Force :-

A pull or push which changes or tends to change the state of rest or of uniform motion or dir^n of motion of any object is called force. Vector quantity (mag + dir^n)

effect

- may change only speed
- may change only dir^n of motion
- may change both the speed and dir^n
- may change size and shape of a body.

Unit :-

a) Newton and $\frac{Kg \cdot m}{s^2}$ (MKS)

b) dyne and $\frac{g \cdot cm}{s^2}$ (CGS)

c) $1 N = 10^5$ dyne

Kilogram force (Kgf)

The force with which earth surface attracts a 1 kg body towards its centre is called Kilogram force. thus

$$\left[Kgf = \frac{\text{Force in Newton}}{g} \right]$$

For force / 3 imp →
- dir^n
- mag
- point of application (Rotation effect)

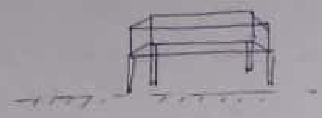
Types of forces
- Electromagnetic force
- Gravitational force
- Contact force
  - Normal reaction
  - Tension
  - friction
- Nuclear force

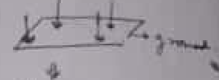
Contact force :-

Forces which are transmitted b/w the bodies by short-range atomic molecular interaction are called contact forces. When two objects come in contact they exert contact forces on each other.

a) Normal force

It is the component of contact force ⊥ar to the surface. It measures how strongly the surface in contact are pressed against each other. It is the electromagnetic force.



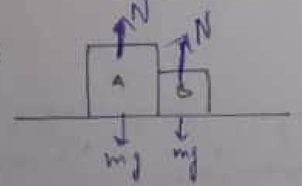


exerted by 4 legs of table on earth.

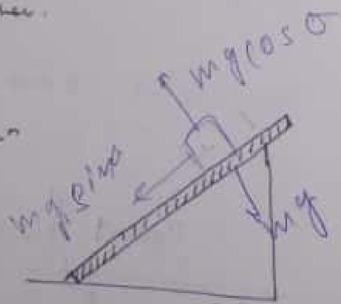
* Normal force acts ⊥ar to the surface
* Normal force acts in such a fashion that it tries to compress the body.
* Normal force is a dependent force, it comes in role when on surface presses the other.

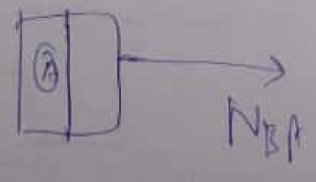
e.g. Draw normal force dir^n

a)

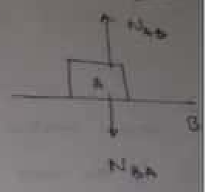


b)





84



Q. -

find

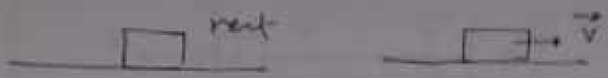
a) force

b) con

Sol^n

Newton's 1st law :-

It states that if a body is at rest, or in motion without any external force, then it will continue in re[st] or motion same as before



* external
* Net
* Newton law's of motion are valid only on interti[al] frame of ref^n.

Newton's 2nd law :-

"The rate of change of a momentum of a body is directly proportional to the applied force and takes place in the dir^n in which the force acts".

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

Force ← $\vec{F}$; $\vec{p}$ → momentum.

chang = (m) (v)

m → mass change ; v → Speed, dir^n

if mass = const $\vec{F} = m\frac{d\vec{v}}{dt}$

so

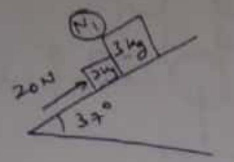
$\vec{F} = ma$ or $\vec{F}_{net} = m\vec{a}$

(*) Force can't change the momentum along the dir^n normal to it i.e component of velocity normal to the force doesn't change.

(*) Newton's 2nd law is strickly applicable to a single point particle. In case of rigid bodies or system of particles or system of rigid bodies $\vec{F}$ refers to total external force acting on system and refer's to acc^h of centre of mass of the System.

11.

Q:- find out the contact force b/w 2kg and 3kg block
Placed on the inclined plane.



draw FBD also.

$N_1 = 12N$

Newton's 3rd law :-

Statement " for every action there is equal and opposite reaction".

Condⁿ :-

* two different bodies
* Nature should be same
* magnitude should be same
* Direction should be opposite.

ex:

⇒ 

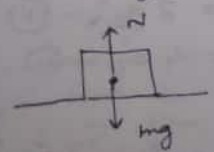
electrostatic force (action - reactⁿ pair)

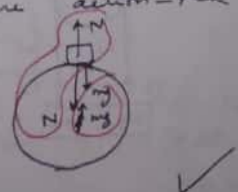
⇒ 

(gravity force)

Check point of your concept

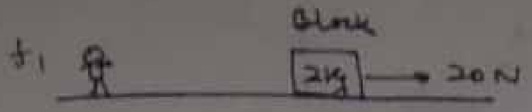
Is N and mg are action-rcⁿ pair ?



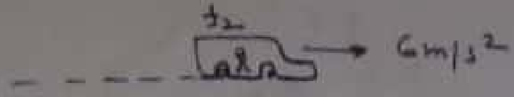


✓

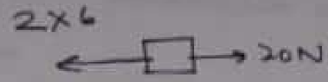
e.g



$a_{Bf_1} = \frac{20}{2} = 10 m/s^2$



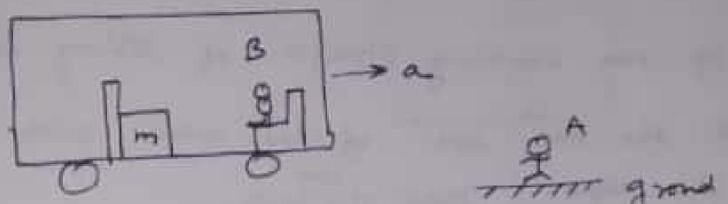
for f_2 frame of refn



$20 - 12 = 2 \times a$

$a = \frac{8}{2} = 4 m/s^2$

e.g



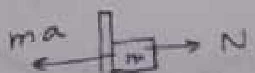
$N = ma$ – normal reaction exerted by the support when we see from A.

$N = m(0)$ – respect to B. — (11)

$= 0$

But the normal force is exerted in non-inertial frame also. So eqn (11) is wrong therefore we conclude that Newton law is not valid in non-inertial frame.

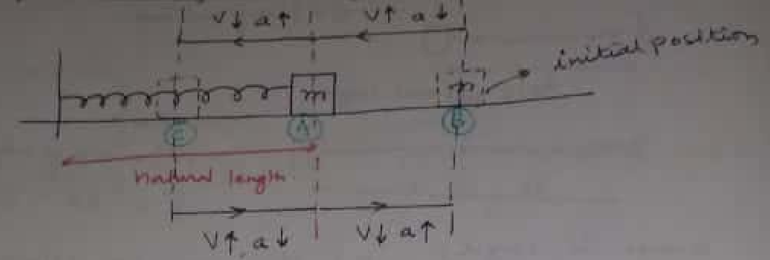
⇒ we introduced concept of pseudo force here



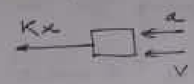
$N = ma$

*** Pseudo force doesn't depend on velocity dirn (mind it) 😎

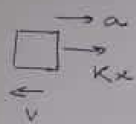
Analysis of Spring - Block System



i) from B to A, speed of Block ↑es and accⁿ decrease (due decrease in spring force Kx)

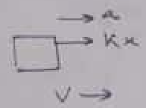


ii) from A to C, speed of Block ↓es and accⁿ ↑es (due to increase in spring force Kx)

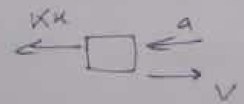


iii) At C the block stops momentarily at this instant and since the spring is compressed spring force is towards right and block starts to move towards right.

from C to A, speed of block ↑es and accⁿ ↓es (due to decrease in spring force Kx)



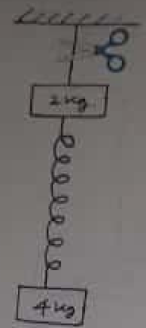
v) Again block crosses point A due to inertia then from A to B speed decreases and accⁿ increase



Q. Find instant

Solⁿ

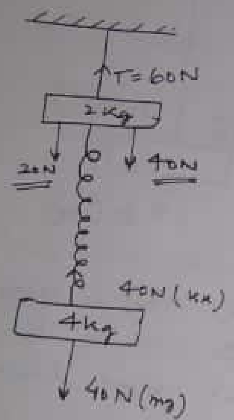
eg



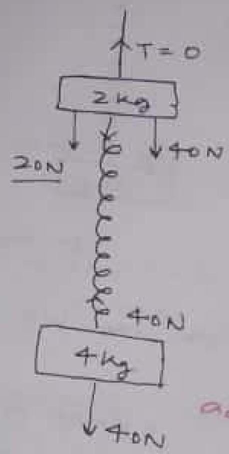
find accⁿ of 2kg and 4kg block just after cut.

Solⁿ

Before



After



$acc^n = \frac{60N}{2} = 30 m/s^2$ Ans

$acc^n = \frac{40-40}{4} = 0 m/s^2$ Ans

Concept:-

What happen when spring is cut?:-

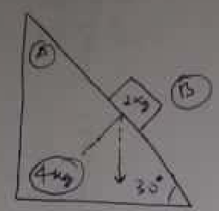
Ans The spring forces changes instantaneously and becomes zero because one end of the spring is free

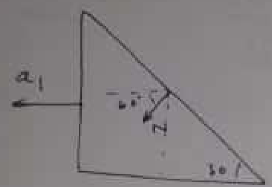
Q:-

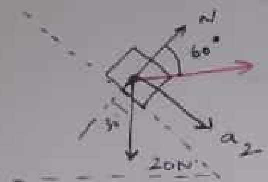
Q:-

Q:

Lets do it by pseudo







$N\cos 60° = 4a_1$ — (I)

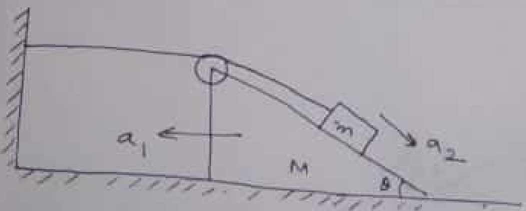
$20\cos 30° = N + 2a_1\cos 60°$ — (II)

$20\sin 30° + 2a_1\sin 60° = 2 \cdot a_2$ — (III)

unknown N, a_1, a_2

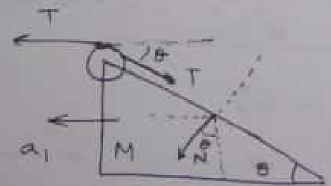
* Q:-

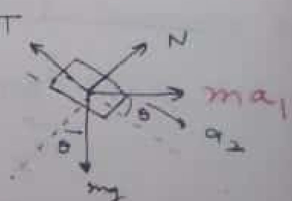
find a_1, a_2, N, T



$-a_1 + 0 + 0 + a_2 = 0$

$a_1 = a_2$ — (IV)





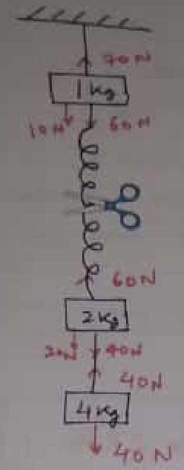
$T + N\sin\theta - T\cos\theta = Ma_1$ — (I)

unknown a_1, a_2, T, N

$Mg\cos\theta = N + ma_1\sin\theta$ — (II)

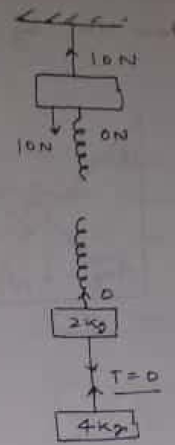
$mg\sin\theta + ma_1\cos\theta - T = ma_2$ — (III)

Q:-



find T and accⁿ of each block

Sol'

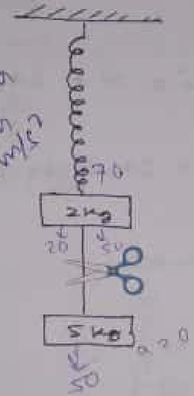


* String changes instantaneously from 70N → 10N

acc^n = 0 m/s^2

free fall (g m/s^2)

Q:-



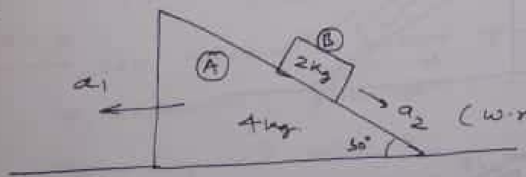
70 − 20 = 2a

50 = 2a

a = 25 m/s^2

find accⁿ of each block?

Q:-

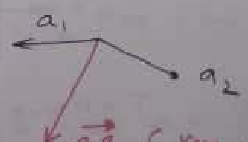


a_2 (w.r.to to 4kg)

$\vec{a}_{BA} = \vec{a}_B - \vec{a}_A$

$\vec{a}_2 = \vec{a}_B - \vec{a}_1$

$\vec{a}_B = \vec{a}_2 + \vec{a}_1$



$\vec{a}_B$ (Very confusing to imagine)

Contrained Motion :-
- → String contraint
- → Pulley constraint
- → Wedge constraint

1) String constraint :-

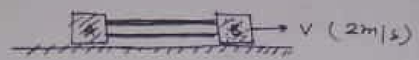
When the two object are connected through a string and if the string have following properties

a) The length of string remains const i.e it is massless, inextensible string

b) Always remains taut i.e doesn't slacks.

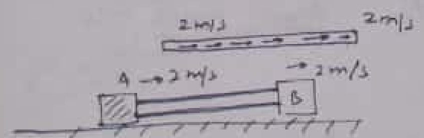
Then the parameters of the motion of the objects along the length of the string have definite relation b/w them.

1st format (when string is fixed)

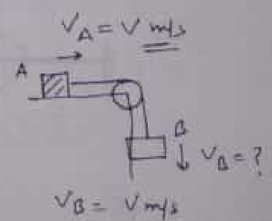


The Block B moves with velocity V (2m/s) i.e each particle of block B moves with velocity 2m/s or V.

* If string remains attached to block B, it is necessary that velocity of each particle of string is same = V



e.g Pulley is fixed then also

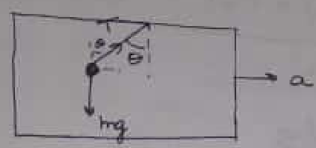


* The speed of each point of the string is V m/s (along the string.)

Q:-

Constant accⁿ (a) relative to ground, Find deflection of pendulum from verticle as observed from the ground frame and also from the frame attached with the car.

Solⁿ from ground frame.



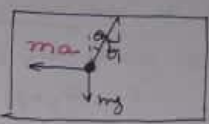
$T\cos\theta = mg$

$T\sin\theta = ma$

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

$\theta = \tan^{-1}(a/g)$

from car frame



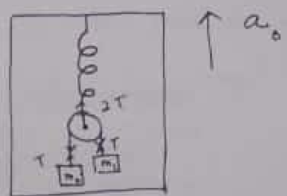
$T\cos\theta = mg$

$T\sin\theta = ma$

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

$\theta = \tan^{-1}(a/g)$

Q:-

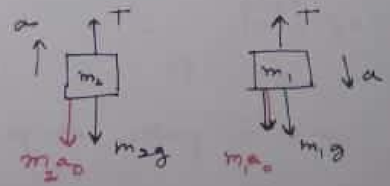


find deformation in the Spring and Tension.

Solⁿ Lets relative to centre of pully,

m_1 accelerates ↓ with a

m_2 " ↑ with a.



$T - m_2a_0 - m_2g = m_2a$ — (I)

$m_1a_0 + m_1g - T = m_1a$ — (II)

$a_0(m_1 - m_2) + g(m_1 - m_2) = (m_1 + m_2)a \Rightarrow a = \frac{(m_1 - m_2)}{(m_1 + m_2)}(g + a_0)$

then we get T,

$$T - m_2 a_0 - m_2 g = m_2 a$$

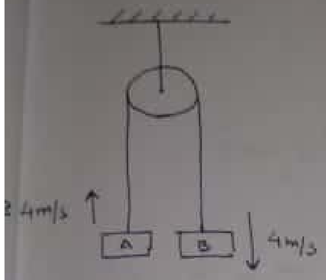
$$T = m_2(a_0+g) + m_2 \frac{(m_1-m_2)}{(m_1+m_2)}(a_0+g)$$

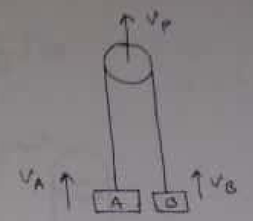
$$= \frac{(a_0+g)\left(m_2(m_1+m_2) + m_2(m_1-m_2)\right)}{(m_1+m_2)}$$

$$= \frac{(a_0+g)(2m_1 \cdot m_2)}{(m_1+m_2)}$$ Ans

For $x = \frac{2T}{K} = \frac{4m_1 \cdot m_2(a_0+g)}{K}$ Ans

2) Pulley - Block constraint (when pulley is also moving)
or atwood machine.





understanding
1st method

Pulley is moving with velocity v_P and
Both Block have velocity V_A and V_B resp.

$$\vec{V}_{AP} = \vec{V}_A - \vec{V}_P \quad \text{and} \quad \vec{V}_{BP} = \vec{V}_B - \vec{V}_P$$

But we know that w.r.to to pulley frame

$$\vec{V}_{AP} = -\vec{V}_{BP}$$

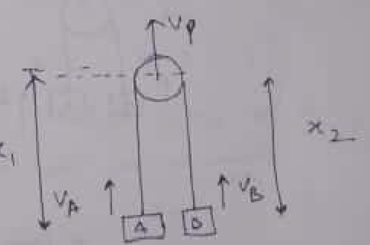
$$\vec{V}_A - \vec{V}_P = -(\vec{V}_B - \vec{V}_P)$$

$$\vec{V}_A - \vec{V}_P = -\vec{V}_B + \vec{V}_P$$

$$\left[\vec{V}_P = \frac{\vec{V}_A + \vec{V}_B}{2}\right]$$

* Vector sign imp

2nd method (point method)



$$x_1 + x_2 = \text{const}$$

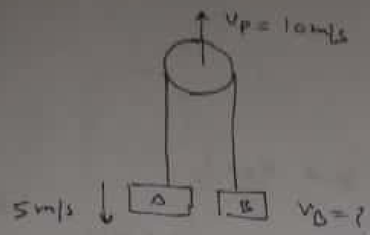
$$\frac{dx_1}{dt} + \frac{dx_2}{dt} = 0$$

$$V_{AP} + V_{BP} = 0$$

$$V_A - V_P + V_B - V_P = 0$$

$$\left[V_P = \frac{V_A + V_B}{2}\right]$$

e.g

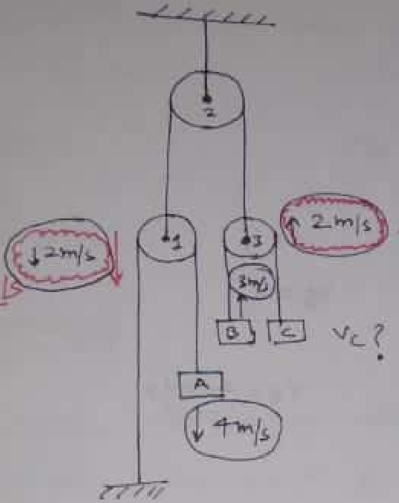


$v_B = 25\,m/s$

e.g

$V_{P_1} = \frac{0-4}{2}$

$V_{P_1} = -2\,m/s$



↑ $V_{P_3} = 2\,m/s$ upward.

V_C? Let assume V_C ↓ dirⁿ

$$V_{P_3} = \frac{V_B + V_C}{2}$$

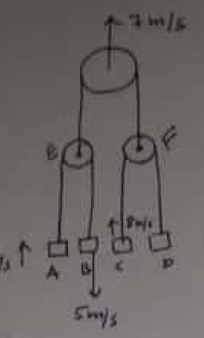
$$2 = \frac{3 - V_C}{2}$$

$$-V_C = 4 - 3 = 1$$

$V_C = -1\,m/s$ ⇒ It say opposite to the dirⁿ we assumed.

So V_C ↑ 1 m/s

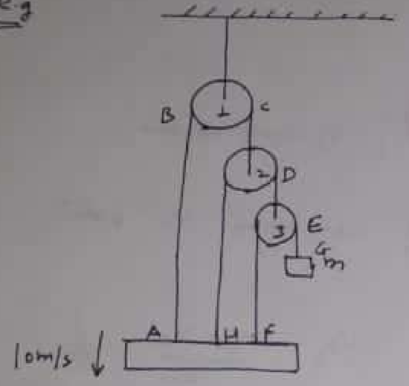
e.g



find $v_D = ?$

$v_D = 23\ m/s$

e.g



$v_G = ?$

$v_G = 70\ m/s$

$$V_1 = \frac{V_A + V_{P_2}}{2}$$

$$0 = V_A + V_{P_2}$$

$$V_{P_2} = -V_A = -(-10) = 10\ m/s$$

$$V_{P_2} = \frac{V_H + V_{P3}}{2}$$

$$V_{P_3} = 2 \times 10 - V_H$$

$$= 20 - (-10) = 30\ m/s$$

$$V_{P_3} = \frac{V_G + V_F}{2}$$

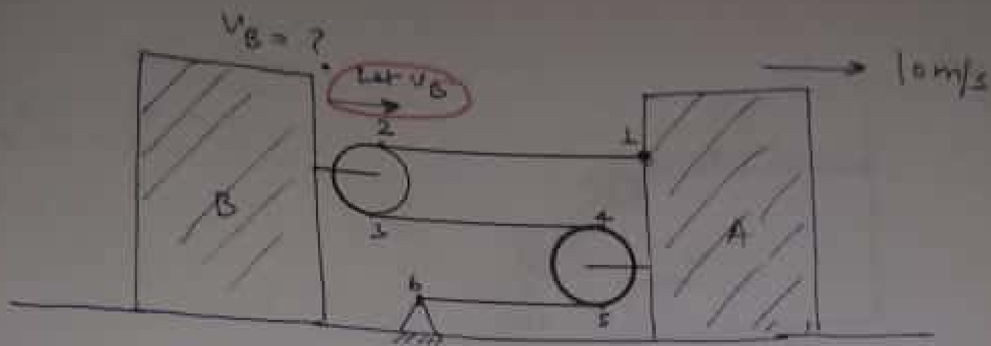
$$30 \times 2 - V_F = V_G$$

$$60 - (-10) = V_G$$

$$V_G = 70\ m/s$$

Scanned by CamScanner

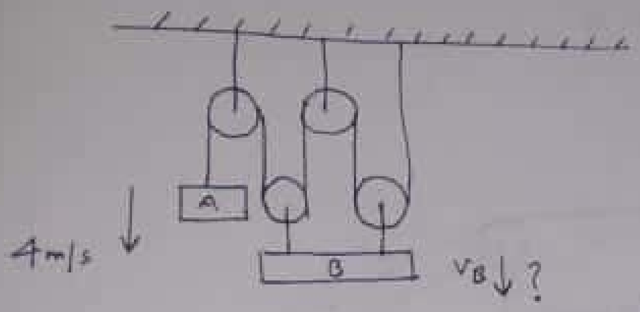
e.g



$$10 - v_B - v_B + 10 + 10 + 0 = 0$$

$$v_B = 30/2 = 15\ m/s$$

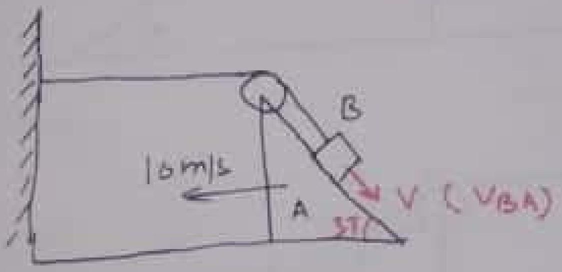
e.g



$V_B = ?$

Ans $V_B = -1\ m/s$

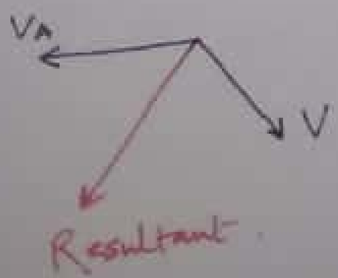
e.g



V_{BA} = Velocity of B with resp to wedge

$$V = V_B - V_A$$

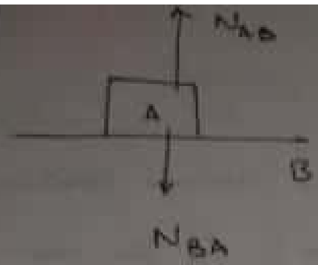
$$V_B = V + V_A$$

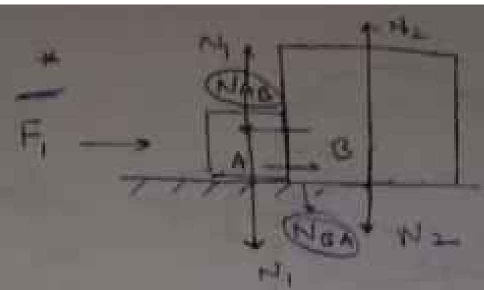


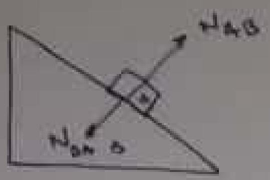
Wrong concept

$$V_B \cos 37 = 10$$

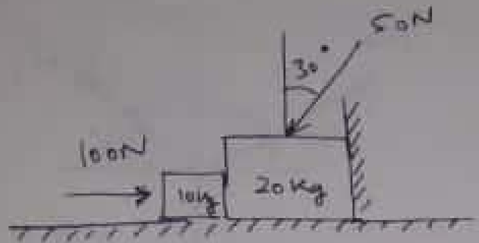
$$V_B = 10/\cos 37$$

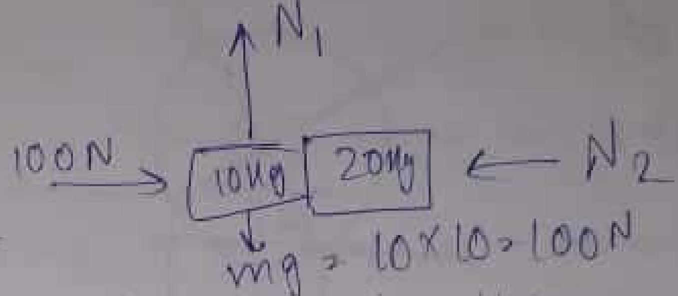






Q. –



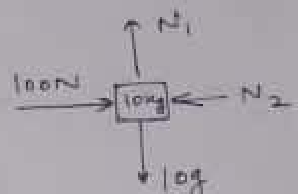


Find

a) forces exerted by surfaces (floor and wall) on blocks.

b) contact force b/w two blocks

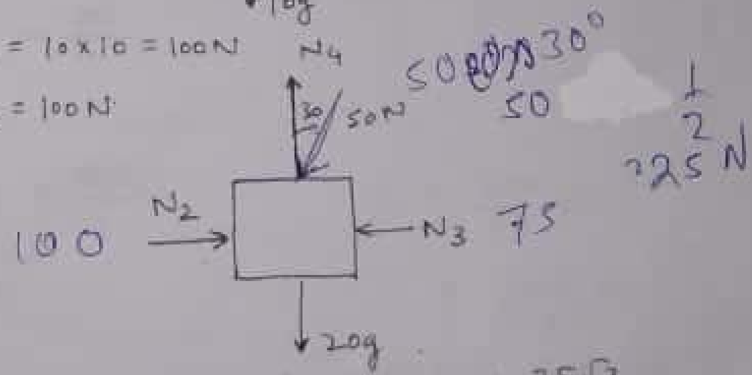
Sol^n ~~FBD of 10kg~~



$N_1 = 10 \times 10 = 100N$

$N_2 = 100N$

FBD of 20kg.

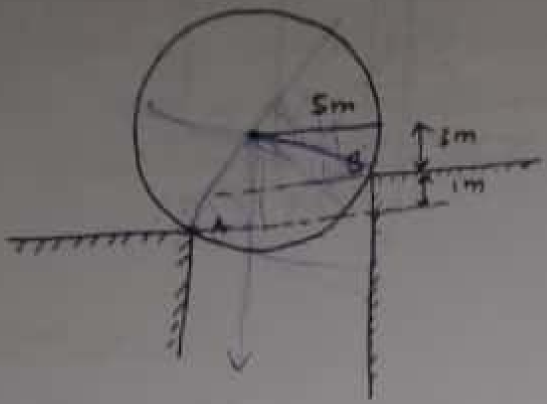


$N_4 = 20g + 50\cos 30 = \underline{200 + 25\sqrt{3}}$

$N_2 = N_3 + 50 \sin 30°$

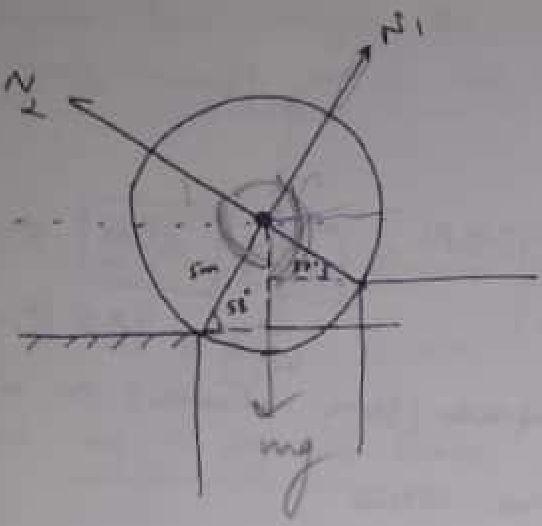
$N_3 = 100 - \frac{50}{2} = \underline{75}$

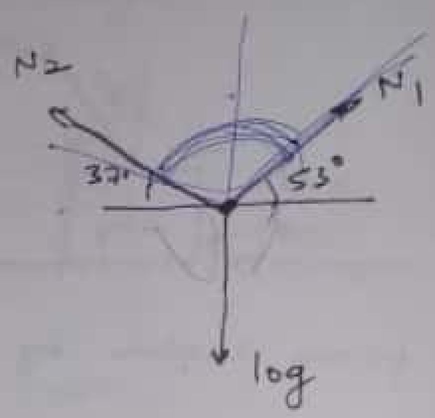
Q:-



find out the normal reaction at point A and B if the mass of sphere is 10 kg.

Soln





$$\frac{10g}{\sin 90} = \frac{N_1}{\sin(90° + 37°)} = \frac{N_2}{\sin(90 + 53°)}$$

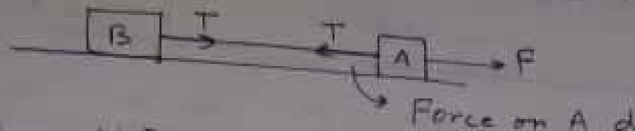
$$\frac{100}{1} = \frac{N_1}{4/5} \qquad N_1 = 80N$$

$$\frac{100}{1} = \frac{N_2}{3/5} \qquad N_2 = 60N \text{ Ans}$$

b) Tension

Tension in a string is an electromagnetic force. It arises when a string is pulled.

String (massless, inextensible)



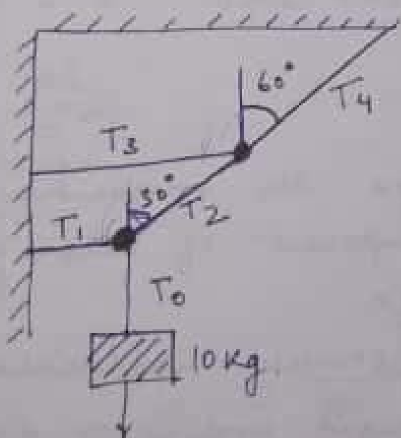
* Tension dir^n is always along the string in such a way to reduce length.

f_{SA} = Force on string due to A
f_{SB} = " " " " B

$|f_{SA}| = |f_{SB}|$ (because mass = zero)

(*) T = F. String is consider to be made of a number of small segments which attracts each other due to electromagnetic nature. The attraction force b/w two segment is equal and opposite due to newton's third law.

(Q.) System shown is in eq^b. Find mag of tension in each string.



$T_1 = \frac{100}{\sqrt{3}}$ N

$T_2 = \frac{200}{\sqrt{3}}$ N

$T_3 = \frac{200}{\sqrt{3}}$ N

$T_4 = 200$ N

$T_0 = 100$ N.

c) Friction force :- It is the component of contact force tangential to the surface. It opposes the relative motion (or attempted relative motion) of the two surface in contact.

Steps

1) Select the Body :-

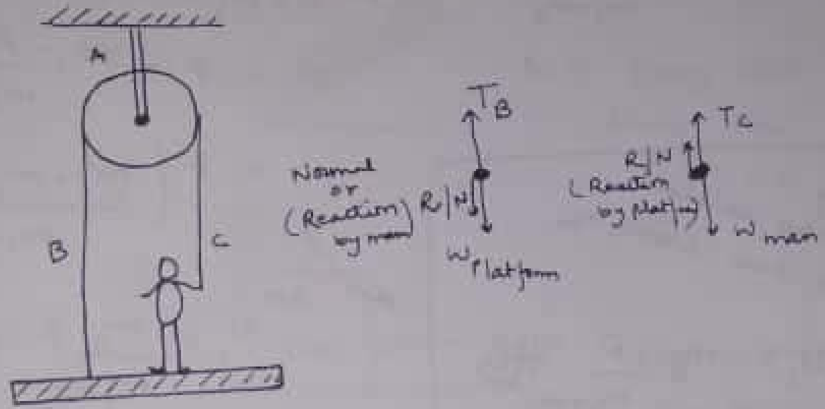
* Select the body such that all the parts of the body or system must have the same acc^n.

2) Identify the force :-

* You should be very much clear about the nature and dir^n of forces which are acting on the body.

3) Make a free body digram (FBD) :-

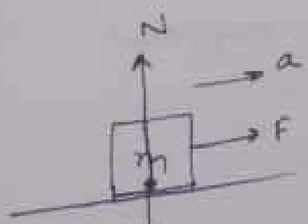
* Draw vector representing the forces acting on the body with this point as the common origin.



4) Select axes and write equation :-

examples

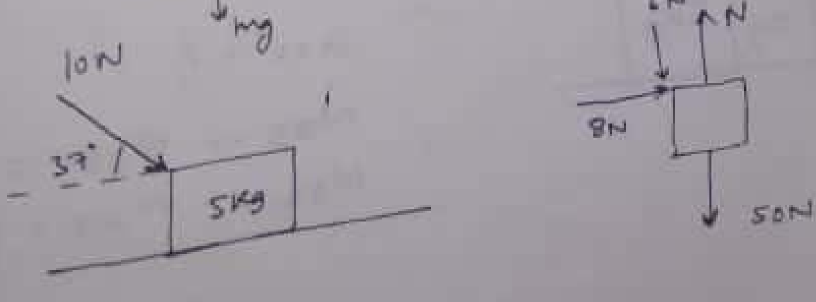
a)



$F = ma$

$a = F/m$ Ans

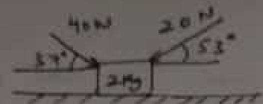
b)



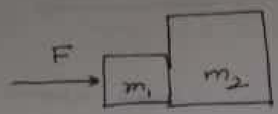
$N = 50 + 6 = 56$

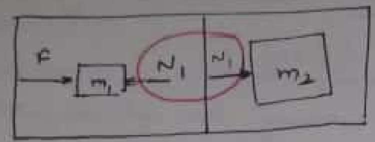
$a = \frac{8}{5}$ m/sec^2

c)



d) find acc^n and normal rea





$acc^n = \frac{F}{m_1+m_2}$

$F - N_1 = m_1 a$

$N_1 = F - m_1 \cdot \frac{F}{m_1+m_2}$

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

so $N_1 = \frac{m_2 F}{m_1+m_2}$ Ans

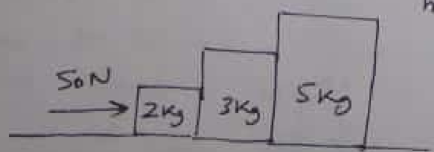
Directly we also calculate N_1 → see block m_2

$N_1 = m_2 \cdot \frac{F}{m_1+m_2}$ Ans

* If force F be applied on m_2, the acc^n will remain the same, but the force of contact, or normal or reaction will be different

$N_1 = \frac{m_1 F}{m_1+m_2}$

e)



$acc^n = ?$

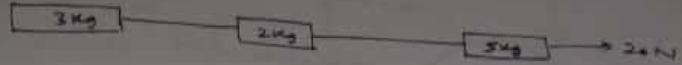
N_{53} or N_{35} = ?

N_{32} or N_{23} = ?

Q:-

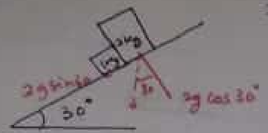
Q:

(Q7)



find a, tension in all string

Q:-



$2g\sin30 \rightarrow N$ FBD of 2kg Block

$2g\sin30° - N = 2g\sin30$

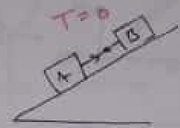
$N = 0$

$g\sin30$, N for 1kg Block

$g\sin30 + N = g\sin30$

$N = 0$

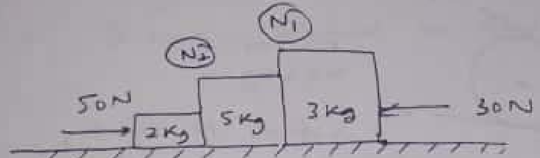
* Concept.



Both going down with same acc^n so

$T = 0$

Q:-



find contact force b/w block and acc^n:

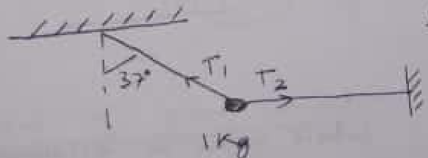
$50 - N_1 = 2a$

$N_1 - N_2 = 5a$

$N_2 - 30 = 3a$

$N_1 = 36N$, $N_2 = 46N$, $a = 2m/s^2$

(Q:)



System is eq^b.

find T_1 and T_2.

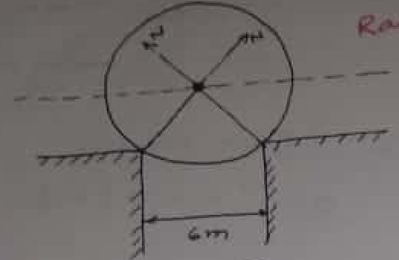
Draw fbd also.

Q:-

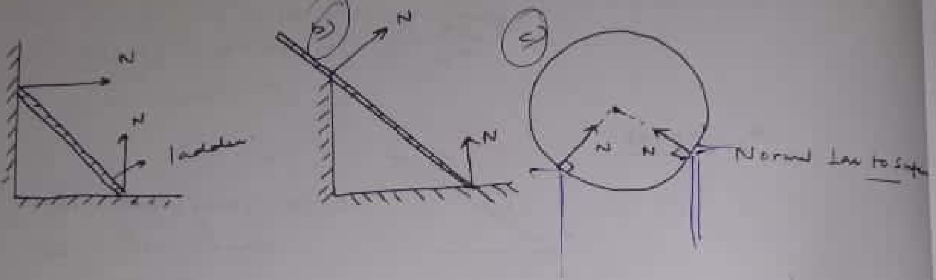
m = 5 kg.

Radius = 5m

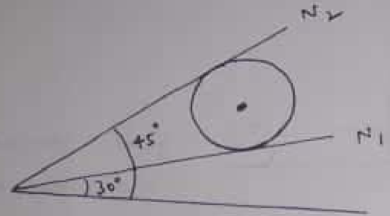
find N ?



concept



Q:-

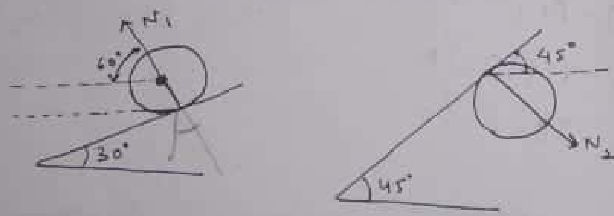


r = 1m

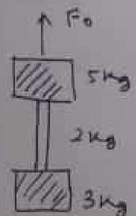
m = 2 kg.

find N_1 and N_2.

hint:



Q:-



Whole system is accelerated upward with $2 m/s^2$

a) find F_0

b) what is the net force on rope.

c) Tension at middle point of rope.

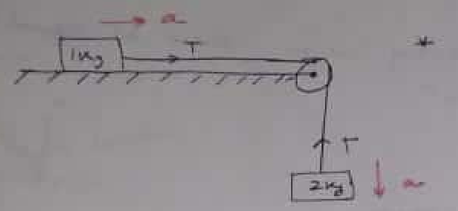
a) 120N b) 4N c) 48N.

Pulley Block system :-

Pulley → massless, frictionless.

rope → massless, inextensible

<u>ex</u>



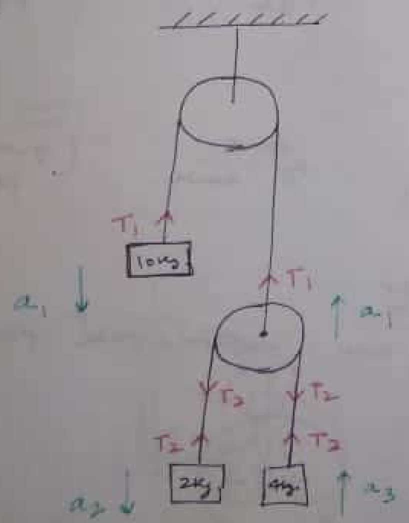
* contraint ⇒ both having same acc^n because taught with string

$T = 1 \cdot a$

$2g - T = 2a$

$2g = 3a$ $\quad a = 2g/3 \ m/s^2, \quad T = 1 \cdot \frac{2g}{3} N$

<u>ex</u>



⇒ unknown list T_1, T_2, a_1, a_2, a_3

so we need 5 eq^n

$T_1 = 2T_2$ — (i)

$a_2 + a_1 + a_1 - a_3 = 0$ — (ii)

$10g - T_1 = 10a_1$ — (iii)

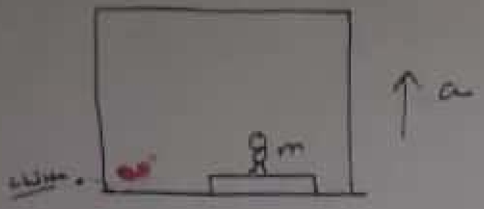
$2g - T_2 = 2a_2$ — (iv)

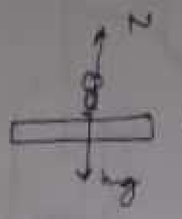
$T_2 - 4g = 4a_3$ — (v)

$T_1 = 2 \times \frac{800}{23}$, $\quad a_1 = 70/23 \downarrow$, $a_2 = \frac{170}{23}\uparrow$

$a_3 = 30/23 \uparrow$

Lift problem



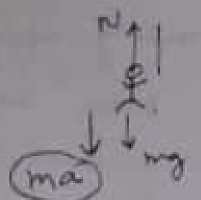


ground frame

$N - mg = ma$

$N = m(g+a)$

chitti frame



Psedo force

$a_{mc} = 0$

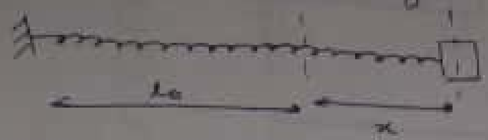
$N = m(g+a)$

feel heavy when acc^n (↑ upward) dir^n
or when speed is ↑ing in upward dir^n.
or when speed is ↓ing in down ward dir^n

- * upward accelerated $N = m(g+a)$, $N >$ Actual weight (mg)
- * downward " $N = m(g-a)$ $N <$ Actual weight (mg)
- * $a = g \Rightarrow N = 0$, Thus free fall man experience weightlessness
- * if $a > g$ and lift is accelerated downward, so the man will be accelerated upward and stay at the ceiling of the lift.
- * Magnitude and dir^n of velocity doesn't play role in apparent weight.

Spring force

K = spring constant



$F \propto x$

$|\vec{F}| = Kx$ → magnitude

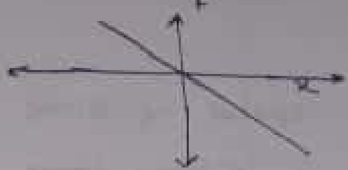
$\vec{F} = -Kx$ (here x is change in length)

K = spring const or stiffness const

= N/m

* when spring is in its natural length, spring force = 0

* Graph b/w F and x



e.g.

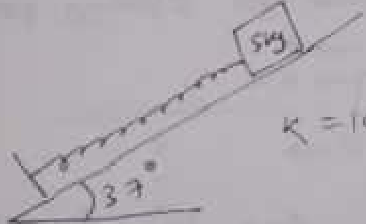
K = 10 N/m

find x

$10 \times x = 2 \times 10$

$x = 2\,m$ Ans

e.g.



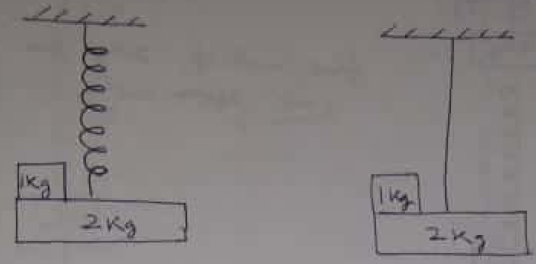
K = 100 N/m

$100 \times x = 5 \times g \times \sin 37^\circ$

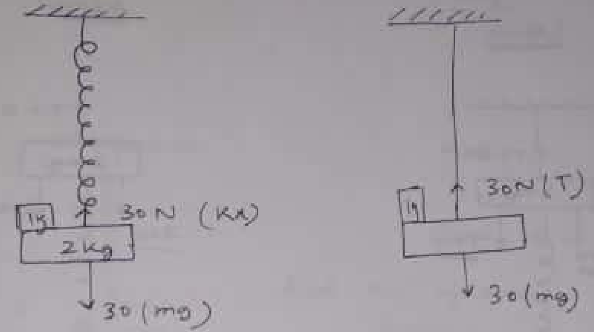
$100 \times x = 5 \times 10 \times \frac{3}{5}$

$x = .3\,m$ Ans

Q:- Find out the acc^n of 2 kg block in the figures at the instant 1 kg block falls from 2 kg block (at t = 0)

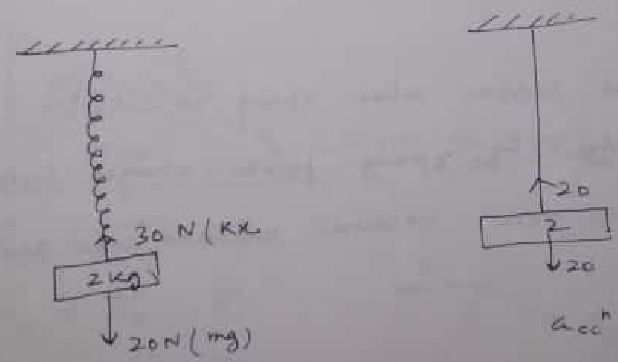


Sol^n FBD before fall of 1 kg.



* After the fall of 1 kg block Tension change instantaneously
But
spring force (kx) doesn't change instantaneously.

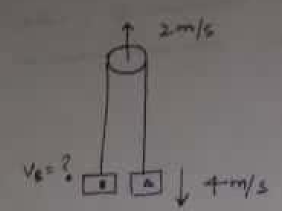
So, FBD just after fall of 1 kg block



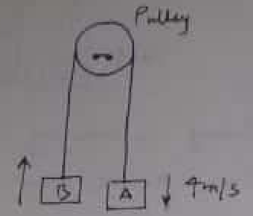
acc^n = $\frac{30-20}{2} = 5 m/s^2$
upward

acc^n = $\frac{20-20}{2} = 0 m/s^2$

e.g



Solⁿ



$$\vec{V}_{AP} + \vec{V}_{BP} = 0$$

$$V_A - V_P + V_B - V_P = 0$$

$$-4 - 2V_P + V_B = 0$$

$$V_B = 4 + 2 \times 2 = \underline{8 m/s}$$

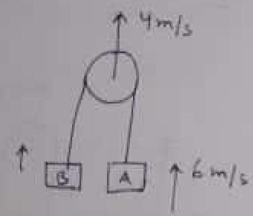
or direct formula Or ⟸

$$V_P = \frac{V_A + V_B}{2}$$

$$2 = \frac{-4 + V_B}{2}$$

$$V_B = \underline{8 m/s}$$

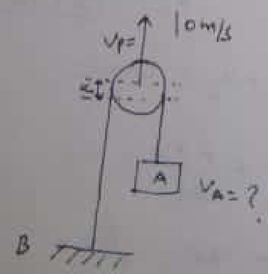
e.g



$$4 = \frac{6 + V_B}{2}$$

$$V_B = 8 - 6 = \underline{2 m/s}$$

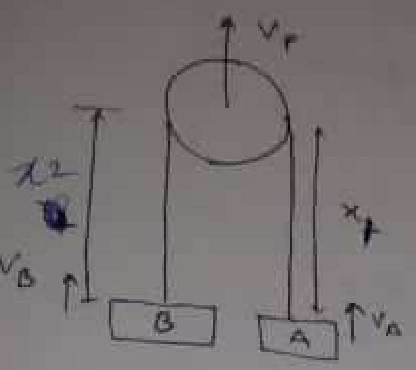
e.g



$$10 = \frac{V_A + 0}{2}$$

$$V_A = 20 m/s \text{ (upward)}$$

Point method



By relative concept → Same thing implement in point method but thinking process is different

$V_{AP} = -V_{BP} = 0$

$V_{AP} + V_{BP} = 0$

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

$-V_A + V_P + V_P - V_B = 0$

$2V_P = V_A + V_B$

$V_P = \frac{V_A + V_B}{2}$

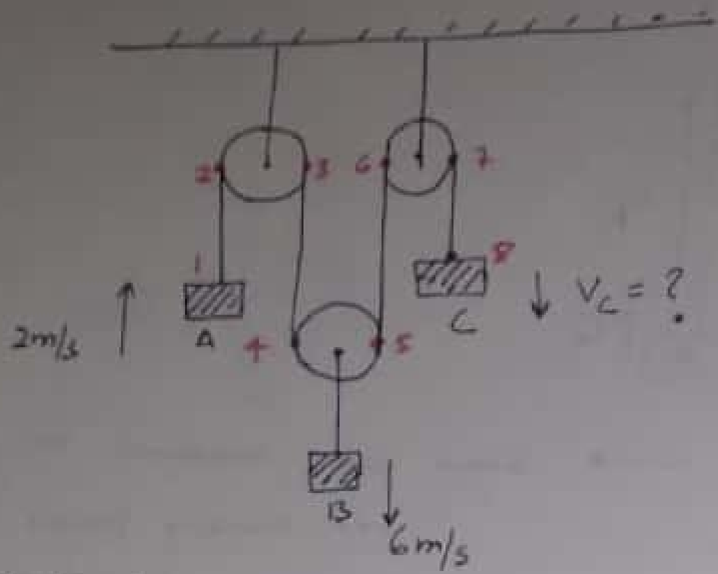
Solving strategy

1) First choose the longest string in the given problem which contains the point of which velocity / accⁿ to be find out

2) Now mark a point on the string where it comes in contact or leaves the contact of real bodies

3) If due to motion of a point, length of the part of a string with point is related, increased then its speed will be taken +ve otherwise -ve.

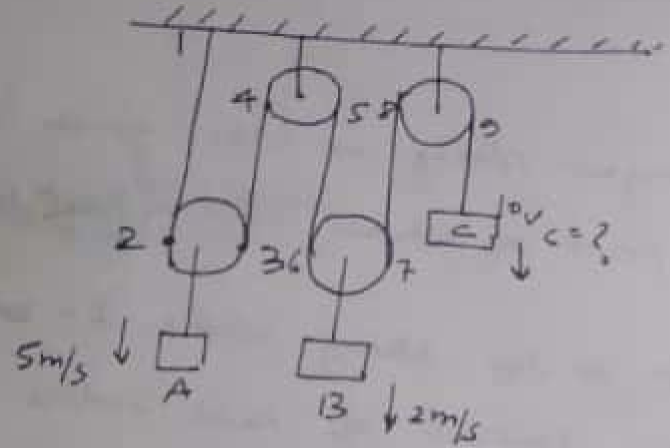
e.g



$-2+0+0+\underline{6}+\underline{6}+0+0+V_c = 0$

$V_c = \underline{-10\,m/s}$

e.g



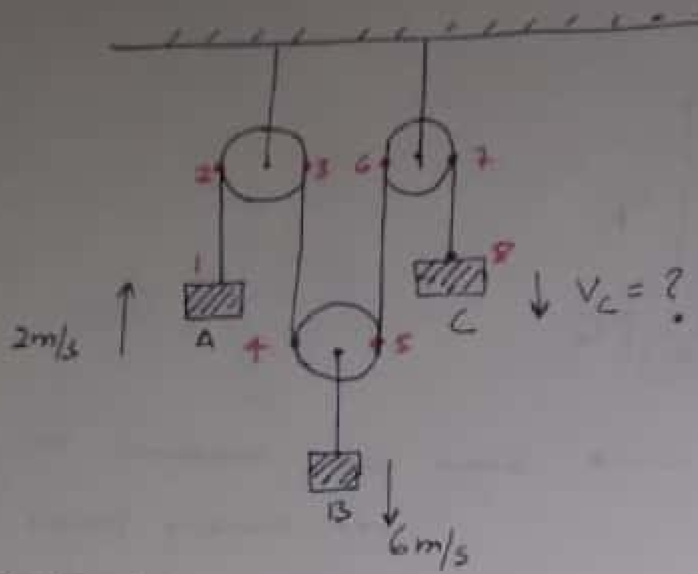
$5+5+0+0+2+2+0+0+V_c = 0$

$V_c = -14\,m/s$

(−) means opposite to the dir^n we assumed so

$V_c \uparrow 14\,m/s$ **Ans**

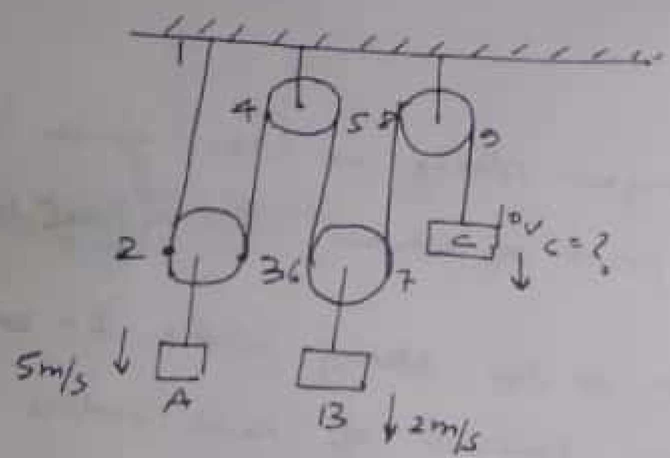
e.g



$-2 + 0 + 0 + 6 + 6 + 0 + 0 + V_c = 0$

$V_c = -10 m/s$

e.g



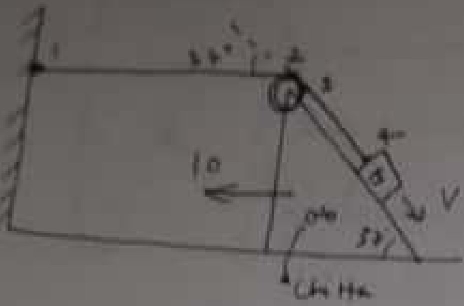
$5 + 5 + 0 + 0 + 2 + 2 + 0 + 0 + V_c = 0$

$V_c = -14 m/s$

(−) means opposite to the dir^n we assumed so

$V_c \uparrow 14 m/s$ **Ans**

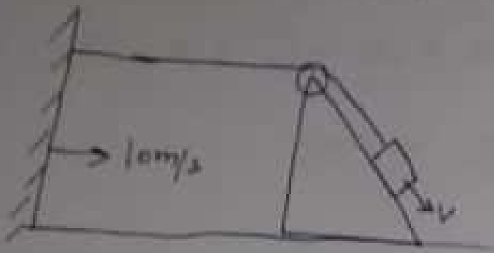
1st method



2nd method

$$0 - 10 + 10\cos 37 - 10\cos\ldots$$

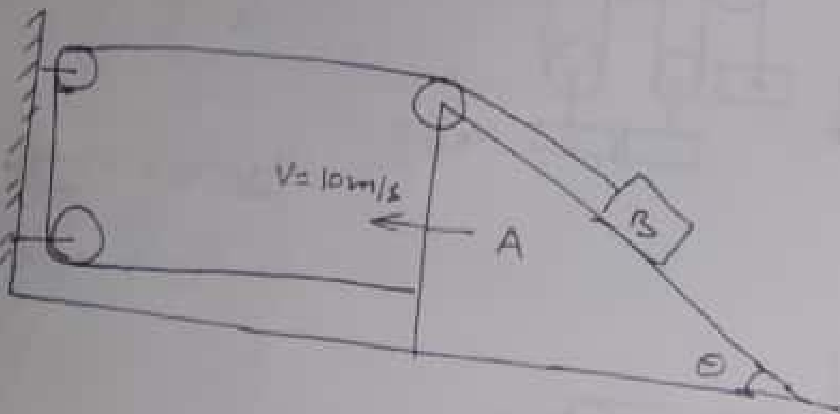
$V = 10\,m/s$



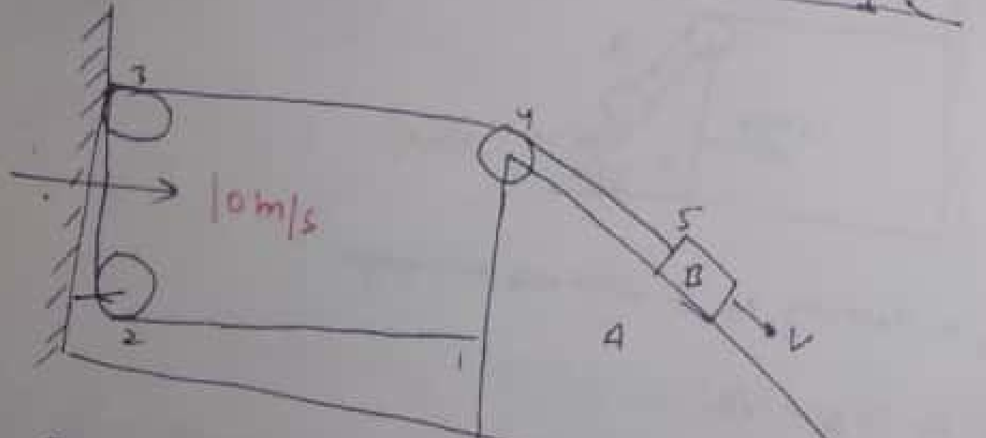
$$-10 + 0 + 0 + V = 0$$

$V = 10\,m/s$

Q:-



Sol^n

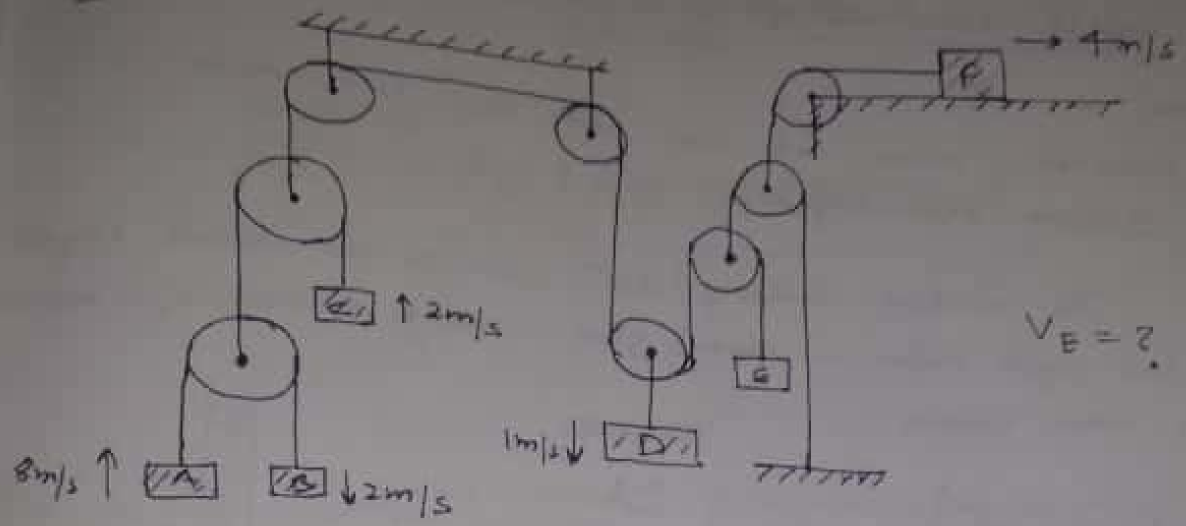


$$0 - 10 - 10 + 0 + V = 0$$

$V = 20\,m/s$

Scanned by CamScanner

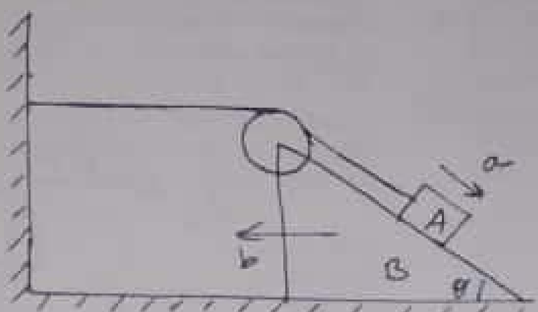
e.g



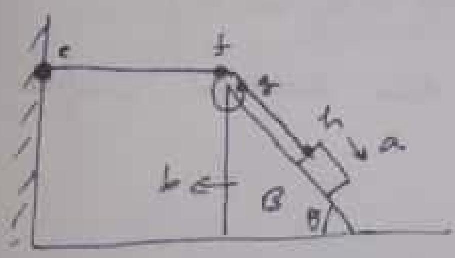
$V_E = ?$

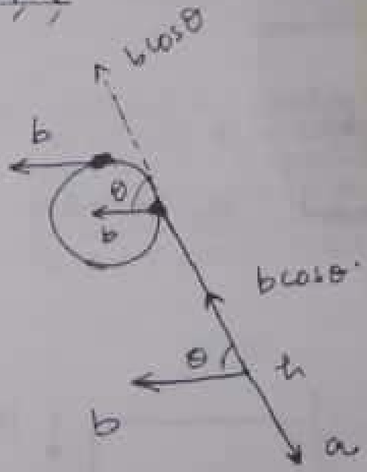
$V_E = 3\frac{1}{2}$ m/s

e.g



find out the relation b/w acc^n a and b





$$0 - b + b\cos\theta - b\cos\theta + a = 0$$

$$a = b$$

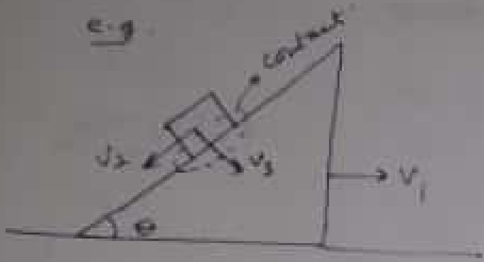
Wedge constraint :-

Condⁿ

1) Contact must not be lost b/w two bodies.
11) Bodies are rigid.

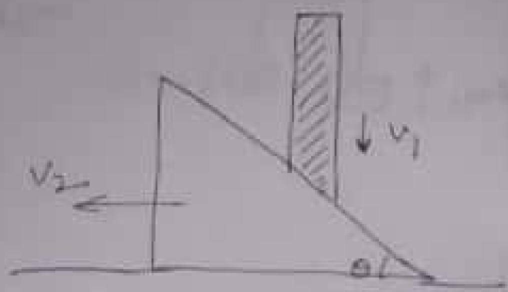
The relative velocity / accⁿ ⊥ar to the contact surface the two rigid object is always zero. Wedge constraint is applic for each contact

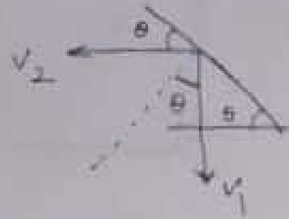
e.g.



$V_3 = V_1 \sin\theta$

e.g.

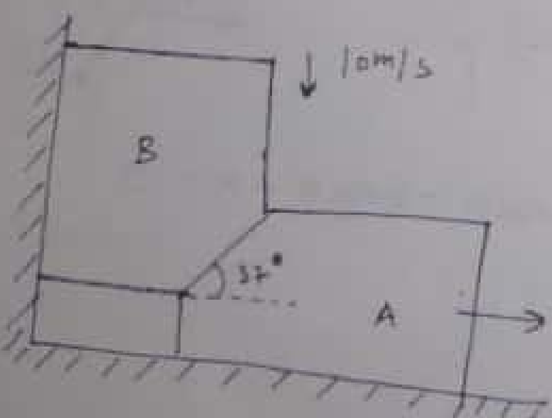


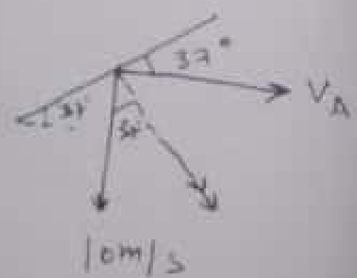


$$[V_2 \sin\theta = V_1 \cos\theta]$$

Component of velocity ⊥ar to the contact surface should be equal

e.g.





$10 \cos 37° = V_A \sin 37$

$10 \times \frac{4}{5} = V_A \times \frac{3}{5}$

$V_A = 40/3$ m/s