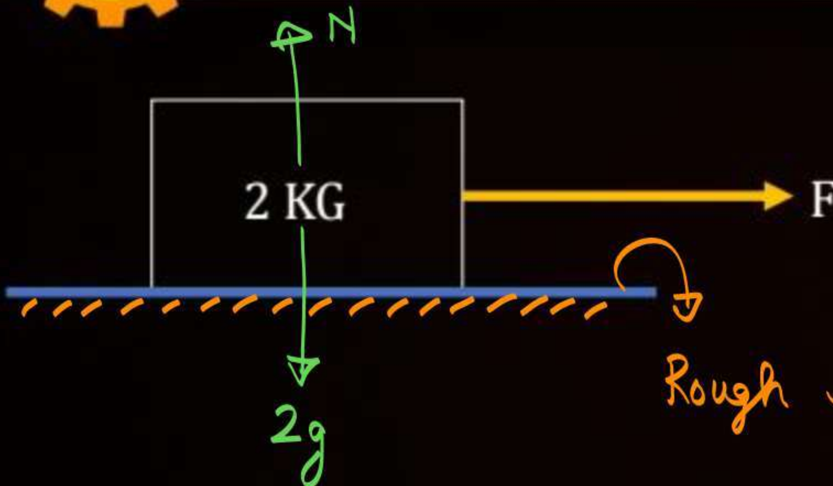
⇒ opp to dir of slipping.

Draw the direction of friction in following cases




f

Graph Between Applied Force and Force of Friction

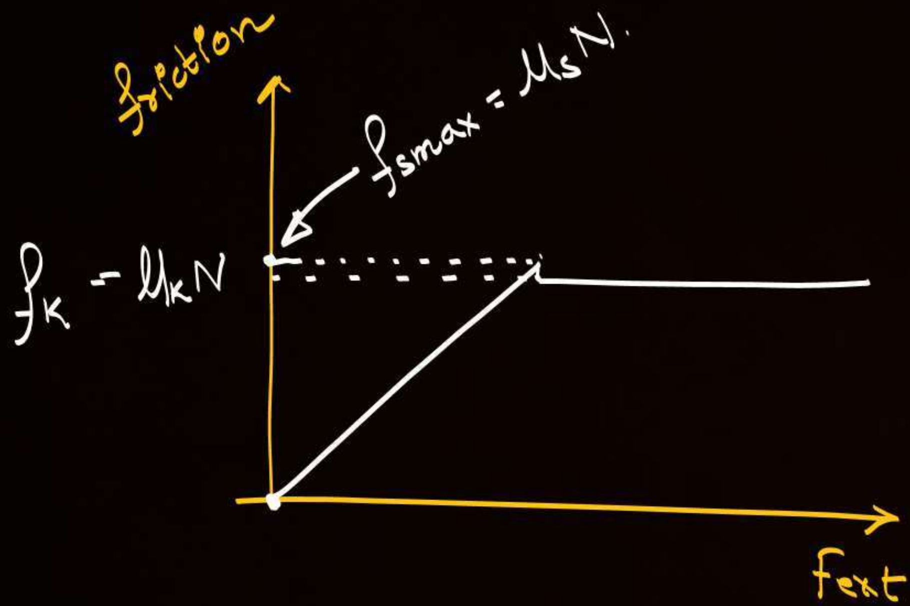


Rough $\mu = 0.5$

$N = 20$

1. $f_{s\,max} = \mu_s N = 0.5 \times 20 = 10\,N$ Max value of f_{static}.

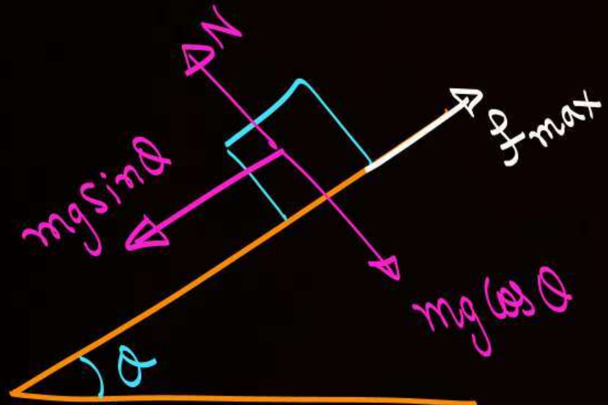
f_{ext}	f	
2N	2	Self adjust. Rest Static friction
4N	4	
6 N	6	
9N	9	
9.999	9.999.	
10.1	10	Motion $f = f_k$
15	10	
100	10	

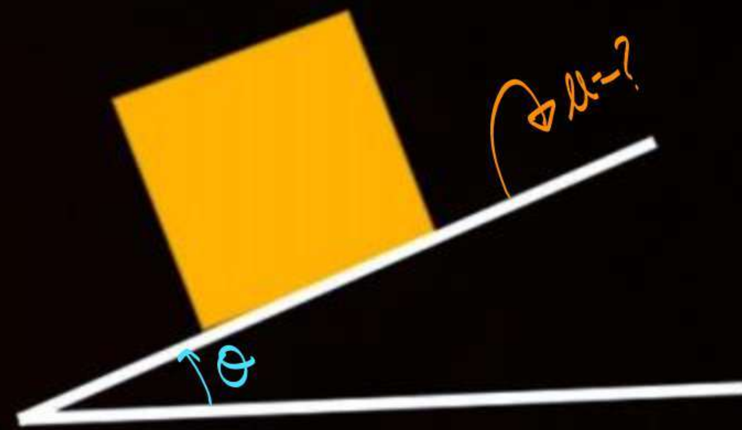


friction
fsmax = μsN
fK = μKN
Fext

Angle of Repose

θ = Angle from Horizontal where block Just Slip.



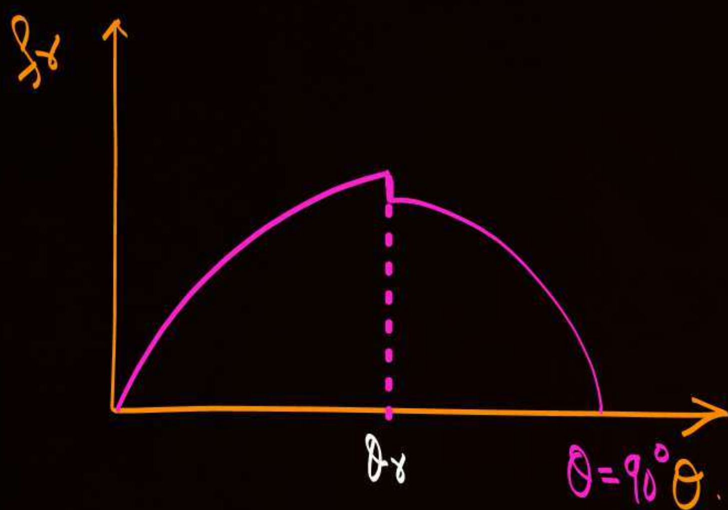


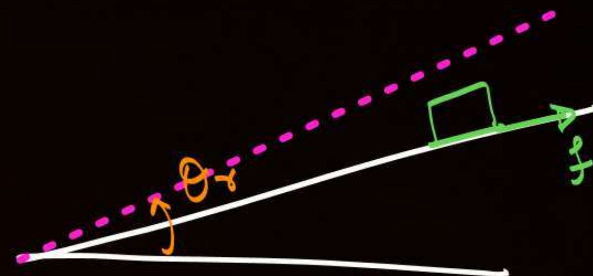
Just Slipping.

$$mg\sin\theta = f_{s\,max} = \mu_s N$$

$$mg\sin\theta = \mu_s\, mg\cos\theta$$

$$\mu = \tan\theta$$





$\boxed{\theta_r = \tan^{-1}(\mu)}$

$\theta < \theta_r$

$f = f_{static}$ = Self adjus

$\boxed{f = mg\sin\theta}$

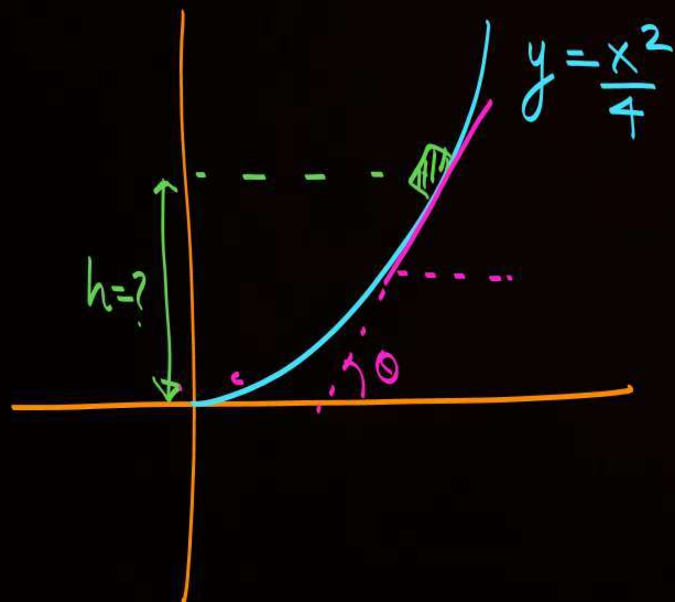
$\theta > \theta_r$

$f_r = f_K = \mu_K mg\cos\theta.$

QUESTION- 46

An inclined plane is bent in such a way that the vertical cross-section is given by $y = x^2/4$ where y is in vertical and x in horizontal direction. If the upper surface of this curved plane is rough with coefficient of friction $\mu = 0.5$, the maximum height in cm at which a stationary block will not slip downward is ______ cm.

[JEE (Main)-2021]



$\mu = 0.5$

$\tan\theta = \mu$ then block will slip.

$\frac{dy}{dx} = \frac{2x}{4} = \mu$

$\frac{x}{2} = 0.5$

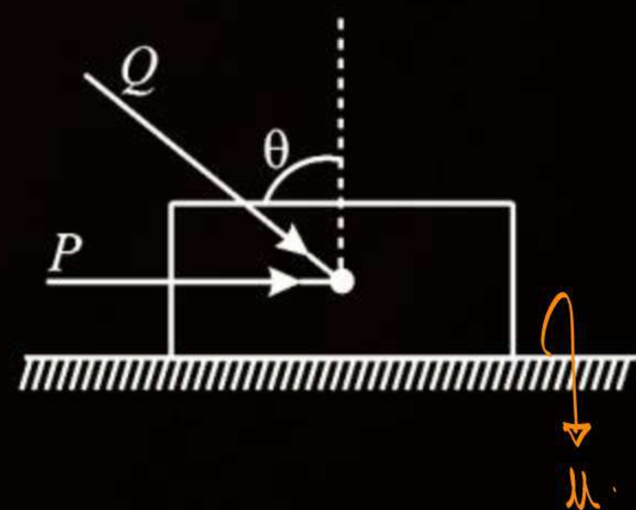
$x = 1m$

$y = \frac{1}{4} = 0.25$

$= 25 cm$

QUESTION- 47

A block of mass m lying on a rough horizontal plane is acted upon by a horizontal force P and another force Q inclined at an angle θ to the vertical. The block will remain in equilibrium if the coefficient of friction between it and the surface is : (JEE Mains)

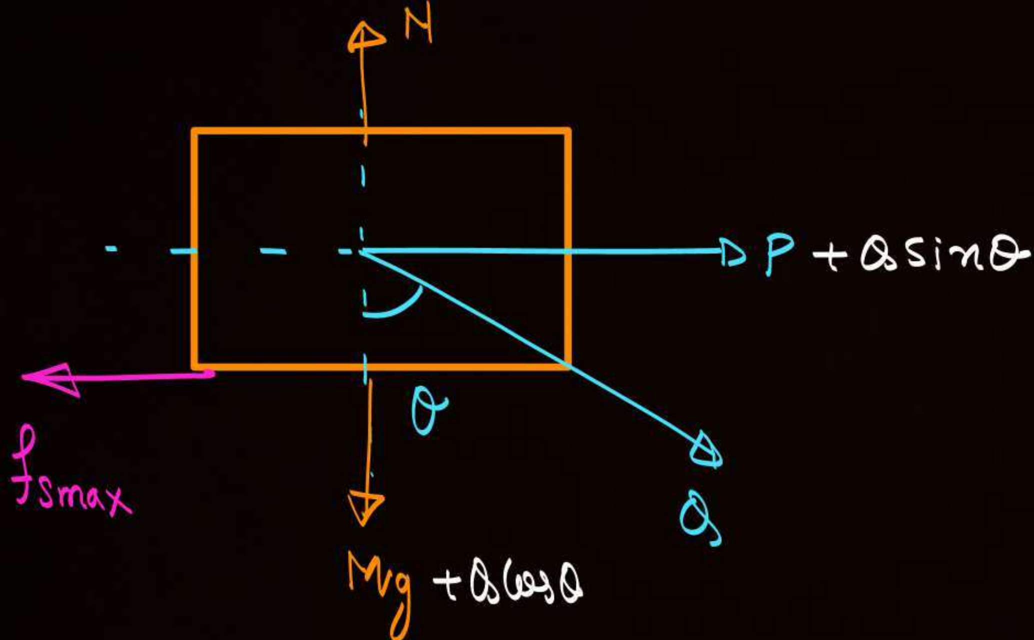


(1) $\dfrac{P + Q\sin\theta}{mg + Q\cos\theta}$ Ans

(2) $\dfrac{P\cos\theta + Q}{mg - Q\sin\theta}$

(3) $\dfrac{P + Q\cos\theta}{mg + Q\sin\theta}$

(4) $\dfrac{P\sin\theta + Q}{mg - Q\cos\theta}$



$$N = Mg + Q\cos\theta.$$

$$P + Q\sin\theta = f_{smax}$$

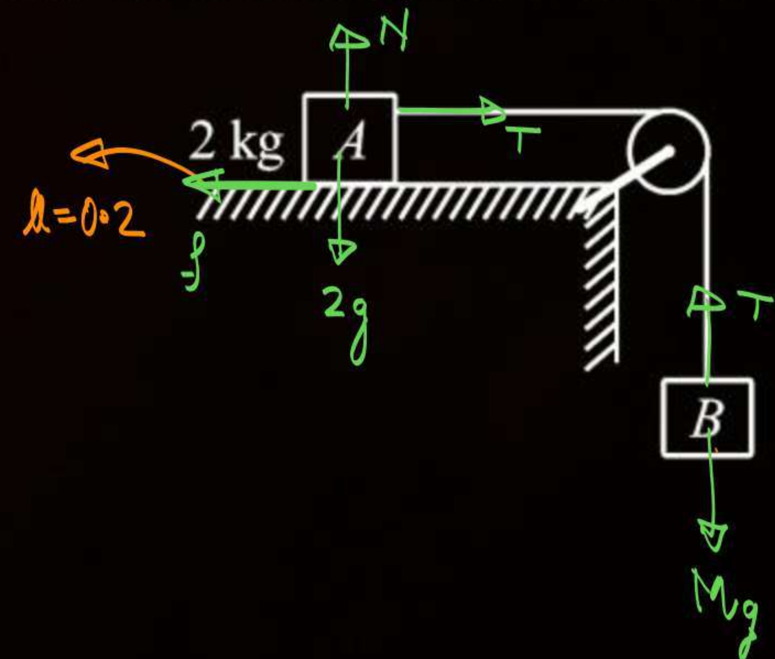
$$P + Q\sin\theta = \mu(N)$$

$$P + Q\sin\theta = \mu(Mg + Q\cos\theta)$$

$$\boxed{\frac{P + Q\sin\theta}{Mg + Q\cos\theta} = \mu}$$

QUESTION- 48

The coefficient of static friction, μ_s, between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. ($g = 10\ m/s^2$)



$Mg = f_{s\,max}$

$M\cancel{g} = 0.2(2\cancel{g})$

$M = 0.4\ Kg$

(1) 4.0 kg

(2) 0.2 kg

(3) 0.4 kg Ans

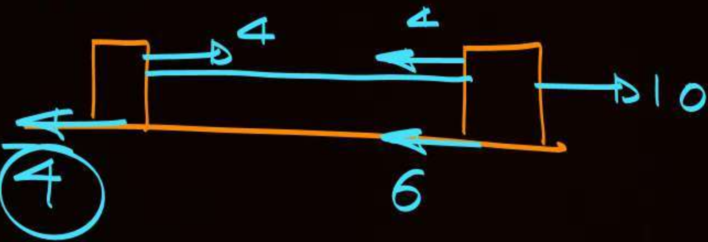
(4) 2.0 kg

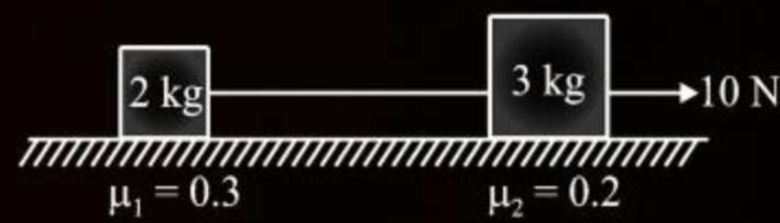
QUESTION- 51

Two blocks of masses 2 kg and 3 kg placed on a horizontal surface are connected by a massless string. If 3 kg is pulled by 10 N as shown in figure, then force of friction acting on 2 kg is [Take $g = 10\ m/s^2$]

(JEE).

1. 6 N
2. 4 N (Ans)
3. 8 N
4. 12 N





$f_{s\,max} = 0.3 \times 20 = 6\,N$

$f_{s\,max} = 0.2 \times 30 = 6\,N.$

QUESTION- 52

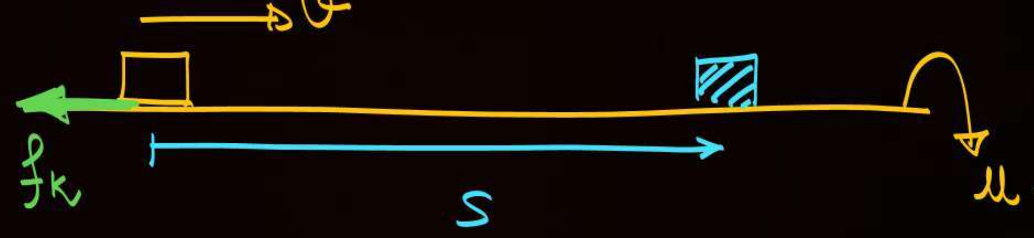
A body of mass m moves with a velocity v on a surface whose friction coefficient is μ. If the body covers a distance s and finally come rest then v will be: (JEE).

(1) $\sqrt{2\mu g s}$ Ans

(2) $\sqrt{\mu g s}$

(3) $\sqrt{\mu g s/2}$

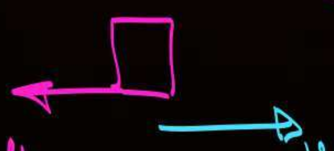
(4) $\sqrt{3\mu g s}$



$f_K = \text{Const} = \mu_K N$
$= \mu m g.$

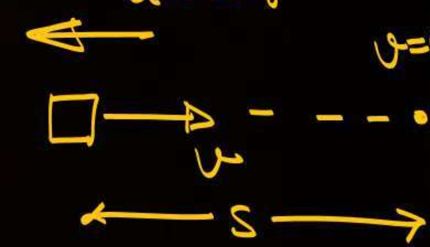
$\mu \cancel{m} g = \cancel{m} a$

$a = \mu g$



Retard ⇐ $\mu m g$

$a = \mu g$



$\cancel{v^2} - u^2 = 2as$

$\cancel{-}v^2 = \cancel{-}2\mu g S$

$v = \sqrt{2\mu g S}.$

QUESTION- 53

A block of mass 5 kg resting on a horizontal surface is connected by a cord, passing over a light frictionless pulley to a hanging block of mass 5 kg. The coefficient of kinetic friction between the block and the surface is 0.5. Tension in the cord is: $(g = 9.8\ m/s^2)$

(1) 49 N

(2) Zero

(3) 36.75 N

(4) 12.75 N

$f_{s\,max} = \mu N$

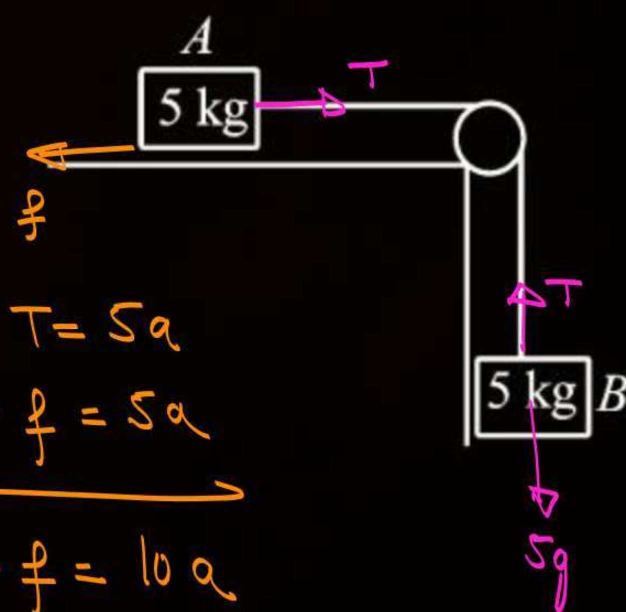
$= 0.5 \times 5 \times 9.8$

$a = \dfrac{5g - f}{10}$

$5g - T = 5a$

$T - f = 5a$

$5g - f = 10a$

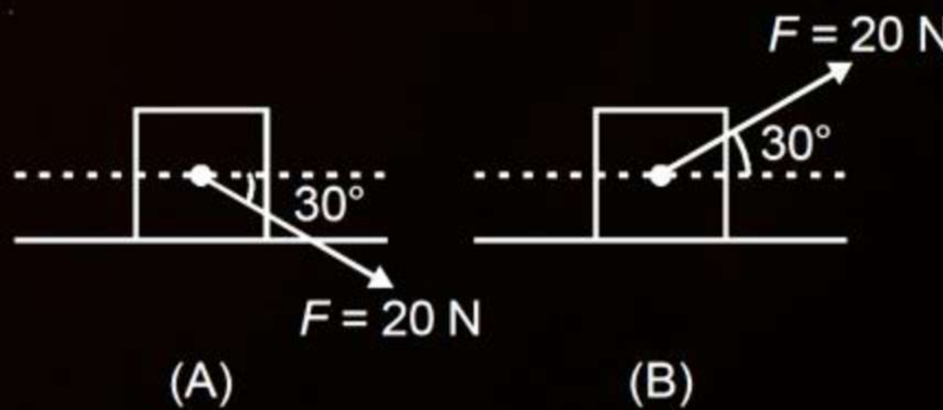


QUESTION- 58

A block of mass 5 kg is (i) pushed in case (A) and (ii) pulled in case (B), by a force $F = 20$ N, making an angle of 30° with the horizontal, as shown in the figures. The coefficient of friction between the block and floor is $\mu = 0.2$. The difference between the accelerations of the block, in case (B) and case (A) will be: ($g = 10\ ms^{-2}$)

[JEE (Main)-2019]

1. $0.4\ ms^{-2}$
2. $3.2\ ms^{-2}$
3. $0\ ms^{-2}$
4. $0.8\ ms^{-2}$



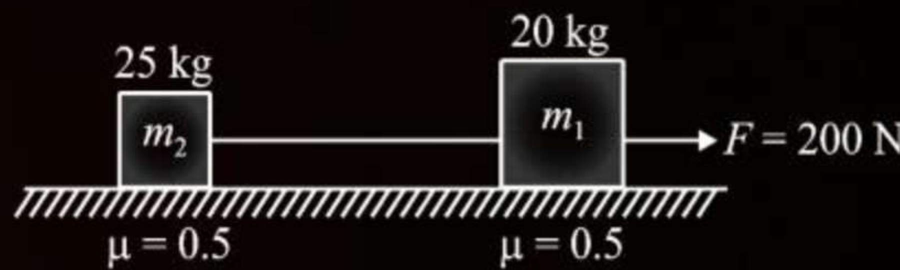
QUESTION- 59

The coefficient of static friction between a wooden block of mass 0.5 kg and a vertical rough wall is 0.2. The magnitude of horizontal force that should be applied on the block to keep it adhere to the wall will be ______ N. [$g = 10\ ms^{-2}$]

[JEE (Main)-2021]

QUESTION- 60

In the given figure, $F = 200$ N, $m_1 = 20$ kg, $m_2 = 25$ kg, $g = 10\ \text{m/s}^2$. Find the friction acting on the block of mass m_2 [Take $g = 10\ \text{m/s}^2$]



(1) 125 N

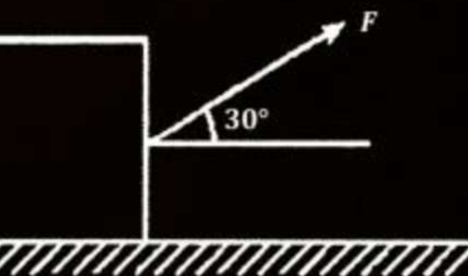
(2) 120.5 N

(3) 100 N

(4) 123.2

QUESTION- 61

A mass m rests under the action of a force F as shown in the figure on a horizontal surface. The coefficient of friction between the mass and the surface is μ. The force of friction between the mass and the surface is:



(1) μmg

(2) $\mu\left[mg + \frac{F}{2}\right]$

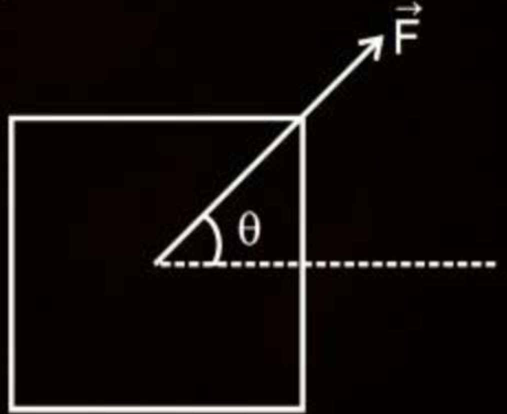
(3) $\frac{F\sqrt{3}}{2}$

(4) $\mu\left[mg - \frac{F}{2}\right]$

QUESTION- 62

A block of mass m slides along a floor while a force of magnitude F is applied to it at an angle θ as shown in figure. The coefficient of kinetic friction is μ_K. Then, the block's acceleration 'a' is given by: (g is acceleration due to gravity)

[JEE (Main)-2021]



(1) $\frac{F}{m}\cos\theta + \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

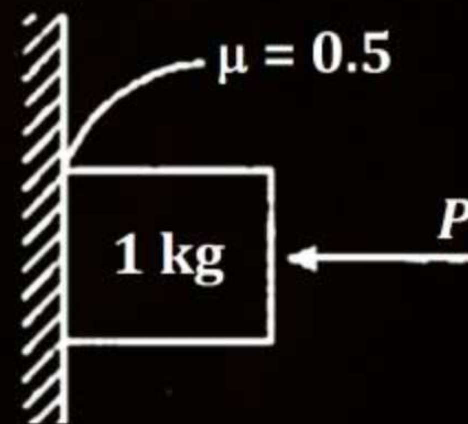
(2) $\frac{F}{m}\cos\theta - \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

(3) $-\frac{F}{m}\cos\theta - \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

(4) $\frac{F}{m}\cos\theta - \mu_K\left(g + \frac{F}{m}\sin\theta\right)$

QUESTION- 63

Minimum force required to keep a block of mass 1 kg at rest against a rough vertical wall is P. If a force $P/2$ is applied then the acceleration of the block will be:
(Take $g = 10\ \mathrm{m/s^2}$)



(1) $5\ \mathrm{m/s^2}$

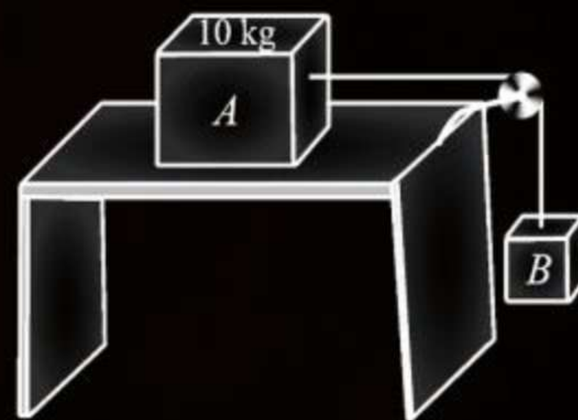
(2) $2.5\ \mathrm{m/s^2}$

(3) $2\ \mathrm{m/s^2}$

(4) $0.9\ \mathrm{m/s^2}$

QUESTION- 64

If mass of $A = 10$ kg, coefficient of static friction = 0.2, coefficient of kinetic friction = 0.2. Then mass of B to start motion is



(1) 2 kg

(2) 2.2 kg

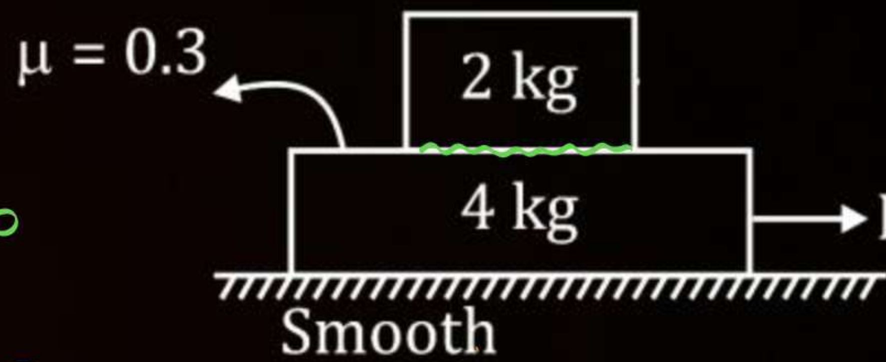
(3) 4.8 kg

(4) 200 kg

$\boxed{\text{Break} \longrightarrow 10:45 \text{ PM}}$

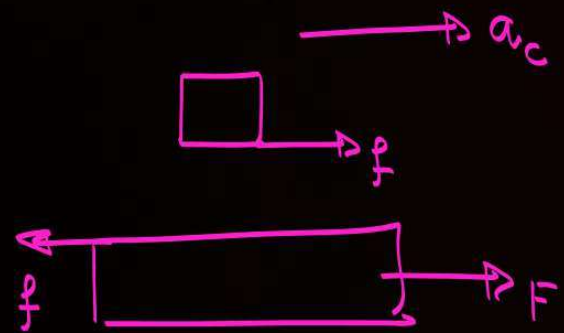
QUESTION- 65

Find force when there A will slip over B.



(*) $F > 0$

both block will move.



$f = 2a$

$F - f = 4a$

$F = 6a$

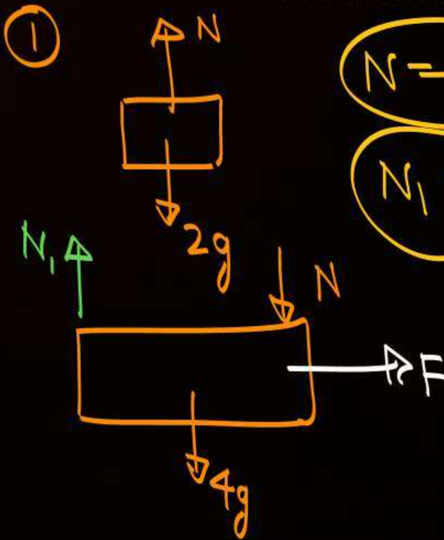
$a = \frac{F}{6}$

(2) $f_{smax_1} = \mu N$

$= 0.3 \times 20$

$= 6N$

(1)



$N = 20$

$N_1 = 4g + N = 60$

$$f = 2a$$

$$f = 2\left(\frac{F}{6}\right)$$

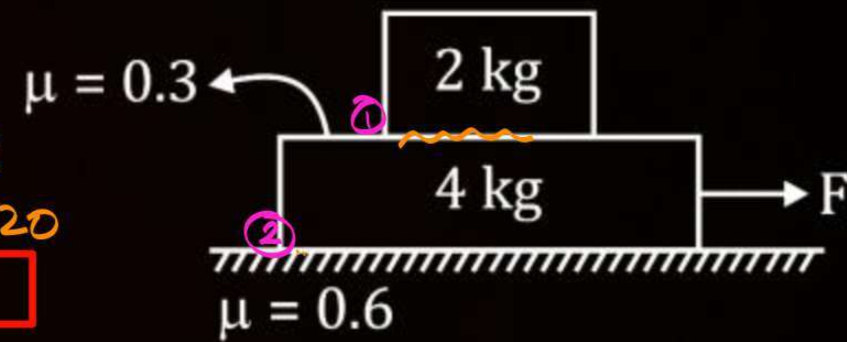
$$\uparrow f = \frac{F}{3} \uparrow$$

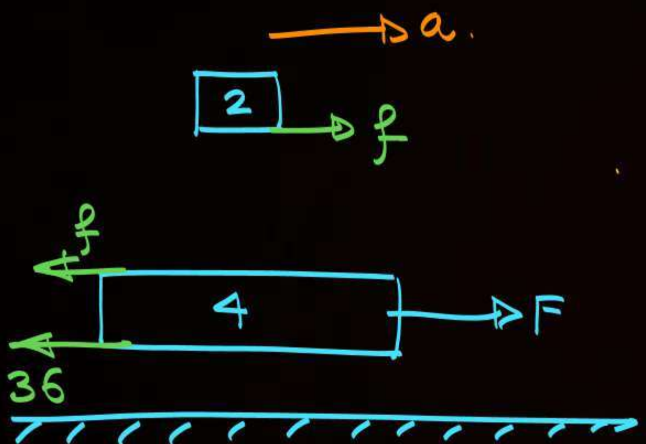
$$\text{Limit} = 6\,N$$

F at which slipping start $\quad 6 = \frac{F}{3} \quad F = 18$

QUESTION- 66

Find force when there A will slip over B.



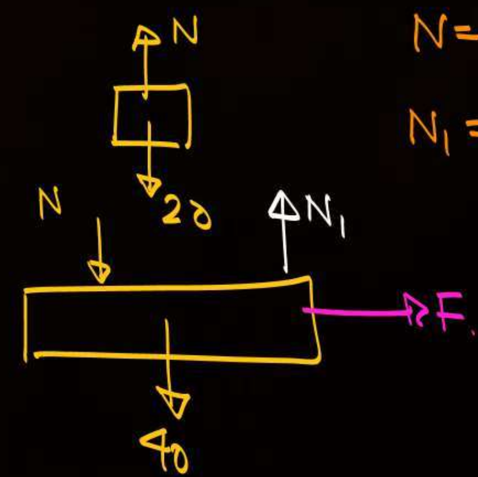


$f_{smax_1} = 0.3 \times N$
$= 0.3 \times 20$
$\boxed{= 6\text{ N}}$

$f_{smax_2} = 0.6 \times N_1$
$= 0.6 \times 60$
$= 36\text{ N}$

$N = 20$

$N_1 = 60.$



F > 36 N both will start Moving

$f = 2a$

$F - f - 36 = 4a$

$F - 36 = 6a$

$a = \dfrac{F-36}{6}$

$f = 2a$

$f = 2\left(\frac{F-36}{6}\right)$

Limit

6N

when A will slip $f = 6$

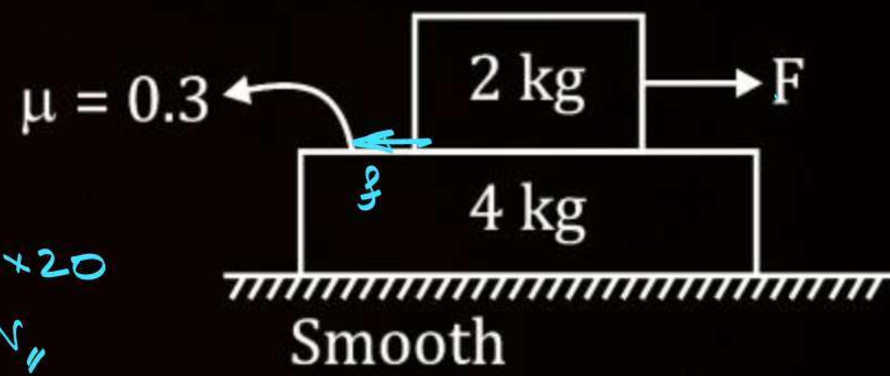
$3\cancel{6} = \cancel{2}\left(\frac{F-36}{6}\right)$

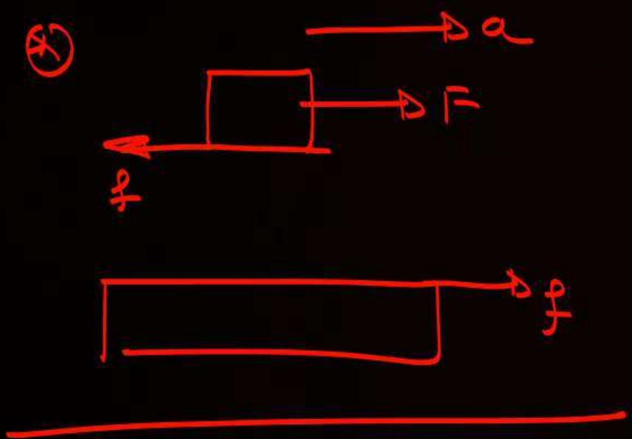
$18 = F - 36$

$F = 36 + 18 = 54\,N$

QUESTION- 67

Find force when there A will slip over B.

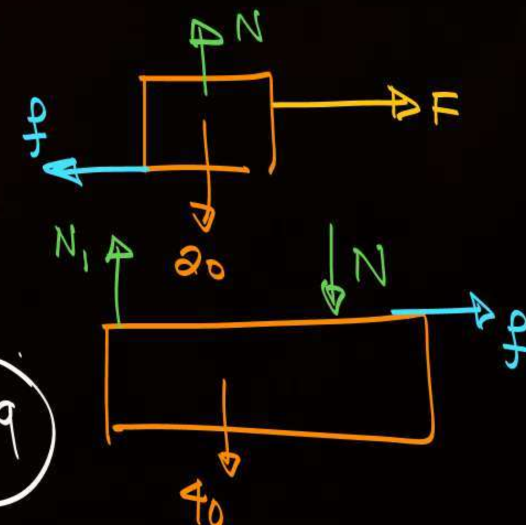




$$F - f = 2a$$
$$f = 4a$$
$$F = 6a$$
$$a = \frac{F}{6}$$

$$f_{s\,max_1} = \mu N = 0.3 \times 20 = 6N$$

$$f = 4\frac{F}{6}$$
$$f = \frac{2F}{3}$$
$$6 = \frac{2}{3}F$$
$$F = 9$$



$N = 20$

$N_1 = 60.$

QUESTION- 68

Two blocks A and B of masses $m_A = 1$ kg and $m_B = 3$ kg are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F that can be applied on B horizontally, so that the block A does not slide over the block B is: [Take, $g = 10\ m/s^2$]

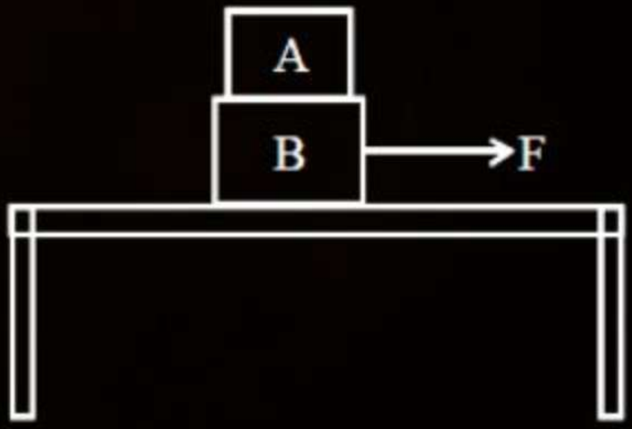
[2019 Main]

(1) 12 N

(2) 16 N

(3) 8 N

(4) 40 N



* Draw F.B.D.
  & Calculate f_{smax} on both Surface.

* Consider that force at which both Start Moving with Common acc.

* Write the Equations of Motion

* $a =$ ____

* Put in any Eq to find $f = ?$

* For Slipping $f = f_{smax}$

  $F = \text{Ans}$

Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points + Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

Circular motion

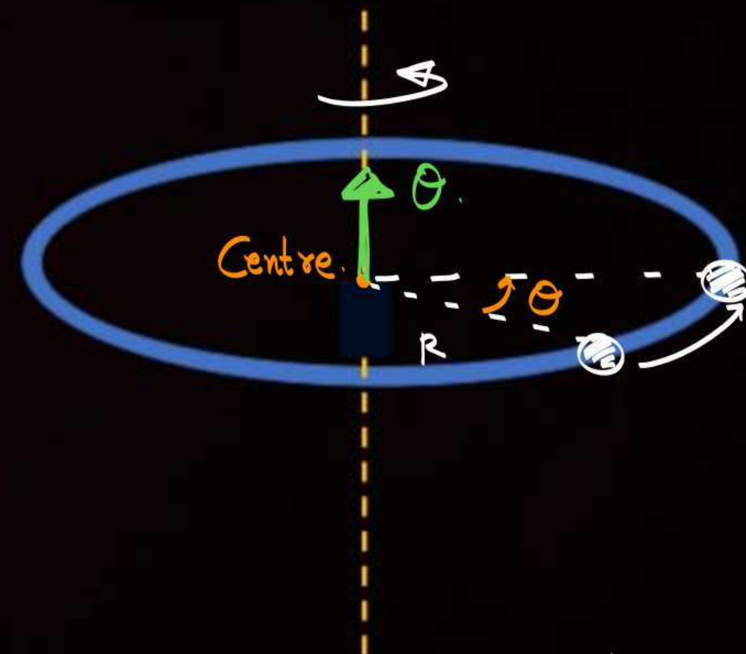
$180^\circ = \pi \, rad$

θ = Angular disp (Vector) (Axial Vector)
(rad)

$\boxed{\omega = \frac{d\theta}{dt} = \text{Angular Velocity} \left(\frac{rad}{s}\right)}$

$\boxed{\omega_{av} = \frac{\theta_2 - \theta_1}{t_2 - t_1}}$

$\boxed{\alpha = \frac{d\omega}{dt} \qquad \alpha_{av} = \frac{\omega_2 - \omega_1}{t_2 - t_1}}$ $\left(\frac{rad}{s^2}\right)$.



Axial = which acts on axis of Rotation.

⊙ one Complete Rot

$$\omega = \frac{\theta_{Total}}{T} = \frac{2\pi}{T}$$

$$\boxed{\omega = \frac{2\pi}{T} = 2\pi\nu}$$

$$\nu = \frac{1}{T}$$

⊛ rpm, rps ⟹ unit of freq.

⊛ $\nu = 360\ rpm$

$$= \frac{360}{60}\ rps$$

$$\boxed{\nu = 6\ rps}$$

$$\omega = 2\pi\nu$$

$$= 2\pi(6) = 12\pi\ \frac{rad}{s}.$$

V=Rw and tangential acceleration

$\theta \rightarrow$ ✓

body Rotate.

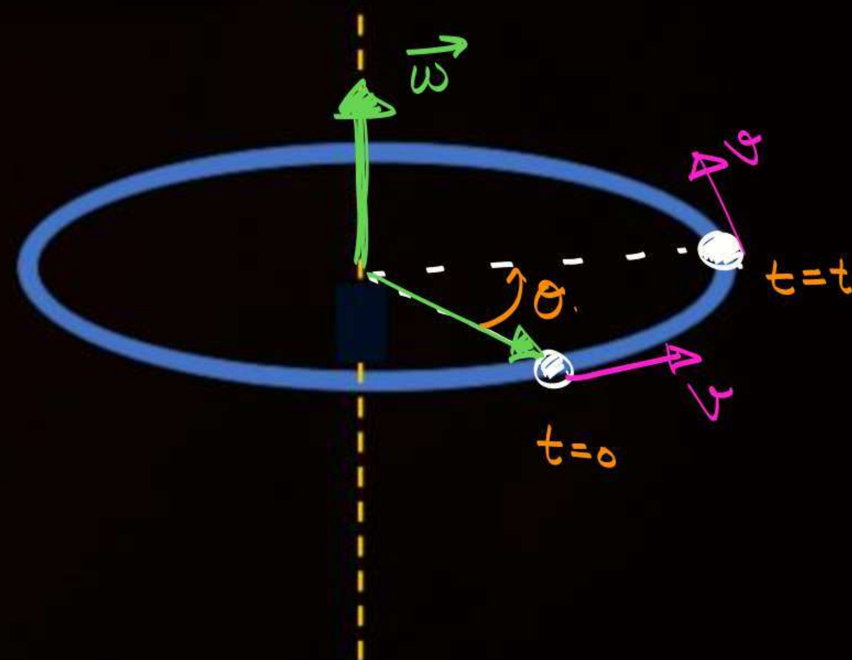
Vary time.

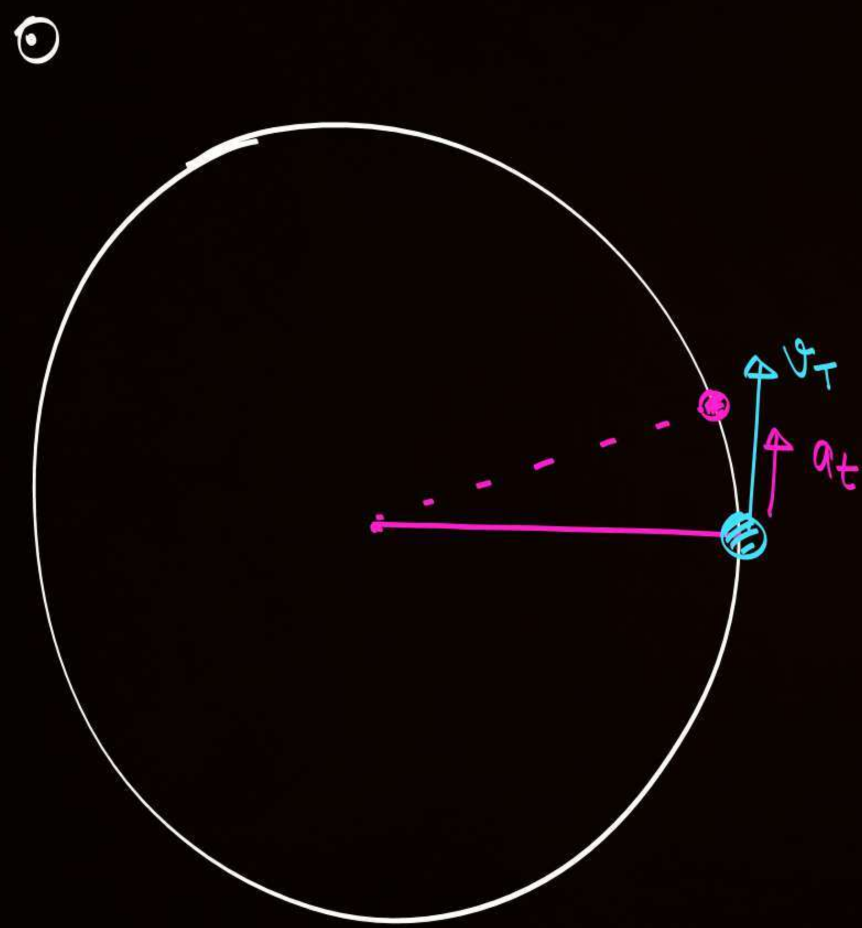
$\omega = \frac{d\theta}{dt}$

$\boxed{\text{agar } \omega \text{ hai } \text{~~toh~~ } v \text{ hai}}$

Relation between v_T & ω.

$\boxed{\vec{v}_T = \vec{\omega} \times \vec{R}}$ $\boxed{v_T = R\omega}$ Imp - 1





$$\alpha = \frac{d\omega}{dt}$$

In Case tangential Speed → change.

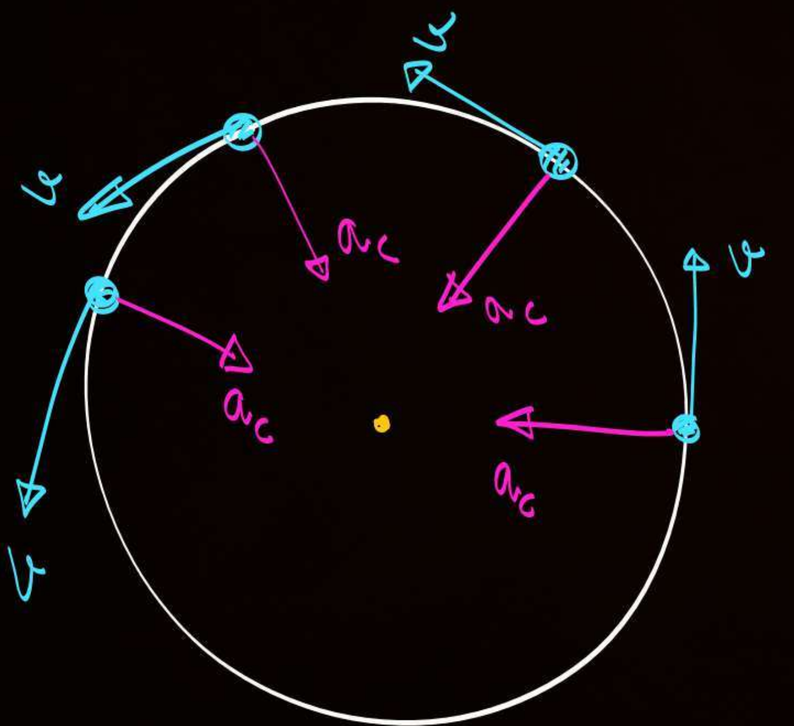
$$\boxed{v = \omega \times R}$$

diff wrt time

$$\vec{a_t} = \vec{\alpha} \times \vec{R}$$

$$a_t = R\alpha$$

In CM the direction of velocity keeps on changing.



Centripetal acc ⇒ dir change.

$$\boxed{a_c = \frac{v^2}{R} = R\omega^2}$$

UCM and NUCM

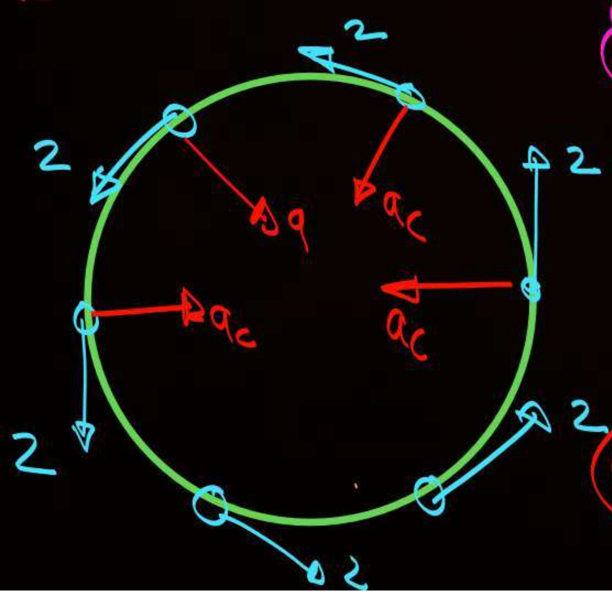
UCM

Uniform Circular Motion.

$\alpha = 0$ $\omega = \text{Const}$

$a_t = 0$ $v = \text{Const}$

$\left.\begin{matrix}\omega = \text{Const} \\ v = \text{Const}\end{matrix}\right\}$ Ex $\omega = 4\ \text{rad/s}$, $v = 2\ \text{m/s}$.



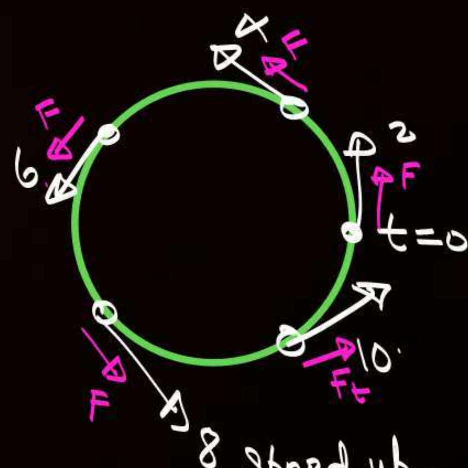
$* \ a_t = R\alpha = \dfrac{d|v|}{dt} = 0$

$* \ a_c = \dfrac{v^2}{R} = R\omega^2$

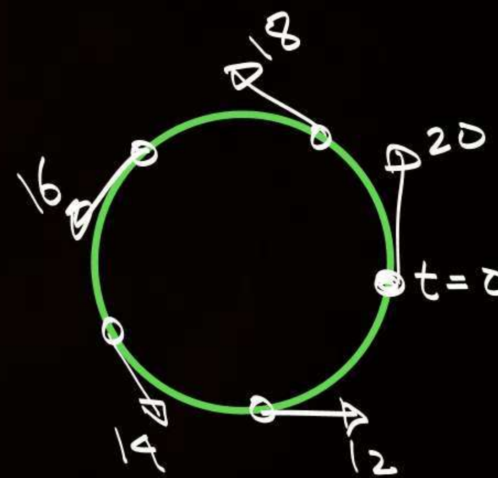
$a_{net} = a_c$

NUCM

$\left.\begin{matrix}\omega = f(t) \\ v = f(t)\end{matrix}\right\}$ Ex: $\omega = t^2$, $v = 4t^3$.



Speed up.



Slow down

$a_t = R\alpha = \dfrac{d|v|}{dt} \neq 0.$

$a_c = \dfrac{v^2}{R} = R\omega^2 \neq 0.$

$$\boxed{a_{net} = \sqrt{a_t^2 + a_c^2}}$$

QUESTION- 63

Match the matrix:

$\left|\frac{d\vec{v}}{dt}\right|$ = Mag of Rate of Change of vel.

= Mag of acc.

$\frac{d}{dt}|v|$ = Rate of Change of Mag of Velocity.

= Rate of change of Speed = a_t.

Column-I		Column-II	
(a)	UCM $\rightarrow a_c = ✓$ r $\rightarrow a_t = \times$ q	(p)	$\left\|\frac{dv}{dt}\right\| = 0$
(b)	NUCM r s	(q)	$\frac{d\|v\|}{dt} = 0$
		(r)	$\left\|\frac{dv}{dt}\right\| \neq 0$
		(s)	$\frac{d\|v\|}{dt} \neq 0$

Kinematics of Circular Motion

Kinematics

$x \rightarrow$ Position

$x_f - x_i =$ displacement

$v = \frac{dx}{dt}$ = Inst vel

$= \frac{x_2 - x_i}{t_2 - t_1}$ = Avg vel

$\Big\}$ Slope of x/t

$a = \frac{dv}{dt}$ = Inst velocity

$= \frac{v_2 - v_1}{t_2 - t_1}$ = avg velocity

$\Big\}$ Slope of v/t

Area of $v/t = x_f - x_i$, Area of $a/t = v_f - v_i$

$x \rightarrow \theta$

$\omega = \frac{d\theta}{dt}$

$\omega_{av} = \frac{\theta_2 - \theta_1}{t_2 - t_1}$

$\alpha = \frac{d\omega}{dt}$

$\alpha_{av} = \frac{\omega_f - \omega_i}{t_f - t_i}$

Area of $\alpha/t = \omega_f - \omega_i$ area of $\omega/t = \theta_f - \theta_i$.

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 - u^2 = 2as$

$S_{nth} = u + \frac{a}{2}(2n-1)$.

$\omega_f = \omega_0 + \alpha t$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$\omega_f^2 - \omega_0^2 = 2\alpha\theta$.

$\theta_{nth} = \omega_0 + \frac{\alpha}{2}(2n-1)$.

- $\omega = 2\pi\nu$
- $v = R\omega \quad \bar{v} = \bar{\omega} \times \bar{R}$
- $a = R\alpha \quad \bar{a} = \bar{\alpha} \times \bar{R}$
- $a_c = \frac{v^2}{R} = R\omega^2$

$a_t = R\alpha = \frac{d}{dt}|v|$.

QUESTION- 69

If θ depends on time t in following way

$\theta = 2t^2 + 3$ then

(a) Find out ω average upto 3 sec.

(b) ω at 3 sec

$t=0 \quad \theta = 3\,rad$

$t=3 \quad \theta = 21\,rad$

(a) $\theta = 2t^2 + 3$

$\omega = \frac{d\theta}{dt} = 4t$

at $t=3$ Inst $\omega = 12\,\frac{rad}{s}$

$\omega_{av} = \frac{\theta_f - \theta_i}{t_f - t_i} = \frac{21-3}{3} = \frac{18}{3} = 6\,\frac{rad}{s}$

QUESTION- 70

A particle moves in a circular path of radius 1 m with an angular speed

$\omega = 2t^2 + 1$ rad/sec

Find the angle between total acceleration and normal acceleration at t = 1 sec.

Centripetal.

$R = 1m$

at $t = 1s$

$\boxed{\omega = 2t^2 + 1.}$ (Non-uniform) $\Rightarrow a_c = \frac{v^2}{R} = R\omega^2 = 1 \times (3)^2 = 9\ m/s^2.$

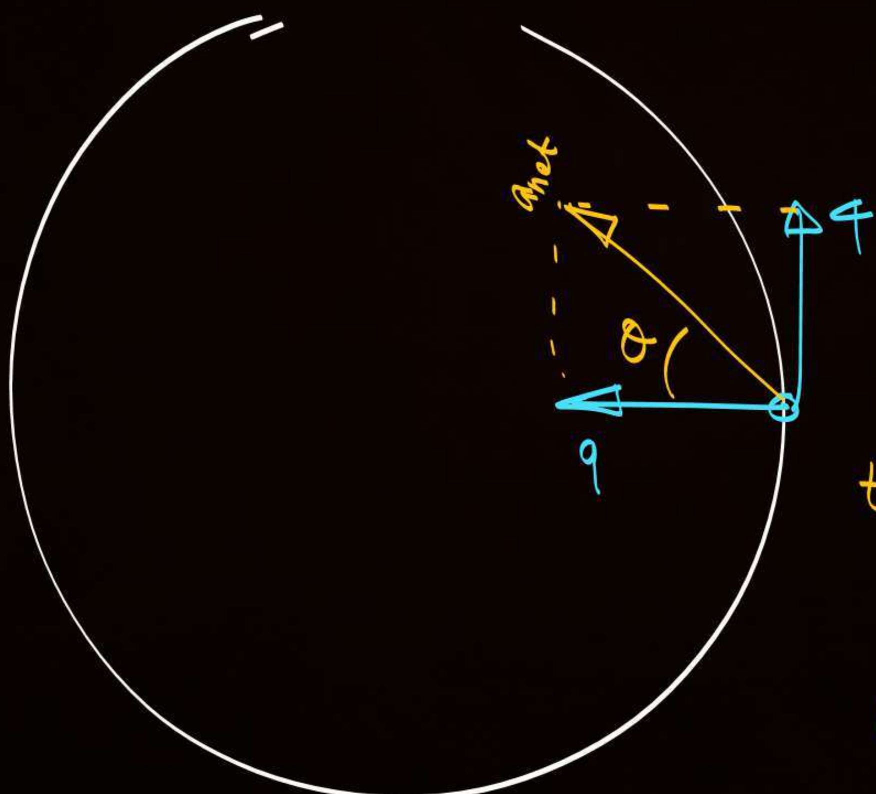
at $t = 1s$

$\omega = 2 \cdot 1^2 + 1 = 3.$

$\Rightarrow a_t = R\alpha = \frac{d}{dt}|v| = 1 \times 4 = 4 m/s^2.$

$\alpha = \frac{d\omega}{dt} = 4t$

at $t = 1$ $\alpha = 4$



$$a_{net} = \sqrt{9^2 + 4^2}.$$

$$\tan\theta = \frac{4}{9}$$

$$\boxed{\theta = \tan^{-1}\left(\frac{4}{9}\right)}$$

QUESTION- 71

A particle moves in a circle of radius 2.0 cm at a speed given by $v = 4t$, where v is in cm/s and t in seconds.

(a) Find the tangential acceleration at $t = 1$ s.

(b) Find total acceleration at $t = 1$ s.

$R = 2$ cm.

$\boxed{v = 4t}$ Non-uniform

Speed up

$a_t = \frac{d}{dt}(4t) = 4$

$a_c = \frac{v^2}{R} = R\omega^2 = \frac{4^2}{2} = 8 \frac{cm}{s^2}$

at $t = 1$ $v = 4$

$a_{net} = \sqrt{4^2 + 8^2}$

QUESTION- 72

$\alpha = \text{Const.}$

A car wheel is rotated to uniform $\boxed{\text{angular acceleration}}$ about its axis. Initially its angular velocity is zero. It rotates through an angle θ_1 in the first 2 sec, in the next 2 sec, it rotates through an additional angle θ_2, the ratio of $\frac{\theta_2}{\theta_1}$ is:

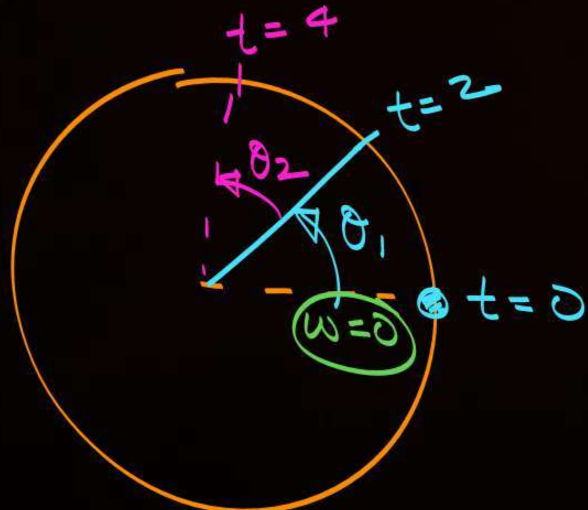
(1) 1

(2) 2

(3) 3

(4) 5

$t = 0 \quad \omega = 0$



$\alpha = \text{Const}$ Kinematics Equation → Valid.

$$\theta = \omega t + \frac{1}{2}\alpha t^2$$

$$t = 2\,s \quad \theta_1 = \frac{1}{2}\alpha(2)^2$$

$$t = 4\,s \quad \theta_1 + \theta_2 = \frac{1}{2}\alpha(4)^2$$

$$\frac{\theta_2 + \theta_1}{\theta_1} = \frac{16}{4} \Rightarrow \frac{\theta_2}{\theta_1} + 1 = 4$$

$$\frac{\theta_2}{\theta_1} = 3$$

QUESTION- 73

A solid body rotates about a stationary axis with an angular retardation $\alpha = k\sqrt{\omega}$, where ω is the angular velocity of body. Find the time after which body will come to rest if at $t = 0$, angular velocity of body was ω_0.

$$\alpha = -K\sqrt{\omega} \quad \Rightarrow \quad \frac{d\omega}{dt} = -K\omega^{1/2}$$

$t = 0$

$\omega = \omega_0$

$$\int_{\omega_0}^{0} \frac{d\omega}{\omega^{1/2}} = -\int_{t=0}^{T} K\,dt$$

QUESTION- 75

What is the value of linear velocity, if $\vec{\omega} = 3\hat{\imath} - 4\hat{\jmath} + \hat{k}$ and $\vec{r} = 5\hat{\imath} - 6\hat{\jmath} + 6\hat{k}$

(1) $6\hat{\imath} + 2\hat{\jmath} - 3\hat{k}$

(2) $-18\hat{\imath} - 13\hat{\jmath} + 2\hat{k}$

(3) $4\hat{\imath} - 13\hat{\jmath} + 6\hat{k}$

(4) $6\hat{\imath} - 2\hat{\jmath} + 8\hat{k}$

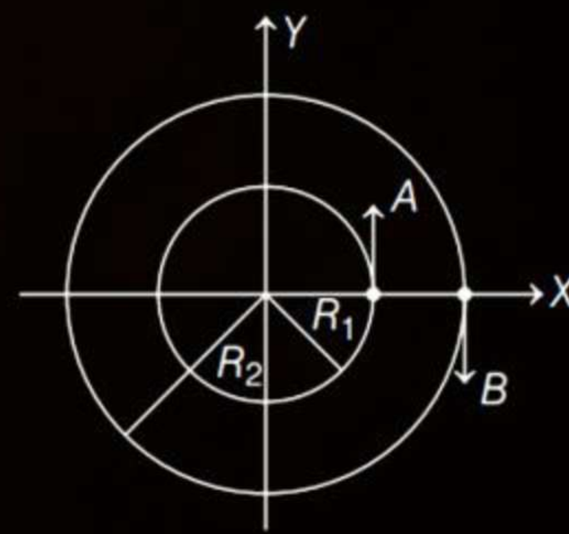
$\vec{\omega} = 3\hat{i} - 4\hat{j} + \hat{k}$

$\vec{r} = 5\hat{i} - 6\hat{j} + 6\hat{k}$.

$$v = \vec{\omega} \times \vec{r} = \begin{vmatrix} \hat{i} & -\hat{j} & \hat{k} \\ 3 & -4 & 1 \\ 5 & -6 & 6 \end{vmatrix} = \hat{i}(-4\times6 + 6) - \hat{j}(18-5) + \hat{k}(-18+20)$$

QUESTION- 76

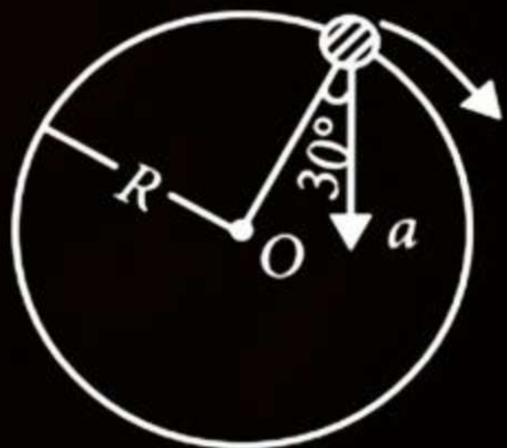
Two particles A and B are moving on two concentric circles of radii R_1 and R_2 with equal angular speed ω. At $t = 0$, their positions and direction of motion are shown in the figure. The relative velocity $v_A - v_B$ at $t = \dfrac{\pi}{2\omega}$ is given by (2019 Main)



1. $\omega(R_1 + R_2)\hat{\imath}$
2. $-\omega(R_1 + R_2)\hat{\imath}$
3. $\omega(R_1 - R_2)\hat{\imath}$
4. $\omega(R_2 - R_1)\hat{\imath}$

QUESTION- 77

In the given figure, $a = 15\ \text{m s}^{-2}$ represents the total acceleration of a particle moving in the clockwise direction in a circle of radius $R = 2.5$ m at a given instant of time. The speed of the particle is:



(1) $4.5\ \text{m s}^{-1}$

(2) $5.0\ \text{m s}^{-1}$

(3) $5.7\ \text{m s}^{-1}$

(4) $6.2\ \text{m s}^{-1}$

QUESTION- 78

The radial and tangential acceleration are represented by a_r and a_t respectively. The motion of a particle will be circular if:

(1) $a_r = 0$ but $a_t \neq 0$

(2) $a_r = 0$ and $a_t = 0$

(3) $a_r \neq 0$ but $a_t = 0$

(4) $a_r \neq 0$ and $a_t \neq 0$

QUESTION- 79

The speed of a particle moving in a circle of radius $r = 2$ m varies with time t as $v = t^2$ where, t is in second and v in ms^{-1}. The net acceleration at $t = 2$ s is: **[2012]**

(1) $\sqrt{40}\ ms^{-2}$

(2) $\sqrt{60}\ ms^{-2}$

(3) $\sqrt{80}\ ms^{-2}$

(4) $10\ ms^{-2}$

QUESTION- 80

A particle starts moving in a circular path of radius 2m with initial speed 2 m/s at constant angular acceleration. After two complete revolutions, its speed becomes 8 m/s. Find the angular acceleration of the particle.

QUESTION- 81

A particle is moving along a circular path with a constant speed of 10 ms^{-1}. What is the magnitude of the change in velocity of the particle, when it moves through an angle of $60°$ around the centre of the circle? (2019 Main)

(1) $10\sqrt{2}$ m/s

(2) 10 m/s

(3) $10\sqrt{3}$ m/s

(4) zero

Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points + Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

Circular Dynamics

How to write the equations when a particle is in circular motion?

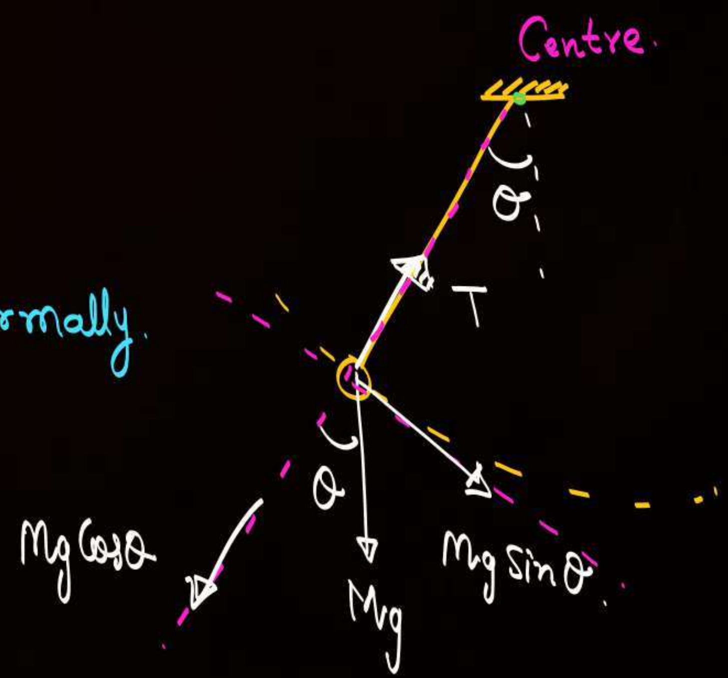
For any Circular Motion.

1. Draw F.B.D.

2. Resolve all force Tangentially & Normally.

3. $\sum F_{net}$ towards Centre $= \frac{mv^2}{R}$

3. $\sum F_{net\ tang} = m(R\alpha)$



Circular Dynamics

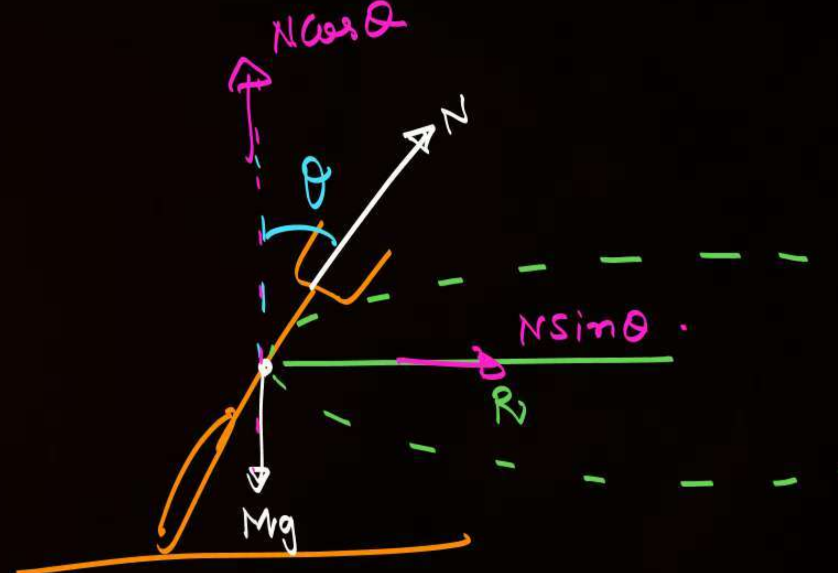
❖ **Bending of Cyclist**

$$N\sin\theta = \frac{mv^2}{R}$$

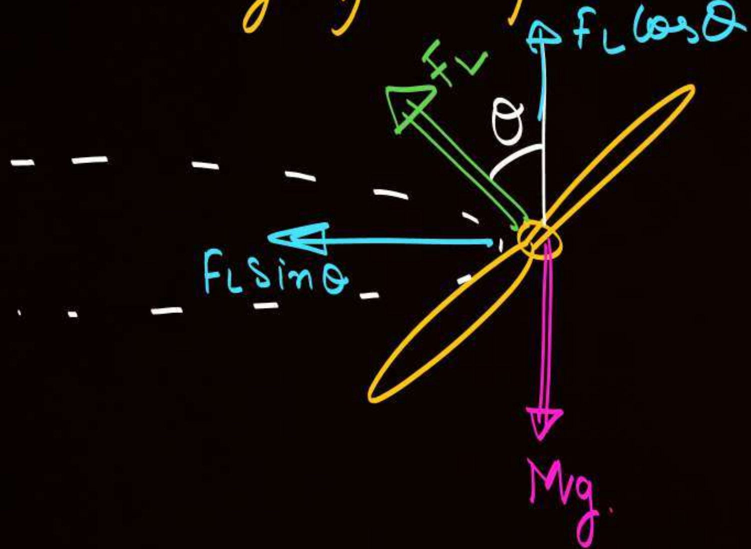
$$N\cos\theta = mg$$

$$\tan\theta = \frac{v^2}{Rg}$$

$$\boxed{v = \sqrt{Rg\tan\theta}}$$



Banking of aeroplane.



$$F_L \sin\theta = \frac{mv^2}{R}$$

$$F_L \cos\theta = mg$$

$$\tan\theta = \frac{v^2}{Rg}$$

$$\boxed{v = \sqrt{Rg\tan\theta}}$$

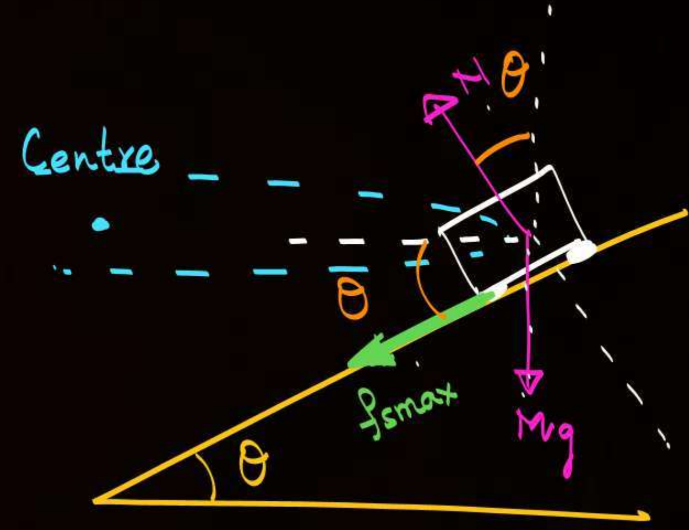
Circular Dynamics

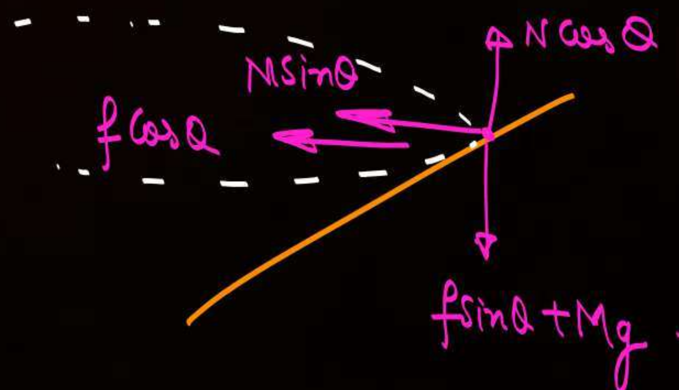
❖ **Banking of Road**

v_{max} of Car on banked Road.

$$f\cos\theta + N\sin\theta = \frac{mv^2}{R}$$

$$N\cos\theta = f\sin\theta + Mg$$





Circular Dynamics

❖ **Banking of Road**

v_{max} of Car on banked Road.

$$f\cos\theta + N\sin\theta = \frac{mv^2}{R}$$

$$N\cos\theta = f\sin\theta + Mg$$

$$f = \mu N$$

$$N(\mu\cos\theta + \sin\theta) = \frac{mv^2}{R}$$

$$N(\cos\theta - \mu\sin\theta = mg$$

$$\frac{\mu\cos\theta + \sin\theta}{\cos\theta - \mu\sin\theta} = \frac{v^2}{Rg}$$

$$v_{max} = \sqrt{Rg\left(\frac{\mu\cos\theta + \sin\theta}{\cos\theta - \mu\sin\theta}\right)}$$

$$v_{max} = \sqrt{Rg\left(\frac{\mu\cos\theta + \sin\theta}{\cos\theta - \mu\sin\theta}\right)}$$

$$v_{min} = \sqrt{Rg\left(\frac{\sin\theta - \mu\cos\theta}{\cos\theta + \mu\sin\theta}\right)}$$

Road $\mu = 0$

$$\boxed{v = \sqrt{Rg\tan\theta}}$$

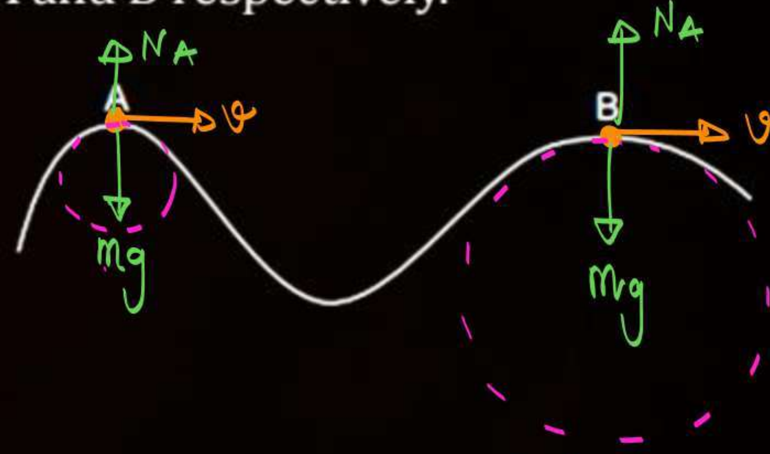
Levelled Road. $\theta = 0$

$$v = \sqrt{\mu_s Rg}$$

❖ Conical Pendulum

QUESTION- 82

A car moves at a constant speed on a road as shown in figure. The normal force by the road on the car is N_A and N_B when it is at the points A and B respectively.



$$mg - N_A = \frac{mv^2}{R_A}$$

$$mg - \frac{mv^2}{R_A} = N_A$$

$R_B \uparrow$

(1) $N_A = N_B$

(2) $N_A > N_B$

(3) $N_A < N_B$ Ans

(4) Insufficient information to decide the relation of N_A and N_B

$$mg - N_B = \frac{mv^2}{R_B}$$

$$N_B = mg - \frac{mv^2}{R_B}$$

$R\uparrow \quad \frac{mv^2}{R}\downarrow \quad N\uparrow.$

QUESTION- 83

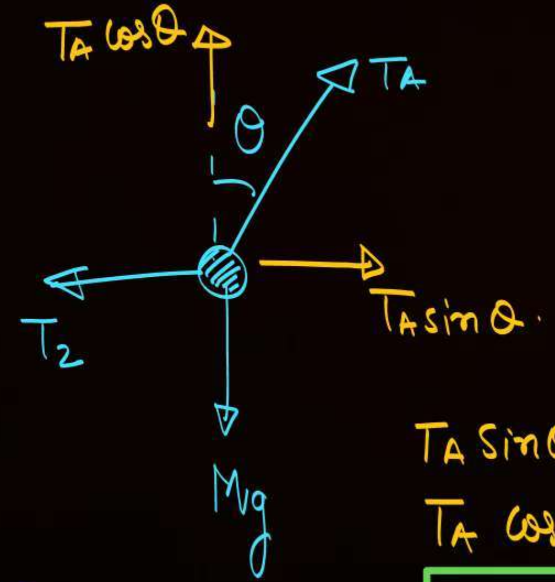
A ball is held at rest in position A in figure by two light cords. The horizontal cord is cut and the ball starts swinging as a pendulum. The ratio of the tension in the supporting cord in position B, to that in position A is:

(1) $\sin^2\theta$

(2) $\cos^2\theta$

(3) $\tan^2\theta$

(4) $1:1$

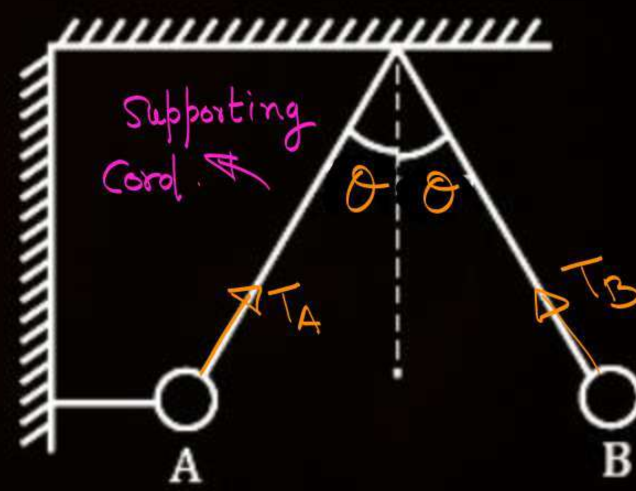


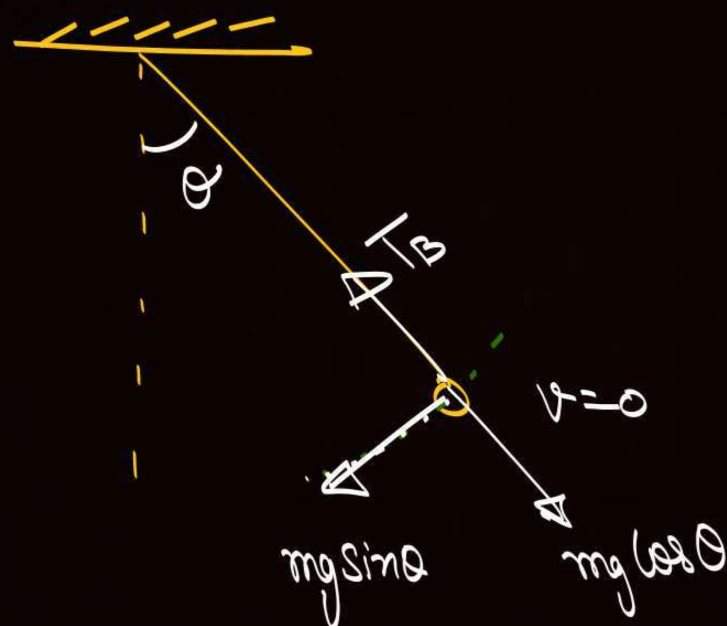
Equilibrium.

$$T_A \sin\theta = T_2$$

$$T_A \cos\theta = mg$$

$$\boxed{T_A = \frac{mg}{\cos\theta}}$$





radiall = $T_B - mg\cos\theta = \frac{mv^2}{R}$

$T_B - mg\cos\theta = 0$

$$\boxed{T_B = mg\cos\theta}$$

$$\frac{T_B}{T_A} = \frac{mg\cos\theta}{\frac{mg}{\cos\theta}} = \cos^2\theta$$

QUESTION- 84

A modern grand-prix racing car of mass m is travelling on a flat track in a circular arc of radius R with a speed v. If the coefficient of static friction between the tyres and the track is μ_s, then the magnitude of negative lift F_L acting downwards on the car is: (Assume forces on the four tyres are identical and g = acceleration due to gravity)

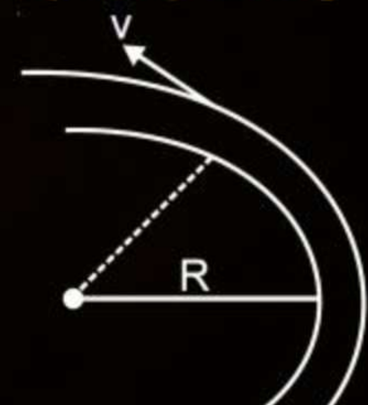
[JEE (Main)-2021]

(1) $m\left(\frac{v^2}{\mu_s R}+g\right)$

(2) $m\left(\frac{v^2}{\mu_s R}-g\right)$

(3) $-m\left(g+\frac{v^2}{\mu_s R}\right)$

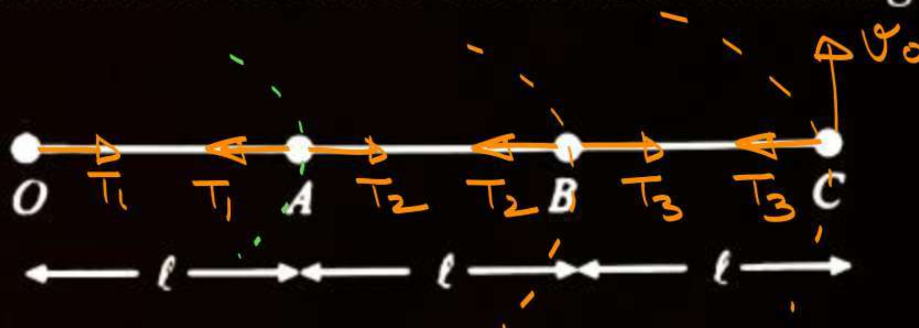
(4) $m\left(g-\frac{v^2}{\mu_s R}\right)$



QUESTION- 85

Three identical particles are joined together by a thread as shown in figure. All the three particles are moving on a smooth horizontal plane about point O. If the speed of the outermost particle is v_0, then the ratio of tensions in the three sections of the string is: (Assume that the string remains straight)

$T_1 : T_2 : T_3 = ?$



(1) 3 : 5 : 7

(2) 3 : 4 : 5

(3) 7 : 11 : 6

(4) 3 : 5 : 6

(C) $\boxed{T_3 = m(3l)\omega^2}$

(B) $T_2 - T_3 = m(2l)\omega^2$

$\boxed{T_2 = 5ml\omega^2}$

(A) $T_1 - T_2 = ml\omega^2$ $\boxed{T_1 = 6ml\omega^2}$

$\omega_{each} = \text{Same}$

QUESTION- 86

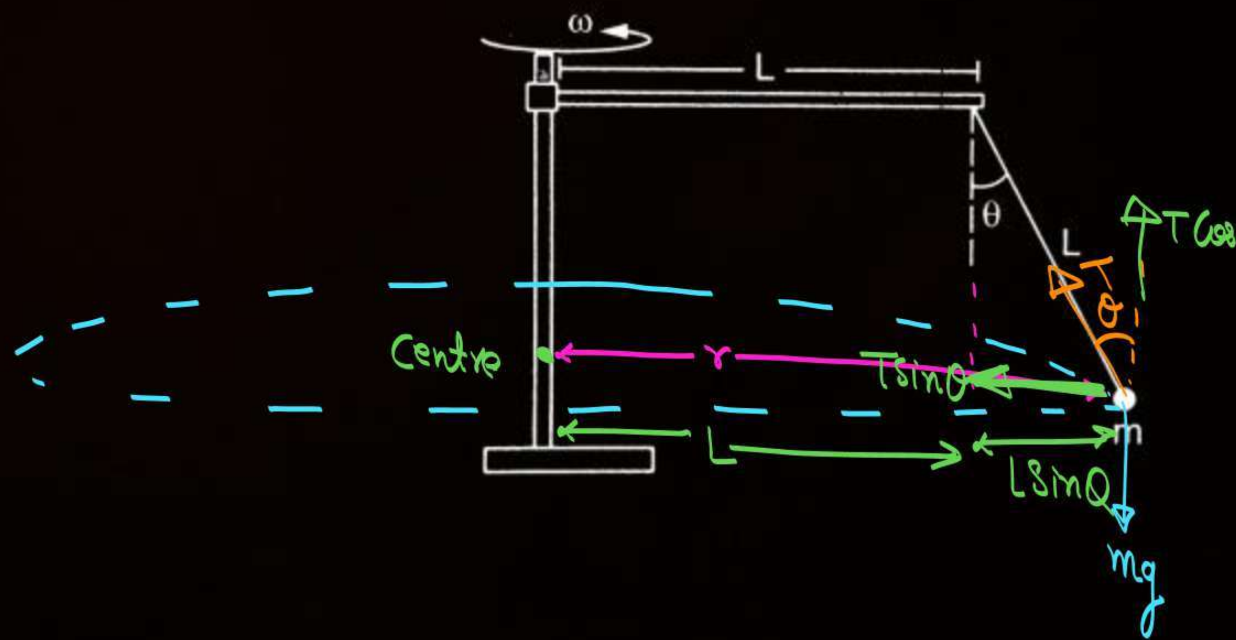
In figure shows a rod of length 20 cm pivoted near an end and which is made to rotate in a horizontal plane with a constant angular speed. A ball of mass *m* is suspended by a string also of length 20 cm from the other end of the rod. If the angle θ made by the string with the vertical is 30°, find the angular speed of the rotation. Take g = 10 m/s².

$T\sin\theta = mr\omega^2$

$T\cos\theta = mg$

$\tan\theta = \frac{r\omega^2}{g}$

$\sqrt{\frac{g\tan\theta}{L+L\sin\theta}} = \omega.$



QUESTION- 88

A particle of mass m is fixed to one end of light spring having force constant k and unstretched length l_0. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is:

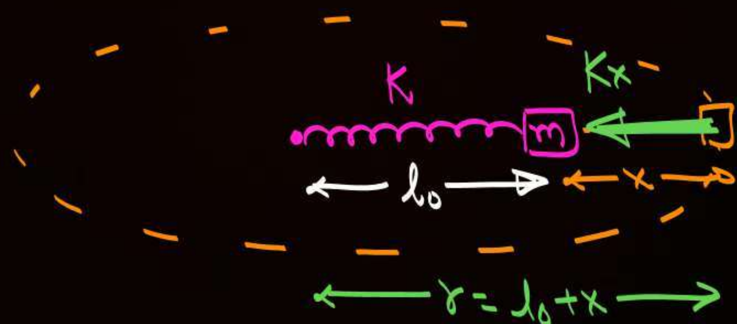
JEE Main 2020 – 8 Jan (Morning)

(1) $\dfrac{l_0 m\omega^2}{k - m\omega^2}$ Ans

(2) $\dfrac{l_0 m\omega^2}{k + m\omega^2}$

(3) $\dfrac{l_0 m\omega^2}{k - m\omega}$

(4) $\dfrac{l_0 m\omega^2}{k + m\omega}$



$Kx = F_{cent}$

$Kx = m(l_0+x)\omega^2$

$Kx = ml_0\omega^2 + mx\omega^2$

$x(K - m\omega^2) = ml_0\omega^2$

$x = \dfrac{ml_0\omega^2}{K - m\omega^2}$

QUESTION- 89

A bead of mass m stays at point $P(a, b)$ on a wire bent in the shape of a parabola $y = 4Cx^2$ and rotating with angular speed ω (see figure). The value of ω is (neglect friction)

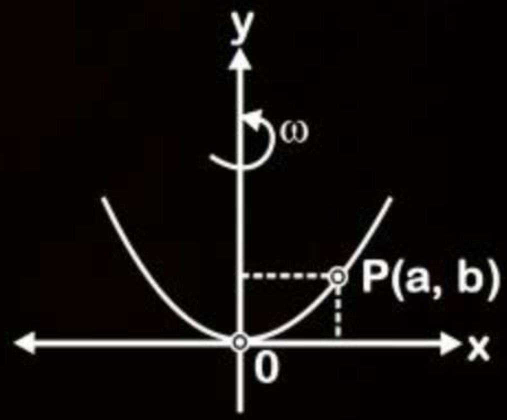
[JEE (Main)-2020]

(1) $2\sqrt{2gC}$

(2) $2\sqrt{gC}$

(3) $\sqrt{\frac{2g}{C}}$

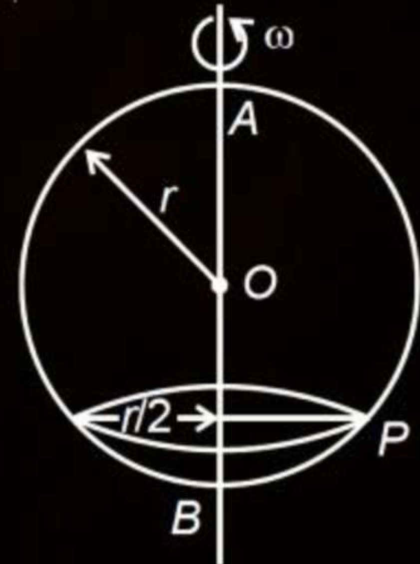
(4) $\sqrt{\frac{2gC}{ab}}$



QUESTION- 92

A smooth wire of length $2\pi r$ is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter AB, as shown in figure, the bead is at rest with respect to the circular ring at position P as shown. Then the value of ω^2 is equal to:

[JEE (Main)-2019]



(1) $\frac{(g\sqrt{3})}{r}$

(2) $\frac{2g}{r}$

(3) $\frac{2g}{(r\sqrt{3})}$

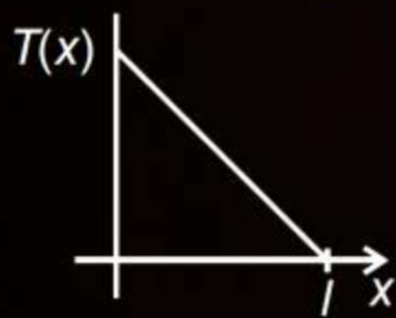
(4) $\frac{\sqrt{3g}}{2r}$

QUESTION- 93

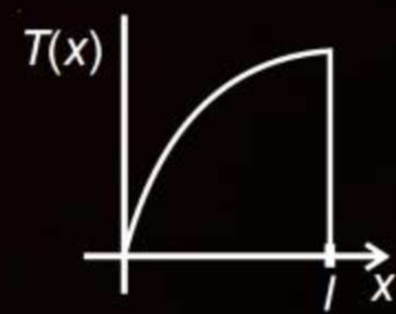
A uniform rod of length l is being rotated in a horizontal plane with a constant angular speed about an axis passing through one of its ends. If the tension generated in the rod due to rotation is $T(x)$ at a distance x from the axis, then which of the following graphs depicts it most closely?

[JEE (Main)-2019]

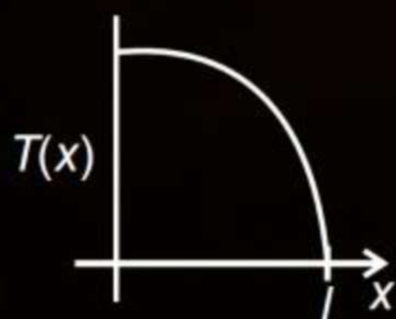
(1)



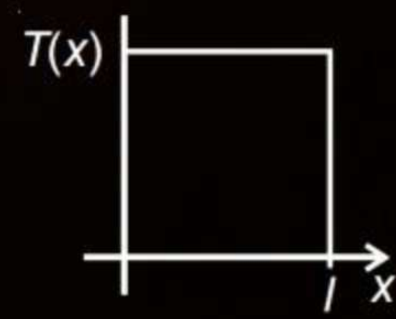
(2)



(3)



(4)

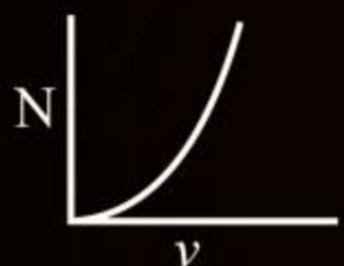


QUESTION- 94

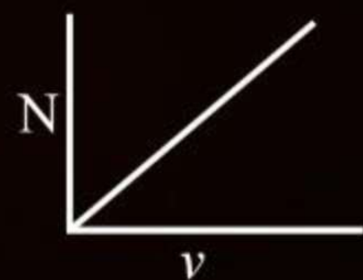
A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (v)?

[JEE (Main)-2022]

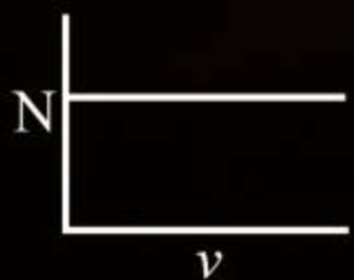
(1)



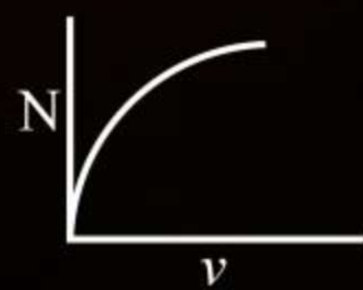
(2)



(3)



(4)

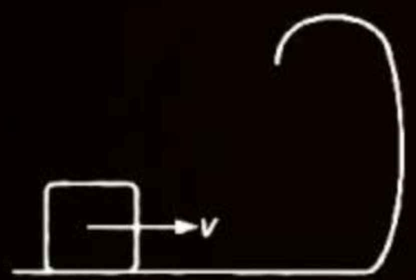


QUESTION- 95

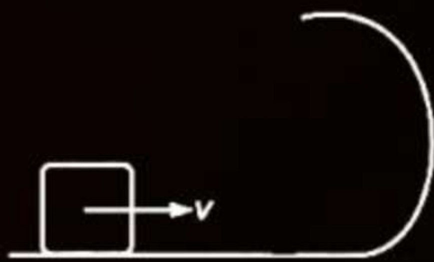
A small block is shot into each of the four tracks as shown below. Each of the tracks rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in

[2001]

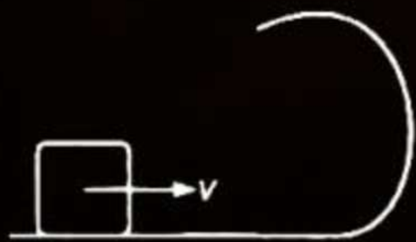
(1)



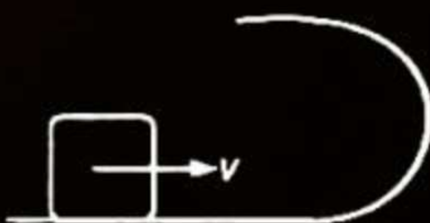
(2)



(3)



(4)



Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points + Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

Break 1:10 AM

Pseudo force

NIF = accelerated frame.

Camera ⟶ NIF observer.
accelerated.

Nakli force. "Pseudo force".

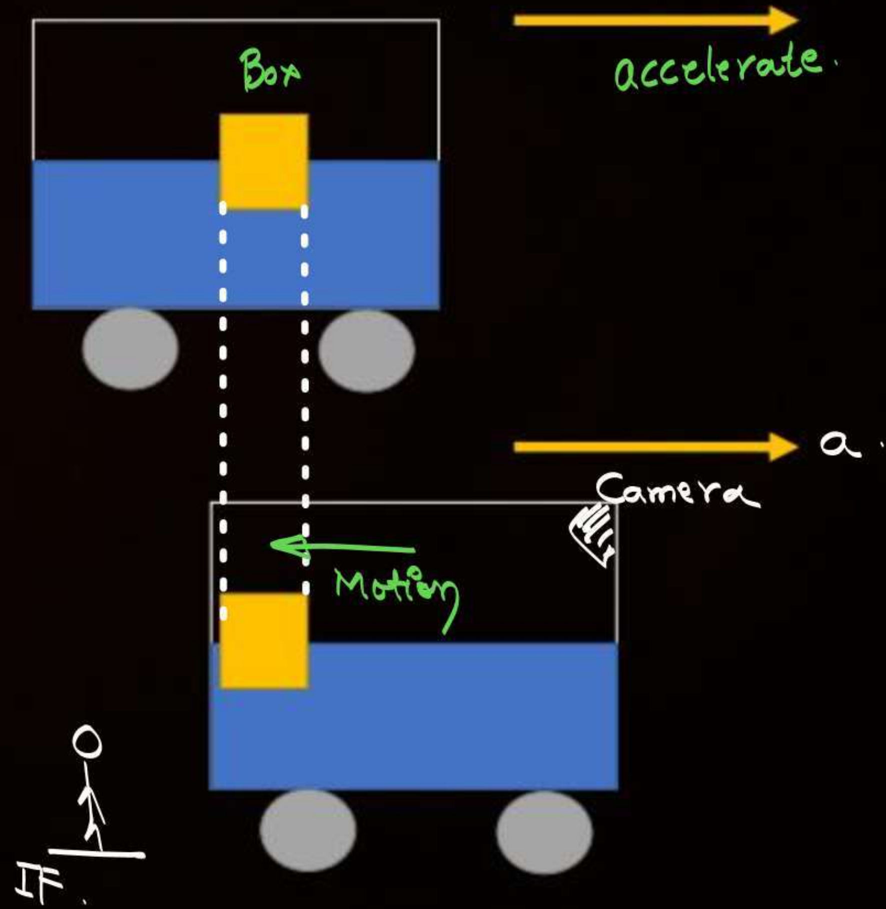
Observer in NIF

$$\boxed{P = -m\vec{a}}$$

m ⟶ mass of body

$\vec{a}$ ⟶ NIF

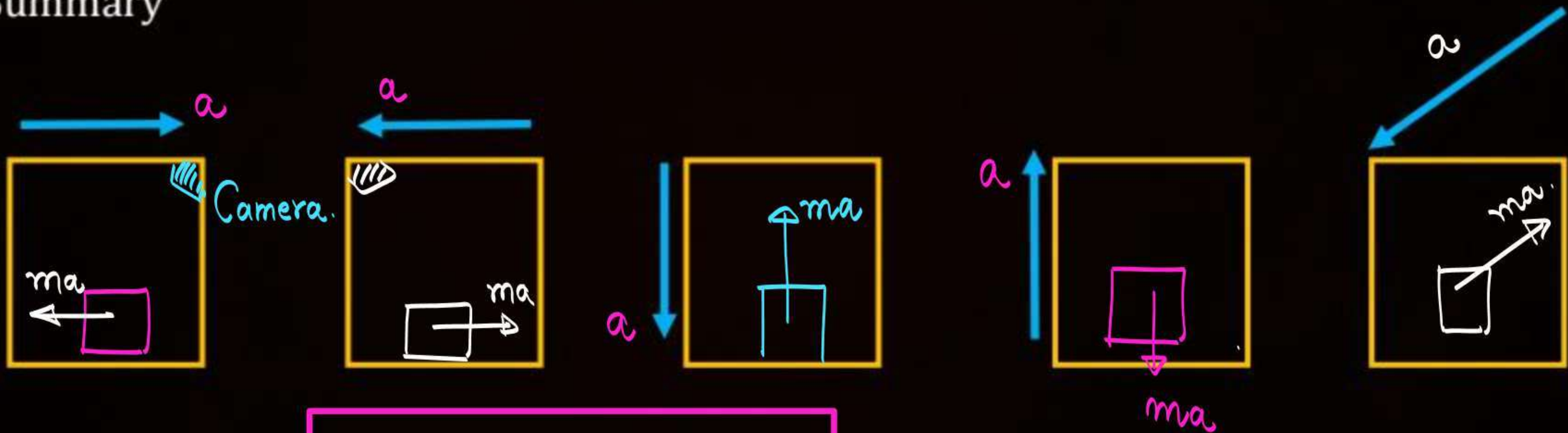
(−) opp to dir of a_{NIF}



Pseudo force

Jab observer inside acc frame hoga!

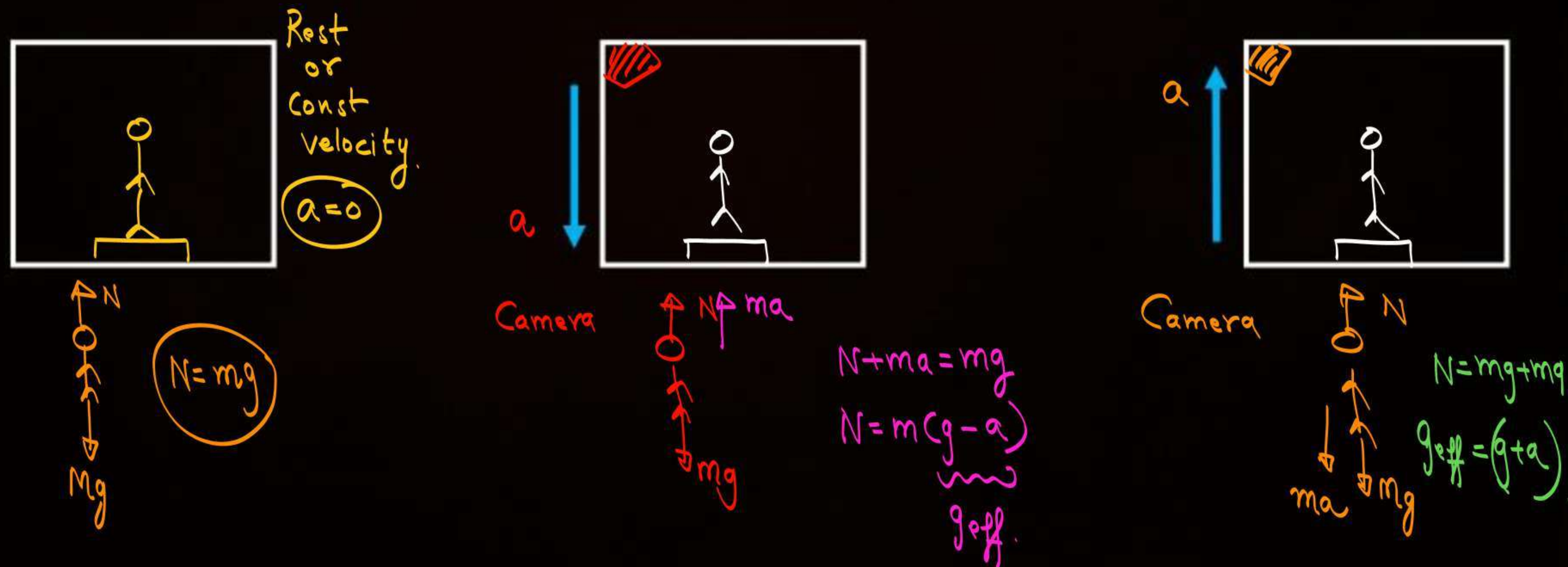
Summary



$\boxed{\text{Pseudo force} \longrightarrow \text{Camera}}$

Pseudo force

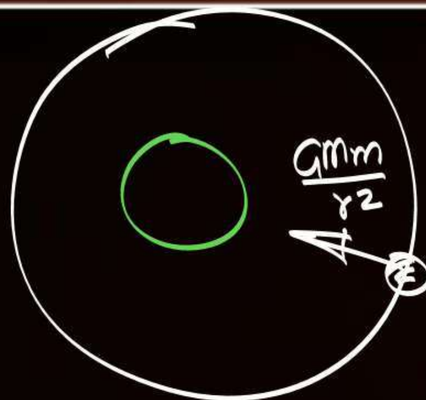
Elevator Problem:



Pseudo force

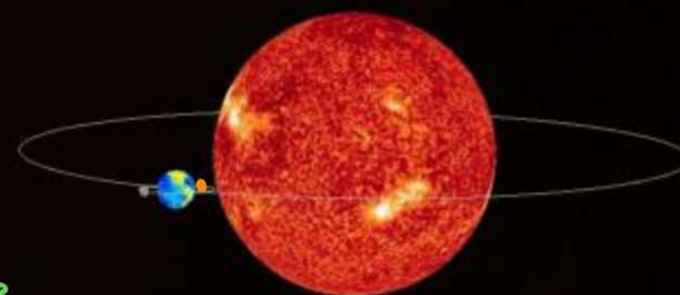
IF

(Motion)

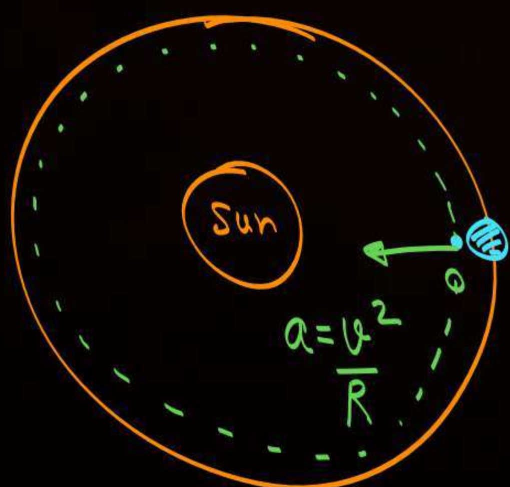


$\frac{GMm}{r^2}$ = Centripetal.

$$F = \frac{GMm}{r^2}$$



NIF

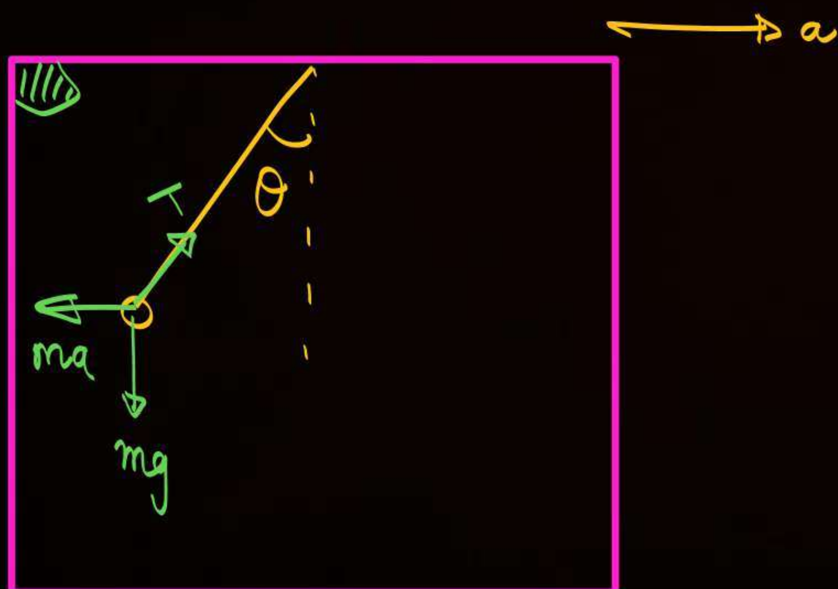


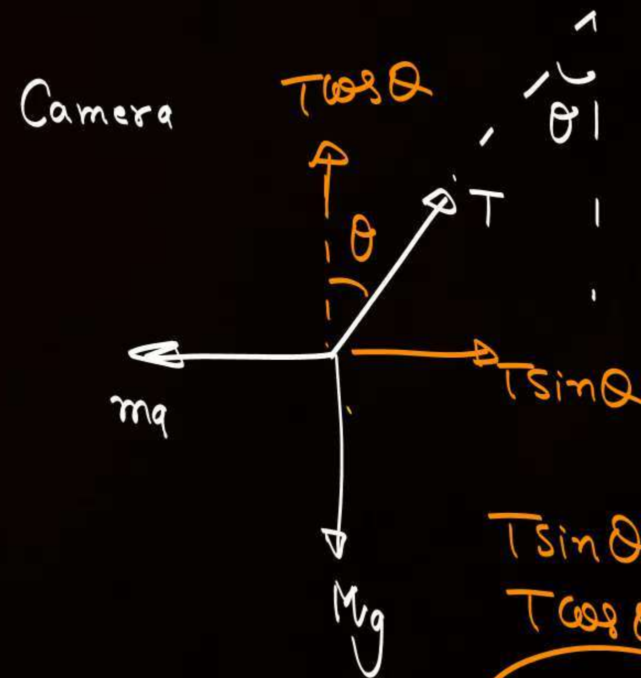
$\frac{mv^2}{R}$ (Centrifugal).

$\frac{GMm}{R^2}$ Rest.

QUESTION- 96

A pendulum is hanging in a car and the car is accelerating with acceleration a. find the angle made by the pendulum with vertical





$T\sin\theta = ma$

$T\cos\theta = mg$

$\tan\theta = a/g$

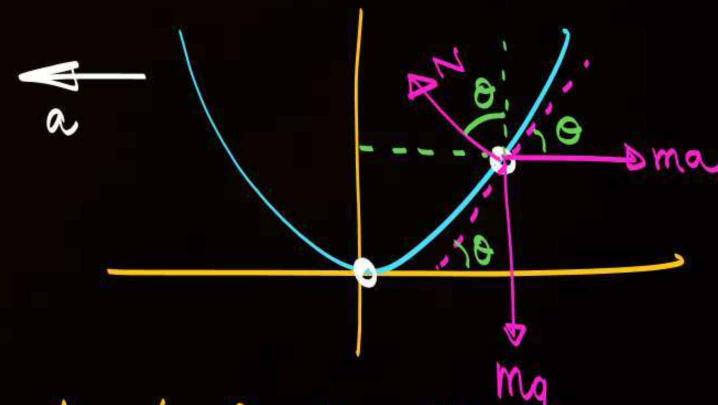
QUESTION- 100

A piece of wire is bent in the shape of a parabola $y = kx^2$ (y axis vertical) with a bead of mass m on the bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equiiibrium position of the bead, where the bead can stay at rest w.r.t. the wire, from the y-axis is:

Ans

(1) $\frac{a}{gk}$

(2) $\frac{a}{2gk}$



(3) $\frac{2a}{gk}$

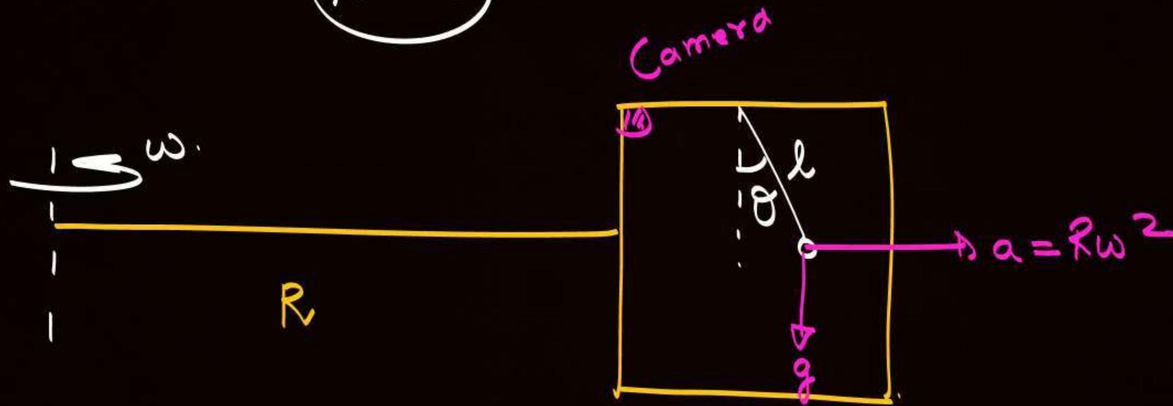
(4) $\frac{a}{4gk}$

$\frac{dy}{dx} = \tan\theta = \frac{a}{g} = 2kx$

$\boxed{x = \frac{a}{2gk}}$

Concept:

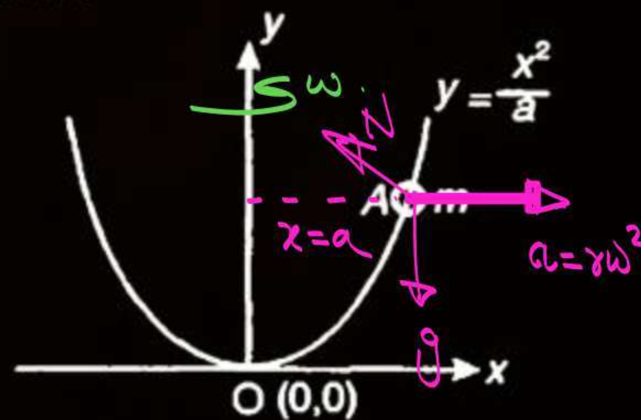
$R >> l$



$$\boxed{\tan\theta = \frac{a}{g} = \frac{R\omega^2}{g}}$$

QUESTION- 99

In the given figure, a smooth parabolic wire track lies in the vertical plane ($x-y$ plane). The shape of track is defined by the equation $y=\left(\frac{x^2}{a}\right)$ (where a is constant). A ring of mass m which can slide freely on the wire track, is placed at the position $A(a,a)$. The track is rotated with constant angular speed ω such that there is no relative slipping between the ring and the track then ω is equal to



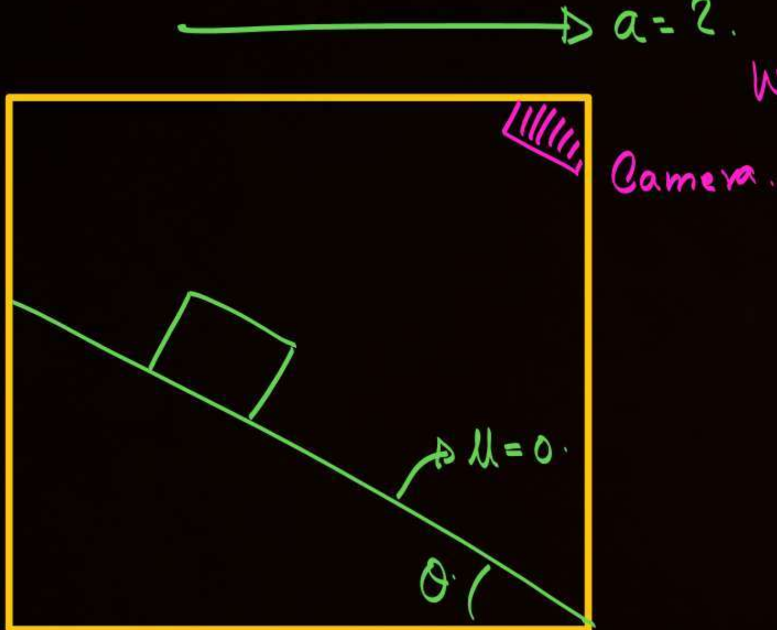
(1) $\sqrt{g/a}$

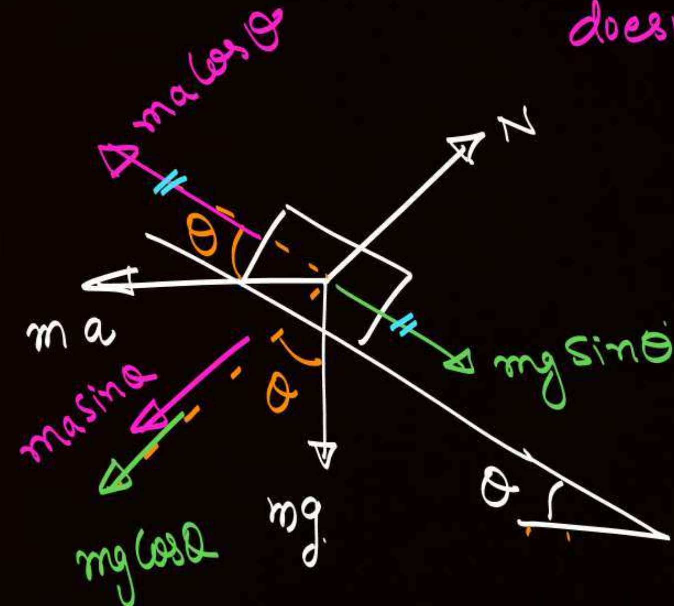
(2) $\sqrt{g/2a}$

(3) $\sqrt{2g/a}$

(4) $(2)^{1/4}(g/a)^{1/2}$

What should be a=? So that block doesnot slip.





$$\cancel{m} a \cos\theta = \cancel{m} g \sin\theta$$

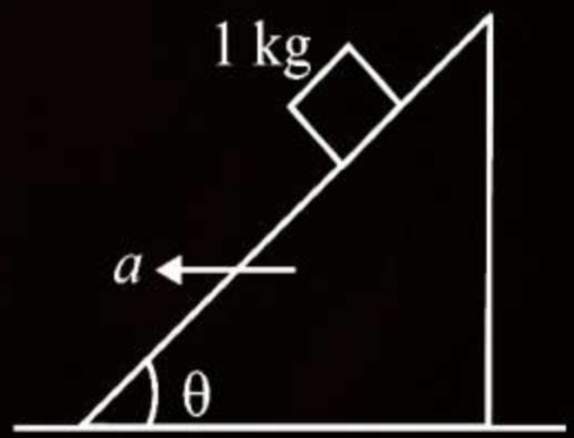
$$\tan\theta = \frac{a}{g}$$

QUESTION- 98

A block of mass m is placed over a wedge of mass M as shown. With what acceleration the system should be pulled so that there is no relative slipping between block and wedge.

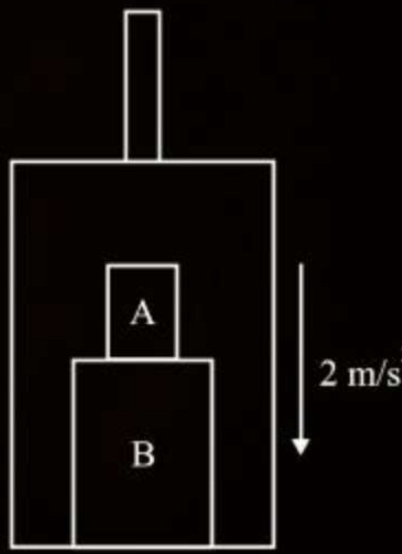
Case1: Wedge is smooth

Case2: friction between block and wedge



QUESTION- 104

The elevator shown in figure is descending with an acceleration of $2\ ms^{-2}$. The mass of the block $A = 0.5$ kg. The force exerted by the block A on the block B is:Take $g = 10\ m/s^2$



(1) 2 N

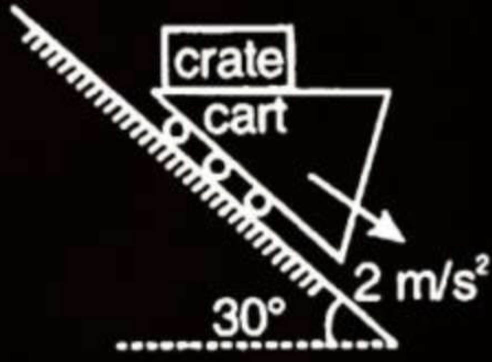
(2) 4 N

(3) 6 N

(4) 8 N

QUESTION- 105

The cart A is restricted to move down with an acceleration $2\ \mathrm{m/s^2}$. There is no friction between the crate and the cart. The mass of crate is $10\ \mathrm{kg}$. The normal force exerted by the cart on the crate is $\left(g = 10\ \mathrm{ms^{-2}}\right)$



(1) 90 N

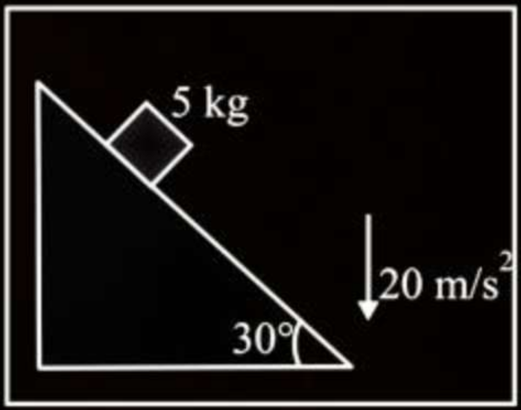
(2) 100 N

(3) 20 N

(4) 70 N

QUESTION- 106

A lift starts moving down with $20\ m/s^2$. Then which of the following is not true?



(1) Acceleration of 5 kg block along incline is $15\ m/s^2$

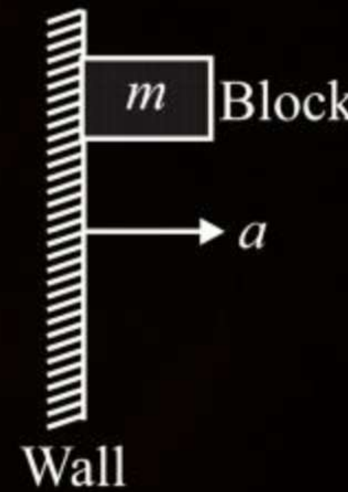
(2) Normal force is $25\sqrt{3}$ and acceleration is $5\ m/s^2$ along incline

(3) Normal force is zero

(4) Acceleration of 5 kg is $20\ m/s^2$ downwards

QUESTION- 107

In the given figure, a block always be in equilibrium. If the wall moved towards right with acceleration a, if μ is the coefficient of friction, then minimum value of a is:



(1) μg

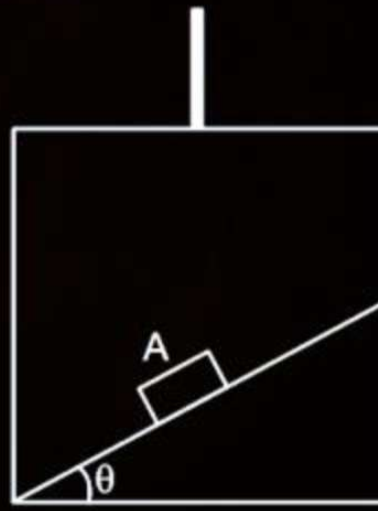
(2) g/μ

(3) $m/\mu g$

(4) $\mu m g$

QUESTION- 108

A block A can slide on a frictionless incline of angle θ and length l, kept inside an elevator going up with uniform acceleration a. Find the time taken by the block to slide down the length of the incline if it is released from the top of the incline.



QUESTION- 109

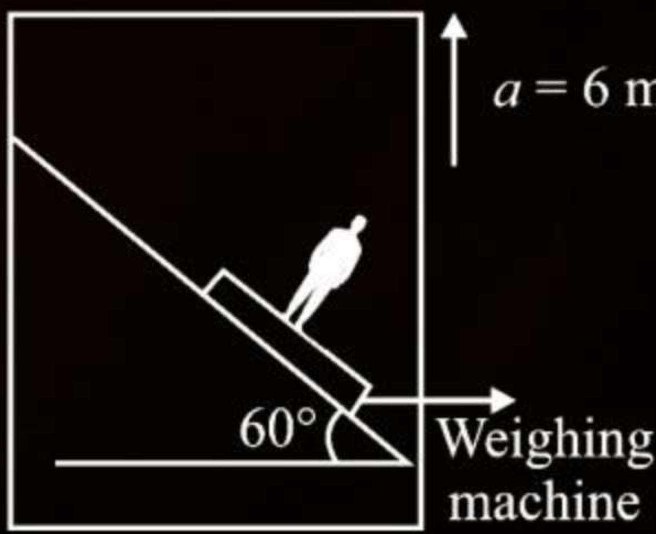
An elevator is accelerating upwards with a acceleration of $6\ m/s^2$. Inside it a person of mass 50 kg is standing on a weighing machine which is kept on an inclined plane having angle of inclination $60°$. The reading of the weighing machine is:

(1) 40 kg

(2) 160 kg

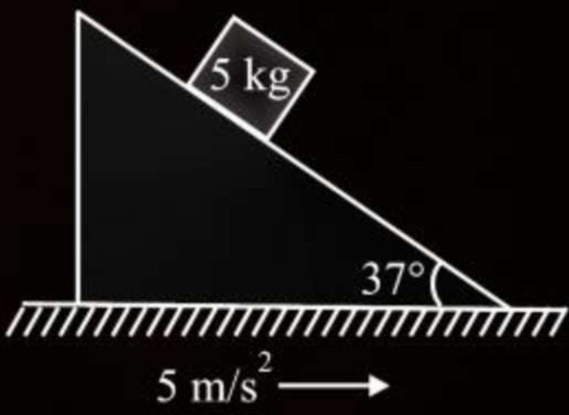
(3) 80 kg

(4) 50 kg



QUESTION- 110

Inclined plane is moved towards right with an acceleration of 5 ms^{-2} as shown in figure. Find force in newton which block of mass 5 kg exerts on the incline plane. (All surfaces are smooth)



(1) 50 N

(2) 60 N

(3) 55 N

(4) 70 N

Pdf & Notes $\Rightarrow$ PW app
from Manzil batch.

Theory $\rightarrow$ Imp points +
Formula.

Questions $\rightarrow$ Q.no
$\rightarrow$ Solution

Homework

❖ DPP of NLM

Laws
friction
Circular.

Min lec → 20 lec.
×2
40 hrs

9 hrs

→ Small Remaining Topics

Self try

Farthur.