ARJUNA NEET BATCH

$\vec{v} = \text{const}^n$ $a = 0$ $F = 0$

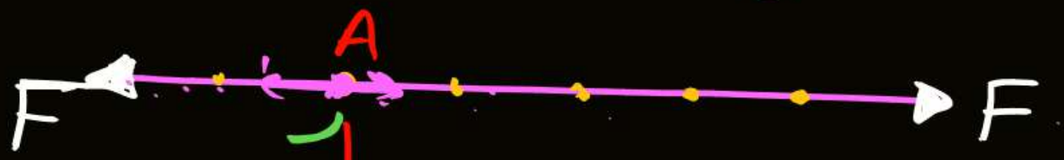
LAWS OF MOTION

LECTURE - 03

ToDays Goal

- questions on equilibrium ($F_{net} = 0$)
  - rest
  - $\vec{v}$ = const
- Momentum
- Newtons 2nd Law of Motion
- question 2nd Law

Ideal string ($m=0$)



→ Tension at A ??

~~(a)~~ zero (wrong)

~~(b)~~ F

~~(c)~~ 2F

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

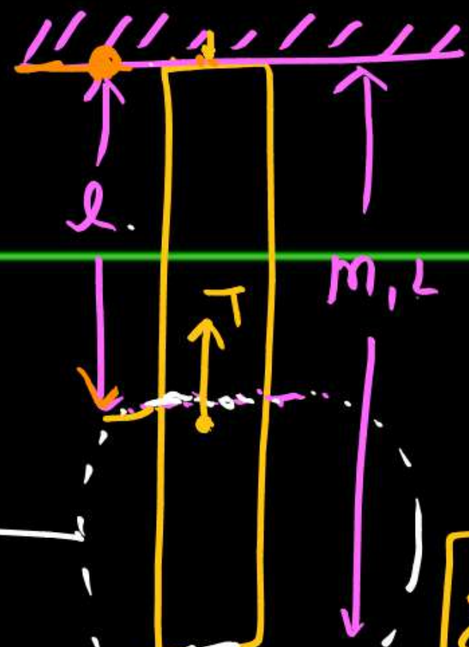
(a) $Mg\frac{L}{L+l}$ (b) $\frac{Mg}{L}(L-l)$

(c) Mg (d) $\frac{l}{L}Mg$

mR^2 $T = F = MLT^{-2}$

mR^2 if $l = 0$ $(T = mg)$

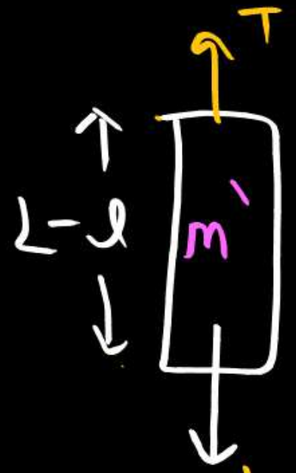
mR^2 if $l = L$ $(T = 0)$



$L \longrightarrow M$

Unit length $= \left(\frac{M}{L}\right)$ of mass

$(L-l)$ length $= \frac{M}{L}(L-l)$ of Mass



F.B.D

$m'g = \frac{M}{L}(L-l)g$

$\Sigma F_y = 0$

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

ARJUNA

Ans → Pain is maximum at 'E'

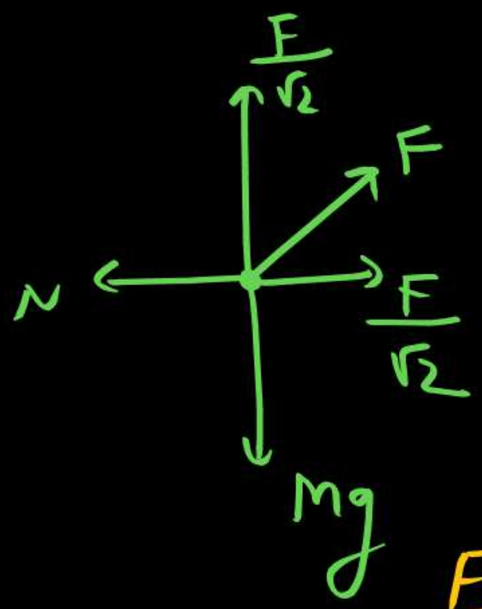
Block A of mass 4 kg is to be kept at rest against a smooth vertical wall by applying a force F as shown in figure. The force required is ($g = 10\ m/s^2$)

(a) $40\sqrt{2}$ N

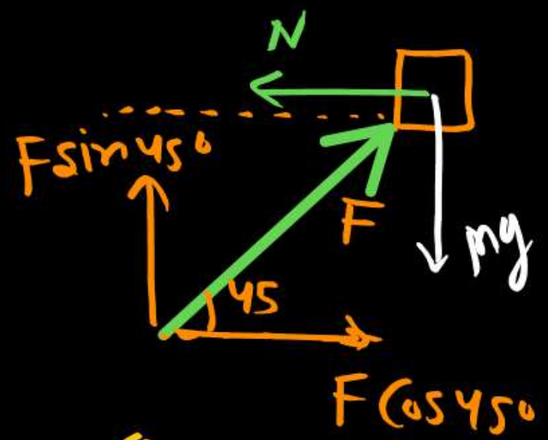
(b) $20\sqrt{2}$ N

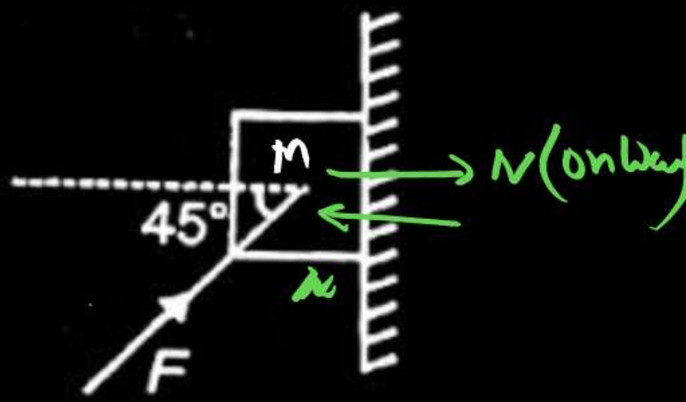
(c) $10\sqrt{2}$ N

(d) $15\sqrt{2}$ N



F.B.D of block



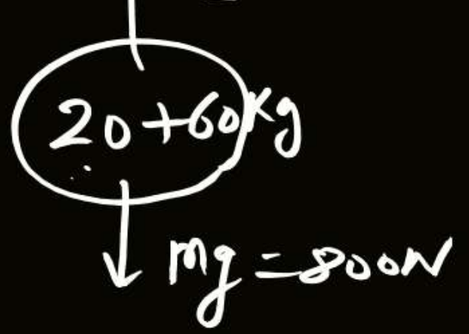


$$\frac{F}{\sqrt{2}} = mg$$

$$F = \sqrt{2}\,mg = \sqrt{2} \times 4 \times 10 = 40\sqrt{2}\ N$$

ARJUNA

MR*



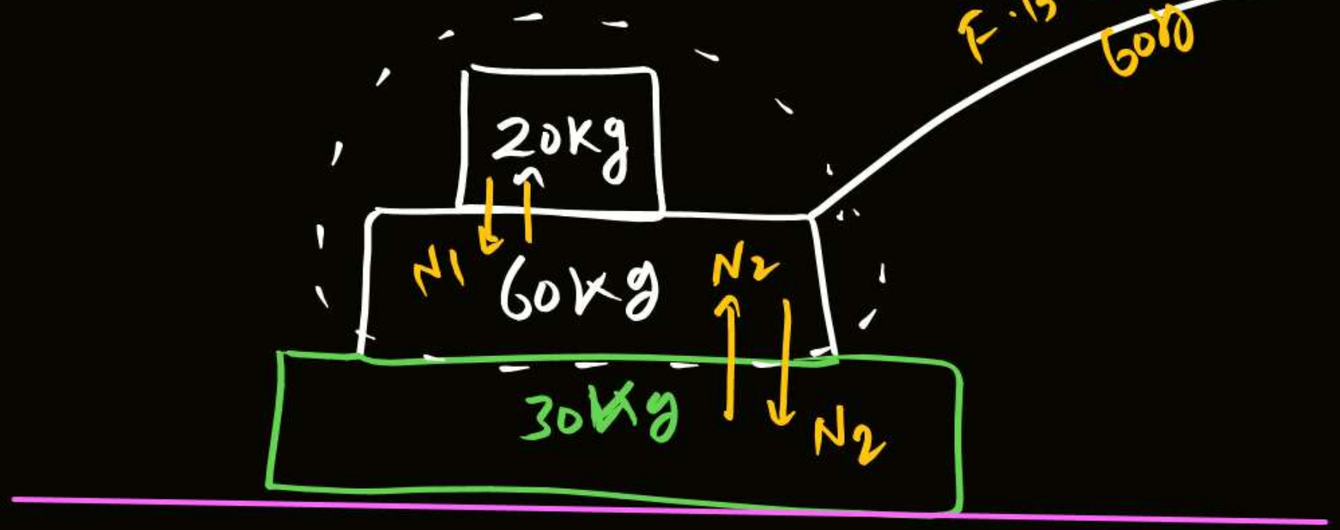
मजदूरी

F.B.D of 

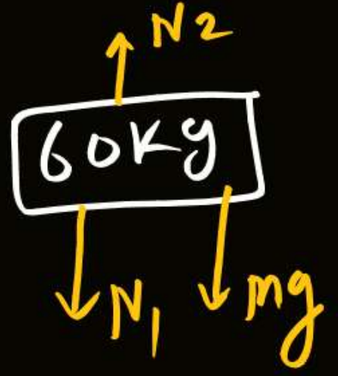
mg = 200

N_1 = 200N

Find force on 60kg due to 30 kg



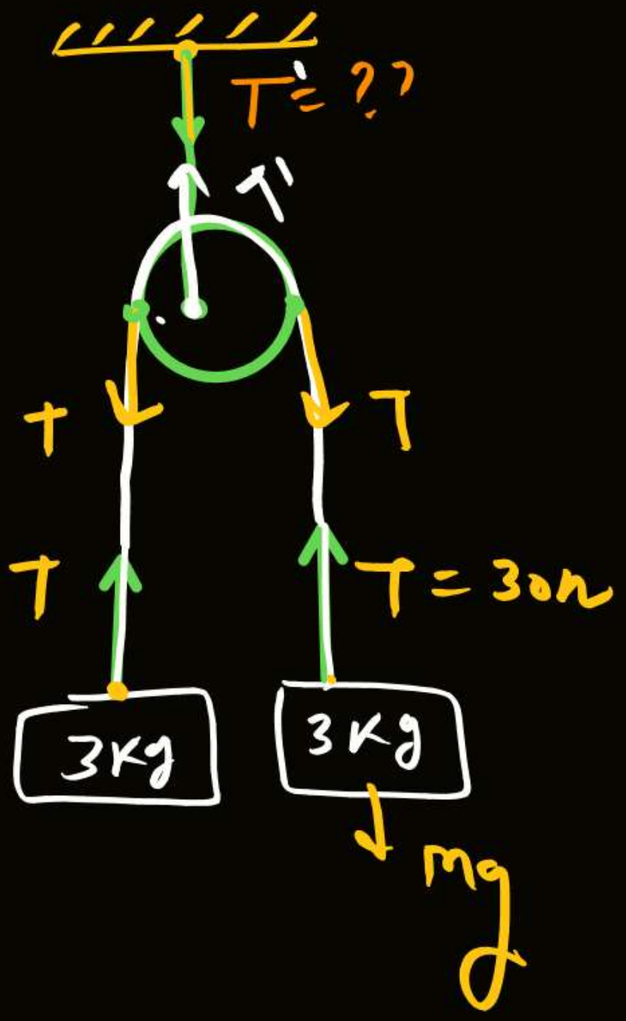
F.B.D of 60kg



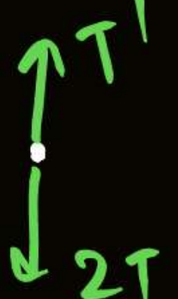
$N_2 = N_1 + mg$

$= 200N + 600N$

$N_2 = 800N$



F.B.D Pulley



$\Sigma F_y = 0$

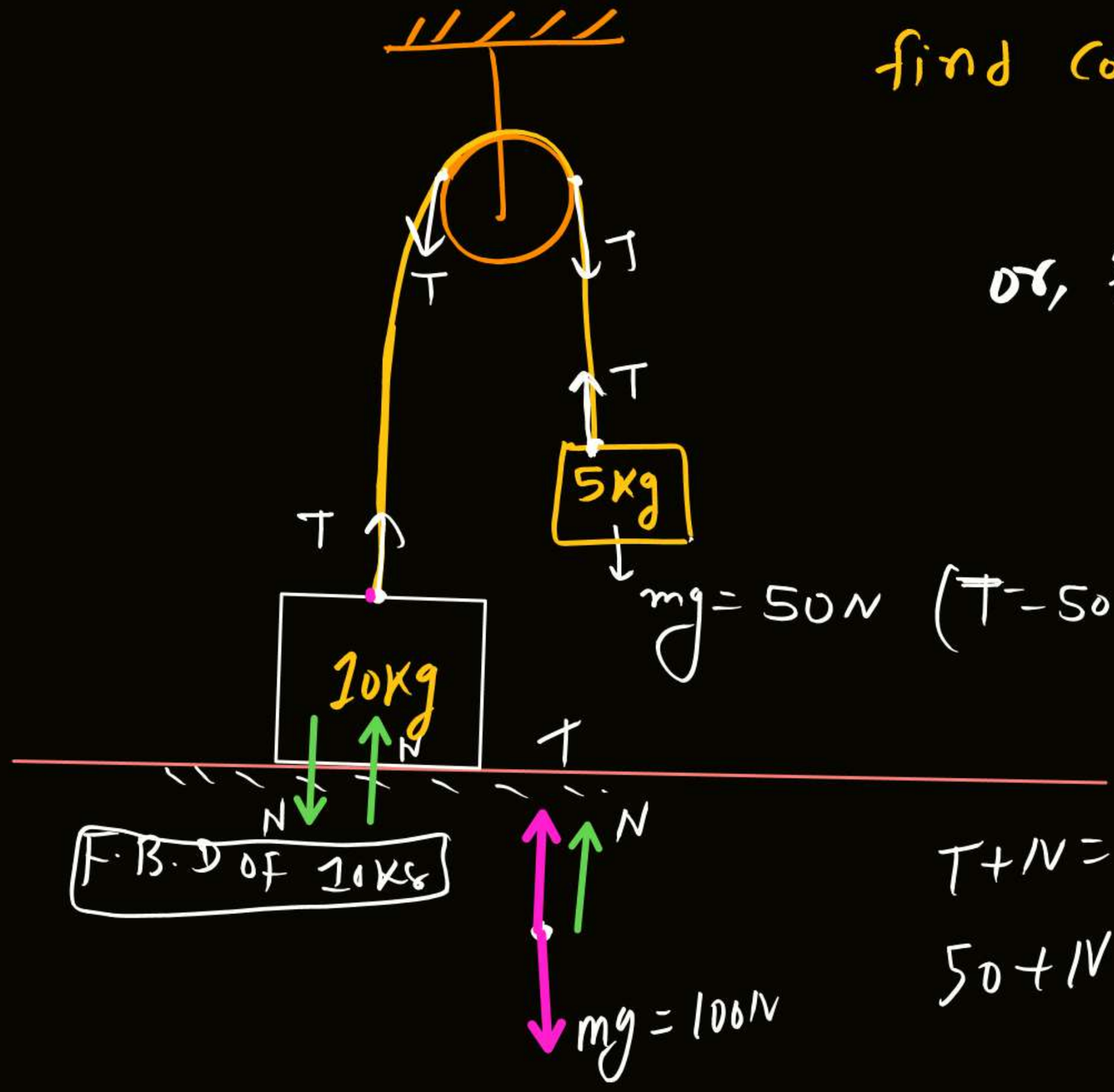
$T' = 2T$

$= 2 \times 30$

$= 60\,N$

find Contact force b/w 10kg and Ground

or, find force applied by Ground 10kg ??



mg = 50N (T = 50 Newton)

T + N = 100

50 + N = 100

N = (100 - 50) Newton

In the following figure, the object of mass m is held at rest by a horizontal force as shown. The force exerted by the string on the block is

(a) F

(b) mg

(c) $F + mg$

(d) $\sqrt{F^2 + m^2 g^2}$

$\Sigma F_y = 0$ (rest)

$T\sin\theta = mg$ — (i)

$T\cos\theta = F$ — (ii)

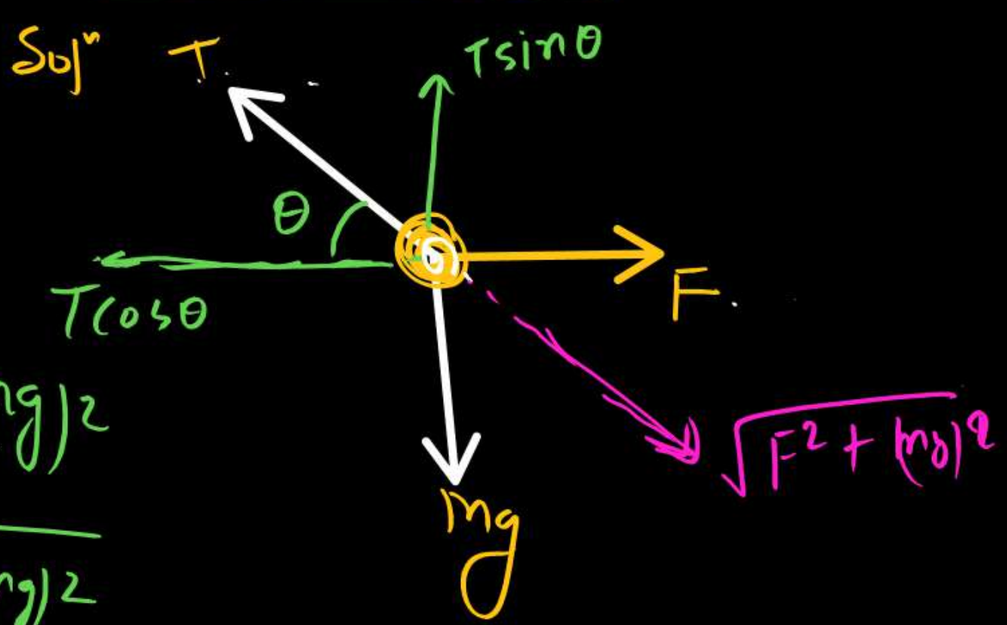
(i)^2 + (ii)

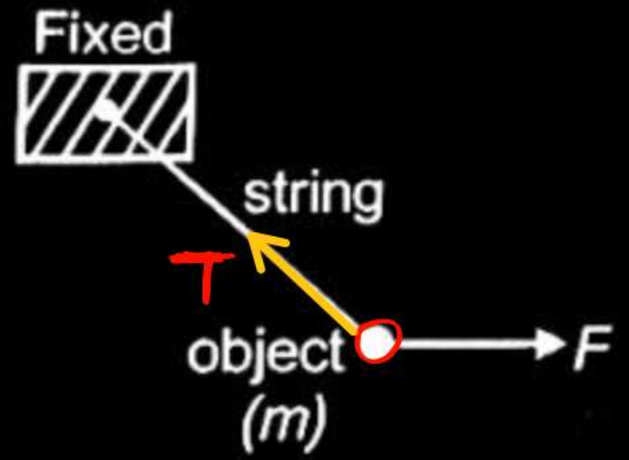
$T^2(\sin^2\theta + \cos^2\theta) = F^2 + (mg)^2$

$T = \sqrt{F^2 + (mg)^2}$

F.B.D of object

Sol^n





ARJUNA

A block of weight W is supported by three strings as shown in figure. Which of the following relations 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)

(a) $T_1 = T_2$ (b) $T_1 = T_3$

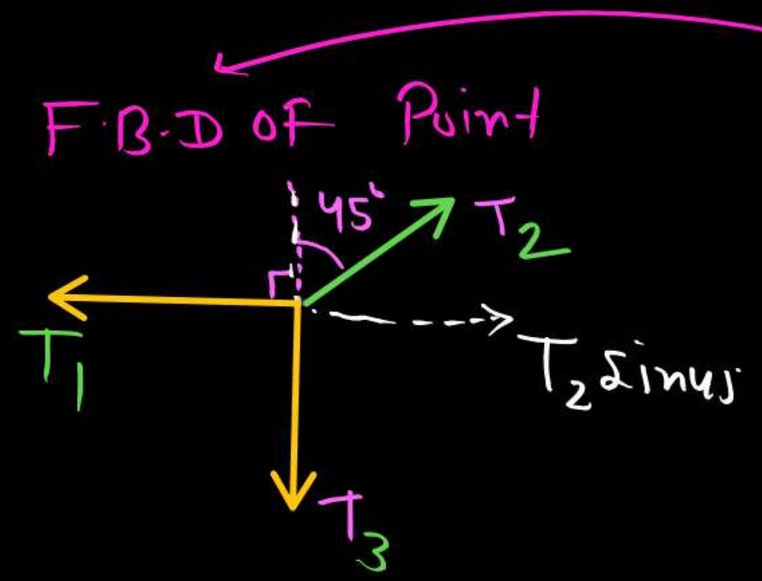
(c) $T_2 = T_3$ (d) $T_1 = T_2 = T_3$

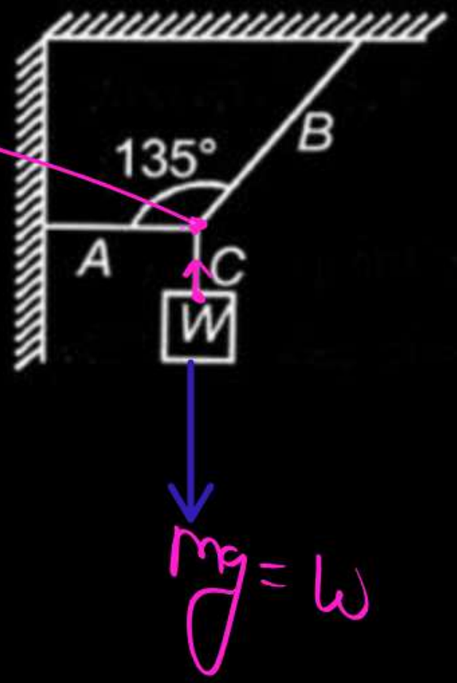
$\Sigma F_x = 0$

$T_1 = T_2 \sin 45^\circ$

$\Sigma F_y = 0$

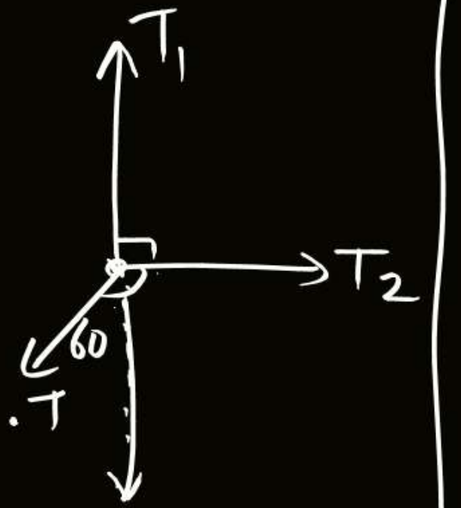
$T_3 = T_2 \cos 45^\circ$





find T_1 & T_2 #

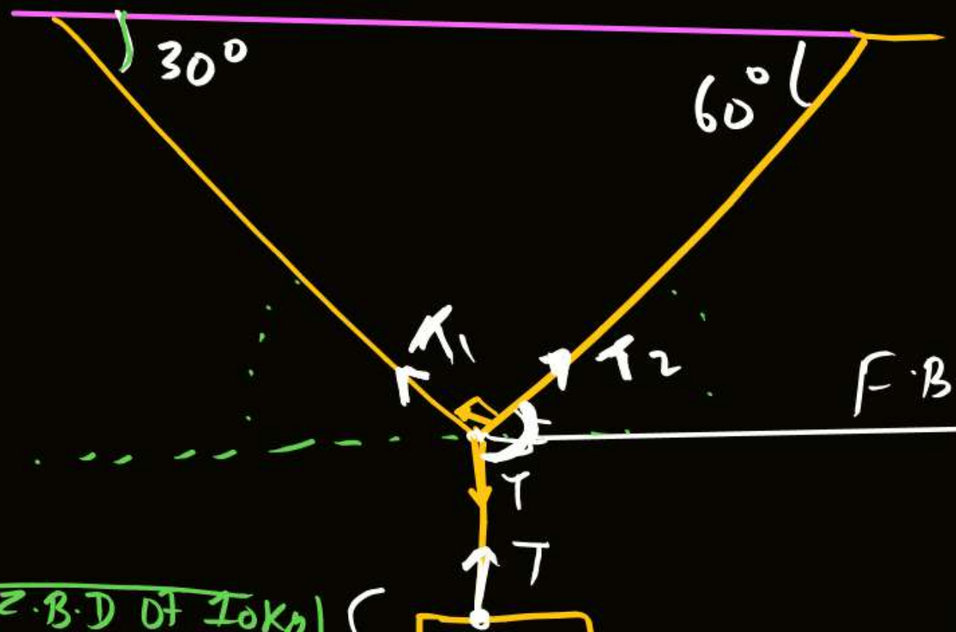
MR*



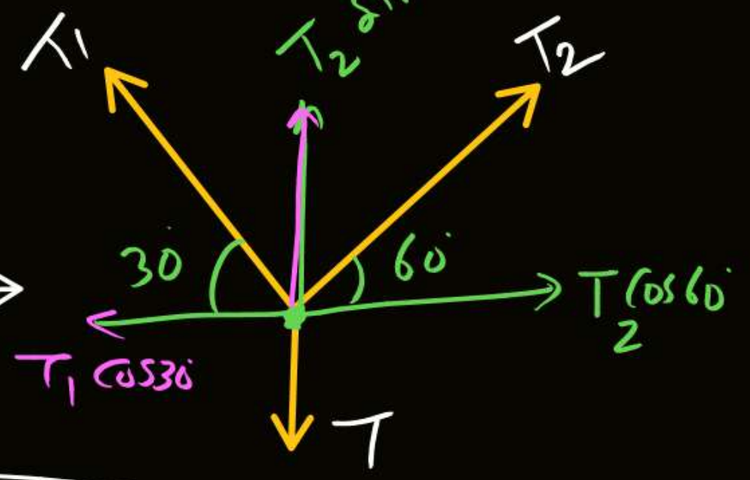
$T_1 = T\cos 60°$

$= 100 \times \frac{1}{2}$

$= 50$ No.



F.B.D of Point



F.B.D of 10Kg

$T = mg$

$T = 100N$

$mg = 10 \times 10 = 100N$

$\Sigma F_x = 0$

$T_2 \cos 60° = T_1 \cos 30°$

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

$T_2 = \sqrt{3} T_1$

$\Sigma F_y = 0$

$T_1 \sin 30° + T_2 \sin 60° = T$

$T_1 \frac{1}{2} + \sqrt{3} T_1 \frac{\sqrt{3}}{2} = 100$

$T_1 \left(\frac{1+3}{2} \right) = 100$

$T_1 = 50N$

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

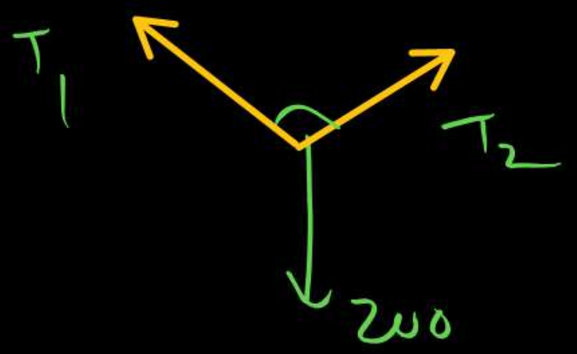
(a) 50 N

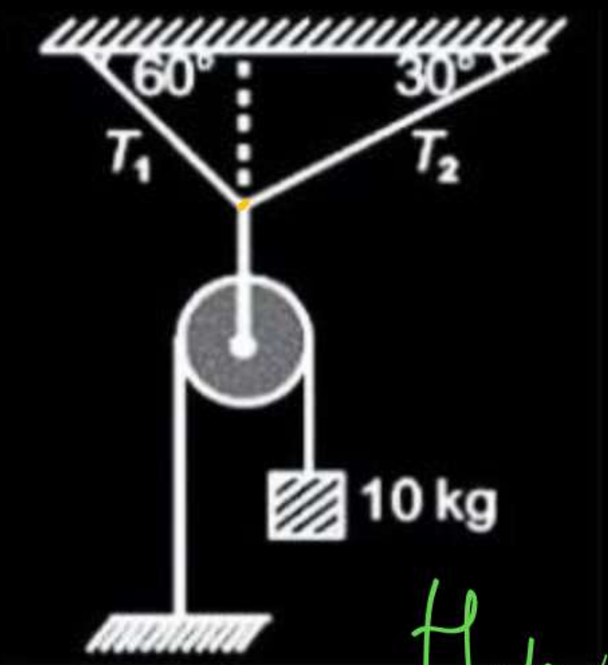
(b) 100 N

(c) $50\sqrt{3}$ N

(d) $100\sqrt{3}$ N

MR*





H.W

ARJUNA

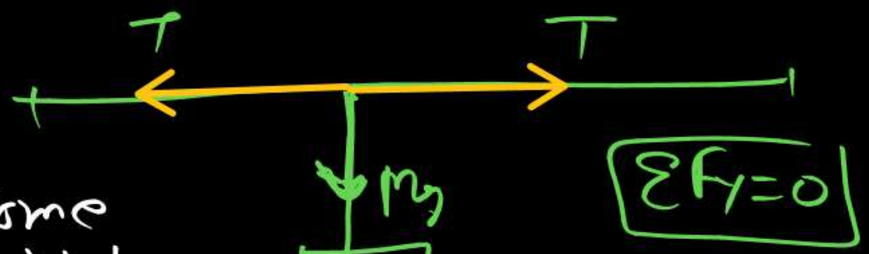
A weight Mg is suspended from the middle of a rope whose ends are at the same level. The rope is no longer horizontal. The minimum tension required to completely straighten the rope is

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

(b) $Mg\cos\theta$

(c) $2Mg\cos\theta$

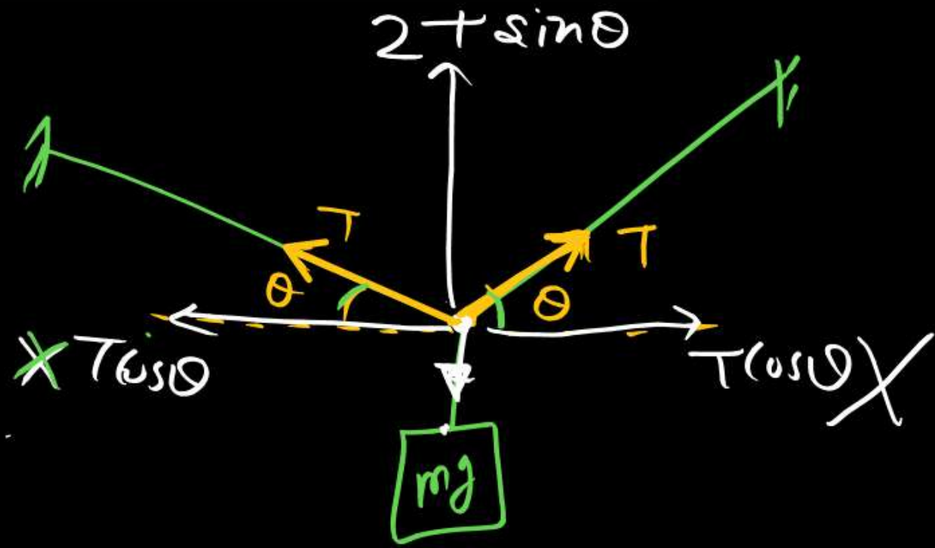
(d) Infinitely large (not Possible)



$\Sigma F_y = 0$

* Rope become Straight when $\theta = 0°$

$$T = \frac{mg}{2\times\sin 0°} = \frac{1}{0} = \infty$$



$2T\sin\theta = mg$

$$T = \left[\frac{mg}{2\sin\theta}\right]$$

ARJUNA

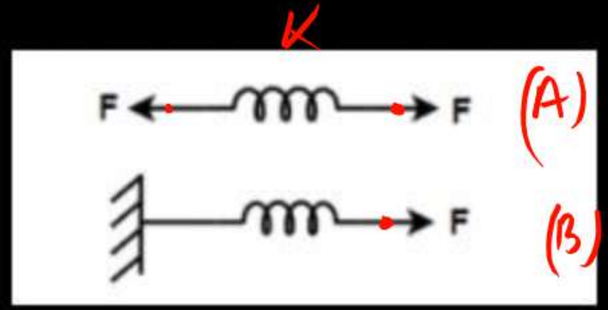
Figure shows two cases. In first case a spring (spring constant K) is pulled by two equal and opposite force F at both ends and in second case is pulled by a force F at one end. Extensions (x) in the spring will be

(a) In both cases $x = \frac{2F}{K}$

(b) In both cases $x = \frac{F}{K}$

(c) In first case $x = \frac{2F}{K}$, in second case $x = \frac{F}{K}$

(d) In first case $x = \frac{F}{K}$, in second case $x = \frac{2F}{K}$



Case-1

Ideal spring

F → x (elongation) = 0

Case-2

F ← → F

Tension = F at each point

$F = Kx$

$x = F/K$

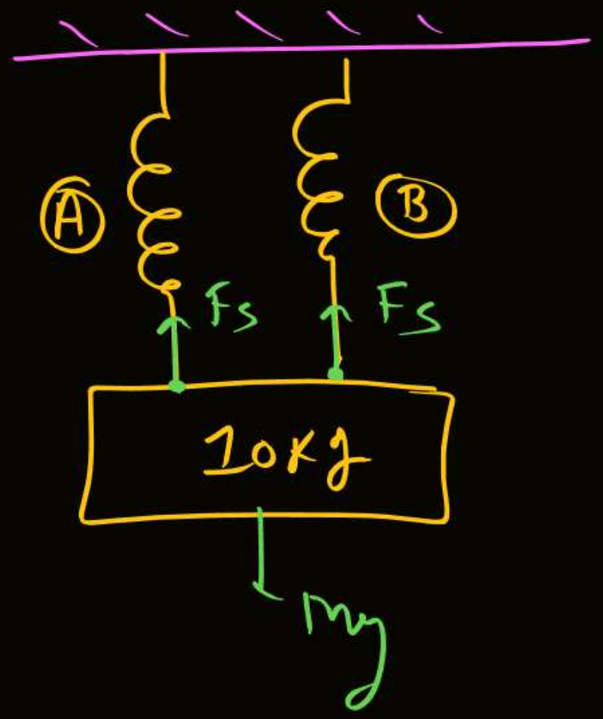
Case-3

F | → F

$x = \frac{F}{K}$

ARJUNA

find value of spring force in 'A' & 'B'; if A & B are the ideal spring.



$$2F_s = mg$$

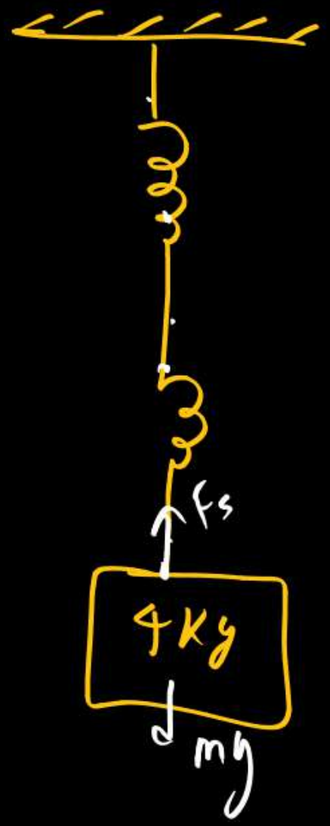
$$F_s = \frac{mg}{2} = \boxed{50N \text{ each}}$$

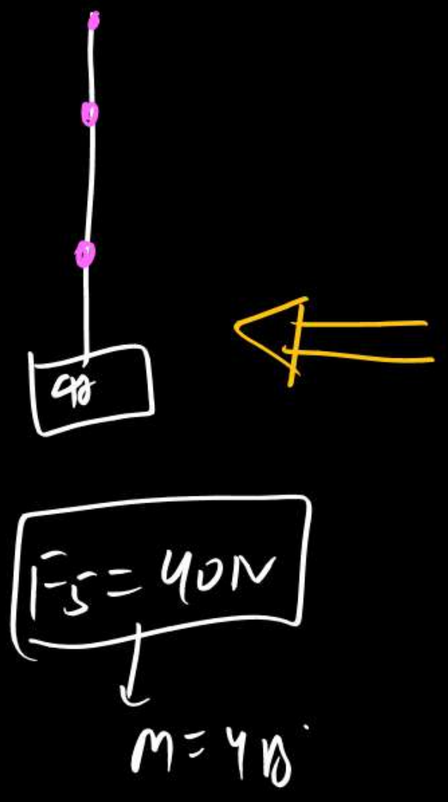
A block of mass 4 kg is suspended through two light spring balances A and B. Then A and B will read respectively :

(a) 4 kg and zero kg
(b) zero kg and 4 kg
(c) 4 kg and 4 kg
(d) 2 kg and 2 kg

जब भी spring का reading equilibrium में पूछे तो उसे string मानकर उस पे tension निकाल दो ॥

यही spring force





A body of mass 5 kg is suspended by a spring balance on an inclined plane as shown in figure. The spring balance measure :

(a) 50 N

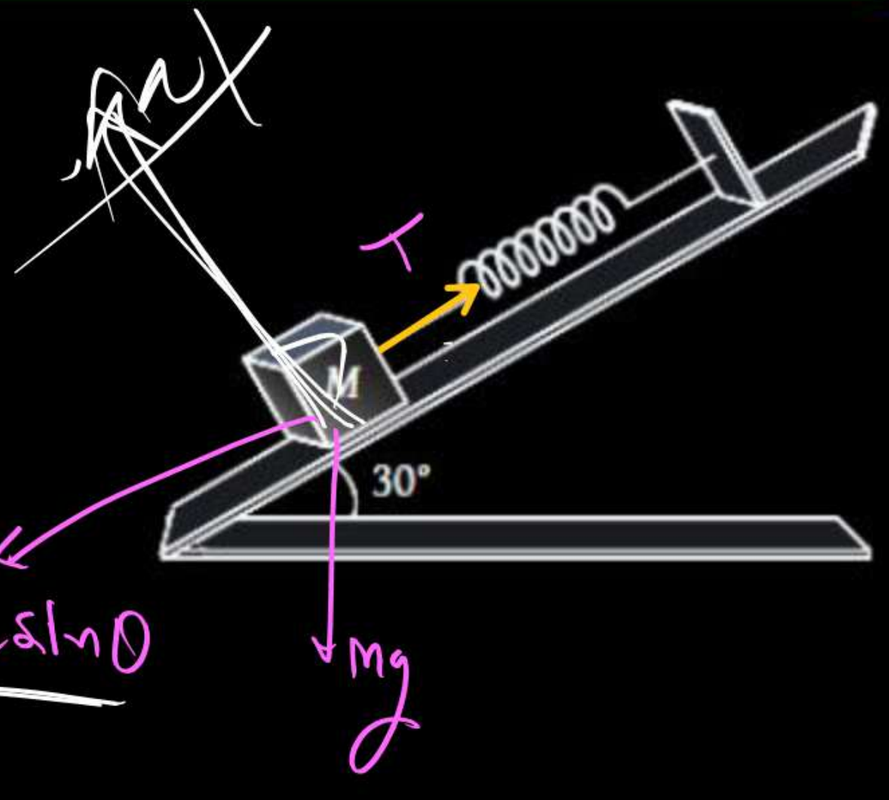
(b) 25 N

(c) 500 N

(d) 10 N

$T = mg\sin\theta$

$= 5 \times 10 \times \sin 30$



As shown in figure, two equal masses each of 2 kg are suspended from a spring balance. The reading of the spring balance will be:

(a) zero

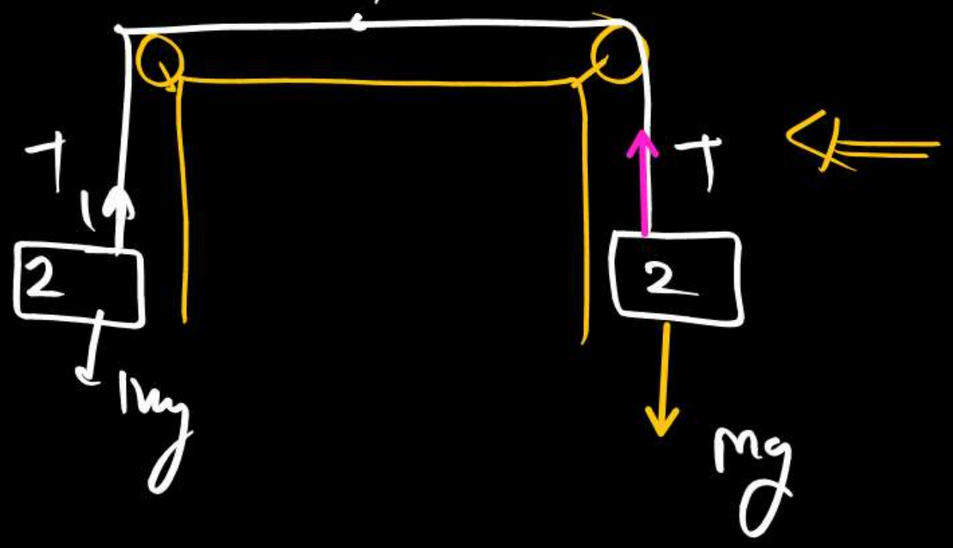
(b) 2 kg

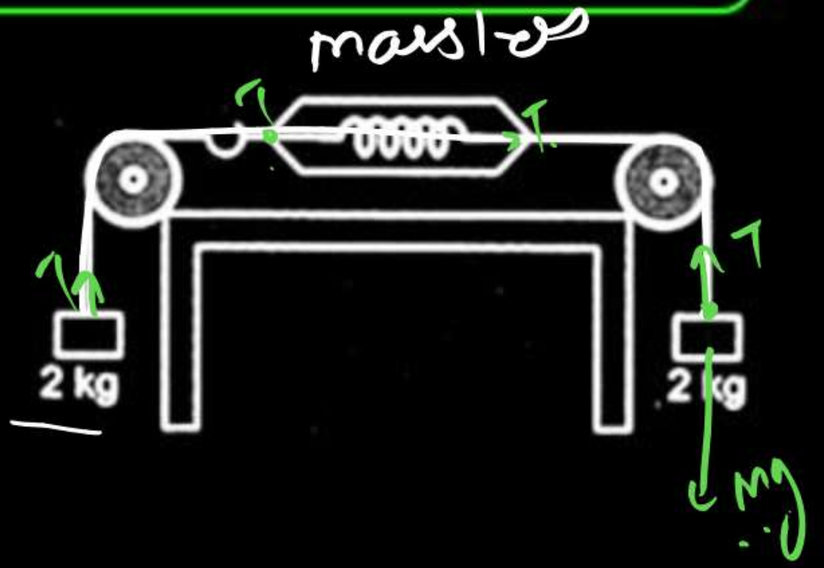
(c) 4 kg

(d) Between zero and 2 kg

Soln

$T = mg = 2 \times 10 = 20\ N$





ARJUNA

Momentum

→ Motion Contained in a body is called Momentum.

$\vec{P} = m\vec{V}$

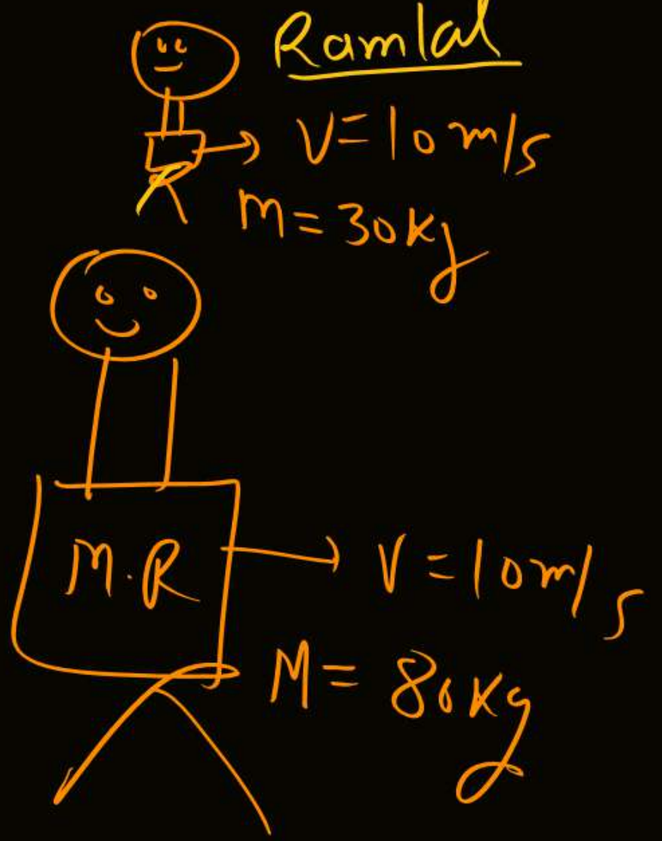
$= kg\ m/sec$

= vector

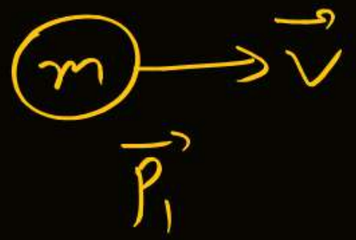
$\vec{P}$ = mass (velocity)

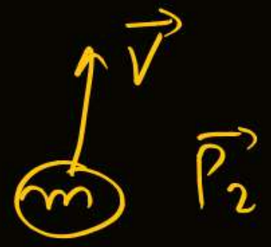
⇒ direction of momentum along velocity.

$\vec{P} = \vec{V}$



Q Correct statemen is ??

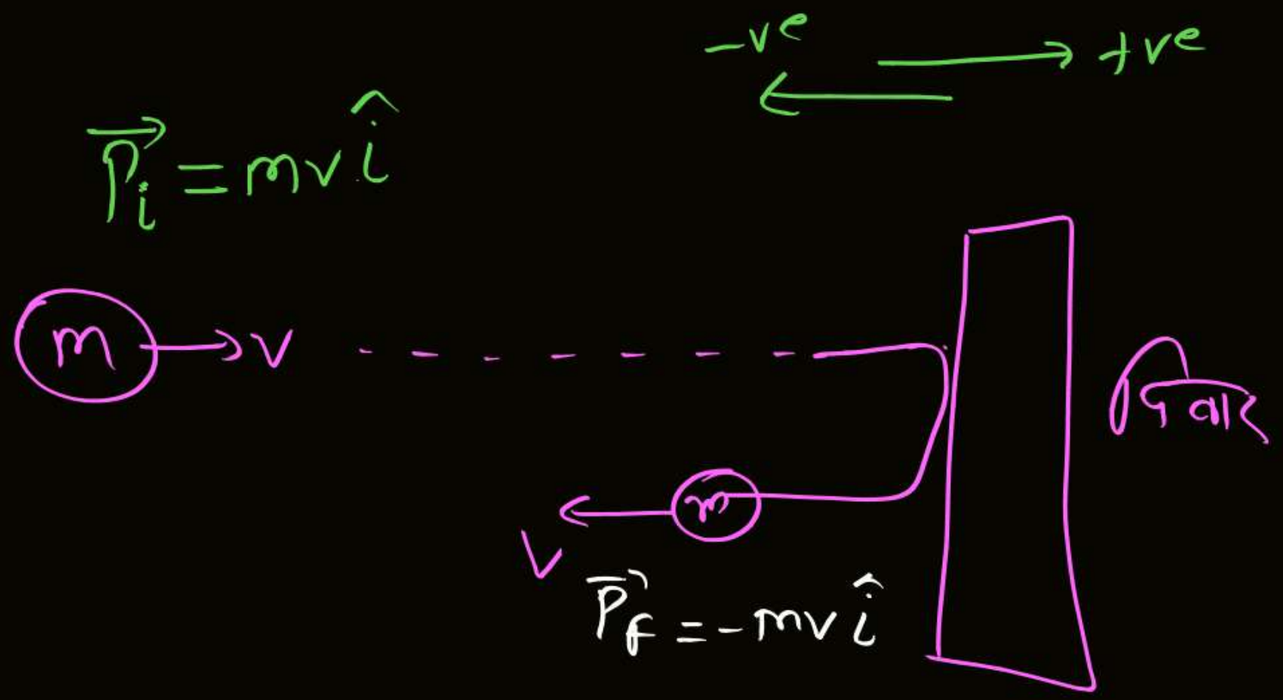




(i) $\vec{P_1} = \vec{P_2}$

(ii) $|\vec{P_1}| = |\vec{P_2}|$

(iii) both (i) & (ii) is correct



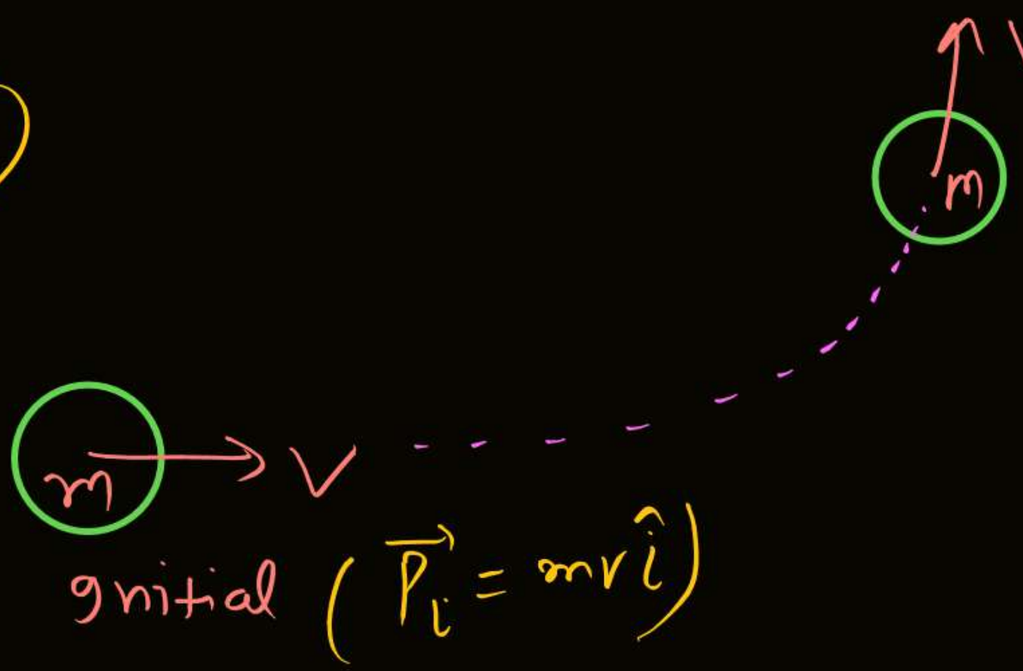
ⓐ rebound with same speed then find magnitude of change in momentum.

Sol $\vec{\Delta P} = \vec{P_f} - \vec{P_i} = -mv\hat{i} - mv\hat{i} = -2mv\hat{i}$

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

Ans

(a)



Final $\left(\vec{P_f} = mv\hat{j}\right)$

Initial $\left(\vec{P_i} = mv\hat{i}\right)$

(a) Find change in Momentum

Soln

$$\vec{\Delta P} = \vec{P_f} - \vec{P_i}$$

$$\vec{\Delta P} = mv\hat{j} - mv\hat{i}$$

$$|\vec{\Delta P}| = \sqrt{(mv)^2 + (-mv)^2}$$

$$= \sqrt{2}\, mv \quad \underline{R}$$

$$\vec{P} = M_v = mV$$

Newton 2nd Law

$$\vec{F}_{Avg} = \frac{\Delta P}{\Delta t}$$

Momentum change

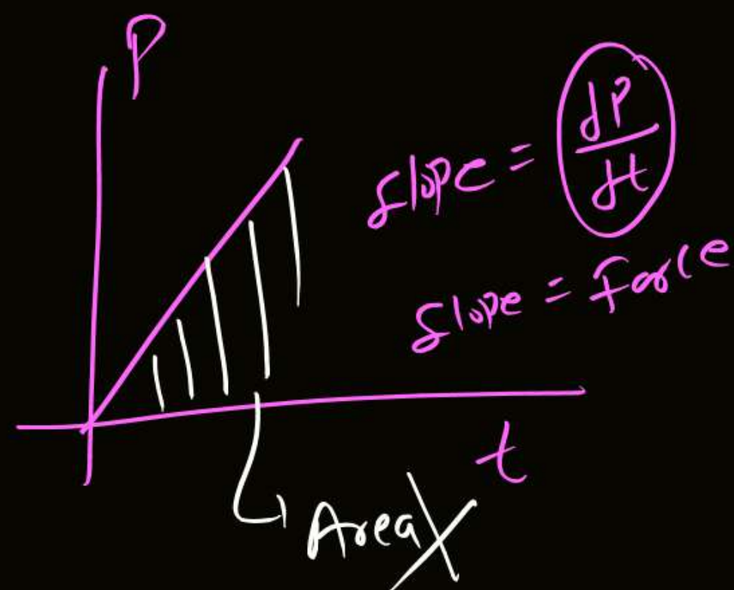
Force

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

Rate of change in momentum w.r.t. time is called force.

Force

$$\vec{F}_{Avg} = \frac{\Delta \vec{p}}{\Delta t} \qquad \vec{F}_{Inst} = \frac{d\vec{p}}{dt}$$



slope $\left(\frac{dP}{dt}\right)$ of Momentum time graph is called force

$$\int_{t_i}^{t_f} \vec{F}\,dt = \int_{P_i}^{P_f} dP$$

change in momentum = $\int \vec{F} \cdot d\vec{t}$

= Area of force - time graph = ΔP

A cricketer catches a ball of mass 150 g in 0.1 s moving with speed 20 m/s, then the experiences force of

(a) 300 N

(b) 30 N

(c) 3 N

(d) 0.3 N

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

H.W

A force of 6 N acts on a body at rest and of mass 1 kg. During this time, the body attains a velocity of 30 m/s. The time for which the force acts on the body is

(a) 7 second

(b) 5 second

(c) 10 second

(d) 8 second

ARJUNA

A body of mass 3 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is given by :

(a) Zero

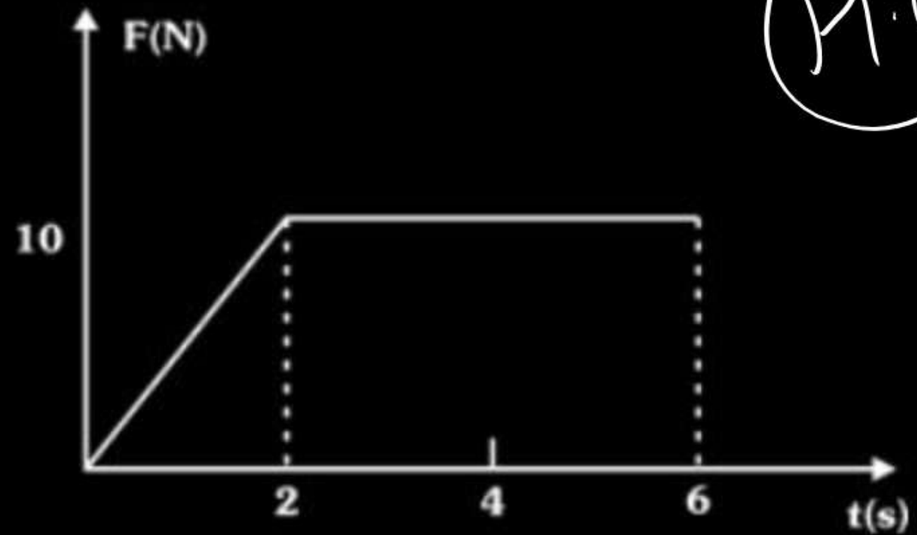
(b) 5 N-s

(c) 30 N-s

(d) 50 N-s

H.W

H.W



ARJUNA

THANK YOU ☺