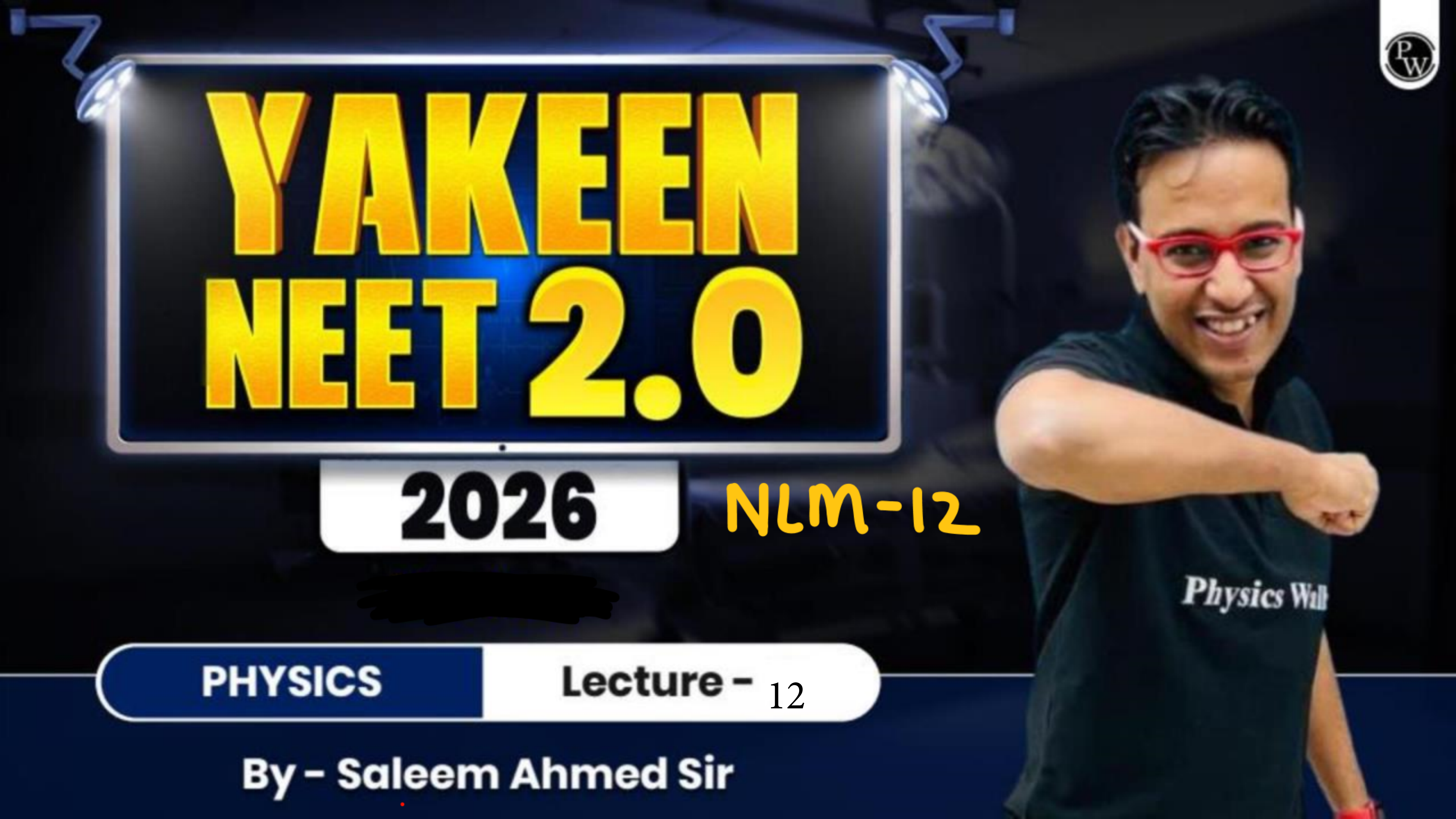
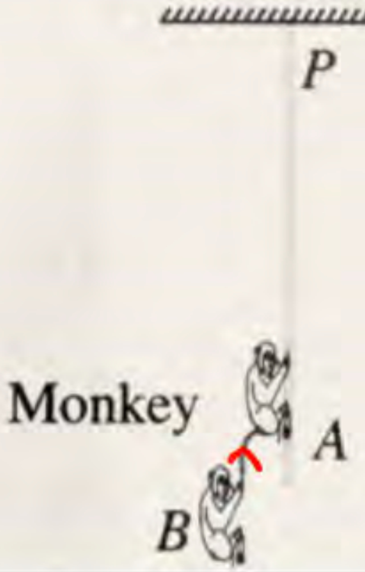

YAKEEN
NEET 2.0
2026
NLM-12
[redacted]
PHYSICS
Lecture - 12
By - Saleem Ahmed Sir

Topics to be covered

1. Questions practice
2.
3.
4.

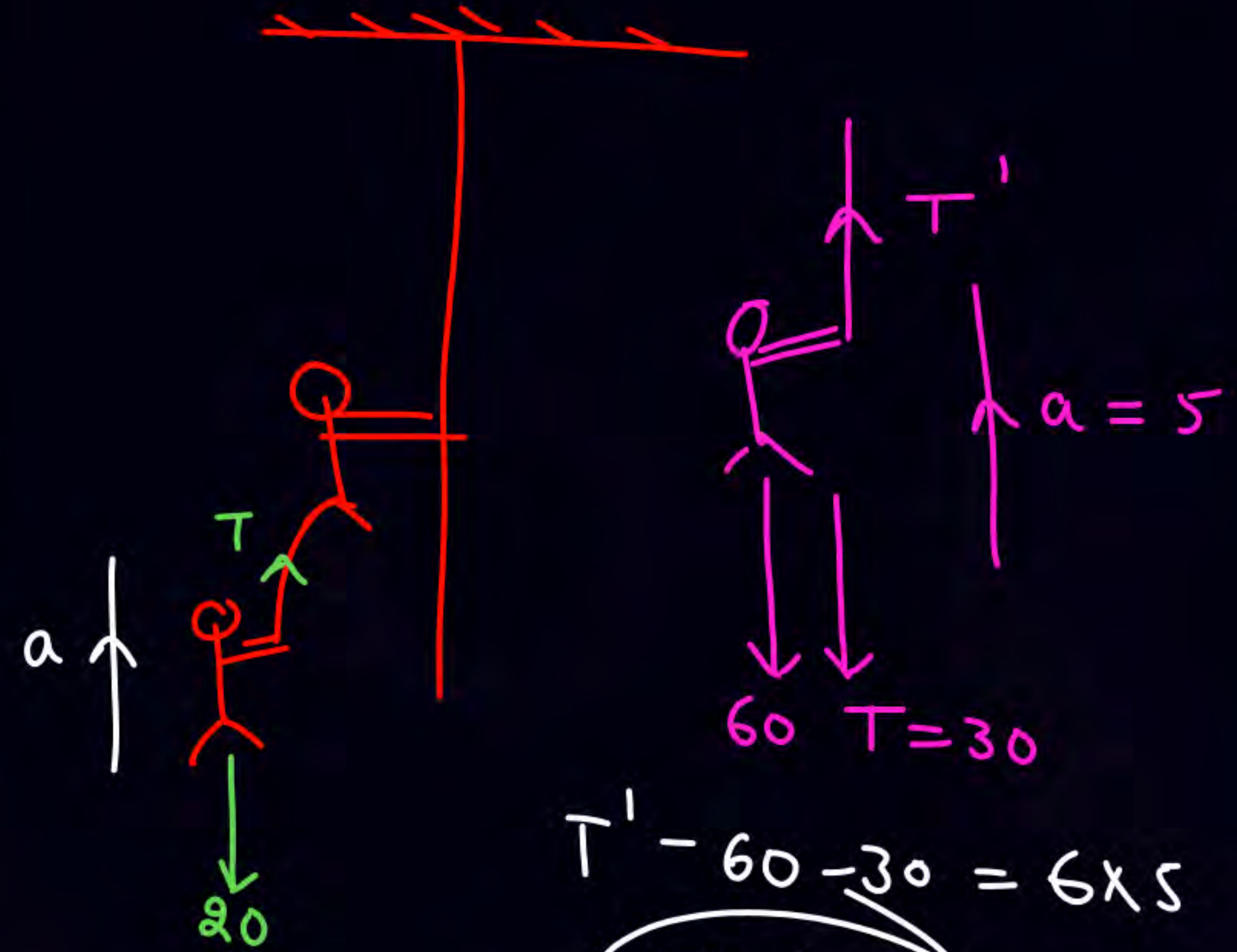
A monkey A (mass = 6 kg) is climbing up a rope tied to a rigid support. The monkey B (mass = 2 kg) is holding on the tail of monkey A. If the tail can tolerate a maximum tension of 30 N, what maximum force should monkey A apply on the rope in order to carry monkey B with it? ($g = 10\ \mathrm{m\,s^{-2}}$)



Ans 120

$$30 - 20 = 2 \times a$$

$$\boxed{a = 5}$$

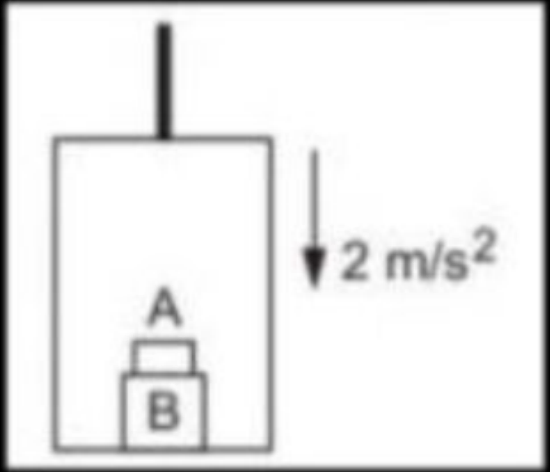


$$T' - 60 - 30 = 6 \times 5$$

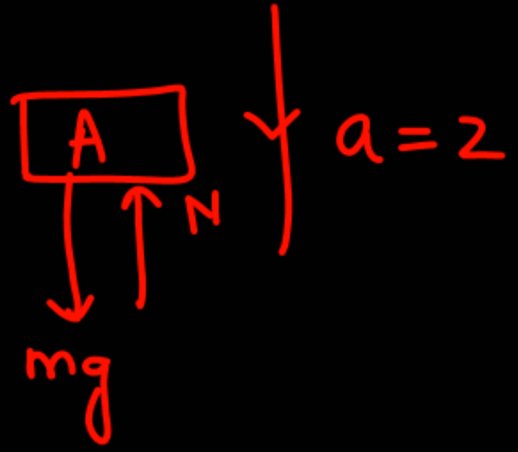
$$T = 120$$

H/W

The elevator shown in figure (5-E5) is descending with an acceleration of 2 m/s^2. The mass of the block A is 0·5 kg. What force is exerted by the block A on the block B?



$mg - N = m \times a$



$\frac{10}{2} - N = \frac{1}{2} \times 2$

$N = 4$

Ans: (4 N)

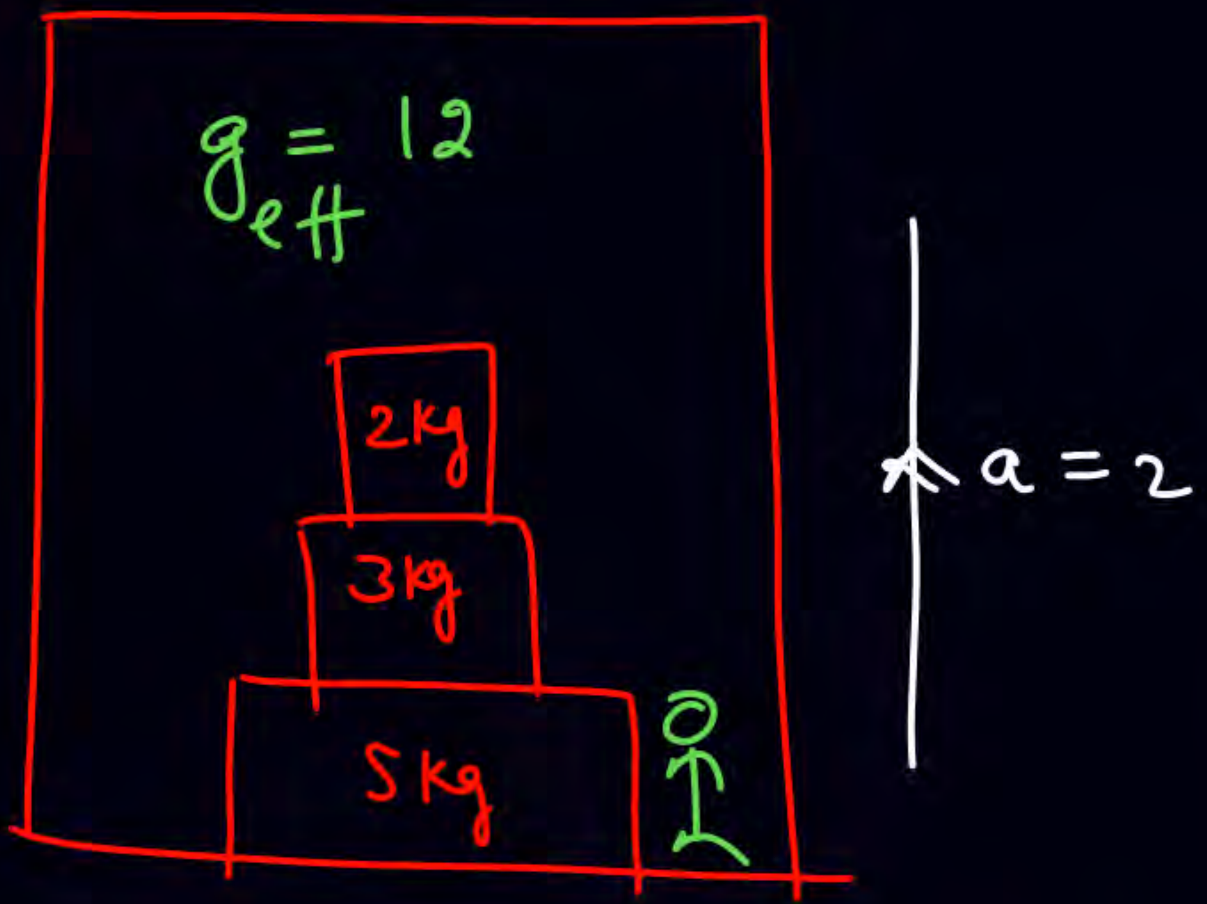
① force b/w 2kg & 3kg

$$N = 2 \times g_{eff} = 2 \times 12 = 24$$

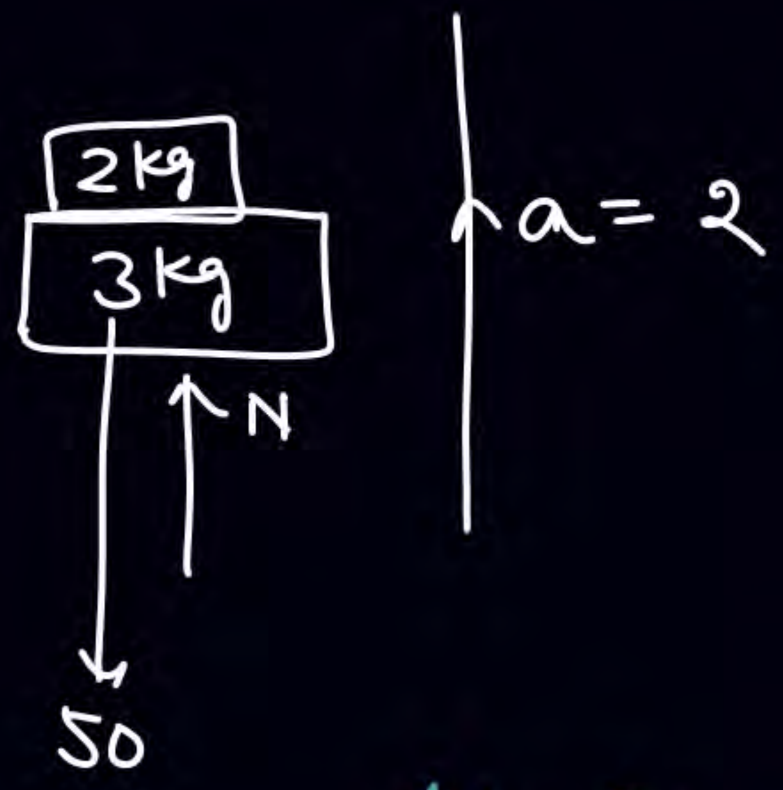
② Force b/w 3kg & 5 kg

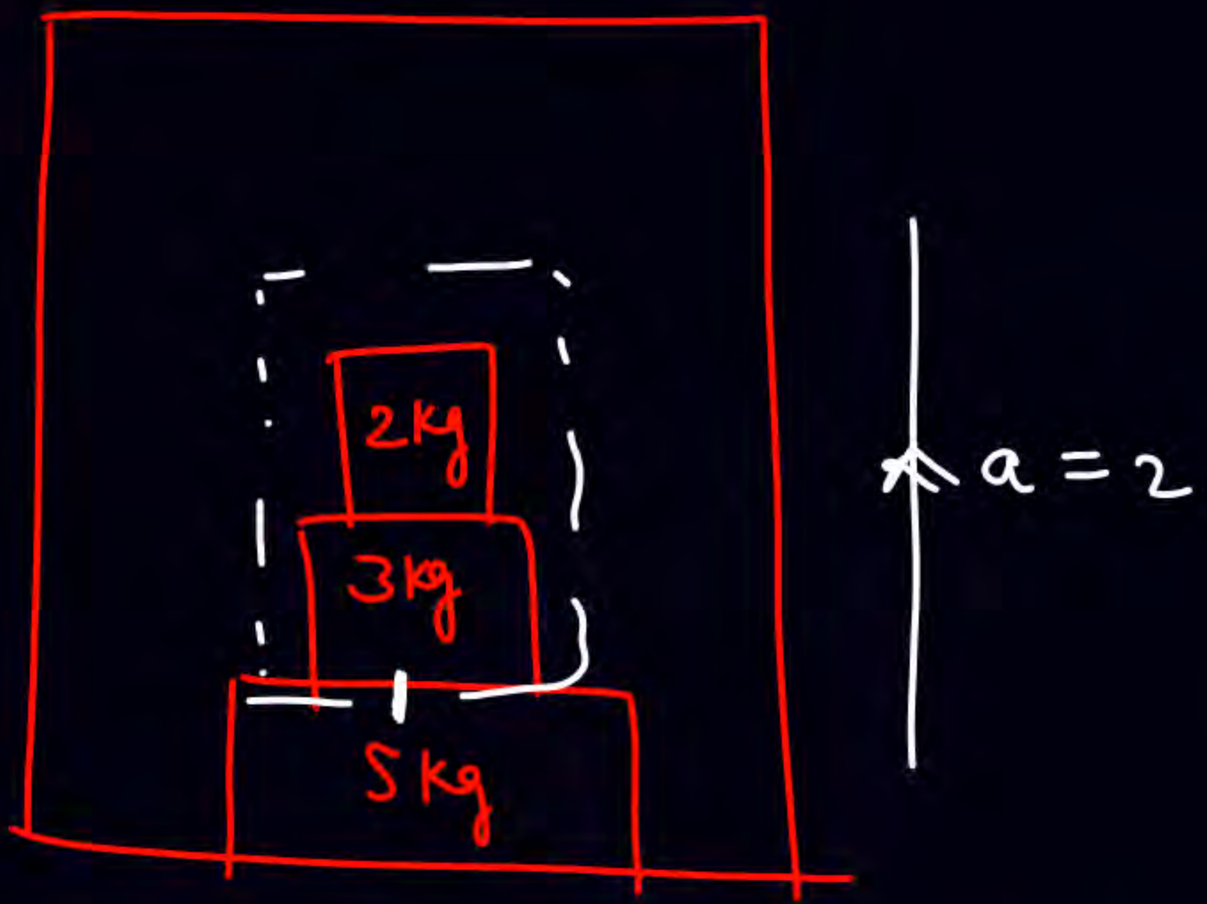
$$= 5 \times 12 = 60\,N$$

③ force b/w 5kg & lift $\Rightarrow 10 \times 12 = 120$



Force b/w 3kg & 5kg





$$N - 50 = 5 \times 2$$

(1) find normal force between 10kg & 20kg

$= 10 \times 8$

(2) find normal force between 20kg & 30kg

$= 30 \times 8$

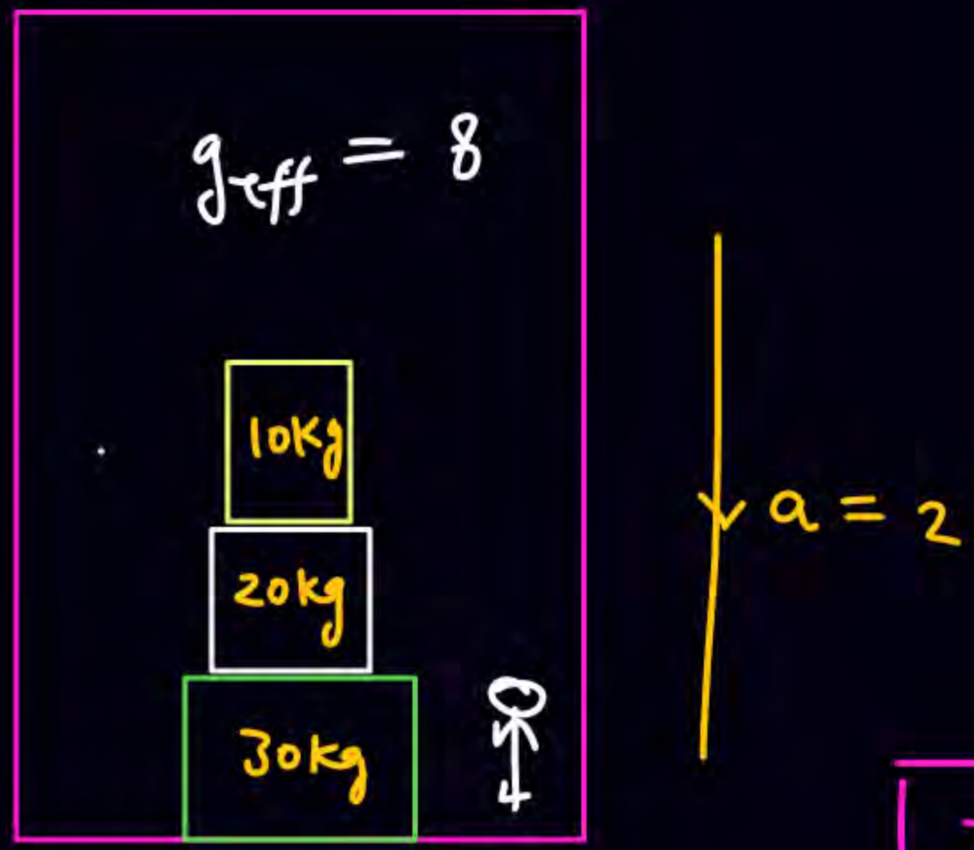
(3) find normal force between 30kg & lift.

$= 60 \times 8$

(4) F_{net} force on 10kg $= 10 \times 2$

" " 20kg $= 20 \times 2$

" " 30kg $= 30 \times 2$



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

H/W

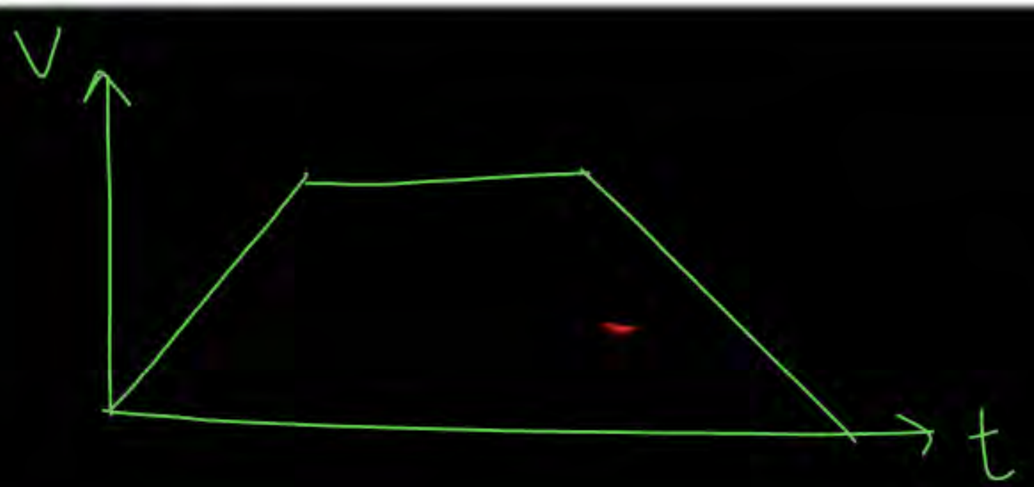
$m(g+a) = 720$

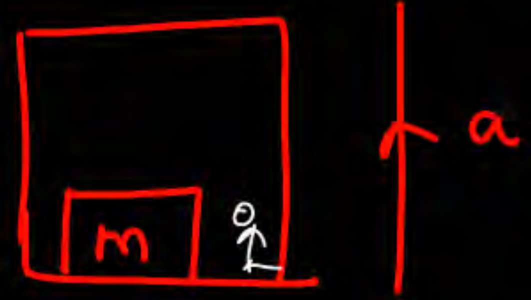
$m(g-a) = 600$

$\frac{10+a}{10-a} = \frac{6}{5}$ $= 50+5a = 60-6a$

$a = \frac{10}{11} = .9$

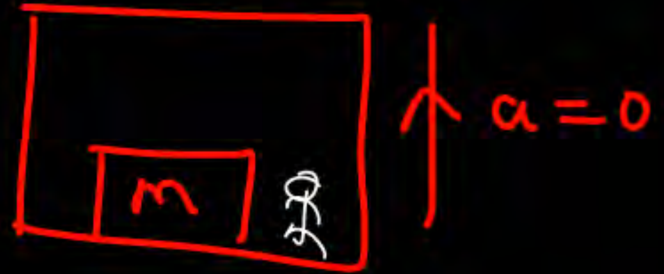
A person is standing on a weighing machine placed on the floor of an elevator. The elevator starts going up with some acceleration, moves with uniform velocity for a while and finally decelerates to stop. The maximum and the minimum weights recorded are 72 kg and 60 kg. Assuming that the magnitudes of the acceleration and the deceleration are the same, find (a) the true weight of the person and (b) the magnitude of the acceleration. Take $g = 9{\cdot}9\ m/s^2$.





$N > mg$

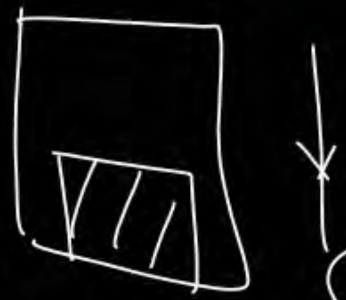
$N = m(g+a)$



$N = mg$

$N = m(g-a)$

$N < mg$



free fall

$a = g$

$N = 0$

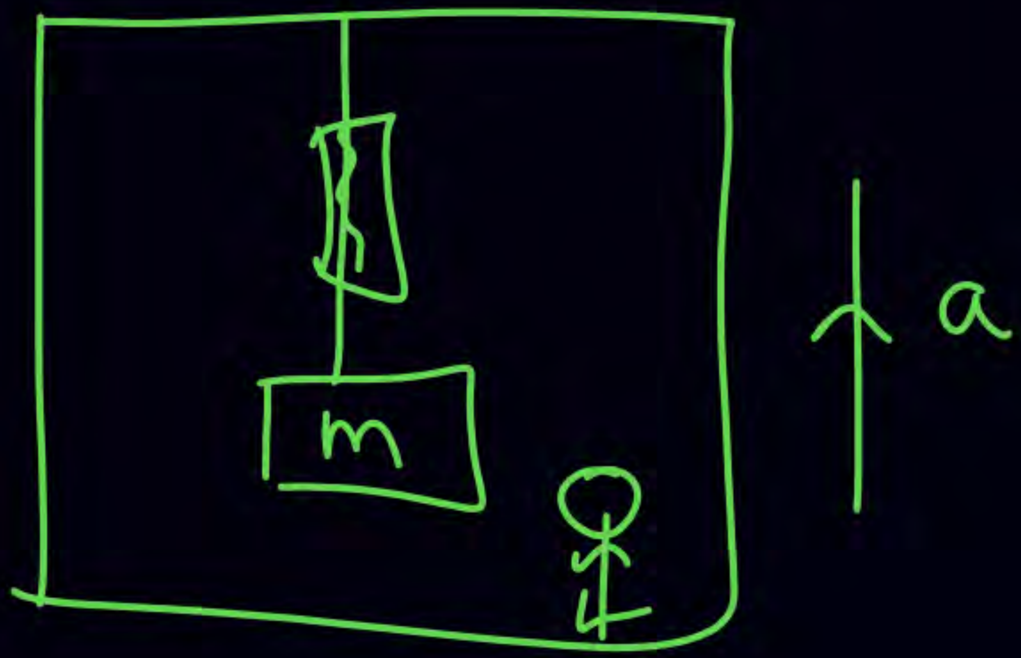
Ans: 66 kg and 0.9 m/s²

$$m(g-a) = 600$$

$$m\left(10 - \frac{10}{11}\right) = 600$$

$$m = \frac{600 \times 11}{100}$$

$$mg = \frac{6\cancel{0}\cancel{0} \times 11}{1\cancel{0}\cancel{0}} \times 1\cancel{0} = 660$$



$$T = 2\pi\sqrt{\frac{l}{g_{eff}}} = 2\pi\sqrt{\frac{l}{g+a}}$$

H/W

$\boxed{g+a}\ \uparrow a$ $\boxed{g-a}\ \downarrow a$

A pendulum bob of mass 50 g is suspended from the ceiling of an elevator. Find the tension in the string if the elevator (a) goes up with acceleration $1{\cdot}2\ m/s^2$, (b) goes up with deceleration $1{\cdot}2\ m/s^2$, (c) goes up with uniform velocity, (d) goes down with acceleration $1{\cdot}2\ m/s^2$, (e) goes down with deceleration $1{\cdot}2\ m/s^2$ and (f) goes down with uniform velocity.

(a) $T = m(g+a)$

(b) $T = m(g-a)$

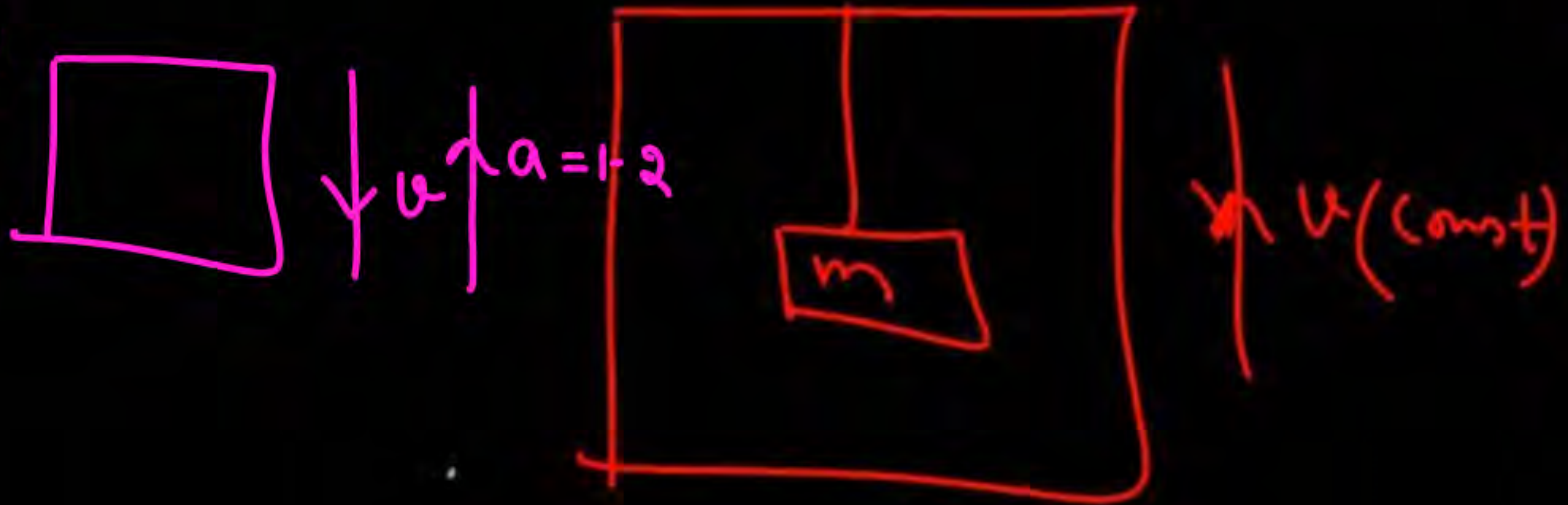
(c) $T = mg$

(d) $T = m(g-a)$

(e) $T = m(g+a)$

(f) $T = mg$

(e)



Ans: (a) 0.55 N, (b) 0.43 N, (c) 0.49 N, (d) 0.43 N, (e) 0.55 N, (f) 0.49 N

$$(\vec{F}_{net})_{ext} = \frac{d\vec{P}}{dt}$$

If $\quad 0 \quad \vec{P} \longrightarrow$ const

If $(\vec{F}_{net})_{ext} = 0$, $\quad \vec{P}_i = \vec{P}_f$

Conserv. of momentum.

(1)

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

$$P_i = P_f$$

$$2 \times 10 + 0 = 2 \times 2 + 3V$$

$$V = \frac{20-4}{3} = \frac{16}{3}$$

Q

$\xrightarrow{10\,m/s}$ 2kg $\quad \xrightarrow{5\,m/s}$ 4kg $\Rightarrow$ $\xrightarrow{5\,m/s}$ 2kg $\quad$ 4kg $\xrightarrow{} v = ?$

$$P_i = P_f \Rightarrow 2\times10 + 4\times5 = 2\times5 + 4V \Rightarrow V = \frac{30}{4}$$

$\xrightarrow{10\,m/s}$ 2kg $\quad \xrightarrow{2\,m/s}$ 4kg $\Rightarrow$ $\xrightarrow{1\,m/s}$ 2kg $\quad$ 4kg $\xrightarrow{} v = ?$

$$\vec{P_i} = \vec{P_f}$$

$$2\times10 + 2\times4 = 2\times1 + 4V$$

$$26 = 4V, \quad \boxed{V = \frac{13}{2}}$$

$\xrightarrow{10\,m/s}$ 2kg $\quad$ Rest 4kg $\Rightarrow$ 2kg + 4kg $\xrightarrow{} V$

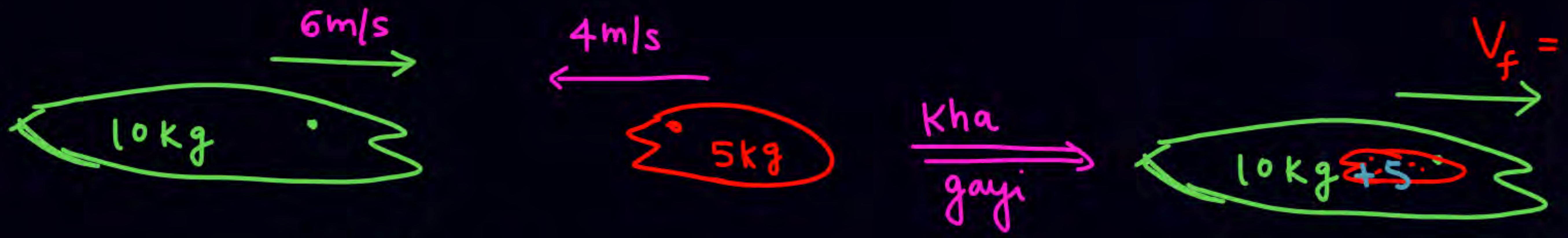
$$2\times10 + 0 = 6\times V \Rightarrow V = \frac{20}{6}$$

Q

$$P_i = P_f \Rightarrow \quad 4\times 10 - 2\times 2 = 4V + 2\times 8$$

$$36 = 4V + 16 \qquad \boxed{V=5}$$

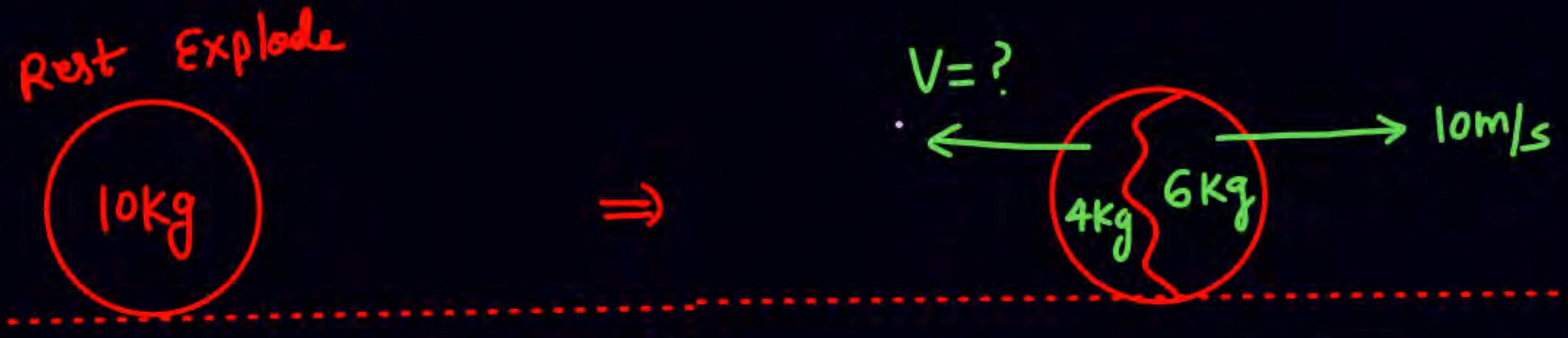
Q



$$10\times 6 - 5\times 4 = 15\, V_f$$

$$V_f = \frac{60-20}{15} = \frac{40}{15}$$

Q



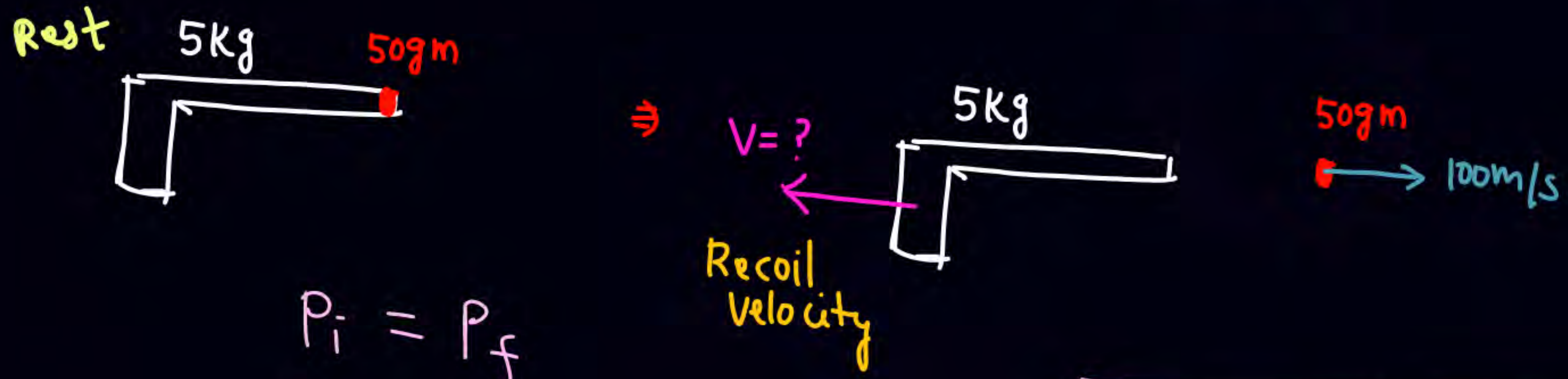
$$P_i = P_f$$

$$0 = 6 \times 10 - 4V \Rightarrow V = 15\,m/s$$

$6kg \equiv \vec{P}$

$4kg \equiv -\vec{P}$

Q



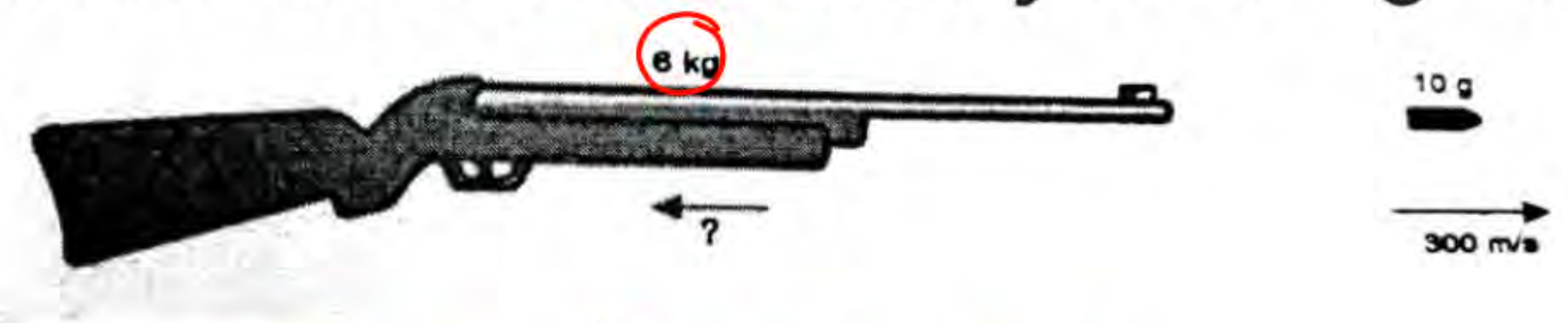
$$P_i = P_f$$

$$0 = \frac{50}{1000} \times 100 - 5V$$

$$V = 1$$

muzzle velocity ⇒ Relative velocity

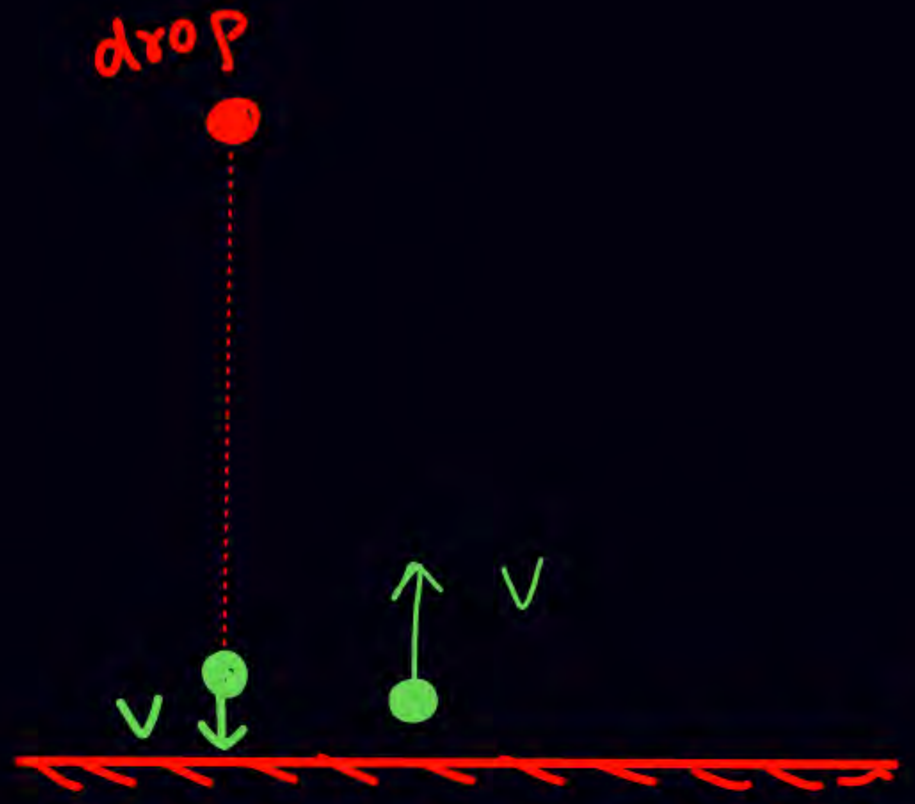
A bullet of mass 10 g is fired from a gun of mass 6 kg with a velocity of 300 m/s. Calculate the recoil velocity of the gun.



Sol

$$0 = \frac{10}{1000} \times 300 - 6v$$

$$\boxed{v = \frac{1}{2} = .5\ m/s}$$



(elastic)

Change in momentum $= 0$ ✗

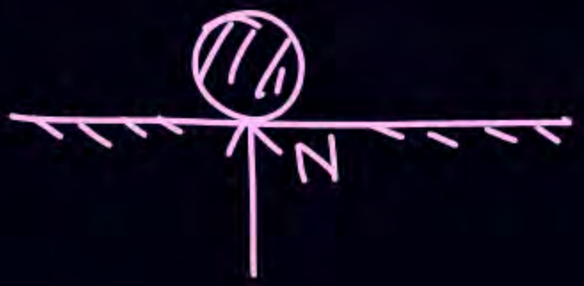
$= 2mv$

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

$= 2mv\hat{j} \equiv$ Impulse

$(\vec{P}_i)_{\text{just before collision}} = mv(-\hat{j})$

$(\vec{P}_f)_{\text{just after collision}} = mv(\hat{j})$



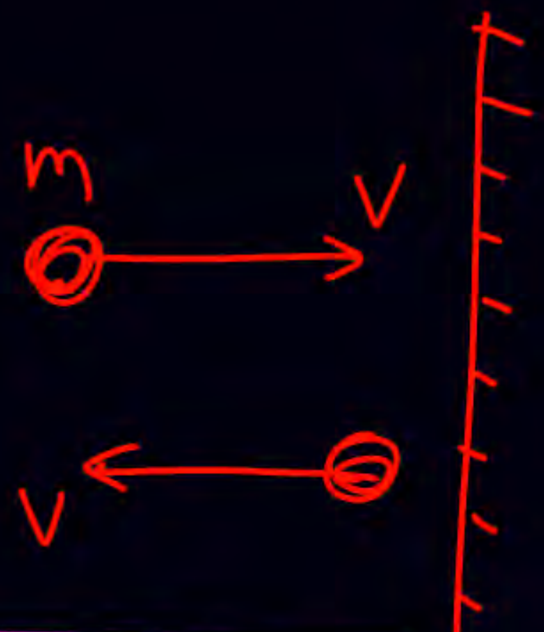
$\langle \vec{F} \rangle = \dfrac{\Delta \vec{P}}{\Delta t}$

Q

$\Delta P = m(u+v) =$ Impulse.

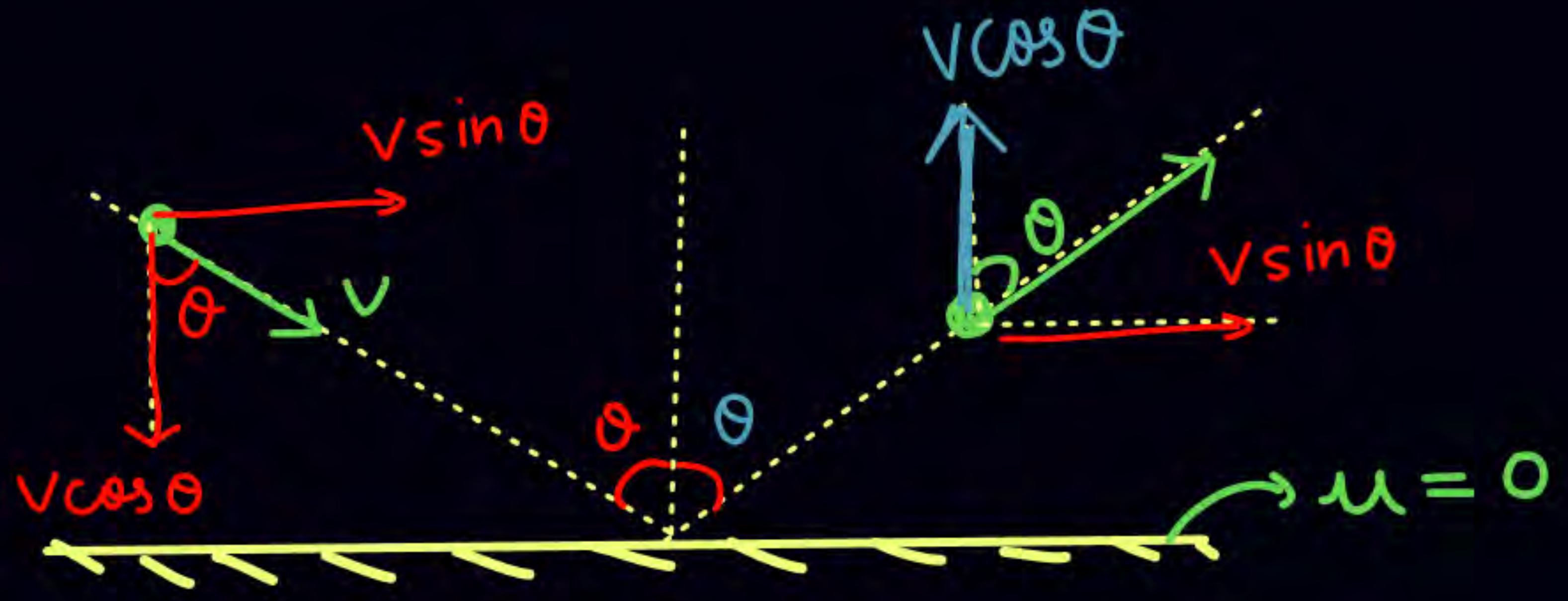
$\Delta \vec{P} = \vec{P}_f - \vec{P}_i = mu - (-mv)$

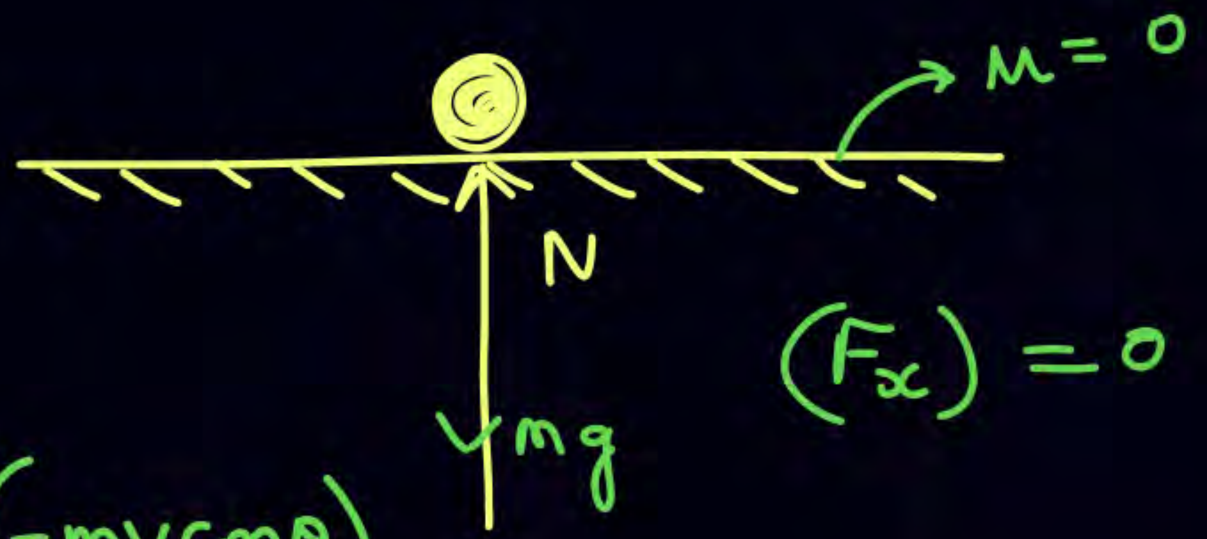
Q



$\boxed{\Delta P = 2mv}$

Q





elastic collision

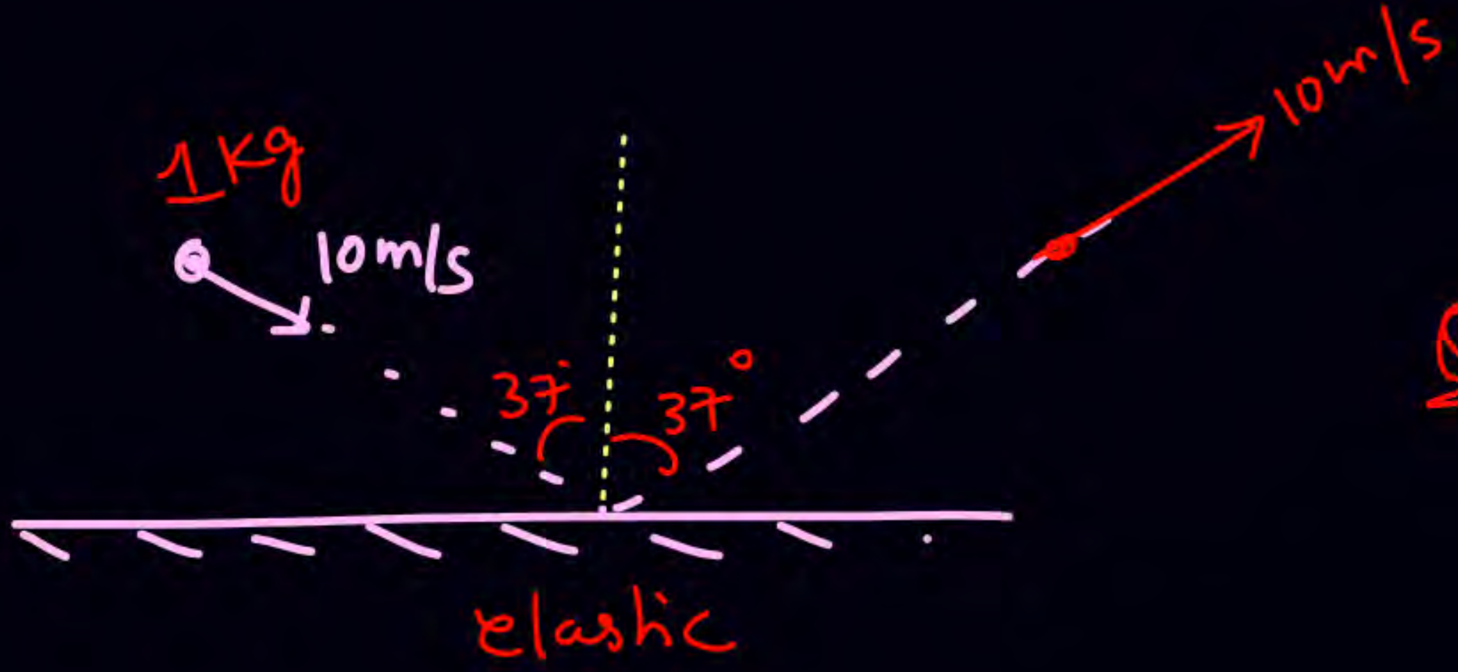
$(F_x) = 0$

$\Delta\vec{P}$ = Change in momentum $= (mv\cos\theta) - (-mv\cos\theta)$

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

$$\boxed{|\Delta\vec{P}| = 2mv\cos\theta}$$

Q



$\Delta P = 2mv\cos\theta$

$= 2 \times 1 \times 10 \times \frac{4}{5}$

$= 16$ = Impulse.

Q

$|\Delta \vec{P}| = 2mv\cos\theta$

Impulse

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

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

$\int_{P_i}^{P_f} dp = \int_0^t F \cdot dt$

$\Delta P = \int F dt = \text{Impulse}$

- Impulse = change in momentum. $= \Delta \vec{P}$
- Impulse $= \int F \cdot dt$.

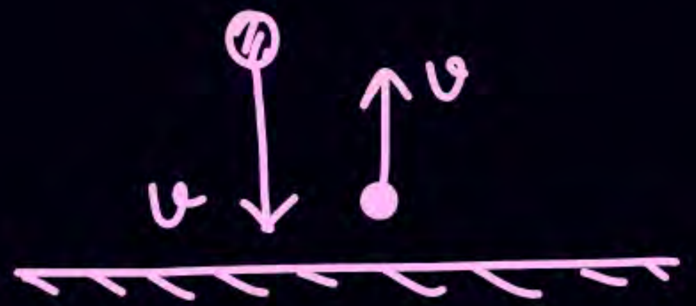
Area = Impulse
= change in moment

If $F \to$ const

$\boxed{\text{Impulse} = F \Delta t}$

Q $F = 1000\,N$
$t = .1\,sec$

Impulse $= 1000 \times .1 = 100\,Ns = P_f - P_i$



$\Delta\vec{p} = 2mv\,\hat{j}$ (of ball)

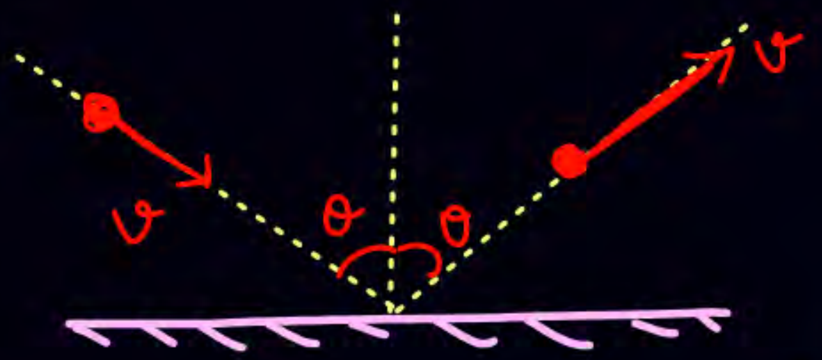
Impulse $= 2mv\,\hat{j}$ (on ball by ground)

Avrg. normal force by ground $= \dfrac{\Delta p}{\Delta t} = \dfrac{2mv}{\Delta t}$

$\Delta t \rightarrow$ time of contact

$\Delta p = J = \text{Impulse}$
$= 2mv$

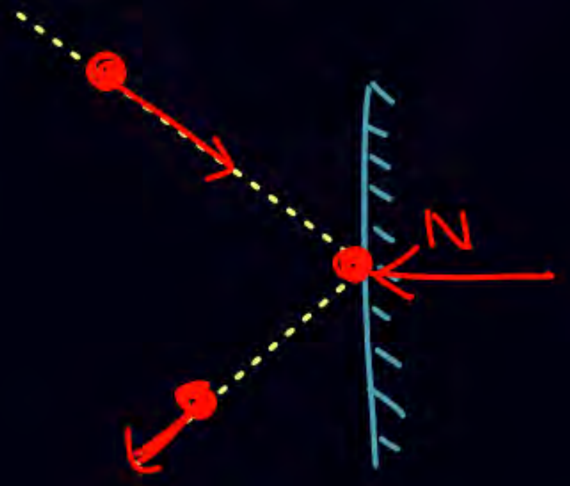
$\langle N \rangle = \dfrac{2mV}{\Delta t}$ (by wall)



$\Delta\vec{p} = 2mv\cos\theta\ \hat{j}$ (of ball)

Impulse $= 2mv\cos\theta\ \hat{j}$ (on ball by ground)

Avrg. normal force by ground $= \dfrac{\Delta p}{\Delta t} = \dfrac{2mv\cos\theta}{\Delta t}$



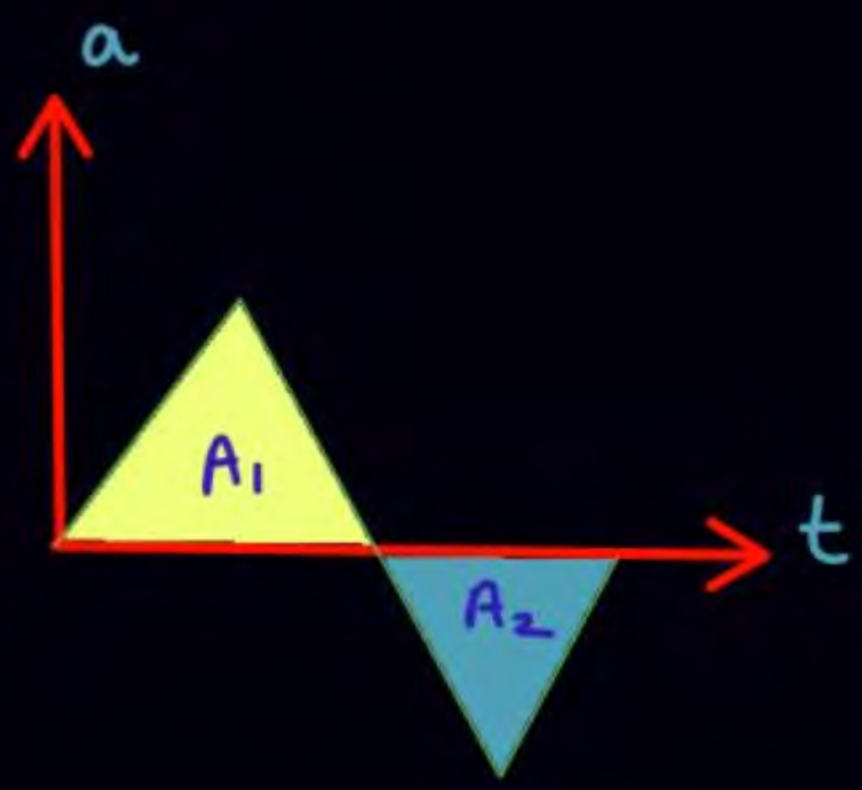
- $\vec{a} = \frac{d\vec{v}}{dt} \longrightarrow \vec{F} = \frac{d\vec{P}}{dt}$

- v-t graph ka slope acc. deta hai $\longrightarrow$ $(P\text{-}t)_{slope} \Rightarrow$ Force Dega

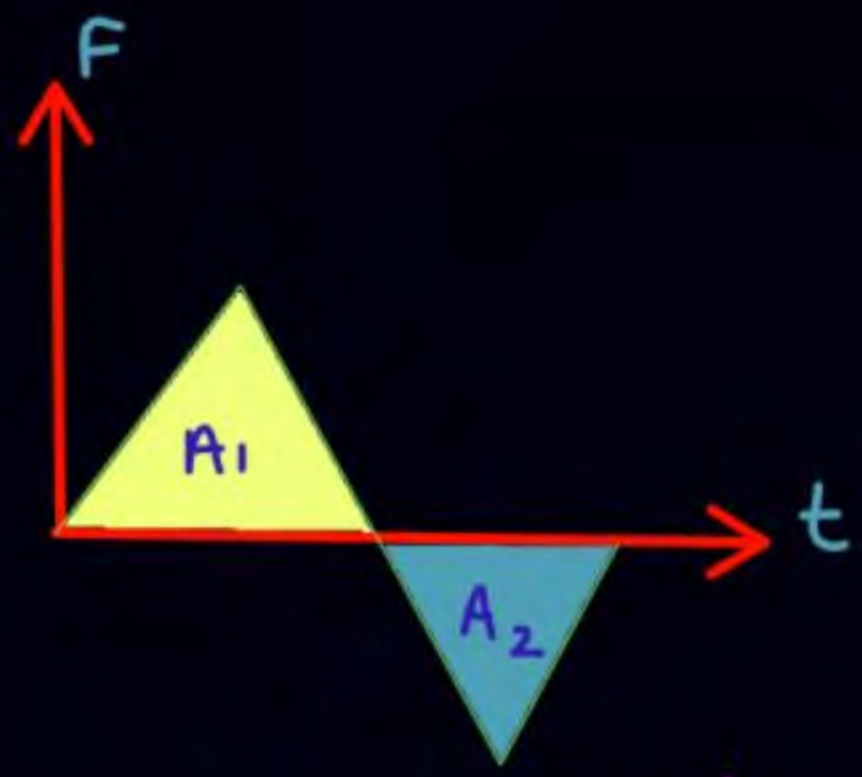
- $\Delta V = \int a \cdot dt$ = Area under curve $\longrightarrow$ $\Delta\vec{P} = \int \vec{F} \cdot dt$ = Impulse

- a-t graph ka area change in velocity deta hai. $\longrightarrow$ F-t Graph ka area change in momentum Dega
  or
  F-t Graph ka area Impulse Dega

- $\langle \vec{a} \rangle = \frac{\Delta\vec{V}}{\Delta t} = \frac{\vec{V}_f - \vec{V}_i}{t_2 - t_1} \longrightarrow \langle \vec{F} \rangle = \frac{\Delta\vec{P}}{\Delta t} = \frac{\vec{P}_f - \vec{P}_i}{t_2 - t_1}$



Area $= A_1 - A_2 = V_f - V_i$ = Change in Velocity



Area $= A_1 - A_2$ = Impulse = change in momentum

Q If momentum $P = t^2 + 4t$

(1) Force at $t = 3$ sec.

$F = \frac{dP}{dt} = 2t + 4$

$t = 3$, $F = 2 \times 3 + 4 = 10$

(2) Avrg force from $t=0 \longrightarrow t = 3$ sec.

$\langle \vec{F} \rangle = \frac{\Delta \vec{P}}{\Delta t} = \frac{\vec{P}_f - \vec{P}_i}{\Delta t} = \frac{21 - 0}{3 - 0}$

$= 7$

Q A particle of mass 2 kg is moving on x-Axis such that its momentum changes as

$P = 3t^2 + 2t$

Find

(1) momentum at $t = 2$

(2) velocity at $t = 2$

(3) Force at $t = 2$

(4) Avrg force from $t=0 \longrightarrow t = 2$ sec.

(5) Impulse imparted on block from $t=0 \longrightarrow t = 2$ sec.

Q A particle of mass 2kg is moving on x-Axis such that its momentum changes as

$$P = 3t^2 + 2t$$

Soln

Find

1. momentum at $t = 2$ $\longrightarrow$ $P = 12 + 4 = 16$
2. velocity at $t = 2$ $\longrightarrow$ $P = mv \Rightarrow 16 = 2v \Rightarrow \boxed{v = 8}$
3. Force at $t = 2$ $\longrightarrow$ $F = \frac{dP}{dt} = 6t + 2$, $t = 2 \Rightarrow F = 14$, $a = 7$
4. Avrg force from $t=0 \longrightarrow t=2$ sec. $\longrightarrow$ $\langle F \rangle = \frac{P_f - P_i}{\Delta t} = \frac{16-0}{2-0} = 8$
5. Impulse imparted on block from $t=0 \longrightarrow t=2$ sec. $\longrightarrow$ $J = \Delta\vec{P} = P_f - P_i = 16 - 0$

$$\langle \text{कद्दू} \rangle = \frac{\int (\text{कद्दू})\, dt}{\int dt} \qquad \langle i \rangle = \frac{\int i\, dt}{\int dt}$$

$$\langle F \rangle = \frac{\int F\, dt}{\int dt} = \frac{\int_0^3 (2t+4)\, dt}{\int_0^3 dt} = \frac{(t^2+4t)\Big|_0^3}{3-0}$$

$$= \frac{9+12-0}{3} = 7$$

Q A particle start motion from rest such that net force on particle. (2kg) is $F = 6t^2 + 2t$

find. (1) Velocity at $t=2$ sec.

Solⁿ $a = \frac{F}{m} = \frac{6t^2+2t}{2}$

$a = 3t^2 + t$

$\int_0^V dv = \int_0^2 (3t^2+t)\,dt$

(2) Repeat above ques if at $t=0$, initial velocity is $+10$ m/s

Solⁿ

$a = \frac{F}{m} = \frac{6t^2+2t}{2}$

$a = 3t^2 + t$

$\int_{10}^V dv = \int_0^2 (3t^2+t)\,dt$

Q A particle start motion from rest such that net force on particle. (2kg) is $F = 6t^2 + 2t$

find. (1) Velocity at $t = 2$ sec.

(2) Repeat above ques if initial velocity is +10m/s at $t = 0$,

Sol^n $F = \frac{dP}{dt}$

$-^2 - 2t$

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

$$\int_0^{P_f} dP = \int_0^2 (6t^2 + 2t)\,dt$$

Q find force acting on particle at

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

$t = 1$ $\quad F = \text{slope} = \frac{10}{2} = +5$

$t = 1.5$ $\quad F = 1.5$

$t = 3$ $\quad F = 0$

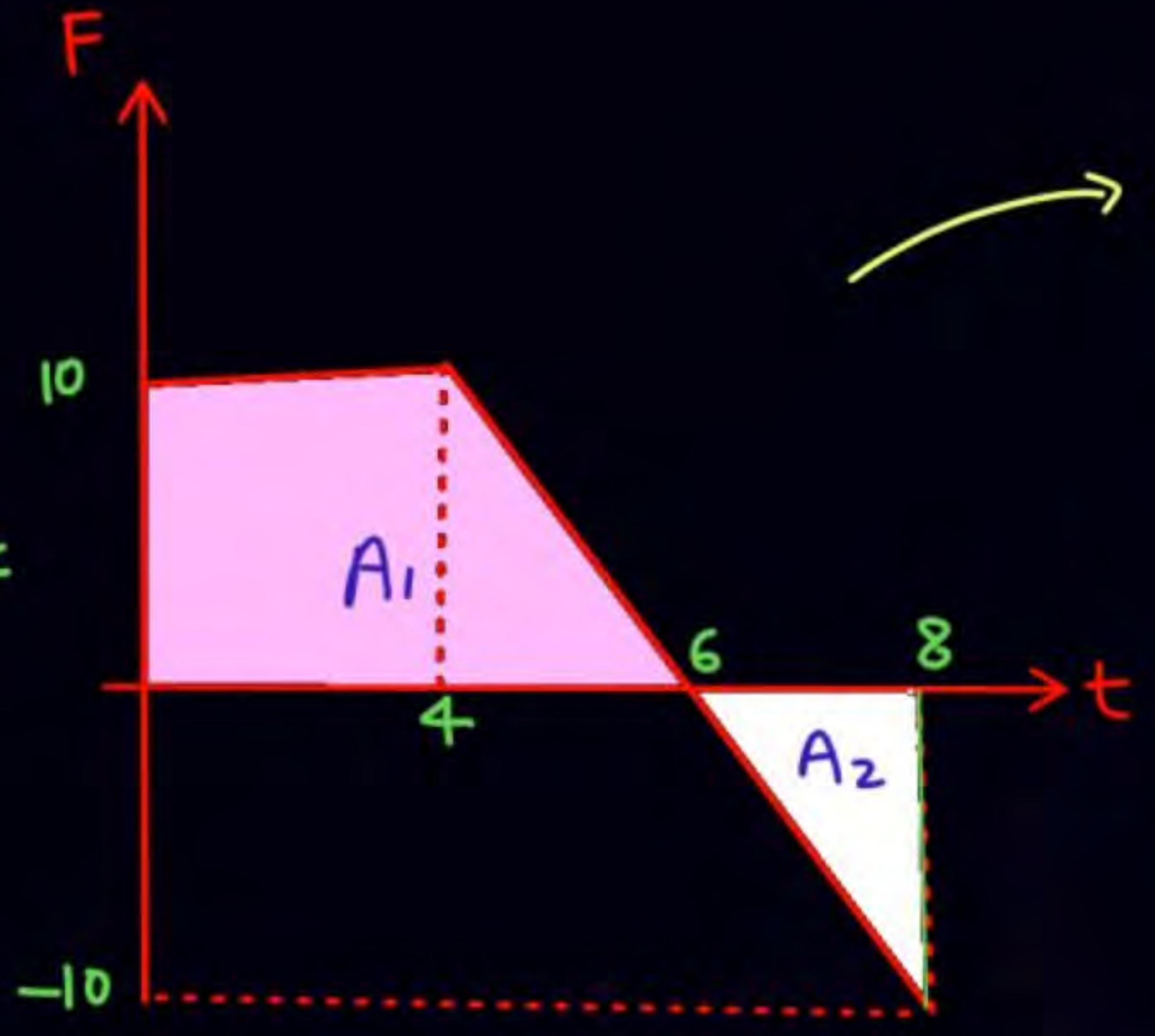
$t = 5$ $\quad F = -2.5$

$t = 7$ $\quad F = -2.5$

$\tan\alpha = \frac{10}{4} = 2.5$

Q $m = 2\,kg$

(a) If particle start motion from rest find its velocity at $t = 8$ sec



(b) If initial velocity of particle at $t = 0$ sec is $+10\,m/s$. find velocity at $t = 8$ sec.

Solⁿ (a)

$$\text{Area} = P_f - P_i$$

$$\frac{1}{2}\times 10\times 10 - \frac{1}{2}\times 2\times 10 = 2v_f - 0$$

$$\boxed{v_f = 20}$$

Solⁿ (b)

$$\text{Area} = P_f - P_i$$

$$\frac{1}{2}\times 10\times 10 - \frac{1}{2}\times 2\times 10 = 2v_f - 2\times 10$$

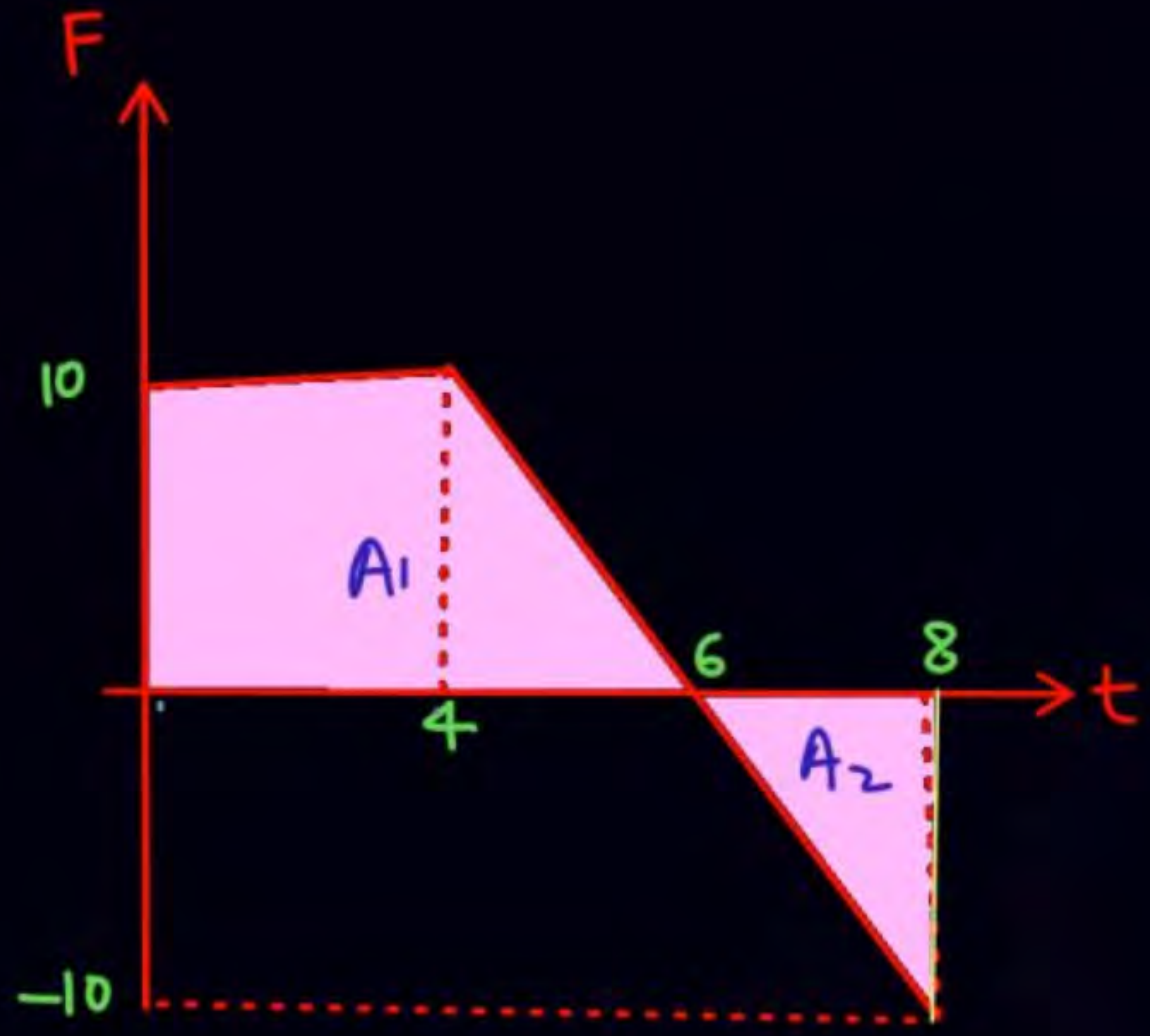
$$V_f = 30$$

Q $m = 2\,kg$

Find impulse imparted on particle from

(1) $t=0 \longrightarrow t=8$

Sol^n $A_1 - A_2 = $ ✓



(2) $t=0 \longrightarrow t=6\,sec.$

Ans A_1

Q

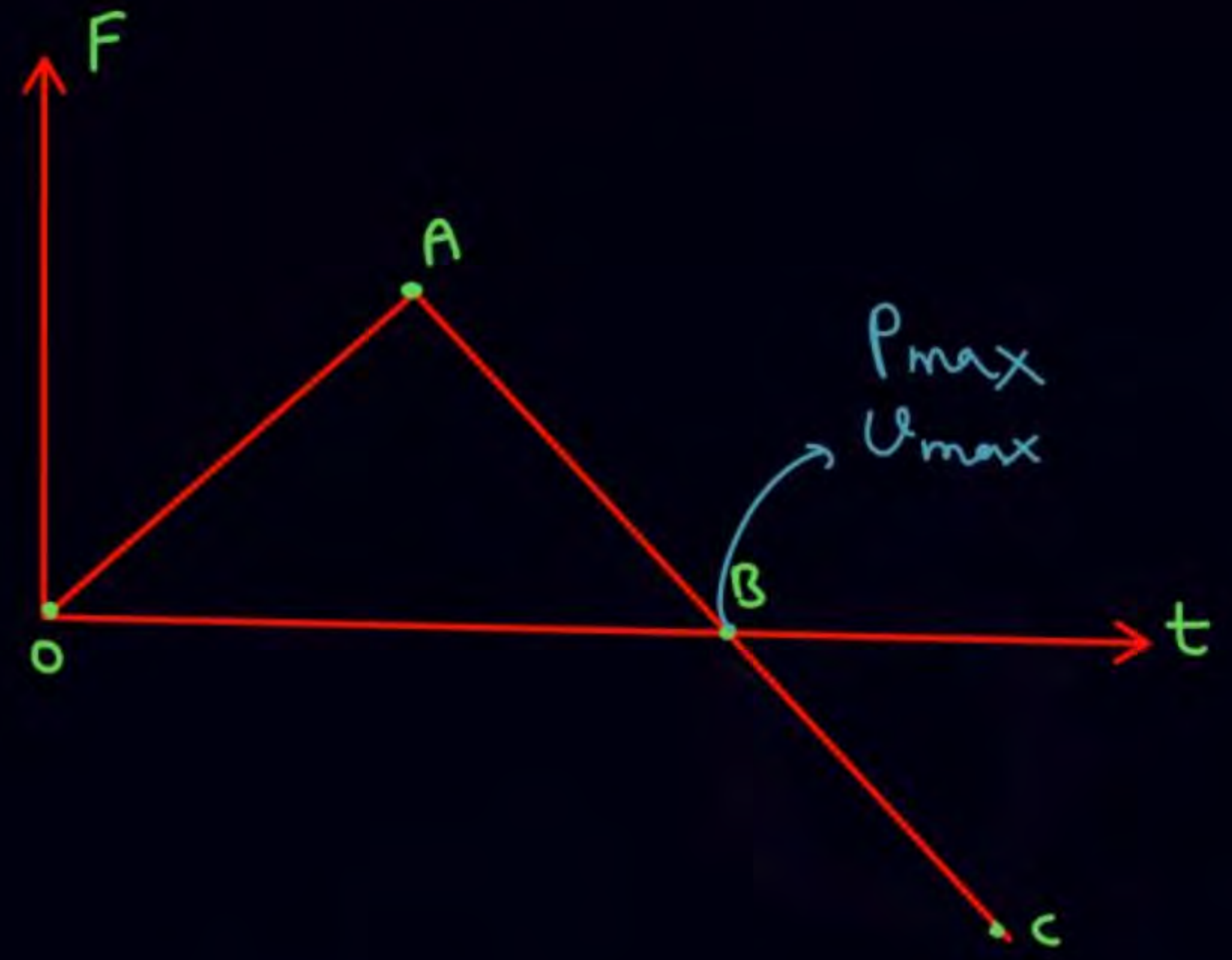
If particle start motion from rest. Then its velocity will be max at

(1) O

(2) A

(3) B

(4) C



$m = 2\,kg$

Q If a force 1000N act on a particle for ·2 sec. find change in momentum. and final velocity (if $u = 0$)

Sol^n

$$\text{Impulse} = \int F\,dt = F\int dt = Ft$$

$$\text{Impulse} = 1000 \times .2 = 200 = P_f - P_i$$

$$\boxed{200 = P_f - 0}$$

$$200 = 2 \times v_f$$

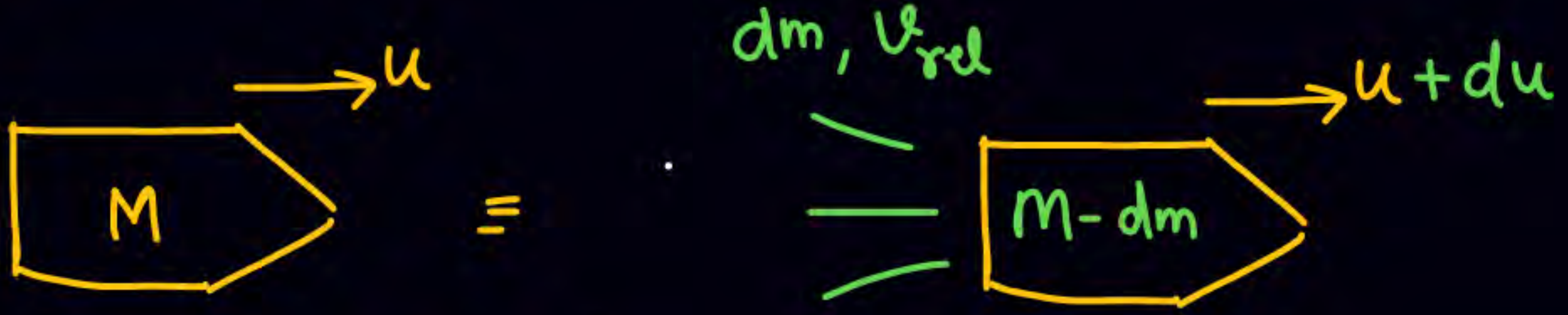
$$\boxed{v_f = 100}$$

$$v = u + at$$
$$= 0 + \frac{1000}{2} \times .2$$

$$\boxed{v = 100}$$

$$P = mv = 2 \times 100$$
$$P_f = 200$$

Rocket propulsion Dont write Derivation



$$P_i = P_f$$

$$mu = (dm)\,v_{gas} + (M-dm)(u+du)$$

$$mu = dm\,(v_{rel} + u + du) + (M-dm)(u+du)$$

$$mu = dm \cdot v_{rel} + u\,dm + dm \cdot du + mu + m\,du - u\,dm - dm \cdot du$$

$$0 = dm \cdot v_{rel} + m\,du$$

$$-v_{rel}\,dm = m\,du$$

$$\vec{v}_{rel} = \vec{v}_{gas/rocket}$$

$$\vec{v}_{rel} = \vec{v}_{gas} - \vec{v}_{rocket}$$

$$\vec{v}_{gas} = \vec{v}_{rel} + \vec{v}_{rocket}$$

$$-v_{rel}\frac{dm}{dt} = m\frac{du}{dt} = ma = F_{thrust}$$

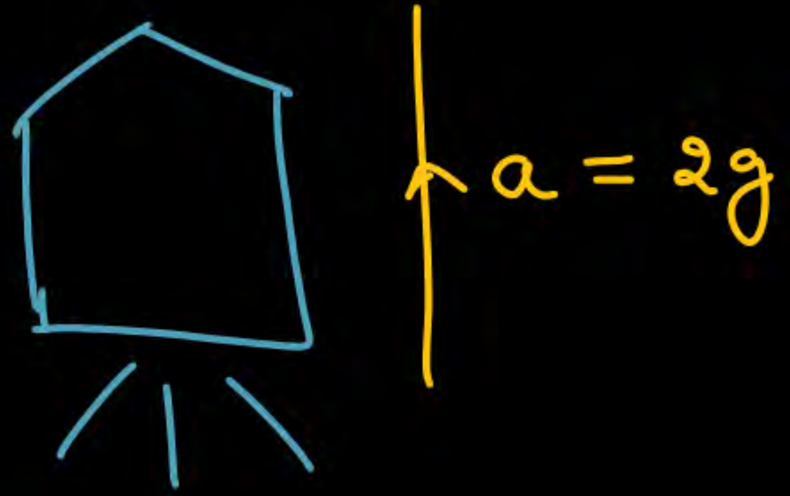
$$\boxed{F_{thrust} = -v_{rel}\frac{dm}{dt}}$$

$$\boxed{F_{thrust} = v_{rel}\frac{dm}{dt}}$$

Q

gases are ejecting at the rate of 1 kg/sec
Find V_{rel} for gas to have an upward accelerat
of 2g. (uplift)

Sol^n

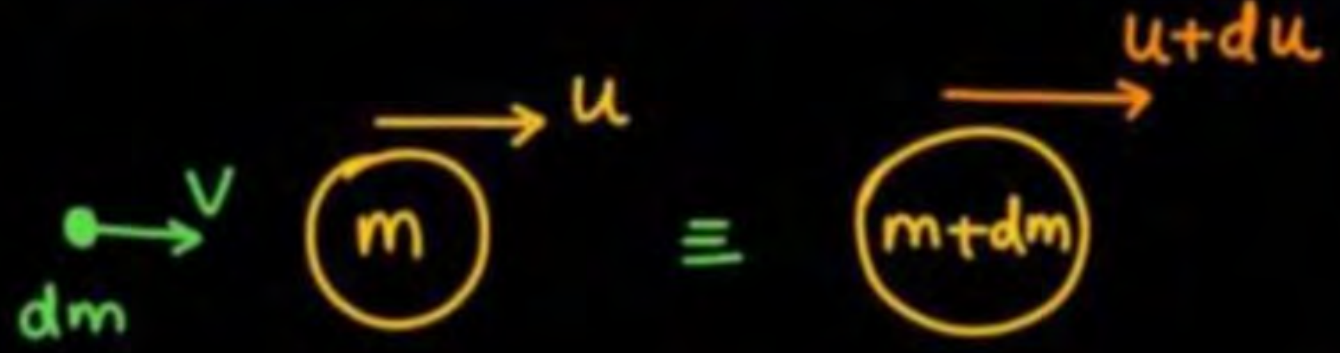


$$v_{rel}\frac{dm}{dt} - mg = m \times 2g$$

$$v_{rel} \times 1 = 3 \times 1000 \times 10$$

$$v_{rel} = \checkmark$$

Variable mass System



$$dm.v + mu = (m+dm)(u+du)$$

$$v\,dm + \cancel{m}u = \cancel{m}u + m\,du + u\,dm + dm.du$$

Neglect

$$v\,dm = m\,du + u\,dm$$

$$v\,dm - u\,dm = m\,du$$

$$(v-u)\,dm = m\,du$$

$$v_{rel}\frac{dm}{dt} = m\frac{du}{dt}$$

$$v_{rel}\frac{dm}{dt} = ma$$

$$\boxed{v_{rel}\frac{dm}{dt} = F_{thrust}}$$

$v \Rightarrow$ at time 't'

$$F_{thrust} - mg = ma$$

$$-v_{rel}\frac{dm}{dt} - mg = m\frac{dv}{dt}$$

$$\frac{dv}{dt} = -\frac{v_{rel}}{m}\frac{dm}{dt} - g$$

$$\int_u^v dv = \int_{m_0}^{m} -v_{rel}\frac{dm}{m} - \int_0^t g\,dt$$

$$v - u = -v_{rel}\ln\frac{m}{m_0} - gt$$

$$\boxed{v = u - gt + v_{rel}\ln\left(\frac{m_0}{m}\right)}$$

Rm

$$m = m_0 - \lambda t.$$

A rocket, with an initial mass of 1000 kg, is launched vertically upwards from rest under gravity. The rocket burns fuel at the rate of 10 kg per second. The burnt matter is ejected vertically downwards with a speed of 2000 m/s relative to the rocket. Find the velocity of the rocket after 1 min of start.

Sol

$$v = u - gt + \ln\left(\frac{m_0}{m}\right) v_{rel}$$

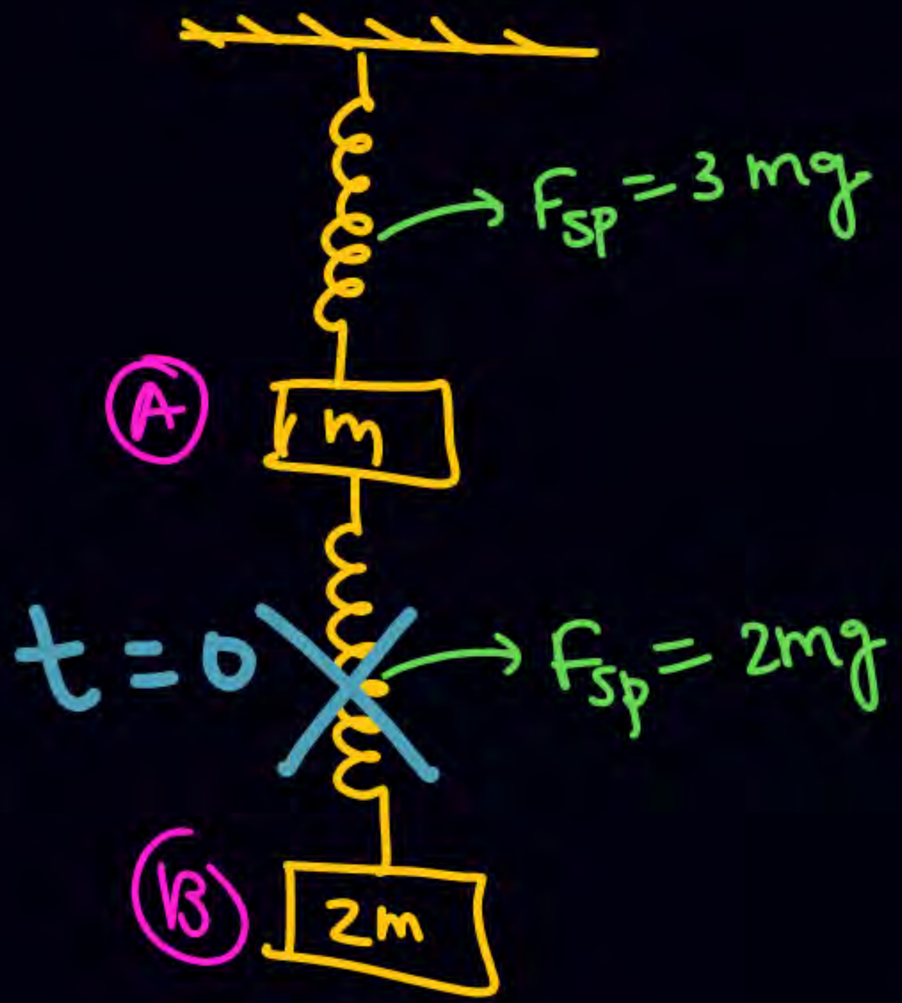
$$v = 0 - 10 \times 60 + \ln\left(\frac{1000}{600}\right) \times 2000$$

$$t=0, \quad a = \frac{2000 \times 10 - 10000}{1000}$$

$$a = 10$$

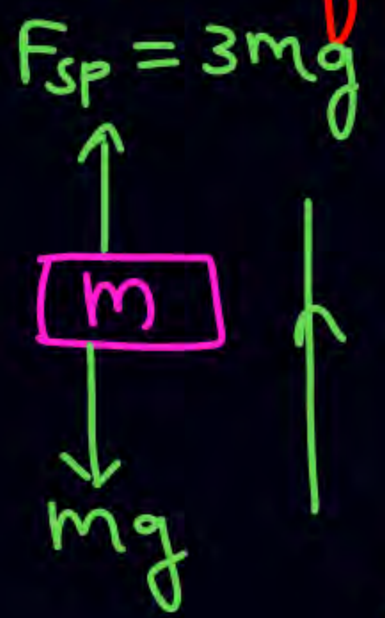
spring force $\longrightarrow$ आलसी / सुस्त

Cutting of spring



If at $t=0$, Lower spring is cut then find acc. of each block at $t=0^+$ (just after)

Sol^n

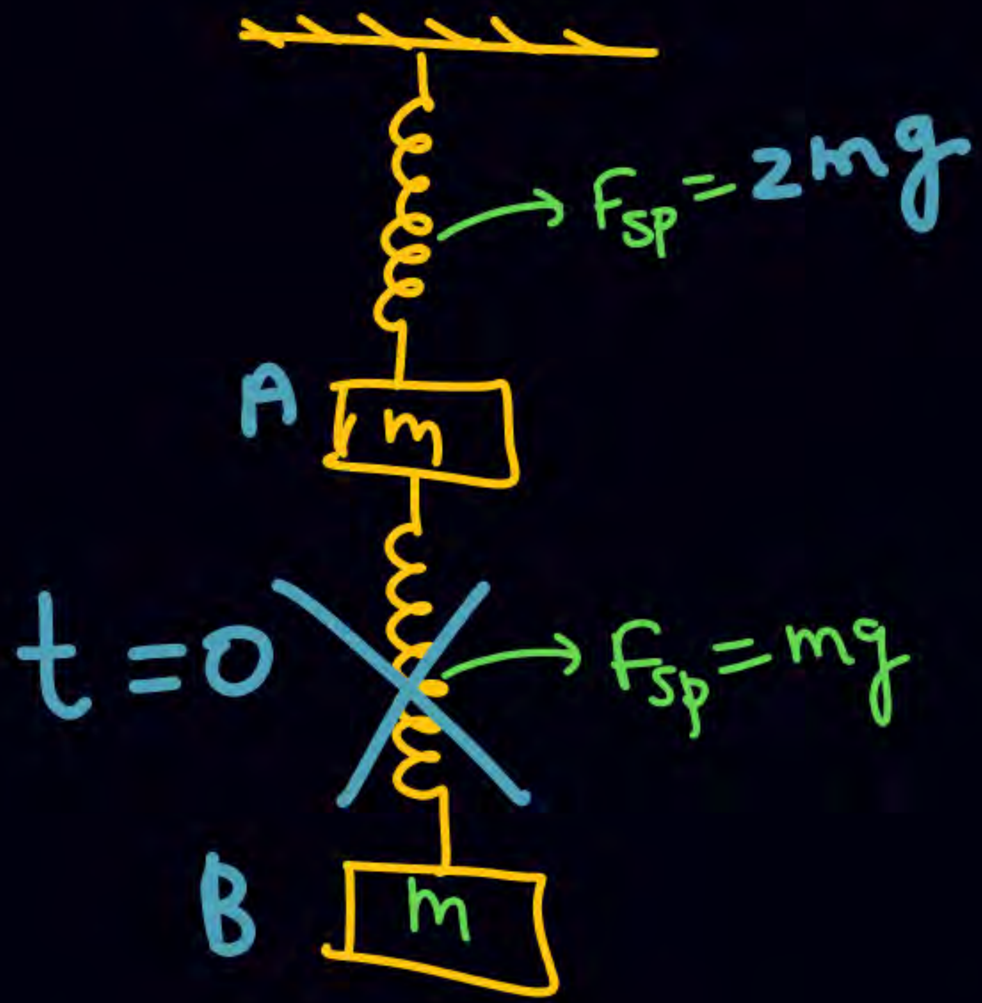


$$a = \frac{3mg - mg}{m} = 2g \uparrow$$

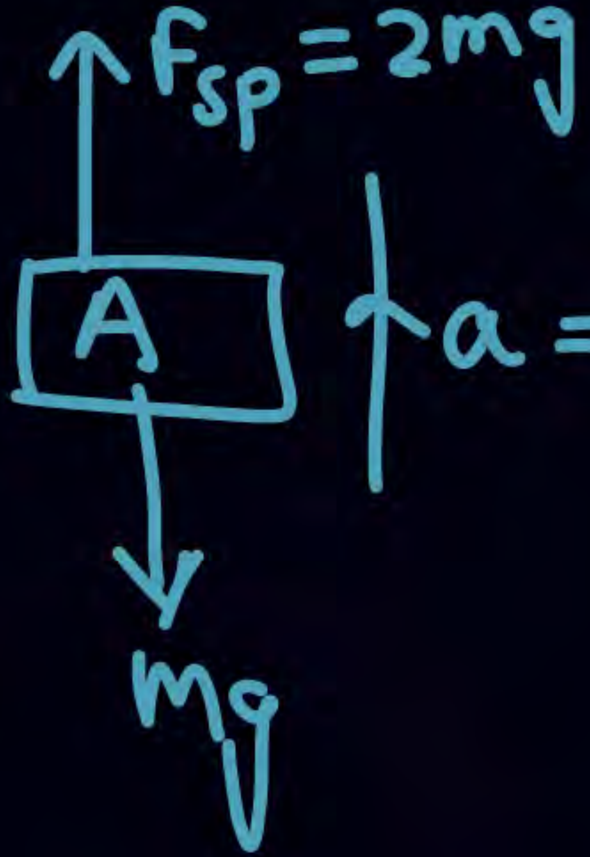
$\boxed{B}$ $a = g$

$$t = 0^+$$

Cutting of spring

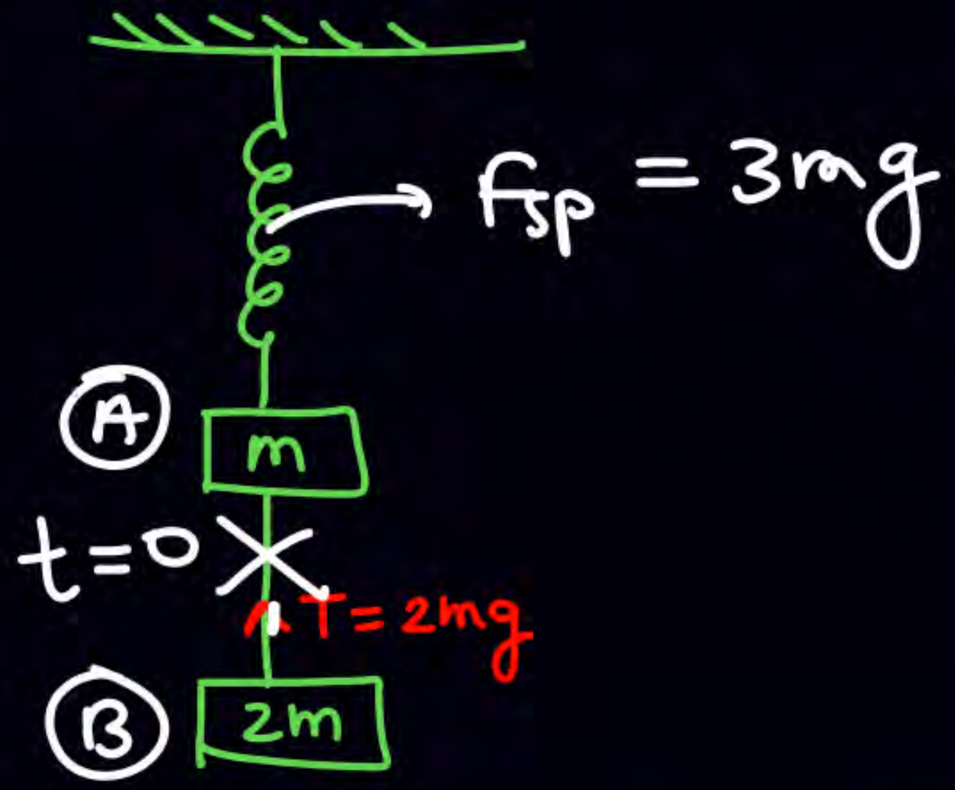


Sol: $t = 0^+$ $\quad a_B = g \downarrow$



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

Q

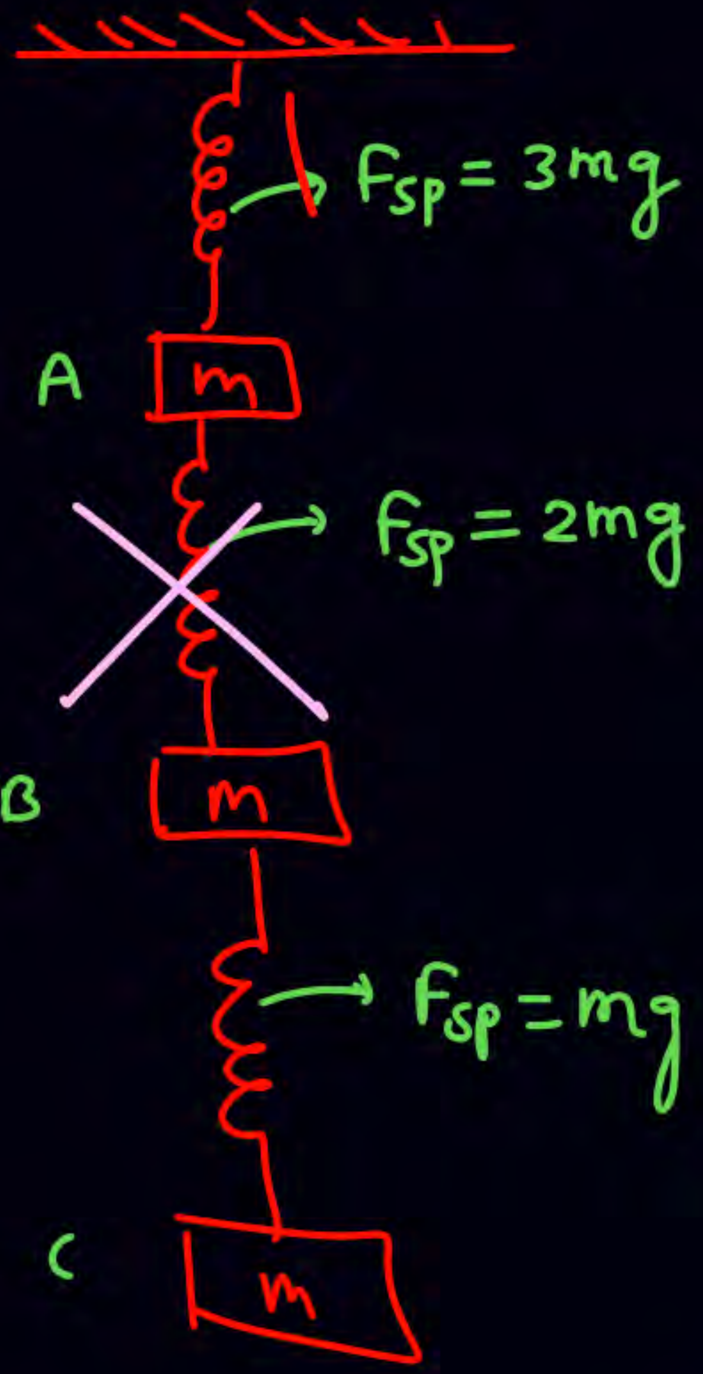


If at $t=0$, Lower string is cut find acc. of both the block.

$t = 0^+$

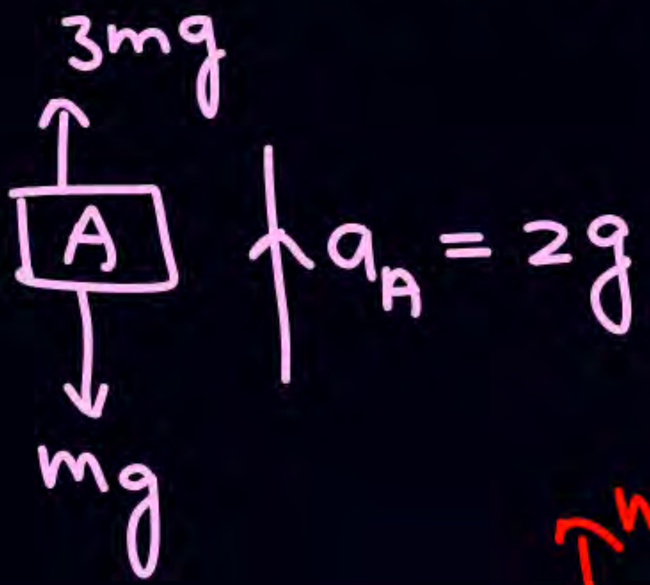
$a_B = g \downarrow$

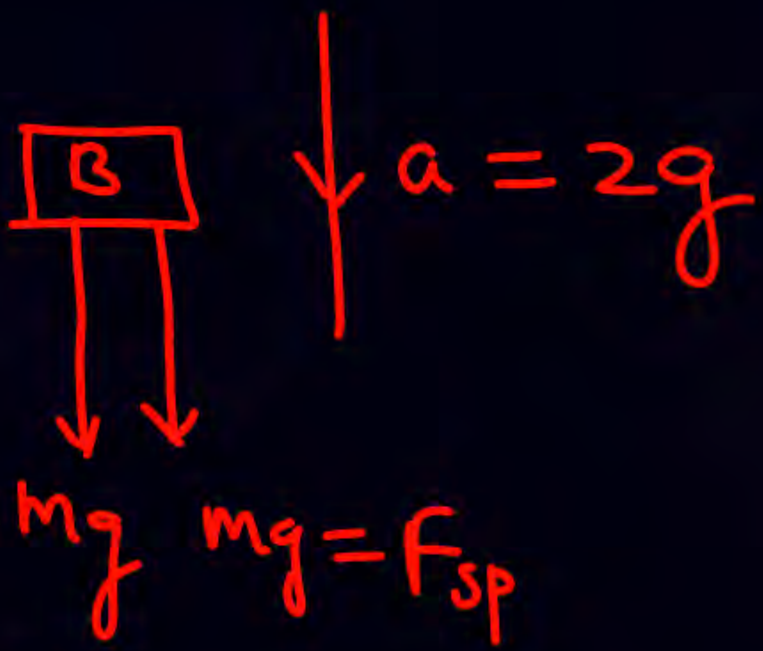
$a_A = 2g \uparrow$

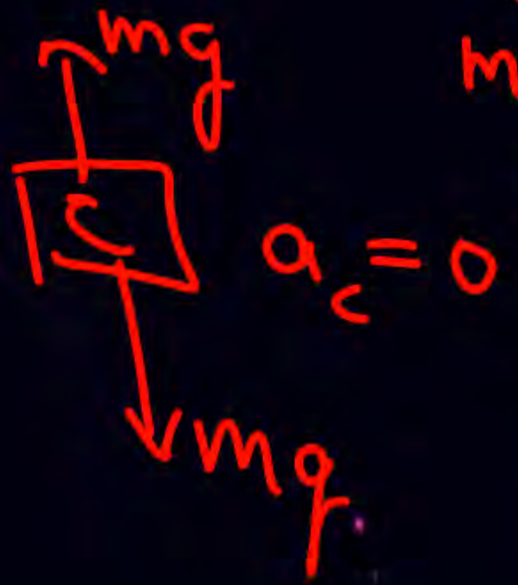
Q 

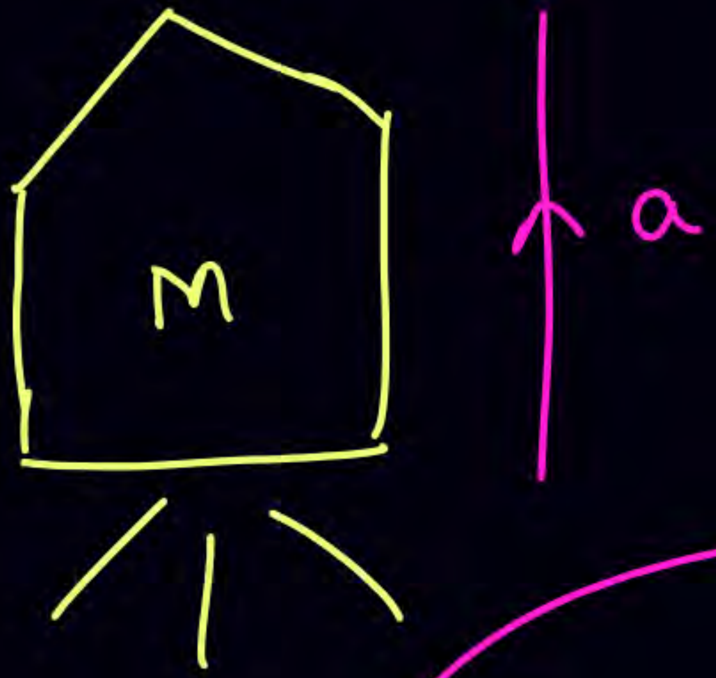
find acc of A, B, C just after cutting of spring if at $t=0$ middle spring is cut.

Sol: $t = 0^+$,









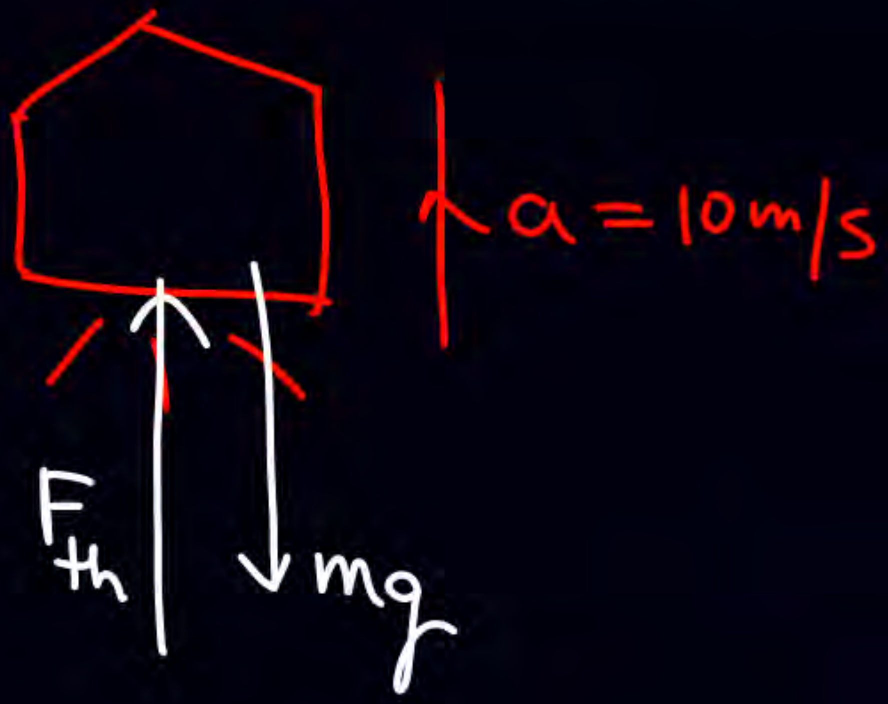
$$F_{thrust} - Mg = Ma$$

$$F_{thrust} = v_{rel}\frac{dm}{dt}$$

45. A rocket with a lift-off mass 3.5×10^4 kg is blasted upwards with an initial acceleration of 10 m/s^2. The initial thrust of the blast is-

(*a*) 14.0×10^5 N (*b*) 1.76×10^5 N

(*c*) 3.5×10^5 N (*d*) 7.0×10^5 N



$$F_{th} - mg = ma$$

$$F_{th} = m(g+a)$$

$$= 3.5 \times 10^4 \times 20$$

$$= 7 \times 10^5$$

46. Fuel is consumed at the rate of 100 kg/sec in a rocket. The

exhaust gases are ejected at a speed of 4.5×10^4 m/s. What is the thrust experienced by the rocket?

(a) 3×10^6 N
(b) 4.5×10^6 N
(c) 6×10^6 N
(d) 9×10^6 N

$$F_{thrust} = v_{rel} \frac{dm}{dt}$$

$$\frac{dm}{dt} = 100 \text{ kg/sec}$$

$$= 4.5 \times 10^4 \times 100$$

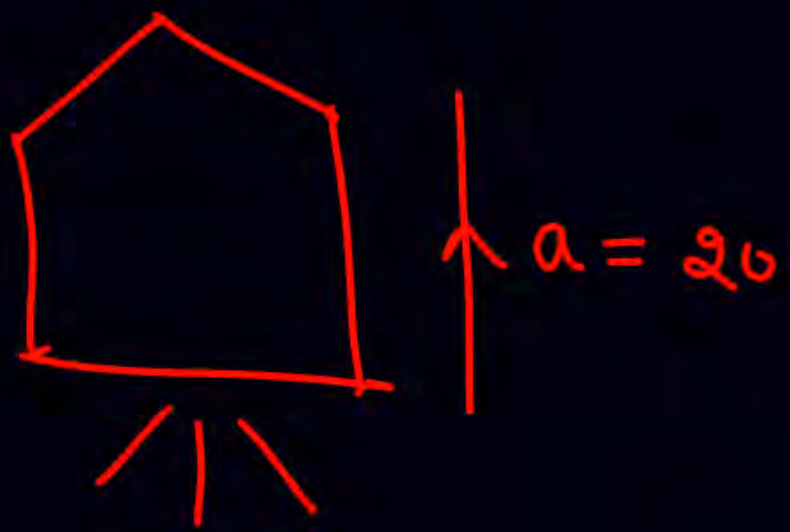
$$= \underline{4.5 \times 10^6}$$

47. A 6000 kg rocket is set for vertical firing. The exhaust speed is 1000 m/sec. How much gas must be ejected each second to supply the thrust needed to give the rocket an initial upward acceleration of 20 m/sec^2? (Consider $g = 9.8$ m sec^{-2} acceleration due to gravity)

(*a*) 92.4 kg/sec (*b*) 178.8 kg/sec

(*c*) 143.2 kg/sec (*d*) 47.2 kg/sec

(Arjuna JEE Physics M-2)



$$F_{th} - mg = ma$$

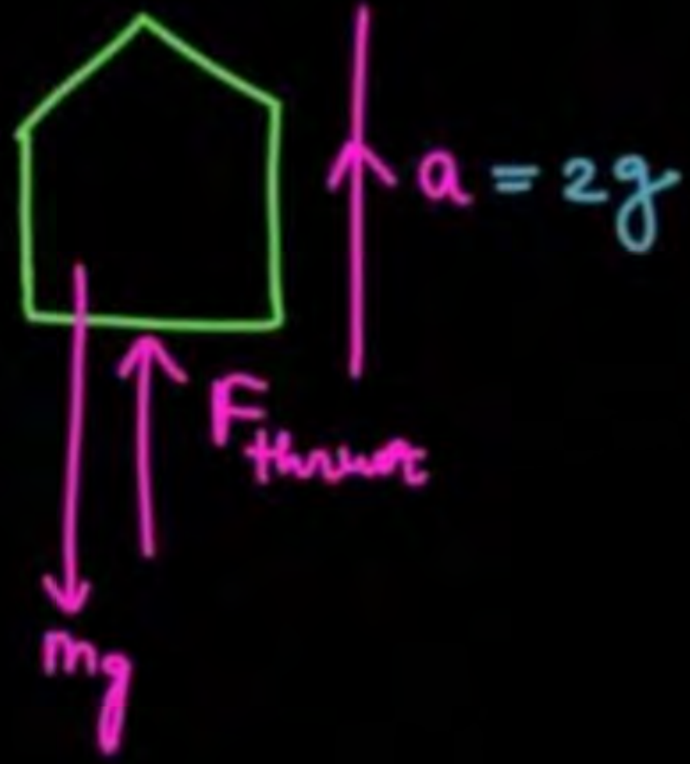
$$1000\frac{dm}{dt} - 6000 \times 9.8 = 6000 \times 20$$

$$\frac{dm}{dt} = 6 \times 29.8 = 1788$$

Q

gases are ejecting at the rate of 1 kg/sec
Find V_{rel} for gas to have an upward acceleration of 2g. (uplift)

Sol^n



$$F_{thrust} - mg = ma$$

$$v_{rel}\frac{dm}{dt} - mg = m(2g)$$

$$v_{rel} \cdot 1 = 3mg$$

$$v_{rel} = 3 \times 100 \times 10$$

$$= 30$$


@SALEEMSIR_PW

THANK YOU