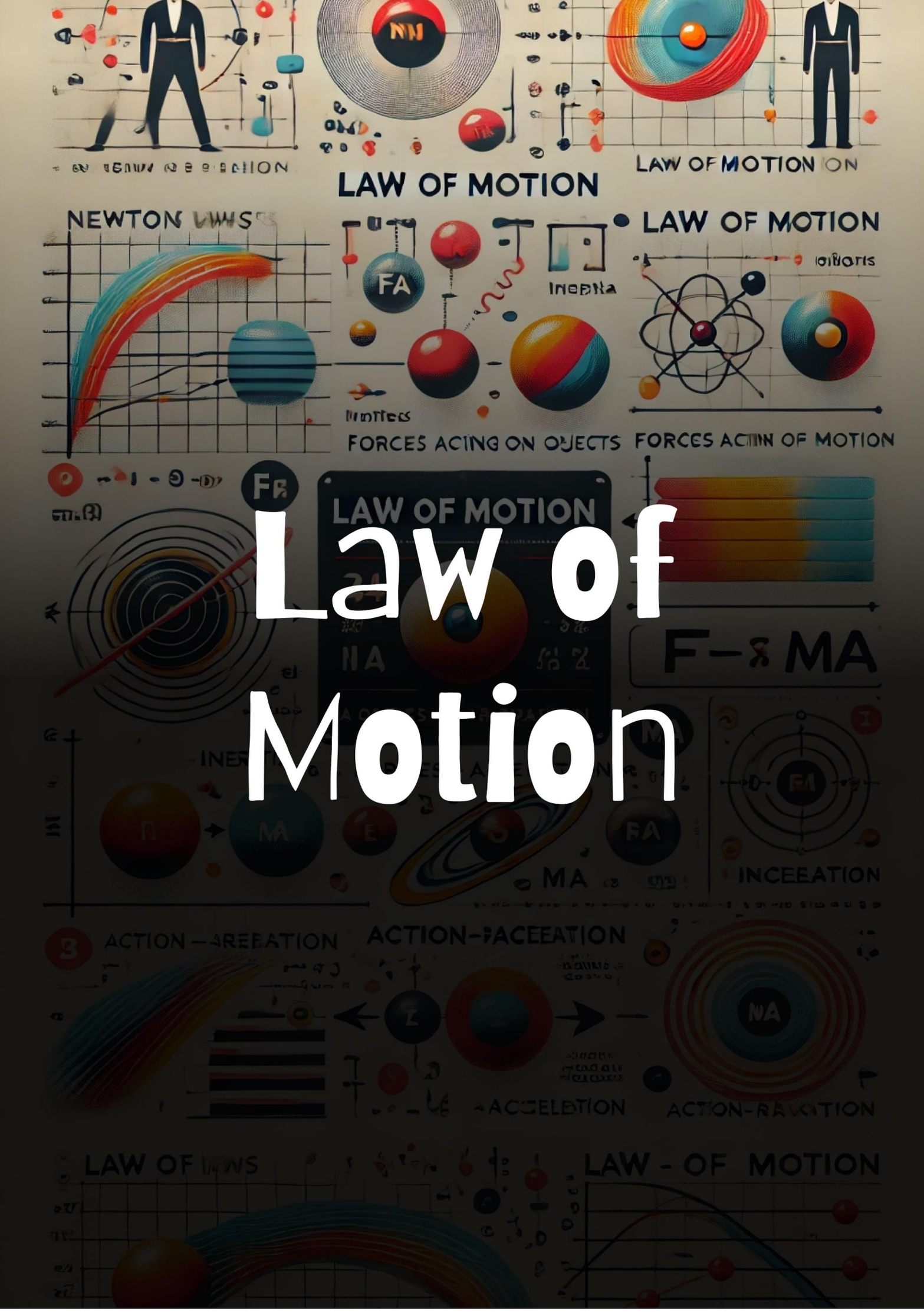

Law of Motion

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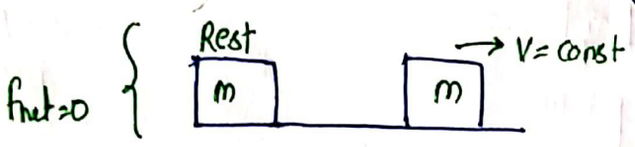
LAW OF MOTION

Velocity	accl^n
LT^{-1}	LT^{-1}
m/sec	m/sec^2

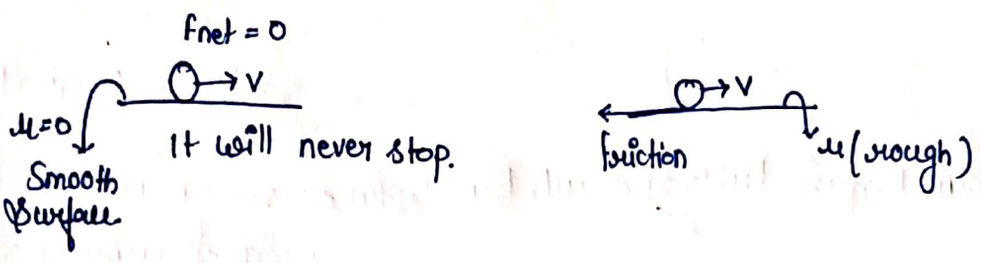
disp - Motion ke along accl^n - force ke along or change in velocity.

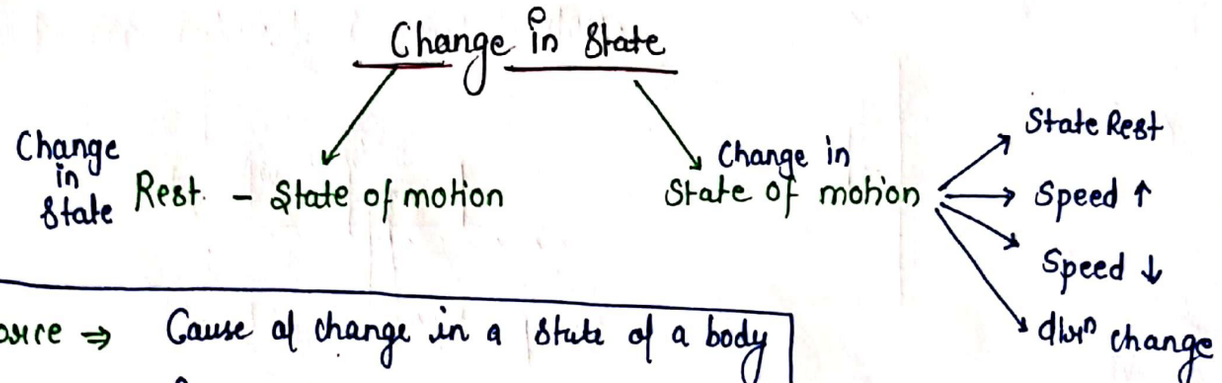
Physical State of a body define with the help of Velocity.

1. State of Rest
2. State of Uniform motion (V = Const)
3. No net force required to keep the object in a same state



Ex!





Force ⇒ Cause of change in a state of a body
Pull or Push

INERTIA ⇒ Property of a body due to which it oppose the Cause of Change in State of a body

Inertia oppose motion = false
Inertia oppose Cause of change in Motion → True

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⇒ Inertia is not a physical quantity.
⇒ Unit & dimension less
⇒ It cannot be measure but it can compaired

Inertia $\propto$ mass

↳ Can be compaired, but can't be measured.

Types of Inertia

Inertia of rest

Inertia of motion (Inertia of Const Velocity)

Inertia of Speed

Inertia of direction

Newton first Law :- [Law of Inertia]

If $(f_{ext})_{Net} = 0$ then state of a body remain same

equilibrium. $\vec{v}$ = Const / $\vec{v} = 0$

hense - $\vec{a} = 0$

Qu when an object is in equilibrium state, then

1. It must be at rest 2. No force is acting on it 3. Its net acceleration must be zero
4. All of these

Qu when an object is at rest.

① force is required to keep it in rest state 2. No force is acting on it.
③ A large number of forces may be acting on it which balance each other
④ It is in vacuum.

Qu An athlete does not come to rest immediately after crossing the winning line due to the.

① Inertia of rest ② Inertia of motion ③ Inertia of direction ④ None

Qu

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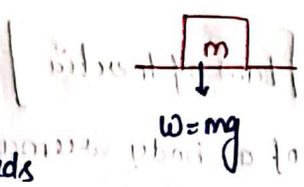
Qu If a force of constant magnitude acts in direction perpendicular to the motion of a particle, then its.

1. Speed is uniform
2. momentum is uniform
3. Velocity is uniform
4. All of these

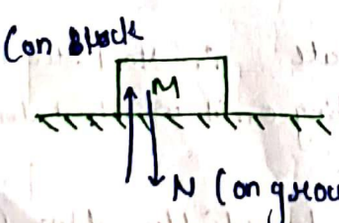
- Weight ⇒ Gravitational force acting on the body.
  - = $\vec{F} = m\vec{g}$
  - = Vector
  - = Newton
  - = direction always towards centre of earth (downwards)

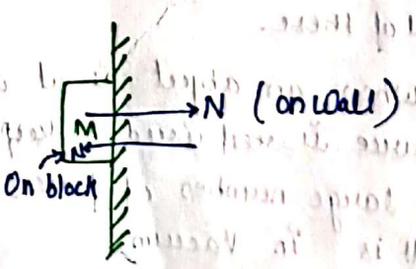
Mass → quantity of matter contained in a body.
= Scalar
= kg



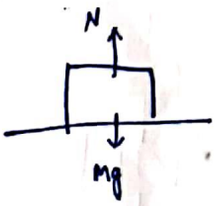
Normal Reaction ⇒

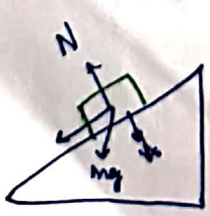
Contact force ⇒ which act due to contact, perpendicular to the contact
Always in pair – equal and opposite
perpendicular to contact surface





Normal Reaction ⇒





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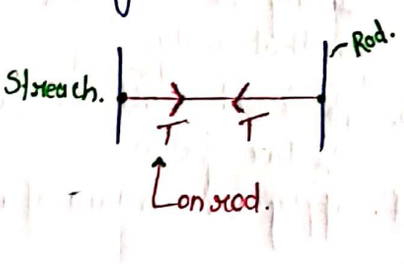
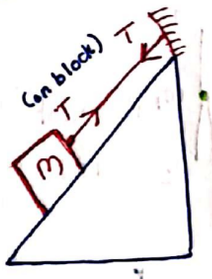
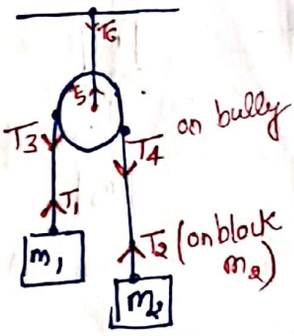
Tension force :⇒ H away from contact point along the length of string

= In ideal string (Massless), Tension same at all the point



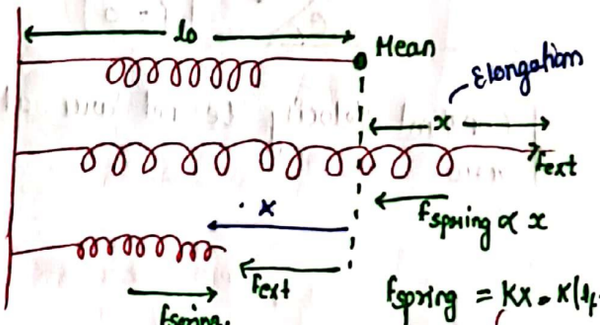




$T_1 = T_2 = T_3 = T_4$

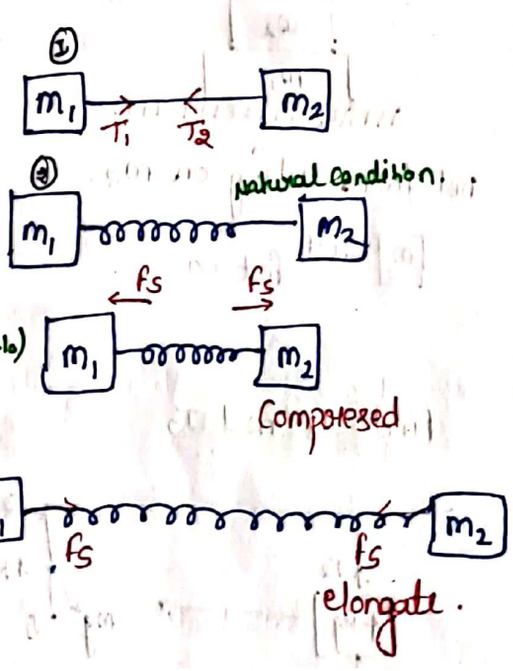
Ideal string = Value same

Spring :⇒ Force always towards the mean position.



$F_{spring} = Kx = K(l_f - l_o)$

Spring Const



Newton first Law of motion ⇒

= Law of Inertia / Law of equilibrium

= qualitative defination of motion

If $\sum f_{net} = 0$ then $\sum a_{sys} = 0$ hence $\vec{v} = \text{const}$, $\vec{u} = 0$

If net force acting on body is zero then it will continuous its state.

$\sum \vec{f}_x = 0$ then $\vec{a}_x = 0$ Y का पता

$\sum f_y = 0$ then $\vec{a}_y = 0$ x का पता

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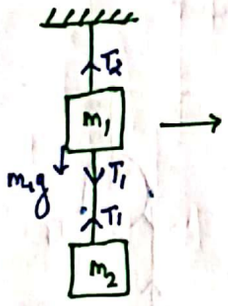
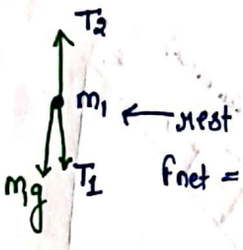
F.B.D ⇒ Free body diagram ⟶

1. Take that body seperate from the system represent it by paint.
2. Identify all the forces acting on that body.
3. Represent all the force in Vector form.
4. apply newton law of motion.

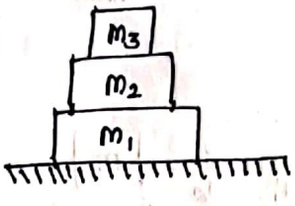


⟶



$$T_2 = T_1 + m_1 g$$

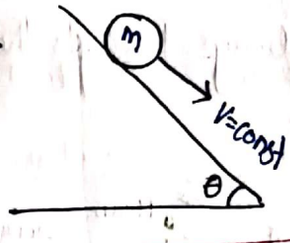
Que



net force acting on m_2.

m_2 rest $F_{net} = 0$

Que



Find net force on m = ??

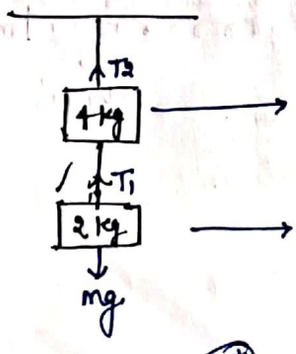
$\vec{v}$ = const

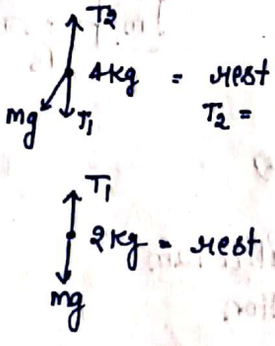
$a = 0$

$f = 0$

Constant Velocity ⇒ net force always zero

Que Find T_1 and T_2



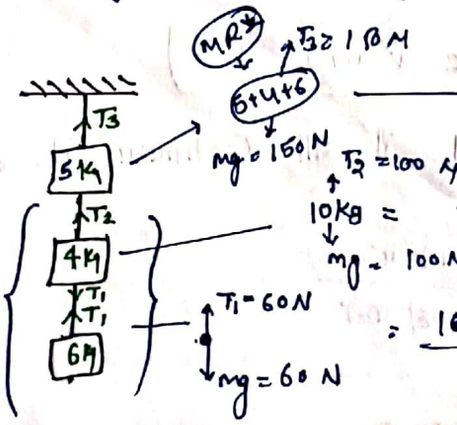


$T_2 = T_1 + mg = 20 + 4 \times 10 = 60\ N$ Ans

$T_1 = mg$

$T_1 = 2 \times 10 = 20\ N$

Que



$T_3 = T_2 + mg$

$100 + 5 \times 10 = 150\ N$ Ans

$T_2 = T_1 + mg$

$60 + 4 \times 10 = 100\ N$.

$T_1 = mg$

$= 6 \times 10 = 60\ N$

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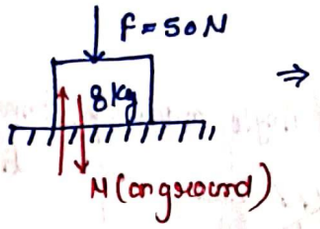
Qu Find contact force (Normal) b/w 8 kg and ground.



⇒

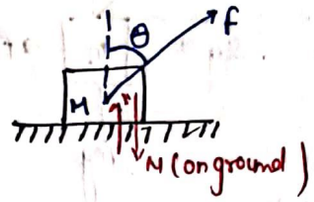
F = 50N

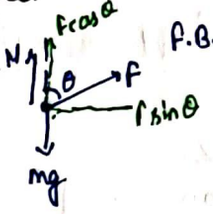
mg = 8×10 = 80 N

N = 50 + 80

N = 130 Ans

Qu Find contact force on object exerted by block ??





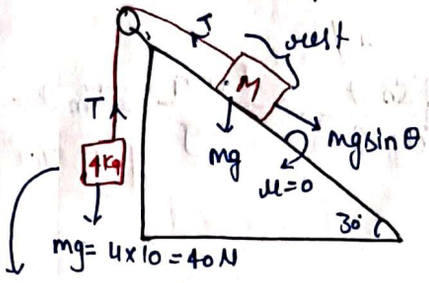
F.B.D on block.

$\sum f_y = 0$

$N + f\cos\theta = mg$

$\boxed{N = (mg - f\cos\theta)}$ Ans

Qu If System is in equilibrium then find value of (m)



T = 40N — (I)

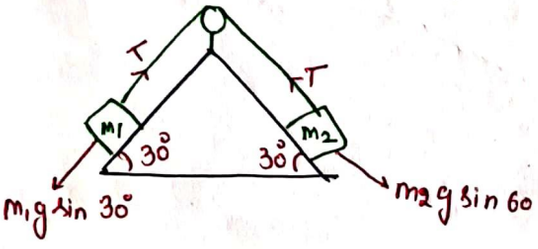
T = mgsinθ — (II)

$4g = m \times 10 \times \sin 30°$

$4 = m\frac{1}{2}$

$\boxed{m = 8\ kg}$

Qu Find relation b/w m_1 & m_2 so that system is in equilibrium.

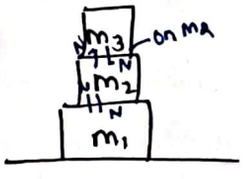


$m_1 g \sin 30 = m_2 g \sin 60$

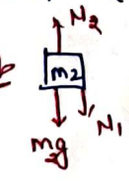
$m_1\left(\frac{1}{2}\right) = m_2 \times \frac{\sqrt{3}}{2}$

$\boxed{m_1 = \sqrt{3}\, m_2}$

Qu Find force applied by m_1 on m_2



F.B.D of m_2



$N_2 = N_1 + m_2 g$

$N_2 = m_3 g + m_2 g$

$\boxed{N_2 = g(m_3 + m_2)}$

F.B.D of M_3

$N_1 = m_3 g$

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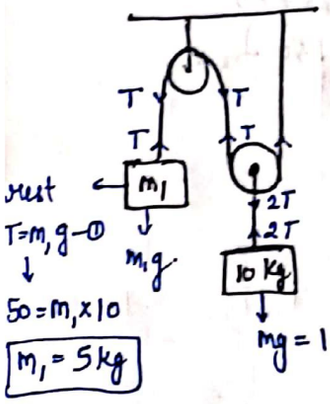
Qu Find m so that System is in equilibrium



$2T = 100$

$T = 50N$

And find tension

$(I)^2 + (II)^2$

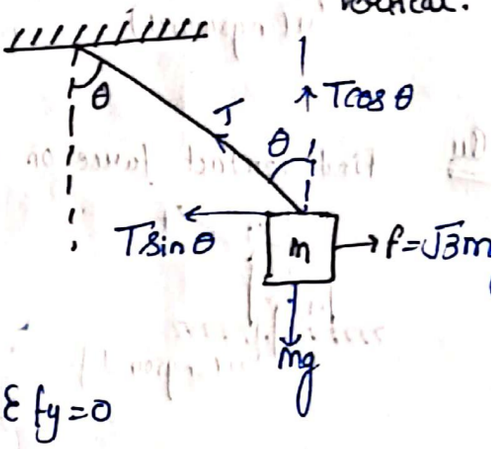
$T^2(\sin^2\theta + \cos^2\theta) = (2mg)^2 + (\sqrt{3}mg)^2$

$T^2 = 4m^2g^2$

$T = \sqrt{4m^2g^2}$

$= 2mg$ B2

Qu Find θ Angle made by string from Vertical.



$\Sigma f_y = 0$

$T\cos\theta = mg$ — (I)

$T\sin\theta = \sqrt{3}mg$ — (II)

II / I

$\frac{T\sin\theta}{T\cos\theta} = \frac{\sqrt{3}mg}{mg}$

$\tan\theta = \sqrt{3}$

$\theta = 60^\circ$ A2

Qu The Tension (T) is the string (assumed to be weight) in the arrangement show in (neglect friction everywhere) if system is in equilibrium.

① 50 N
② 25 N
③ 30 N
④ 500 N

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Q. A Vertical force F is applied at one end of a Uniform rope of mass M and length L. Find out tension in the rope as a function of x.

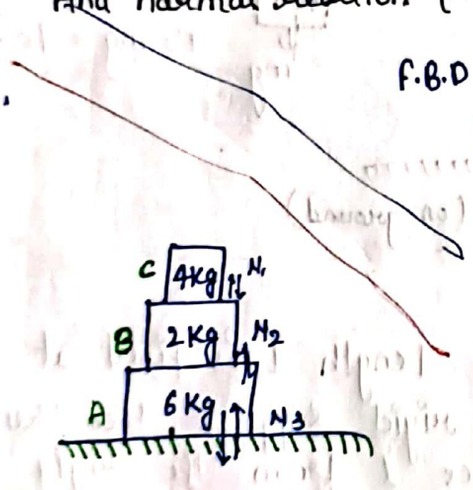
① F + mg

② $F + \frac{mgL}{x}$

③ $\frac{FL + Mgx}{L}$ ✓

④ $\frac{Fx + MgL}{L}$

Ques Find normal reaction (Contact force) B/w A & B.



F.B.D of (C)

$\Sigma f_y = 0$

$N_1 = 40N$

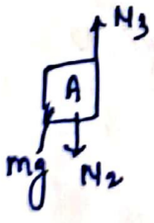
F.B.D of 'B'

$\Sigma f_y = 0$

$N_2 = N_1 + mg$

$N_2 = 40 + 20 = 60N$

F.B.D of A



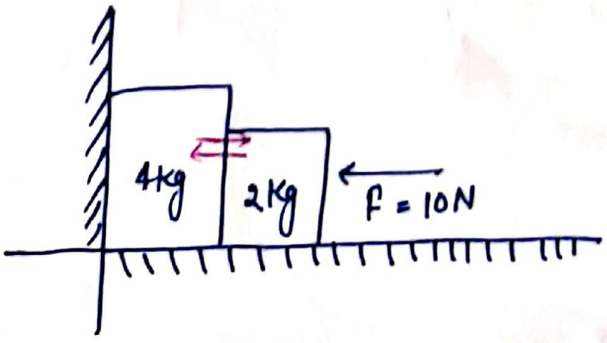
$f_y = 0$

$N_3 = N_2 + mg$

$= 60 + 60$

$N_3 = 120N$

Find Contact force B/w 4kg and 2 kg.



$\Sigma f_x = 0$

$N_1 = 10\ N$ Ans

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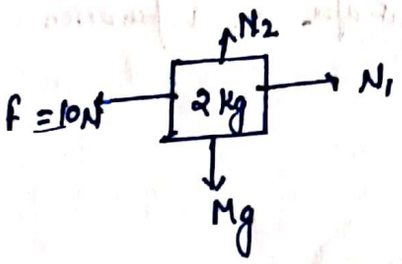
F.B.D of '2 kg'

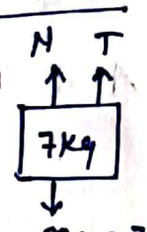


$N_2 = Mg$ $\quad \Sigma f_y = 0$

$N_2 = 20N$

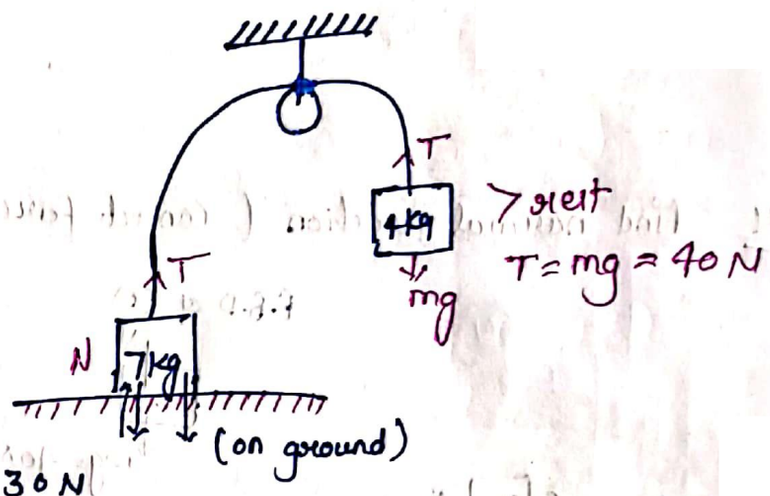
Find Contact force b/w ground 7 kg Block

F.B.D



$T + N = 70$

$N = 70 - 7 = 70 - 40 = 30\,N$



Que A Uniform rope of mass M and Length L is fixed at its upper end Vertically from a rigid support, then the tension in the rope at the distance l from the rigid support is

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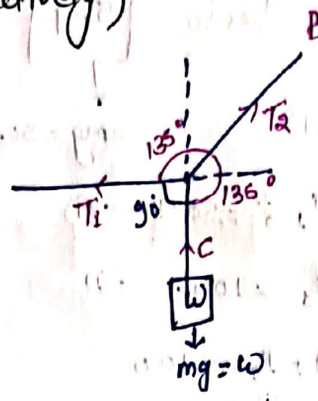
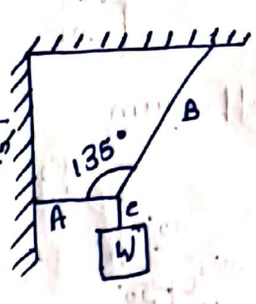
Qu A block of weight W is supported by three strings as shown in figure which of the following relation is true for tension in the string? (Here T_1, T_2 and T_3) are the tension in the string A, B and C respectively)

1. $T_1 = T_2$
2. $T_1 = T_3$ ✓
3. $T_2 = T_3$
4. $T_1 = T_2 = T_3$



Lami's theorem

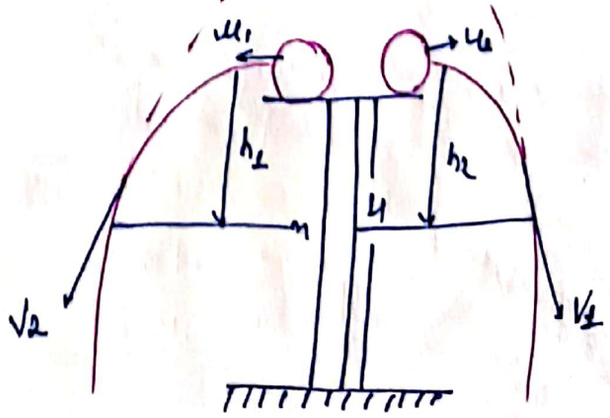
$$\frac{T_1}{\sin 135} = \frac{T_2}{\sin 90} = \frac{T_3}{\sin 135}$$



Qu A Block of weight W is supported by three strings as shown in figure. which of the following relation is true for tension in the strings? (Here T_1, T_2 and T_3) are the tension in the strings A, B and C respectively).

(1) $T_1 = T_2$
(2) $T_1 = T_3$
(3) $T_2 = T_3$
(4) $T_1 = T_2 = T_3$

Qu Find time when they are moving ⊥r to each other also find Sep^n B/w them when they are ⊥r to each other



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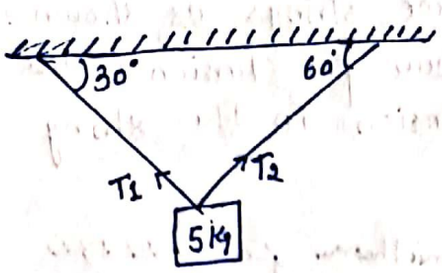
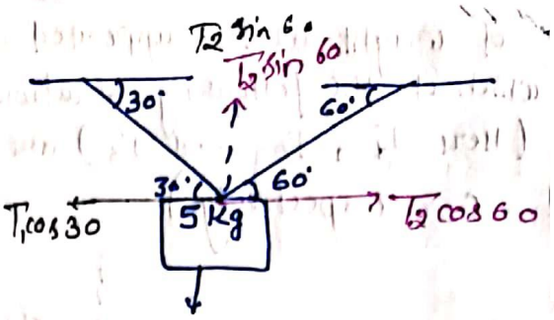
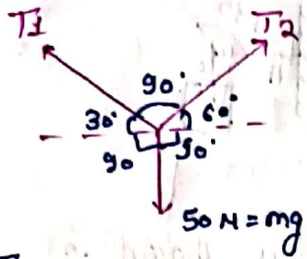




Lami's theorem



$\frac{T_1}{\sin 150} = \frac{50}{\sin 90}$

$T_1 = 50 \times \frac{1}{2} = \boxed{25\ N}$

$\Sigma f_y = 0$

$T_2 \frac{\sqrt{3}}{2} + T_1 \frac{1}{2} = 50N$ — ①

$\sqrt{3} T_2 + T_1 = 100$ — ②

$\sqrt{3}(\sqrt{3} T_1) + T_1 = 100$

$4T_1 = 100$

$\boxed{T_1 = 25\ N}$

$\Sigma f_x = 0$

$T_1 \frac{\sqrt{3}}{2} = T_2 \frac{1}{2}$

$\boxed{\sqrt{3} T_1 = T_2}$ — 1)

$\boxed{T_2 = 25\sqrt{3}\ N}$

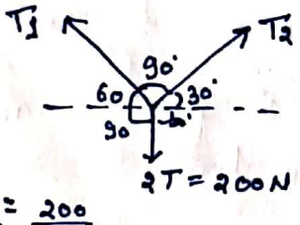
Qu In the arrangement as shown, tension T_2 is ($g = 10\ m/s^2$)

① 50 N

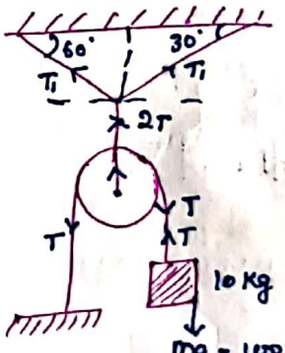
② 100 N

③ $50\sqrt{3}$ N

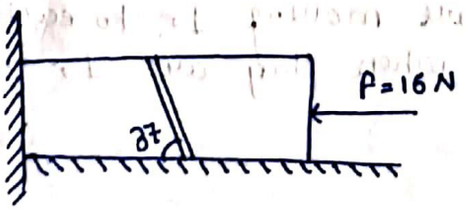
④ $100\sqrt{3}$ N

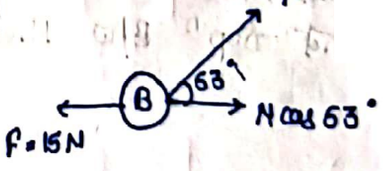


$\frac{T_2}{\sin 150} = \frac{200}{\sin 90}$ $= T_2 = 200 \times \frac{1}{2} = 100\ N$



Qu find Contact force between them.





$\Sigma f_x = 0$

$16 = N \times \frac{3}{5}$

$\boxed{N = 25\ N}$

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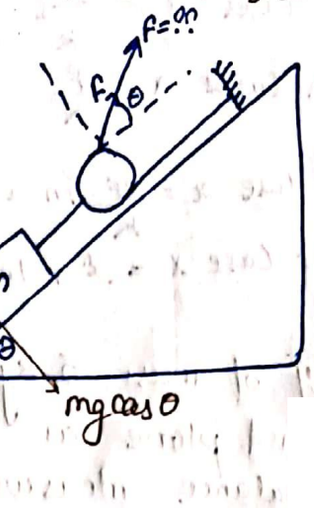
Q. Find f so that object of mass m will at rest as shown in figure



$$T = f + f\cos\theta$$

$$mg\sin\theta = f(1+\cos\theta)$$

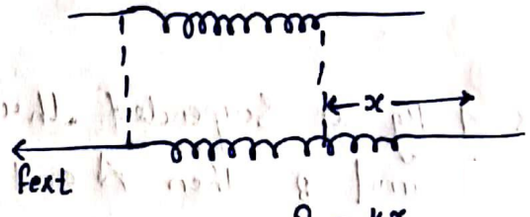
$$\boxed{f = \frac{mg\sin\theta}{(1+\cos\theta)}}$$

$$f = \frac{mg \cancel{2}\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cancel{2}\cos^2\frac{\theta}{2}\cos\frac{\theta}{2}}$$

$$\boxed{f = mg\tan\left(\frac{\theta}{2}\right)}$$ Ans

Ideal - Spring (Massless)

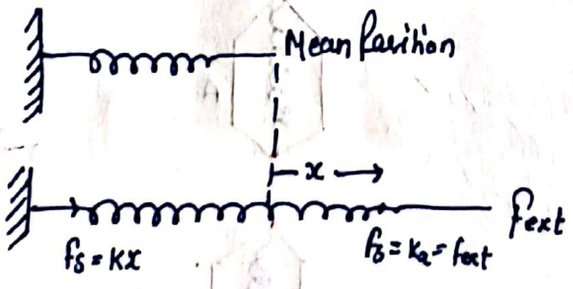
N = 0
Body Contact Remove



$f_s = kx$

$\{f_s = f_{ext}\}$

String assume



Q. figure shows two cases. In first case a spring (spring constant k) is pulled by two equal and opposite force f at both ends in second case is pulled by a force f at one end. Extension (x) in the spring will be.

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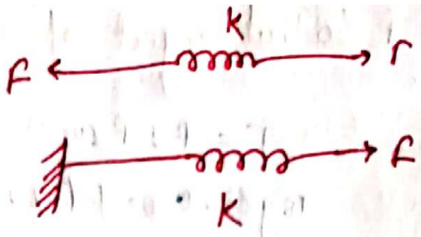
① In both Cases $x = \frac{2E}{K}$

② In both Cases $x = \frac{f}{K}$



③ In first Case $x = \frac{2f}{K}$ in second Case $x = \frac{f}{K}$

④ In first Case $x = E$, In see Case $x = \frac{2E}{K}$

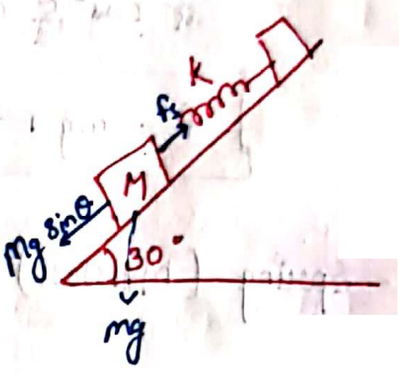
Que A body of mass 5 kg Suspended by a spring balance on an Inclined plane as Shown in figure. the spring. the spring balance measure

① 50 N
② 25 N ✓
③ 500 N
④ 10 N

$f_s = mg \sin\theta$

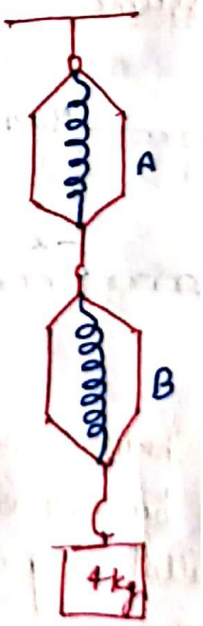
$f_s = 5 \times 10 \times \sin 30^\circ$

$= 25\ N$ Ans



Que A block of mass 4 kg is Suspended through two light Spring balance A and B. Then A and B will read respectively

① 4 kg and Zero kg
② Zero kg and 4 kg
③ 4 kg and 4 kg ✓
④ 2 kg and 2 kg



Que As shown in figure, two equal masses each of 2 kg are Suspended from a Spring balance, the reading of the Spring of the Spring balance will be

① Zero ✓ ② 2 kg ③ 4 kg ④ Between Zero and 2 kg

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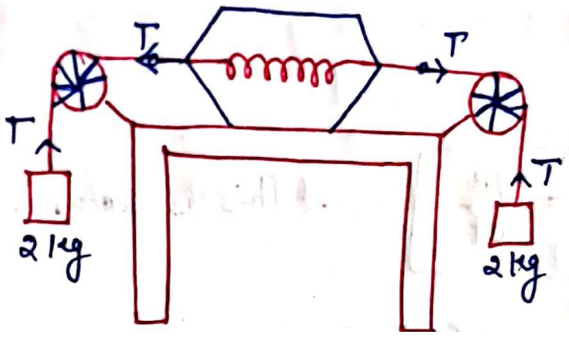
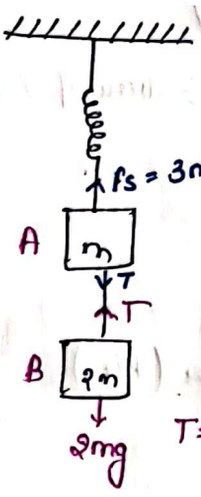


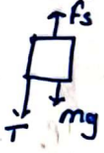
Que



System as shown in figure is in equilibrium. If String is cut then find acceln of A & B

T = 2mg — (i)

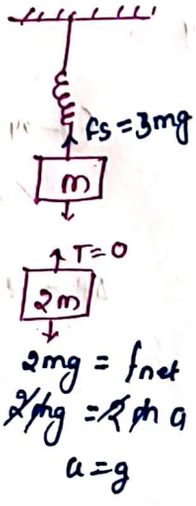
F.B.D of A



$f_s = T + mg$

$= 2mg + mg = 3mg$ — (ii)

after Cutting



$2mg = f_{net}$

$2mg = 2ma$

$a = g$

$f_{net} = 2mg$

$ma = 2mg$

$\boxed{a = 2g}$

Momentum ⇒ Motion Contained in a body

$P \propto v$

$P \propto M$

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

= Vector, direction parallel to velocity

= Unit = kg m/sec.

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Force

$\vec{F}_{avg} = \frac{\Delta \vec{p}}{\Delta t}$

$\vec{F}_{inst} = \frac{d\vec{p}}{dt}$ — This is newton 2nd Law.

$\vec{F}_{avg} = \frac{m[v_f - v_i]}{\Delta T}$

$\vec{F}_{avg} = \frac{\int f\,dt}{\int dt}$

= Slope of (p-t) is force

= Vector physical quantity.

= N

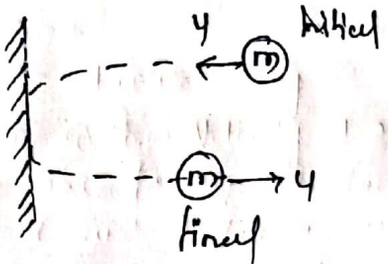
$\int f\,dt = \int dp$ $\quad \Delta p = \int f\,dt$ = area of f-t

$\Delta p = \int f \cdot dt$

p ⇄ f

$\frac{dp}{dt}$ = f = Slope (p/t)

Ans



$\Delta p = ?$

$\Delta p = \vec{p}_f - \vec{p}_i$

$mu\hat{i} - (-mu\hat{i})$

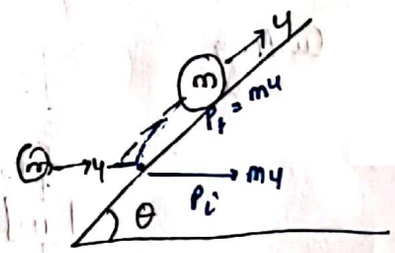
$\Delta p = 2mu\hat{i}$

$|\Delta \vec{p}| = 2mu$

or $\Delta p = 2mu \sin 90$

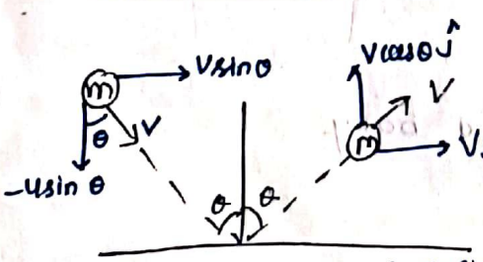
$\Delta p = 2mu$ Ans

Q4



$\Delta p = 2mu \sin\left(\frac{\theta}{2}\right)$

Q4



$\vec{u_i} = v\sin\theta\hat{i} - v\cos\theta\hat{j}$

$\vec{v_f} = v\sin\theta\hat{i} + v\cos\theta\hat{j}$

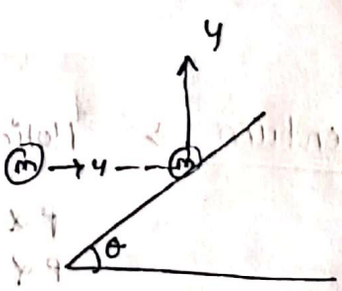
$\Delta \vec{p} = \vec{p}_f - \vec{p}_i$

$mv\sin\theta\hat{i} + mv\cos\theta\hat{j} - mv$

$\sin\theta\hat{i} + mv\cos\theta\hat{j}$

$\Delta p = 2mv\cos\theta\,\hat{j}$ Ans

Q4



$\Delta p = \vec{p}_f - \vec{p}_i$

$= mu\hat{j} - mu\hat{i}$

$\Delta p = \sqrt{(mu)^2 + (mu)^2}$

$\sqrt{2m^2u^2} \Rightarrow (\sqrt{2})mu$

$2mu\sin\left(\frac{\theta}{2}\right)$ Ans

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Newton 2nd Law ⇒

$$\vec{f}_{avg} = \frac{\vec{p}_f - \vec{p}_i}{\Delta t}$$

$$f_{inst} = \frac{d\vec{p}}{dt}$$ = The rate of change in momentum
- force = Slope of p/t graph

$$\vec{f} = \frac{d(mv)}{dt}$$

$$f_{avg} = \frac{\int \vec{f}\cdot d\vec{t}}{\int dt}$$

$$\vec{f} = m\vec{a} + v\frac{dm}{dt}$$ — Newton 2nd Law

If m = const

$$\vec{f} = m\vec{a}$$

$\vec{u}$ = const (m-variable)

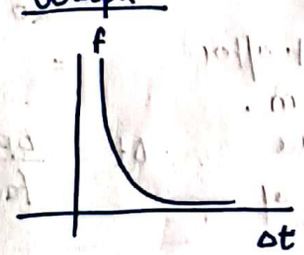
$$f = v\left(\frac{dm}{dt}\right)$$

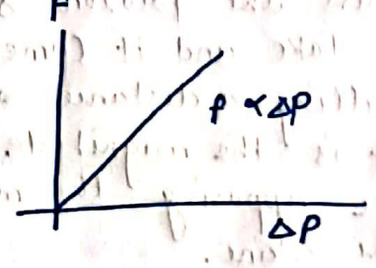
Ex:

$$f = \frac{p_f - p_i}{\Delta t}$$

$$f \propto \frac{1}{\Delta t}$$

Graph





Que A Cricketer Catches a ball of mass 150 g in 0.1 s moving with speed 20 m/s, then the Experience force of.

① 300 N
② 30 N ✓
③ 3 N
④ 0.3 N

m → v = 20 m/s

$$p_i = mv = \frac{150}{1000} \times 20 = 3$$

$$\frac{\Delta p}{\Delta t} = \frac{3}{1/10} = 30\ N$$ Ans

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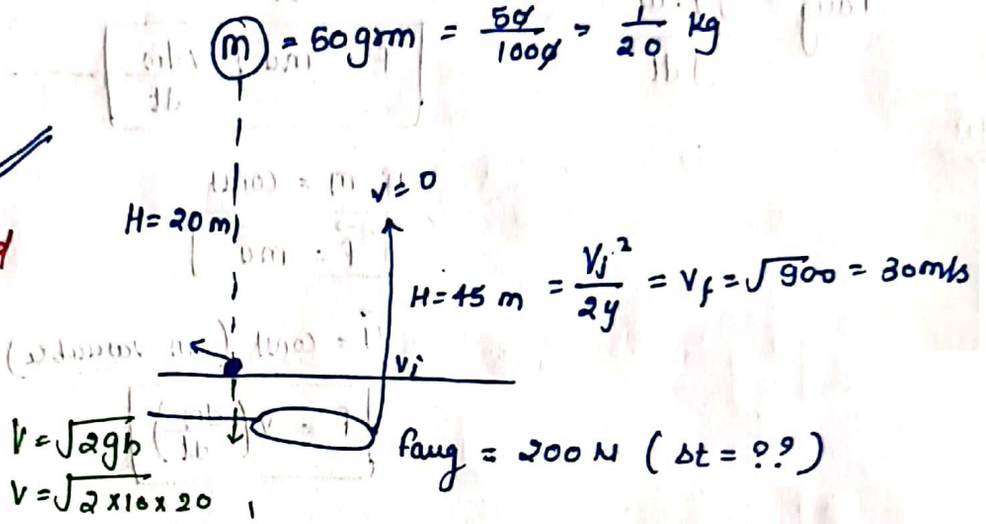
Qu A ball of mass 50 g is dropped from a height of 20 m. A boy on the ground hits the ball vertically upward with a bat with an average force of 200 N, so that it attains a vertical height of 45 m. The time for which the ball remains in contact with the bat is (Take $g = 10\ m/s^2$)

① $\frac{1}{20^{th}}$ of a second

② $1/40^{th}$ of a second

③ $1/80^{th}$ of a second ✓

④ $1/120^{th}$ of a second



Qu A stone of mass 1 kg is thrown with a velocity of 20 m/s across the frozen surface of a lake and it comes rest after travelling a distance of 50 m. What is the magnitude of the force opposing the motion of the stone

$\Delta p = m\vec{v}_f - m\vec{v}_i$

$= m(\vec{v}_f - \vec{v}_i)$

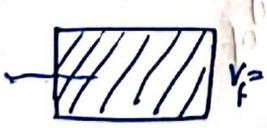
$= \frac{1}{20}[30 - (-20)]$

$= \frac{50}{20} = 2.5$

$\Delta t = \frac{\Delta p}{f_{av}} = \frac{5}{2 \times \frac{200}{40}} = \frac{1}{80}$

Ans $m = 1\ kg$

$v_i = 20\ m/s$



$f = const \leftarrow s = 50\ m$

$a = const$

$s = \left(\frac{u+v}{2}\right)t$

$50 = \frac{20}{2}t$

$t = 5\ sec$

$f = \frac{\Delta p}{\Delta t} = \frac{0 - m4}{\Delta t}$

$= \frac{1 \times 20^4}{5} = 4N$ Q

2nd method

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

$s = \frac{u^2}{2a}$

$a = \frac{20 \times 20}{2 \times 50} = 4$

$a = 4$

$f = ma$

$= 1 \times 4$

$f = 4\ N$ B

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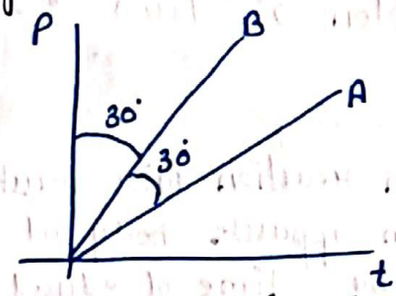
Que For two object P-t graph is given then find Ratio of force acting on the



$$\frac{F_A}{F_B} = \frac{(\text{Slope})_A}{(\text{Slope})_B} = \frac{\tan 30}{\tan 60} = \frac{1}{3}$$

Que A force $\vec{F} = (2t\hat{i} + 3t^2\hat{j})$ N acts on object moving in xcy plane find magnitude of change in momentum of the object in time interval $t=0$ to $t=2$ s

$$\vec{F} = (2t\hat{i} + 3t^2\hat{j})$$

$$\vec{F} = \frac{d\vec{P}}{dt}$$

$$d\vec{P} = \vec{F}\cdot dt$$

$$\int d\vec{P} = \int 2t\,\hat{i}\,dt + \int 3t^2\hat{j}\,dt$$

$$\Delta\vec{P} = 2\left(\frac{t^2}{2}\right)_0^2 \hat{i} + 3\left(\frac{t^3}{3}\right)_0^2 \hat{j}$$

$$\Delta\vec{P} = 4\hat{i} + 8\hat{j}$$

$$|\Delta\vec{P}| = \sqrt{4^2 + 8^2}$$

$$= \sqrt{16 + 64}$$

$$= 8\sqrt{5}$$

$4\sqrt{5}$ kg

Que A force

① 7 sec

② 5 sec

③ 10 sec

④ 8 sec

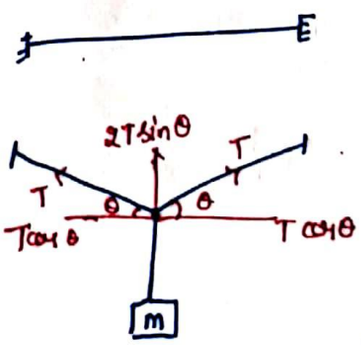
Que A weight Mg is suspended from the middle of a rope whose ends are at the same level. The rope is no longer horizontal, the minimum tension required to completely straight up the rope is

① $\frac{mg}{2}$

② $mg\cos\theta$

③ $2mg\cos\theta$

④ Infinitely large



$$2T\sin\theta = mg$$

$$T = \frac{mg}{2\sin\theta}$$

T = Infinitely

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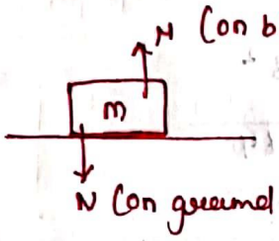
Newton 3rd Law :- There is equal and opposite reaction for every action

Action reaction pair must be on opposite body at a same time of equal magnitude but opposite in direc.

Action reaction must be of same nature.



these two normal are (action - reaction pair)

Significance of Newton's Law

① The first Law talk about the natural state of motion of a body. ie

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Impulse ⇒ Impulse is defined as the change in momentum. It is measured as the product of the average force and time for which the force acts. It is a vector quantity directed along the direction of force.

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

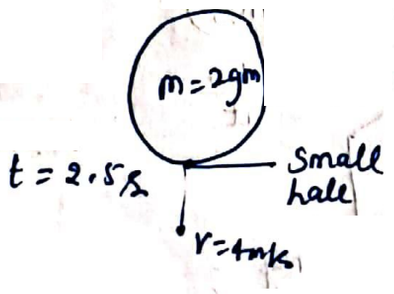
$$\int_{P_i}^{P_f} dP = \int F \cdot dt$$

$$P_f - P_i = \int F \cdot dt$$

$$\boxed{I = \int F \cdot dt}$$

Qu A ballon has 2g of air, A small hall is pierced into it. The air comes out with a velocity of 4 m/s. If the ballon shrinks completly in 2.5 s, the average force acting on the ballon is:

① 0.008 N
② 0.0032 N
③ 8 N
④ 3.2 N



$$F_{avg} = u\frac{\Delta m}{\Delta t}$$

$$= 4 \times \frac{2}{1000 \times \frac{5}{2}}$$

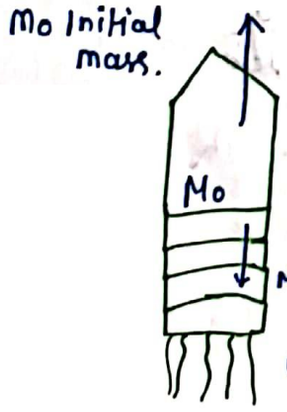
$$\frac{16}{5 \times 1000} \quad 3.2$$

$$\boxed{F = 0.0032\ N}$$

(2)

Rocket Problem ⇒ Variable mass System $\frac{dm}{dt}$ $\vec{v}$ = const

$$f = v\frac{dm}{dt}$$



$F_{upthrust} = u\frac{dm}{dt}$

u = Velocity of gas

$\frac{dm}{dt} = \alpha$ = Rate of

Mass after time = $M_0 - \left(\frac{dm}{dt}\, t\right)$

Initial acceln ⇒ F.B.D of Rocket (t=0)

$$F_{net} = u\frac{dm}{dt} - M_0 g$$

$$M_0 a_0 = u\frac{dm}{dt} - m_0 g$$

$$\boxed{a = \frac{u\frac{dm}{dt}}{M_0} - g}$$

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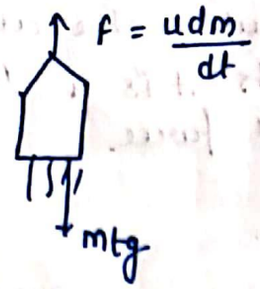
after time t



$$f_{net} = \frac{u\,dm}{dt} - m_t g$$

$$m_t a_t = \frac{u\,dm}{dt} - m_t g$$

$$a_t = \frac{\frac{u\,dm}{dt}}{m_t} - g$$

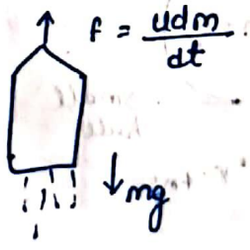
$$a_t = \frac{\frac{u\,dm}{dt}}{\left(m_0 - \frac{dm}{dt}t\right)} - g$$

Qu A 800 kg rocket fired from earth so that Exhaust Speed is 1200 m/s. Then Calculate mass of fuel burning per second, to provide Initial thrust to Overcome its weight ($g = 10\ m/s$)

$m = 800\ kg$

$u = 1200\ m/s$

$\frac{dm}{dt} = ?$



$$\frac{u\,dm}{dt} = mg$$

$$1200\left(\frac{dm}{dt}\right) = 800 \times 10$$

$$\frac{dm}{dt} = \frac{80}{12} = 6.67\ kg/s$$

Qu A Cracker rocket is ejecting gases at a rate of 0.05 kg/s with a velocity 400 m/s. The accelerating force on the rocket is ~~minute after the blast is ($g = 10\ m/s^2$)~~

~~① 34.4 m/s²~~
~~② 27.5 m/s²~~
~~③ 3.50 m/s²~~
~~④ 13.5 m/s²~~

① 20 dyns
② 20 N
③ 200 N
④ Zero

$$f = u\frac{dm}{dt} = 400 \times \frac{5}{100}$$

$$= 20\ N$$

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Conservation of momentum

If net External force acting on the body / system is zero the momentum of body / system will be Conserved.

$$\vec{F} = \frac{d\vec{P}}{dt}$$

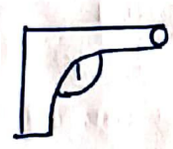
If $\vec{F}_{net} = 0$

$$0 = \frac{d\vec{P}}{dt}$$

$$\vec{P} = \text{Const}$$

$$\boxed{\vec{P}_f = \vec{P}_i}$$

Gun bullet System :-



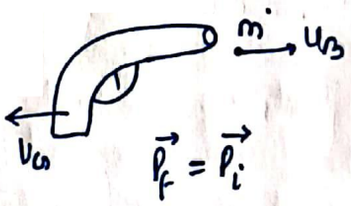
System — Gun + bullet

M = mass of Gun

m = Mass of bullet

$\vec{P}_i = 0$

$$\boxed{(\vec{f}_{ext})_{Gun\,bullet} = 0}$$



$\vec{P}_f = \vec{P}_i$

$m\vec{u}_B + M\vec{v}_G = 0$

$m\vec{v}_G = -m\vec{u}_B$

$$\boxed{\vec{V}_G = -\frac{m\vec{u}_B}{M}}$$

$$\boxed{K.E = \frac{1}{2}mv^2 = \frac{P^2}{2m}}$$

* Change in momentum of bullet = $P_f - P_i = m\vec{u}_B$

* Change in momentum of Gun = $m\vec{u}_B$ = $m\vec{u}_G$

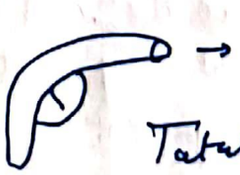
$$\boxed{\vec{P}_{Gun} = -\vec{P}_{Bullet}}$$

$K.E = \frac{P^2}{2m}$ → same

$K.E \propto \frac{1}{m}$

$$\boxed{K.E_{bullet} > K.E_{Gun}}$$

$$\boxed{\frac{K.E_B}{K.E_G} = \frac{M}{m}}$$



n - bullet per sec →

Total force on Gun.

force on one bullet = $\frac{m\vec{u}_B}{t}$

force on n-bullet = $\frac{Nm\,u_B}{t}$

$$\boxed{\text{force of } N\text{-ball} = nmu_B}$$

for on Gun = nmu_B

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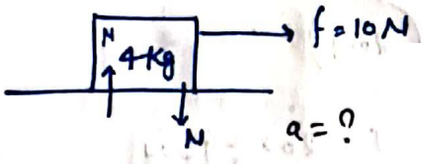
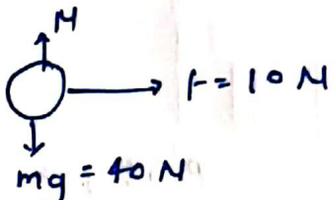
Dynamic of a body ⇒

$\vec{F}_{net\ Unbalance} = m\vec{a}$



f.B.D of 4Kg



N = 40 newton

$\Sigma f_x = 10N$

$ma = 10$

$4a = 10$

$a = \frac{10}{4} = \boxed{2.5\ m/s^2}$ Ans

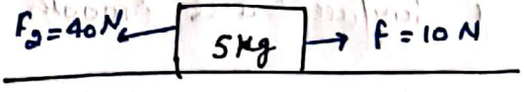
Q. 

Find acel^n =

$\Sigma f_x = (40+20)$

$10a = 60$

$\boxed{a = 6\ m/s^2}$

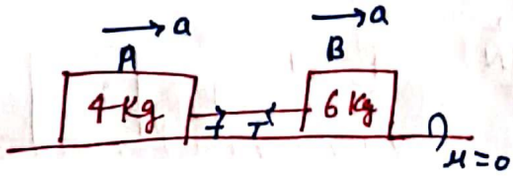
Ans 

$\Sigma f_x = m\vec{a}$

$30 = 5a$

$\boxed{a = 6\ m/s^2}$

Connected body motion :- Find acel^n A & B and tension in string ??



f.B.D of 4Kg

$T = 4a$ — ①

f.B.D of 6Kg

$20 - T = 6a$ — ②

$20 - 4a = 6a$

$10a = 20 \Rightarrow \boxed{a = 2\ m/s^2}$

Using eqn 1.

$T = 4a$

$= 4 \times 2$

$T = 8\ m/s^2$ Ans

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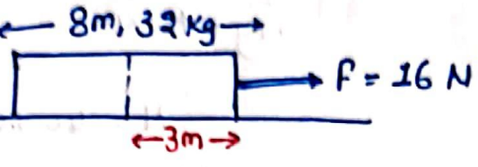
Qu A massive string of length 8m and mass 32 kg. then find tension at a point 3 m from a end where force is applied

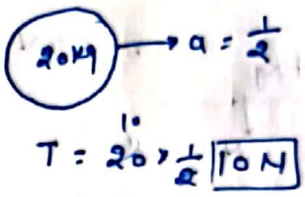
MR*

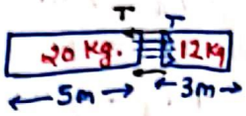
$a_{Body} = \frac{f_{net}}{m}$

$= \frac{16}{32}$

$\vec{a} = \frac{1}{2} m/s^2$







Mass of 8m is 32 kg

" " 1m = $\frac{32}{8}$ = 4 kg/m

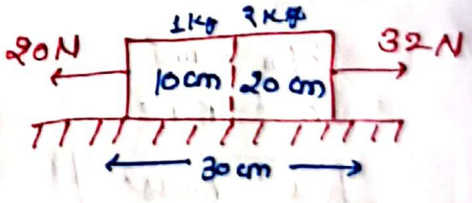
" " 3m = 4 × 3 = 12 kg.

Qu figure shows a Uniform rod of length 30 cm having a mass 3.0 kg. The rod is pulled by constant forces of 20 N and 32 N as shown, find the force Exerted by 20 cm part of the rod on the 10 cm part (all surface are smooth) is.

① 36 N
② 12 N
③ 54 N
④ 24 N

1 kg = f = ma

1 × 4 = 4 .



$a = \frac{32-20}{3} = \frac{12}{3} = 4 m/s^2$

Qu Arrangement of two block system is as shown. the net force acting on 1 kg and 2kg blocks are (assuming the surface to the frictionless) respectively.

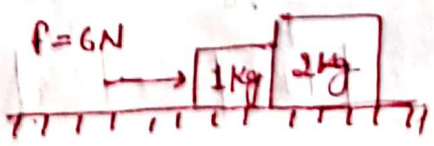
ⓐ 4N, 8N
ⓑ 1 N, 2N
ⓒ 2N, 4N
ⓓ 3 N, 6N

$a_{sys} = a_{1kg} = a_{2kg} = \frac{6N}{3}$

a = 2m/s²

$f_{1kg} = ma = 1 \times 2 = 2N$

$f_{2kg} = ma = 2 \times 2 = 4 N$ →



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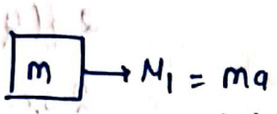
Que Two blocks are in contact on a frictionless table. One has mass m and the other 2m. A force f is applied on 2m as shown in the figure. Now the same force f is applied from right on m, In the two cases respectively, the ratio of force of Contact b/w two blocks will be.

① Same
② 1:2
③ 2:1
④ 1:3

Case-1

$a_{system} = \frac{f}{3m}$

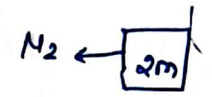


$N_1 = \frac{mf}{3m}$

$N_1 = \frac{f}{3}$

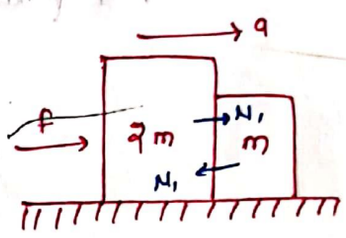
Case-2

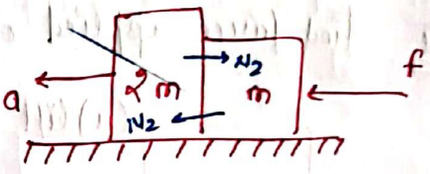
$a_{sys} = \frac{f}{3m}$



$N_2 = 2m \times \frac{f}{3m}$

$N_2 = \frac{2f}{3}$



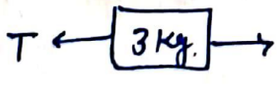


$\Rightarrow \frac{N_1}{N_2} = \frac{1}{2}$ B

Que figure shows two blocks connected by a light, inextensible string as shown in figure. A force of 10 N is applied on the bigger block at 60° with horizontal, then the tension in the string connecting the two masses is.

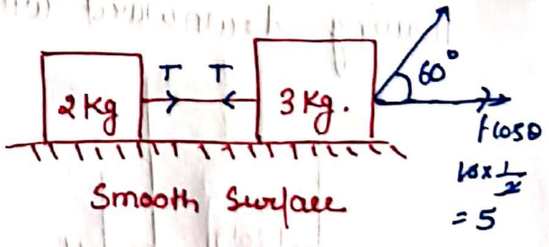
① 5N
② 2N
③ 1N
④ 3N

F.B.D of 3kg.

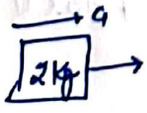


$5 - T = ma$ — (i)

$5 - T = 3a$



F.B.D of 2 kg



$T = ma$

$T = 2a$ — (ii)

$5 - T = 3a$ — (i)

$T = 2a$ — (ii)

$5 = 5a$

$a = 1\ m/s$

Put the value of a $T = 2a$

$T = 2 \times 1 = 2N$ B

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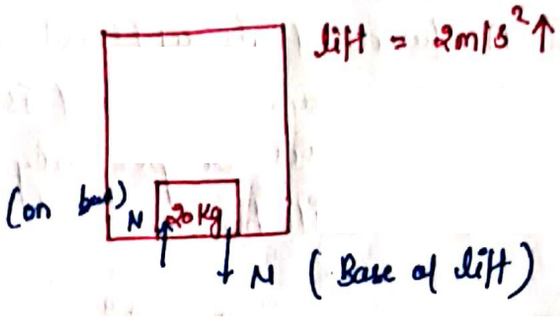
Qu find force applied on base of lift by 20 kg block.



$(N - mg) = ma$

$N - mg = ma$

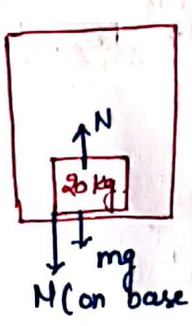
$N = ma + mg$

$N = m(a+g)$

$20(2+10) = 240\ N$

$20 \times 12 = 240\ N$

Qu find force applied on base of lift by 20 kg block.



$N = 20(10-4)$

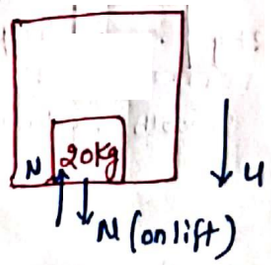
20×6

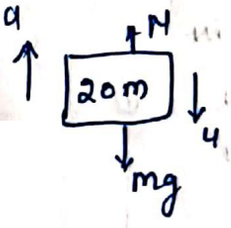
$= 120\ N$

$(mg - N) = ma$

$N = mg - ma = m(g-a)$

Qu find force applied on base of lift by 20 kg block lift is moving downward with retardation $4m/s^2$ then find Normal





$N - mg = ma$

$N = mg + ma = 200 + 20 \times 4 = 280\ N$

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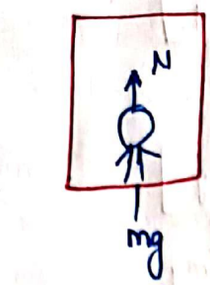
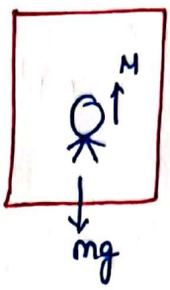
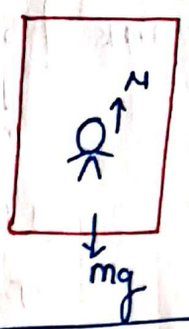
Apparent Weight ⇒



$N = mg$



$N = mg + a$



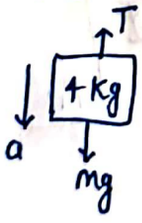
$N = m(g - a)$

Qu Tension in the rope at the rigid support is ($g = 10\ m/s^2$)

(a) 760 N
(b) 1360 N
(c) 1580 N
(d) 1620 N

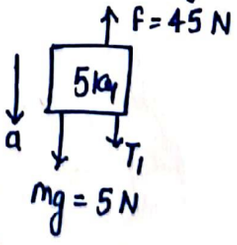
Qu Find tension in string b/w 4kg and 5 kg.

Soln F.B.D of 4 kg



$mg - T = 4 \times a$ — (ii)

F.B.D of 5 kg



$50 + T_1 - 45 = 5 \times a$ — (i)

(i) + (ii)

$50 + T - 45 = 5a$ — (i)
$40 - T = 4a$ — (ii)

$45 = 9a$

$a = \frac{45}{9} = 5\ m/s^2$

Putting value of a in eq (i)

$40 - T = 4 \times 5$
$T = 40 - 20 =$ **20 N**

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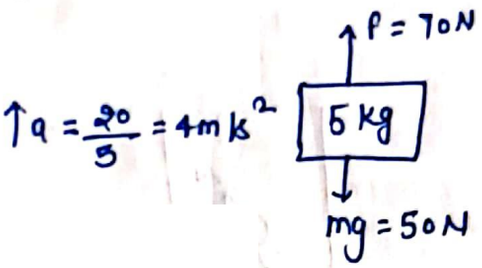
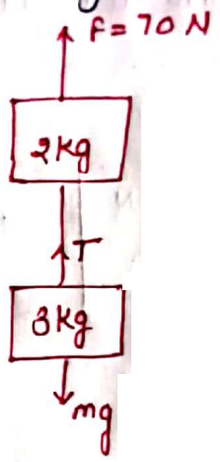
Qu Find tension in String connected B/w 2kg and 3kg.



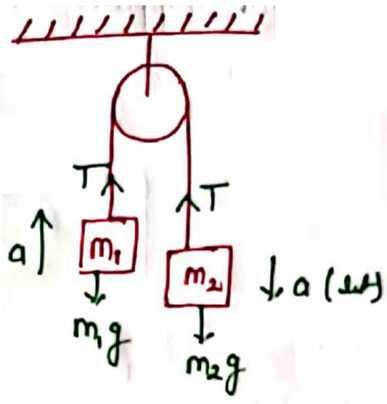


Think about

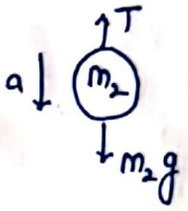
$T - mg = ma$

$T = m(g+a) = 3 \times (10+4) = 42\ N$ Ans

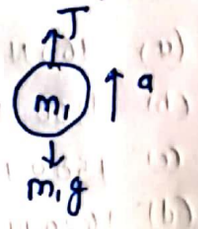
Qu If ($m_2 > m_1$) then find acceleration of m_1 and m_2 and Tension in String.



F.B.D of m_2



F.B.D of m_1



$m_2g - T = m_2a$ — (I) $\quad T - m_1g = m_1a$ — (II)

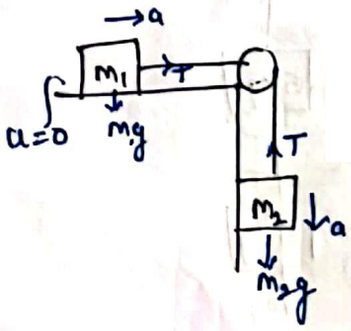
(I) + (II) $\quad m_2g - T = m_2a$

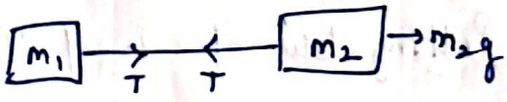
$T - m_1g = m_1a$

$m_2g - m_1g = (m_1+m_2)a$

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

Qu Find acceleration of Block M_1 and M_2 and tension in String.





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

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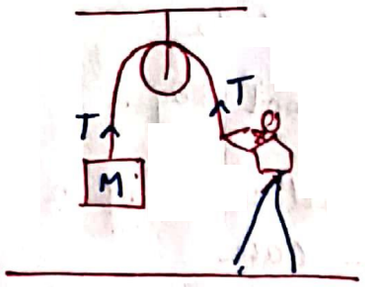
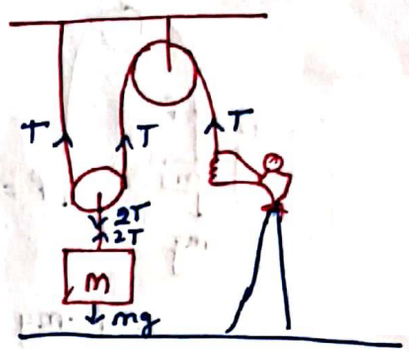
Que In which case pulling the block will be easy.



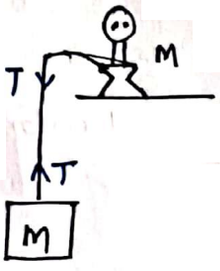
(A)



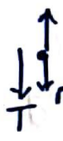
(B)

In case - B.

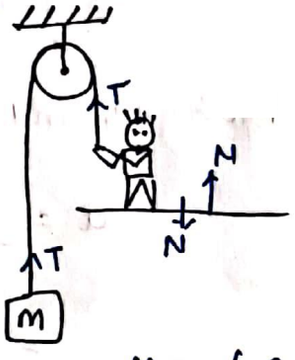
Que



Man F.B.D



$N = T + Mg$



Man F.B.D

$T + N = mg$

$N = mg - T$

In which case easy to pull.
Find Normal rxn b/w Ground & man in Both Case

Ans B will be easy

Que The arrangement shown, the mass m will ascend with an acceleration (Pulley and rope are massless)

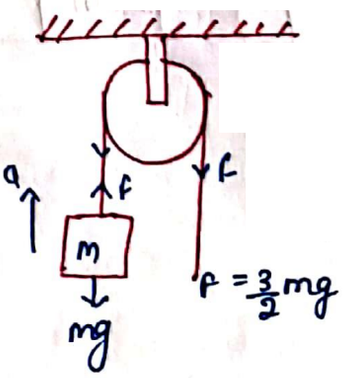
① zero
② $\frac{g}{2}$
③ c
④ 2g.

$f - mg = ma$

$\frac{3}{2}mg - mg = ma$

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

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



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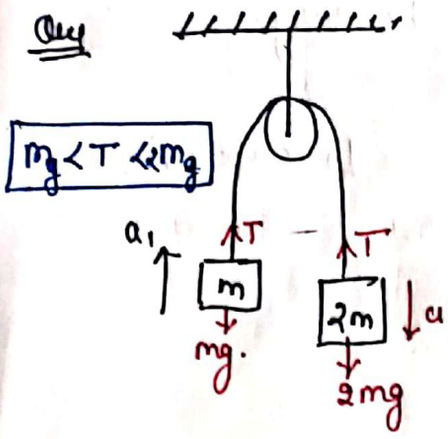
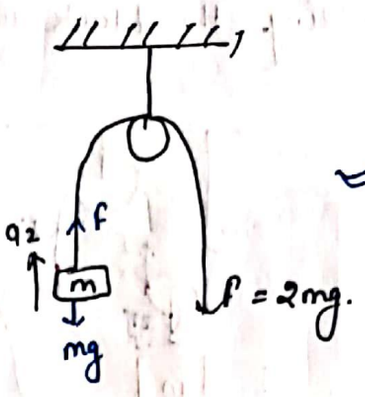
Que





(a) $a_1 = a_2$

(b) $a_1 > a_2$

(c) $a_1 < a_2$

(d) Can't Say

Find acceleration of m in Both Case.

$$a = \left(\frac{2m-m}{2m+m}\right)g = \frac{m}{3m}g$$

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

$f - mg = ma$

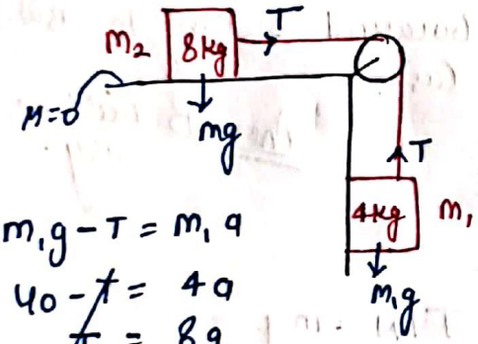
$2mg - mg = ma$

$mg = ma$

$a_2 = g$

Allen module
case-3 Base.

Que Find acceleration of Block m_1 and m_2 and tension in String.



$m_1 g - T = m_1 a$

$40 - T = 4a$

$T = 8a$

$40 = 12a$

$a = \frac{40}{12} = \frac{10}{3}\ m/s$

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

$$= \frac{40}{12} = \frac{10}{3}$$

F.B.D of 8kg.

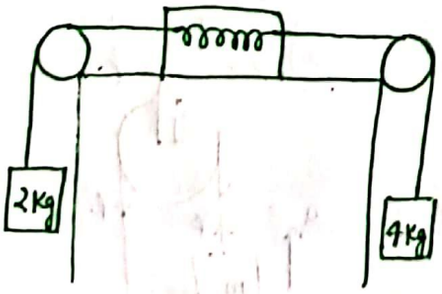
$T = 8a$

$T = 8 \times \frac{10}{3} = \frac{80}{3}$

$T = \frac{m_1 m_2}{m_1 + m_2} g = \frac{32}{12} \times 10$

$= \frac{80}{3}$

Que Reading of Spring.



$$T = \frac{2 \times 4 \times 2}{4+2} g$$

$\frac{16g}{6} = \frac{8g}{3}$

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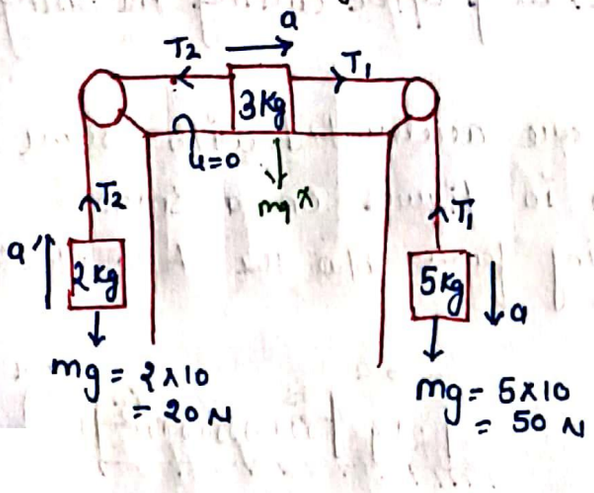
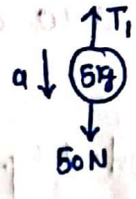
4 Find acel^n of System



f.B.D 5kg.



$50 - T_1 = 5a$ — (I)

$T_1 - T_2 = 3a$ — (II)

$T_2 - 20 = 2a$ — (III)

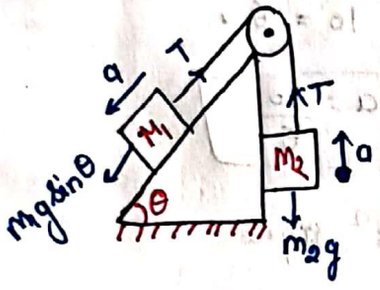
$30 = 10a$

$\boxed{a = 3\ m/s^2}$

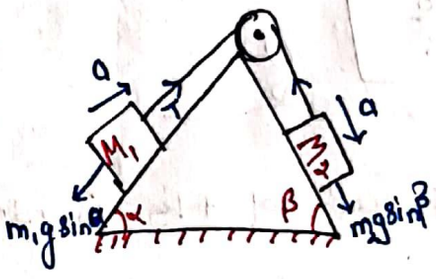
$a = \frac{50-20}{10} = \frac{30}{10} = \boxed{3\ m/s^2}$

Pulley module me Case 4, 5, 6.

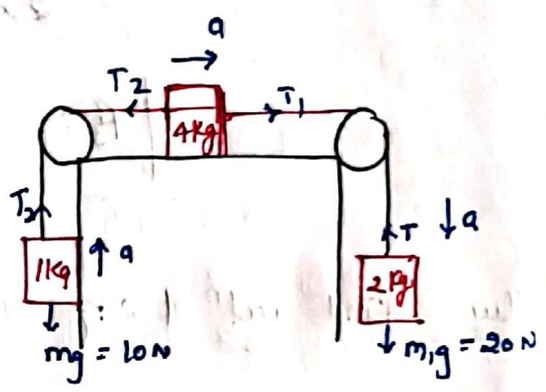
Qu Find acceleration of M_1 and M_2



$a = \frac{m_1 g \sin\theta - m_2 g}{m_1 + m_2}$



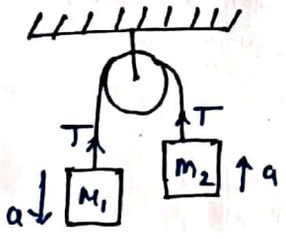
$a = \frac{m_2 g \sin\beta - m_1 g \sin\alpha}{m_1 + m_2}$



$a = \frac{20-10}{7} = \frac{10}{7}\ m/s^2$

IIT

Qu Find Tension in string if $(m_1 >> m_2)$

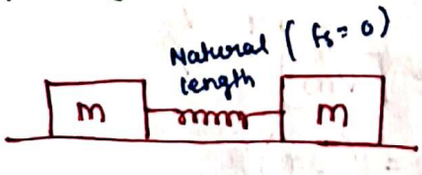


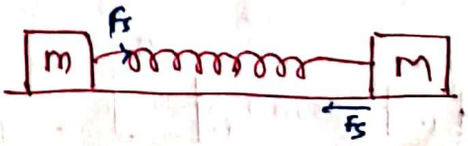
$T = \frac{2 m_1 m_2}{m_1 + m_2} g$

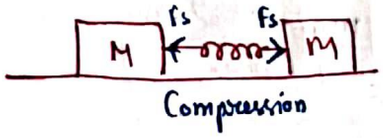
$T = \frac{2 m_1 m_2}{m_1} g$

$\boxed{T = 2 m_2 g}$

Spring force :→







Spring force in spring becomes zero slowly after cutting the spring.

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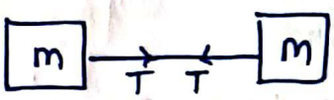
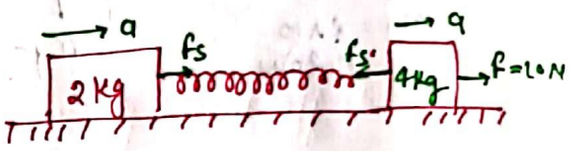


Tension force in string becomes zero Exactly after cutting the string.

Que Two blocks of mass 2kg and 4kg are accelerated with same accel^n by a force 10N as shown in figure on a smooth horizontal surface. then the spring force b/w the two blocks will be (Spring is massless)

① 5 N
② 10 N
③ $\frac{10}{3}$ N
④ $\frac{5}{3}$ N



Using eq^n — (1)

$f_s = 2a$

$= 2 \times \frac{10}{3}$

$f_s = \frac{10}{3}$ B

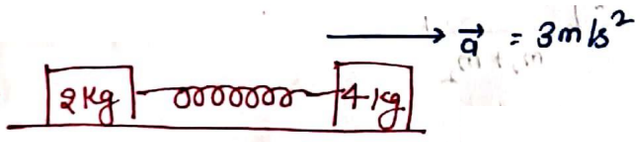
$10 - \sqrt{8} = 4a$ — (1)

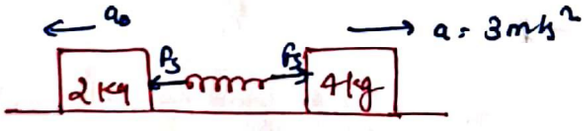
$\sqrt{8} = 2a$ — (2)

$10 = 6a$

$a = \frac{10}{6}$

Que Find accel^n of 2kg if accel^n of 4kg is $3 m/s^2$ right





$f_s = 2 \times a_0$

$12 = 2a_0$

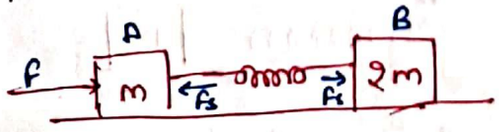
$a_0 = \frac{12}{2} = 6 m/s$

$f_s = ma$

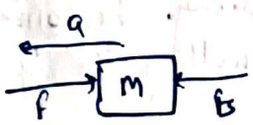
$= 4 \times 3$

$= 12 N$

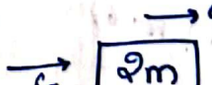
Que Find accel^n of B Block if accel^n of A Block is a_0 towards left



Sol^n.



$f_s - f = ma_0$ — (1)



$f_s = (2m)a'$

$f + ma_0 = 2ma'$

$a' = \frac{f + ma_0}{2m}$ B

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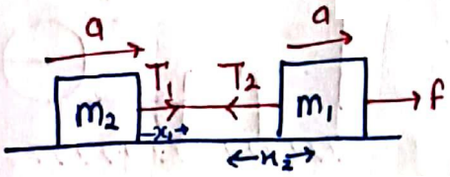
Constrain Motion ⇒ Total work done by Internal force is zero.



$(W_{tension})_{Total\ sy} = 0$

T (internal force)

$Tx + T.x\cos 180 = 0$

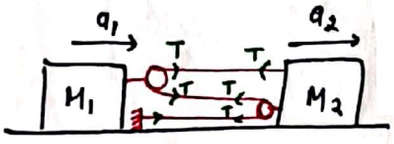
$W = Tx - Tx = 0$

$m_1 + m_2 \rightarrow f$

$a = \left(\frac{f}{m_1+m_2}\right)$

does not depend on tension.

Que Constrain Motion :⇒.
find relation b/w a_1 and a_2



Soln $2Ta_1 = 3Ta_2$

$2a_1 = 3a_2$ Ans

Que A block is dragged on smooth plane with the help of a rope which moves with velocity V. The horizontal velocity of the block is.

① V

② $\frac{V}{\sin\theta}$

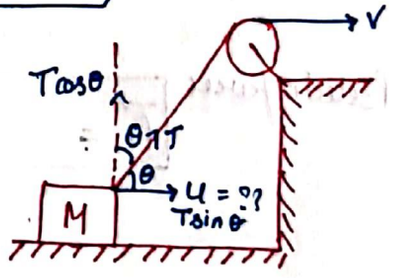
③ $V\sin\theta$

④ $\frac{V}{\cos\theta}$

$T.v = const$

$T\sin\theta u = TV$

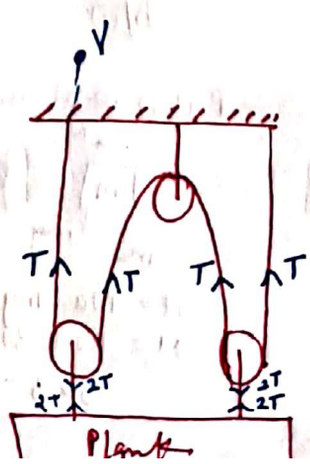
$u = \frac{V}{\sin\theta}$ Ans



HCV **Que** And Relation b/w a_1 and a_2

$4Tv_p = TV$

$v_p = \frac{v}{4}$ b



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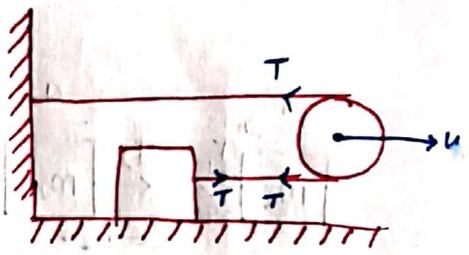
Q. In the figure shown, the pulley is moving with velocity u. the velocity of the block attached with string

① 4u
② 3u
③ 4
④ 2u

$2Tu = V_0 T$

$V_0 = 2u$ Ans



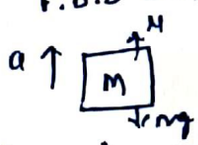
Pseudo force :→ A Non real force having real effect
- Technique to Validate laws of motion in Non-Inertial from of reference

Pinki	Kallua	Ramlal
rest ($u=0$)	$v=$ const	accln
$\Sigma f_x = 0$	$\Sigma f_x = 0$	$\Sigma f_x = 0$
$a_x = 0$	$a_x = 0$	$a_x = a$
$\Sigma f_y = 0$	$\Sigma f_y = 0$	$\Sigma f_y = 0$
$a_y = 0$	$\Sigma a_y = 0$	$a_y = 0$
* Law of motion Valid		* Laws of motion is not Valid
* Inertia frame of reference		* Non inertial frame.

Pseudo force $\boxed{\vec{f_c} = m\vec{a}}$ only applicable in non-Inertial accelerated frame

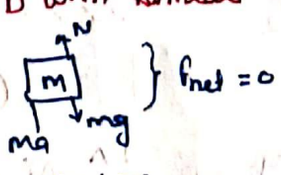
Ques find Contact force b/w Block & surface of lift.

F.B.D w.r.t Pinki

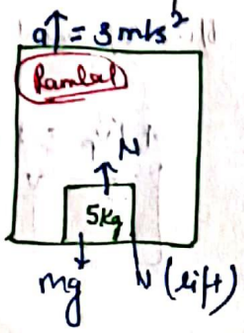


$(N-mg) = ma$
$N = ma + mg$
$N = m(a+g)$
$5(3+10) = 65$

F.B.D w.r.t Ramlal



$N = ma + mg$
$N = m(3+10)$
$5 \times 13 = 65N$



Pinki

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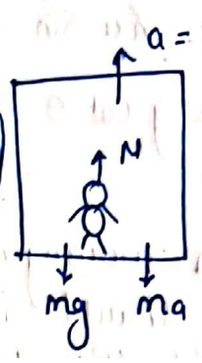
Que A man weigh 80 kg. He stands on a weighing scale in a lift which is moving upwards with uniform acceleration of $5 m/s^2$. What would be the reading on the scale ($g = 10 m/s$)

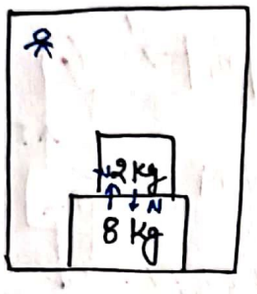
① Zero
② 400N
③ 800N
④ 1200N

$N = m(g+a)$ or
$80(10+5)$
80×15
$= 1200$

$N = mg + ma$
$m(g+a)$



Que



$a_{lift} = 4 m/s^2$

Find Contact force B/w 2kg & 8 kg

F.B.D of 2 kg w.r.t. Ground

← Rest w.r.t R.L

$f_y = 0$

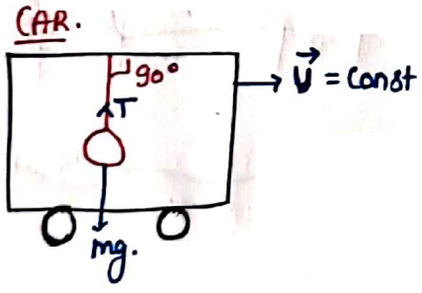
$N + ma = mg$

$m(g-a)$

$2(10-4)$

$= 12 N$

Que

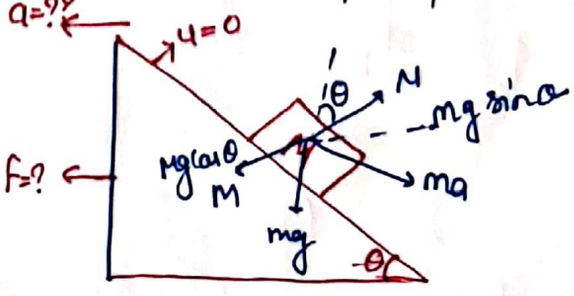


Que Select the Correct Statement regarding pseudo force

1. It is electromagnetic in origin
2. Newton's 3rd Law is applicable for it.
3. It is a fundamental force
4. It is used to make Newton's Law applicable in non-Inertial frame

Find acel^n of Inclined plane so that Block will free fall

for free fall - $N = 0$



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⊥r to Inclined

$mg\cos\theta = N + ma\sin\theta$

$mg\cos\theta = ma\sin\theta$

$$a = g\cot\theta$$ Ans

Qus In the given arrangement all surface are smooth; what acceleration should be given to the system, for which the Block M_2 doesn't slide down.

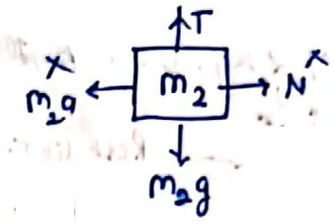
① $\frac{m_2 g}{m_1}$

② $\frac{m_1 g}{m_2}$

③ g

④ $\frac{m_2 g}{m_1 + m_2}$

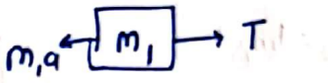
F.B.D of m_2 w.r.t (A.I)



$\Sigma F_y = 0$

$T = m_2 g$ — (I)

F.B.D of m_1



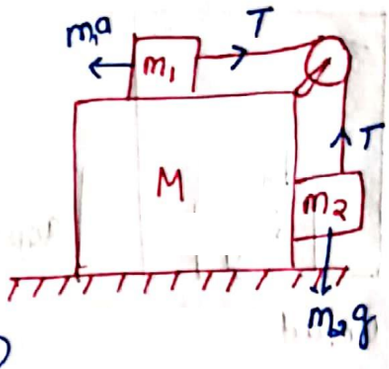
$\Sigma F_x = 0$

$T = m_1 a$ — (II)

(I) — (II)

$m_2 g = m_1 a$

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



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