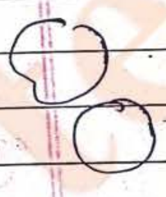
⇒ 09/08/2011 ⇒

Frame of Refrence:

(I) Inertial frame	(II) Non-Inertial frame
(i) whose acceleration is zero $(\vec{a} = \vec{0})$ $\vec{v}$ = constant (Along straight line path) $= \vec{0}$ (rest)	(i) whose acc^n is not zero $(\vec{a} \neq \vec{0})$ (magnitude, direction, or change)



Note:→ By definition Earth is a non-Inertial frame of refrence

But it is assume to an Inertial frame.

1) Newton first law:→ (law of Inertia)
A body remains at ~~sta~~ state of rest or state or uniform motion along straight line unless and until some neck ~~extre~~ external force applied on an object.

↓
(Resultant)

In other words:-

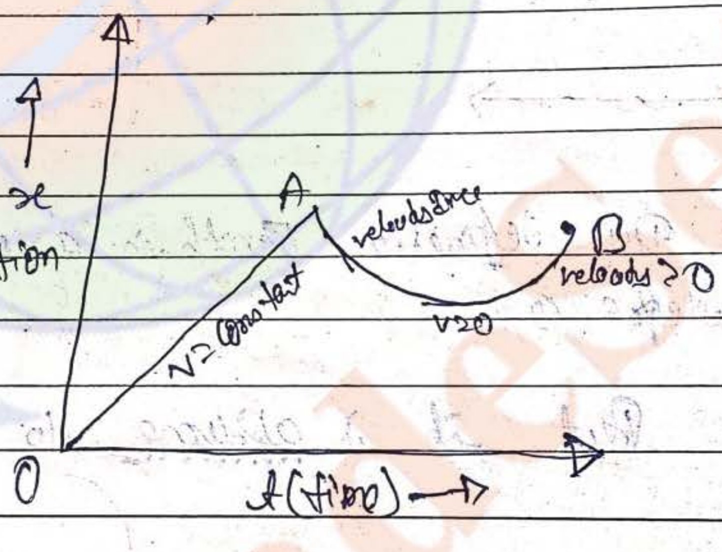
If the vector sum of all the all the force acting on the body is zero the body remains unaccelerated, ($\vec{a}$ is 0)

$\Rightarrow \vec{a} = \vec{0}$

$\vec{v}$ = constant
(= rest)

- It (Newton first law) defines the inertial frame. It means newton first law ~~is~~ is only valid in Inertial frame of reference.

eg :->



O → A

($\vec{F}_{net} = \vec{0}$)

Note> Newton first law gives the definition of force.

Newton valid for Particle

Inertial →

Particle behavior.

Newton Second law: →

$$\left[\left(\vec{F}_{net}\right)_{ext} = m\vec{a}\right]$$

$$\boxed{\vec{a} = \frac{\left(\vec{F}_{net}\right)_{ext}}{m}}$$

Net external force and acc^n of body are measure from some Inertial fram of refrence.

$$\left(\vec{F}_{net}\right)_{ext} = \frac{d\vec{P}}{dt} \qquad \Big| \quad \vec{P} = m\vec{v}$$

$$= m\frac{d\vec{v}}{dt}$$

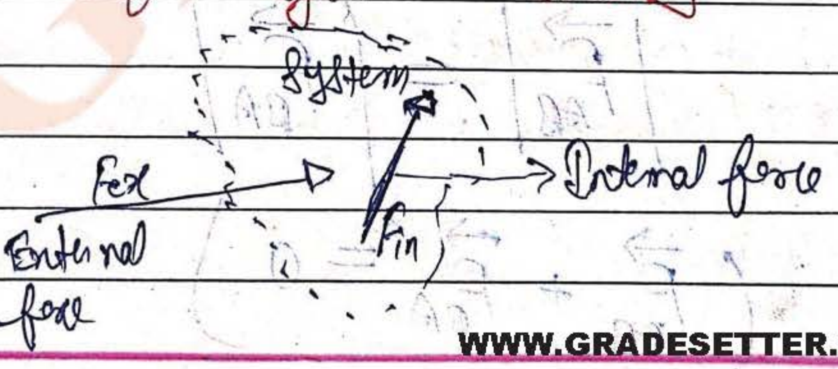
$$= m\vec{a}$$

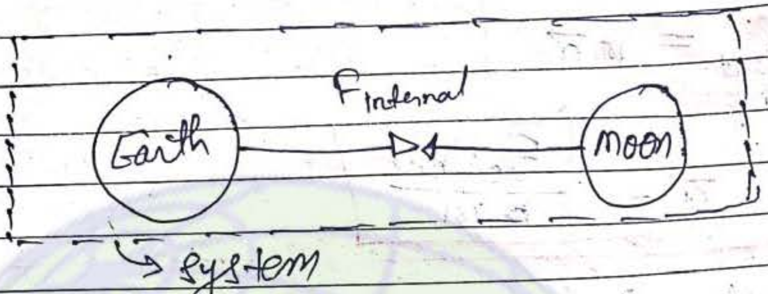
If $\left(\vec{F}_{net}\right)_{ext} = \vec{0}$ { Reasions may be

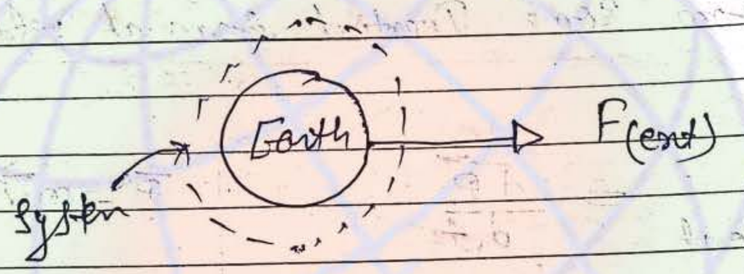
$\vec{a} = \vec{0} \; (m \neq 0)$ { Body is ~~zero~~ mass less

$\vec{v} =$ Constant

Ho On the Basis of System - Boundry

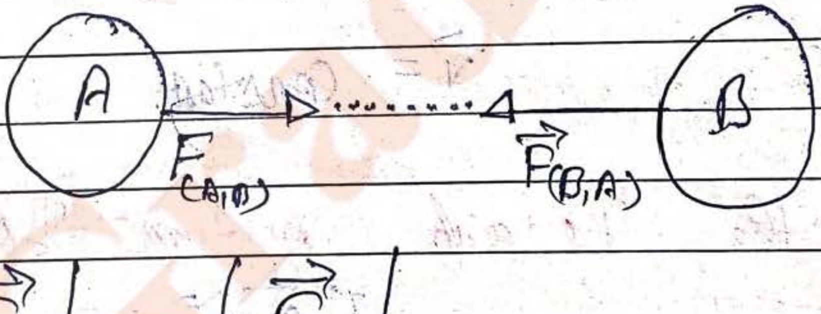






⊛ ~~Nef~~ Newtons third law :->

Every action has alway equal ~~(in magnitude)~~ (in magnitude) and opposite (in direction) reaction



$$\left|\vec{F}_{AB}\right| = \left|\vec{F}_{BA}\right|$$

$$\left(\vec{F}_{AB} + \vec{F}_{BA} = 0\right)$$

(ados → (Pas) Imaginary force
~~acts one body~~

Page No.: 5

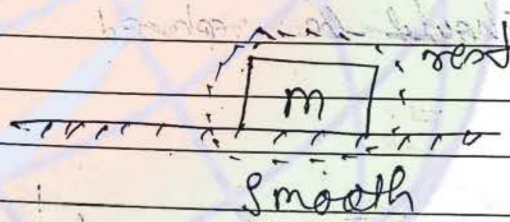
Note → (conclusion)

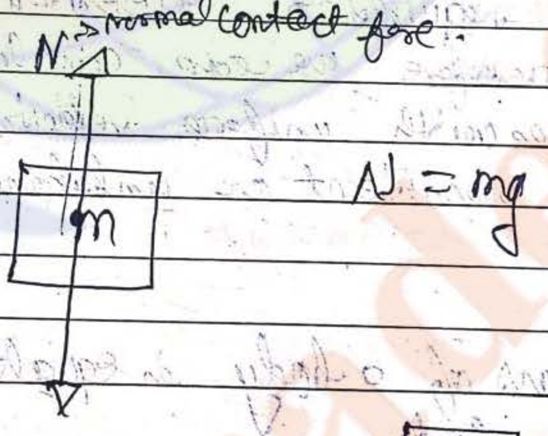
Ø

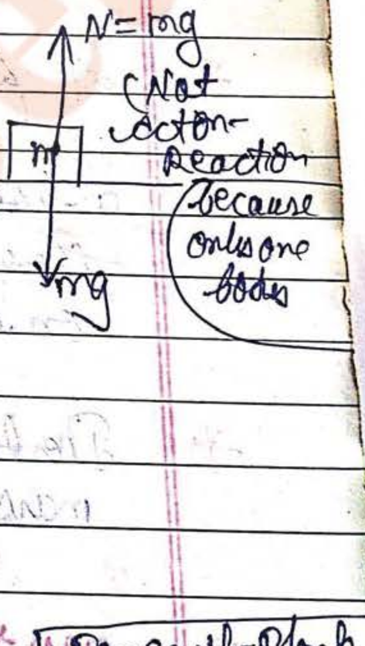
According to Newton's third law all real forces always exist in pair.

~~Ao~~ Acation and reaction force always act on two different bodies. There is no time take between action and reaction force.

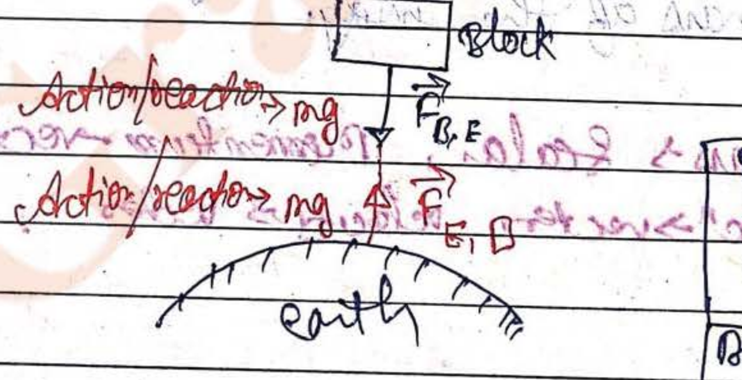
Action and reaction force always lie along ~~S~~ same line But directed in opp. direction







(Not action-Reaction because only one body)



Per earth-Block system mg is an Internal ~~f~~ force

But If the system is Block mg is an external force

mg → gravitation force

Self →

Limitation ~~s~~ of Newton law :-

1) ~~Three law~~

Newton laws are valid for particles moving with ordinary speeds. i.e. speeds much less than that of light.

Note:→ In the case of high velocity particles Newtonian mechanics ~~[illegible]~~ or classical mechanics should be replaced ~~b~~ with Einstein theory of relativity.

ii) In the case of atomic Particles (for example motion of electrons within the atom), Newton mechanics should be replaced with quantum mechanics.

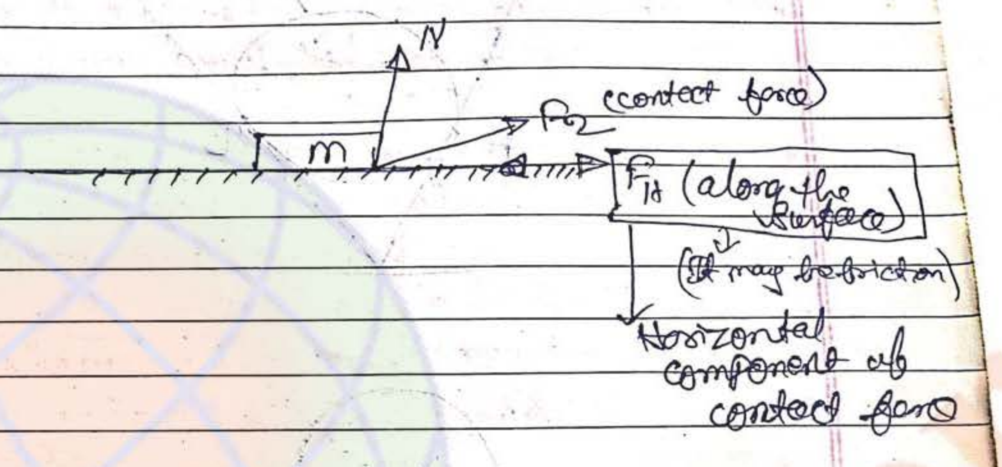
* A force is required to accelerated a particles. Therefore we can conclude that if a body moves with uniform velocity or is at rest there is no resultant or unbalance force acting on it

* Inertial mass of a body is equal to gravitational mass of the body.

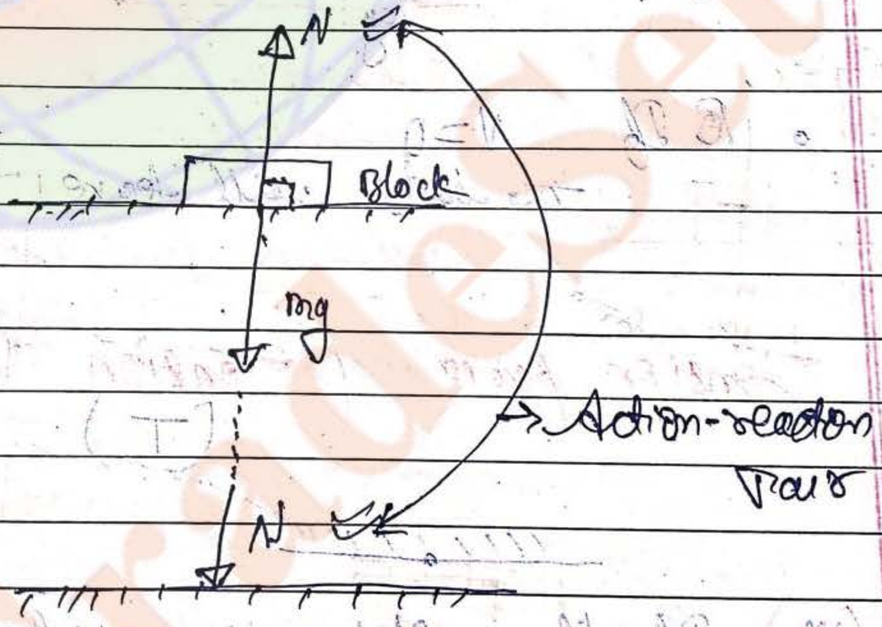
* mass → scalar, Momentum → vector, force → vector
acc^n → vector, velocity → vector ,

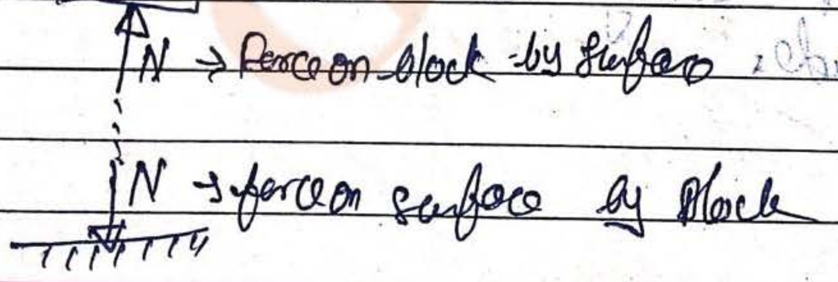
Normal contact force.

(Normal reaction) N ⇒

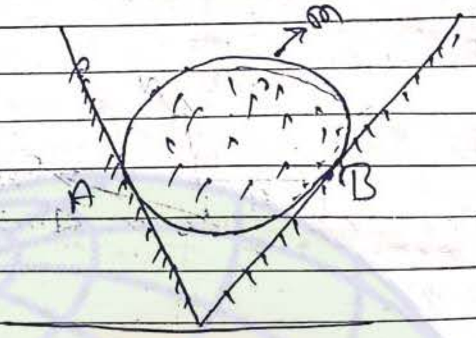


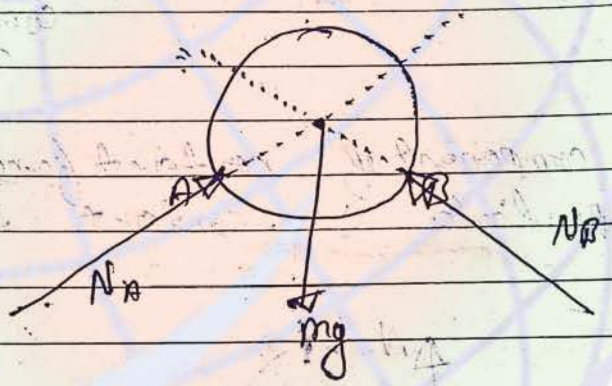
It is normal component of contact force. It direction is always perpendicular to contact surfaces.





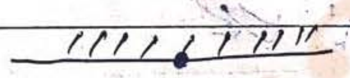
Example:->





- If $N=0$
  The body will leave the contact surface.

* Tension force (तनाव) (Tension in the string (T)

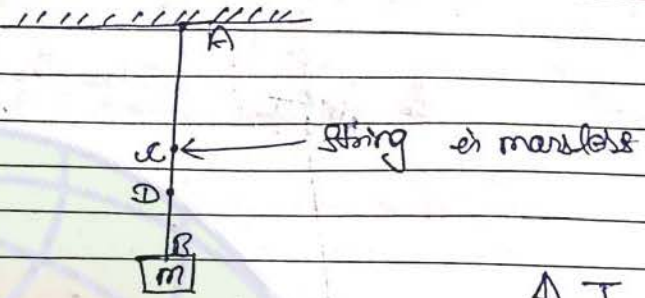


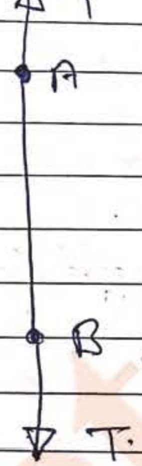
(*) If the string is massless the tension at on all the points in string will be same in magnitude.

masless → Ideal string →

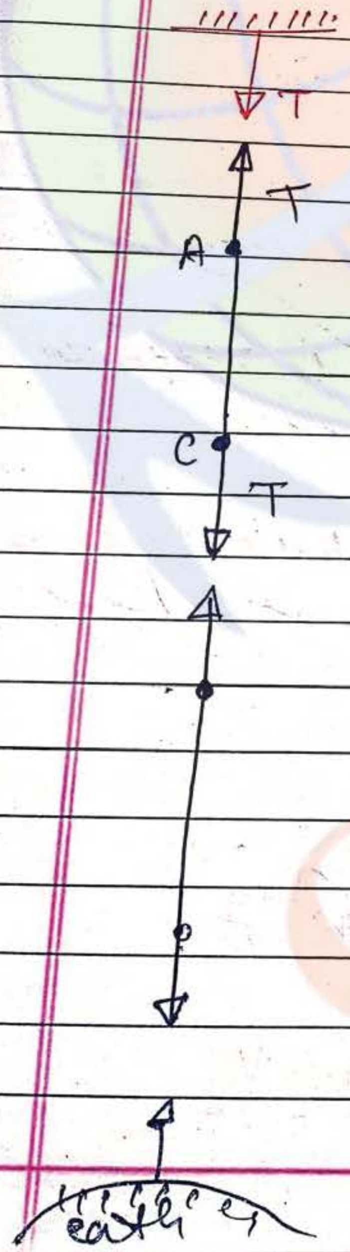
Isolate → seperate

*

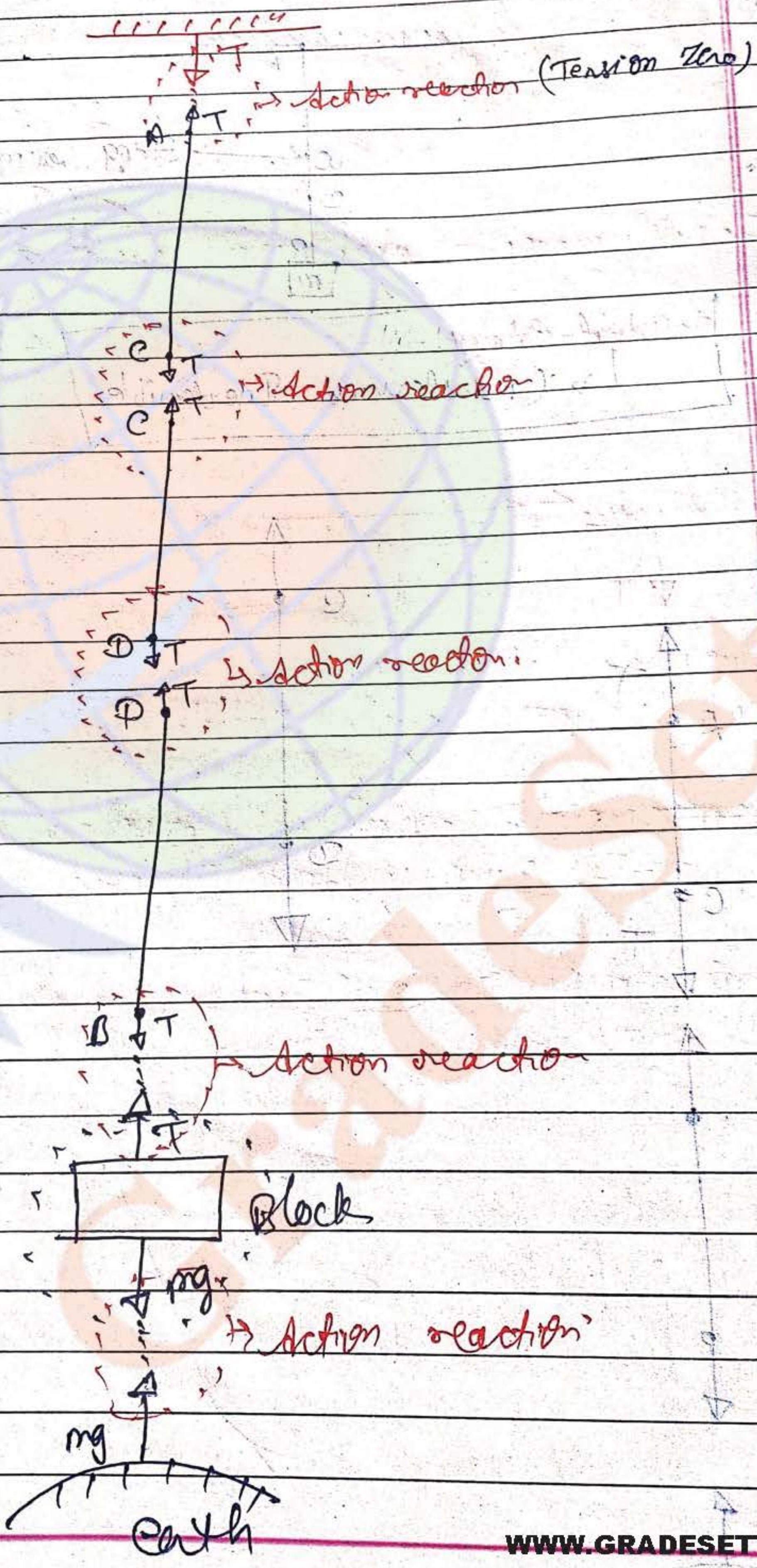




Ideal String :→
↳ (massless and Inextensible

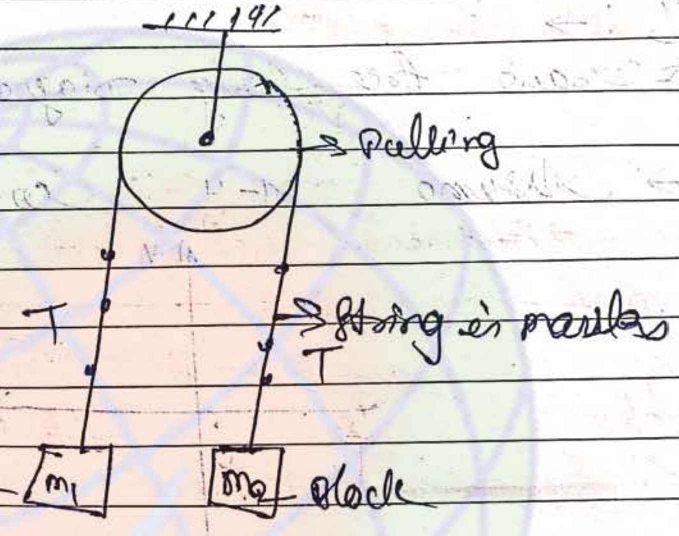


Ideal means not possible



* Ideal Pully :→

↳ (massless and smooth (frictionless)



* F.B.D (Free body diagram)

↳ Showing all the forces acting on a body isolated from system.

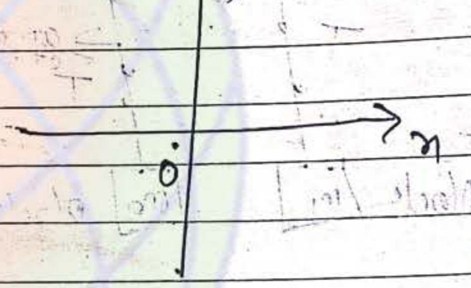
Net force acting on the body is ~~zero~~ must be zero, then bodies is equilibrium

Problem related to equilibrium of body ~~(Translatory~~ equilibrium)

i) Decide the system
ii) Identify the forces

Step-I :→ Draw free body diagram (F.B.D)

Step II :→ Assume x-y co-ordinate system



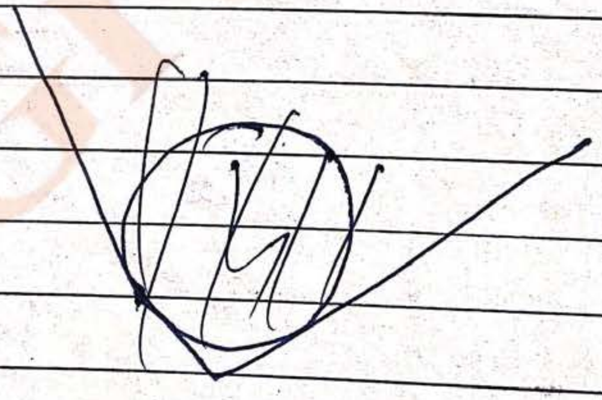
And take the component of all the forces along ~~x~~ x and y axis

Step III :→ Balance the forces along ~~x and or~~ x-axis and y-axis.

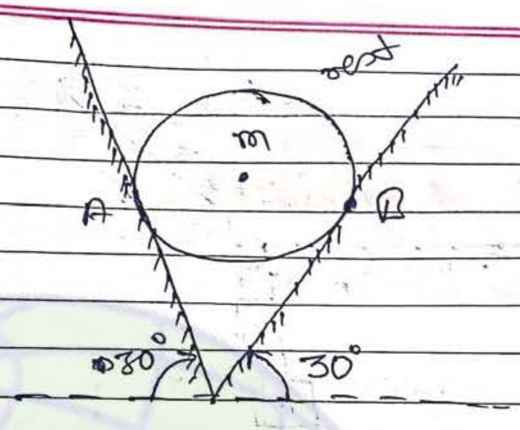
$\Sigma F_x = 0$ (Algebric sum taken with sign)

$\Sigma F_y = 0$

ex:→

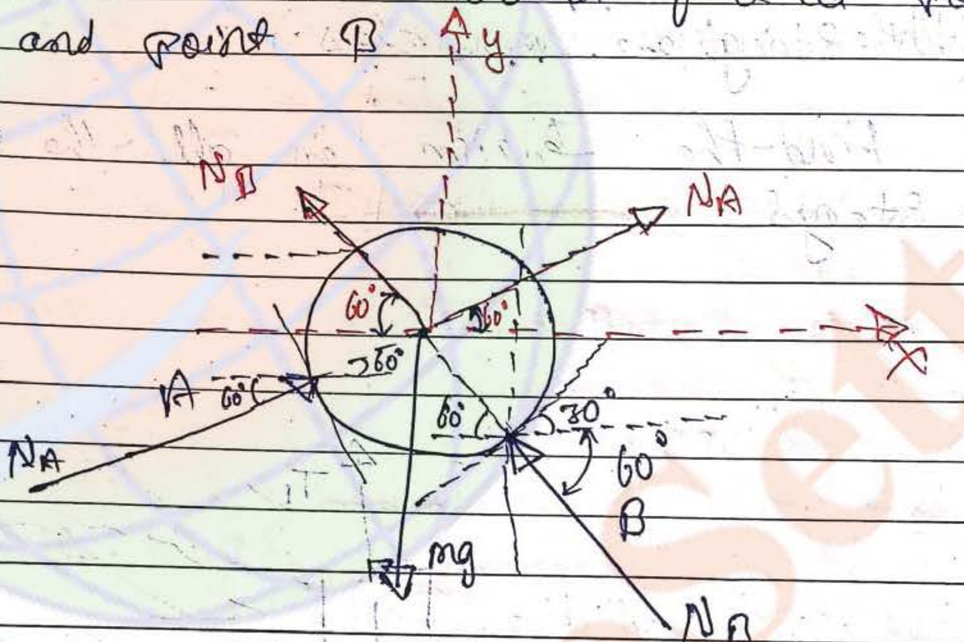


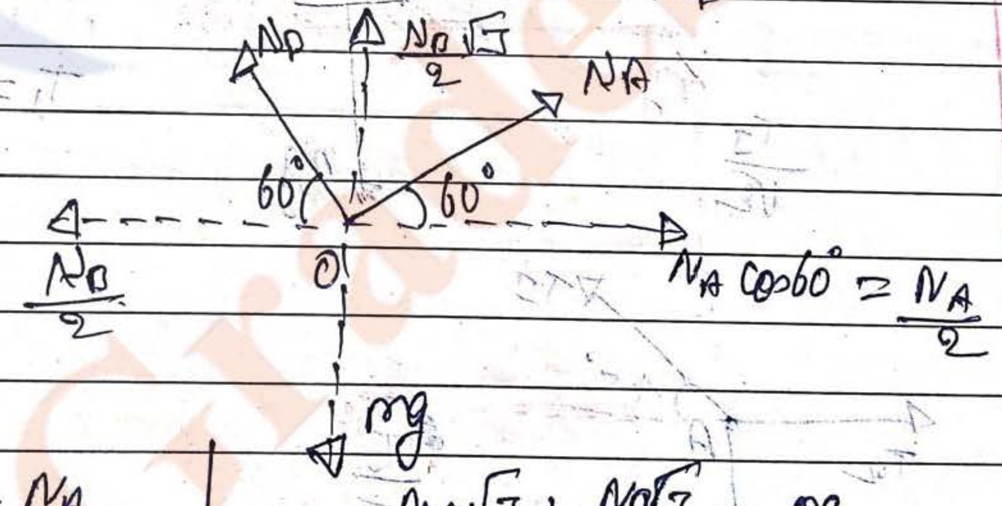
example:>



Find the normal contact force at point A and point B

Soln





$$\frac{N_B}{\cancel{2}} = \frac{N_A}{\cancel{2}}$$

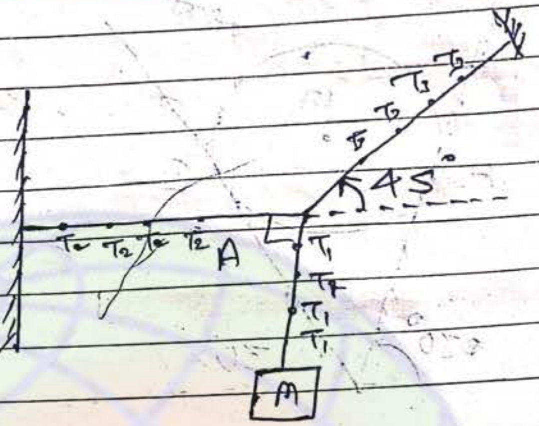
$$N_B = N_A$$

$$\frac{N_A\sqrt{3}}{2} + \frac{N_B\sqrt{3}}{2} = mg$$

$$N_A\sqrt{3} = mg$$

$$\left(N_B = N_A = \frac{mg}{\sqrt{3}}\right)$$

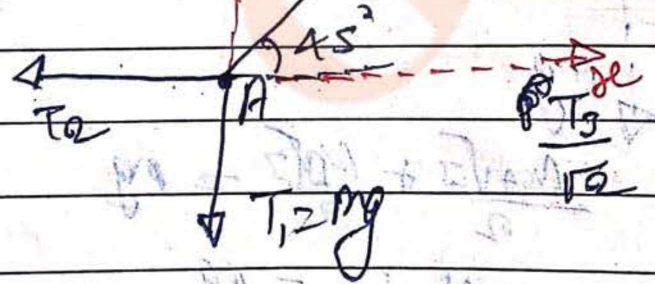
Question :->



(All the string's are mass less.)

Find the tension in all the three strings.

$T_1 = mg$ —(1)



(String always pulling force खिंचेगा) point से दूर tension force होगा

$$T_2 = \frac{T_1}{\sqrt{2}} \quad \text{—②}$$

$$\frac{T_3}{\sqrt{2}} = mg \quad \text{—③}$$

$$T_3 = mg\sqrt{2}$$

$$T_2 = mg$$

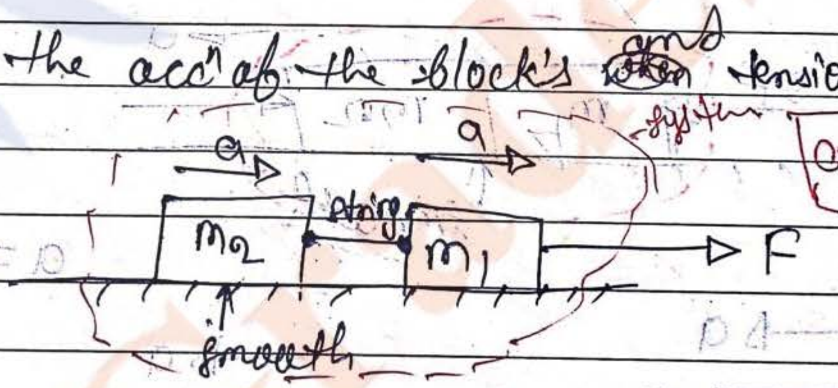
Application of Newton's laws :-

$$\left(\vec{F}_{net}\right)_{ext} = m\vec{a}$$

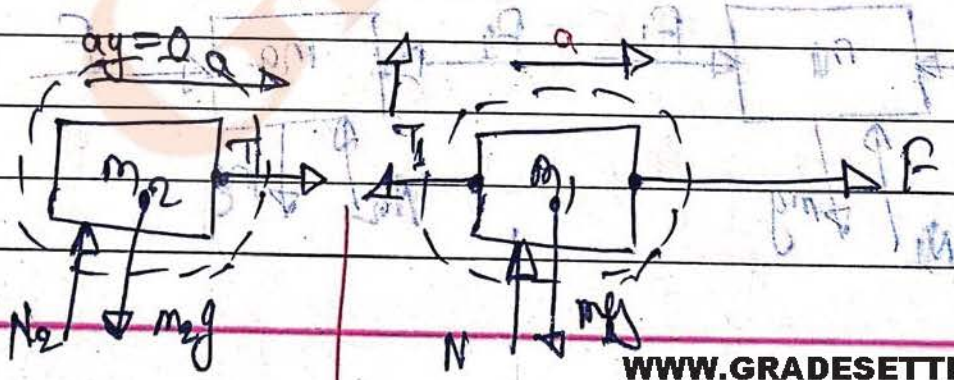
- magnitude of accⁿ of connected blocks is same.
- The connected block may be upon orizontial surface or Inclined surface

✳ Find the accⁿ of the block's and tension in the string

$$\boxed{a = \frac{F}{m_1 + m_2}}$$



$$\left(\vec{F}_{net}\right)_{ext} = m\vec{a}$$



~~Det~~ sum of Internal force is always zero.

For m_2,

$$N_2 = m_2 g$$
$$T = m_2 a \quad — ①$$

For m_1

$$F - T = m_1 a \quad — ②$$

eq① + eq②

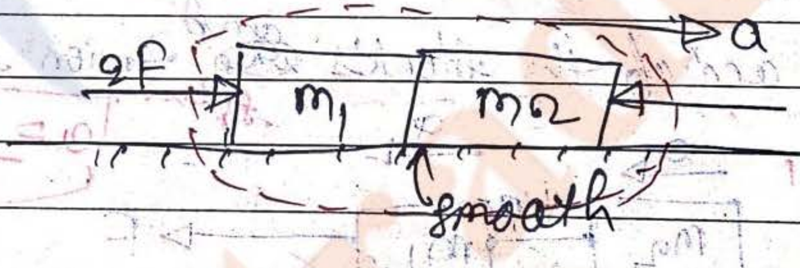
$$F = (m_1+m_2)a$$

$$\boxed{a = \frac{F}{m_1+m_2}}$$

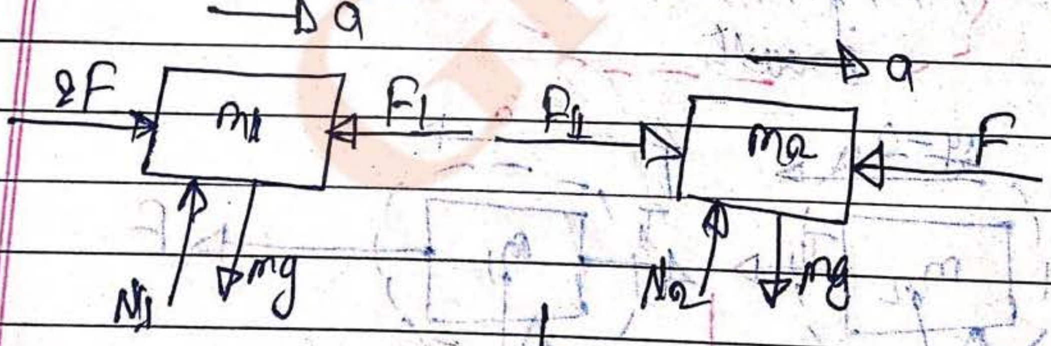
$$T = m_2 a$$

$$\boxed{T = \frac{m_2 F}{m_1+m_2}}$$

Q.) Find the ~~For~~ Force applied by m_1 ~~to~~ and m_2



$$a = \frac{F}{(m_1+m_2)}$$

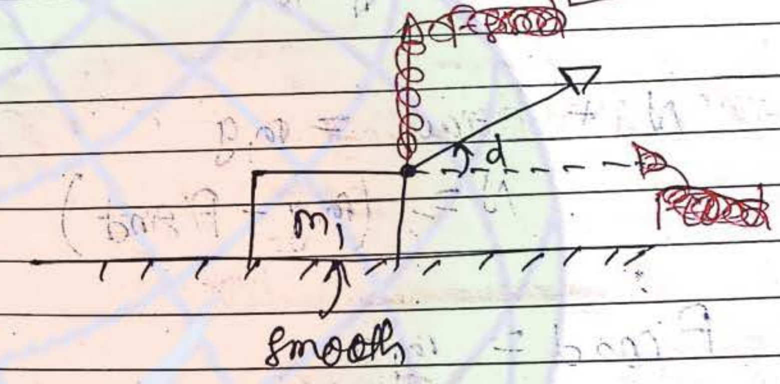


$F = m.a \quad a = \frac{F}{.}$

$$(F_1 - F) = m_2 a$$

$$\boxed{F_1 = F + \frac{m_2 F}{(m_1 + m_2)} = F\left(1 + \frac{m_2}{m_1 + m_2}\right)}$$

Q-)



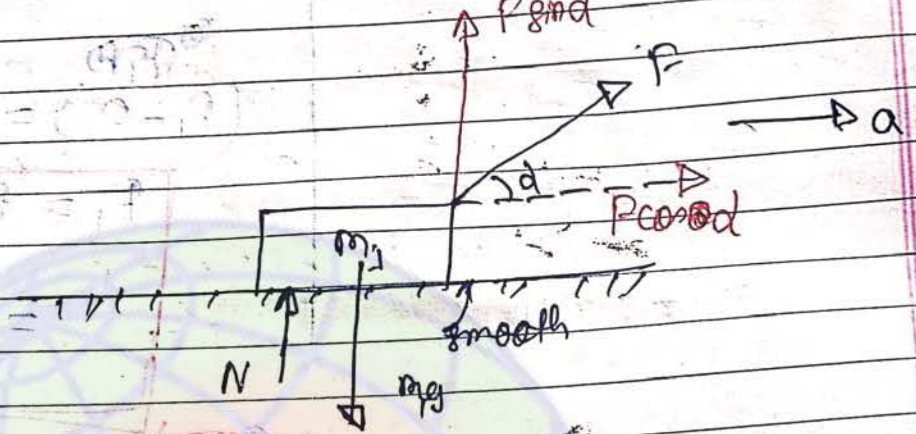
Block does not leave the contact force.

(I) Find the normal reaction by the horizontal surface on the block and accn on the block.

(II) Find the velocity of the block at the time t.

(III) Find the distance travelled by the block in first three second. If the force = 10N and $m_1 = 2$kg.

Soln-)



$$N + F\sin\alpha = m_1 g$$

$$N = (m_1 g - F\sin\alpha)$$

$$F\cos\alpha = m_1 a$$

$$a = \left(\frac{F\cos\alpha}{m_1}\right)$$

$$\frac{dv}{dt} = \left(\frac{F\cos\alpha}{m_1}\right)$$

$$\int_0^v dv = \left(\frac{F\cos\alpha}{m_1}\right)\int_0^t dt$$

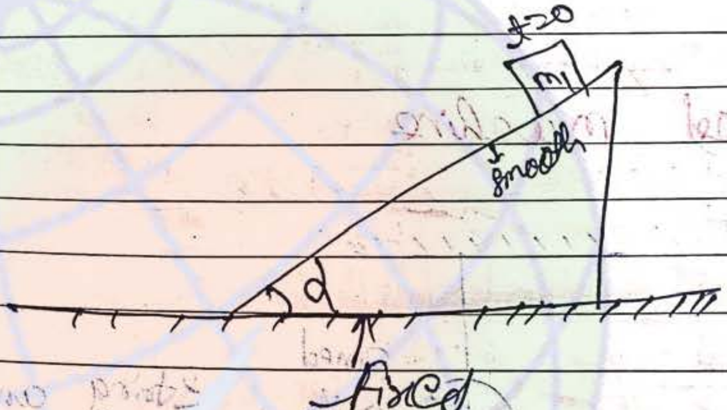
$$v = \left(\frac{F\cos\alpha}{m_1}\right)t$$

$$\frac{dx}{dt} = \left(\frac{F\cos\alpha}{m_1}\right)t$$

$$\int_0^x dx = \left(\frac{F\cos\alpha}{m_1}\right)\int_0^t t\,dt$$

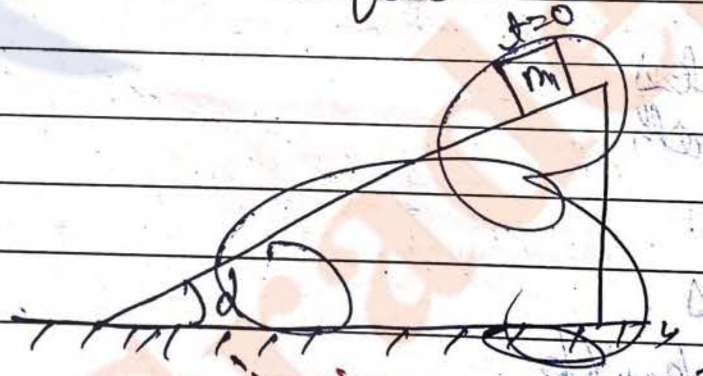
$$x = \left(\frac{F\cos\alpha}{m_1}\right)\frac{t^2}{2}$$

eg:→

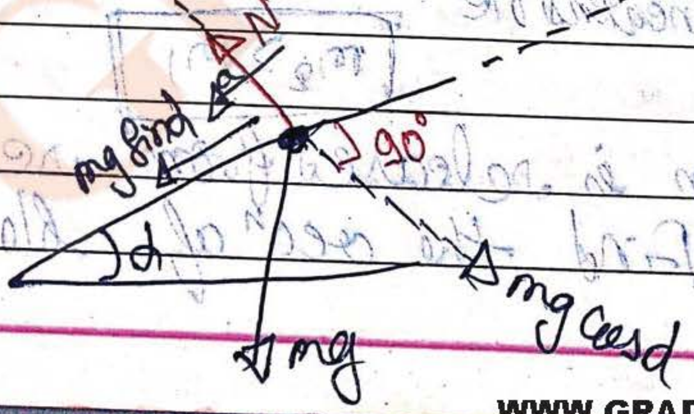


A block of ~~m~~ mass m_1 is realesed from rest on smooth Inclined surface.

(i) Find the acc^n of block moving motion on Inclined surface.



F.B.D.



Inextensions के opp चलना शुरू हो जायेगा

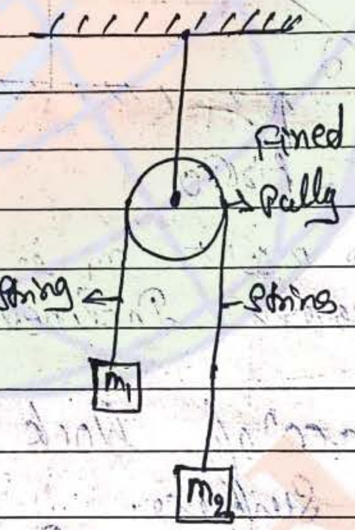
$N = mg\cos\alpha$

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

$a = g\sin\alpha$

eg

② Atwood machine



String and Pully are massless.

Pully
↳ massless
and smooth

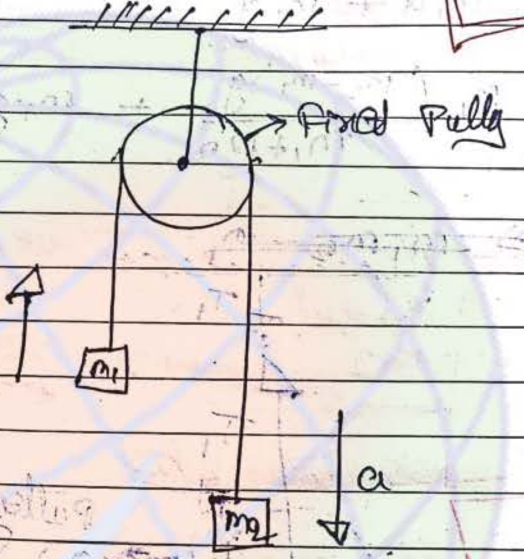
String →
massless
and Inextensible

$\boxed{m_2 > m_1}$

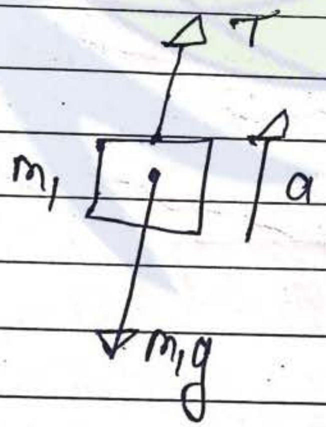
A system is released from rest.
Find the acc^n of blocks and tension

in the strings

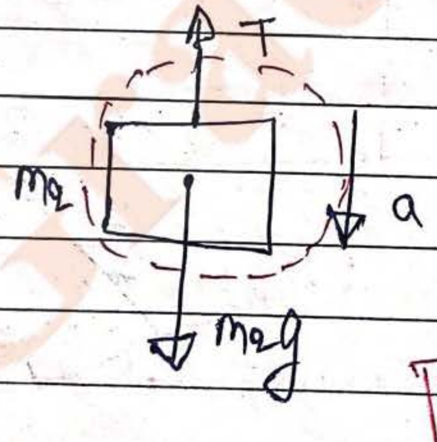
$$\boxed{T = \frac{2m_1m_2\,g}{(m_1+m_2)}}$$



F.B.D



$$T - m_1 g = m_1 a \quad \text{—(1)}$$



$$m_2 g - T = m_2 a \quad \text{—②}$$

eq① + eq②

$$\boxed{a = \frac{(m_2-m_1)g}{m_1+m_2}}$$

Equilibrium ⇒ zero

$$T = \left(\frac{2m_1 m_2 g}{m_1+m_2}\right)$$

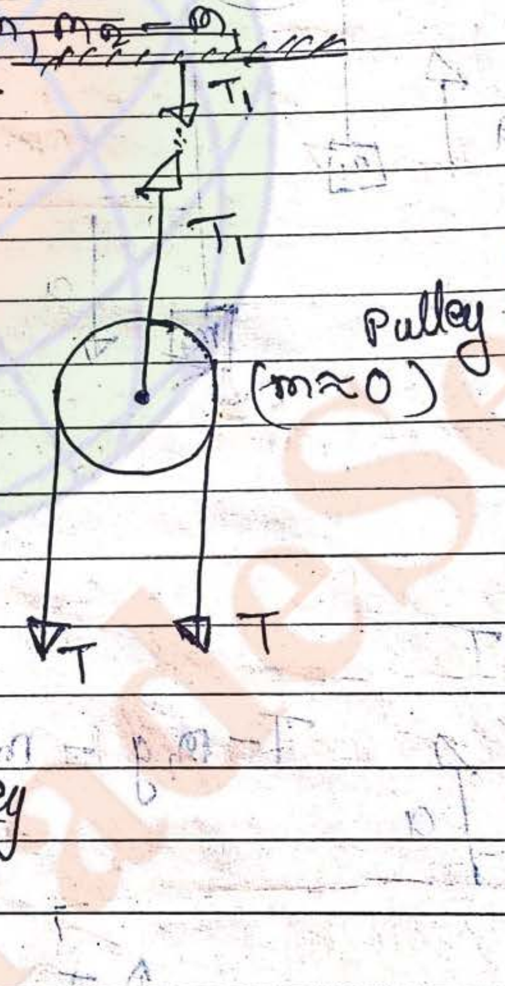
Solve करने पर होगा

$$T - m_1 g = m_1 a$$

$$T = m_1 a + m_1 g$$

$$= m_1 \frac{(m_2-m_1)g}{m_1+m_2} + m_1 g$$

~~⇒ $m_1 m_2 = m_1$~~

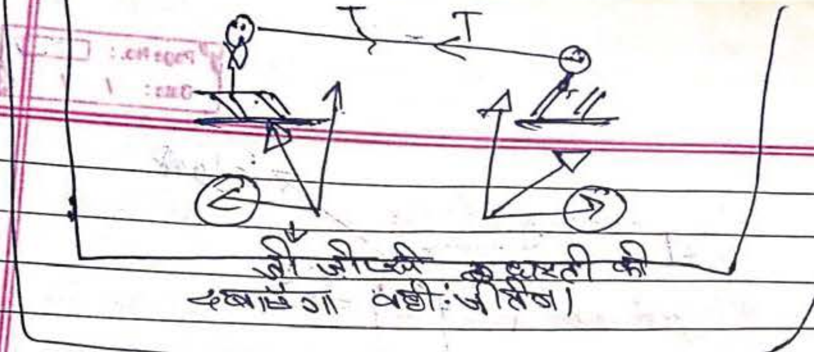


$$T_1 = 2T$$

$$\boxed{T_1 = \frac{4m_1 m_2 g}{m_1+m_2}}$$

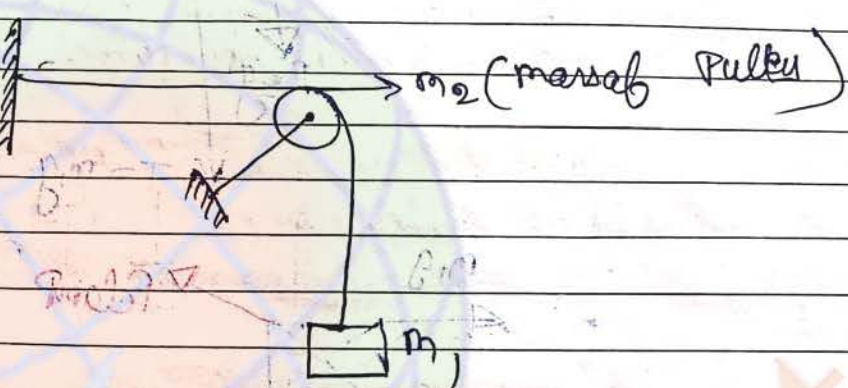
Force by the ceiling on the pulley

↳ Force by the clamp on the pulley



If string is massless tension is same in string

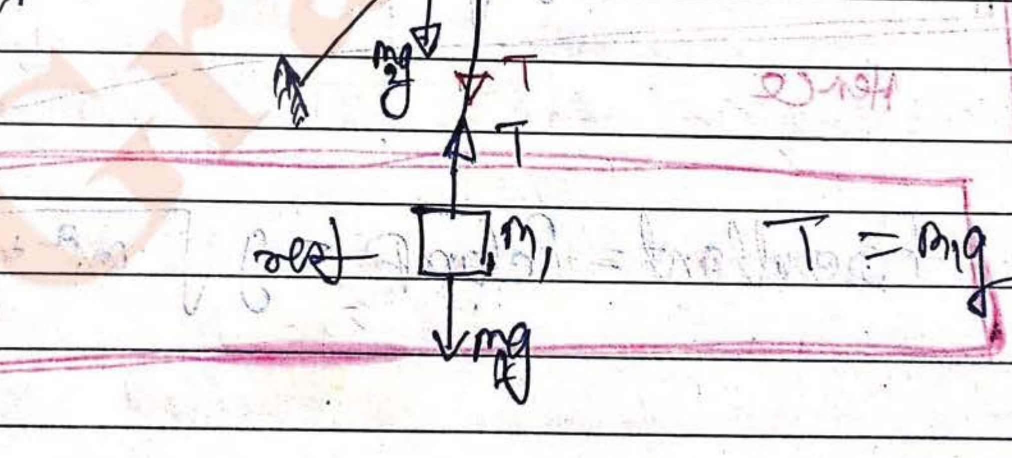
IIT Question
eg:1



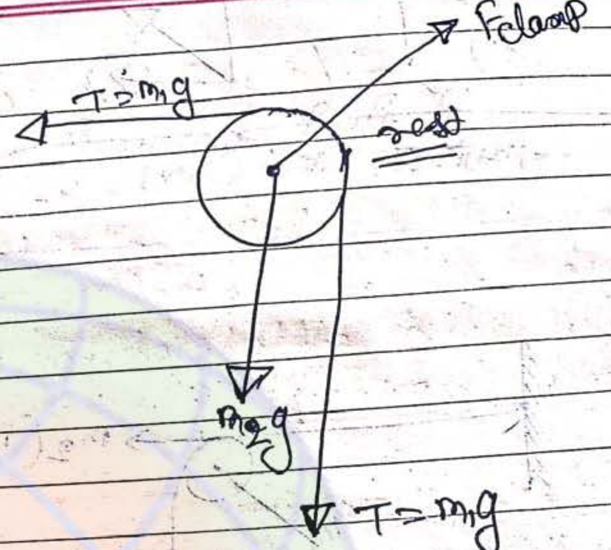
Pully is smooth, there is no friction on Pulley.
String is also massless (Inextensible)

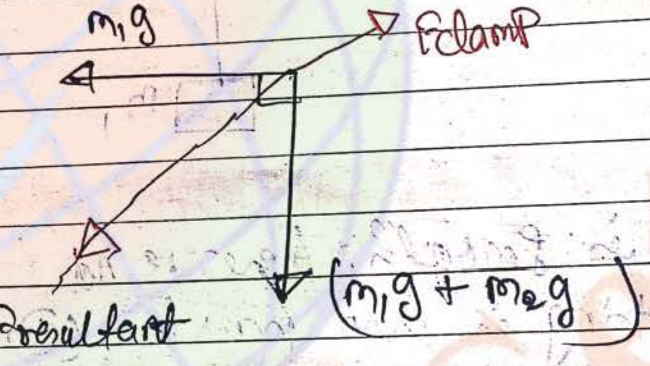
Find the force exerted by the clamp on the Pully

Soln



$T = mg$





$$F_{resultant} = \sqrt{(m_1g)^2 + (m_1g + m_2g)^2}$$

$$F_{clamp} = g\sqrt{m_1^2 + (m_1 + m_2)^2}$$

Hence

$$F_{resultant} = F_{clamp} = g\sqrt{m_1^2 + (m_1 + m_2)^2}$$

Rello read
11.8.2011 (H.C. verma)

Force

Force :- Force is an interaction between two objects.

Force is a vector quantity and If more than one forces act on a particle we can find the resultant force using the law of vector addition.

The various types of forces in nature can be grouped in four categories:-

(a) Gravitational force:-

$$\boxed{F = G\frac{m_1 m_2}{r^2}}$$

Here G is the universal constant having the value $6.67 \times 10^{-11} N m^2/kg^2$

Note:→

The gravitational force exerted by a spherically symmetric body of mass m_1 on another such body of mass m_2 kept outside the first body is $G\frac{m_1 m_2}{r^2}$, where r is the distance between the centre of the two bodies. Thus for the calculation of gravitational force between two spherically symmetric bodies, they can be treated as point mass placed at their centre.

Accⁿ due to gravity (g) :-

The force of attraction exerted by the earth on other objects is called gravity. The direction of this force is towards the centre of the earth which is called the vertically downward direction.

- The value is approximately 9.8 m/s². For simplicity of calculations we shall ~~aff~~ often use $g = 10 m/s^2$.

(b) Electromagnetic force (EM) force:-

If two particles having charges q_1 and q_2 are at rest with respect to the observer, the force between them has a magnitude

$$\boxed{F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}}$$

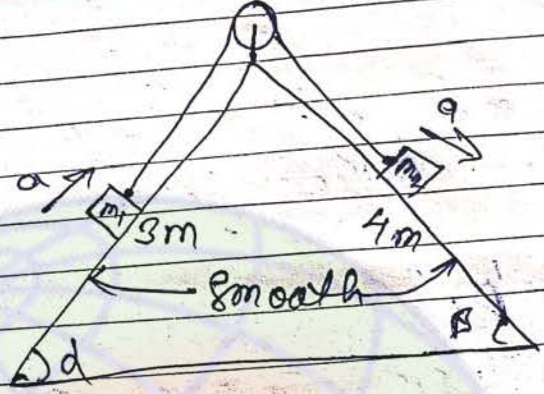
where $\varepsilon = 8.85419 \times 10^{-12} C^2/N\text{-}m^2$ is a constant.

- The quantity $\frac{1}{4\pi\varepsilon_0}$ is $9.0 \times 10^9 \frac{N\text{-}m^2}{C^2}$

Pulley is Ideal means → Pulley is smooth and massless
String is Ideal means → string is massless and Inextensible

Date: 28

(Q)



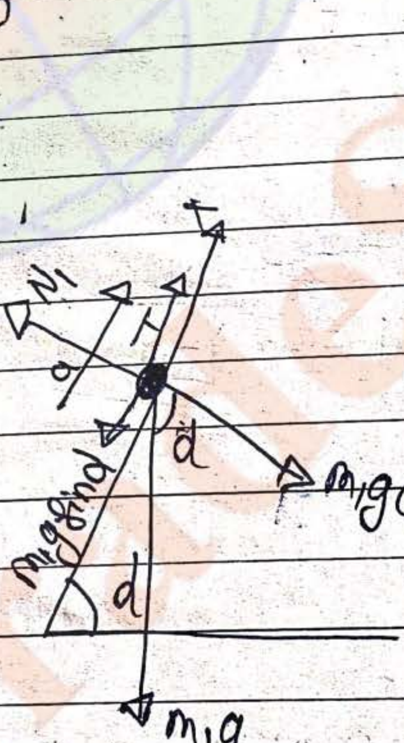
Here, String and Pulley are Ideal, The system is released from rest.

$m_2 > m_1$

Find the accⁿ of the block and tension in the string.

Solⁿ →

make F.B.D.

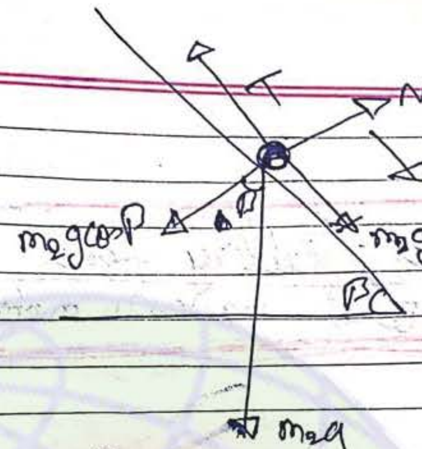


(Inclined normal के opp. में $\cos\alpha$ होगा

$$N_1 = m_1 g\cos\alpha$$

$$T - m_1 g\sin\alpha = m_1 a \quad ①$$

Tension हर हमेशा joint से string की तरफ ही लगता है,



$m_2g\sin\beta - T = m_2a$ —② → acc^n जिधर हो रहा है उधर की force को + opp. force की घटाया जाता है।

eq(I) + eq(II)

$$T\!\!\!/ - m_1g\sin\alpha = m_1a \quad —(I)$$
$$m_2g\sin\beta - \cancel{T} = m_2a \quad —(II)$$

$$m_2g\sin\beta - m_1g\sin\alpha = m_1a + m_2a$$

$$\Rightarrow m_2g\sin\beta - m_1g\sin\alpha = a(m_1+m_2)$$

So,
$$\boxed{a = \frac{m_2g\sin\beta - m_1g\sin\alpha}{m_1+m_2}}$$

Tension force with respect to m_1 from eq(I)

$T = m_1g\sin\alpha + m_1 \textcircled{a}$ → Here we put the value of acc^n

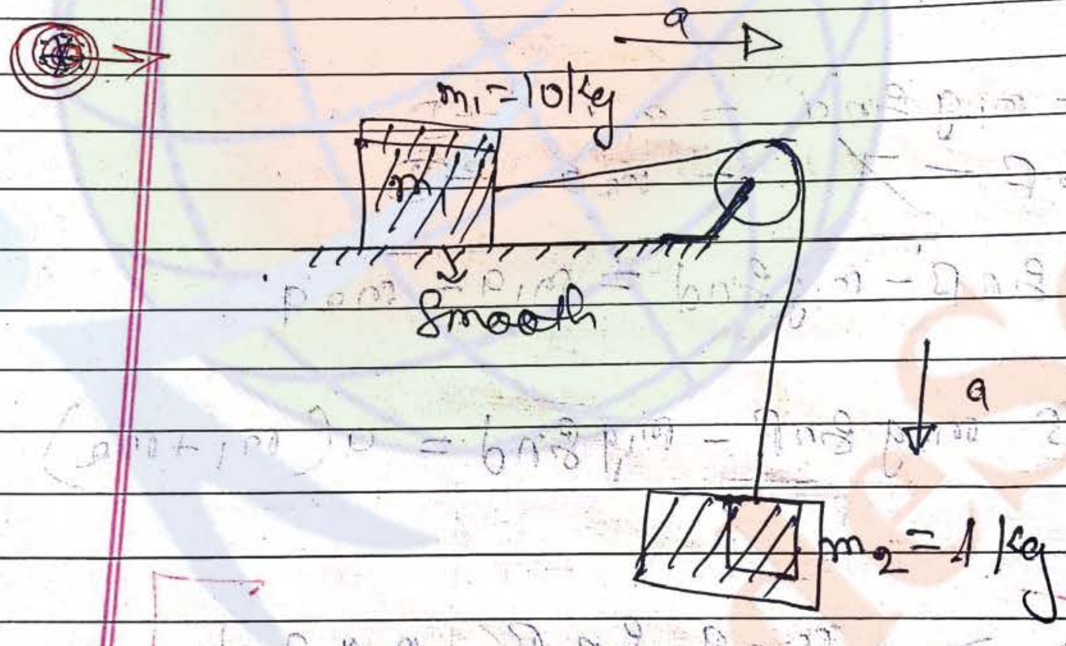
Tension force with respect to m_2 from eq(II)

$m_2g\sin\beta - T = m_2\textcircled{a}$ → Here we put the value of acc^n

(v) Shortcut :⇒

$$\boxed{a = \frac{\text{Net Pulling force}}{\text{Total masses in motion}}}$$

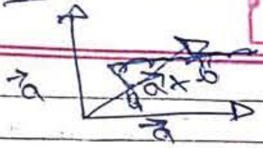
$$\boxed{a = \frac{m_2 g \sin\beta - m_1 g \sin\alpha}{m_1 + m_2}}$$



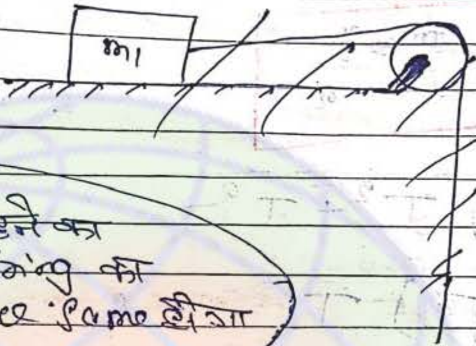
Here Pulley and String are Ideal

The System is released from rest. Find the acc^n of the block and tension in the string

clamp or Resultant for
By vector sum (Parallelogram

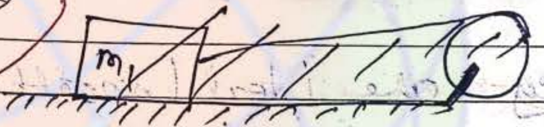


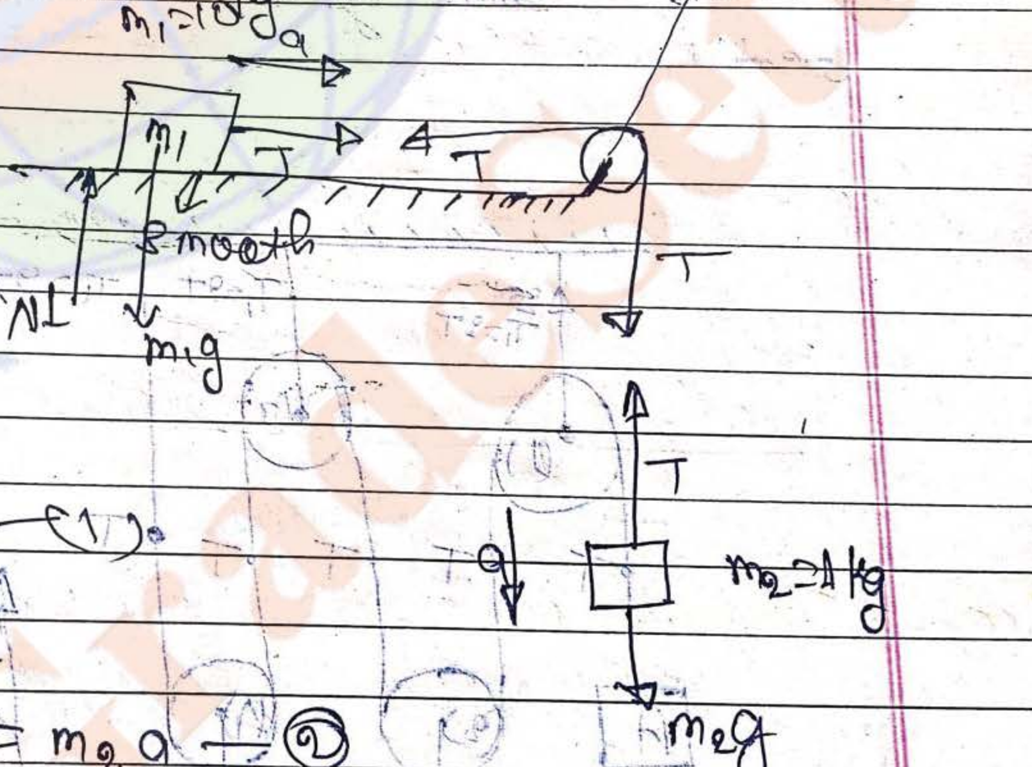
$$\boxed{\vec{a}+\vec{b}=\sqrt{a^2+b^2}}$$



Ideal string कहने का मतलब पूरे string का tension force same होगा

Normal force contact surface के लम्बवत होता है





Per 'm₁'

$T = m_1 a$ —(1)

Per m_2

$(m_2g - T) = m_2 a$ —②

eq ② + eq ①

$$\boxed{a = \frac{m_2 g}{m_1 + m_2}}$$

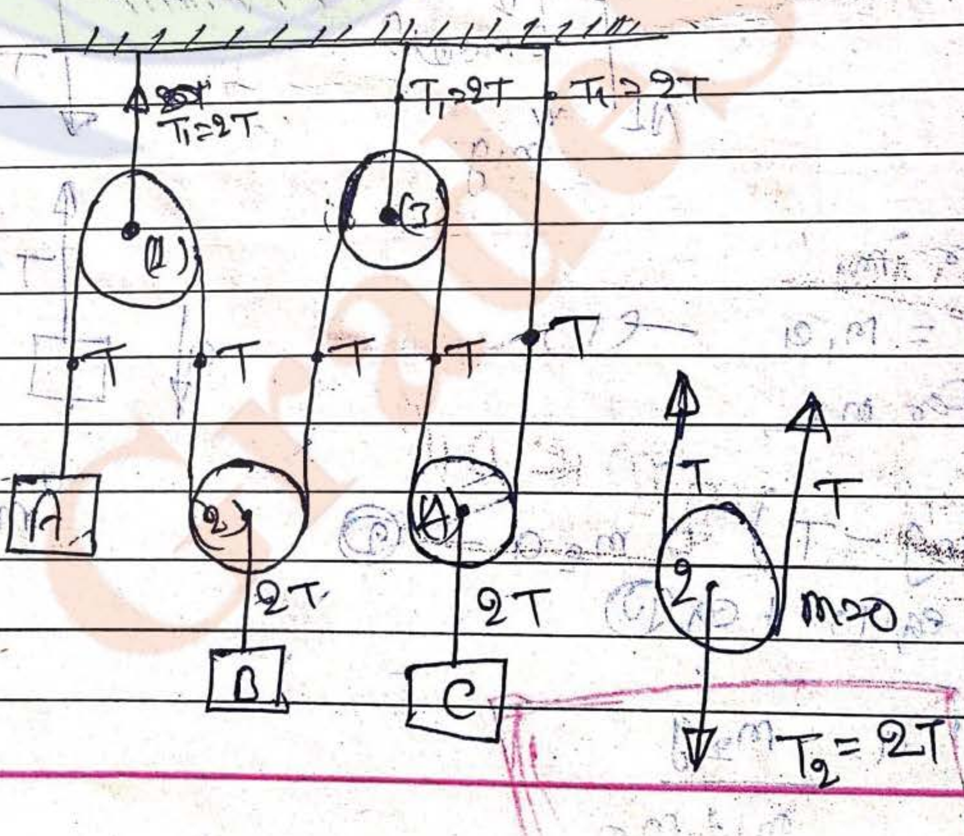
$T = m_1 g$

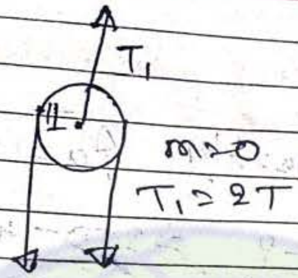
$$\boxed{T = \frac{m_1 m_2 g}{m_1 + m_2}}$$

$$F_{clamp} = \sqrt{T^2 + T^2}$$

$$= (\sqrt{2})\, T$$

⑧ All pulley are Ideal (Smooth and massless) and String are Ideal (massless and Inextensible) whole system are equillibrium and rest.





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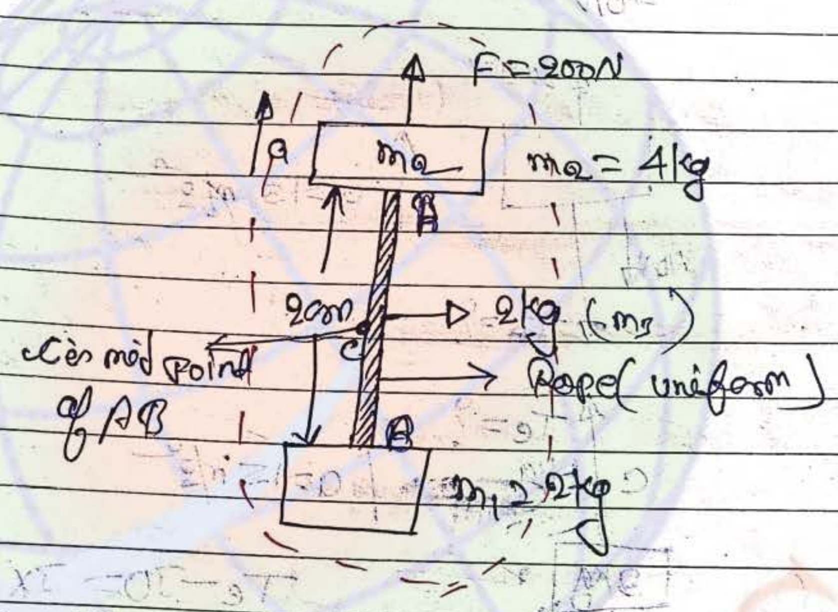


Find the tension at point A, B and find a

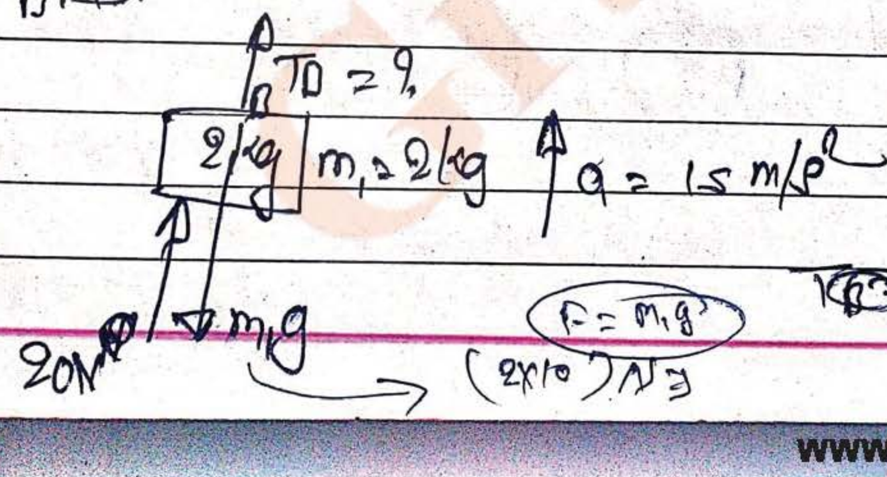
$$a = \frac{200-80}{4+2+2}$$

$\therefore (m_1+m_2+m_3)a = 200-(m_1+m_2+m_3)g$

where $g = 10$

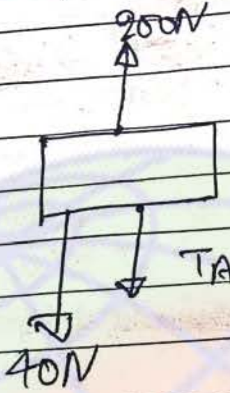
$$= \frac{120}{8} = 15\ m/s^2$$

F.B.D.



$T_B - 20 = 2 \times 15$

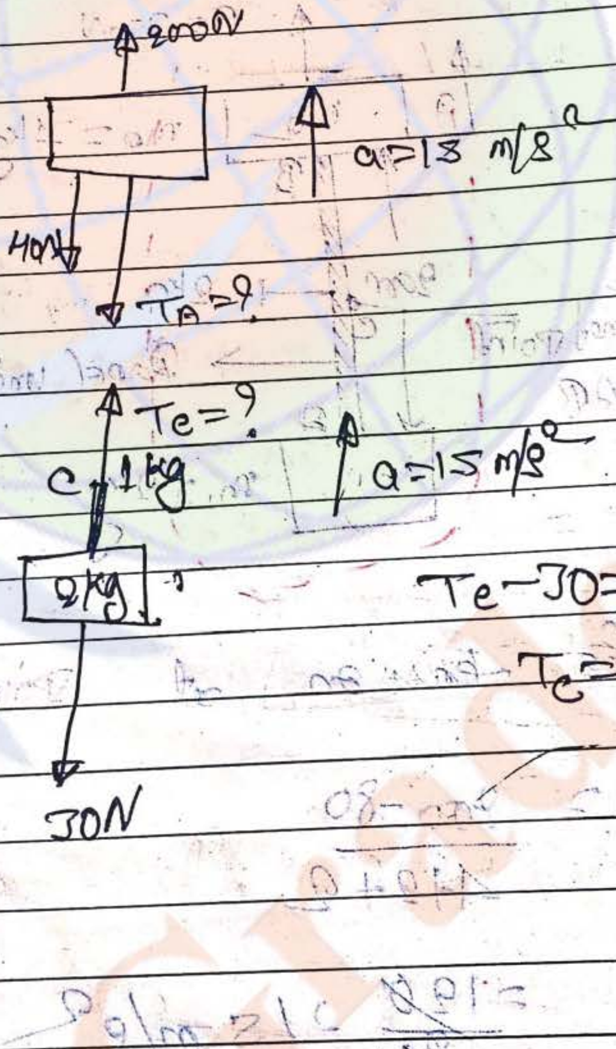
$T_B = 50N$



$m=4kg$ $\uparrow a=15\,m/s^2$

$\Rightarrow 200-40-T_A=4\times15$

$T_A=100N$



$T_c-30=3\times15$

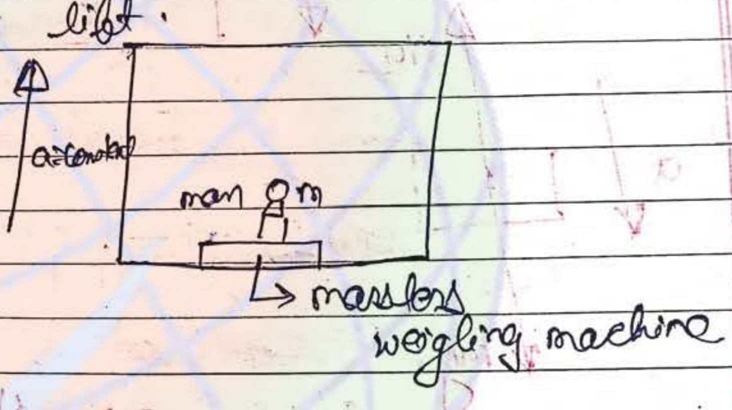
$T_c=75N$ ✓

⇒ Reading of weighing ~~weighing~~ machine ⇒

→ Normal reaction force (N)

Case Ist: ⇒

~~Cos~~ lift is accelerating vertically upward with constant acc^n (a)



$$N_1 - mg = ma$$

$$\boxed{N_1 = m(g+a)}$$

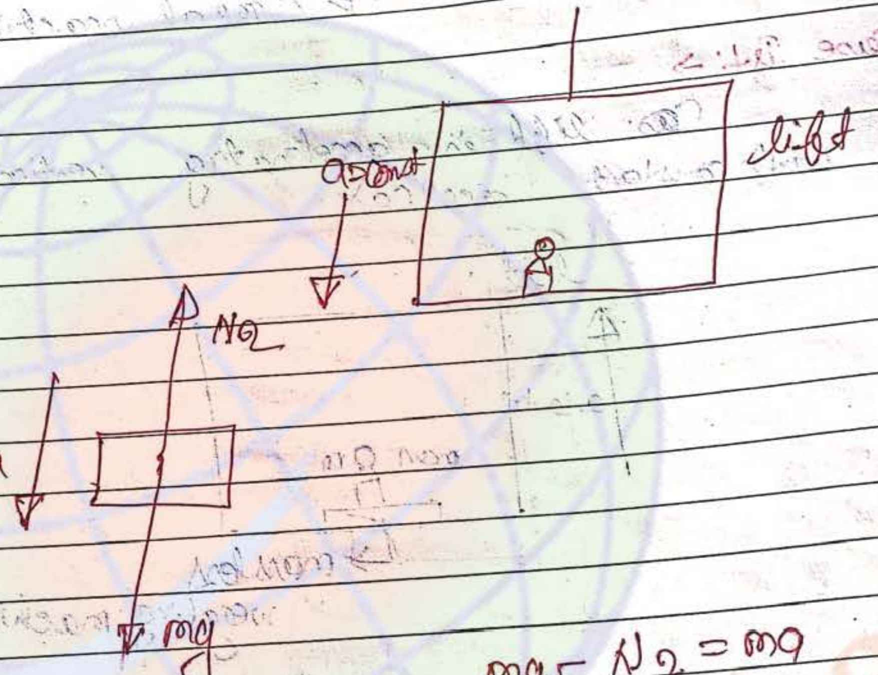
where ⇒

(mg) ⇒ Actual weight (वास्तविक)

N_1 ⇒ Apperent weight (आभासी भार)

w.r.t. Ground
(Inertial frame)

case 2nd :→ Lift is accn vertically downward with constant accn (a)



$$mg - N_2 = ma$$

$$N_2 = mg - ma$$

$$\boxed{N_2 = m(g-a)}$$

V.V.I note

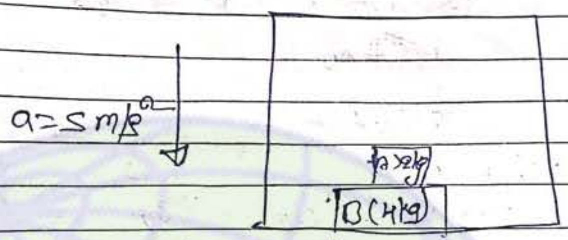
In case of freely falling lift

$$\boxed{a = g},$$

$$\boxed{N = 0}$$

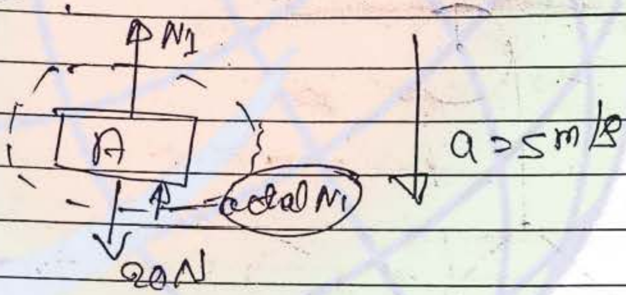
This condition is called weight lessness condition

Example ⇒



Find the force exerted by block A and Block B.
Find the force exerted by the floor of lift on the block 'B'

Sol ⇒ F.B.D



$$20 - N_1 = 2 \times 5$$

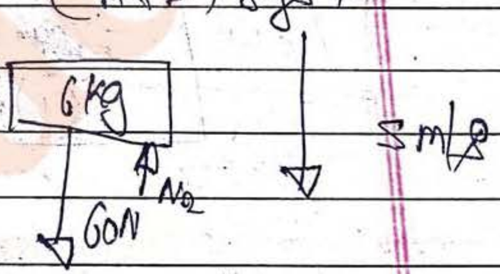
$$20 - N_1 = 10$$

$$-N_1 = 10 - 20$$

$$-N_1 = -10$$

$$N_1 = 10$$

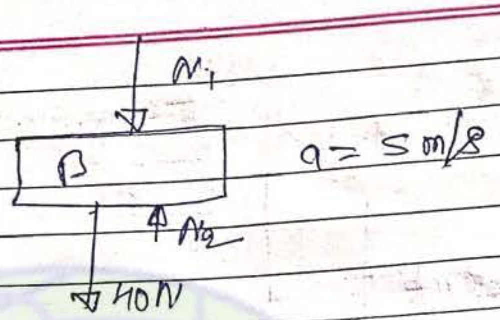
(A+B) system



$$60 - N_2 = 6 \times 5$$

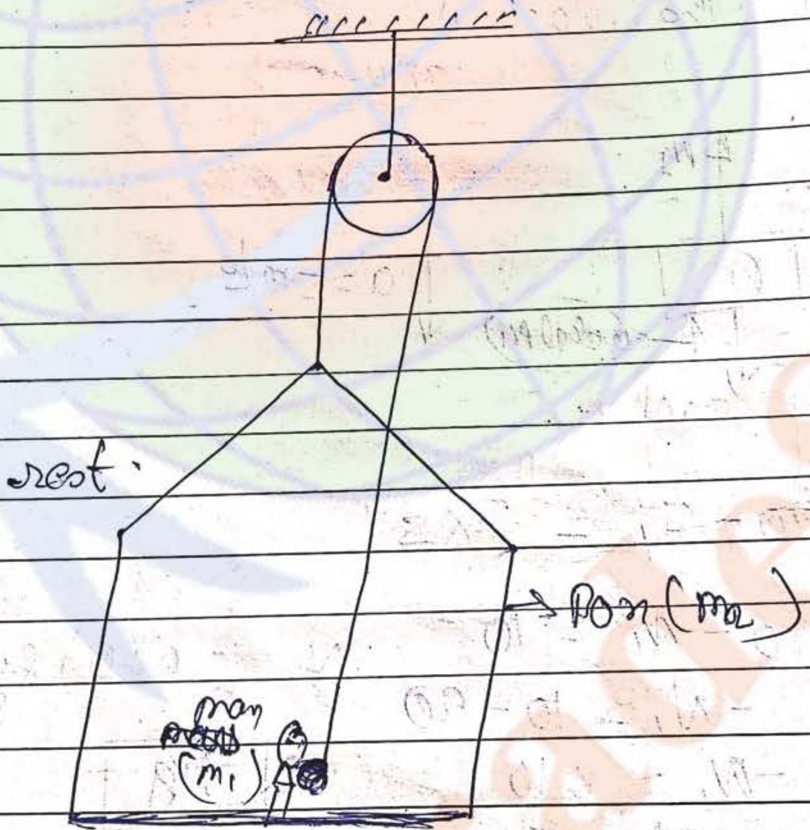
$$N_2 = 60 - 30$$

$$= 30N$$



$$40 + N_1 - N_2 = 4 \times 5$$
$$40 + 10 - N_2 = 20$$
$$N_2 = 30 N$$

Q.)



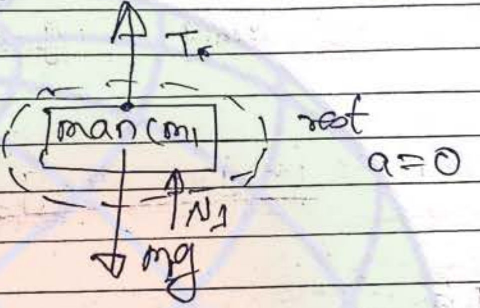
Palley are String are Ideal. The whole system is at rest.

Find the tension in the string (force exerted by man on the string)

Tension force → जितना force से रस्सी को खींचेंगे उतना ही tension force develope. (आमके अलावा external होगा)

Find the force ~~exerted~~ exerted by floor of box on the man.

Soln → F.B.D., w.r.t. of Inertial frame.

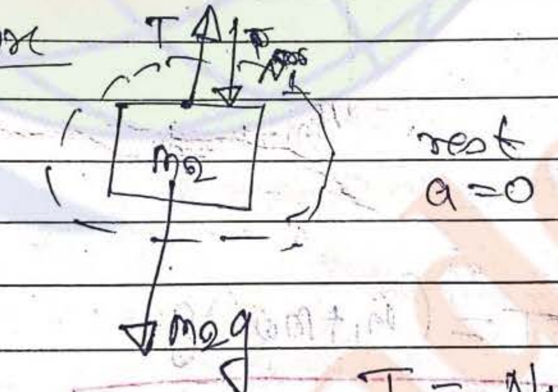


$$m_1 a = m_1 g - N_1 - T$$

$$m_1 g - (N_1 + T_1) = 0$$

$$T + N_1 = m_1 g \quad \text{— ①}$$

Box



$$T = N_1 + m_2 g \quad \text{— ②}$$

eq ① + eq ②

$$T + \cancel{N_1} = m_1 g$$

$$T - \cancel{N_1} = m_2 g$$

$$T = \frac{(m_1 + m_2) g}{2}$$

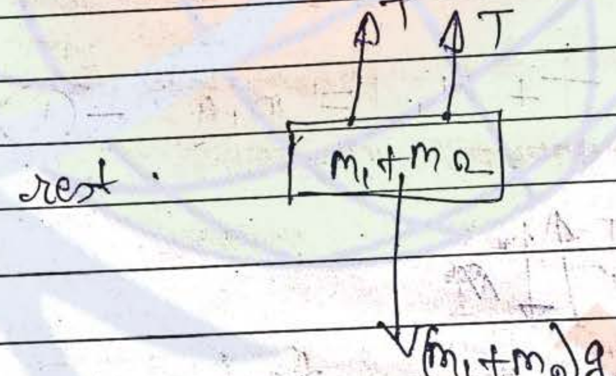
$$N_1 = m_1 g - T$$

$$= m_1 g - \left(\frac{m_1+m_2}{2}\right)g$$

$$= \frac{2m_1 g - m_1 g - m_2 g}{2}$$

$$N_1 = \frac{(m_1 g - m_2 g)}{2}$$

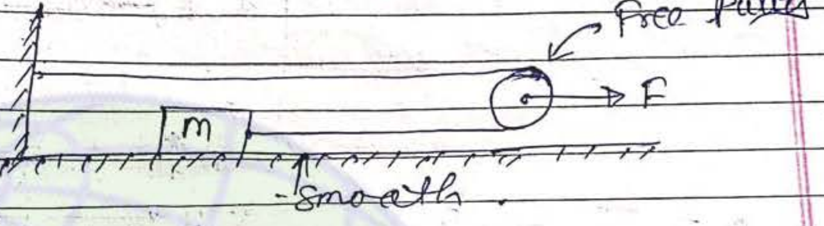
⇒ New system's
(mass+Ram)



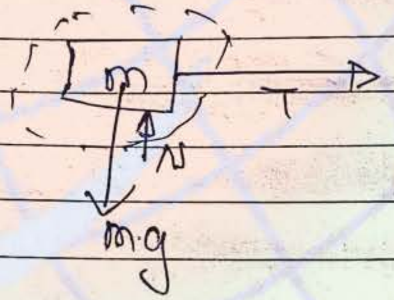
$$2T = (m_1+m_2)g$$

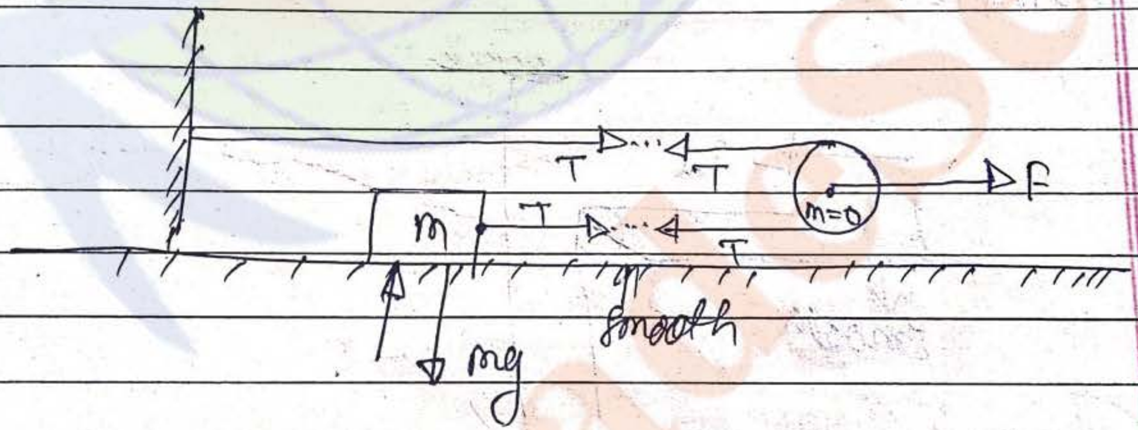
$$\boxed{T = \frac{(m_1+m_2)g}{2}}$$

enample



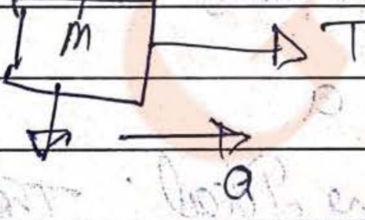
Pulley and String are Ideal. Find the acc on block and pulley





Block -

For Pulley



$F = 2T$

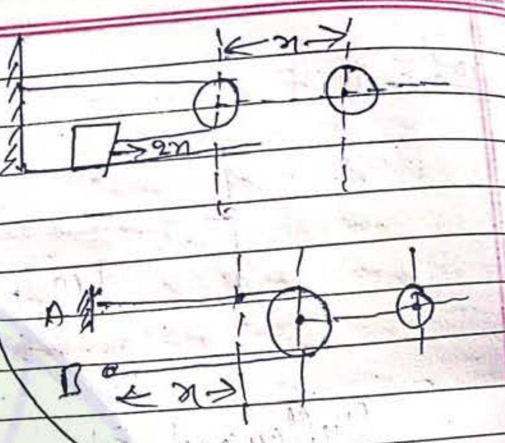
$T = \frac{F}{2}$

$T = ma$

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

यदि Pully x चलती है तो block 2x चलेगा।

v.v.i



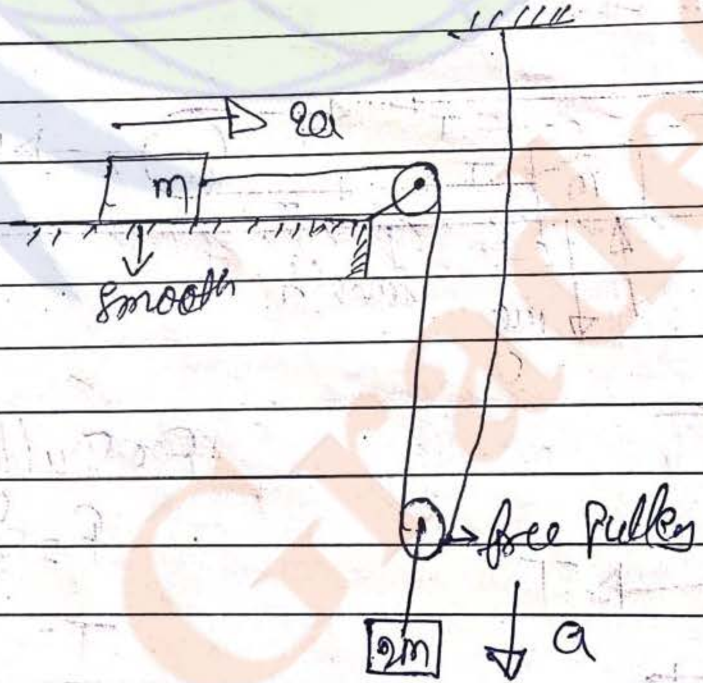
$$a_{block} = \frac{T}{m} = \frac{F}{2m}$$

conform

$$\boxed{a_{block} = 2a_{pulley}}$$

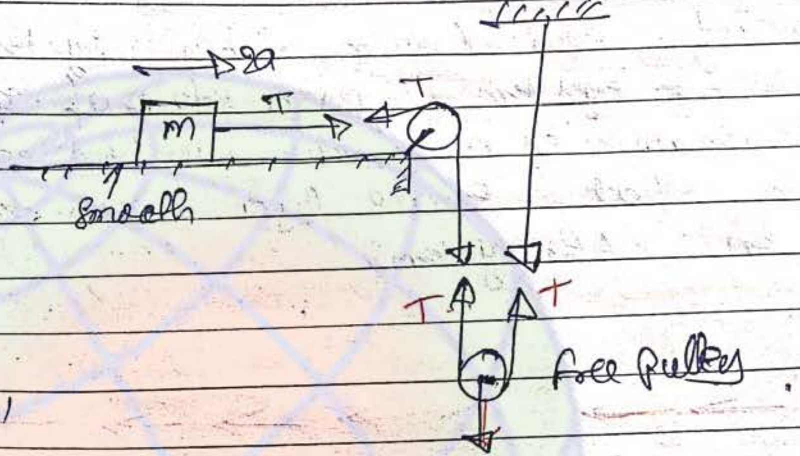
$$a_{pulley} = \frac{F}{4m}$$

example:-



All pulley and string are Ideal. The system is released from rest. Find the acc^n of blocks and tension in the string

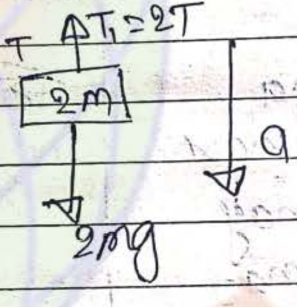
F.B.D.



For 'm'

$T = m(2a)$ — ①

For '2m'



$2mg - 2T = (2m)a$

$\cancel{2}\cancel{m}g - \cancel{2}(2\cancel{m}a) = \cancel{2}\cancel{m}a$

$g - 2a = a$

$a = \frac{g}{3}$

$T = 2ma$

$T = \frac{2mg}{3}$

Self studies :->

* Newton first law of motion also related as :->

Newton first law of motion is relate to State of equillibrium. If a system is in a ~~state of~~ system is in a state of equillibrium it will remain in equilibrium unless compelled to chang that state by a non-zero force acting on the system.

$\Sigma f = ma$

$\Sigma f_x = ma_x$

$\Sigma f_y = ma_y$

$\Sigma f_z = ma_z$

$\Sigma(f_x\hat{i} + f_y\hat{j} + f_z\hat{k}) = ma_x\hat{i} + ma_y\hat{j} + ma_z\hat{k}$

$\Sigma f_x = ma_x$

$\Sigma f_y = ma_y$

$\Sigma f_z = ma_z$

Advance form :->

$\vec{F} = \frac{d\vec{P}}{dt}$ where $\vec{P} = m\vec{v}$

Tension :→ Tension in a String is generated by the Intermolecular force of attraction.

example :→

Tension force हर एक Joint से दूर string की तरफ ही होता है।

→ massless and light :→

$$F_{net} = ma$$

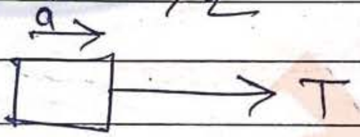
$$F_{net} = 0 \times a$$

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

Note :→ Net force on a massless or light body is always zero.

$$F = 2T$$

$$T = F/2$$

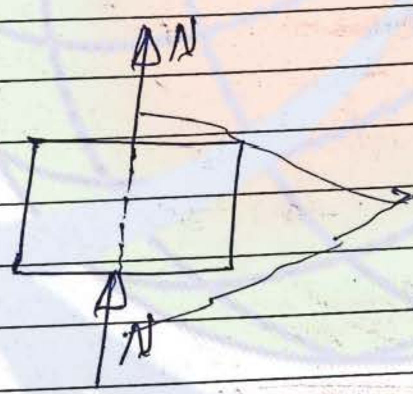


$$T = ma$$

$$\frac{F}{2} = ma$$

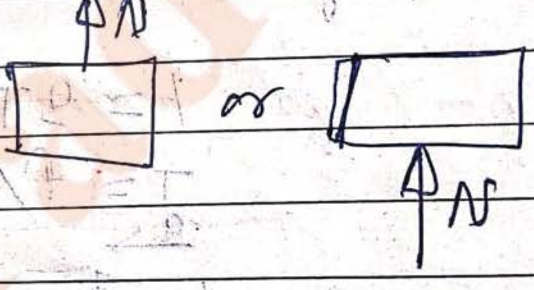
$$\boxed{a = \frac{m}{2m}}$$

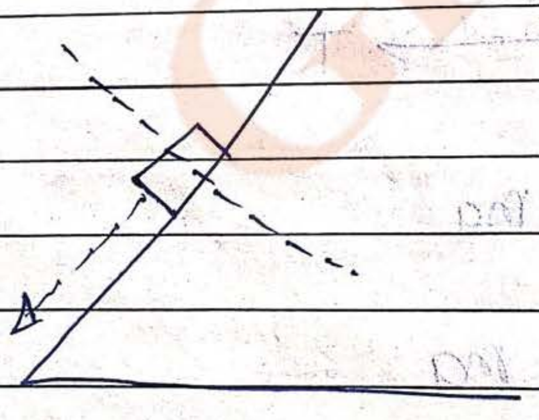
⑧ **Normal reaction:→** Normal reaction is generate by ~~For~~ Intermolecular force normal reaction arises only when their is a comparison at the contect surface that is when one surface comparison the outer one.

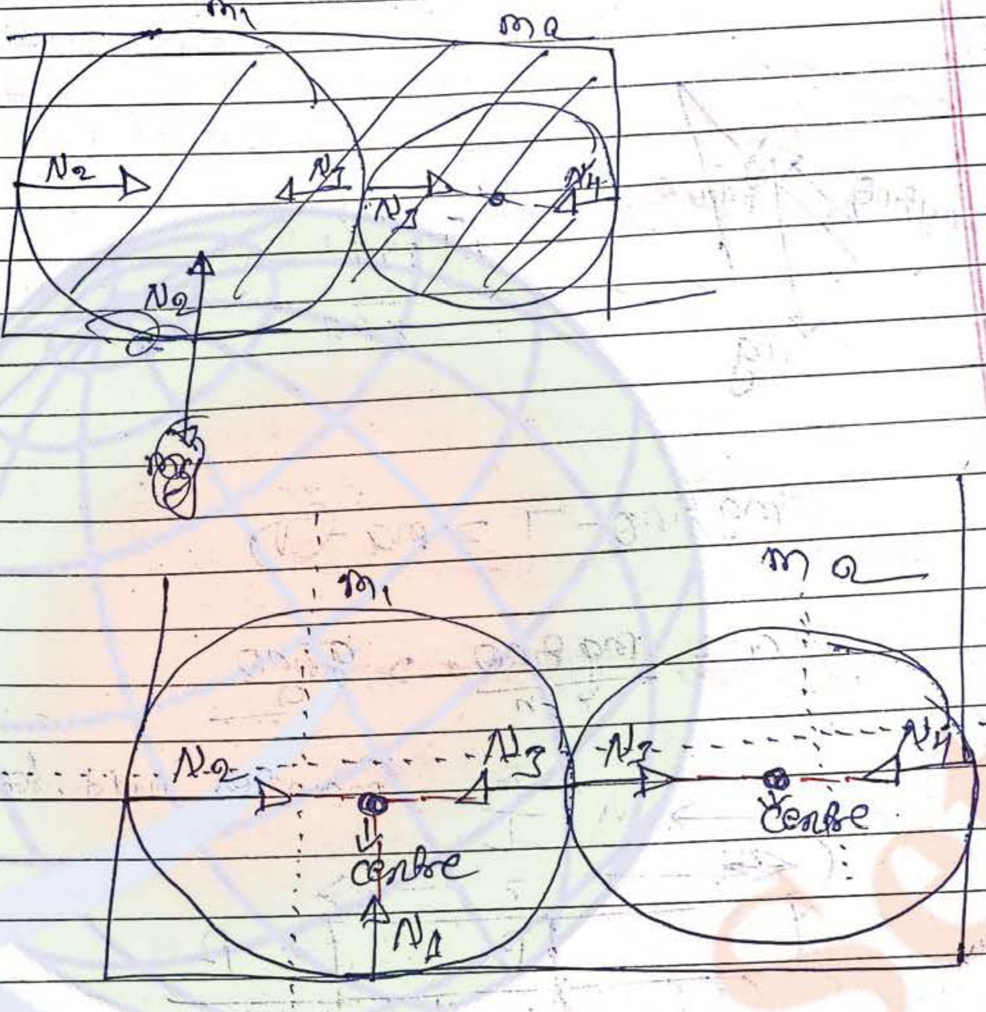


दोनों में से किसी भी स्थान पर हम Normal force दिखा सकते हैं।

जैसे→







Note:⇒ Normal Reaction at any spherical body Passes through its centre.

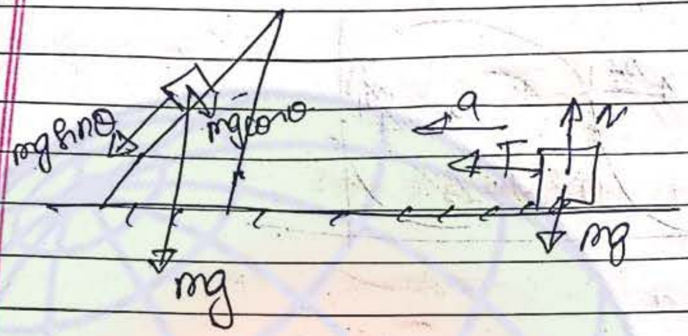
$\lambda = \frac{m}{L}$ => mass per unit length

Sheet => Ex=1

P=> 128

Q=>④

20°>

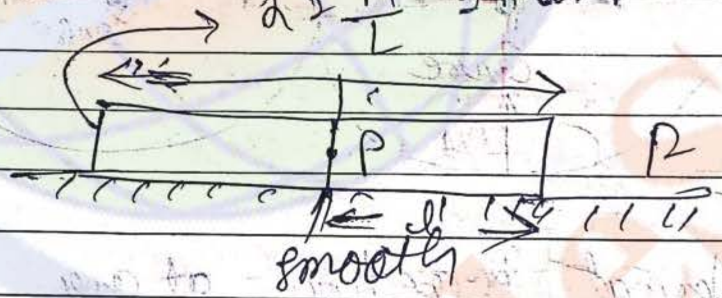


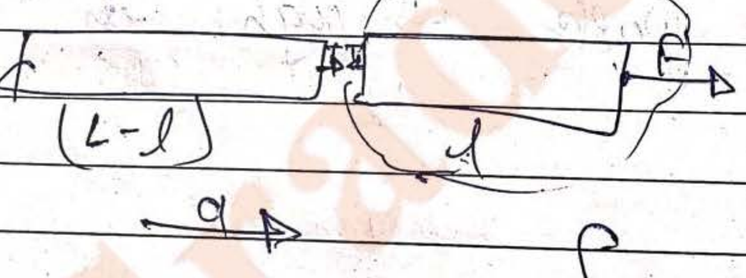
$$mg\sin\theta - T = ma \quad ①$$

$$a = \frac{mg\sin\theta}{2m} = \frac{g\sin\theta}{2}$$

$\lambda = \frac{m}{L}$ => mass per unit length

15>





$$a = \frac{F}{\lambda L}$$

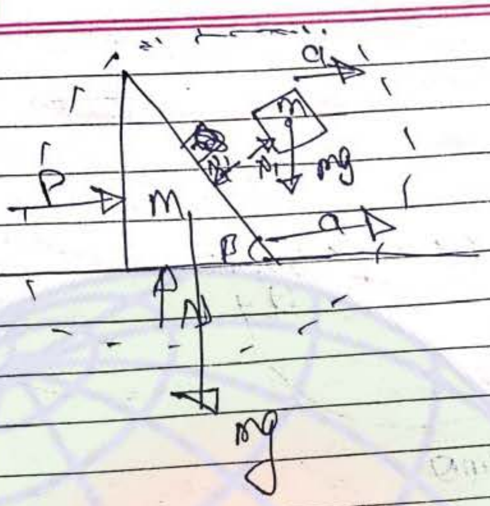
$$T = \lambda(L-l) \times \frac{F}{\lambda L}$$

$$T = \frac{F}{L}(L-l)$$

$$F - T = (\lambda l) \times \frac{F}{\lambda L}$$

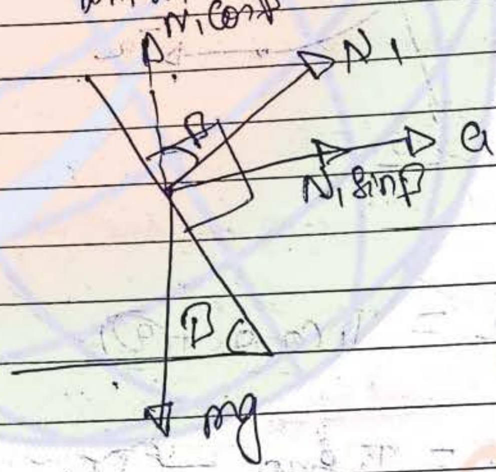
$$T = F\left(1 - \frac{l}{L}\right)$$

20) w.r.t. ground



For two block system

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



$N_1 \sin\beta = ma$ ①

$N_1 \cos\beta = mg$ ②

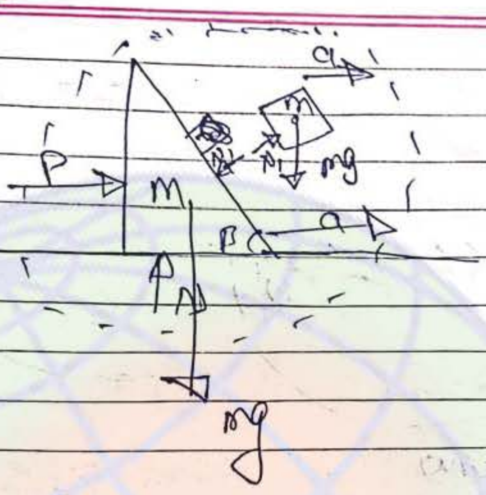
eq ① ÷ eq ②

$g \tan\beta = a$

$P = (M+m)a$

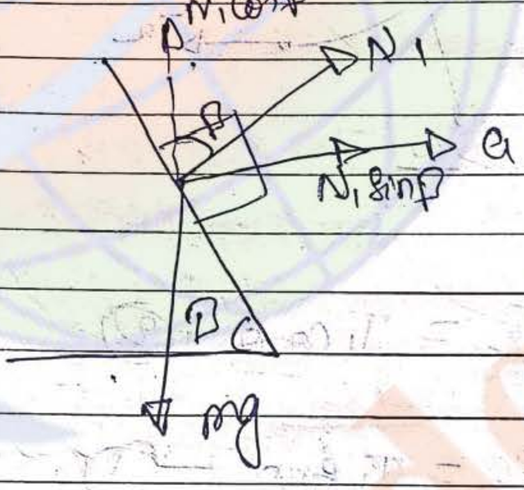
$P = (M+m) g \tan\beta$

20) w.r.t. ground



For two block system

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



$N_1 \sin\beta = ma$ — ①

$N_1 \cos\beta = mg$ — ②

eq ① ÷ eq ②

$g \tan\beta = a$

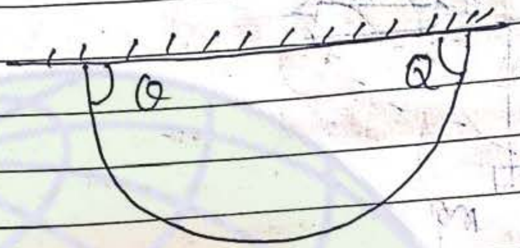
$P = (M+m)a$

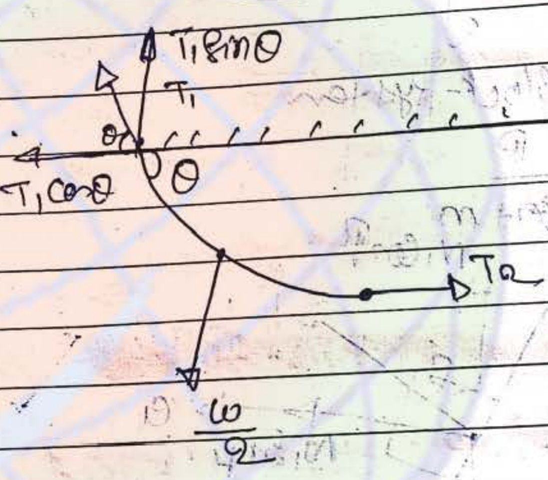
$P = (M+m) g \tan\beta$

Ex: 9

Page→180

4.)





$$T_2 = T_1 \cos\theta \quad \text{—} \; ②$$

$$\frac{w}{2} = T_1 \sin\theta \quad \text{—} \; ①$$

eq ① ÷ eq ②

$$\tan\theta = \frac{w}{2T_2}$$

$$T_2 = \left(\frac{w}{2}\right)\cot\theta$$

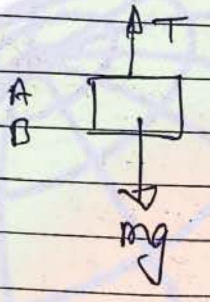
$$T_1 = \frac{T_2}{\cos\theta}$$

$$= \frac{w\cos\theta}{2\sin\theta \cdot \cos\theta}$$

$T_1 = \frac{\omega}{2\sin\theta}$

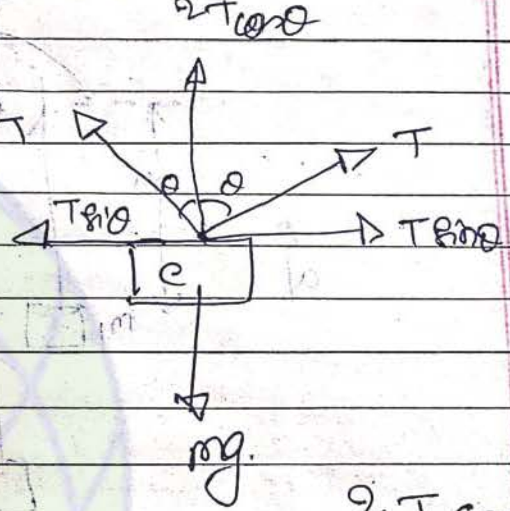
$= \left(\frac{\omega}{2}\right)\csc\theta$

③



$a = 0$

$T = mg$

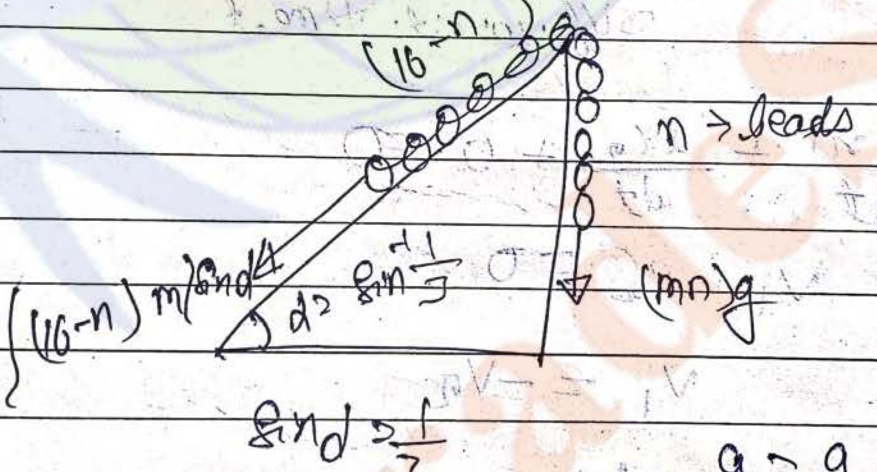


$2T\cos\theta = mg$

$2mg\cos\theta = mg$

$M = (2m)\cos\theta$

⑦



$\sin\alpha = \frac{1}{3}$

$a = \frac{g}{2} = \frac{(mng) - (16-n)mg\sin\alpha}{16m}$ $\frac{1}{3}$

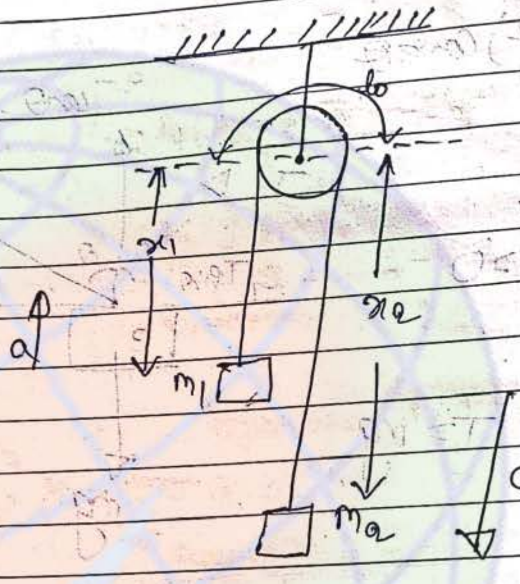
$n =$

* Constraint relation :⇒

String constraint ⇒ length of string = constant.

(Pulleys and string ⇒ Ideal)

en→1.



l = length of string

$x_1 + x_2 + l_0$ = constant

Diff. w.r.t. time "t"

velocity का differentia acc^n देगा

$$\frac{dx_1}{dt} + \frac{dx_2}{dt} + 0 = 0$$

$$V_1 + V_2 = 0$$

$$V_1 = -V_2$$

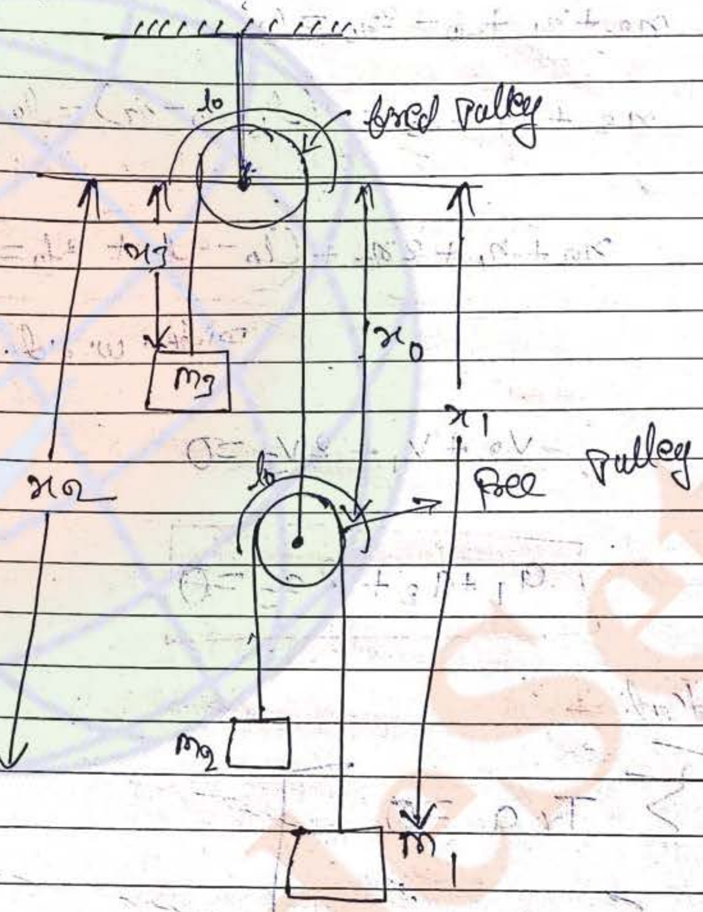
$$dy,$$

$$a_1 = -a$$

String → Ideal)

40%

2.) All pulley and String are Ideal



The System is released from rest

For String - 1,

$$x_3 + x_0 + l_0 = l_1 \Rightarrow \text{constant} \quad ①$$

For String - 2

$$(x_2 - x_0) + l_0 + (x_1 - x_0) = l_2$$

y

$$x_2 + x_1 + l_0 - 2x_0 = l_2$$

$$x_2 + x_1 + l_0 - 2(l_1 - l_0 - x_3) = l_2$$

$$x_2 + x_1 + 2x_3 + (l_0 - 2l_1 + 2l_0 = l_2)$$

Diff. w.r.t.

$$v_2 + v_1 + 2v_3 = 0$$

$$\boxed{a_1 + a_2 + 2a_3 = 0}$$

V.I.P shortcut :→

$$\sum T \times a = 0$$

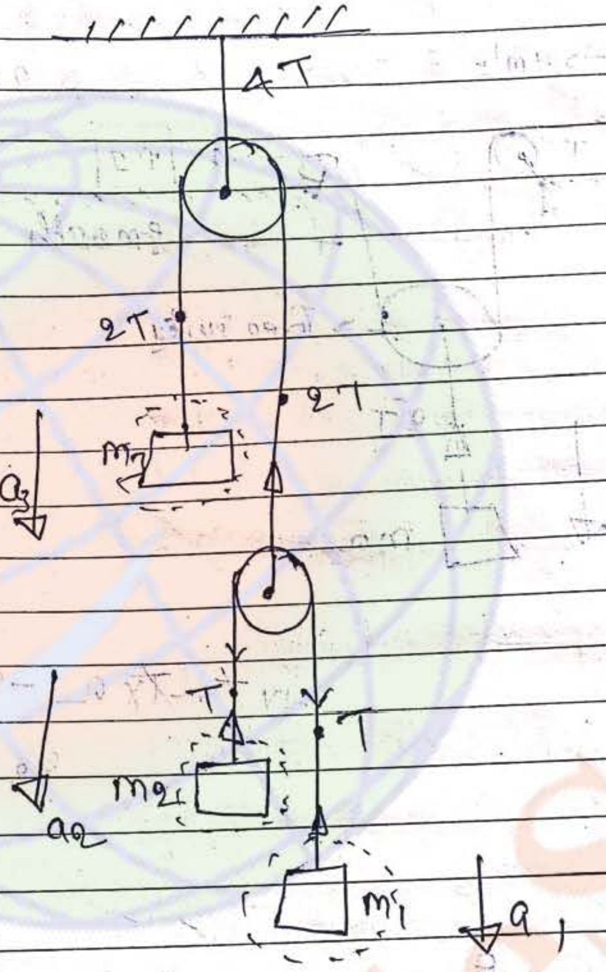
$$\sum T \times v = 0$$

(I) T×a = +ive, If T and a are in the same direction

(I') T×a = -ive, If T and 'a' are in the opp. direction

(I'') If T is at some angle then take component.

4

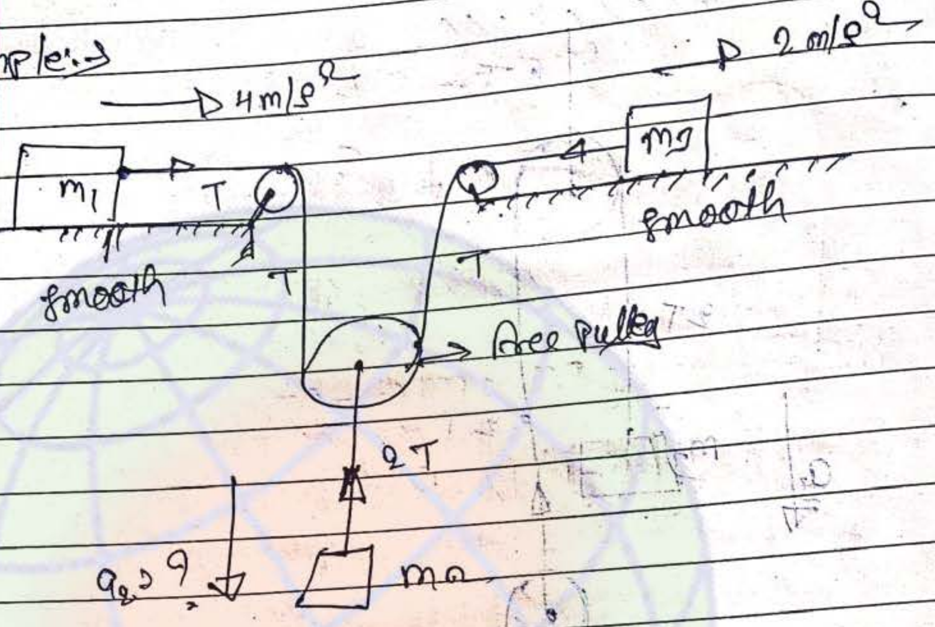


'a' की respect से opp. है इसलिए ~~as~~ -ve.

$$-Ta_1 - Ta_2 - 2Ta_3 = 0$$

$$a_1 + a_2 + 2a_3 = 0$$

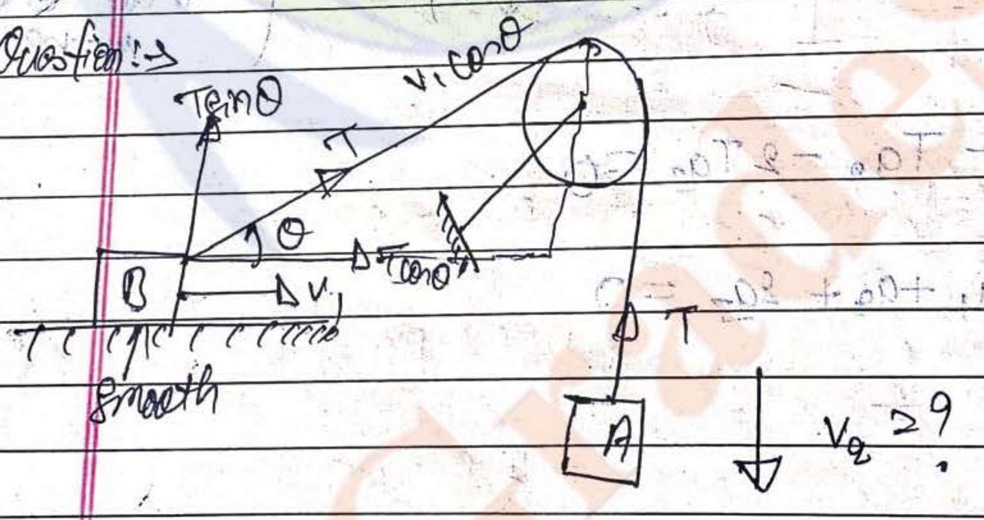
example:→



$$4\times\cancel{T} - \cancel{T}\times 2 - 2\cancel{T} a_2 = 0$$

$$a_2 = 1 \text{ m/s}^2$$

Question:→



$$l^2 = x^2 + h^2$$

$$2l\frac{dl}{dt} = 2x\cdot\frac{dx}{dt}\,0$$

$$\frac{dl}{dt} = \frac{x}{l}\cdot\frac{dx}{dt}$$

Soln

$$\Sigma T\cdot V = 0$$

$(T\cos\theta)\cdot v_1 - Tv_2 = 0$

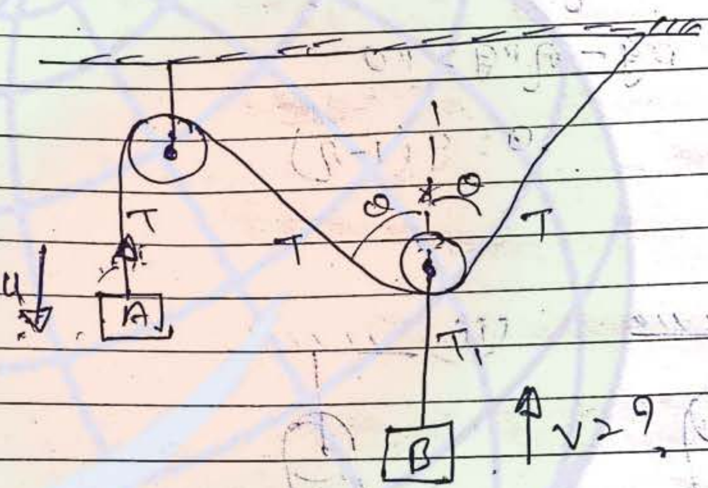
$v_2 = V_1\cos\theta$

method ②

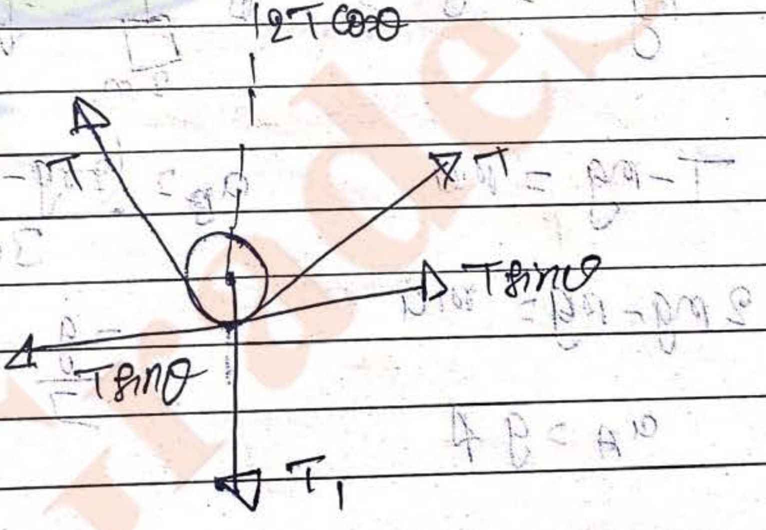
②

$v_1\cos\theta = v_2$

Q:>



Pulley and string are Ideal
Find the velocity of block B

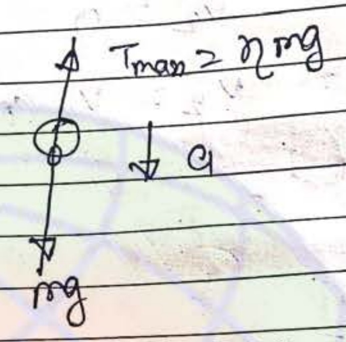


$T_1 = 2T\cos\theta$

Now,
$T\times u + 2T\cos\theta\times V = 0$ ∴ $V = \frac{u}{2\cos\theta}$

Exercise → 2 → (Sheet Question)
Page → 17

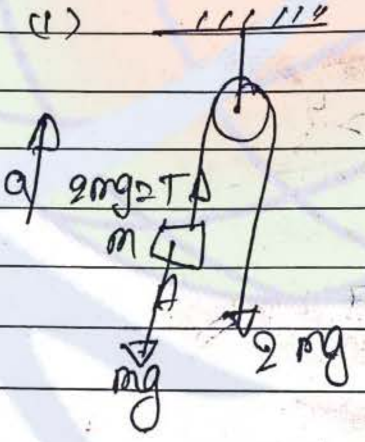
8.)



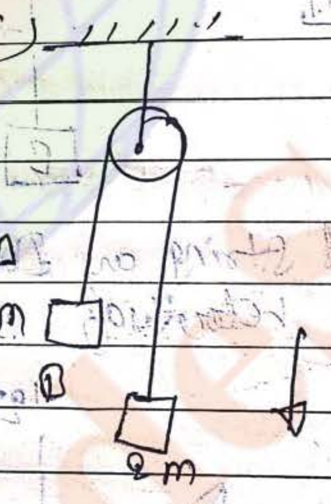
$$mg - \eta mg = ma$$

$$a = g(1-\eta)$$

11.) (I)



(II)



$$T - mg = ma$$

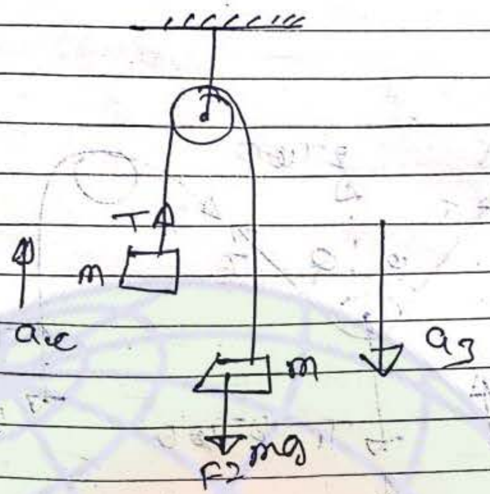
$$2mg - mg = ma$$

$$a_A = g \uparrow$$

$$a_B = \frac{(2mg - mg)}{3m}$$

$$= \frac{g}{3}$$

(iii)

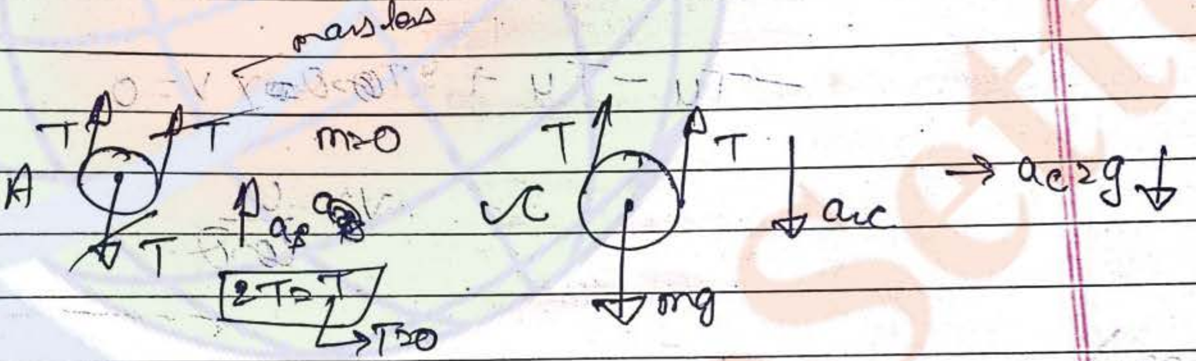


$a_3 = \frac{2mg - mg}{2m}$

$= \frac{g}{2}$

$$\left(a_A > a_c > a_B\right)$$

13.)



$2T = T \rightarrow T = 0$

$\rightarrow a_c = g \downarrow$

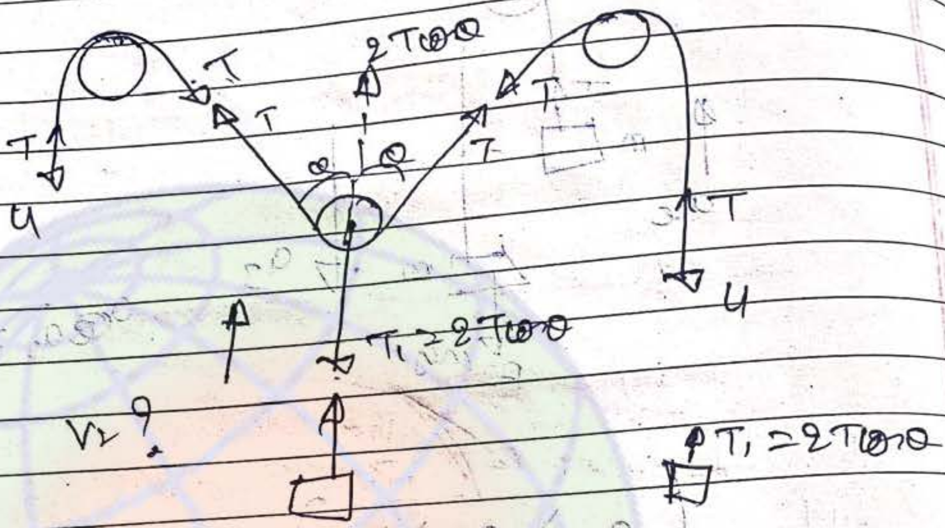
$\Sigma Ta = 0$

$\cancel{T} a_A - 2\cancel{T} a_c = 0$

$a_A = 2a_c = 2g \uparrow$

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

$= g$

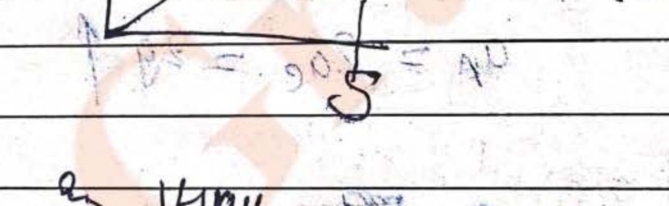


$\Sigma T \cdot v = 0$

$-Tu - Tu + 2T\cos\theta \times V = 0$

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

22.)



$y = kx^2$

$x^2 = 4ay$

$(5)^2 = 4 \times a \times 50$

$\frac{25}{50 \times 4} = a$

$\therefore a = \frac{1}{8}$

$F = kt^2$

$50 = k \cdot (5)^2$

$k = 2$

$F = 2t^2$

$ma = 2t^2$

$a = \frac{2}{10} t^2$

$a = \frac{1}{5} t^2$

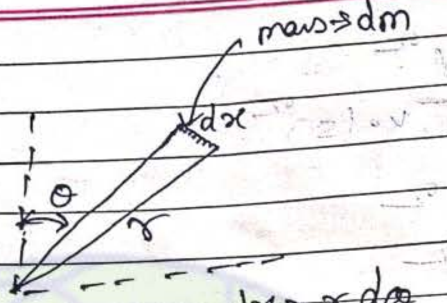
$$\int_0^v dv = \frac{1}{5} \int t^2 \, dt$$

$$v = \frac{1}{5} \left(\frac{t^3}{3} \right)_0^5 = \frac{1}{15} \left(5^3 - 0^3 \right) = \frac{25}{3} \text{ m/s}$$

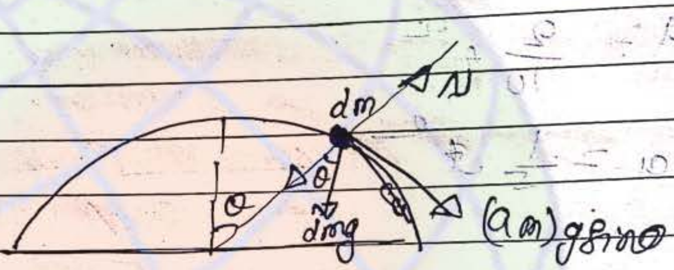
23. Sol^n

$l = r\phi$

$\phi = \frac{l}{r}$



$dx = r\,d\theta$



$$dm = \frac{m}{l} \times dx$$

$$= \frac{m}{l} \cdot r\,d\theta$$

$$\sqrt{-t} = \int (dm)\, g \sin\theta$$

$$= \int \frac{m}{l}\, g \cdot r \cdot \sin\theta\, d\theta$$

$$= \frac{mgr}{l} \int_{\theta=0}^{\theta=\phi} \sin\theta\, d\theta$$

$$= \frac{mgr}{l} \left[-\cos\theta\right]_0^{l/r}$$

Q27→

T_1 sind

T_1 co

Put

T_1 si

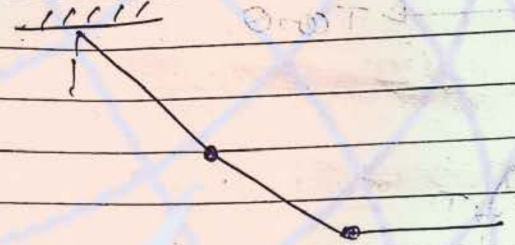
T_1

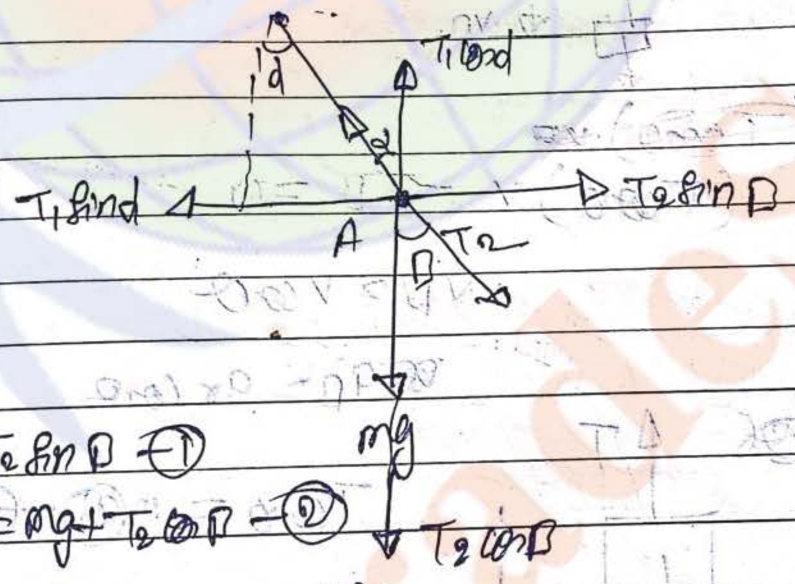
$$F_t = \frac{mgr}{l}\left[\left(-\cos\theta\frac{l}{r}\right) - (-\cos\theta)\right]$$

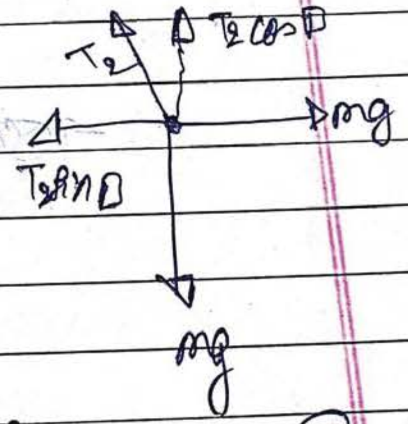
$$F_\theta = \frac{mgr}{l}\left(1-\cos\frac{l}{r}\right)$$

$$a_t = \frac{\sqrt{3}}{m} = \frac{\cancel{m}gr}{l}\left(1-\cos\frac{l}{r}\right)$$

Q27)







$T_1\sin\alpha = T_2\sin\beta$ — ①

$T_1\cos\alpha = mg + T_2\cos\beta$ — ②

Put value of T_2 (Back देखे)

$T_1\sin\alpha = \overset{\sqrt{2}\,(mg)\,\frac{1}{2}}{T_2\sin\beta}$ — ①

$T_1\cos\alpha = mg + \sqrt{2}mg \cdot \frac{1}{\sqrt{2}}$

$= 2mg$ — ②

$(eq1)^2 + (eq2)^2$

$T_1^2 = 5(mg)^2$

$T_1 = (\sqrt{5})mg$

$\sqrt{2}, T_1 = \sqrt{5}\cdot T_2$

$T_2\sin\beta = mg$ — ①

$T_2\cos\beta = mg - 4$

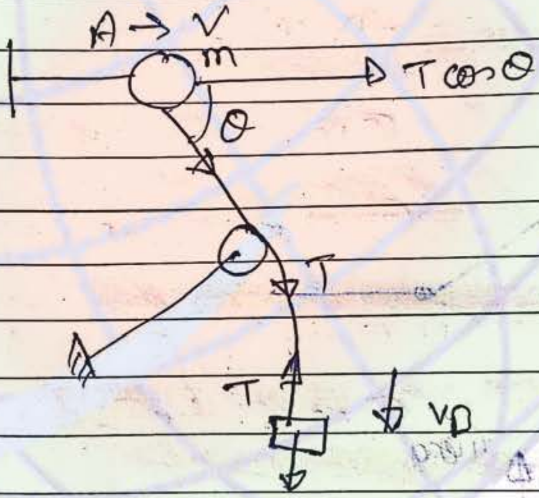
$\tan\beta = 1$

$\beta = 45°$

$T_2 = \frac{mg}{\sin\beta}$

$= \sqrt{2}(mg)$

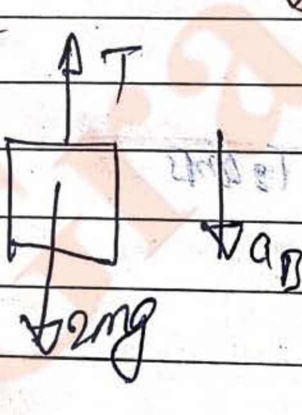
28.



$(T\cos\theta)v - TB = 0$

$v_B = v\cos\theta$

$a_B = a_r\cos\theta$



$T\cos\theta = m\,a_r$ — ①

$$2mg - T = (2m)\,a_B$$

$$2mg - T = (2m) \times a_r \cos\theta \quad \text{②}$$

Put $T = \frac{m a_r}{\cos\theta}$ in eq ②

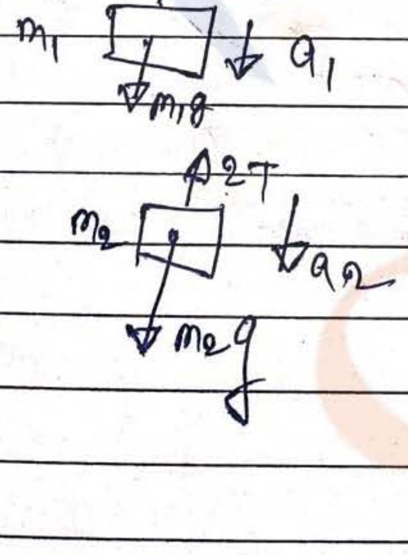
$$2mg - \frac{m a_r}{\cos\theta} = (2m) \times a_r \cos\theta$$

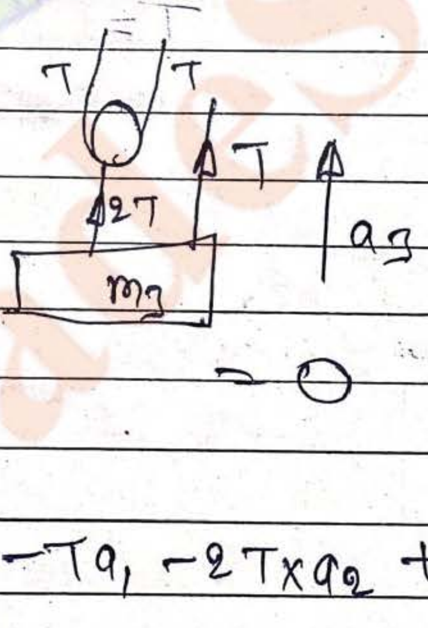
$$2g = 2a_r \cos\theta + \frac{a_r}{\cos\theta}$$

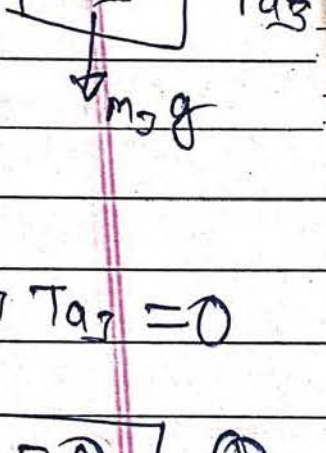
$$2g = a_r \left(\frac{2\cos^2\theta + 1}{\cos\theta}\right)$$

$$a_r = \frac{2g\cos\theta}{1 + 2\cos^2\theta}$$

Sol)







$$= 0$$

$$-Ta_1 - 2T \times a_2 + 3Ta_3 = 0$$

$$\boxed{a_1 + 2a_2 - 3a_3 = 0} \quad \text{①}$$

For 'm₁'

$m_1 g - T = m_1 a_1$ —— ②

For 'm₂'

$m_2 g - 2T = m_2 a_2$ —— ③

For 'm₃'

$3T - m_3 g = m_3 a_3$ —— (4)

Find a_1 from eq ②

find a_2 from eq ③

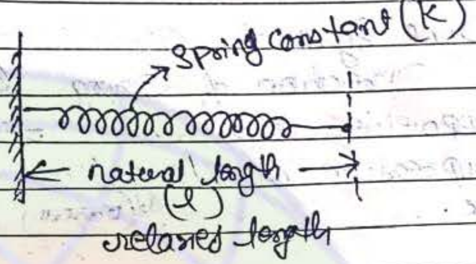
Find a_3 from eq ④

Put in eq ①

$T =$

Spring

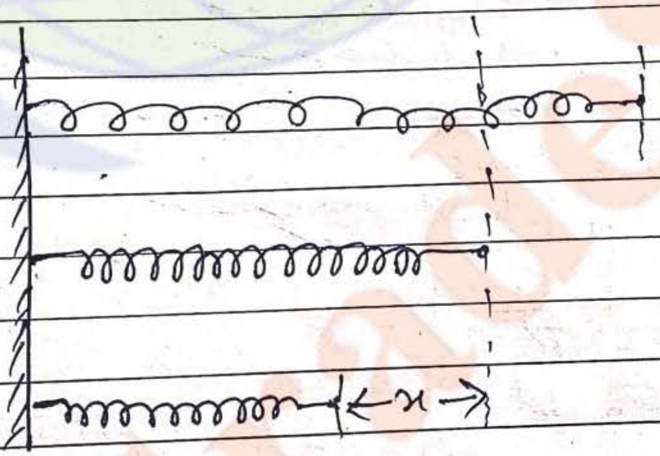
Spring Force



K = Spring constant
or
→ stiffness constant
or
→ Force constant
or
→

$$\boxed{K = \frac{1}{l}}$$

l → natural length



$$\boxed{\vec{S} = -Kx}$$

$$|\vec{S}| = Kx$$

x = change in length

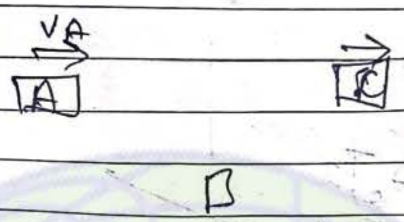
(−)ive sign :→
Direction of spring force is always opposite to the ~~compress~~ direction of compression or alongation in the spring x.

दबाना (खिंचना)

$$\boxed{|F_s| = kx}$$

D.P.P-3 NO. 20

4.)



$a_A = 12t$

$\frac{dv_A}{dt} = 12t$

$\int_0^{v_A} dv = 12\int_0^{t} t\,dt$

$v_A = 6t^2$

B is at rest

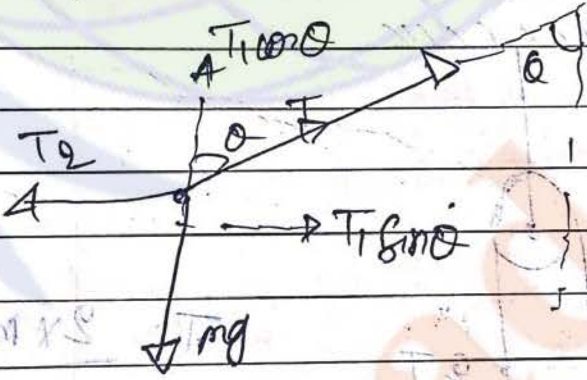
$\boxed{V_A = V_C}$

$V_C = 3t$

$6t^2 = 3t$

$t = \frac{1}{2}s$

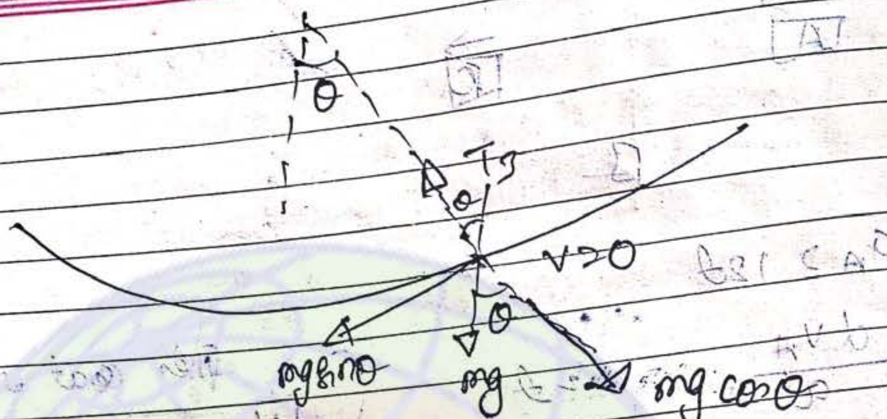
5) In position "A"



$T_1\sin\theta = T_2$ ...①

$T_1\cos\theta = mg$

$$\boxed{T_1 = \frac{mg}{\cos\theta}}$$

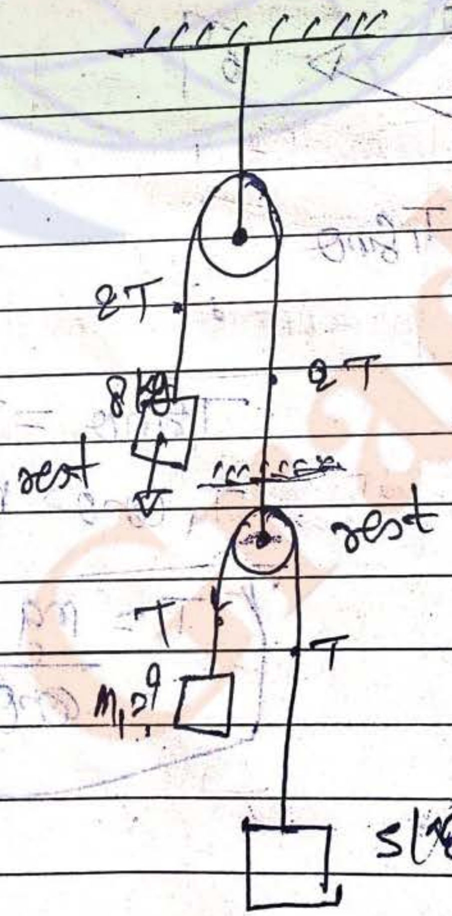


$T_2 = mg\cos\theta$ — ②

$\frac{T_2}{T_1} = \frac{mg\cos^2\theta}{mg} = \cos^2\theta$

$= \frac{3}{4}$

8) Ans ↠



$2T = mg$

$2T = 80$

$T = 40N$

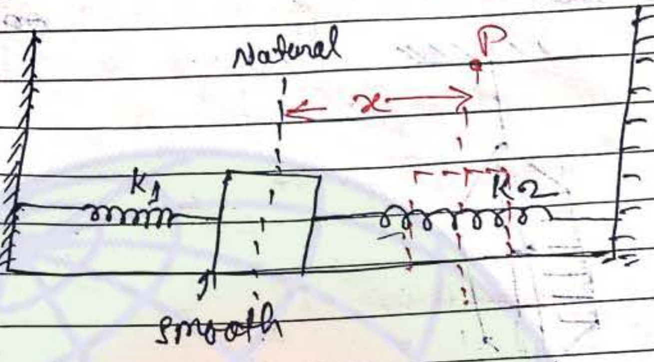
$T = \frac{2\times m_1 \times 5\times g}{(m_1+5)}$

$\overset{2}{\cancel{40}} = \frac{2m_1 5\times \overset{5}{\cancel{10}}}{m_1+5}$

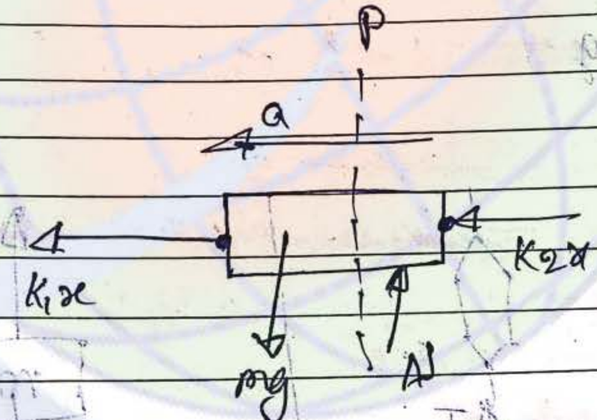
$2m_1 + 10 = 5m_1$

$3m = 10$

Example based on Spring force :-



Block is displaced to distance x in right ward direction and then released. Find the initial acc^n of the block (Just after release)

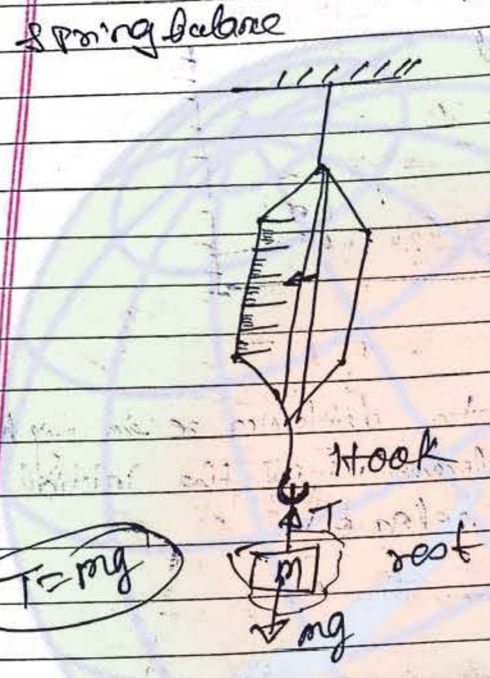


$$a = \frac{(k_1 x + k_2 x)}{m}$$

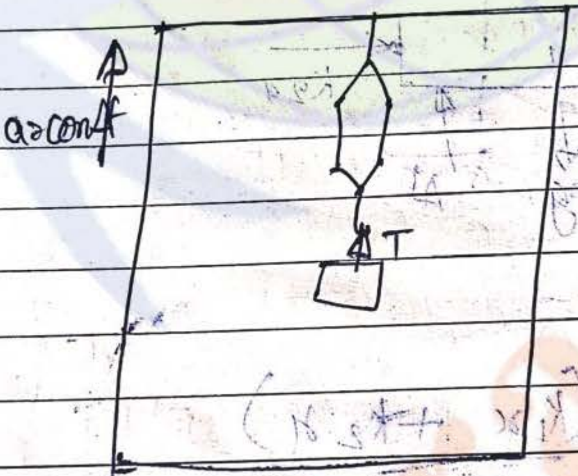
$$\boxed{a = \frac{(k_1 + k_2)x}{m}}$$

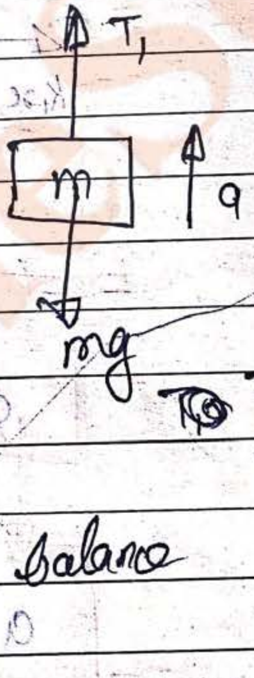
Reading of Spring balance :→

↳ It measures the force on the hook



$\boxed{T=mg}$





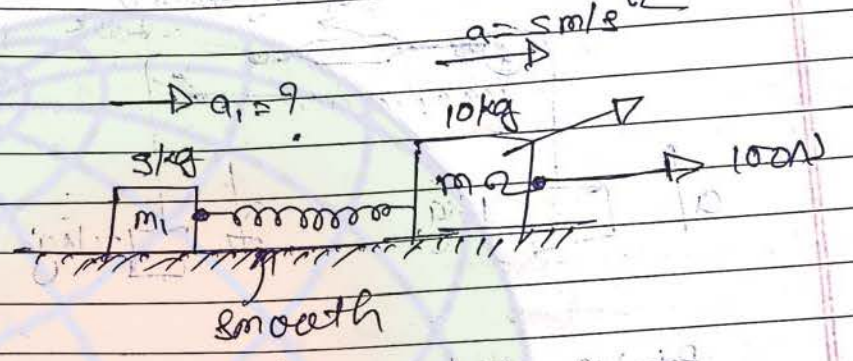
$T_1 - mg = ma$

$T_1 = m(a+g)$

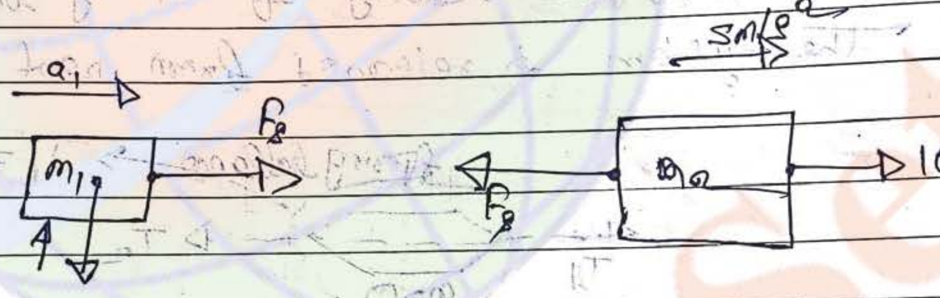
Find the reading of spring balance

@ If the spring is massless, spring force will be same in magnitude at all point in the spring

example:→



method 1st: Spring is massless.



$$100 - F_s = 10\times 5$$

$$F_s = 5a_1 \quad —①$$

$$F_s = 50N$$

$$a_1 = \frac{F_s}{5} = \frac{50}{5} = 10 m/s^2$$

concept

method IInd

Note:→

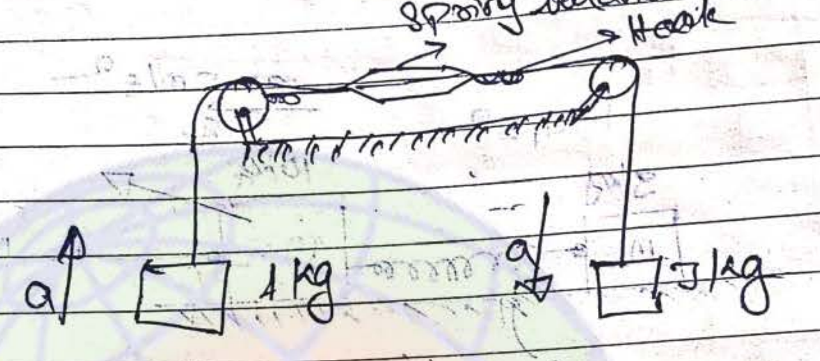
$$\vec{F}_{net} = \vec{F_1} + \vec{F_2} + \dots$$

$$= m_1\vec{a_1} + m_2\vec{a_2}$$

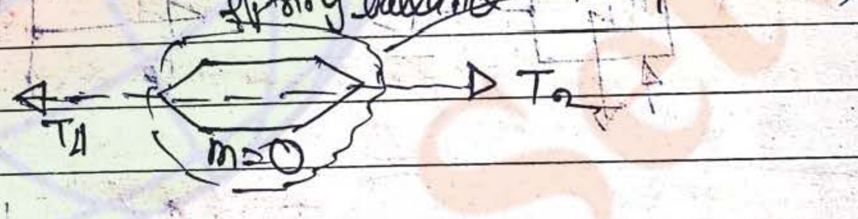
$$100 = 5a_1 + 10\times 5$$

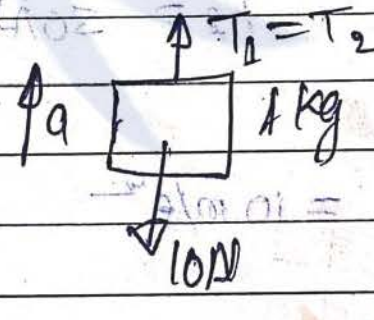
$$a_1 = 10 m/s^2$$

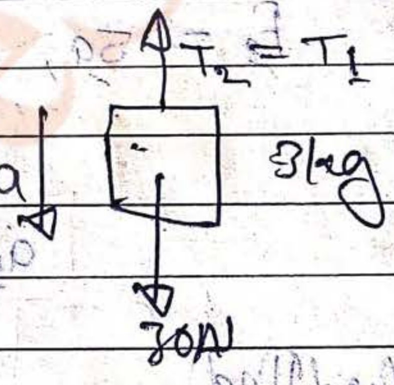
example .



String ~~and spo~~ spring and Pulley is massless,
Find the reading of spring balance
The system is released from rest .







$T - 10 = 1 \times a$ —①

$30 - T = 3 \times a$ —②

eq① + eq⑪

$20 = 4a$

$a = 5 m/s^2$

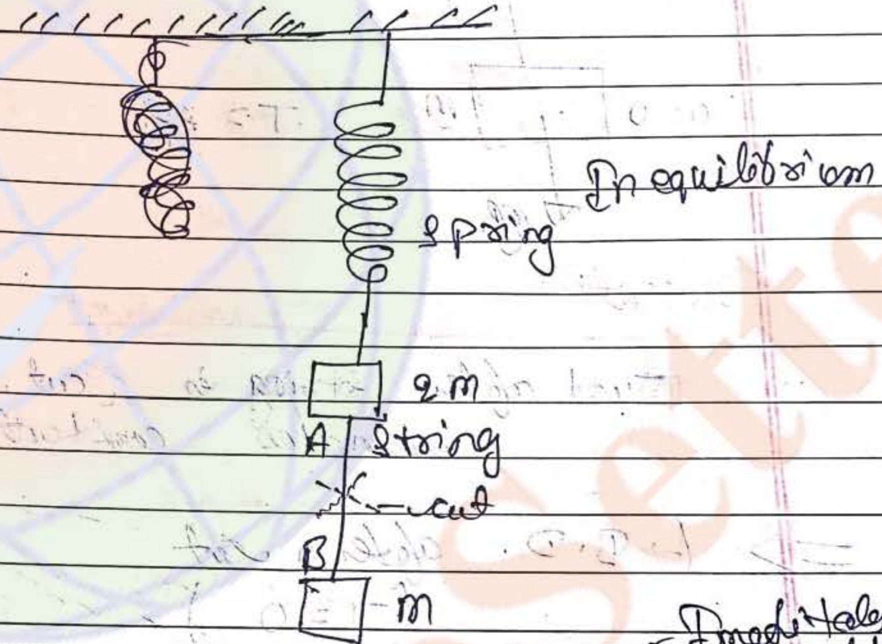
$T = \boxed{15N}$

* If the string is cut, tension force in this string becomes zero.

(But it is not true for spring.)

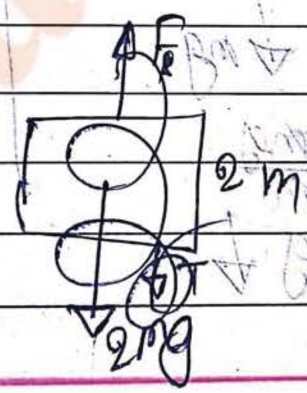
example:-

IIT 2006



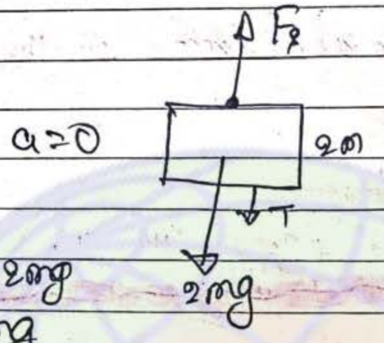
If the string AB is cut, (or Immediately after) find the accⁿ of blocks 2m and m Just after the spring is cut

Soln F.B.D. ~~before cut~~



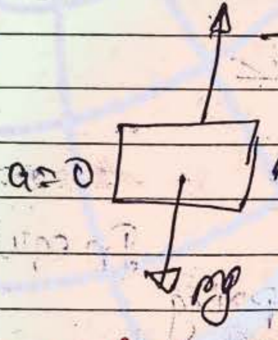
(काटने के बाद T=0 होगा

⇒ F.B.D before cut



$F_s = T + 2mg$

$F_s = 3mg$

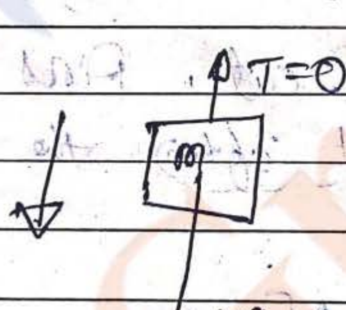


$T = mg$

Concept! →

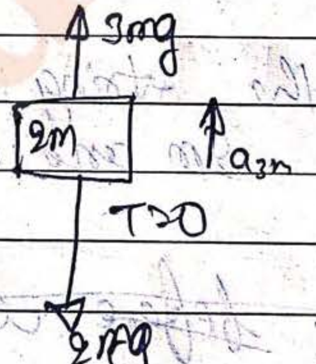
Just after string is cut, spring force remains constant.

⇒ F.B.D. after cut (T=0)



$a_m = \frac{mg}{m}$

$= g \downarrow$



$a_{2m} = \frac{3m - 2mg}{2m}$

$= \frac{mg}{2m} = \frac{g}{2} \uparrow$

sheet

Force का Integration → momentum देगा

momentum का different Force देगा

4) Ans →

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

$$F = kt(t' - t)$$

$$F = ktt' - kt^2$$

$$\frac{dP}{dt} = (ktt' - kt^2)$$

~~Force~~

$$\begin{tikzcd} \text{momentum} \arrow[d, "\text{Diff.}"] & \text{momentum} \\ \text{Force} & \text{Force} \arrow[u, "\text{Integr.}"'] \end{tikzcd}$$

Impulse

$$\int_0^P dP = \int_0^t (kt\,t' - kt^2)\,dt$$

$$P = \left[\frac{kt't^2}{2} - \frac{kt^3}{3}\right]^0 \quad \text{—①}$$

$t = t'$

$$P = \frac{kt'^3}{2} - \frac{kt'^3}{3}$$

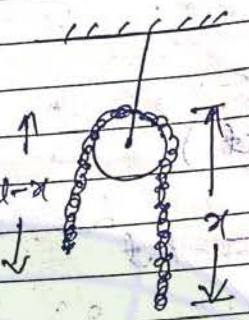
$$\boxed{P = \frac{kt'^3}{6}}$$

$$mv = \left(\frac{kt'}{2}t^2 - \frac{kt^3}{3}\right)$$

$$m\int_0^x dx = \int_0^{t'} \left(\frac{kt'}{2}t^2 - \frac{kt^3}{3}\right)dt$$

$m = X$

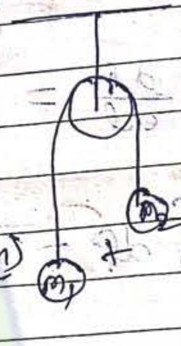
5.)



$\lambda \rightarrow$ wt. per unit length(l)

$\lambda = mg$

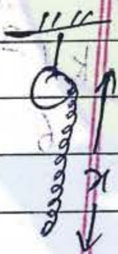
$\frac{\lambda}{g} = m$



$\frac{\lambda(l-x)}{g}$ $(\lambda x/g)$

$a = \frac{(m_2-m_1)g}{m_1+m_2} = \frac{m_2 g - m_1 g}{m_1+m_2}$

(b)



$x = (\lambda \cdot x)$
$a = (2x-l)g$
$= g(l-2x)$
$= \frac{g}{l}\left(1-\frac{2x}{l}\right)$

$a = \frac{\lambda x - \lambda(l-x)}{\lambda g}$

$= \frac{(\cancel{\lambda}x - \cancel{\lambda}l + \cancel{\lambda}x)g}{\cancel{\lambda}l/g} \Rightarrow \frac{(x-l+x)g}{l}$

$\Rightarrow \left(\frac{2x-l}{l}\right)g$

$\Rightarrow \left(\frac{2x}{l}-1\right)g$

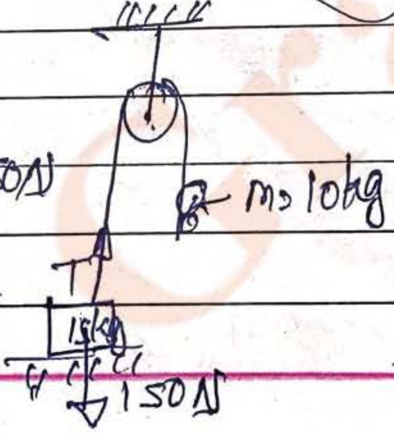
~~$a = \left(\frac{2x-l}{l}\right)g = 0$~~

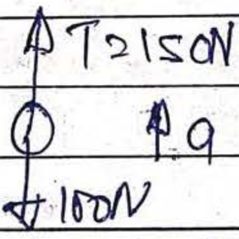
~~$a = 0$~~

$x = l/2$

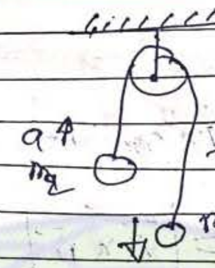
6.)

$T \geq 150N$





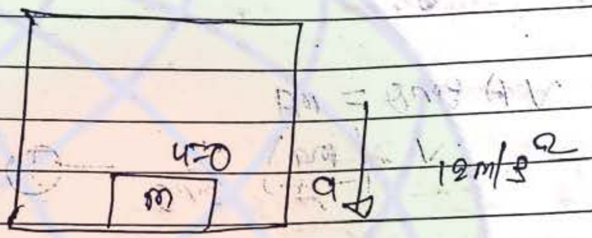
$a = \frac{150-100}{10}$ $\therefore a = 5m/s^2$

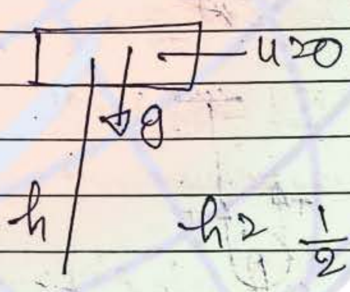


$T = \frac{2m_1m_2g}{m_1+m_2}$

$a = \frac{(m_2-m_1)g}{m_1+m_2}$

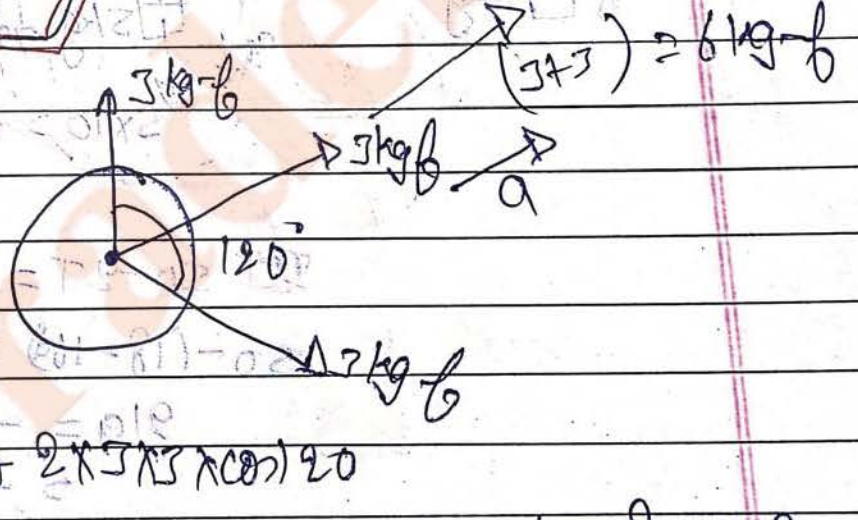
7.)





$h = \frac{1}{2} g(0.2)^2 = 20cm$

9.) $\boxed{1kg\text{-}f = 9.8 N}$

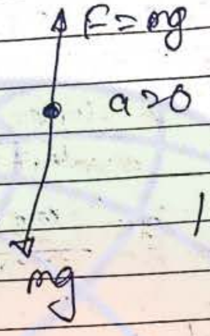


$R = \sqrt{3^2+3^2+2\times3\times3\times\cos120}$

$= 3kg\text{-}f$

$a = \frac{6\times9.8}{7} m/s^2$

10.)



$a = 0 \rightarrow V = \text{constant}$

$|\vec{F}| = |\vec{V} \times \vec{A}|$

$= VA \sin\theta$

$VA \sin\theta = mg$

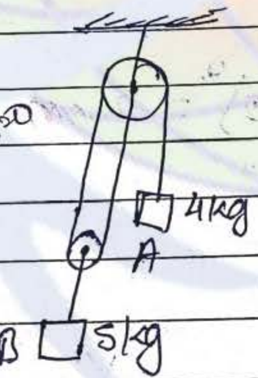
$V = \left(\frac{mg}{A}\right) \frac{1}{\sin\theta}$ — ①

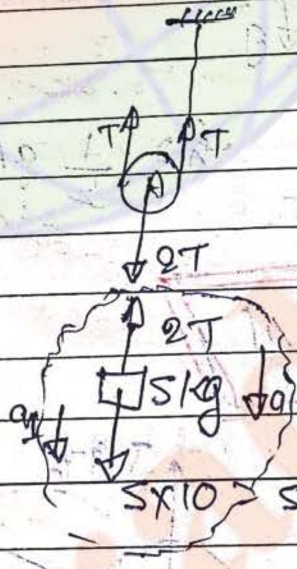
$V_{min} = \frac{mg}{A}$

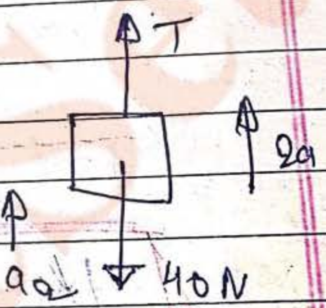
12.)

$-2 \times a_1 + a_2 = 0$

$a_2 = 2a_1$







$T - 40 = 4 \times 2a$ — ②

$2T = 80 \times 16a$

$50 - 2T = 5 \times a$ — ①

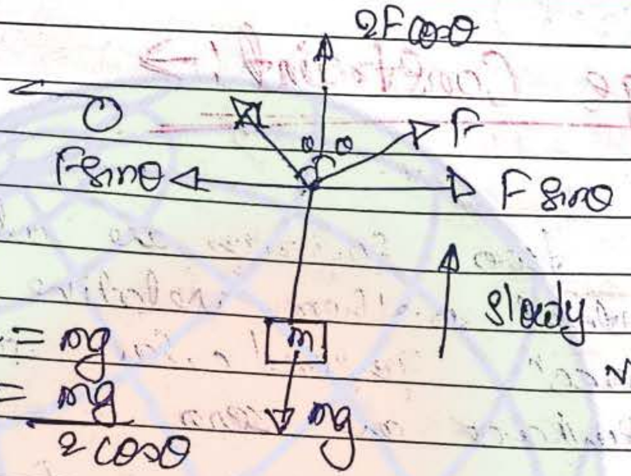
$50 - (18 - 16a) = 5a$

$21a = -30$

$= -3g$

$a = \frac{-g}{7} m/s^2$

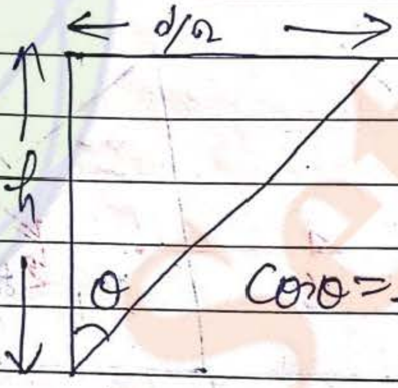
14 cm



$2F\cos\theta = mg$

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

v = constant
a = 0



$\cos\theta = \frac{h}{\sqrt{h^2 + \frac{d^2}{4}}}$

Contraining velocity-velocity का relation
accⁿ- accⁿ का relation

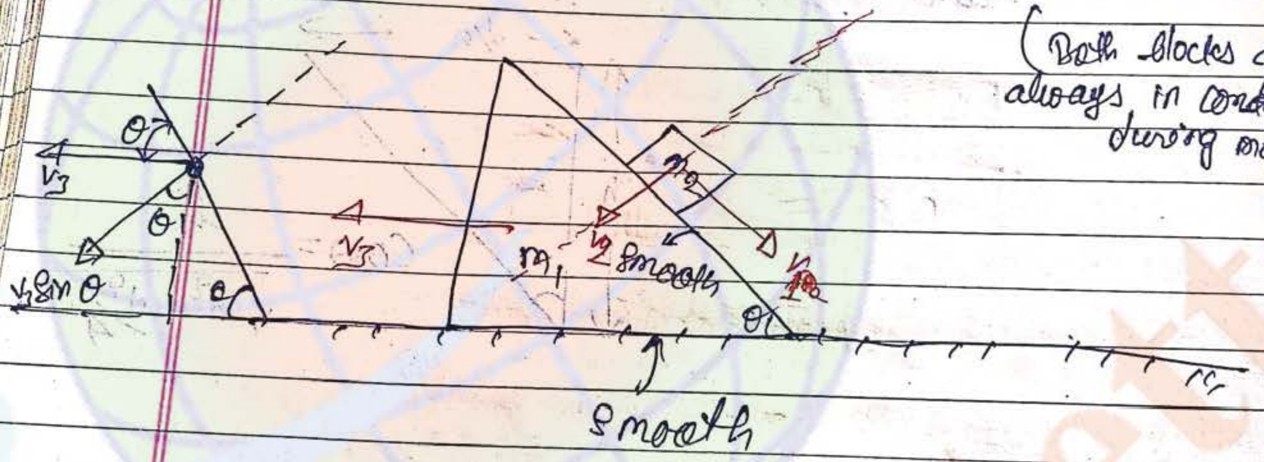
~~Weight Constraint :->~~

(हुक्का)

Wedge Constraint :->

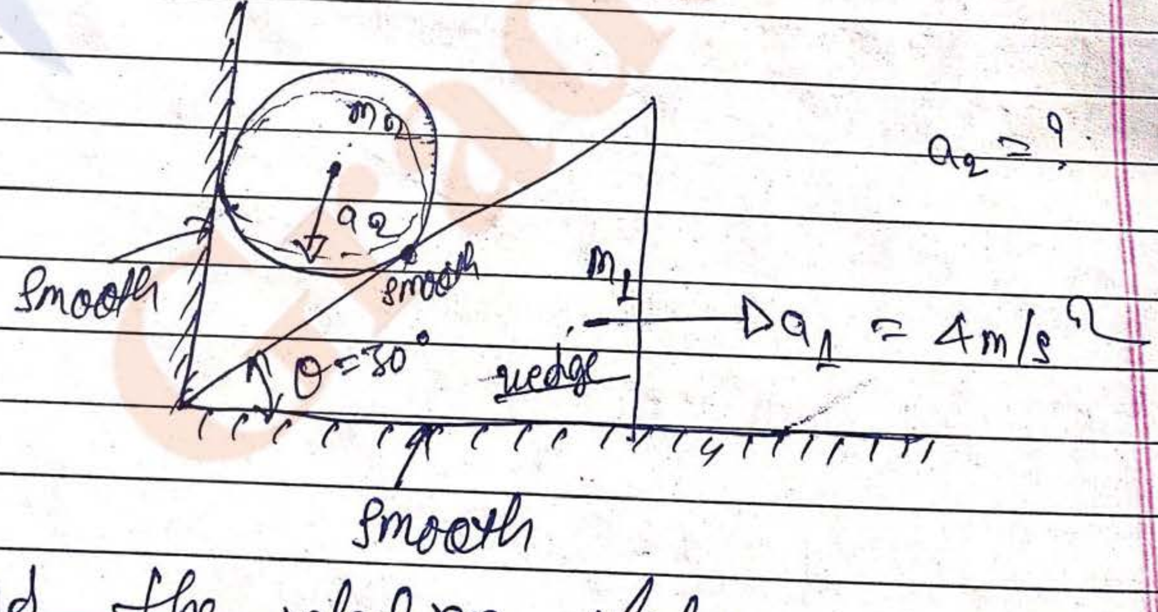
when the two surfaces are always in regular contact so their relative velocity and relative accⁿ perpendicular to the contact surface are zero

(Both blocks are always in contact during motion.)



$$\boxed{v_2 = v_3 \sin\theta}$$

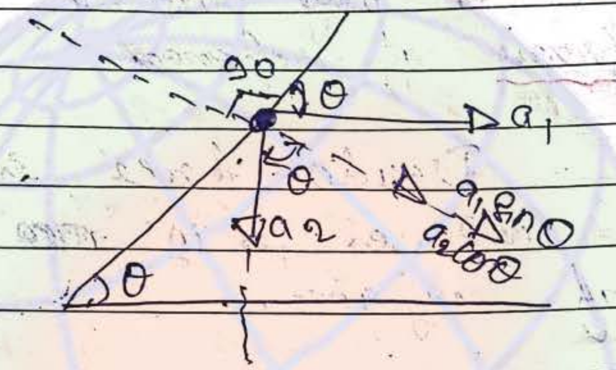
Q.)



a_2 = ?

Find the relation between a_1 and a_2.

(1) If accⁿ of a_1 is $4 m/s^2$ then what is the value of a_2?



$a_2 \cos\theta = a_1 \sin\theta$ (Relative velocity को zero करने के कारण)

$\boxed{a_2 = a_1 \tan\theta}$

$a_2 = 4 \times \tan 30°$

$\Rightarrow 4 \times \frac{1}{\sqrt{3}} m/s^2$

Newton के mass of acc [illegible]

Pseudo force

It is an Imaginary force
It is only observed In non Inertial frame of refrence.

Pseudo force is observed when the observer is in non-Inertial frame of refrance.

$$\boxed{F_p = m a}$$

F_p → magnitude of Pseudo force

a ⇒ magnitude of acc^n of non-Inertial frame

m ⇒ mass of an object which is observed from non-Inertial frame.

Note :→ There is no action and reaction pair of Pseudo force.

(Non-Inertial से ही Pseudo force आभास होता है |

Real visualisation of Pseudo force

In the figure the birds moves outwards as the marry to round starts rotating we can understood it with the help of "Pseudo force"

(1) why we need Pseudo force? —

The concept of Pseudo force is among the most important concepts of Physics, so lets try to find out the actually what Pseudo force is?

The concept of Pseudo force starts with a Question that what is the difference between "Law of Inertia" and Newtons first law?

⇒ So, First we see that what are law of Inertia and Newtons first law?

Law of Inertia: —

Law of Inertia say's that every body resists any change in its state of motion. In other word if we want to change the state of motion of body we have to apply some external force

OR

If there is change in motion (if motion is accelerates) there must be some net external force acts on it and vice-versa.

~~Law of~~

Newton's first law :-
If a body is at rest or in uniform motion (along a straight line), it will be in the same state unless compelled by any external force to change the motion.

In other words if you want change in motion, you have to apply some external force.

So if there is some ~~acc~~ acceleration there must be some external force and vice-versa.

⇒ The meaning of above two laws is same both are saying the same thing that if acceleration is zero, so the external force must be zero.
and if acceleration ~~is~~ non-zero the net external force must be non-zero.

⇒ So have ~~newton~~ newton copies Galileo law of Inertia or if there is some difference between both the laws)

Sol^n → If we get the answer of this question we will understand the concept ~~of~~ and need of pseudo force — — —. — — —. — — —.

⇒ Difference between law of Inertia and newton first law ?—

Actually Newton founs that if we observe from accelerates frame, the law of Inertia is not valid.

Law of Inertia is valid only when we observe from the non-accelerated frames.

To overcome this problem (To apply law of Inertia from the accelerated frame)

He give the concept of Pseudo force and Proposed his first law (It is also known as update version of law of Inertia)

* Newton सबसे पहले सिर्फ यह बोला था कि अगर कोई body स्थिर है तो वह स्थिर ही रहेगी जबतक की उस पर कोई external force नहीं लगाया जाए। लेकिन फिर बाद में newton यह भी बात बोला कि अगर कोई भी body accelerated है तो वह accelerated ही रहेगी जब तक की उस पर कोई external force apply ना किया जाए।

और इस प्रकार ऊपर वाला यही दोनों law Newton law का update version of law of Inertia कहलाता है।

आगे :-

so from the above discussion we can understand law of Inertia is valid only from the non-accelerated frames (At rest or moving with uniform velocity)

that's why these frames are known as Inertial frame

Inertial frame ⇒ (a=0) ⇒ means rest or moving with const velocity
↓
((means non-accelerating frame))

But, also
we know that, from accelerated frames the law of Inertia is not valid, so these frames are known as Non-Inertial frames

from above discussion we also understand that what are Inertial and non-Inertial frames are

so overcome this problem (To apply law of Inertia from non-Inertial frames) Newton Introduced the concept of "Pseudo force"

⇒ means एक बात जान लें Newton, non-Inertial frame से भी अपने law को सही करने के लिए एक pseudo force का concept दिया|

Note - सबसे पहले आप पीछे वाला दोनों पेज पढ़िये फिर ये वाला पेज पढ़ियेगा |

⟹ Now Let's Consider Monu as an observer: —

Let's say monu is observing Box B —
Acceleration of Box $B = 0$
So,
for Law of Inertia to applicable,
$F_{net, ext} = 0$
So to make $F_{net, ext} = 0$, Newton added a hypothetical force (Pseudo force) on the Box B in the opposite direction of acceleration of train (as shown in back figure)

Here the magnitude of Pseudo force and the friction force on the Box B is same. So the net force on the Box B is zero and law of Inertia is applicable from the accelerated frame (train)

So,

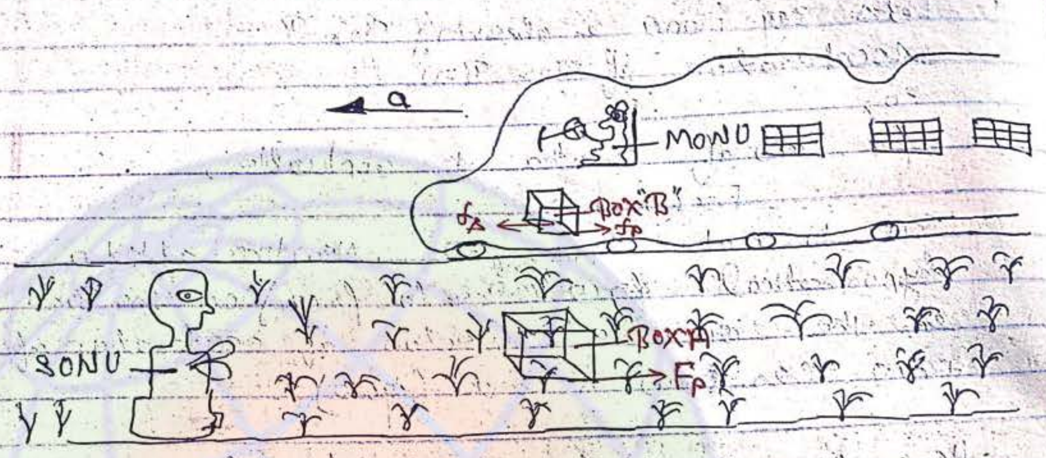
$$\boxed{F_p = F_s}$$

⟹ Let's say Monu is observing Box A: —

Let acc^n of Box A is "a" towards left (acc^n to monu)
But, $F_{net} = 0$, So to apply law of Inertia Newton applies a Pseudo force F_p on the Box A in the opposite direction of acc^n of train (as shown in the figure)
Here the Pseudo force F_p on the Box A is ma (towards left)

⟹ Always remember Pseudo force is not a real force, it is just a mathematical adjustment to apply "Law of Inertia" from the accelerated frames. It is hypothetical force.

Lets take an example to understand that exac
non-accelerated frames :—



⟹ Now we will see the observation of

MONU (accelerated frame / non-Inertial frame)

BOX A: → (I) According to MONU, the Box A is moving towards right (दाया) with an acc^n "a". (due to relative motion.) so it's acc^n (lom. acc) is non-zero, But we know that the Box A is on the ground and the net force on it is Zero.

(II) So law of inertia is valid for monu as he is in the accelerated frame.

BOX B: – (I) According to MONU, the Box B is at rest so it's acceleration is Zero. But we know that there is a static friction on the Box B (due to which it could move with the train) so the force on it is non-zero.

(II) So the law of inertia is invalid for MONU as he is in the accelerated frame.

---

how law of

Towards
two train
train an
There are
the gro
Here
SONU
MONU

monu and

SON

BOX A: →
(On
net

(II)

BOX

how law of Inertia is valid only from the

→ In the above example, a train is moving towards left with an acceleration "a". There are two train boys SONU and MONU. MONU is in the train and SONU is on the ground.
There are two Box, Box A and Box B, Box A is on the ground and Box B is in the train.
Here
SONU = Inertial frame = non-accelerating frame = ground
$(a = 0)$
MONU = Non-Inertial frame = accelerating frame = train
$(a \neq 0)$,

MONU and SONU :—

SONU (non-accelerated frame/ Inertial frame)

BOX A :→ (i) According to SONU, the Box A is at rest (on the ground), so it's acceleration is zero, and the net force on it is also zero

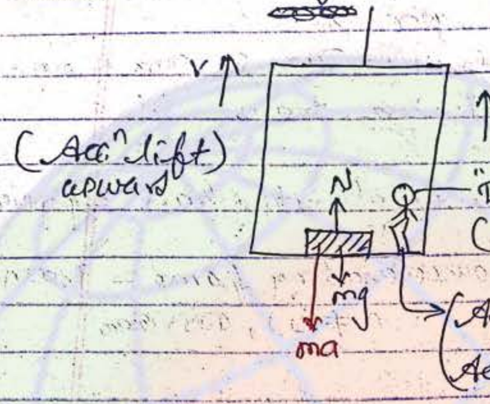
(ii) So law of Inertia is valid for sonu as he is in the non-accelerated

BOX B :- (i) According to Sonu the Box B is moving with the train with an acceleration "a". So it's acceleration is non-zero and there is a static force is on it. So force is non-zero.

(ii) So law of Inertia is valid for sonu as he is in the non-accelerated

Now, visualisation of concept of Pseudo force in the lift acc^n upwards :-

<A> observation of Box A, from the lift frame(accelerated fr Here we will use Pseudo force in the opposite direction of frames acceleration.



(accelerated frame, Non-Inertial frame)

(According to Boy A the Box is at rest, According to him acceleration of Box is Zero.)

So, according to newton first laws :-

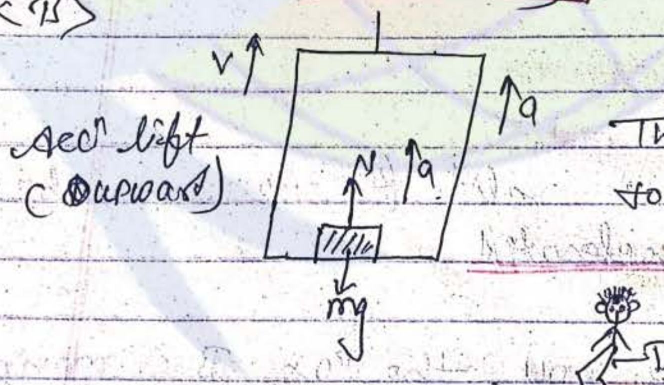
$F_{net,ext} = m.a$

$F_{net,ext} = 0$

$N - mg - ma = 0$

$\boxed{N = m(a+g)}$

<B>



The acceleration of Box according to Boy B is "a" (upwards) !!

Boy B (Non accelerated frame, Inertial frame)

So, According to Newton's first laws :-

$F_{net,ext} = ma$

$(N - mg) = ma$

$\boxed{N = m(a+g)}$

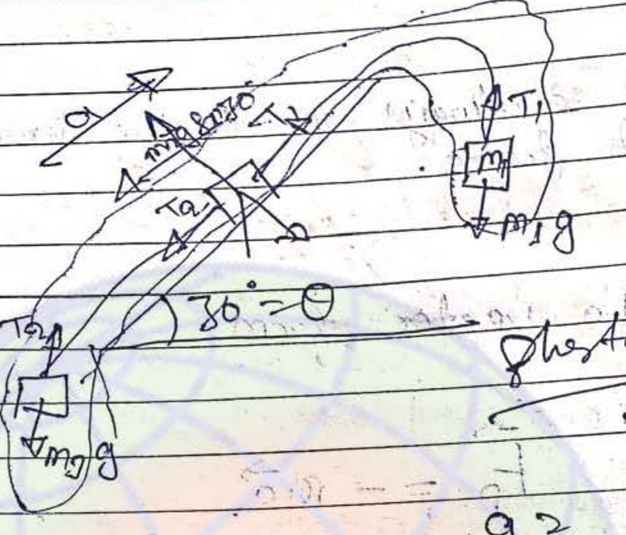
⇒ यही तो है frame of refrance का concept आप कहीं से भी देखीयेगा तो answer तो "same" चूँकि same ही आयेगा। दोनों case में lift ऊपर जा रहा है सिर्फ observer अलग है।

Direction of Pseudo Force:→

1) It direction is always opp. to the direction of non-Inertial frame.

In vector form

$$\vec{F}_p = -m\vec{a}_n$$



Shortcut

$$a = \frac{m_1 g - m_3 g - m_2 g \sin 30^\circ}{m_1 + m_2 + m_3}$$

Net method

$$T_2 - m_3 g = m_3 a \quad ①$$

$$T_1 - T_2 - m_2 g \sin 30^\circ = m_2 a \quad ②$$

$$m_1 g - T_1 = m_1 a \quad ③$$

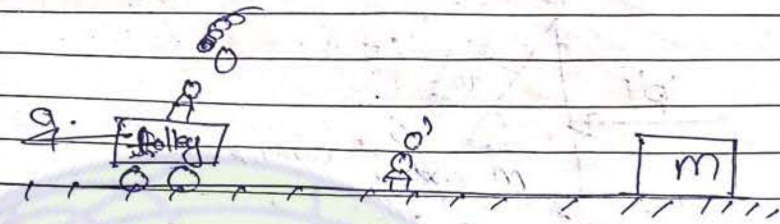
Relative

$$\vec{a}_{b,t} = \overset{\vec{0}}{\vec{a}_{b,g}} - \vec{a}_{t,g}$$ VVI

$$\boxed{\vec{a}_{b,t} = -\vec{a}_{t,g}}$$

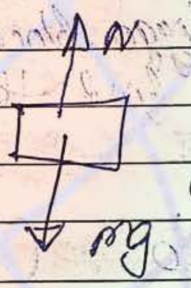
Example of Pseudo force :-> $\vec{a}_{b,t}$

example 1.)



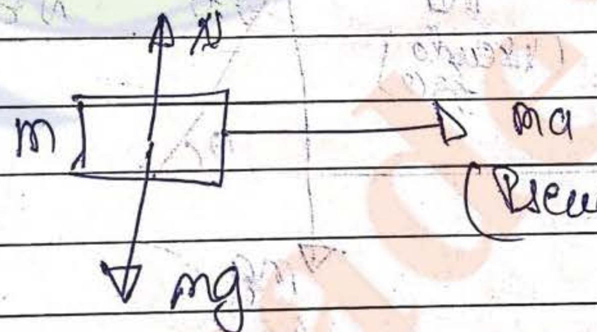
F.B.D, w.r.t - "O", (w.r.t. Inertial frame)
ground

$N = mg$



rest
$a = 0$

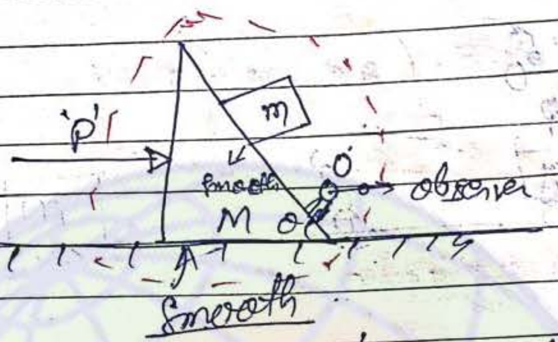
F.B.D. (w.r.t. non-Inertial)(trolley).



(Pseudo force

a → accⁿ of block
w.r.t. trolley

$N = mg$



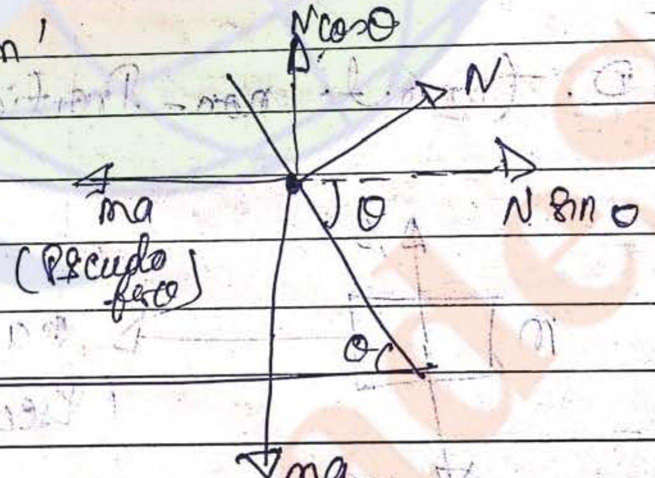
(Smaller block is always at rest w.r.t. bigger block)

Find the normal contact reaction exerted by bigger block on smaller block
And find the force 'P'

Sol→

w.r.t. "O" (non-Inertial)

F.B.D of 'm'



$$N\cos\theta = mg \quad ①$$

$$N = \frac{mg}{\cos\theta}$$

$$N\sin\theta = ma \quad ②$$

$(a = g\tan\theta)$ → होनेपर sleep sleep नही करेगा।

modified FC

a → relative acc^n

$a = g\tan\theta$

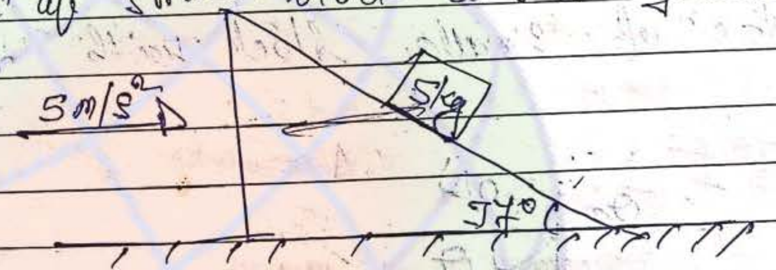
$P = (M+m)g\tan\theta$ ∵ $F = m \times a$

In the given figure :—

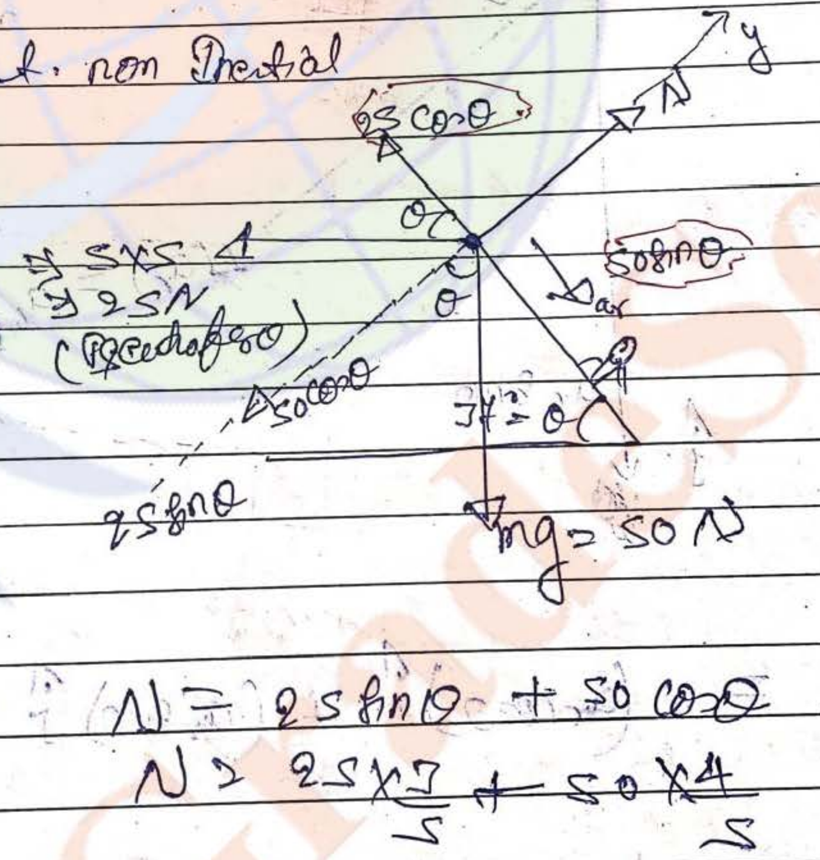
i) Find the normal contact force.

ii) Acc^n of smaller block relative to bigger block.

iii) Acc^n of smaller block w.r.t. ground.



Ans :- w.r.t. non Inertial



$N = 25\sin\theta + 50\cos\theta$

$N = 25 \times \frac{3}{5} + 50 \times \frac{4}{5}$

$N = 55$ Newton

Acc^n

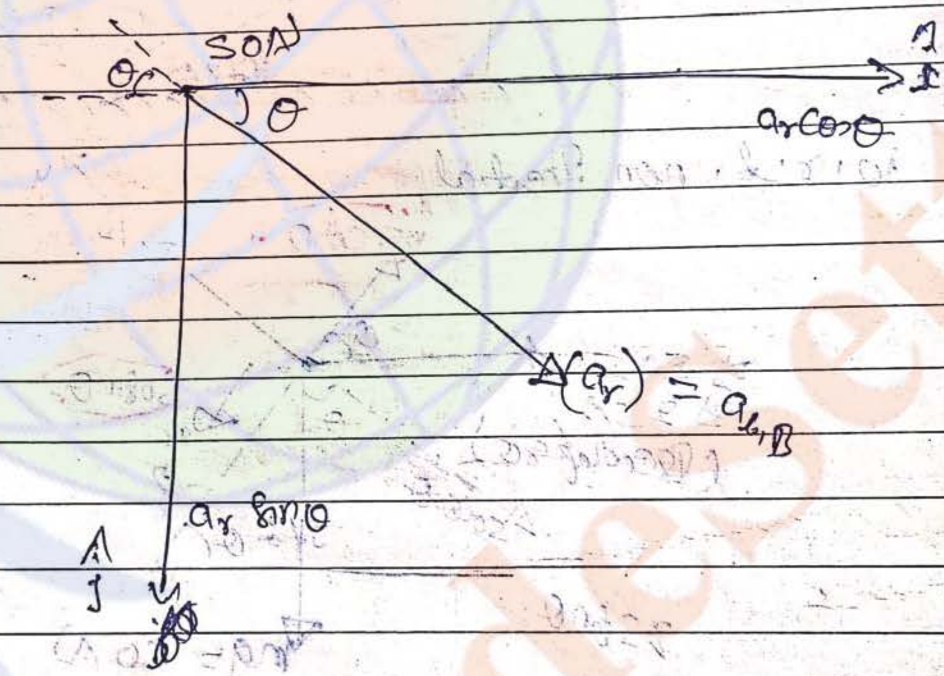
Accⁿ of smaller block relative to bigger block

$$\Rightarrow \left(50\sin\theta - 25\cos\theta\right) = ma_r$$

$$\frac{\overset{10}{\cancel{50}}\times 3}{\cancel{5}} - \frac{\overset{5}{\cancel{25}}\times 4}{\cancel{5}} = 5\times a_r$$

$$a_r = 2\ m/s^2$$

Accⁿ of smaller block with respect to ground



$$\vec{a}_{b,B} = (a_r\cos\theta)\hat{i} + (a_r\sin\theta)\hat{j} = \left(\frac{8}{5}\hat{i}\right) + \left(\frac{6}{5}\hat{j}\right)$$

$$\vec{a}_{b,B} = \vec{a}_{b,g} - \vec{a}_{B,g}$$

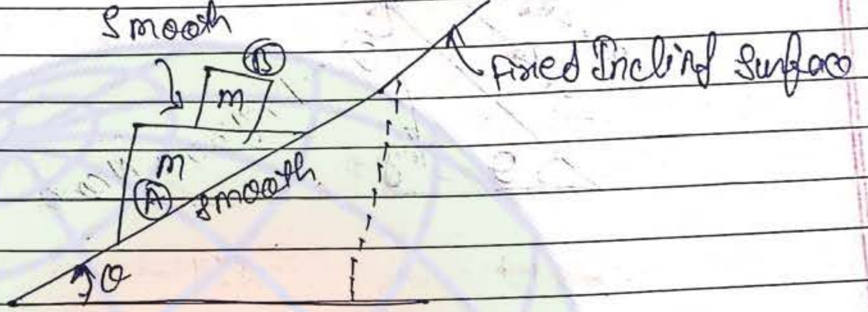
$$\vec{a}_{b,g} = \vec{a}_{b,B} + \vec{a}_{B,g} = \left(\frac{8}{5}\hat{i} + \frac{6}{5}\hat{j} + 5\hat{i}\right)$$

22m/s →

a = 4m/s² →

$$\Rightarrow \left(\frac{8}{5}+5\right)\hat{i} + \frac{6}{5}\hat{j}$$

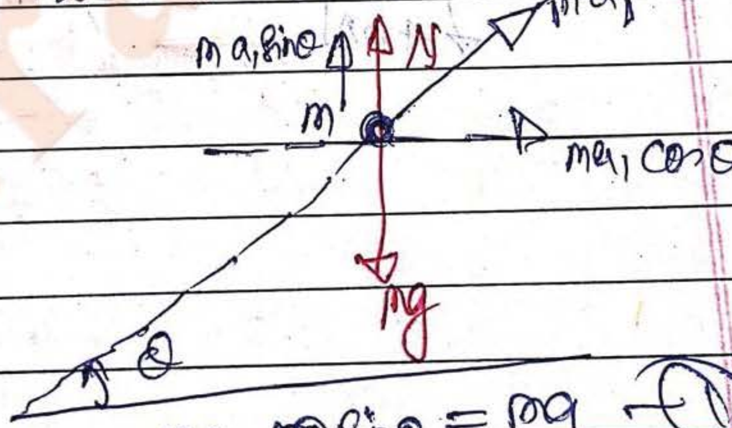
Example:→



Both blocks are released from rest on smooth inclined plane surface. As shown in the figure. Find the acc^n of lower block A.

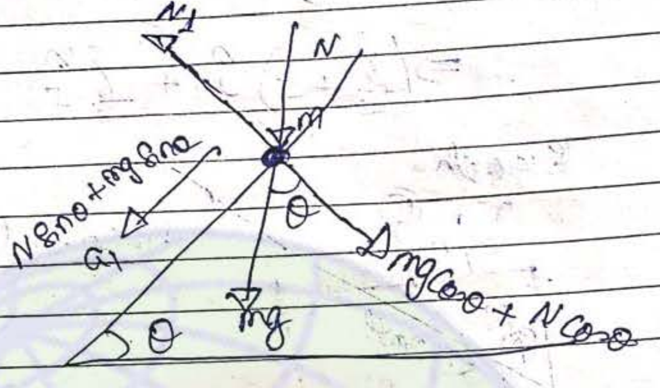
Sol^n→

F.B.D of Block B, w.r.t. block "A"



$$N + ma_1 \sin\theta = mg \quad \text{—①}$$

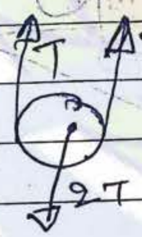
w.r.t. to Ground

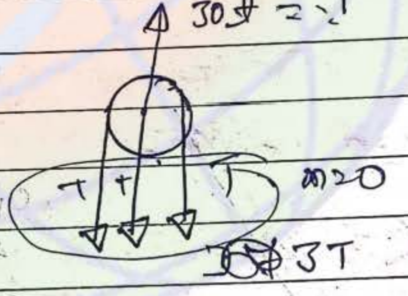


$\cancel{\phi}$ N sinθ + mg sinθ = ma₁ — ②

D.P.P. 8 ≥ 21

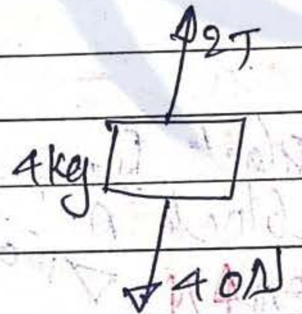
3) Ans





$\cancel{3}T = \overset{10}{\cancel{30}}\, t$

T = 10 t

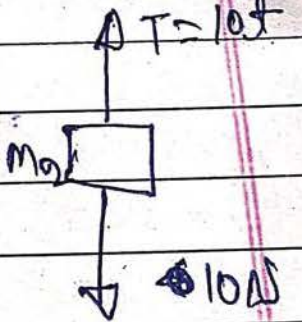


2T ≥ 40 N

20 t ≥ 40

t ≥ 2 s

t = 2 s



10 t = 10

t = 1 s

8.) $f = 48$; $F = 120N$

$a_1 = ?$

$a_2 = ?$

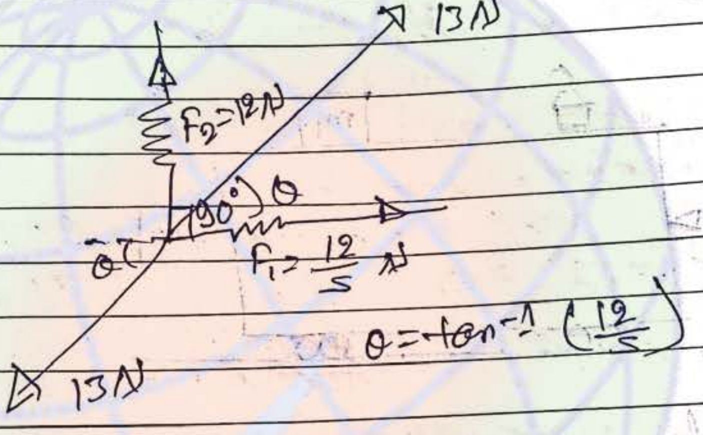
$T = 40N$

$\frac{40-10}{4} = a_1$

$a_2 = 30 \, m/s^2$.

Sn= 4

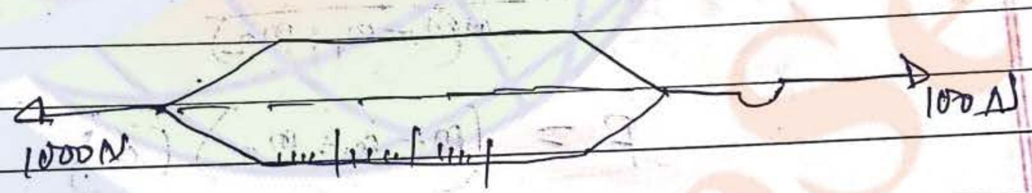
⑦

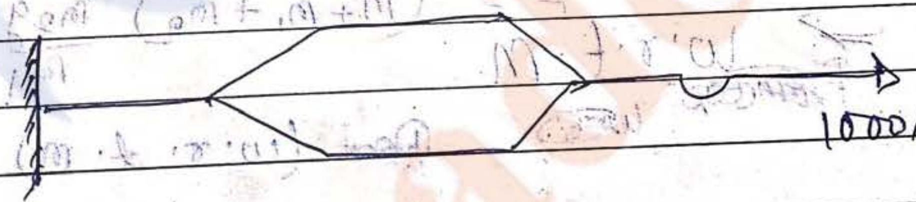


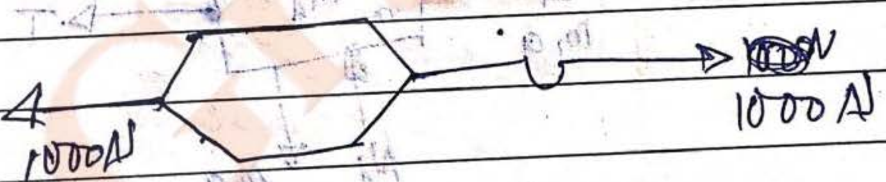
$\theta = \tan^{-1}\left(\frac{12}{5}\right)$

$\sqrt{3} = 1.23$

9.)







Two are Same

23/8/2011 → SNR Sir

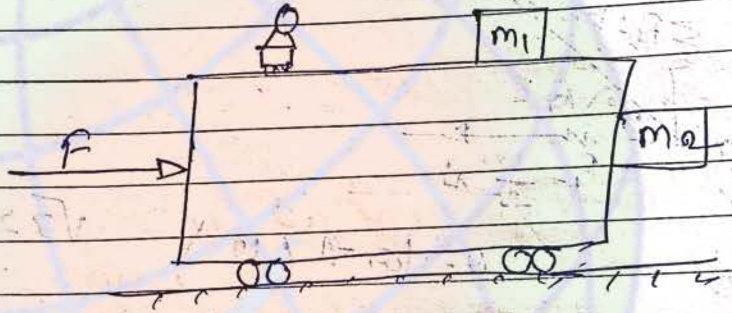
Impulse:-

$$\text{Impulse}(\vec{I}) = \vec{F}(\Delta T)$$

↳change in momentum

$$\Rightarrow \int F dt$$

Exercise 2
Question No. 16



w.r.t Ground

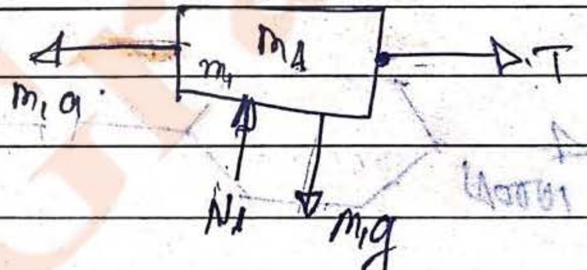
common acc^n → $a = \dfrac{F}{(M+m_1+m_2)}$

$$F = (M+m_1+m_2)(a)$$

$$F = (M+m_1+m_2)\frac{m_2 g}{m_1}$$ → Teach

→ w.r.t. M

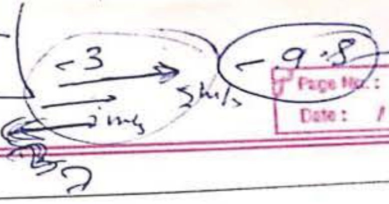
~~Ground~~ ~~w.r.t.~~ Rest (w.r.t. M)

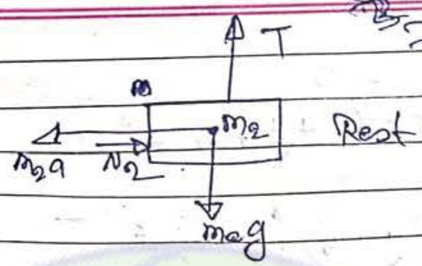


$T = m_1 a$ —①

$m_2 g = m_1 a$ ∴ $a = \dfrac{m_2}{m_1} g$

$S_{rel} = u_{rel} t + \frac{1}{2} a_{rel} t^2$





$T = m_2 g$ — ②

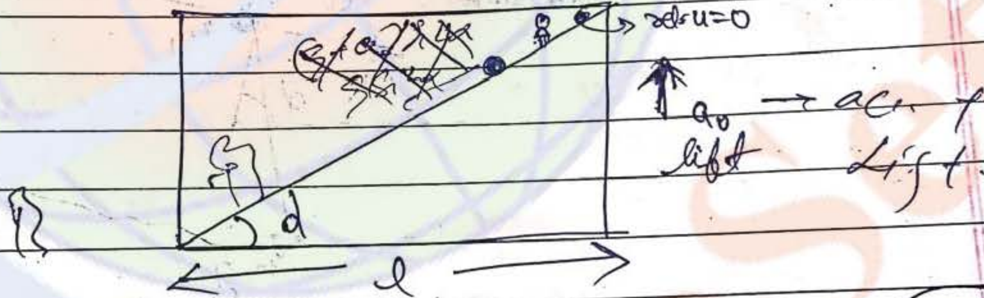
→

$N_2 = m_2 a$ — ③

From eq (iii)

$N_2 = \frac{m_2 m_2 g}{m_1} = \frac{m_2^2 g}{m_1}$ Ans

C.V
9:34

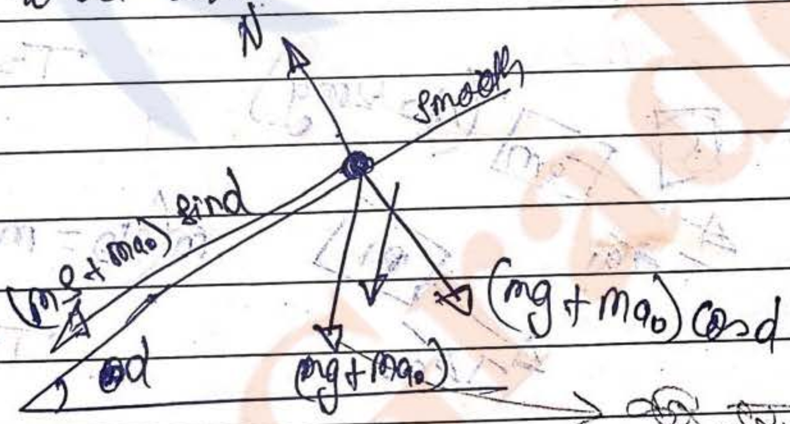


w.r.t. lift :→

$g_{eff} = \boxed{g + a_0}$

Due to g effective

$\boxed{g_{effective} = g + a_0}$



→ इसका component ले रहे है।

$(mg + ma_0)\sin\alpha = M a_{rel}$.

$a_{rel} = (g + a_0)\sin\alpha$

$$\cos\alpha = \frac{l}{x}$$

$$\boxed{S_{rel} = x = \frac{l}{\cos\alpha}}$$

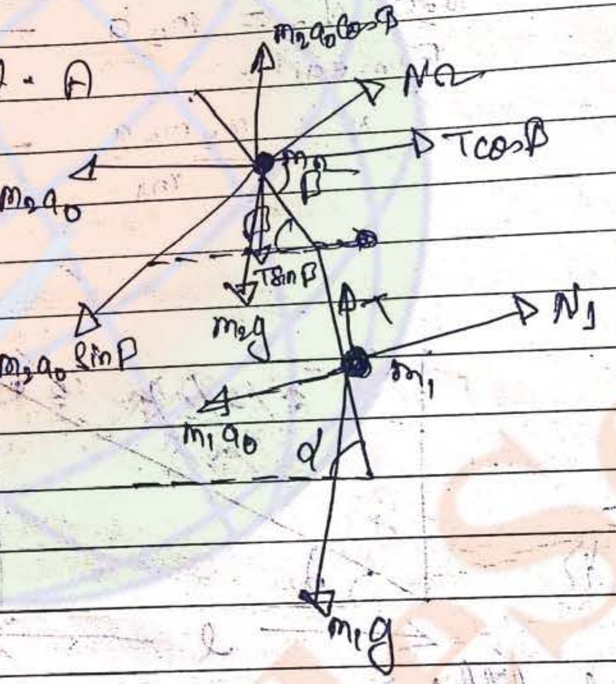
$$S_{rel} = \overset{0}{\cancel{u_{rel} \times t}} + \frac{1}{2} a_{rel} t^2$$

$$\frac{l}{\cos\alpha} = \frac{1}{2}(g+a_0)(\sin\alpha) t^2$$

$$t = \sqrt{\frac{2l}{\cos\alpha (g+a_0) \sin\alpha}}$$

35 ⟹ $20 \cdot r \cdot l \cdot A$

a_0



Exercise →
Q → 16 :→

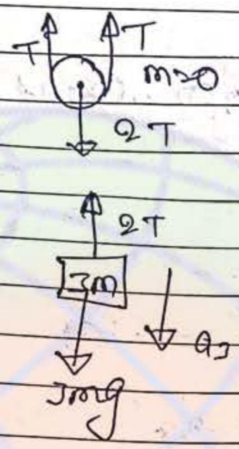
$\boxed{5}$

$(N_1 = 2mg)$

$(N_2 = mg)$

$T = 2ma_1$ —(I)

$T = ma_2$ —(II)



$$3mg - 2T = (3m)a_3 \quad ③$$

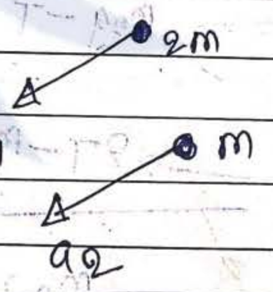
$$\Sigma Ta = 0$$

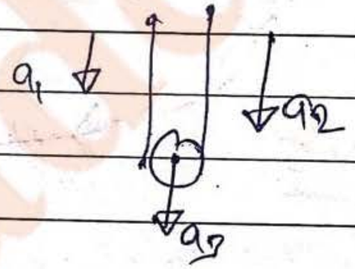
$$\cancel{T}a_1 + a_2\cancel{T} - a_3 2\cancel{T} = 0$$

$$\Rightarrow \quad a_1 + a_2 - 2a_3 = 0 \quad (4)$$

P.T.O →

method - 2





$$\boxed{\vec{a}_{2m,P} = -\vec{a}_{m,P}}$$

$$a_1 - a_3 = -(a_2 - a_3)$$

$$a_1 + a_2 = 2a_3$$

Pseudo force

Put,

a_1, a_2, a_3 from eq ①, ② and ③ in equation 4

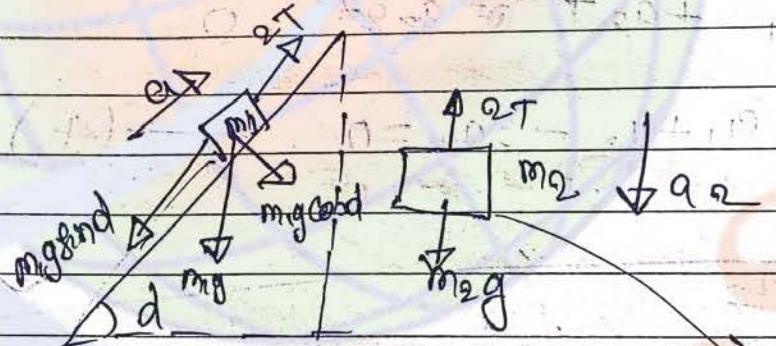
T = ✓

a_2 ?

$a_1 + a_2 - 2a_3$ — ④

$\frac{T}{2m} + \frac{T}{m} - 2x$

M-for



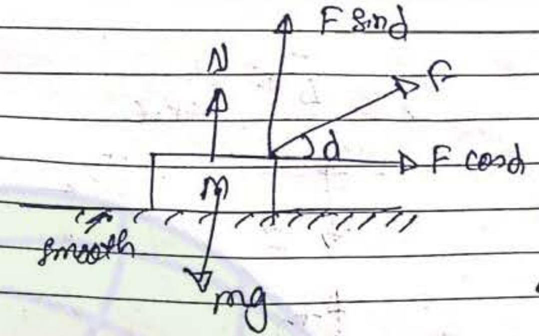
$m_2 g - T = m_2(2a)$ — ①

② $2T - m_1 g \sin\alpha = m_1 a$ — ②

$m_2 2 \eta m_1$

Surface छोड़ेगा तो N=0

18.)



$F \sin\alpha + \overset{0}{\cancel{N}} = mg$

at $t = t_0$ (leave the surface)

$at_0 \sin\alpha = mg$

$t_0 = \frac{mg}{a \sin\alpha}$

$F \cos\alpha = ma$

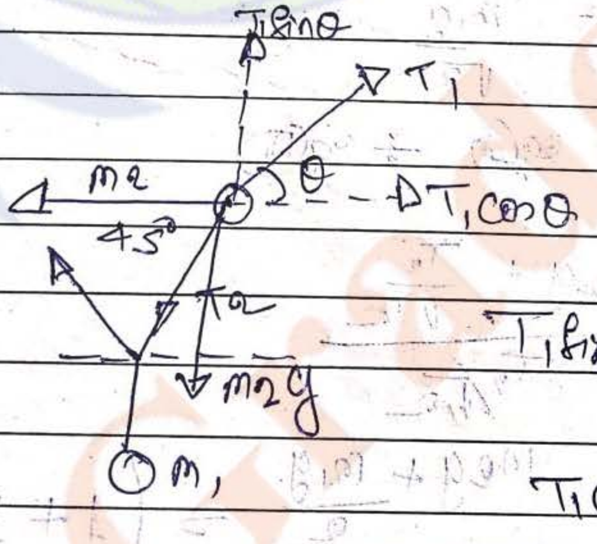
$a t \cos\alpha = m\frac{dv}{dt}$

$$m\int_{t=0}^{v} dv = (a\cos\alpha)\int_{t=0}^{t_0} t\,dt$$

v_2

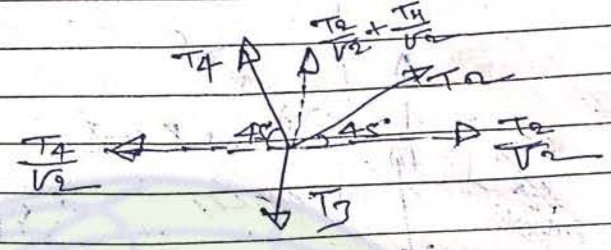
$\frac{dx}{du}$

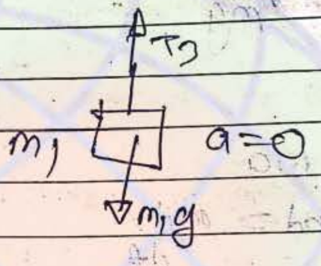
19.) ans! →



$T_1 \sin\theta = m_2 g + \frac{T_2}{\sqrt{2}}$ — ①

$T_1 \cos\theta = \frac{T_2}{\sqrt{2}}$ — ②





$$T_3 = m_1 g \quad — ③$$

$$\frac{T_2}{\sqrt2} = \frac{T_4}{\sqrt2} \quad — ④$$

$$\frac{T_2}{\sqrt2} + \frac{T_4}{\sqrt2} = T_3 = m_1 g$$

$$\frac{2T_2}{\sqrt2} = m_1 g$$

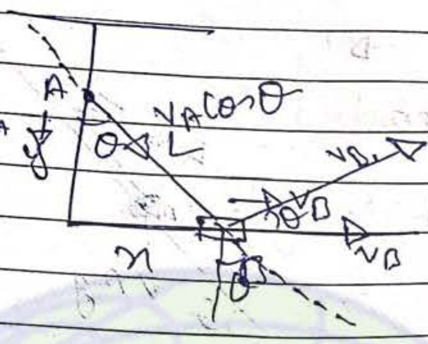
$$T_2 = \frac{m_1 g}{\sqrt2}$$

Now ~~eq~~ eq① ÷ eq②

$$\tan\theta = \frac{m_2 g + \frac{T_2}{\sqrt2}}{T_2/\sqrt2}$$

$$= \frac{m_2 g + \frac{m_1 g}{2}}{\frac{m_1 g}{2}} = \left(1 + \frac{2m_2}{m_1}\right)$$

21.) g



$$L^2 = x^2 + y^2$$

$$x = \sqrt{L^2 - y^2}$$

$$v_A \cos\theta = v_B \sin\theta$$

$$\boxed{v_B = -v_A \cot\theta}$$

$$v_B = v_A \times \frac{y}{x}$$

Diff. w.r.t. time

$$\frac{dv_B}{dt} = v_A\left[\frac{x \times \frac{dy}{dt} - y \times \frac{dx}{dt}}{x^2}\right]$$

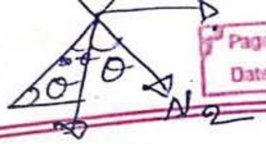
$$= v_A\left[\frac{x v_A - y \times v_B}{x^2}\right]$$

$$= v_A\left[\frac{x v_A - y \times (-v_A)\frac{y}{x}}{x^2}\right]$$

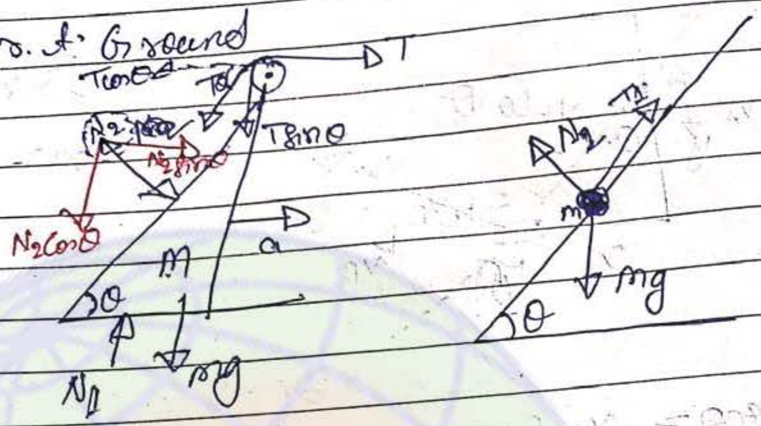
$$= \frac{v_A^2\left(x + \frac{y^2}{x}\right)}{x^2} = \frac{v_A^2\left(x^2 + y^2\right)}{x^2}$$

$$= \frac{v_A^2 L^2}{\left(L^2 - y^2\right)^{3/2}}$$

Note>



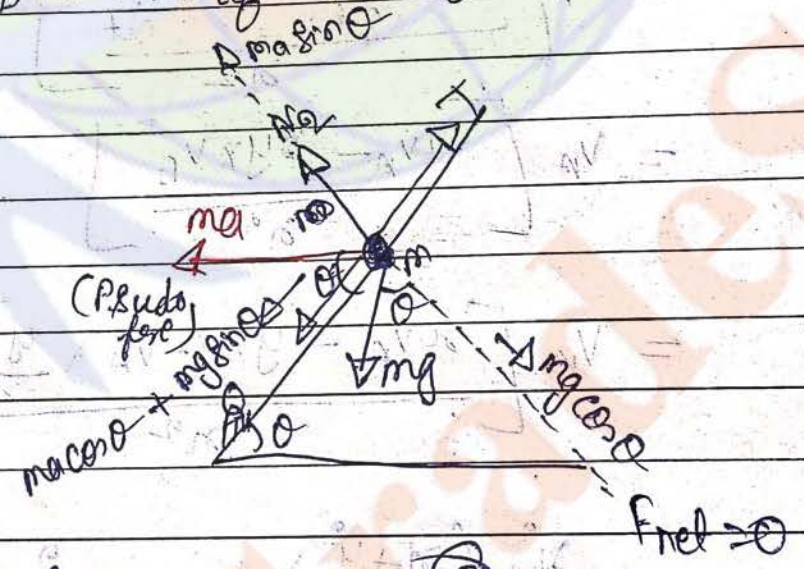
Q3.) w.r.t. Ground



$N_2 \sin\theta + T - T\cos\theta = ma$ — ①

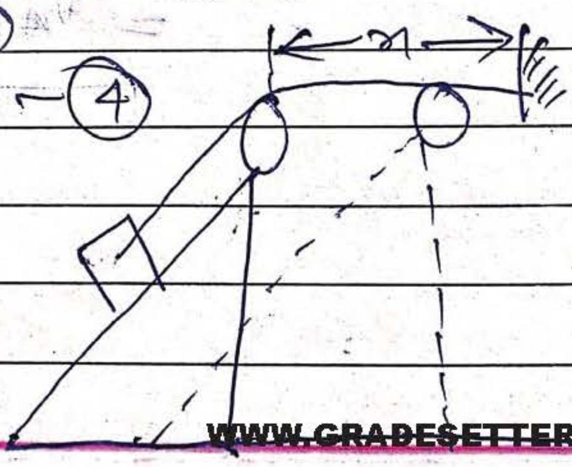
$N_1 = (mg + T\sin\theta + N_2\cos\theta)$ — ②

F.B.D. of 'm' w.r.t. 'M'



$N_2 + ma\sin\theta = mg\cos\theta$ — ③

$(mg\sin\theta + ma\cos\theta - T) = ma$ — ④

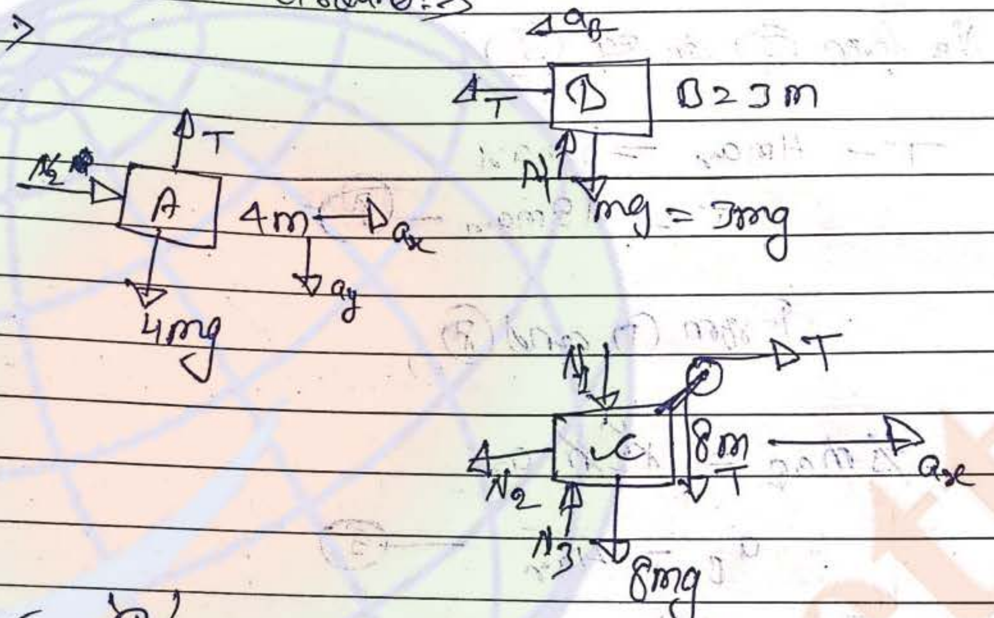


Now, N_2 from eqn ③ in eq ① st

$(mg\cos\theta - ma\sin\theta)\sin\theta + T - T\cos\theta = ma$ — ⑤

solve eq ④ and ⑤

Q24. Ans → w.r.t. Ground:→



For 'B'

$T = 3m \times a_B$ — ①

$N_1 = 3mg$ — ②

For 'A'

$N_2 = 4m \times a_x$ — ③

$4mg - T = 4m \times a_y$ — ④

For 'C'

$T - N_2 = 8m \times a_x$ — ⑤

$N_1 + N_3 + 8mg = N_3$ — ⑥

$\uparrow$ क pa_x 90° है इसलिए a_x zero है।

$$\Sigma Ta = 0$$

$$\cancel{T}a_\beta + \cancel{T}a_x - \cancel{T}a_y = 0$$

$$a_x + a_\beta = a_y \quad ⑦$$

Put N_2 from ③ in eq ⑤

$$T - 4ma_x = 8ma_x$$

$$T = 12ma_x \quad ⑧$$

From ⑦ and ⑧,

$$\cancel{4}\cancel{m}a_\beta = \overset{4}{\cancel{12}}\cancel{m}a_x$$

$$a_\beta = 4a_x \quad ⑨$$

From eq ④

$$\cancel{4}\cancel{m}g - \underbrace{\overset{3}{\cancel{12}}\cancel{m}a_x}_{\text{from eq ⑧}} = \cancel{4}\cancel{m}\overbrace{[a_x + 4a_x]}^{\text{from eq ⑦ and ⑧}}$$

$$g - 3a_x = 5a_x$$

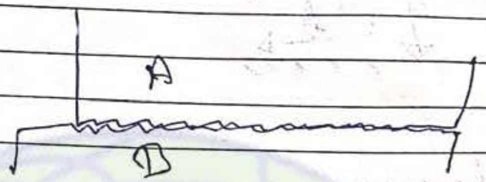
$$a_x = \frac{g}{8} \rightarrow$$

$$a_\beta = 4\frac{g}{8}$$

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

$$a_y = \frac{g}{8} + \frac{g}{2} \qquad a_y = \frac{5g}{8} \downarrow$$

Friction



~~[illegible]~~ Friction is due to:->

1) Interlocking of one surface into other surface. at molecular level

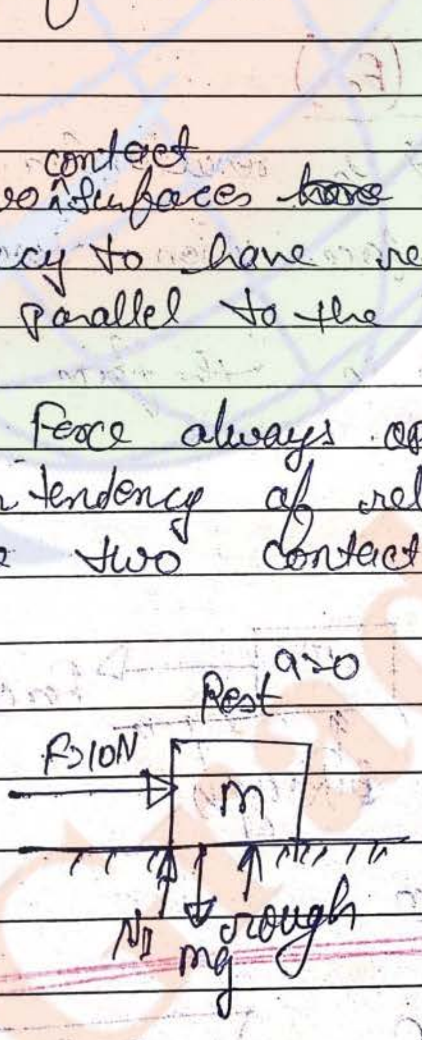
ii) Bonding of molecules of contact surfaces.

Note:->

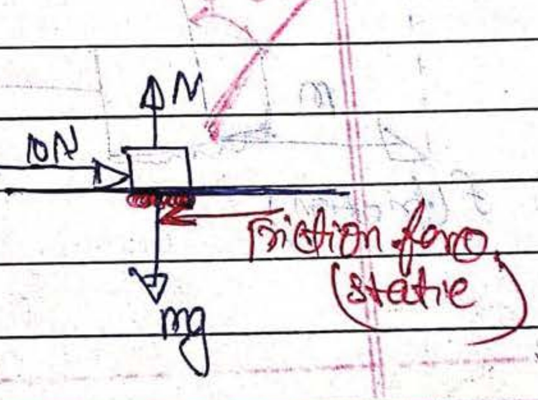
When two contact surfaces ~~have~~ have relative motion or tendency to have relative motion, friction force appears parallel to the contact surface.

- Friction force always opposes the "relative" motion or tendency of relative motion ~~of one~~ between the two contact surfaces.

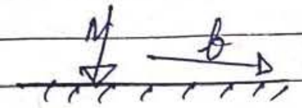
Example:->



$N = mg$



24/8/

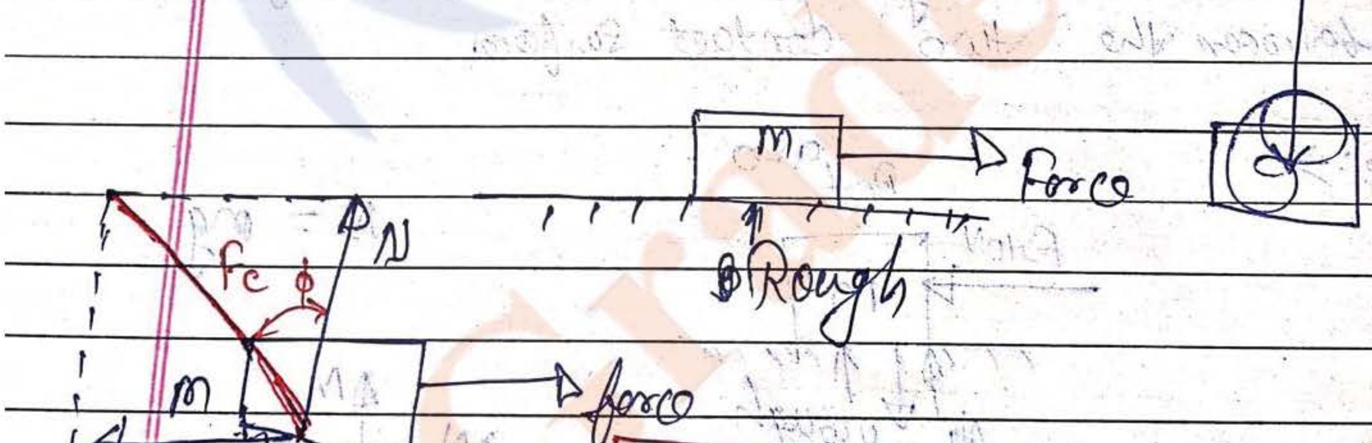


Friction force →
- ① Static ~~fo~~ friction
- kinetic friction.

Contact force :→ (F_c)

↳ It is resultant or net force at the contact surface, when two surfaces are in contact.

It is in the form of action and reaction pair.



$$\boxed{F_c = \sqrt{(f^2 + N^2)}}$$

f_s ⇒ static, K ⇒ kinetic or Dinamic

Angle measured by contact force with the normal reaction is known as Angle of friction

Angle of friction ϕ

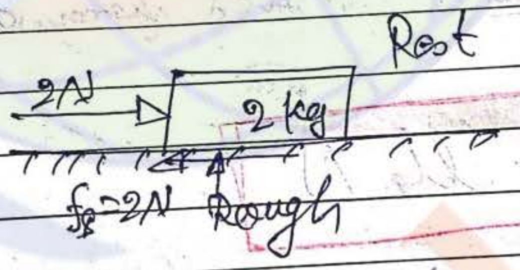
$$\boxed{\tan\phi = \frac{f}{N}}$$

1.) Static friction:→

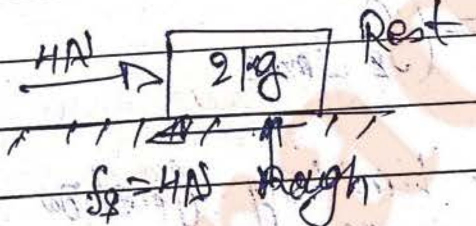
When two contact contact surfaces have tendency of relative motion, static friction force appears parallel to contact surfaces.

example:→

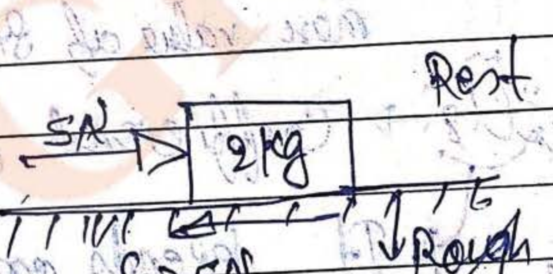
i)



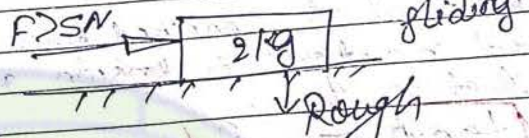
ii)



iii)



iv)



Note:→ Static friction :→

$$\boxed{0 \leq f_s \leq f_L}$$

Here → f_s: Static friction
f_L: Limiting friction

f_s = Component of net (resultant) force ~~[illegible]~~ (applied) parallel to contact surface.

~~Experimentally~~ Experimentally proved formula

$$\boxed{f_L = \overset{max}{\mu_s} N}$$

→ Not a vector Relation

$$f_L = (f_s)_{max}$$

→ Limiting friction or max value of Static friction

μ_s → Coefficient of static friction.

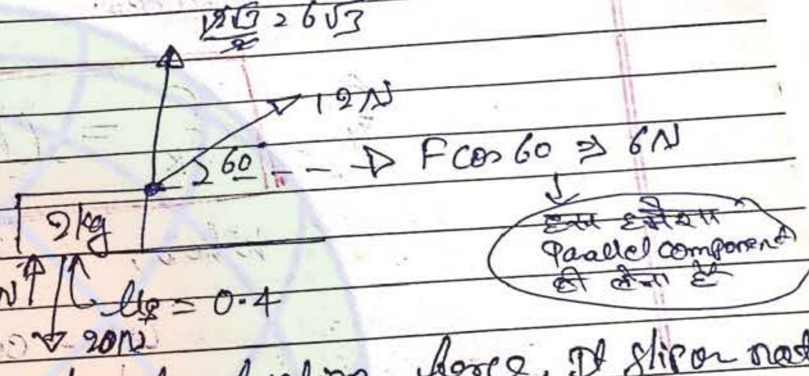
It's value depends on the material and roughness of the two surface in contact.

→ It depends on nature of two contact surfaces.

μ_s → Surface ~~का~~ का nature बदलने के कारण ही बदल सकता है

So f_L ⇒ It is does not depend on area of contact surfaces. It depends on normal contact surface.

example:-



Find the value of friction force, It slip or not

~~$f_L = 0.4 \times 6\sqrt{3}$~~
~~$\Rightarrow 2.4\sqrt{3}$~~

$N + 6\sqrt{3} = 20$
$N = 20 - 6 \times 1.7$
$= 20 - 10.2$
$\Rightarrow 9.8$ Newton.

$f_L = 0.4 \times 10 = 4N$

Here Limiting friction is 4N and actual parallel force 6N,
$6N > f_L$
So, The block will slide.

2.) Kinetic friction :→ or Dynamic friction

when the two contact surface have relative motion, kinetic friction appears parallel to the contact surfaces.

$$\boxed{f_K = \mu_K N}$$

Where, f_K = Independent of the area of the surface in contact.

μ_k = coefficient of kinetic friction

→ Depends on natural of surfaces.

- In general ($\mu_s > \mu_k$)

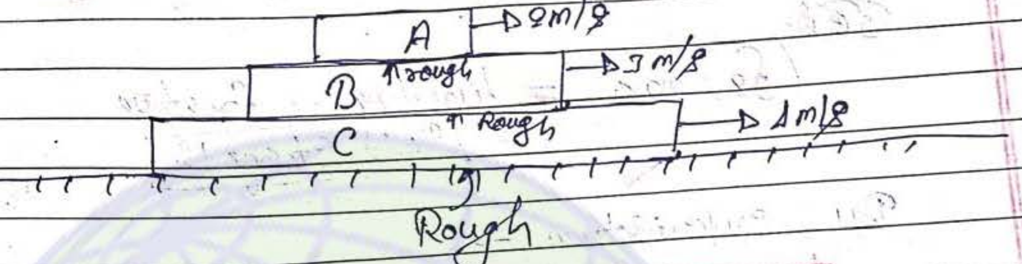
* value of kinetic ~~frict~~ friction force is Independent of relative speed of sliding of ~~a~~ block on the other surface.

(The relative speed should not be too high or very high)

Because If speed is too high then μ_s is change

main Problem & Direction

example

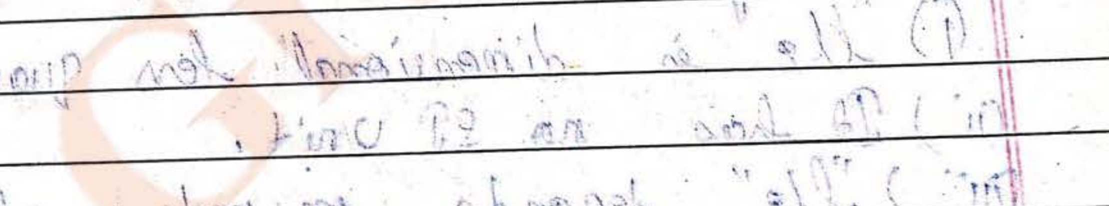


Find the Direction of friction force at all the Smooth Surfaces in contact.

* Self Study :-> 24/8/2011

Q-) what is friction?

If we slide or tie to slid of an object over a rough surface the motion of the object is restected by the bond between the molecule of the object and the surfaces. This opposing force is called friction.



Magnitude of Static friction (f_s)

$$(f_s)_{max} = \text{Limiting friction} = \boxed{\text{Bond Strength}}$$

By experiment:⇒

$$\boxed{(f_s)_{max} \propto N}$$

~~where~~ ~~μ_s~~

$$\boxed{(f_s)_{max} = \mu_s N}$$

where "μ_s" is defined as coefficient of static static friction, N is normal reaction.

$$[\mu_s] = \left[\frac{(f_s)_{max}}{N}\right] = \frac{force}{force} = 1$$

Note:⇒

(i) "μ_s" is dimensional less quantity.
(ii) It has no SI unit.
(iii) "μ_s" depends on nature of contact surface.
(iv) "μ_s" does not depends on area of contact

$$\boxed{0 \le f_s \le (f_s)_{maximum}}$$

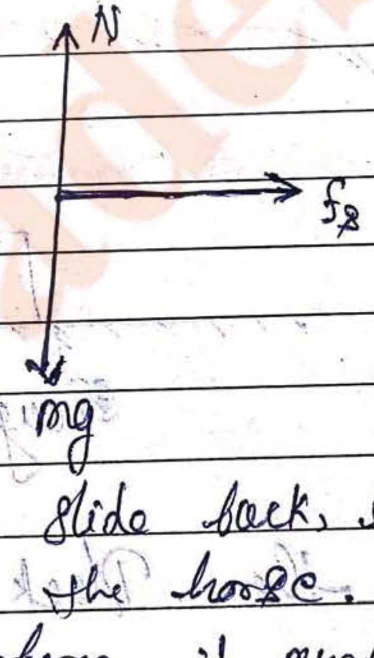
~~Teache~~
Example:-

A ~~boat~~ boy (30 kg) sitting on his horse whips it. The horse speeds up at an avg. accn of 2.0 m/s².

(a) If the boy does not slide back, what is the force of friction exerted by the horse on the body.

(b) If the boy slides back during the accn, what can be said about the coefficient of static friction between the horse and the boy (take g = 10 m/s²).

I. The forces acting on the boy are:-
(a) The weight mg.
(b) The normal contact force N and
(c) The static friction f_s.



⇒ As the boy does not slide back, its accn 'a' is equal to the accn of the horse. As friction is the only horizontal force, it must act along the acc^n and its magnitude is given by Newtons second law.

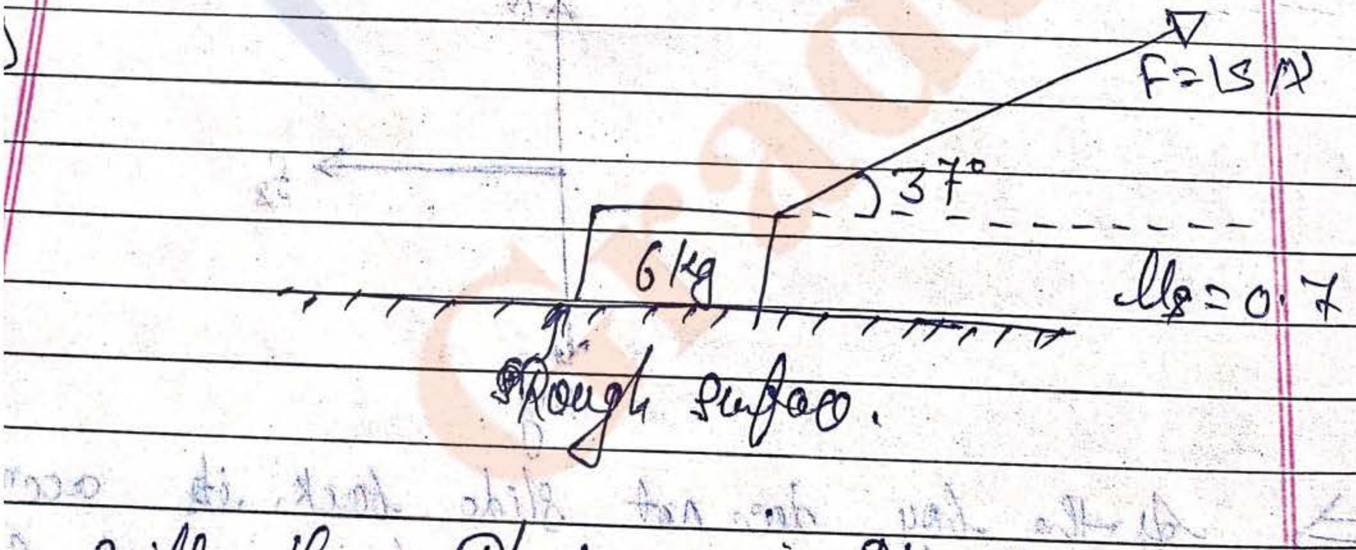
$$(f_s) = m \times a$$
$$\Rightarrow 30 \times 2$$
$$\Rightarrow 60N$$

(b) If the boy slides back, the horse could not exert a friction of 60 N on the ~~boy~~ boy. The maximum force of static friction that the horse may exert on the boy is

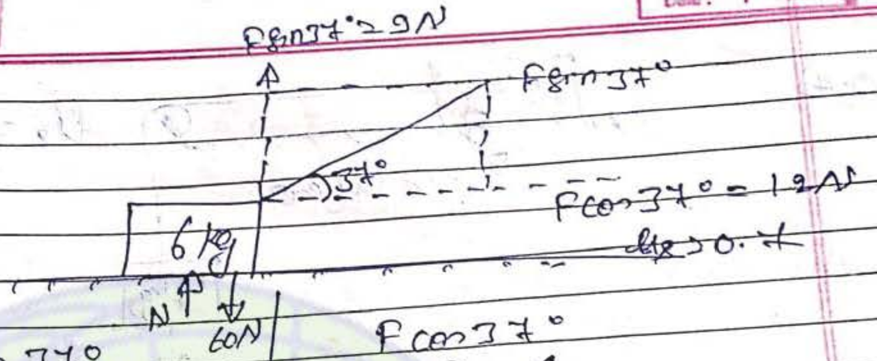
$$f_s = \mu_s N = \mu_s mg$$
$$= \mu_s (30\,kg)(10\,m/s^2)$$
$$= \mu_s\, 300N$$

where μ_s is the coefficient of static friction thus:

$$\mu_s (300N) < 60N$$
$$\mu_s < \frac{60}{300} = 0.20$$



will the Block move. If ~~not~~ no, the find $f(s) = ?$



F sin 37°

F × $\frac{3}{5}$

$\cancel{15}^{3} \times \frac{3}{\cancel{5}}$ = 9N

F cos 37°

F × $\frac{4}{5}$

⇒ $\cancel{15}^{3} \times \frac{4}{\cancel{5}}$ = 12N

F = mg
= 6 × 10
= 60 N

6kg = 60N
In verticle direction

~~N + g = 60~~
~~N + g = 60~~
~~N = 60 − 9 (N coming)~~
~~= 51N~~

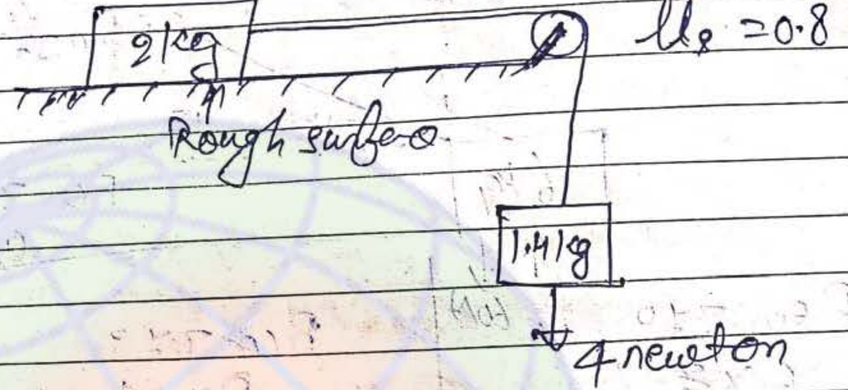
N + 9N = 60 Newton
N = (60 − 9) Newton
= 51 Newton

Bond strength or Limiting Friction =
$f_L = \mu_s N$
= 0.7 × 51
= 35.7 Newton so

Here Fcos37 < Bond strength
so Block will not move.

In Generally μ_s is slightly greater than μ_k.

Q.4



$$(f_s) = \mu_s N$$
$$= 0.8 \times 2 \times 10$$
$$\Rightarrow \cancel{18}\ 16\ N$$

Some ~~question~~ Points ⇒

(i) Static ~~force~~ friction is "~~sel~~ self adjustable friction".

(ii) "$\mu_s N$" is the "maximum possible force" of static friction that can act between the bodies.

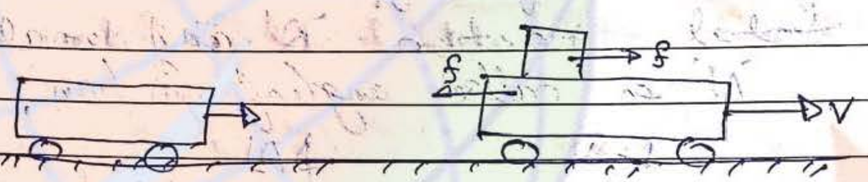
$\mu_s N$ is also known as limiting friction.

Kinetic friction:⇒

The frictional force which oppose the relative motion of contact forces is called kinetic friction

Direction of kinetic friction:⇒

1-> The kinetic friction on a body A slipping against another body 'B' is opposite to the velocity of 'A' with respect to B.

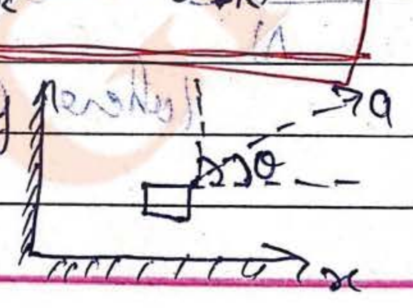


Magnitude of kinetic friction:⇒

The magnitude of the kinetic friction is proportional to the normal force acting between the two bodies.

⇒ magnitude of the kinetic friction is not self adjusting in nature.

$\boxed{f_k = \mu_k N}$ = where fk is magnitude of kinetic friction and N is normal force.



XY is horizontal rough surface

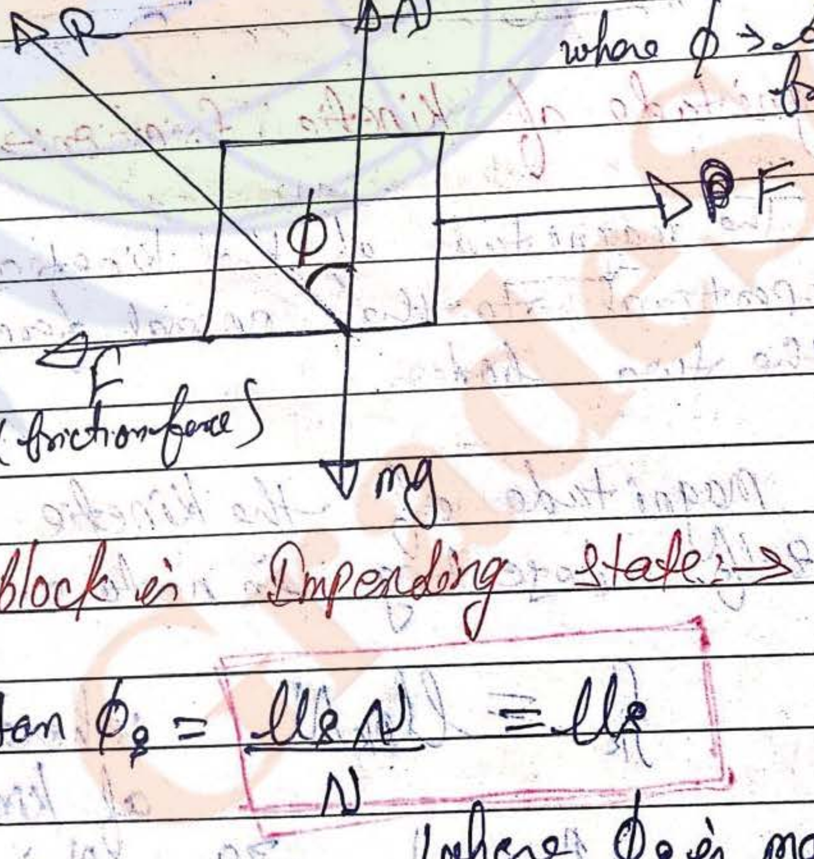
⇒ i) Surface are Smooth μ_k will be small

ii) If the surface are rough μ_k will be large.

26/8/2014

Angle of friction :→

Normal reaction 'N' and friction force 'F' are two components of the total reaction force of the surface on the block. Angle between total reaction 'R' and Normal reaction 'N' is called angle of friction.



where φ → Angle of friction.

1) when block is Impending State :→

$$\tan \phi_s = \boxed{\frac{\mu_s N}{N}} = \mu_s$$

(where ϕ_s is maximum angle of friction)

Angle of friction is same as Angle of repose

Impending → शीघ्र घटित होने वाली घटना (अप्रिय घटना)
onset → आरंभ (प्रायः किसी अप्रिय स्थिति का)

ii) when block is static,

$$\phi \leq \phi_s$$

where ϕ → Angle of friction
ϕ_s → maximum angle of friction,

iii) when block is sliding :→

$$\tan \phi_k = \frac{\mu_k N}{N} = \mu_k$$

Since $\mu_s > \mu_k$, It follows that $\phi_s > \phi_k$.

Note :→ As the force P is gradually increased ; a limiting point is reached where friction force F is not sufficient to prevent onset of motion, when the block is about to move, the state of motion is called "Impending state of motion". At this point friction force has maximum value.

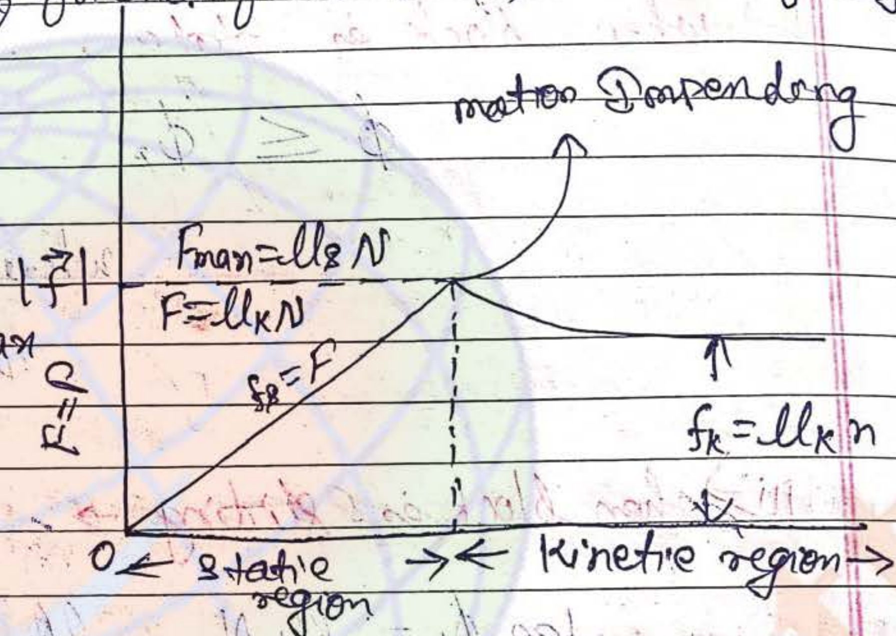
$$F_{s\,max} = \mu_s N$$

where μ_s is defined as coefficient of static friction, N is normal reaction, F → Friction को दर्शाता है (Friction may be static or kinetic friction) [illegible] type [illegible]

f_s → static friction को दर्शाता है,

f_k → kinetic friction को दर्शाता है

⇒ variation of friction force versus external force graph

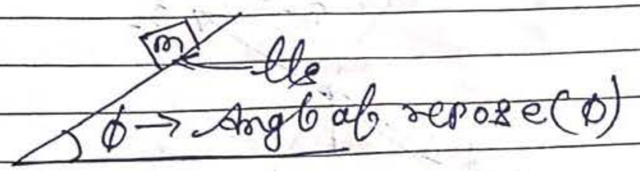


If force P is greater than F_{max}, the block will have a resultant force $P - F_{max}$ on it. The block will accelerate in the direction of resultant force when sliding motion ensues.

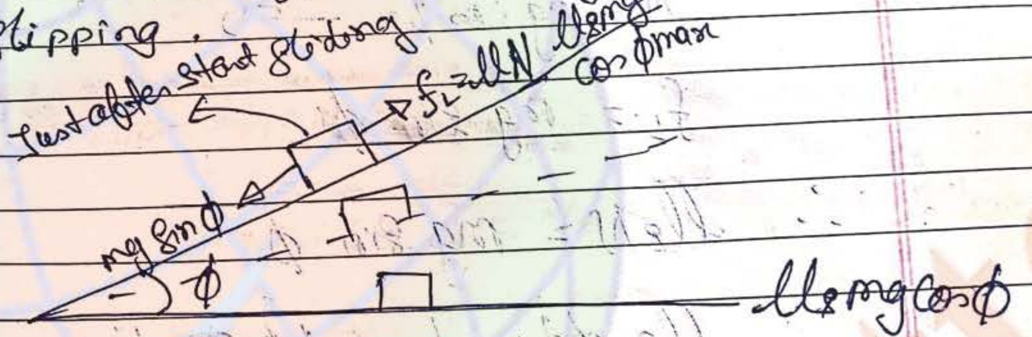
$$F = \mu_k N$$

where, μ_k is defined to be coefficient of kinetic friction.

Angle of repose "ϕ"



In this condition, At angle of repose the block is in limiting equillibrium or limiting Condition. (At the verge of slipping).
Just after this angle, the block will start slipping.



$$\boxed{\tan\phi = \mu_s}$$

$$\boxed{\phi = \tan^{-1}\mu_s}$$

Angle of repose = Angle of friction

Concept :→

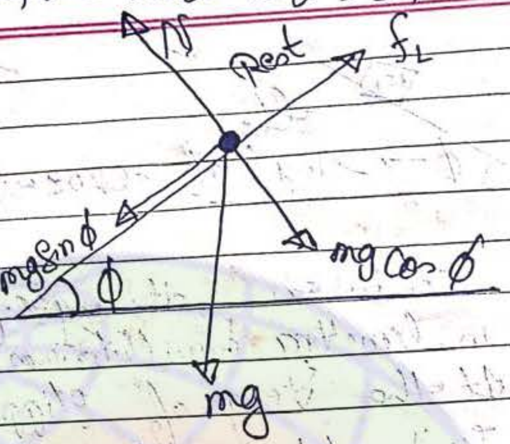
i) If "θ"(Angle of Inclination) $\leq \phi$
The block will not slide

Here, $\tan\theta < \mu_s$

ii) If "θ" (Angle of Inclination) $> \phi$
The block will ~~start~~ sliding.

Here, $\tan\theta > \mu_s$

We find the value of μ_s



$N = mg\cos\phi$ —①

$f_L = mg\sin\phi$ ∵ $f_L = \mu_s N$

∴ $\mu_s N = mg\sin\phi$

$\mu_s \cancel{mg}\cos\phi = \cancel{mg}\sin\phi$ ∵ $N = mg\cos\phi$ from eqn ①

$\mu_s\cos\phi = \sin\phi$

$\mu_s = \frac{\sin\phi}{\cos\phi}$

$$\boxed{\Rightarrow \tan\phi = \mu_s}$$

$$\phi = \tan^{-1}(\mu_s)$$

⇒ IInd method, By formula

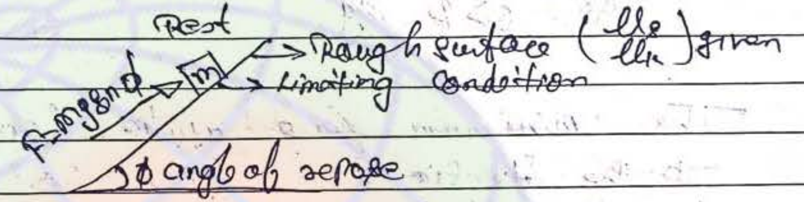
Angle of friction (φ) In limiting condition

$$\tan\phi = \frac{f_L}{N}$$

$$= \frac{\mu_s \cancel{N}}{\cancel{N}}$$

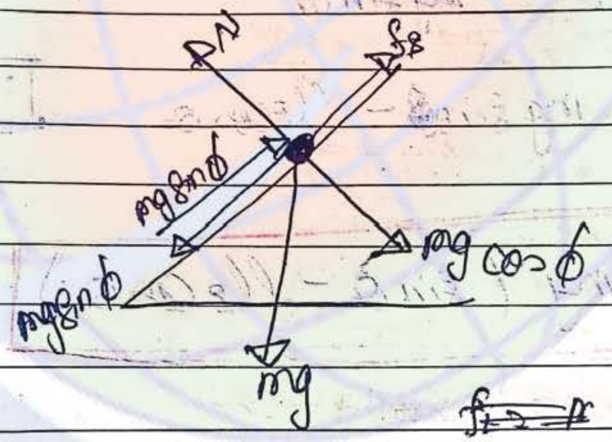
$$\boxed{\tan\phi = \mu_s}$$

Q.>



Find the value of friction force.

Soln>



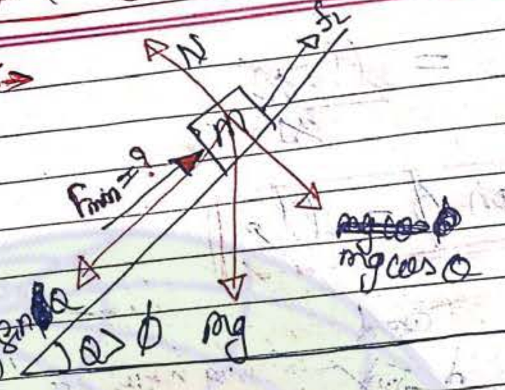
~~$f_L = F$~~ $f_L = mg\sin\phi - mg\sin\phi$

$f_L = 0$

So, it is not slipping because no any parallel component force is work.

V.V.I) If $\theta > \phi$ (Angle of repose)

⇒ 1) Case Ist :⇒



The minimum force applied (on the block) parallel to the Inclined surface, so that the block does slip down the Inclined surface.

$$F_{min} + f_L = mg\sin\phi$$

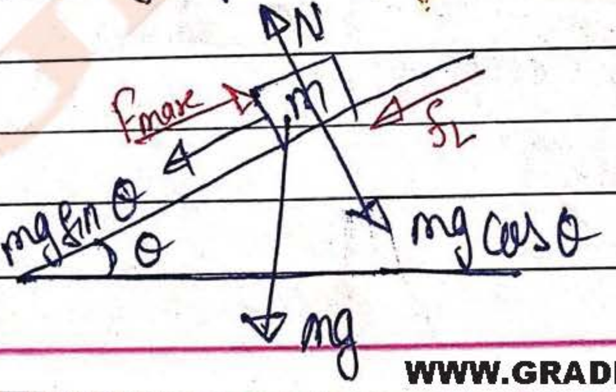
$$F_{min} = mg\sin\theta - \mu_s\cos\theta$$

$\boxed{\because N = mg\cos\theta}$

$$\boxed{F_{min} = mg(\sin\theta - \mu_s\cos\theta)}$$

⇒ Case IInd :⇒

F_{max} = maximum force applied parallel to the contact surface (Inclined surface) so that block does not slip "up" the Inclined surface.



μ ⇒ "Constant value" If work both μ_s and μ_k

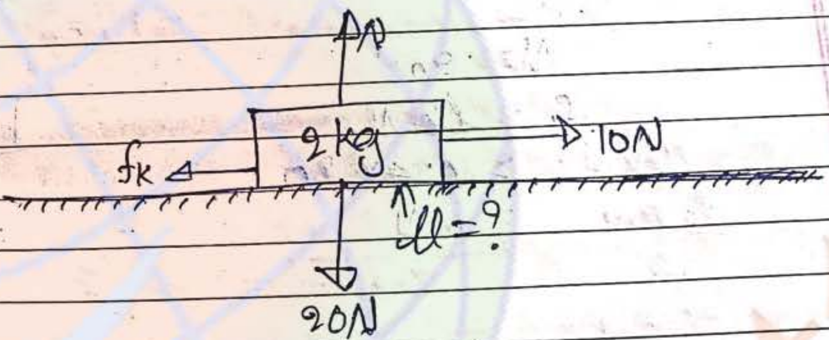
μ_k ⇒ coefficient of kinetic friction.

μ_s ⇒ coefficient of static friction.

$$F_{max} \Rightarrow mg\sin\theta + f_L$$
$$\Rightarrow mg\sin\theta + \mu_s mg\cos\theta$$

$$\boxed{F_{max} = mg(\sin\theta + \mu_s\cos\theta)}$$

Example:⇒

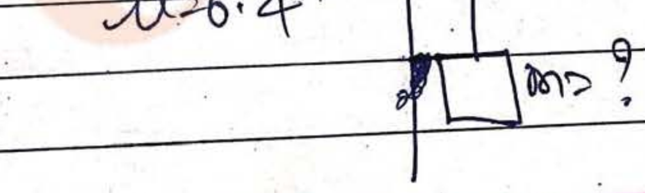


Block is moving with contact velocity on rough horizontal surface as shown in the figure. Find the coefficient of friction "μ_s"

$f_K = \mu_K N$ ∵ $f_K = 10N$, $\mu_K = ?$

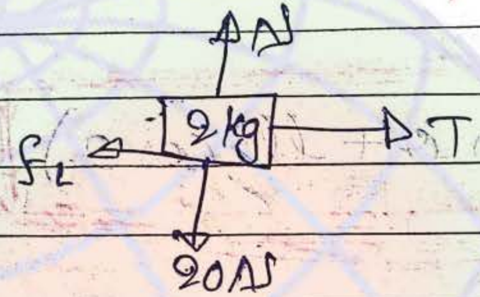
$$1\cancel{0} = \mu_K\, 2\cancel{0}$$
$$\mu_K = 0.5$$

Example:⇒



Find the maximum mass of hanging block, show that block 'A' does not slip

Sol^n >



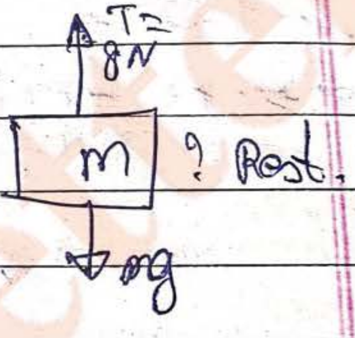
$T = f_L = 8N$

$N = 20N$

$f_L = \mu_s N$

$= 0.4 \times 20$

$= 8N$



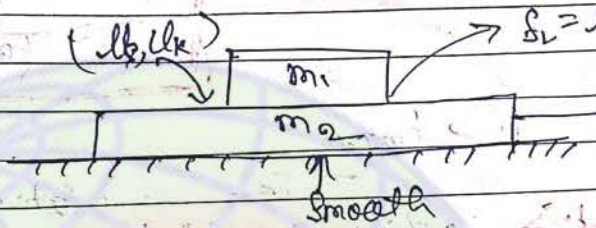
$mg = 8$

$m = 0.8 kg$

⇒ Problem related to double block system

Case ①:→ $\boxed{F_{max} = (m_1+m_2)\mu_s g}$

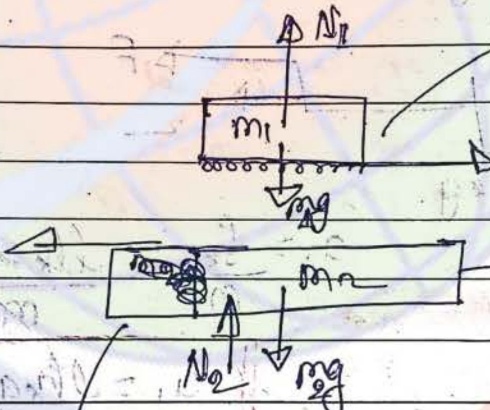
$f_L = \mu_s N_1 = \mu_s m_1 g$



maximum horizontal force applied on lower block such that both blocks moves together with common accⁿ.

जिस पर force नहीं लग रहा

No slipping condition



$$a_{max} = \frac{f_{max}}{m_1} = \frac{f_L}{m_1}$$

$$a_{max} = \frac{\mu_s m_1 g}{m_1}$$

$$\boxed{\therefore\ a_{max} = \mu_s g}$$

max common acceleration,

$$(a_c)_{max} = \mu_s g$$

$$F_{max} = (m_1+m_2)\, a_{max}$$

$$\boxed{F_{max} = (m_1+m_2)\mu_s g}$$

$a_c \Rightarrow$ common acc^n

(i) If $F \le F_{max} \Rightarrow$ Both block moves together (No slipping)

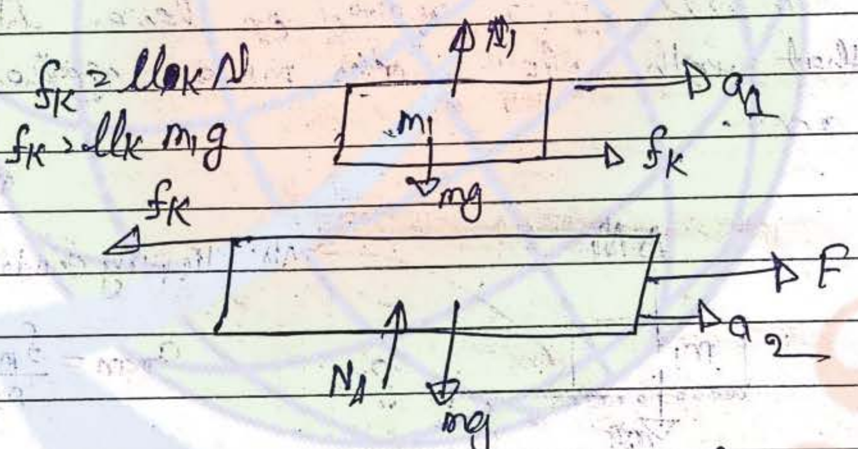
$$\boxed{a_c = \frac{F}{(m_1+m_2)}}$$

(ii) If $F > F_{max}$

There is relative motion (slipping) between m_1 and m_2. Both blocks moves with different accelerations.

$f_K = \mu_K N$

$f_K = \mu_K m_1 g$



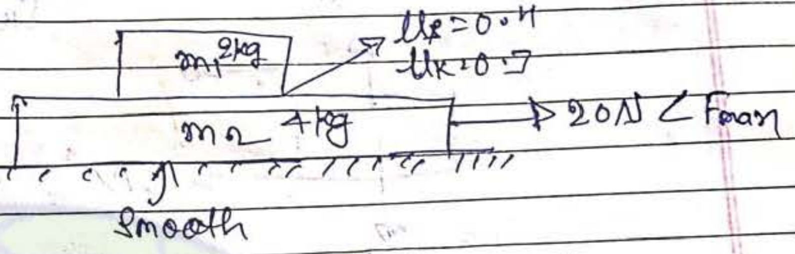
$$a_1 = \frac{f_K}{m_1} = \frac{\mu_K \cancel{m_1} g}{\cancel{m_1}} = \mu_K g$$

$$\boxed{a_1 = \mu_K g}$$ → जिस पर force नहि लगा है

$$F - f_K = m_2 a_2$$

$$\boxed{a_2 = \frac{F - \mu_K m_1 g}{m_2}}$$

Q.)



Find the accⁿ of block of m_1 and m_2

$a_1 = \cancel{0.4 \times g}$
$= \cancel{0.4 \times 10 = 4.0\, m/s^2}$

$a_2 = \cancel{\frac{20 - 0.3 \times 2kg \times 10}{4}}$
$\cancel{= \frac{20-6}{4} = \frac{24}{4} = 6\, m/s^2}$

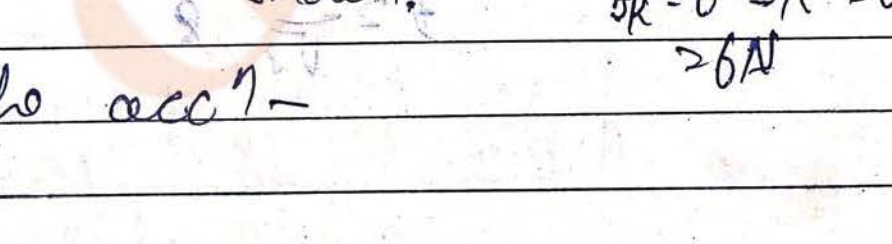
$F_{max} = 6 \times 4$
$= 24\, N$

$a_c = a_1 = a_2 = \frac{\cancel{20}^{10}}{\cancel{6}_3} = \frac{10}{3}\, m/s^2$

There is no slipping.

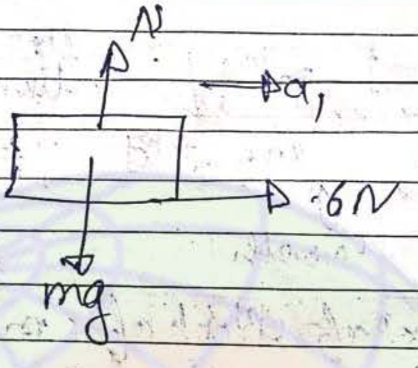
Q2.)

इस body को चलाने का काम friction force कर रहा है।



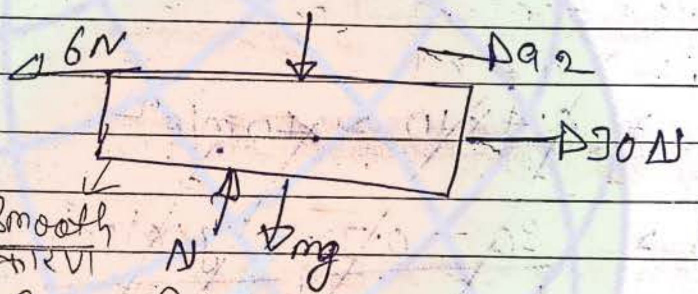
$f_k = 0.3 \times 20$
$= 6N$

Find the accⁿ –



$f_k = \mu_k N$
$= 0.3 \times 20$
$= 6N$

$a_1 = \frac{6}{2} = 3 m/s^2$

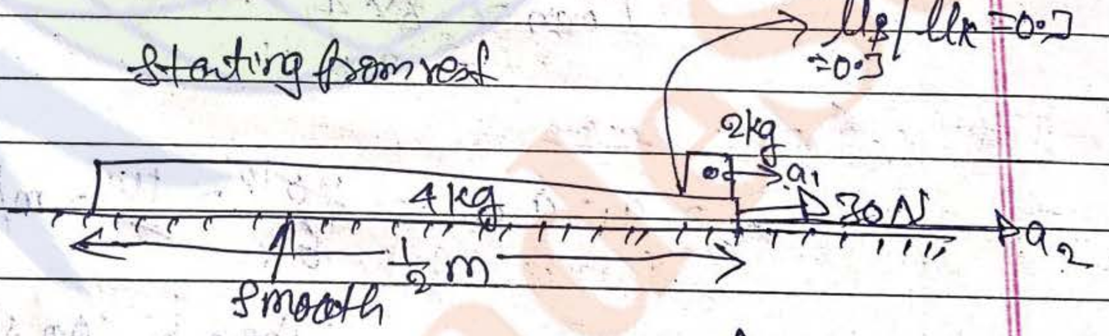


$a_2 = \frac{30-6}{4}$
$= 6 m/s^2$

नीचे smooth होने के कारण friction force नहीं लग रहा है।

Now otha question.

Starting from rest



(Initial) u=0

$$S_{rel} = \cancel{u_{rel} \times t} \xrightarrow{} 0 + \frac{1}{2} a_{rel} t^2$$

$$\frac{1}{2} = \frac{1}{2}(6-3) t^2$$

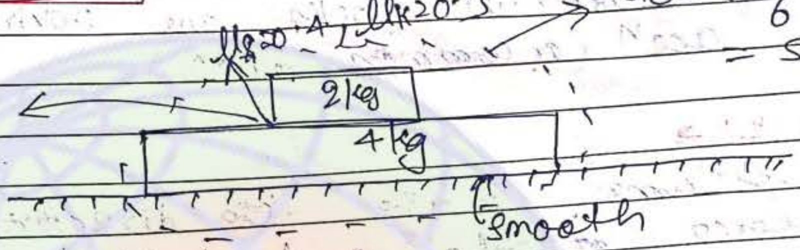
$$t = \frac{1}{\sqrt{3}} s$$

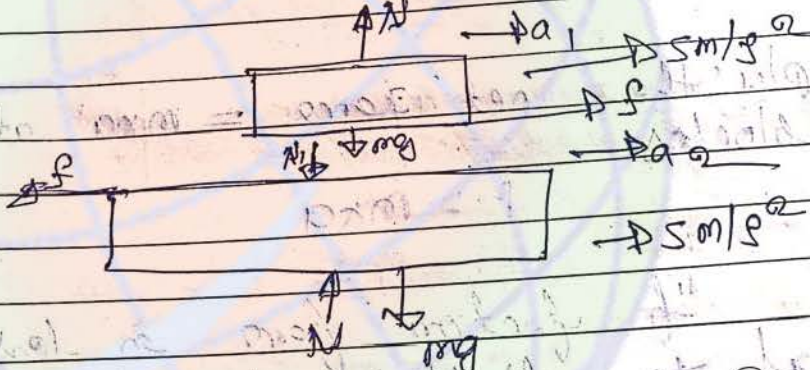
very Important method =>

method-2

$a_c = \frac{30}{6}$
$= 5\ m/s^2$

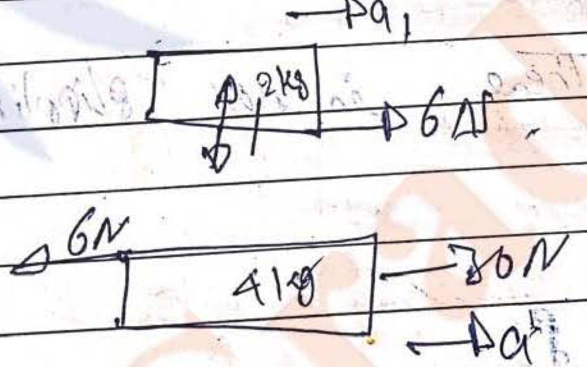
$f_L = 0.4 \times 20$
$\Rightarrow 8N$





$f = 2 \times 5 = 10N > f_L$

There is slipping



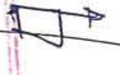
Steps of Short method:⇒

1) Step -1st:⇒

~~P~~ Assume all blocks are moving with same accⁿ (or common accⁿ)

11) Step 2:⇒

Assume ~~&~~ the ~~the~~ direction of friction force at the contact surfaces.



III)

Apply the net force = m×a at all the blocks

$$F = m \times a$$

If friction force is less than or equal to limiting at that contact surface.

$$f \leq f_L$$

Then our ~~as~~ above assumption are right.

There is no slippling at that contact

And

11) $f > f_L$

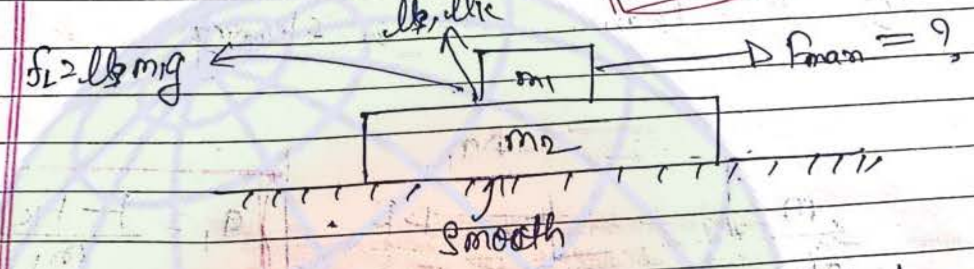
There is slipping at that contact surface.

Then again ~~form~~ ~~D~~ draw the F.B.D. of all the blocks assuming kinetic friction at ~~the~~ all the

contact surface then
apply $F = m \times a$

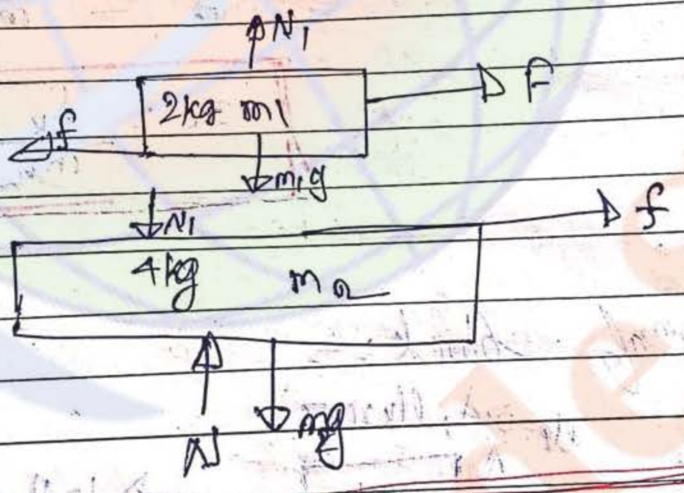
⇒ Case ②

$$\boxed{F_{max} = (m_1+m_2)\frac{\mu_s m_1 g}{m_2}}$$



maximum oriental force applied on upper block so that both blocks moves together.

(अधिकतम force उसको कितना देवेंगे)



$$\boxed{(a_c)_{max} = (a_2)_{max} = \frac{f_L}{m_2} = \frac{\mu_s m_1 g}{m_2}}$$

$m_1 = 2kg$

$m_2 = 4kg$

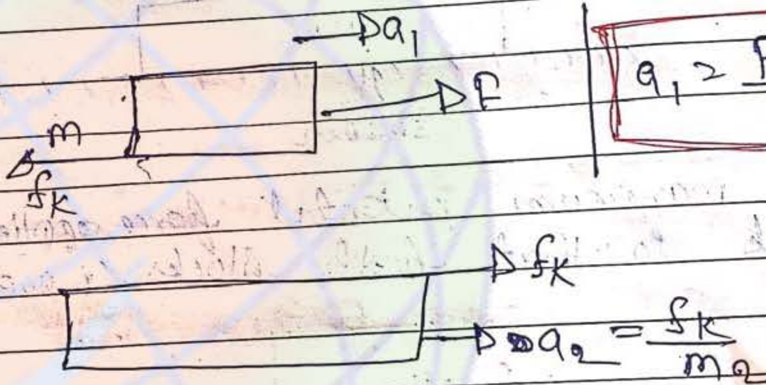
$F_{max} = \frac{6 \times \cancel{4} \times 2}{\cancel{4}}$

$= 12N$

(i) If $F \leq F_{max} \rightarrow$ No slipping

$$\boxed{a_c = \frac{F}{m_1+m_2}}$$

(ii) If $F > f_{max}$, There is slipping

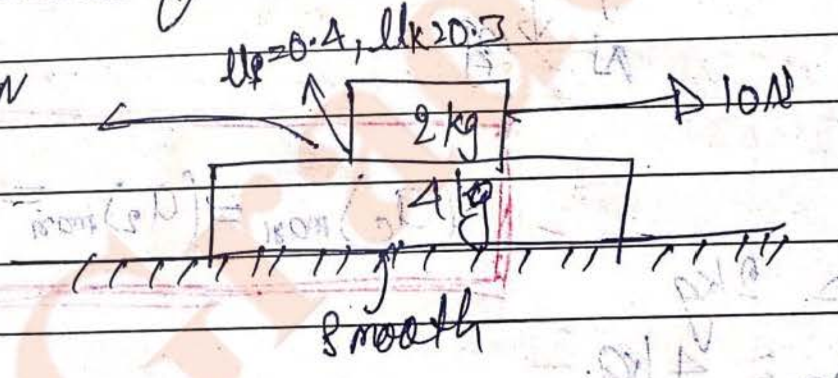


$$\boxed{a_1 = \frac{F - f_K}{m_1}}$$

$$\boxed{a_2 = \frac{f_K}{m_2}}$$

Q-> Find accⁿ of block :->

$f_L = \mu_s . N$
$= 8N$

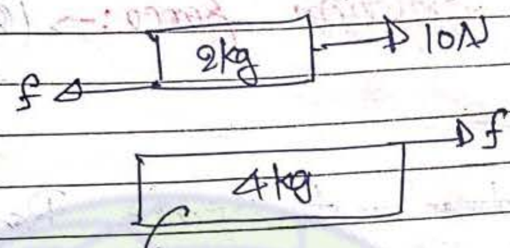


Solⁿ->

$$a_c = \frac{\cancel{10}}{\cancel{6}} = \frac{5}{3} m/s^2$$

$\frac{4}{5} = \frac{4}{5}$ m/s

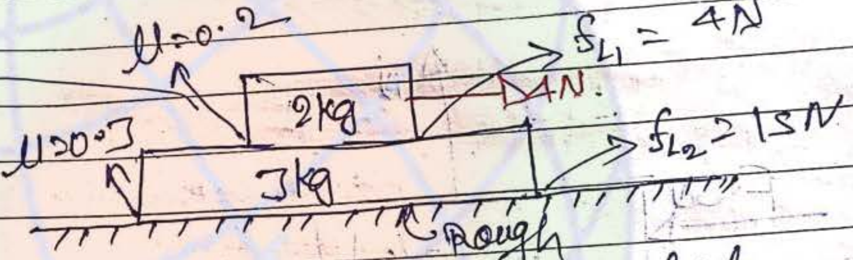
$3 \times \frac{4}{5}$



$f = 4 \times \frac{5}{3} = \frac{20}{3} N < f_L$

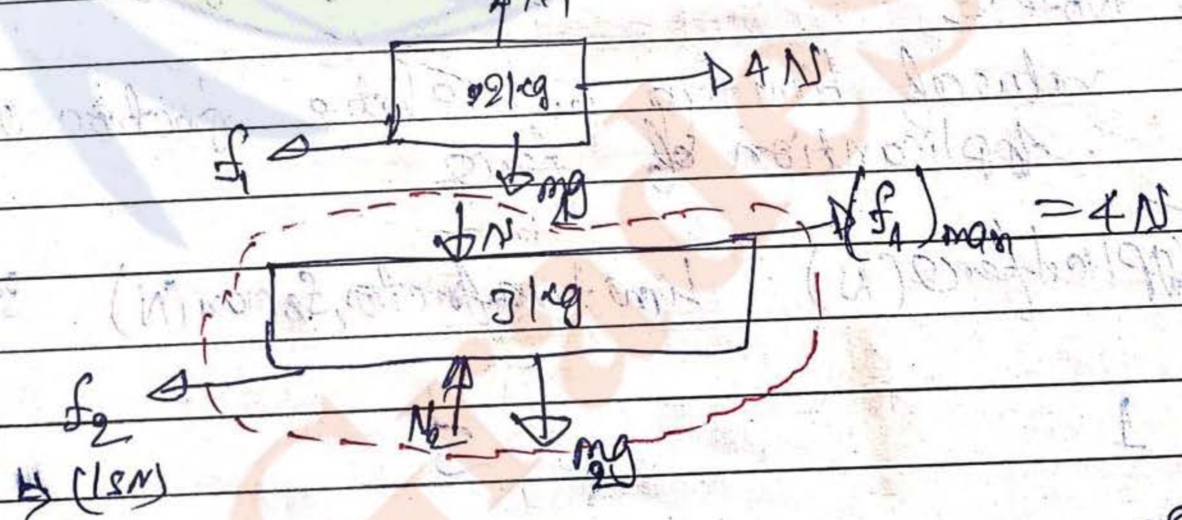
Example :→

$f_L = 0.2 \times 20 = 4N$



Find the acc^n of block and friction at all the contact surfaces.

~~$a_c = \frac{10}{5} = 2\ m/s^2 > 3.$~~



acc^n = 0

f = 0

HW

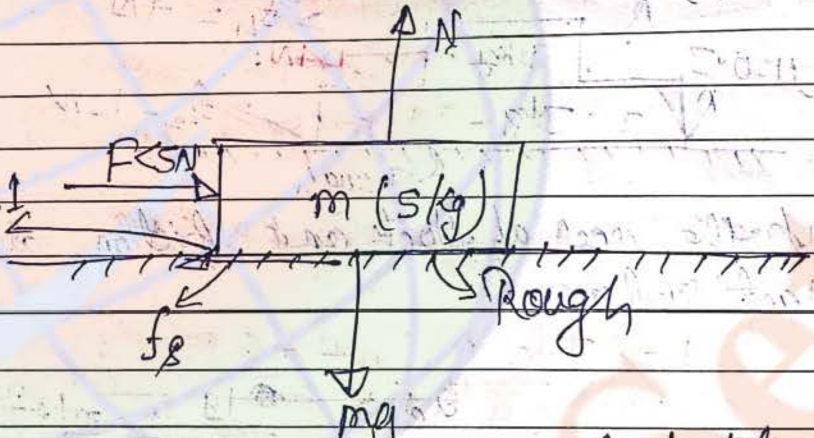
Self Study:⇒

* Properties of friction force:→ (or law of friction)

Property 1st:→

~~If a body does not~~ Read ⇒ Ravie ⇒ P-172
H.C. Verma ⇒ P-88

Q.)

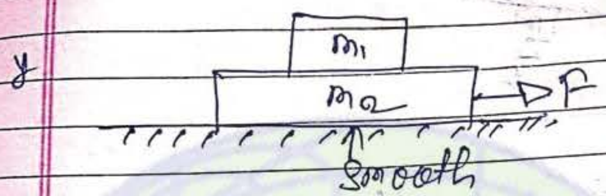


Applied force < 5N

Note:⇒
value of limiting and static friction on application of force

Applied force (N)	Limiting friction, $f_{s,max}$ (N)	Static friction f_s (N)
1	5	1
3	5	3
6	5	5
10	5	5

For Double block system: →



1) $\boxed{a_{max} = \mu_s g}$

ii) $\boxed{F_{max} = (m_1 + m_2)\mu_s g}$

iii) $F \le F_{max} \Rightarrow$ (No slippling)

$$\boxed{a_c = \frac{F}{m_1 + m_2}}$$

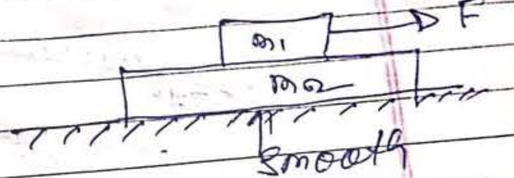
common acc^n

2.) If $F > F_{max}$,
There is slipping

$$\boxed{a_1 = \mu_k g}$$

and

$$\boxed{a_2 = \frac{F - \mu_k m_1 g}{m_2}}$$



1) $\boxed{a_{max} = \frac{\mu_s m_1 g}{m_2}}$ or $\boxed{\mu_s g \times \frac{m}{m_2}}$

ii) $\boxed{F_{max} = (m_1 + m_2)\mu_s . g \times \frac{m_1}{m_2}}$

iii) $F \le F_{max} \Rightarrow$ (No slipping)

$$\boxed{a_c = \frac{F}{m_1 + m_2}}$$

2.) If $F >$ max
There is slipping

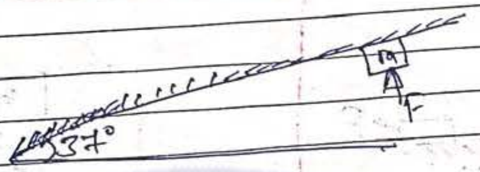
$$\boxed{a_1 = \frac{F - f_K}{m_1}}$$

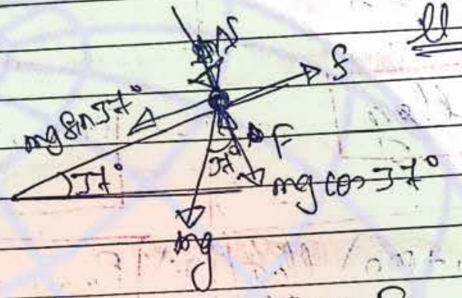
and

$$\boxed{a_2 = \frac{f_K}{m_2}}$$

D.P.P-8 ⇒

1.)





$\mu = 0.5$

$N + mg\cos 37° = F$ — (Statical)

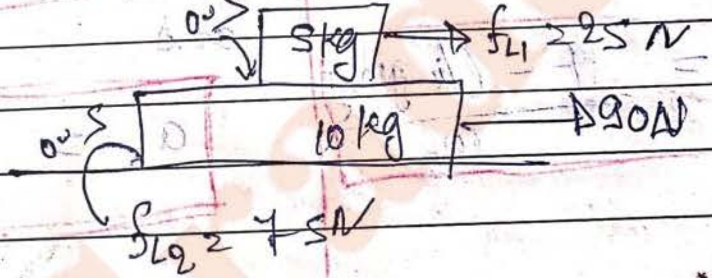
$N = (F - mg\cos\theta)$

$mg\sin\theta = f_L = \mu\{F - mg\cos\theta\}$

$\Rightarrow \frac{mg\sin\theta + \mu mg\cos\theta}{\mu} = F$

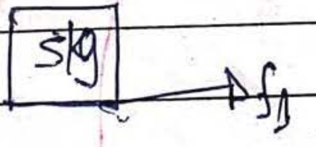
$\Rightarrow \frac{10\times10\left(\frac{3}{5} + 0.5\times\frac{4}{5}\right)}{0.5} = 200N.$

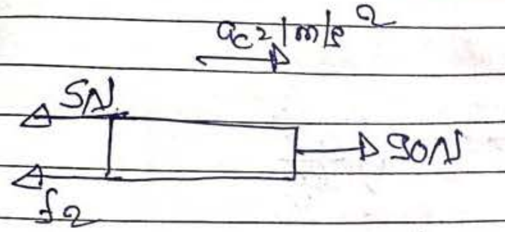
2.) IV.)

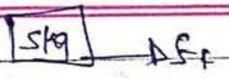


app. friction [illegible]

$a_c = \frac{90-75}{15} = 1 m/s^2$





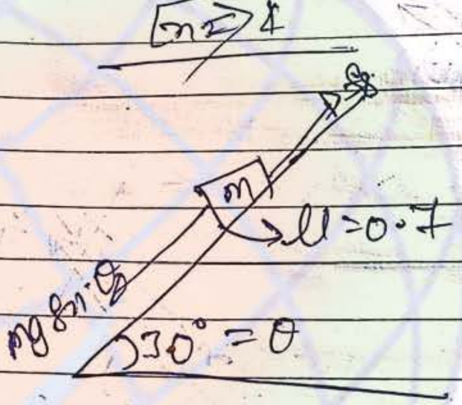


$f_1 = 5 \times 1 = 5N < f_{L1}$

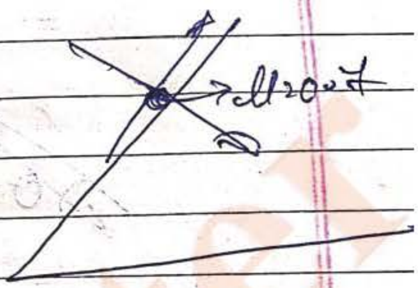
$90 - 5 - f_2 = 10 \times 1$

$f_2 = 75N = f_{L2}$

5.)



or



$\theta = \tan$

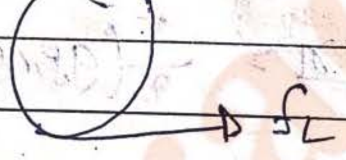
$\theta = \tan^{-1}(\mu_s)$

$= \tan^{-1}(0.7) > 30^\circ$

$f_s = mg\sin\theta$

$= \cancel{2} \times 9.8 \times \frac{1}{\cancel{2}} = 9.8N$

6.)



$(f_{max}) = \mu mg$

$a_{max} = \mu g$

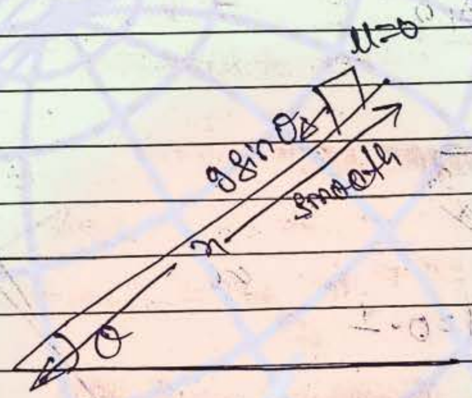
$s = \cancel{ut} + \frac{1}{2}at^2$

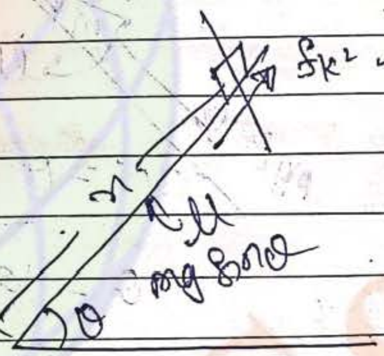
$$S = \frac{1}{2}\mu g t^2$$

$$t_{min} = \sqrt{\frac{2S}{a}} = \sqrt{\frac{2S}{\mu g}}$$

$$t_{min} \propto \frac{1}{\sqrt{\mu}}$$

9.)





$$x = \frac{1}{2}(g\sin\theta)t^2$$

~~$x = \frac{1}{2}(g\sin\theta)t^2$~~

$$a_1 = (g\sin\theta - \mu g\cos\theta)$$

$$x = \frac{1}{2}(g\sin\theta - \mu g\cos\theta)(nt)^2$$

$$x = \frac{1}{2}(g\sin\theta - \mu g\cos\theta)n^2t^2$$

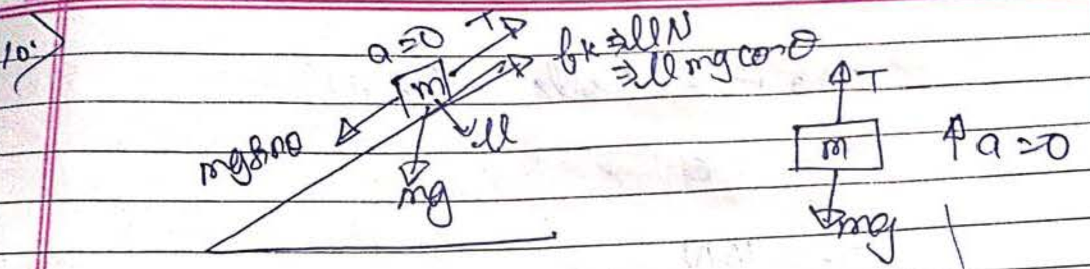
$$\frac{1}{2}(g\sin\theta)t^2 = \frac{1}{2}(g\sin\theta - \mu g\cos\theta)n^2t^2$$

$$\sin\theta = (\sin\theta)n^2 - \mu\cos\theta \cdot n^2$$

$$\mu = \frac{\sin\theta(n^2-1)}{n^2\cos\theta}$$

$$\mu = \tan\left(1 - \frac{1}{x^2}\right)$$

10.



$\mu mg\cos\theta + T = mg\sin\theta$

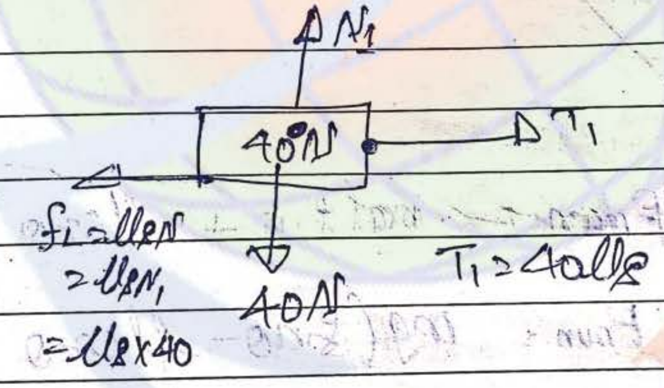
$T = mg \times \frac{1}{2} - \frac{1}{2\sqrt{3}} mg \times \frac{\sqrt{3}}{2}$

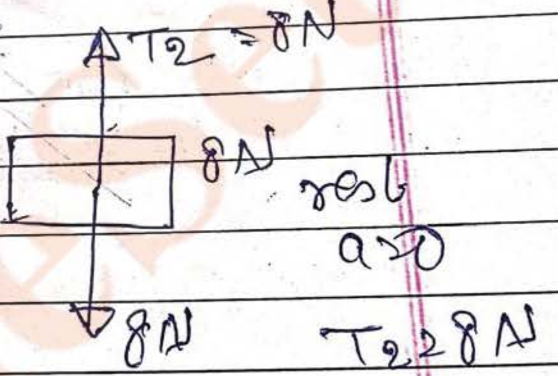
$T = mg\left(\frac{1}{2} - \frac{1}{6}\right)$

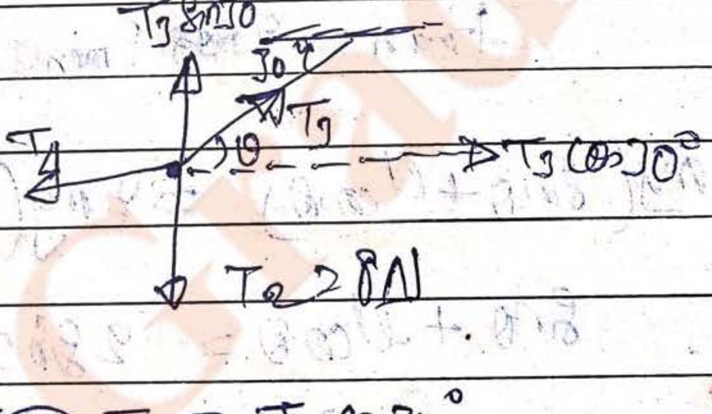
$T = \frac{mg}{3} = mg$

$m = \frac{M}{3}$

11.







$T_1 = T_3\cos 30^\circ$

$40\mu_s = \frac{T_3\sqrt{3}}{2}$

$$\boxed{\delta = \tan^{-1}\mu_s}$$

$T\frac{\sqrt{3}}{2} = 80\mu_s$ —②

$\frac{T}{2} = 8$

$T = 16N$

From eq ②

$\mu_s = \frac{16\sqrt{3}}{80} = \frac{\sqrt{3}}{5} = \frac{1.73}{5}$

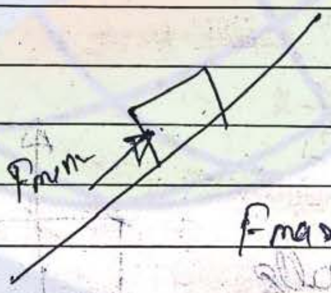
12.) $\delta = \tan^{-1}\mu_s$

$\mu_s = \tan\theta$

$= \tan 45°$

$\mu_s = 1$

17.)



$F_{max} = mg(\sin\theta + \mu\cos\theta)$

$F_{min} = mg(\sin\theta - \mu\cos\theta)$

$F_{max} = 2 F_{min}$

$mg(\sin\theta + \mu\cos\theta) = 2mg(\sin\theta - \mu\cos\theta)$

$\sin\theta + \mu\cos\theta = 2\sin\theta - 2\mu\cos\theta$

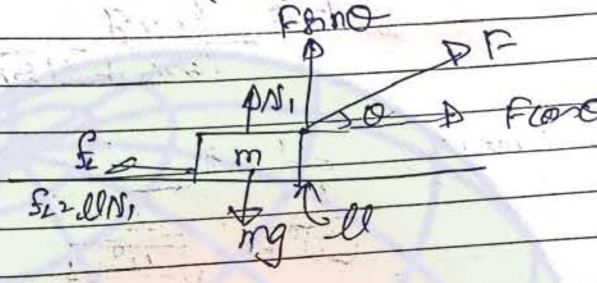
$\sin\theta = 3\mu\cos\theta$

$$\boxed{\tan\theta = 3\mu}$$

$\tan\theta = \mu_s$
$\theta = \tan^{-1}(\mu_s$

19. $\tan\theta = \mu_s$

$\theta = \tan^{-1}(\mu_s)$



$$N_1 + F\sin\theta = mg$$

$$F\cos\theta \geq f_L$$

$$F\cos\theta \geq \mu(mg - F\sin\theta)$$

$$F(\cos\theta + \mu\sin\theta) \geq \mu mg$$

$$F = \frac{\mu mg}{(\cos\theta + \mu\sin\theta)}$$

For F to be min,

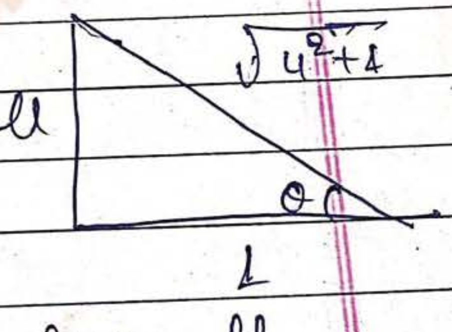
$$x = \cos\theta + \mu\sin\theta = \max$$

$$\frac{dx}{d\theta} = 0$$

$$-\sin\theta + \mu\cos\theta = 0$$

$$\mu\cos\theta = \sin\theta$$

$$\boxed{\tan\theta = \mu}$$



$$\sin\theta = \frac{\mu}{\sqrt{\mu^2+1}}$$

$$\cos\theta = \frac{1}{\sqrt{\mu^2+1}}$$

$$F(\cos\theta + \mu\sin\theta) \geq \mu mg$$

$$F = \frac{\mu mg}{\cos\theta + \mu\sin\theta}$$

$$F_{min} = \frac{\mu mg}{\frac{1}{\sqrt{\mu^2+1}} + \frac{\mu^2}{\sqrt{\mu^2+1}}}$$

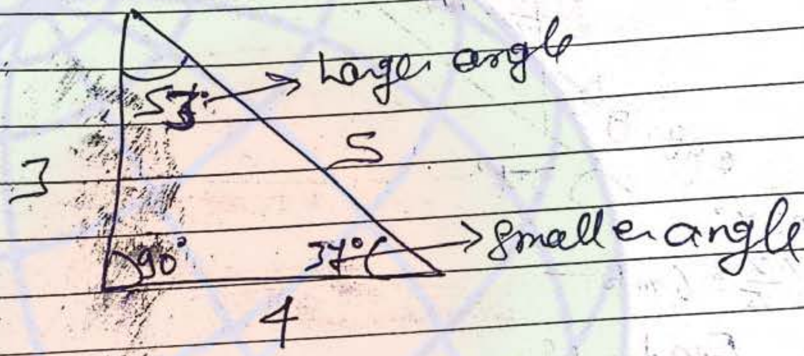
$$\boxed{F_{min} = \frac{\mu mg}{\sqrt{\mu^2+1}}}$$

$$F_{min} = \frac{\frac{3}{4} \times 10 \times 10}{\sqrt{\frac{9}{16} + 1}}$$

$$F_{min} = \frac{\frac{3}{\cancel{4}} \times \overset{2}{\cancel{10}} \times 10 \times \cancel{4}}{5} = 60\,N \text{ Ans}$$

Note:→

In physics this value is generally used who is helpful.



So,

$$\boxed{\sin 37^\circ = \frac{3}{5}}$$

$$\boxed{\cos 37^\circ = \frac{4}{5}}$$

$$\boxed{\sin 53^\circ = \frac{4}{5}}$$

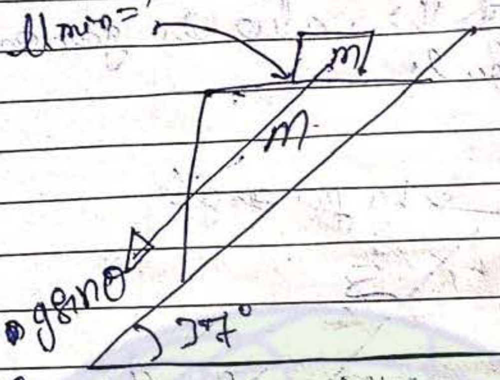
$$\boxed{\cos 53^\circ = \frac{3}{5}}$$

~~New type:~~

Date : / /

30|8|201

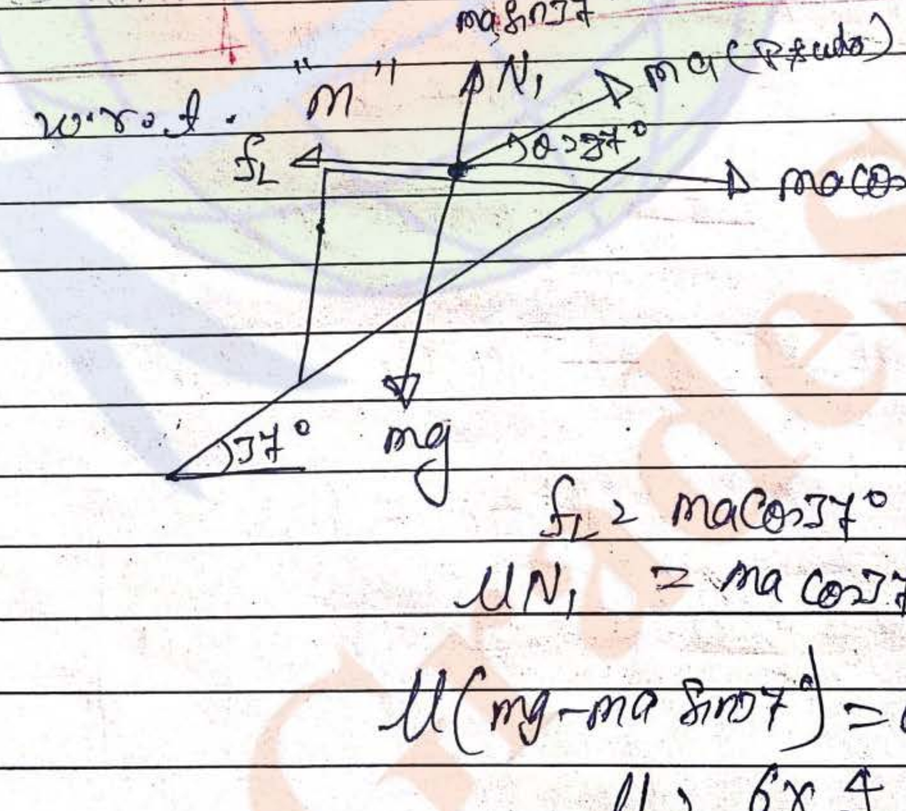
Q.)



3.)

$a = g\sin 37°$
$= 10\times\frac{3}{5} = 6\ m/s^2$

Find the minimum coefficient of friction at the contact surface of m and M ~~that~~ so that smaller block (m), does not slip over the surface of big block (M)



$$f_L = ma\cos 37°$$

$$\mu N_1 = ma\cos 37°$$

$$\mu(mg - ma\sin 37°) = ma\cos 37°$$

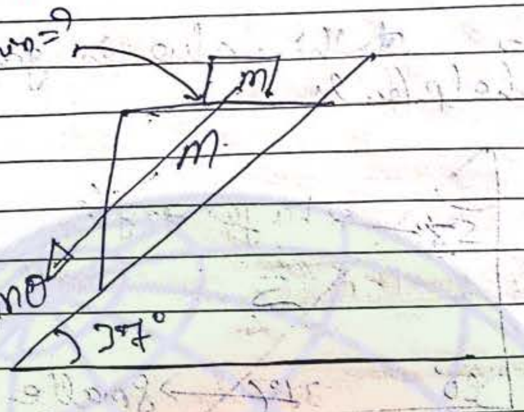
$$\mu = \frac{6\times\frac{4}{5}}{10-6\times\frac{3}{5}} = \frac{6\times\cancel{4}}{\cancel{32}\,8} = \frac{3}{4}$$

30/8/2011

New type: ⇒

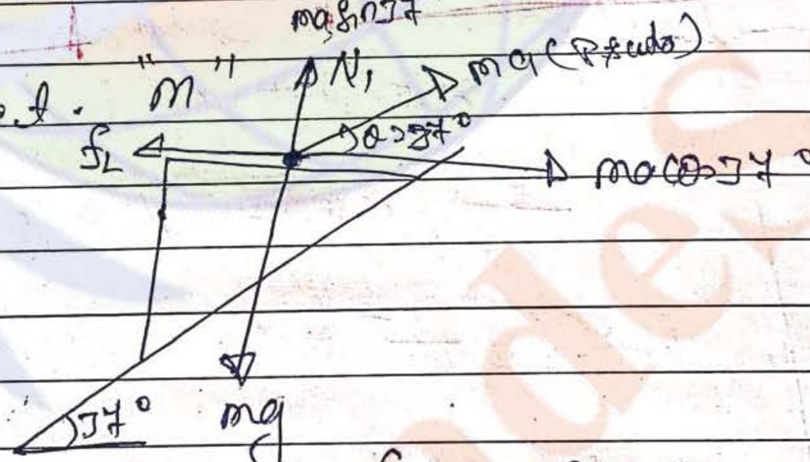
Q.)

3.)



$a = g\sin 37^\circ$
$= 10\times\frac{3}{5} = 6\,m/s^2$

Find the minimum coefficient of friction at the contact surface of m and M so ~~that~~ smaller block (m), it does not slip over the surface of big block (M)



$f_L = ma\cos 37^\circ$

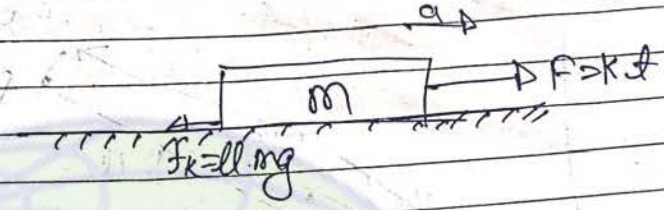
$\mu N_1 = ma\cos 37^\circ$

$\mu(mg - ma\sin 37^\circ) = ma\cos 37^\circ$

$$\mu = \frac{6\times\frac{4}{5}}{10-6\times\frac{3}{5}} = \frac{6\times\cancel{4}}{\cancel{32}\,8} = \frac{3}{4}$$

20/8/2011

3.)



$$a = \frac{kt - \mu mg}{m}$$

$$\frac{m\,dv}{dt} = (kt - \mu mg)$$

$$m\int_0^v dv = \int_0^t (kt - \mu mg)\,dt$$

$$mv = \left(\frac{kt^2}{2} - \mu mgt\right)$$

$$m\int_0^x dx = \int_0^t \left(\frac{kt^2}{2} - \mu mgt\right)dt$$

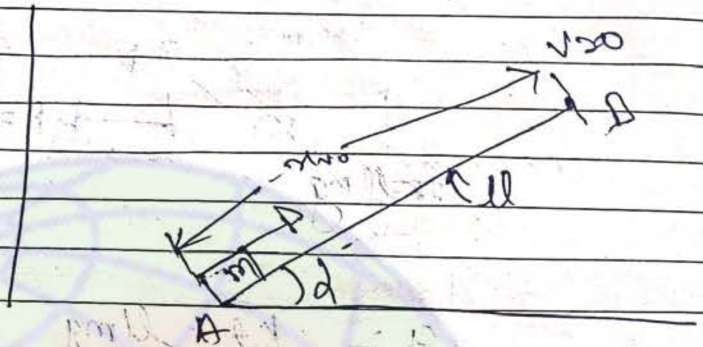
$$mx = \left[\frac{kt^3}{6} - \frac{\mu mgt^2}{2}\right]_{t_0}^{t} //$$

$$kt_0 \geq \mu mg$$

$$t_0 = \left(\frac{\mu mg}{k}\right)$$

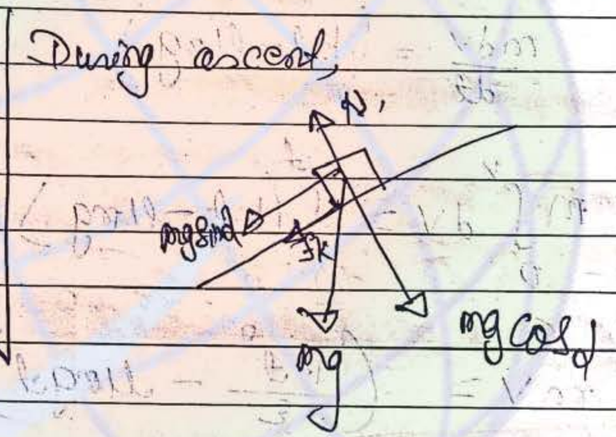
$$\frac{0 \text{ to } t_0}{v=0}$$

5.)



$f_K = \mu mg\cos\alpha$

During ascent,



$a_1 = g\sin\alpha + \mu g\cos\alpha$

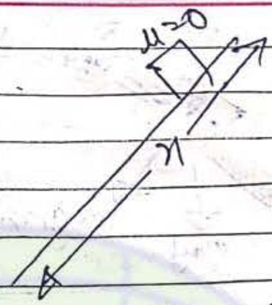
$0^2 = V_0^2 - 2a_1 x$ —

$v_0^2 = 2a_1 x$ — ①

$x = \frac{1}{2}a_1 t_1^2$

$0 = v_0 - a_1 t_1$

$t_1 = \frac{v_0}{a_1} = \frac{\sqrt{2a_1 x}}{a_1} = \sqrt{\frac{2x}{a_1}}$



$x = \frac{1}{2} a_2 t_2^2$ — ①

$a_2 = (g\sin\alpha - \mu g\cos\alpha)$

$\frac{1}{2} a_1 t_1^2 = \frac{1}{2} a_2 t_2^2$

$\frac{t_2}{t_1} = \sqrt{\frac{a_1}{a_2}}$

$\frac{2t_1}{t_1} = \sqrt{\frac{a_1}{a_2}}$

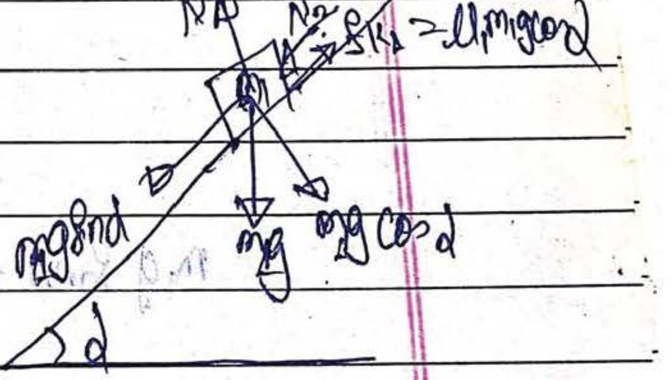
$a_1 = 4a_2$ ①

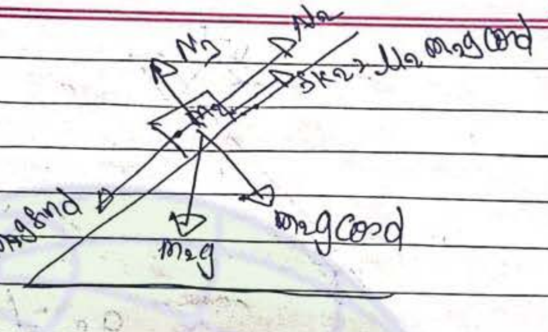
$g(\sin\alpha + \mu\cos\alpha) = 4g(\sin\alpha - \mu\cos\alpha)$

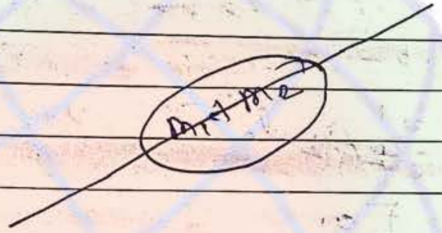
$a_1 = (g\sin\alpha + \mu g\cos\alpha)$

10.)

$(\mu > \mu_2)$







$$a_c = \frac{m_1 g \sin\alpha + m_2 g \sin\alpha - \mu_1 m_1 g \cos\alpha - \mu_2 m_2 g \cos\alpha}{m_1 + m_2}$$

$$m_1 g \sin\alpha - f_{k_1} + N_2 = m_1 a_c \quad ②$$

$$N_2 =$$

(b)

$$a_c \Rightarrow \frac{Aa - bf}{m_1 + m_2}$$

For α min,

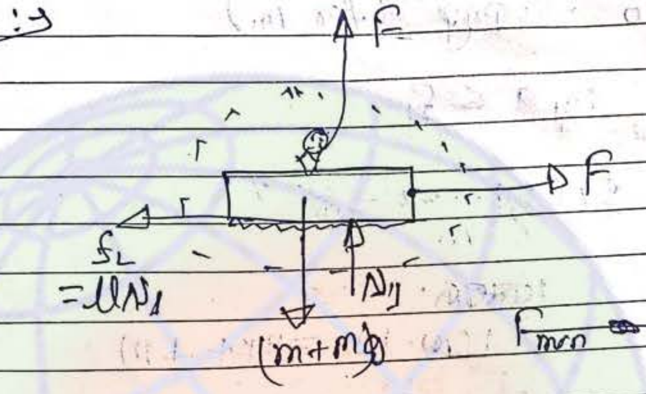
$$(a_c)_{min} = 0$$

$$m_1 g \sin\alpha + m_2 g \sin\alpha = \mu_1 m_1 g \cos\alpha + \mu_2 g m_2 \cos\alpha$$

$$\tan\alpha_{min} = \frac{\mu_1 m_1 + \mu_2 m_2}{m_1 + m_2}$$

$$\alpha_{min} = \tan^{-1}\left(\quad \right)$$

11. Ans :-)



$N_1 + F = (m+M)g$

F_{min} → No slipping

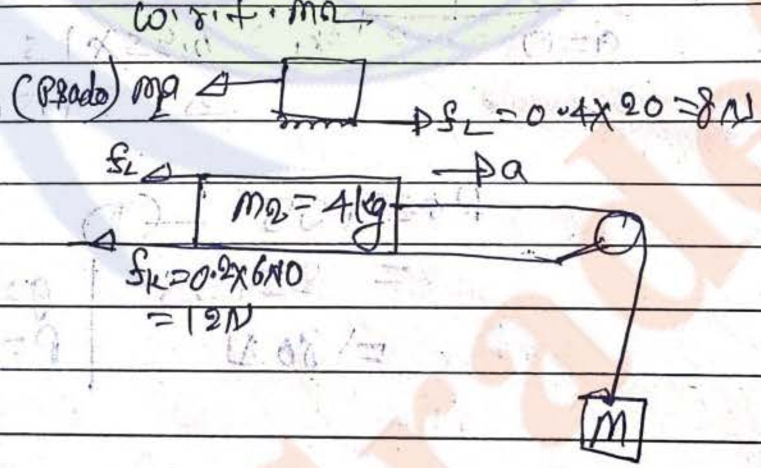
$F \le f_L$ → No slipping

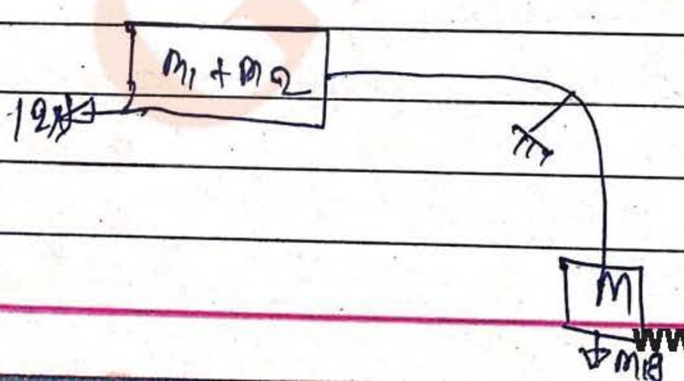
$F_{min} = f_L = \mu N_1$

$F = \mu((m+M)g - F)$

$$F_{min} = \frac{\mu(m+M)g}{1+\mu}$$

12.)





$$a = \frac{Mg - 12}{6 + M}$$ (D)

14) ans

For No slipping (for m_1)

$$m_1 a \le f_L$$

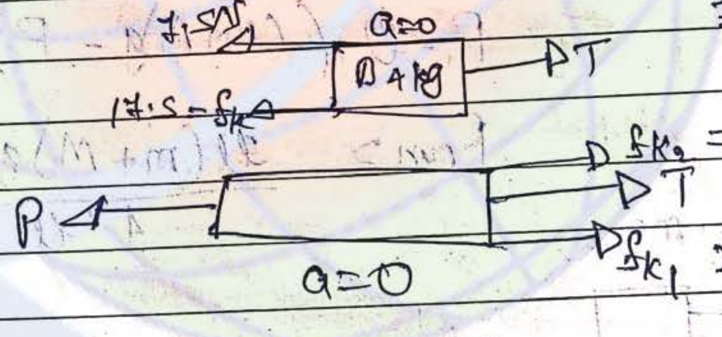
$$\frac{2\times(mg-12)}{6+m} = \cancel{8}\ 4$$

$$10m-12 = 24+4m$$

$$6m = 36$$

$$\boxed{m = 6 kg}$$

19.)



$T = 17.5 + 7.5$
$\Rightarrow 25N$

(Static)

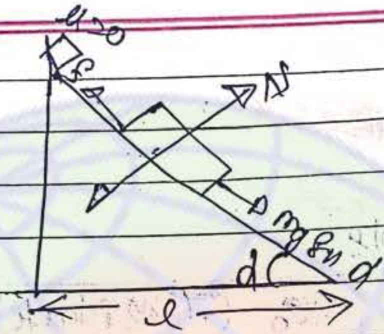
$f_{k_2} = 0.25\times 7 \Rightarrow 17.5N$

$f_{k_1} = 0.25\times 15$
$\Rightarrow 37.50 N$

$P = T + 55$ ①
$= 25+55$
$\Rightarrow 80 N$

$g = 9.8 m/s^2$
$P = 78.4 N$

14) ans



$$\cos\alpha = \frac{l}{x}$$

$$x = l\sec x$$

$$x = 0\times t + \frac{1}{2}(g\sin\alpha - \mu g\cos\alpha)t^2$$

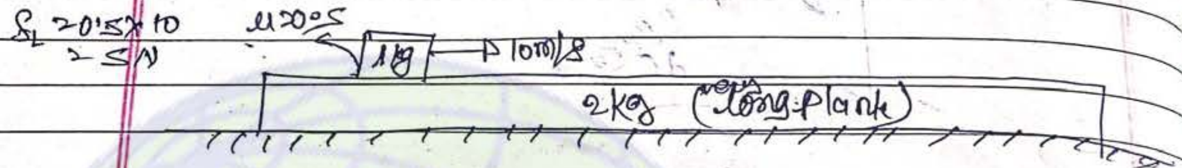
$$t^2 = \frac{2x}{g\sin\alpha - \mu g\cos\alpha}$$

For min 't'

t^2 is min,

$$\frac{d(t)^2}{d\alpha} = 0 \rightarrow$$

Example. →

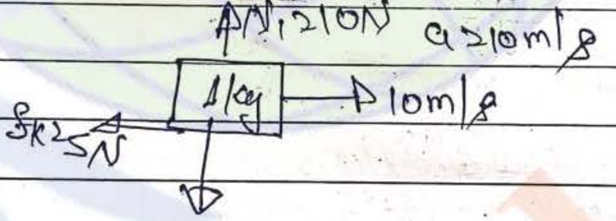


A block on mass 1kg is projected with Initial oriental velocity of 10m/s on a very long plank which is kept on smooth oriental surface.

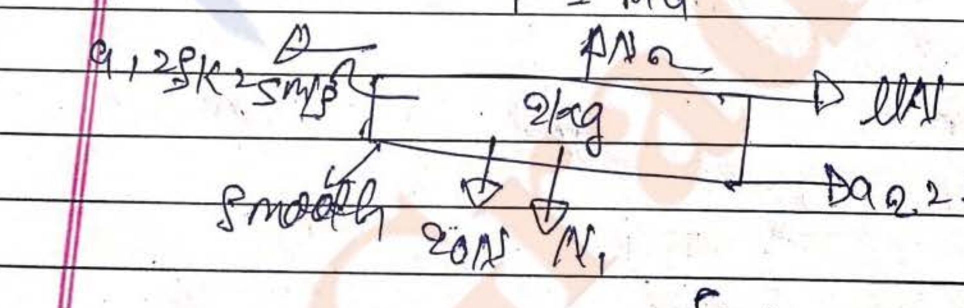
Coeffient of friction between 1kg and 2kg block plank is 0.5.

1) Find the time of after which smaller blocks comes to rest with respect to plank.

Sol →



$F = ma$



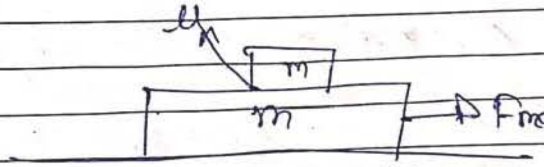
$a_2 = \frac{f_K}{m_2} = \frac{5}{2} m/s^2$

$f_K = 0.5 \times 10 = 5N$

$V_{rel} = U_{rel} + a_{rel} t$

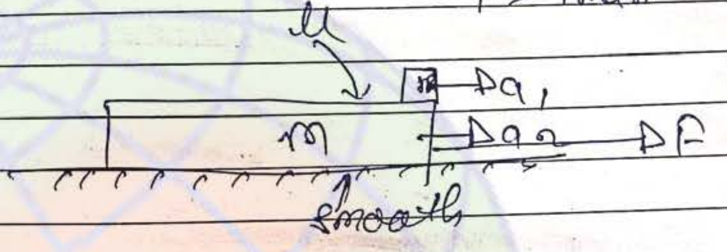
$0 = 10 - \left(5 + \frac{5}{2}\right) t$ $t = \frac{4}{3}$

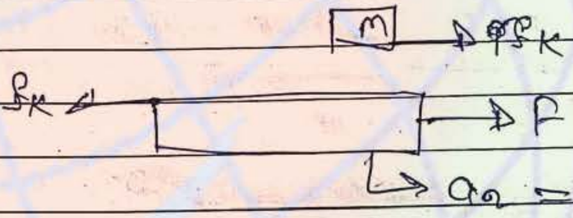
15.)



$F_{max} = \mu g(m+M)$

$F > f_{max} \rightarrow$ slipping





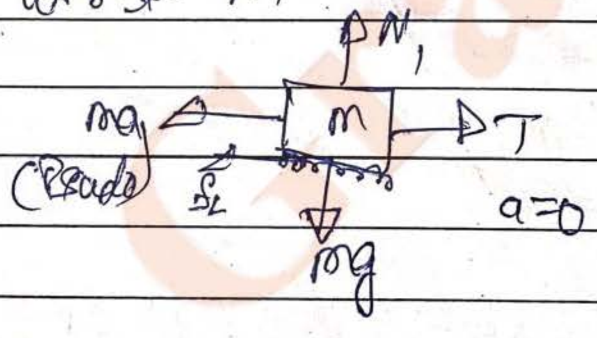
$a_2 = \frac{F - f_k}{M} = \frac{F - \mu mg}{M}$

$S_{rel} = \frac{1}{2} a_{rel} t^2$

$t = \sqrt{\frac{2 s_{rel}}{a_{rel}}}$

$= \sqrt{\frac{2L}{(a_2 - a_1)}}$

16.) w.r.t. M



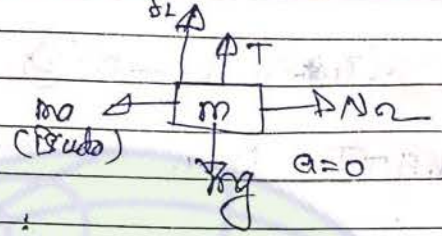
$a = 0$

$a = \frac{F}{2m+M}$ $\longrightarrow$

$N_1 = mg$ —①

$ma + f_L = T$

$ma + \mu mg = T$ —②



$N_2 = ma$ — ①

$T + f_L = mg$

from eq ①

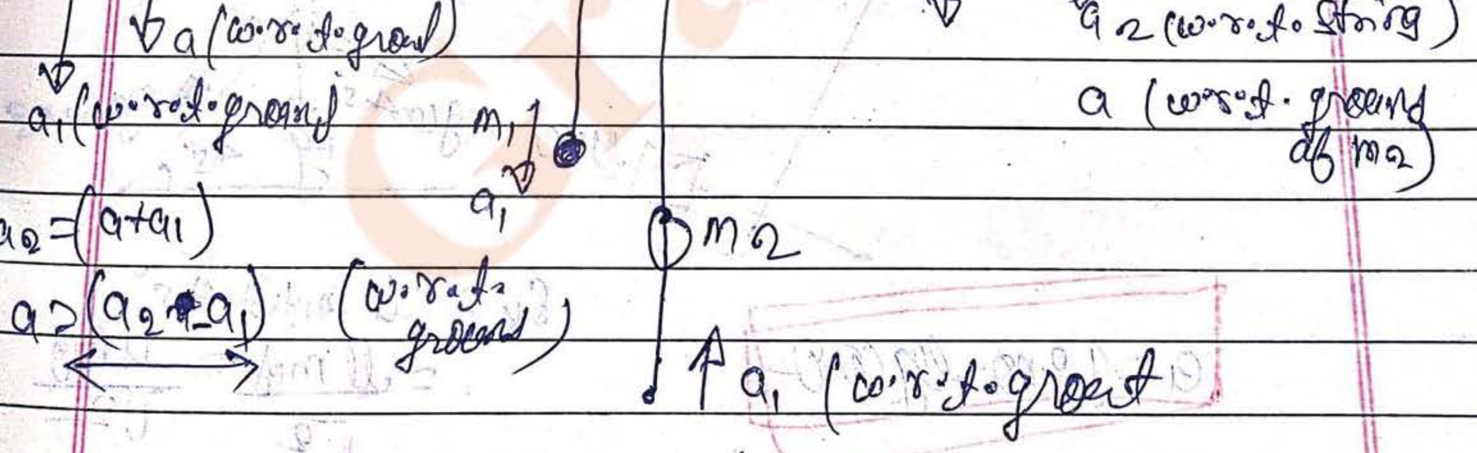
$T + \mu ma = mg$ — ④

$ma + \mu mg + \mu ma = mg$

$ma(1+\mu) = mg(1-\mu)$

$$a_{min} = \frac{g(1-\mu)}{1+\mu}$$

$$F_{min} = (2m+M)\frac{g(1-\mu)}{1+\mu}$$



$a_2 = (a + a_1)$

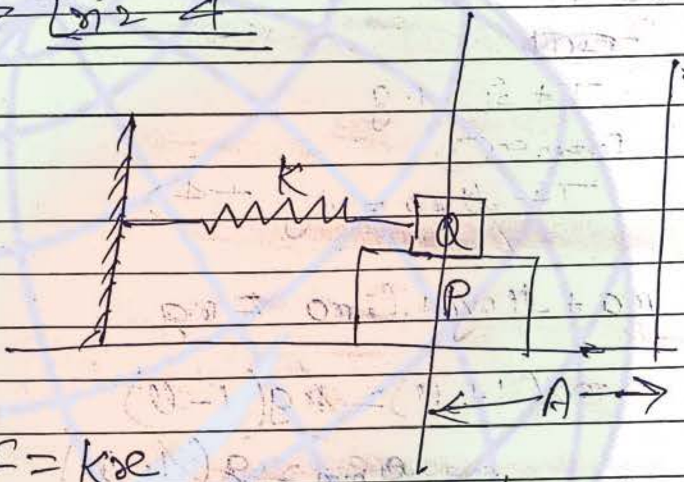
$a = (a_2 - a_1)$ (w.r.t. ground)

$$m_2g - \overset{f_r}{\boxed{T}} = m_2(a_1 \cancel{m_2}) \longrightarrow ②$$

$$\cancel{m_1g} \; m_1g - T = m_1a_1 \longrightarrow ①$$

$\longrightarrow \underline{m = 4}$

0.3)



$F = kx$

$(2m)a_{max} = kx_{max}$

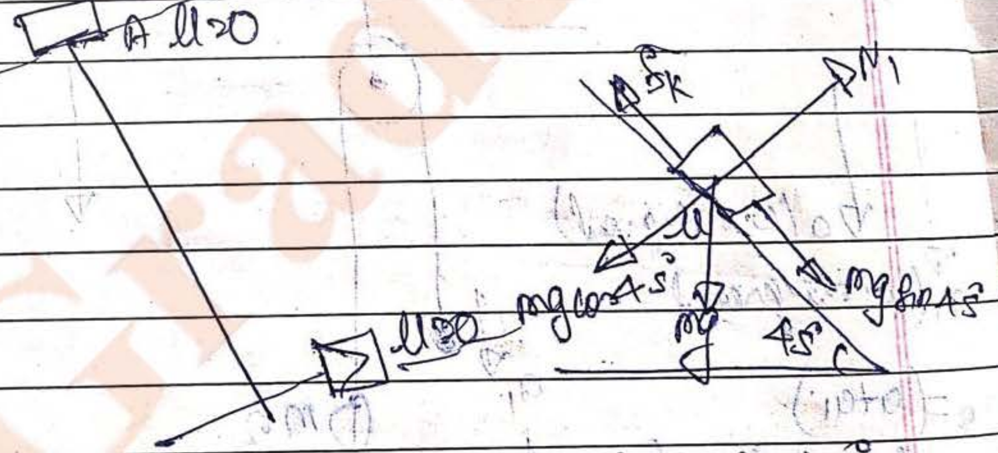
$a_{max} = \frac{k \cdot A}{2m}$

$f_{max} = m\,a_{max}$

$= \frac{\cancel{m}\,k \cdot A}{2\cancel{m}}$

$= \frac{1}{2}kA.$

4.)



$f_K = \mu\,m_1 g\cos 45°$

$= \frac{\mu\,m_1 g}{\sqrt{2}} = \frac{\mu m_1 g}{\sqrt{2}}$

$$\boxed{a = g\sin\theta - \mu g\cos\theta}$$

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

$a = \frac{\cancel{m}}{m}\,\frac{\frac{a}{m}}{F}$

7) $a_1 = \frac{m_1}{m_1}\left(\frac{g}{\sqrt{2}} - \frac{\mu_1 g}{\sqrt{2}}\right) = \frac{g}{\sqrt{2}}(1-0.2)$

$= \frac{0.8\times10}{\sqrt{2}} = \frac{8}{\sqrt{2}}\ m/s^2$

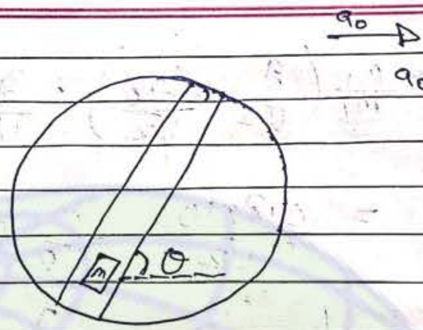
$a_2 = \left(\frac{g}{\sqrt{2}} - \frac{0.3\times g}{\sqrt{2}}\right) = \frac{g}{\sqrt{2}}\times0.7 = \frac{7}{\sqrt{2}}\ m/s^2$

$S_{rel} = \cancel{u_{rel}}^{\,0} + \frac{1}{2}a_{rel}\,t^2$

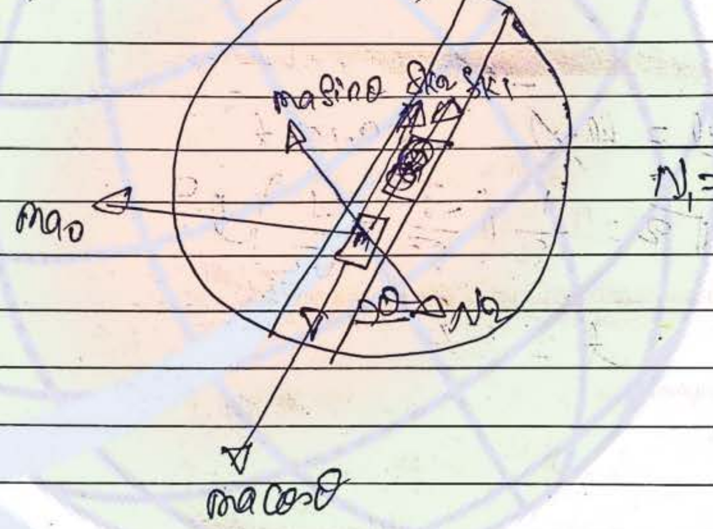
$\sqrt{2} = \frac{1}{2}\left(\frac{8}{\sqrt{2}} - \frac{7}{\sqrt{2}}\right)t^2$

$t = 2s$

S:)



$a_0 = 25 m/s^2$



$N_1 = mg$; $f_{k_1} = \mu mg$

$N_2 = ma\sin\theta$

$f_{k_2} = \mu N_2$

$= \mu ma\sin\theta$

$$a_r = \frac{(ma\cos\theta - f_{k_1} - f_{k_2})}{m}$$

$$= \frac{\cancel{m}a\cos 37^\circ - \frac{2}{5}\cancel{m}g - \frac{2}{5}\cancel{m}a\sin 37^\circ}{\cancel{m}}$$

$$= \overset{5}{\cancel{25}} \times \frac{4}{\cancel{5}} - \frac{2}{\cancel{5}} \times \overset{2}{\cancel{10}} - \frac{2}{\cancel{5}} \times \cancel{25} \times \frac{3}{\cancel{5}}$$

$$\Rightarrow 20 - 4 - 6 = 10 m/s^2$$

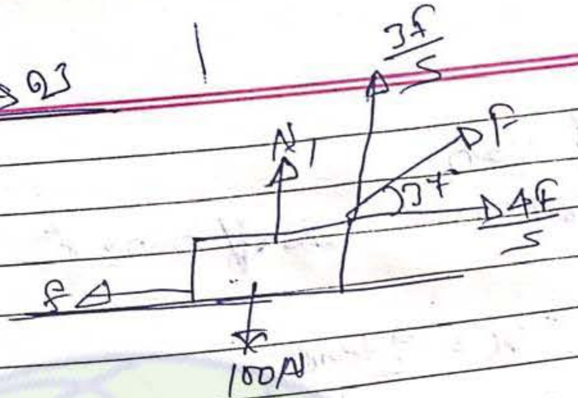
Page No.
Q.P.P.S

Q:)

Per

S:)

3)



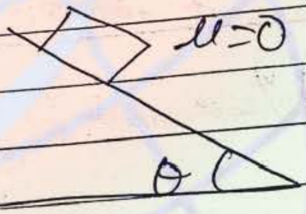
For slipping

~~of~~

$\frac{4f}{5} > f_L$

$4f > 1$

5)



$a = g\sin\theta - \mu g\cos\theta$

$a = g\sin\theta - \alpha x g\cos\theta$ — ②

$v\frac{dv}{dx} = g\sin\theta - \alpha g\cos\theta \cdot x$

$\int_0^v v\,dv = \int_0^x (g\sin\theta - \alpha g\cos\theta \cdot \textcircled{x})\,dx$

$\frac{v^2}{2} = (g\sin\theta \cdot x - \alpha g\cos\theta \cdot \frac{x^2}{2})$

If $v=0$

$g \sin\theta \cdot x = \cancel{d} \, g \cos\theta \cdot \frac{x^2}{2}$

$x = \frac{2\tan\theta}{d}$

For v to be max

$a=0$

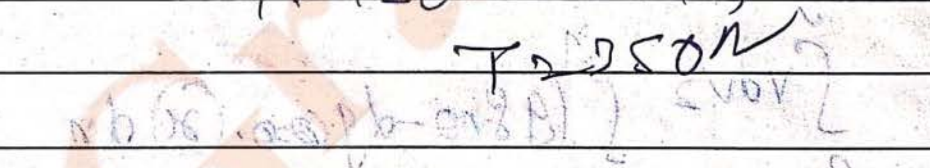
$g\sin\theta - dxg = 0$

$x_1 = \frac{\tan\theta}{d}$

$v = \sqrt{2gx}$

$\boxed{x = 2}$

2.)



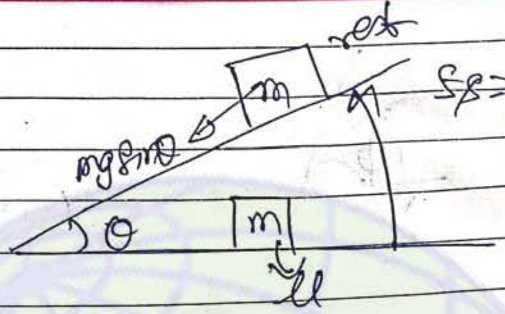
$f_K = 150N$

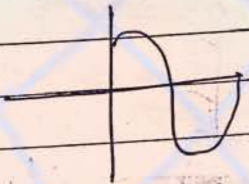
$T - 150N = 50 \times 4$

$T = 350N$

4.)

4.)





$\theta \leq \phi$ (angle of repose)

$f_s = mg\sin\theta$

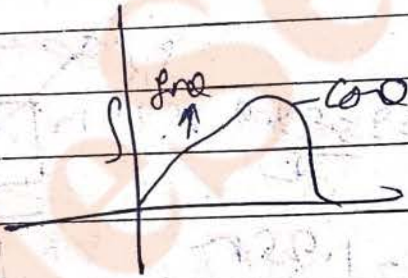
$f_s \propto \sin\theta$

$\theta > \phi$ (sliding)

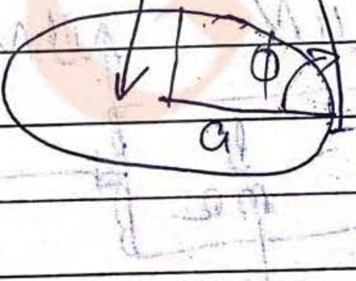
$f_k = \mu N$

$= \mu mg\cos\theta$

$f_k \propto \cos\theta$



6.)

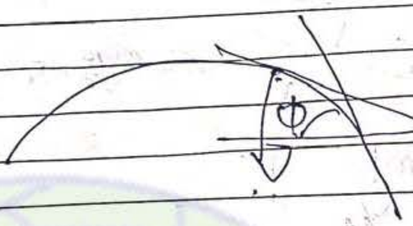


$\tan\phi = \mu = k$

$\frac{h_{max}}{a} = \mu = k$

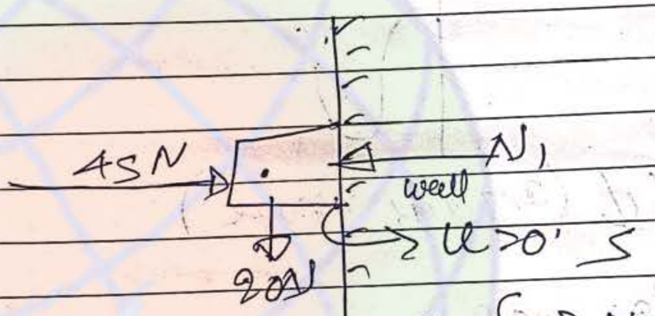
$h_{max} = a\mu = ak$

8.)

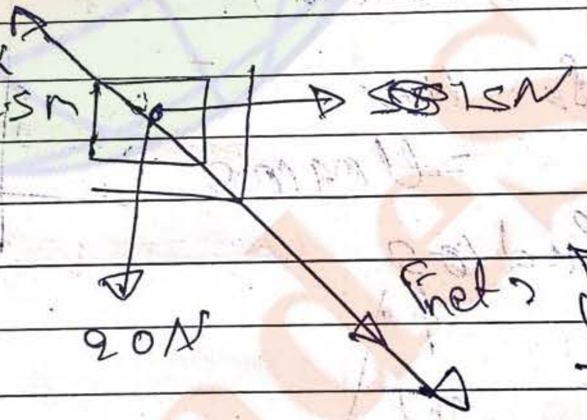


$\mu \geq \tan\theta$

10.)



$f_L = 0.5 \times 45$
$= 22.5N$

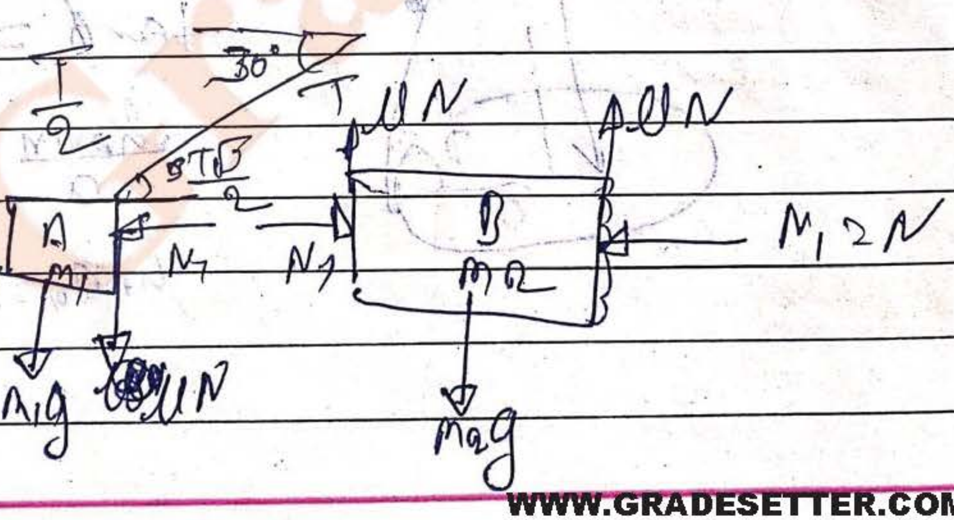


$a = \frac{25-22.5}{2}$

$a = 1.25$

$f_{net} = \sqrt{(20)^2+(15)^2}$
$= 25N$

12.)



$\Rightarrow N_1 = N$

$\Rightarrow m_1 g = \mu N$ ①

$\Rightarrow m_2 g = \mu N$ ~~m a~~

B

$m_2 g - 2\mu N = m a_B$ ②

$200 - 2 \times 0.2 \frac{\sqrt{3}}{2} = 20 \times a_B$

$a_B = 9.$

$N = \frac{T\sqrt{3}}{2}$

$\frac{T}{2} = 100 + 0.2 \times \frac{T\sqrt{3}}{2}$

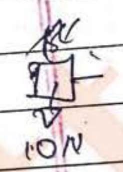
$\frac{T}{2} = 100 + \frac{T\sqrt{3}}{10}$

$\frac{T}{2} - \frac{T\sqrt{3}}{10} = 1000$

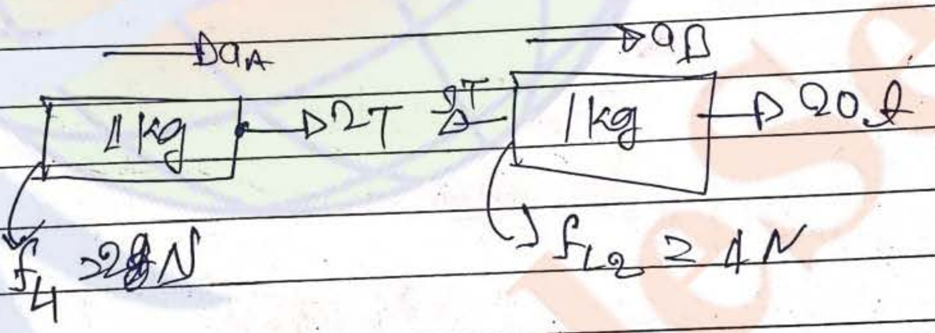
$T(\sqrt{5} - \sqrt{3})$

$= 1000$

$T = \frac{1000}{5 - 1.7\ \ 3.4}$

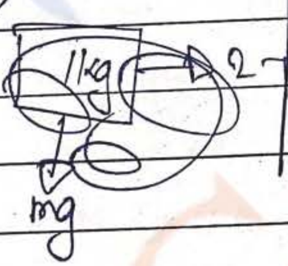


20)



$2T > 2N$

$T > 4N$



$20t > 5$

$t > \frac{5}{20}\ 4$

$t = \frac{1}{4}\ 8$

$2a_A - 3a_B = 0$

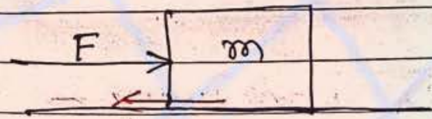
$a_A = \frac{3}{2} a_B$

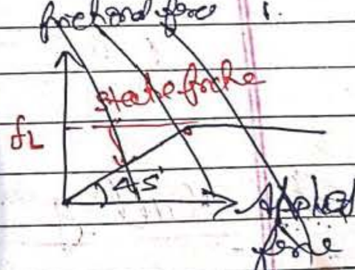
4/9/2012

Revision class

whenever any body slip or on a tendency to slip over the surface of another body than a force is produced on both the bodies tangentially in the opp. direction which can oppose the relative motion b/w the two this force is called as friction.

⇒ Types of friction →





1.) static friction:-
2.) limiting friction
3.) kinetic friction

μ_s → coeff of static frictn

μ_K → ~~[illegible]~~ coeff of kinetic frictn

{ खिचना ढकेलने से easy होता है }
{ Pulling is easia than Pusing }

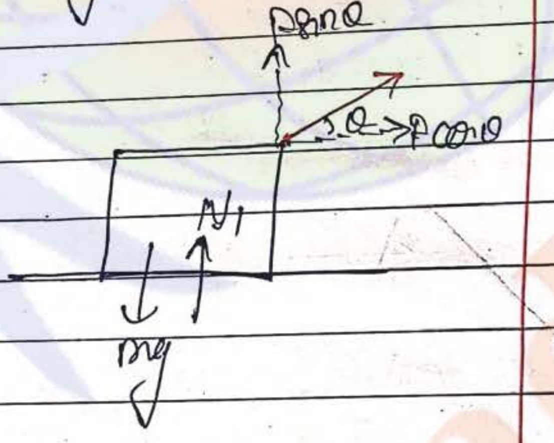
$$f_s \propto N$$
$$f_s = \mu_s N$$

$$f_K \propto N$$
$$f_K = \mu_K N$$

$$\boxed{\mu_K < \mu_s}$$

Pulling is easia than Pusing –

Pulling →

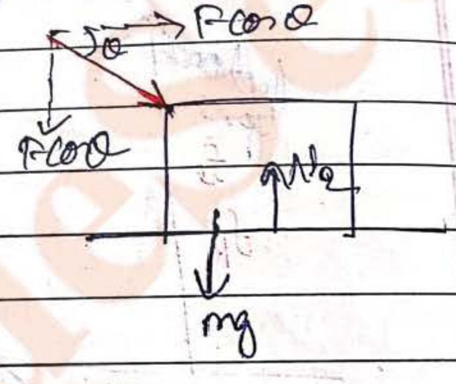


$N_1 = mg - F\sin\theta$

$F\cos\theta > \mu(mg - F\sin\theta)$

$$F > \left(\frac{\mu mg}{\cos\theta + \mu\sin\theta}\right)$$

Pusing →



$N_2 = mg + F\sin\theta$

$F\cos\theta > \mu(mg + F\sin\theta)$

$$F > \left(\frac{\mu mg}{\cos\theta - \mu\sin\theta}\right)$$

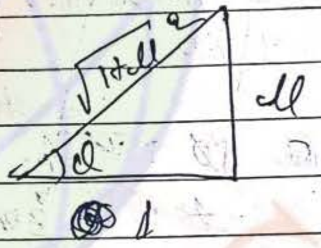
Q15) There is a block of mass "m" which is kept on rough ground surface having coefficient of friction "μ". find out the mag. as well as directe of the applies force so that with minimum ~~mag~~ mag. of this force block can start the motion.

Sol^n

$$\frac{d}{d\theta}\left(\cos\theta+\mu\sin\theta\right)=0$$

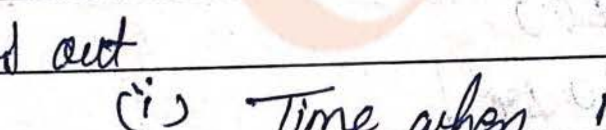
$$\tan\theta=\mu$$

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



$$F_{min}=\frac{\mu mg}{\sqrt{1+\mu^2}}$$

Q)



Find out

(i) Time when A and B start their motion.

B) At t = 6sec find out friction on both the blocks as well as Normal reacⁿ b/w the two blocks

c) Repeat the part B at t=15 sec

D) Draw the following graphs

(i) Friction on A v/s t

ii) " " B v/s t

iii) Normal reacⁿ b/w the two blocks v/s t

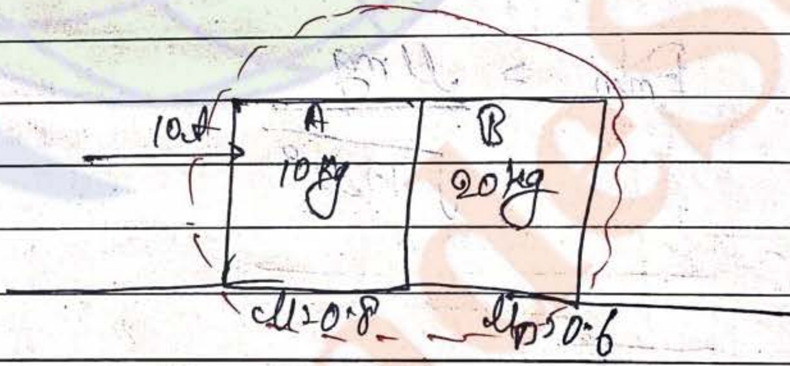
Sol/

~~mg = N~~

~~F=10t~~

~~F = 0.8×100~~
~~= 80~~

~~80 = 10t~~
~~t = 8 sec~~

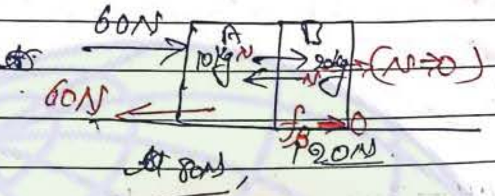


Total limiting friction $= 0.8(100) + 0.6(200)$
$= 200 N$

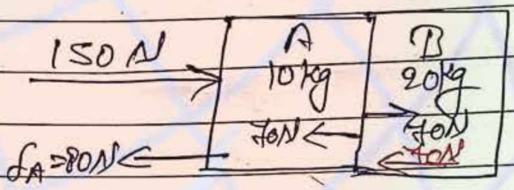
$10t > 200$

$\boxed{t > 20 \text{ sec}}$

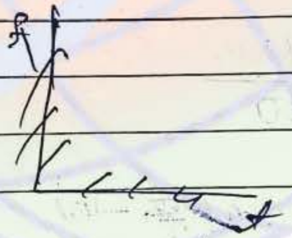
B) $t = 6 sec$

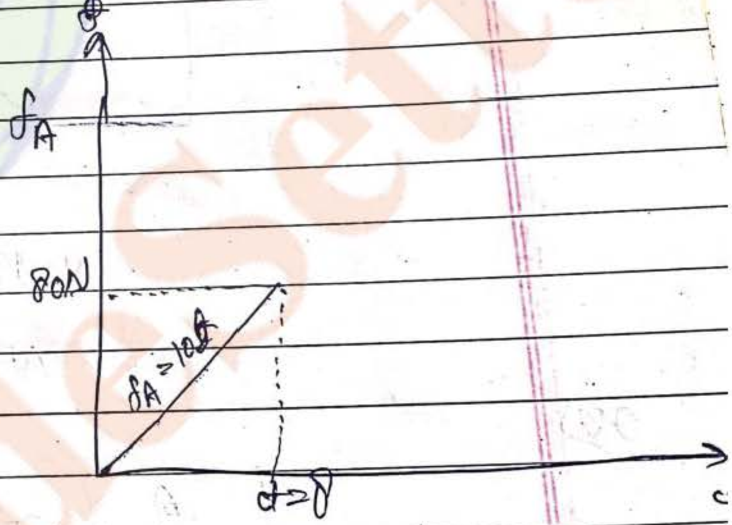


c) $t = 15 sec$

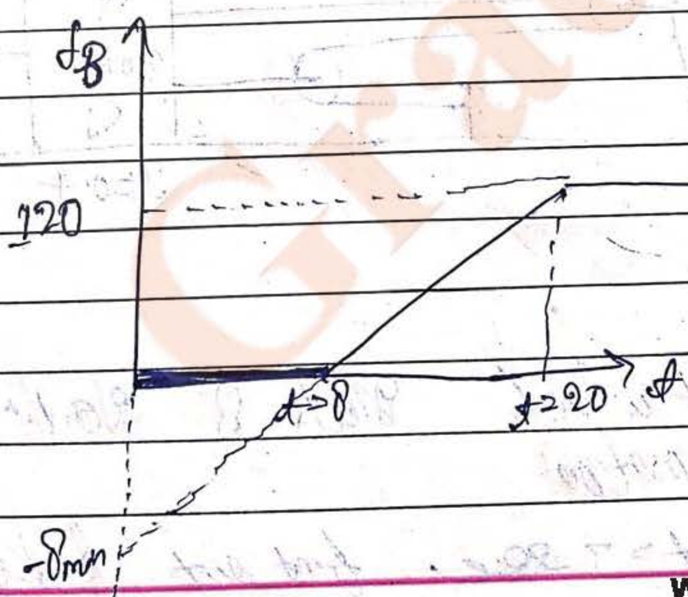


(1) (i)

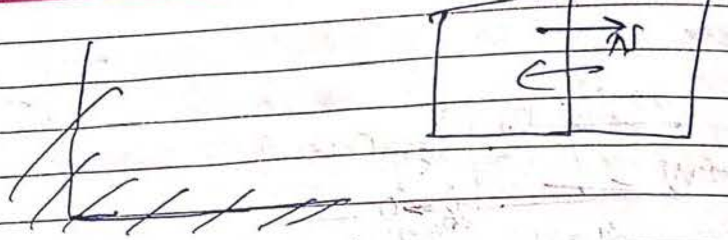




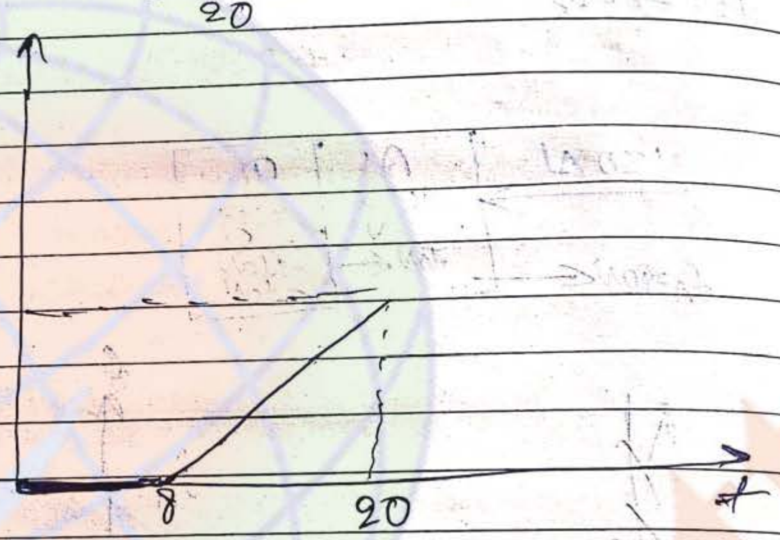
(ii)



iii)



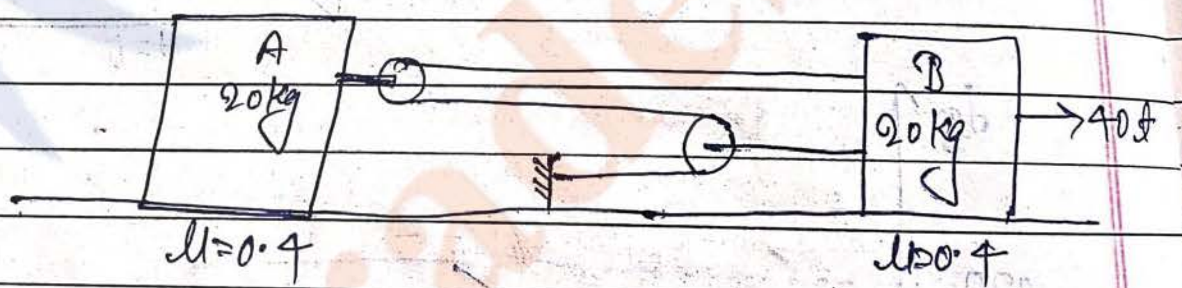
$a = \frac{10t - 200}{20} = \frac{t}{2} - 10$



$N - 120 = 20\left(\frac{t}{2} - 10\right)$

$N =$

Q3.)



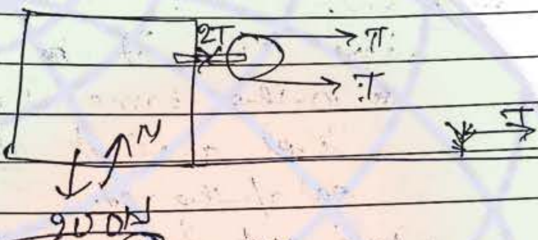
Find out

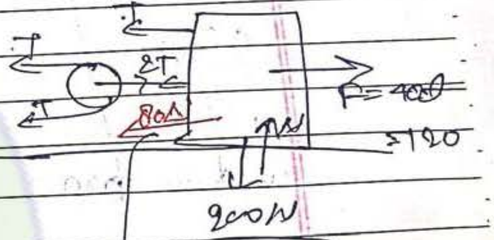
a) Time at which block B start's the motion

b) At t = 3 sec. find out frictio on

both the block as well as tension on the longer string.

8/4





$\boxed{f_l = 80N}$ $\quad$ $\boxed{f_l = 80N}$

$N = 200N$

$2T = 80$

$\boxed{T = 40N}$

$f =$

$f_A = \mu_A N$

$= 0.4 \times 200$

$= 80 N$

$2T + T + 80 = 40t$

$80 + 40 + 80 = 40t$

$t = 5 sec$

A) At $t = 3 sec$

$f_B = 80N$

$3T = 40$

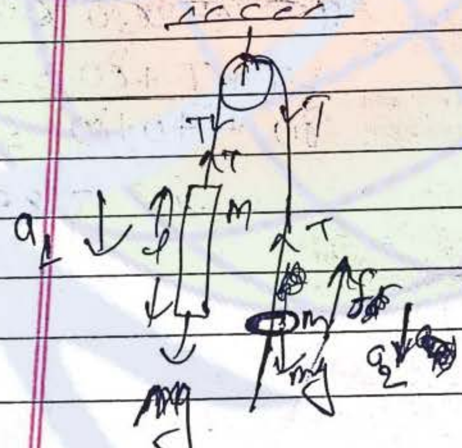
$$\boxed{T = \frac{40}{3} N}$$

$$\boxed{f_A = \frac{80}{3} N}$$

Irodov
Q.4

In the fig. shown at $t=0$ the ring is in the same horizontal level as that of lower end of the rod.
After time "t" it is in the same horizontal level as that of upper end of the rod.
Find out friction acting on the ring.

Soln



$f = \mu N$
$\rightarrow \mu$

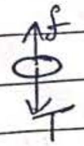
~~F=Mg~~

$$mg - T = Ma_1 \quad -(1)$$

$$mg - f = ma_2 \quad -(11)$$

$$l = \frac{1}{2}(a_1 - a_2)t^2 \quad -(3)$$

$T = f \quad \text{—(iv)}$



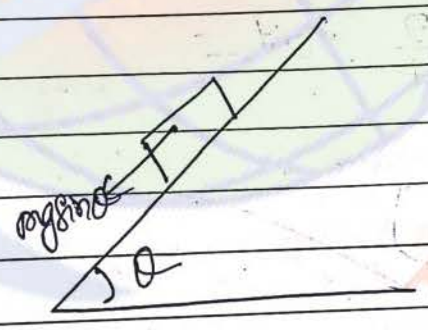
So from eq② and (iv)

$mg - f = ma_1 \quad \text{—(v)}$

from (iii) and (v)

$Ma_1 = ma_2$

✡ Angle of Repose →

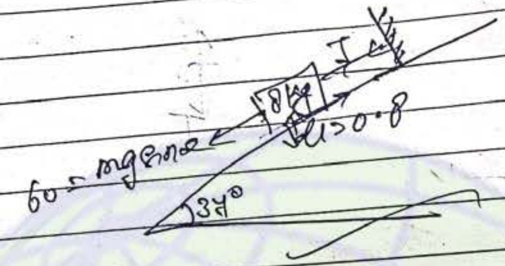


$mg\sin\theta > \mu mg\cos\theta$

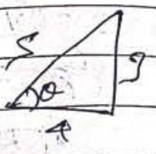
$$\boxed{\tan\theta > \mu}$$

$\theta > \tan^{-1}(\mu)$

05)



find out tension in the str



3/4

$\frac{3}{8 \times 10 \times 5} 4$

= 60

$N = 80N$

$(0.8 \times 80 = 64.0 = 64N)$

T:

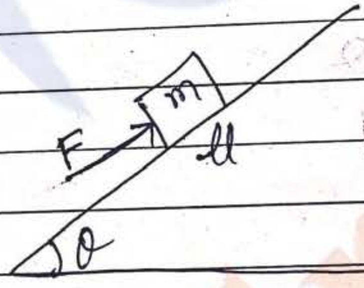
60 − 64N =

3/4

$\tan 37° = \frac{3}{4} = 0.75$

So, (T=0)

06)



$\tan\theta > \mu$

Find out

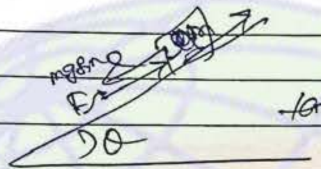
a) The range of the applied force so that block becomes stationary on the inclined surface.

b) Find
when

08)

b) Find out the mag. of the applied force when the friction changes it's direction

Sol^n



$\tan\theta > \mu$

θ

$mg\sin\theta - F_m = \mu mg\cos$

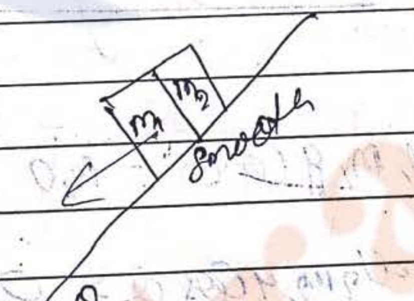
$$\boxed{F_{min} = mg\sin\theta - \mu mg\cos}$$

$F = mg\sin\theta$

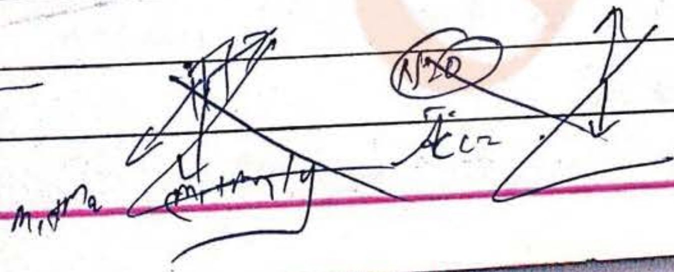
$F_{max} - mg\sin\theta = \mu mg\cos\theta$

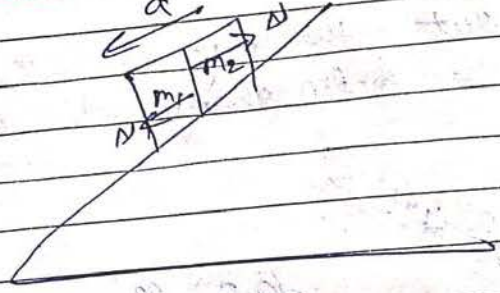
$F_{max} = mg\sin\theta + \mu mg\cos\theta$

Q)



The system is released from rest find out acc^n of each block as well as the normal rea^n b/w the two block.





$m_1 g \sin\theta + N = m_1 a$

$m_2 g \sin - N = m_1 a$

Ques 6 Repeat the previous problem if μ_1 and μ_2 are the friction coeff. for the two blocks resp. under two diff circumstance

a) $\mu_1 > \mu_2$

b) $\mu_1 < \mu_2$

Sol

$m_1 g \sin\theta + N - \mu_1 m_1 g \cos\theta = m_1 a$ —(i)

$m_2 g \sin\theta - N - \mu_2 m_2 g \cos\theta = a$ —(ii)

$m_1 g \sin\theta + N - \mu_1 m_1 g \cos\theta = m_1 \left(\frac{m_2 g \sin\theta - m_1 N - \mu_2 m_2 g \cos\theta}{m} \right)$

$$\boxed{N = \frac{(\mu_1 - \mu_2) m_1 m_2 g \cos\theta}{m_1 + m_2}}$$

→ If $\mu_1 > \mu_2$

$\underline{N \neq 0}$

$$a_1 = a_2 = \frac{(m_1 + m_2) g \sin\theta - (\mu_1 m_1 g \cos\theta + \mu_2 m_2 g_2 \cos\theta)}{m_1 + m_2}$$

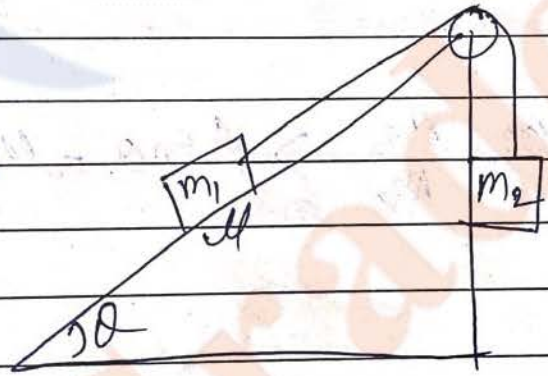
→ If $\mu_1 < \mu_2$ (क्योंकि contact

$N = 0$

$a_1 = g \sin\theta - \mu_1 g \cos\theta$

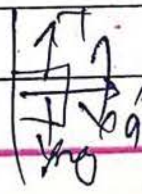
$a_2 = g \sin\theta - \mu_2 g \cos\theta$

10



Find out the ratio of masses $\frac{m_2}{m_1}$

so that →

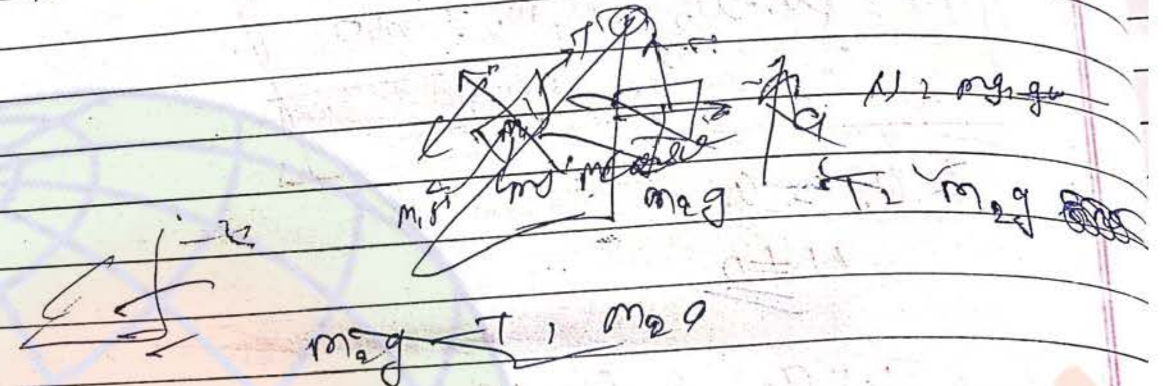


$\boxed{mg = T}$

i) m_2 starts moving up
ii) m_2 starts moving down
iii) It can stay in rest

Soln

a)



[illegible]

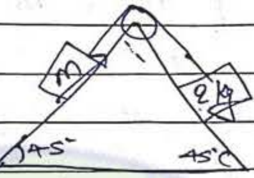
$$m_1 g \sin\theta - m_2 g = \mu m_1 g \cos\theta$$

$$m_1 g(\sin\theta - \mu\cos\theta) > m_2 g$$

$$\frac{m_2}{m_1} < (\sin\theta - \mu\cos\theta)$$

i) $$\frac{m_2}{m_1} > (\sin\theta + \mu\cos\theta)$$

ii) $$(\sin\theta + \mu\cos\theta) > \frac{m_2}{m_1} > (\sin\theta - \mu\cos\theta)$$

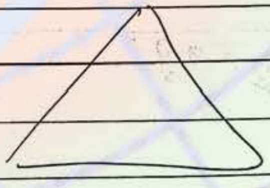


In the fig shown. find out the min as well as max value of 'm' so that system remain as at rest where for both the surfaces

$\mu_s = 0.28$

$\mu_k = 0.25$

Also find out acc of the system if "m" is given the min value given in previous part



$m_1 g \times \frac{1}{\sqrt{2}} - T = m_2 g$

$m_1 g \sin\theta - T = m_2 g \cos\theta$

$m_2 g \sin\theta$ $g \times$

$20 \times$

$m_1 g \sin\theta - T - 0.28 \times m = 0$

$20 \times \frac{1}{\sqrt{2}} - T - 0.25 \times 2 = 0$

$$\frac{90}{\sqrt{2}} - \frac{m(10)}{\sqrt{2}} = \frac{28}{100}\left[\frac{90}{\sqrt{2}} + \frac{m(10)}{\sqrt{2}}\right]$$

$$\boxed{m_{man} = \frac{9}{8}\,kg}$$

$$\frac{10m}{\sqrt{2}} - \frac{90}{\sqrt{2}} = \left[\quad\right]$$

$$m_{man} = \frac{92}{9}\,kg$$

$$a = \frac{\left[\frac{90}{\sqrt{2}} - \frac{90}{8\sqrt{2}}\right] - \frac{1}{4}\left[\frac{90}{\sqrt{2}} + \frac{90}{8\sqrt{2}}\right]}{2+\frac{9}{8}}$$

Q12) The vel of a car is given by $v = 2t^2$ for $0 \le t \le 2$ and after 2sec, vel of car become constant. A block kept on rough surface of car starts sliping at $t = 1$sec and stop slipping at $t = 3$sec. Find out the coeff. of static as well as ~~[illegible]~~ kinetic friction separately b/w the block and surface of car.

30/7

$v = 2t^2$, $0 \le t \le 2$

$t=0$, $v = 0 \rightarrow$ start

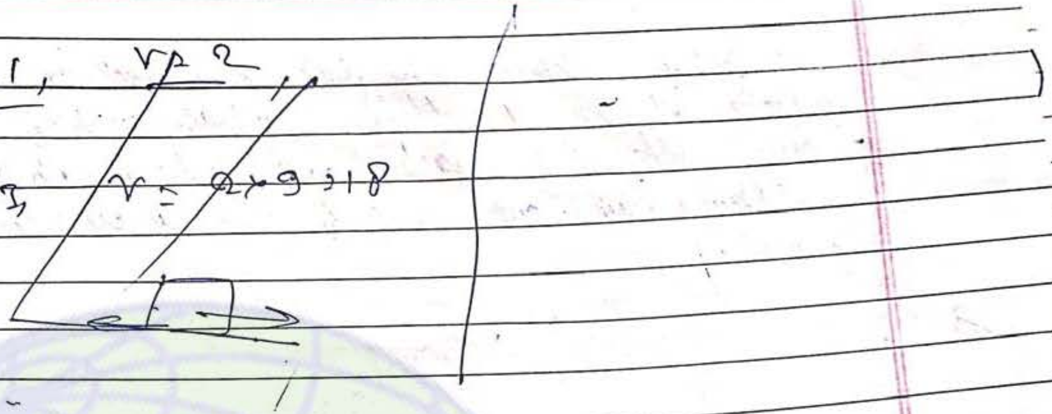
$t=1$, $v = 2 \times 1 = 2$ = constant

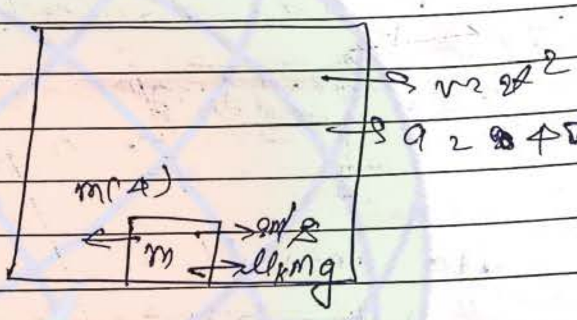
$t=2$, $v = 2 \times 4 = 8 \rightarrow$

$t=3$, $v = 18 \rightarrow$ stop

$t = 1, \quad v = 2$

$t = 3, \quad v = 2 \times 9 = 18$





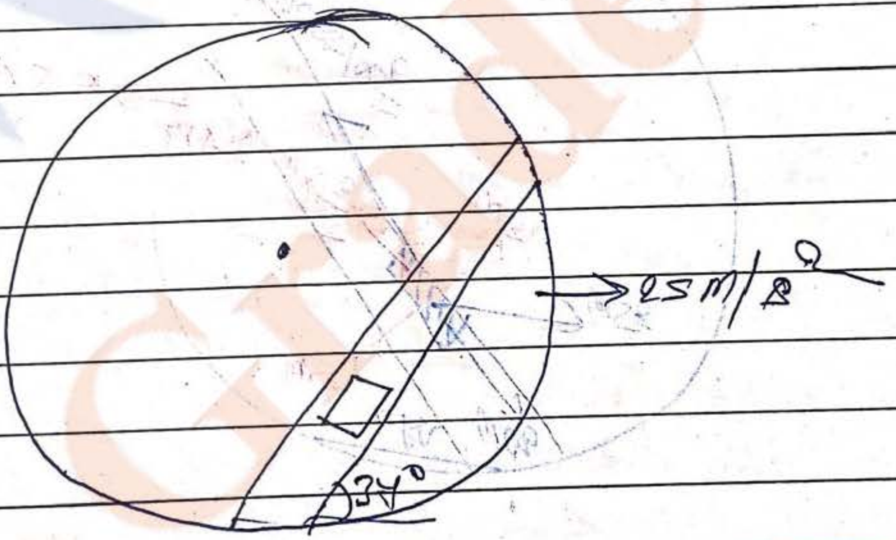
$$\cancel{m}(4) = \mu_s \cancel{m}(g)$$

$$\mu_s = 0.4$$

$$8 = 2 + (\mu_k g)(2)$$

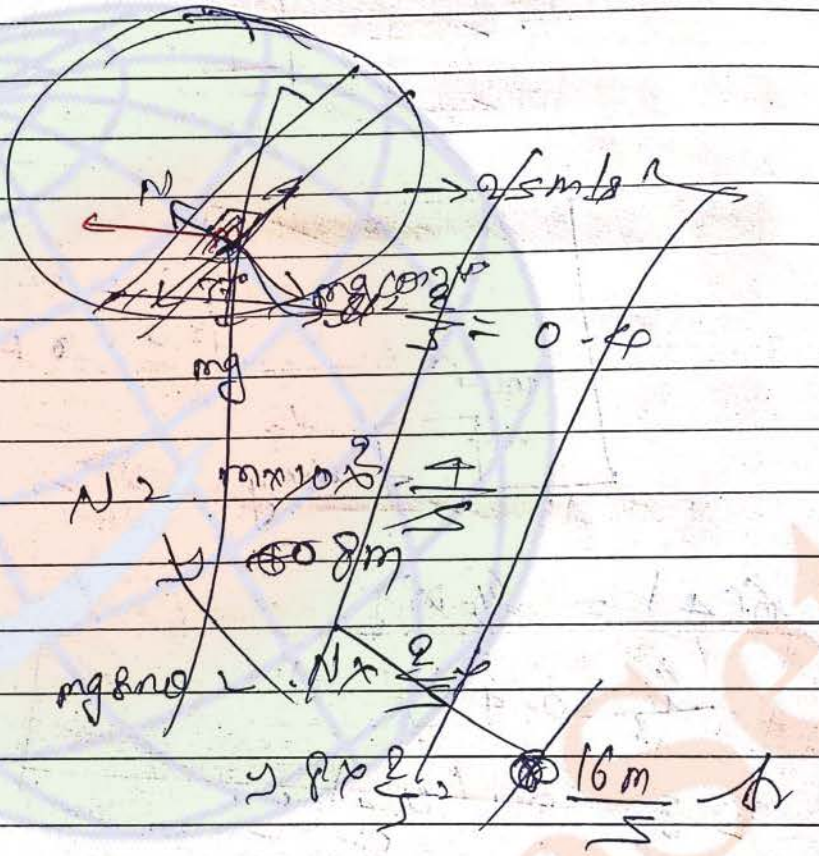
$$\boxed{\mu_k = 0.3}$$

13)



In the fig. shown the disk is acc^n on the smooth horizontal floor. If the coeff of friction b/w the block and surface ab groove is 2/5 than find out acc^n of the block w.r.t. groove.

so^n



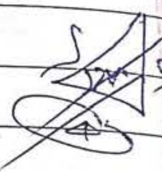
$mg\cos 37° \times \frac{2}{5} = 0.8$

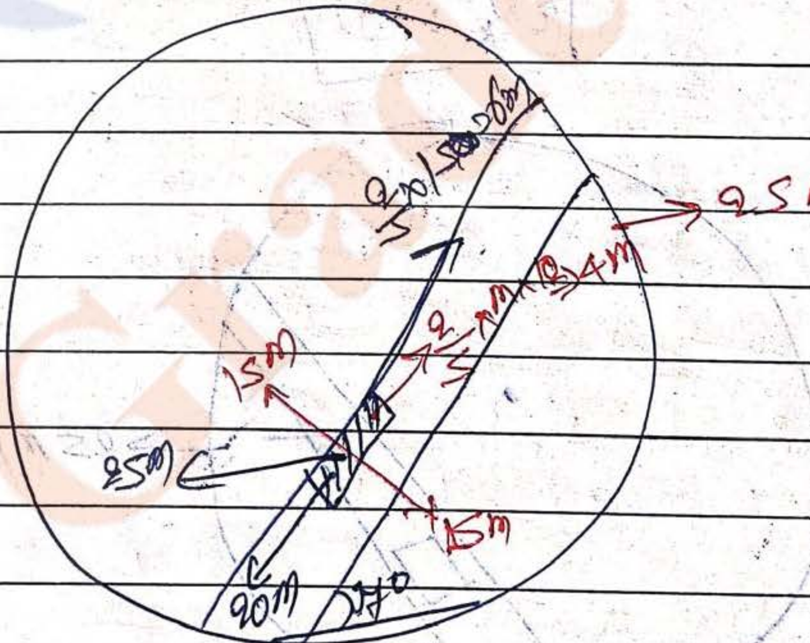
$N = m \times 10 \times \frac{4}{5}$

$= 8m$

$mg\sin\theta = N \times \frac{2}{5}$

$= 8 \times \frac{2}{5} = \frac{16m}{5}$





$a = 20 - 10$

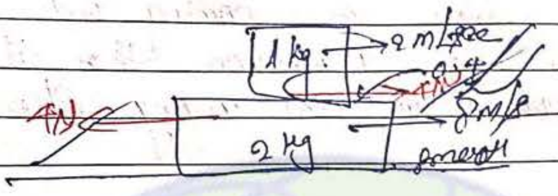
$= 10\ m/s$

Tacs Direct of friction

↳ Read 2 block syst

D.PP → 28, 29

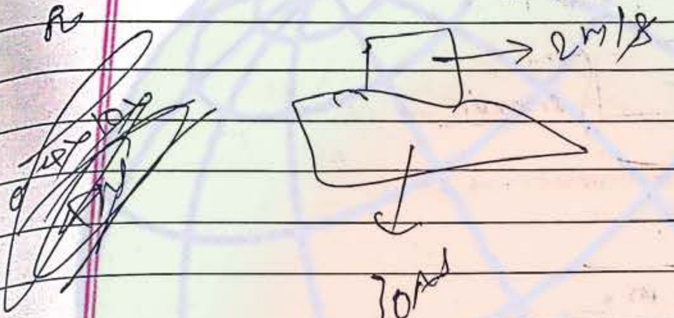
Q13.)



Find out :—

a) time when slippin b/w the two blocks

b) Find out the common vel. at that Instant

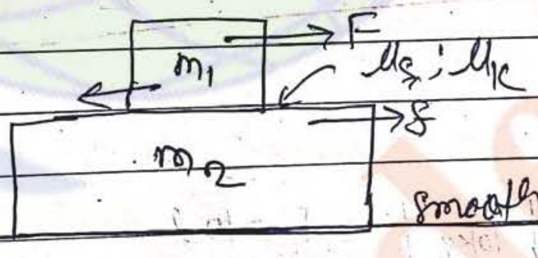


$2+4t = 8-2t$

$t = 1\,sec$

$v = 6\,m/sec$

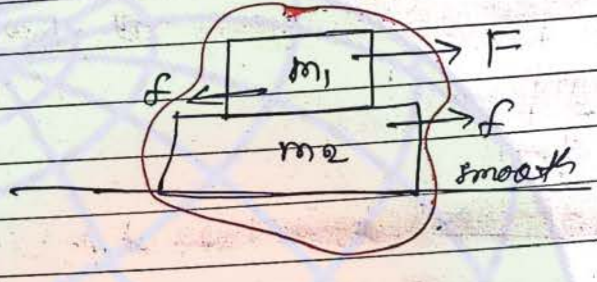
Problems based on two block system



Note (Trick) →

Here we con assume there is no slipping b/w the two blocks it means both are moving together with the same acc^n and find out the friction acting on any of the block under this assumption.

If the friction is coming out to be greater than limiting friction then it mean's our assumption was wrong slipping is taking place.

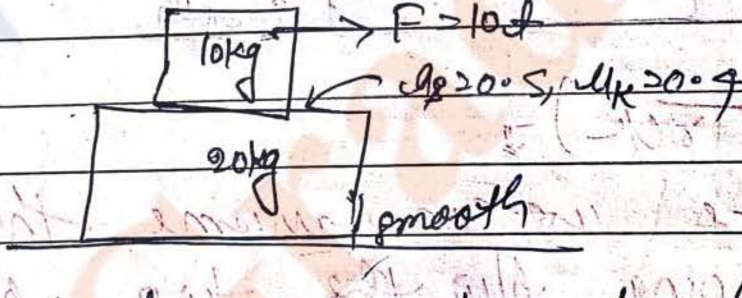


$$a_1 = a_2 = \frac{F}{m_1 + m_2}$$

$$f = \frac{m_2 F}{m_1 + m_2} > \mu_s m_1 g$$

$$\boxed{F = \frac{\mu_s m_1 g (m_1 + m_2)}{m_2}}$$

Q15.)

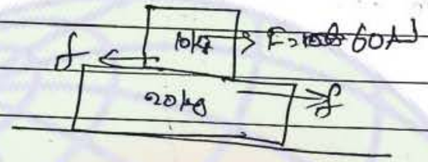


find out (a) The time at which 10 kg block start slipping w.r.t 20 kg block.

b) At t = 6 sec as well as t = 9 sec find out accⁿ of each block as well as friction acting on them

So/4 a) A: 7.5 sec

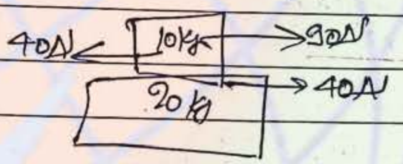
b)



$$a_1 = a_2 = 2 m/s$$

$$f = 20 \times 2 = 40N$$

c)

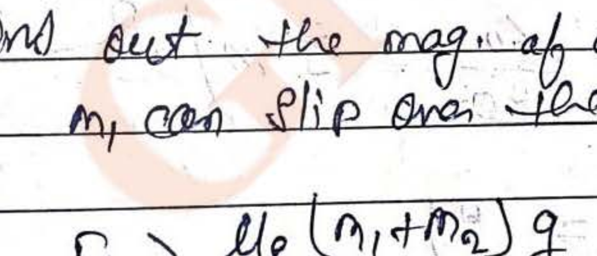


$$a_{10kg} = \frac{90-40}{10} = 5 m/s^2$$

$$a_{20kg} = \frac{40}{20} = 2 m/s^2$$

Type 2nd

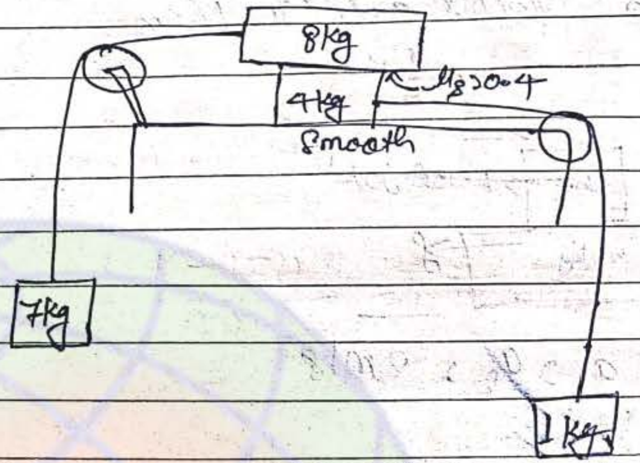
Q16.)



Find out the mag. of applied force here so that m_1 can slip over the surface of m_2

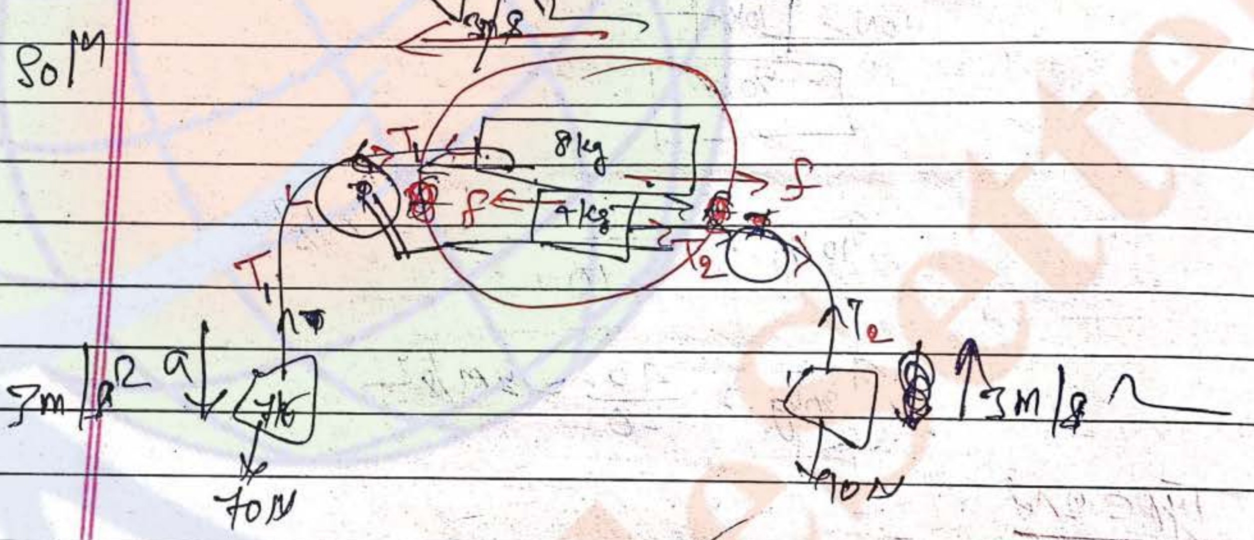
So/4 $F > \mu_s (m_1 + m_2) g$ $a = \frac{F}{m_1 + m_2}$

Q17)



find out the friction acting b/w 4kg and 8kg block

Sol^n



$a = \frac{f}{2}$

$f = 0.4(12)10$

$= 480$

$= 48N$

$a = \frac{60}{20} = 3\ m/s^2$

$70 - T_1 = (21)$

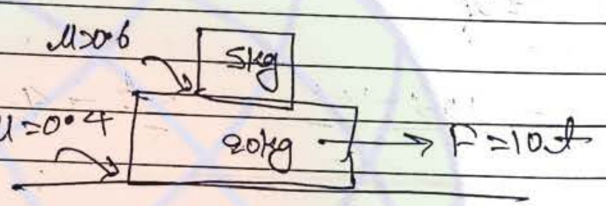
$\boxed{T_1 = 49N}$

$$4g - f = 24$$

$$\boxed{f = 25N}$$

Case 3rd:- when friction also ~~pa~~present on ground

Q18.)



Find out a) Time when 20kg block start slipping w.r.t. ground

b) Time when 5kg block start slipping over the surface of 20kg.

c) Draw the following

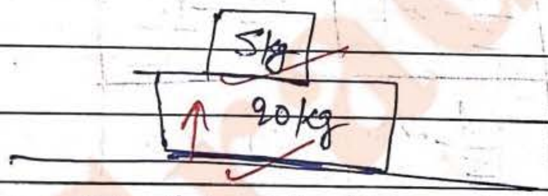
i) Acc of 20kg / time

ii) Accⁿ of 5kg / t

iii) friction on 20kg / t

iv) fricⁿ on 5kg / t

Sol

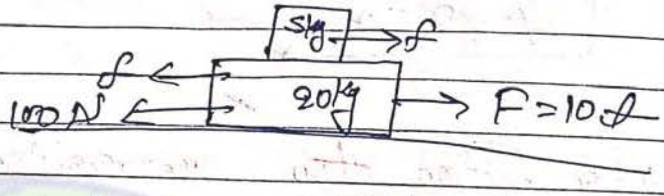


a) limiting friction at ground, $f_L = 0.4(25)10$
$= 100N$

$$10t > 100$$

$$\boxed{t > 10 sec}$$

b)



$$\frac{10t - 130}{20} = \frac{t}{2} - \frac{13}{2}$$

$$a_1 = a_2 = \frac{10t - 100}{25} = \frac{2t}{5} - 4$$

$$f = 2t - 20$$

for 5kg to slip against 20kg

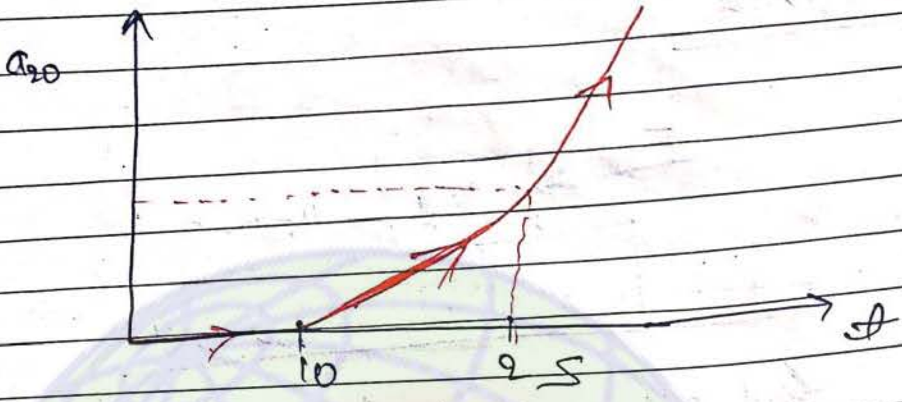
$$2t - 20 > 30$$

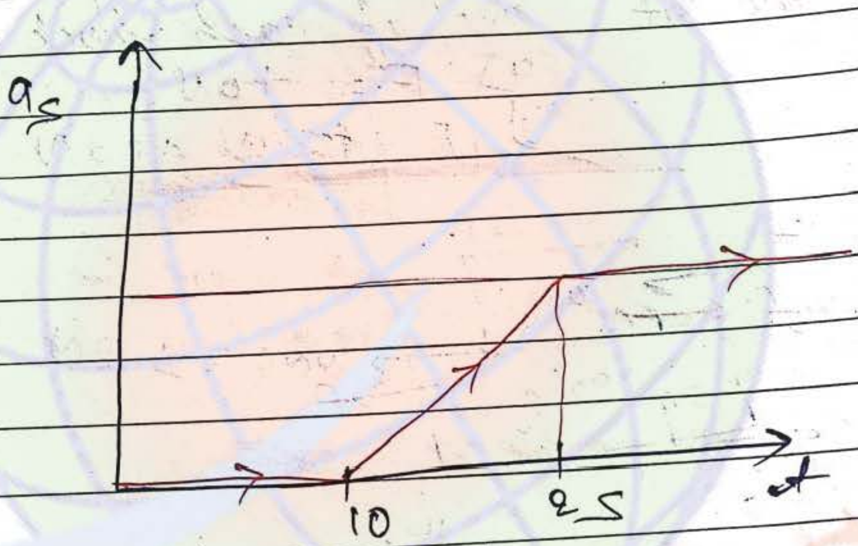
$$2t > 50$$

$$\boxed{t > 25 \text{ sec}}$$

$2t - 20 + 100$

	0-10 sec	10-25 sec	t > 25 sec
a_{20}	0	$\frac{2t}{5} - 4$	$\frac{t}{2} - \frac{13}{2}$
a_5	0	$\frac{2t}{5} - 4$	6
f_{20}	10t	2t + 80	130
f_5	0	2t - 20	30


a20
10
25
t


as
10
25
t

20-08-[illegible] 29

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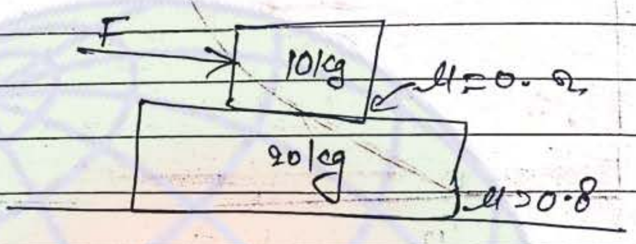
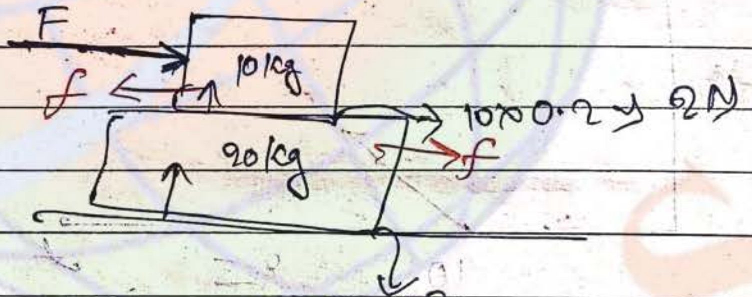
Case IVth

Q19.



find out acc.ⁿ of each block –
a) F = 40N
b) F = ~~[illegible]~~ 400 N

Solⁿ



$10 \times 0.8 \times 30 = 2400$
$= 240N$ $F = ma$

$a = \frac{F}{30}$

$= \frac{4\cancel{0}}{3\cancel{0}}$

a) $a = \frac{40-20}{10} = 2m/s$

b) $a = \frac{400-20}{10} = 38 m/s$

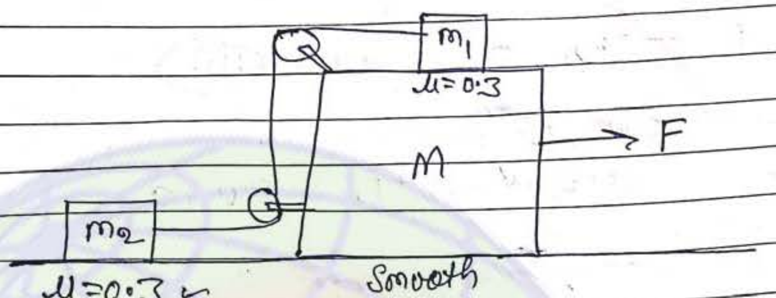
11/9/2013

Q20.)

Solⁿ

11/9/2013

Q20.)



$\mu = 0.3$

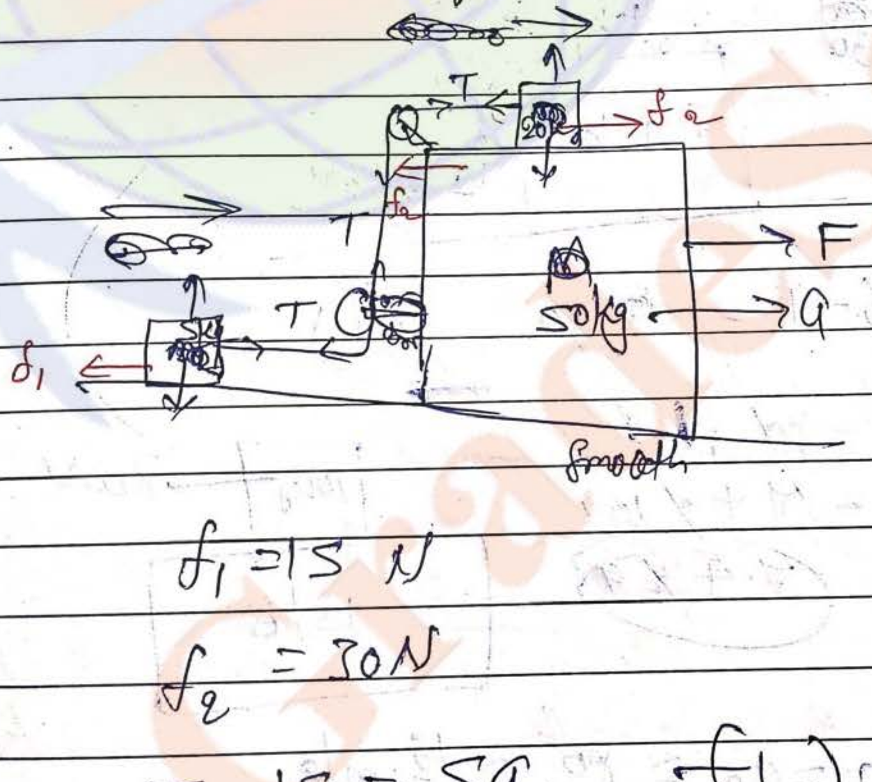
$m_1 = 20kg$

$m_2 = 5kg$

$M = 50kg$

For a certain value of Applied force F the friction on M_1 is twice the friction on m_2. So find out the friction acting on both the blocks, tension in the string, Applied force F, acc^n of all the blocks.

Sol/n



$f_1 = 15 N$

$f_2 = 30N$

$T - 15 = 5a$ ——①

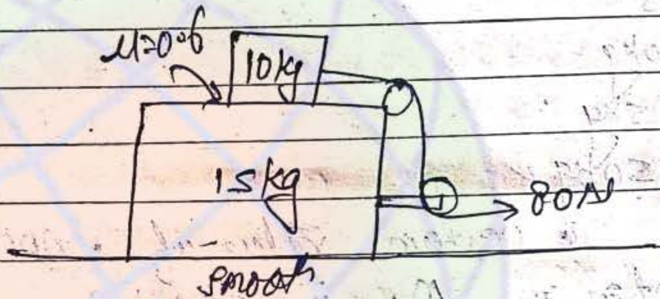
for 20kg

$30 - T = 20a$ ——②

$F - 30 = 50a$ —(iii)

Solve eq ① (ii) & (iii)
and get T, F and a

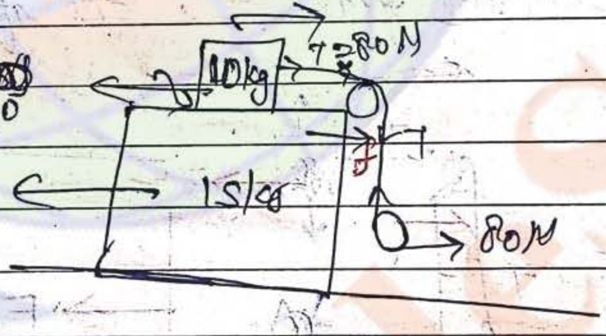
Q21.



Find out acc^n of both the block

80/n

$\frac{0.6\times10}{60}$



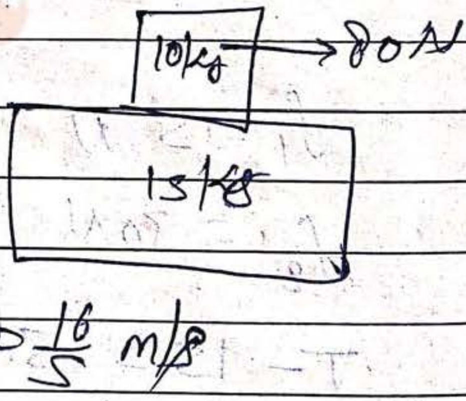
$6 - T = 10a$ —(1)

$\frac{06\times10}{60}$

$6 - 80 = 10a$

$-74 = 10a$

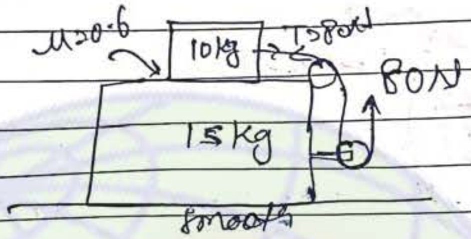
$\boxed{7.4 = a}$



$a_1 = a_2 = \frac{80}{25} = \frac{16}{5}$ m/s²

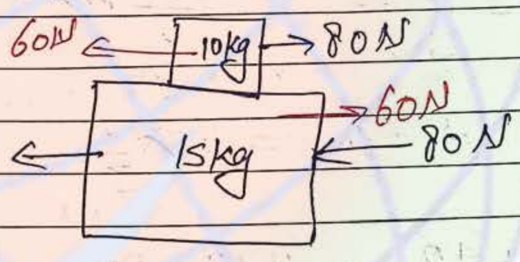
$f = 15\left(\frac{16}{5}\right) = 48N < 60N$

Q21.



Find out acc^n of both the block.

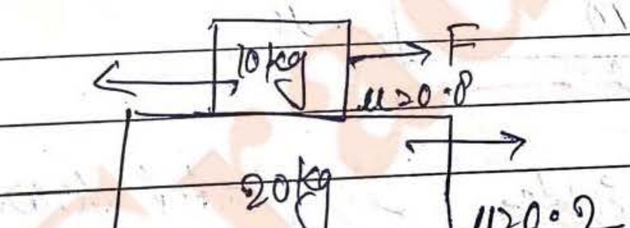
Sol^n



$$a_{10kg} = \frac{80-60}{10} = 2\ m/s^2\ (\rightarrow)$$

$$a_{20kg} = \frac{80-60}{15} = \frac{4}{3}\ m/s^2\ (\leftarrow)$$

Q22.



Find out acc^n of both the block's if

a) F=80N

b) F=160N

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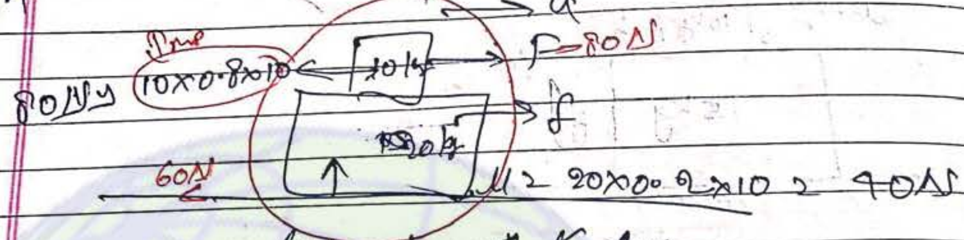
Sol^n



first out ~~acc^n of~~

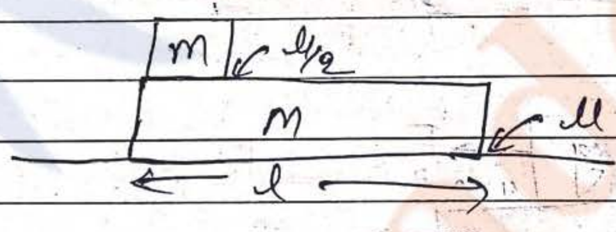
$$a_1 = a_2 = \frac{80-60}{30} = \frac{2}{3}\ m/s$$

$$~~f=60~~\quad f - 60 = 20\times\frac{2}{3}$$

$$f = 60+\frac{40}{3} = \frac{220}{3} < 80$$

⟹ Imp. Question

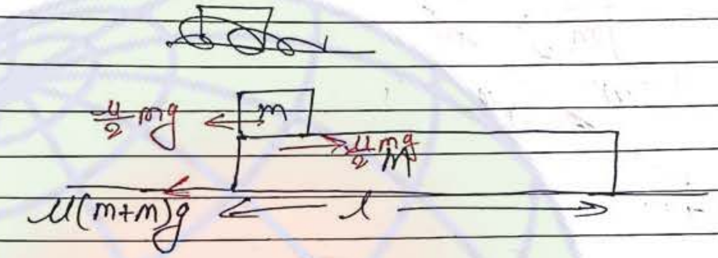
Q23.



The entire system is started towards right with initial vel. "v_0", find out after how much time the block will get separated from the plank.

$\boxed{f = \mu N} \rightarrow \underline{mg}$

30/4



Retardation of $m = \frac{\mu}{2} mg \times \frac{1}{m} = \frac{\mu g}{2}$

Retardation of $M = \frac{\mu(M+m)g}{M} - \frac{\mu mg}{2M}$

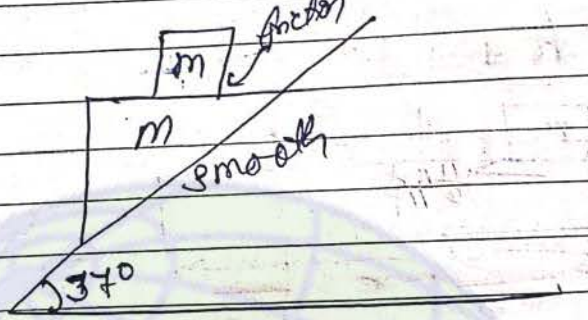
$= \frac{2\mu Mg + \mu mg}{2M}$

$= \mu g + \frac{\mu mg}{2M}$

$l = \frac{1}{2}\left[\mu g + \frac{\mu mg}{2M} - \frac{\mu g}{2}\right] t^2$

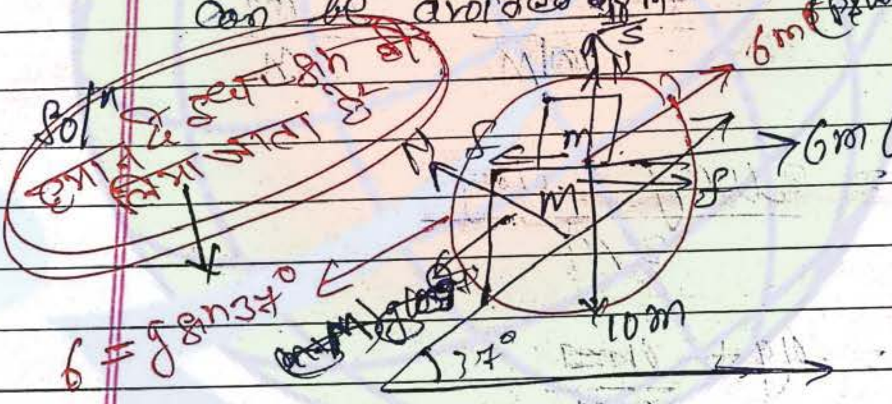
$t = \sqrt{\frac{4Ml}{\mu g(M+m)}}$

Q24)



Find out the min. value of friction coefficient of b/w the block and wedge. So the slipping b/w the two can be avoided.

Sol^n



$6m\cos 37° = \frac{24m}{5}$

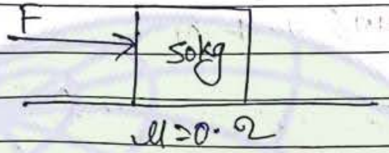
$6 = g\sin 37°$

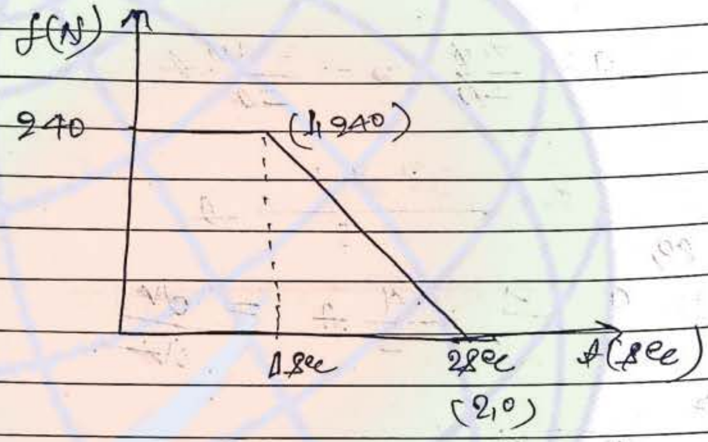
$$\frac{24}{5}m = \mu\left[\frac{32m}{5}\right] \Rightarrow \mu = \frac{3}{4}$$

$$N + \frac{18m}{5} = 10m$$

$$N = 10m - \frac{18m}{5} = \frac{32}{5}m$$

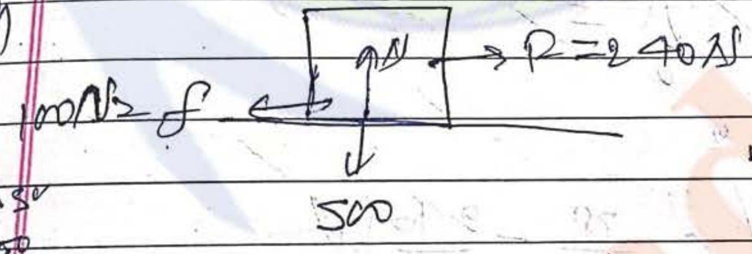
Q25





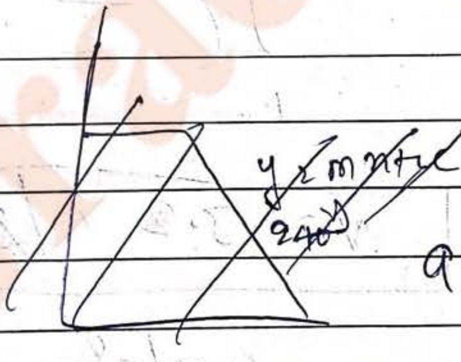
At what time the block will come into rest.

Sol/n.



~~50×a~~

0.20×50 / 1000



$a = \frac{140}{50} = \frac{14}{5}$ m/s²

At $t=1$, $v = \frac{14}{5} = 2.8$ m/sec

$F = -240t + 480$

Net force $\Rightarrow 380 - 240t$

$a = \frac{38\cancel{0}}{5\cancel{0}} - \frac{24\cancel{0}}{5\cancel{0}}t$

$\Rightarrow \frac{38-24}{5}t$

so

$a \Rightarrow \frac{14}{5}t = \frac{dv}{dt}$

$\cancel{a = \frac{dv}{dt}}$

$\cancel{a = \frac{dv}{dt}}$

$\cancel{\int \frac{14}{5}t = \int_0^2 \left(\frac{38}{5} - \frac{24}{5}t\right)dt}$

$$\int_{2.8}^{v} dV = \int_{1}^{2} \left(\frac{38}{5} - \frac{24t}{5}\right)dt$$

$$\boxed{v = 3.2 \text{ m/sec}}$$

$a = -2 \text{ m/s}^2$

$0 = 3.2 - 2t$

$$\boxed{t = 1.6 \text{ sec}}$$