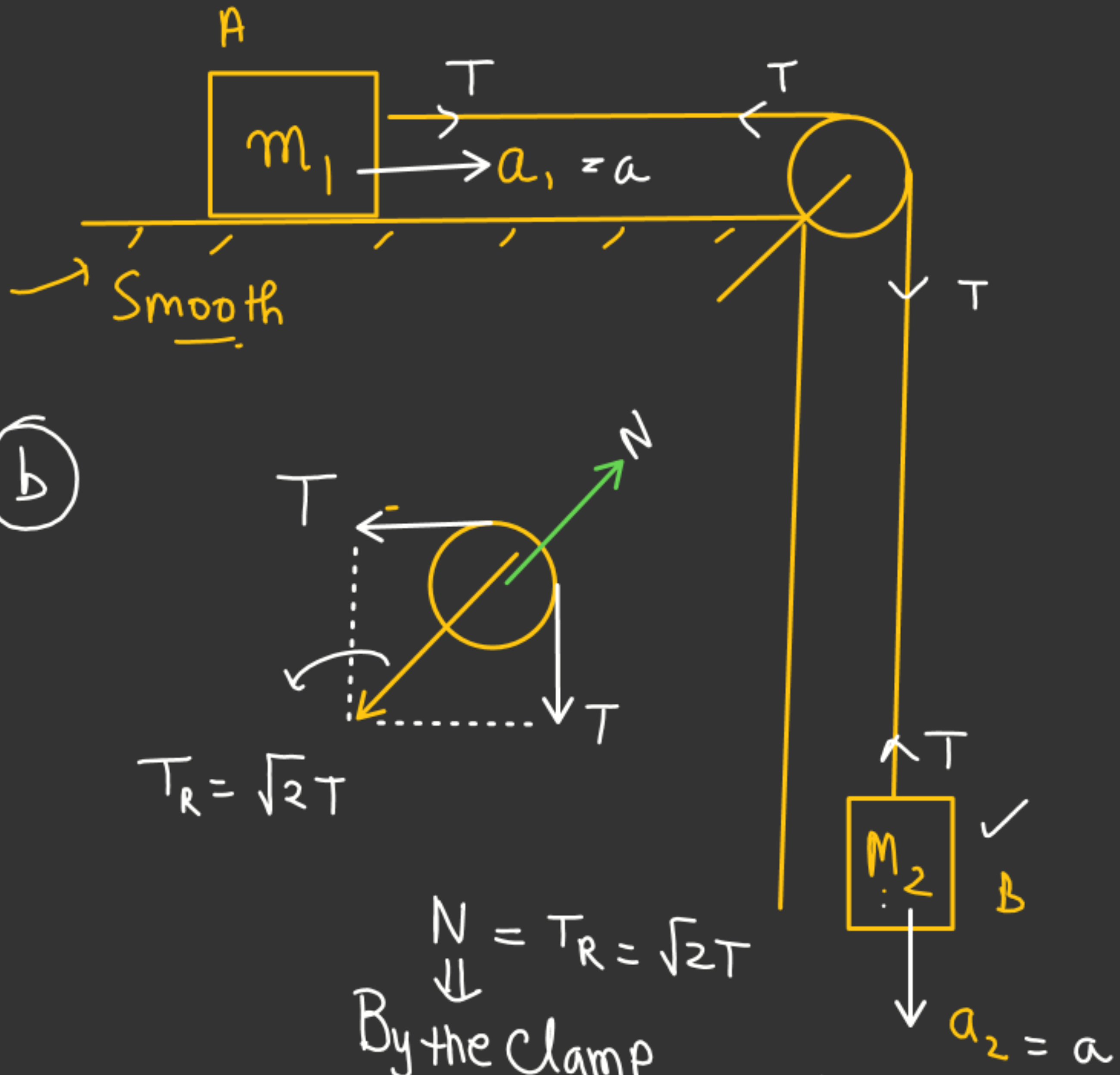
Nishant Jindal

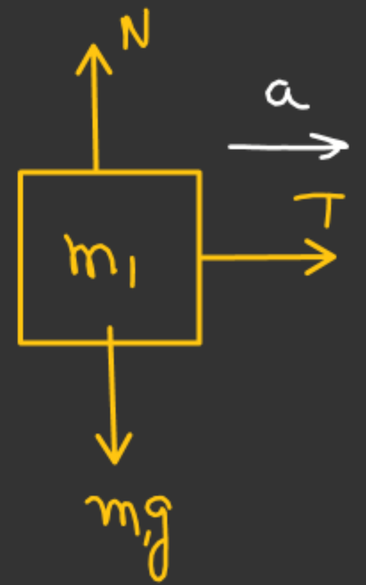
a) Find accleration of block A & B. ✓ b) Also find reaction force on the pully by the clamp.



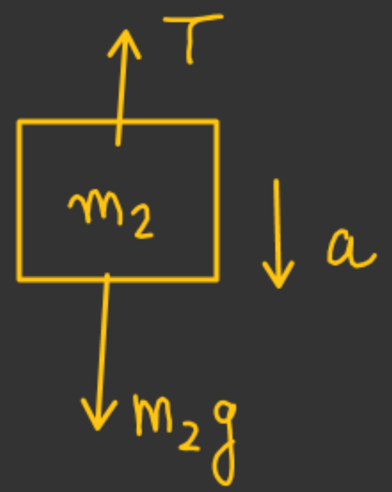
$$\sum \vec{T}\cdot\vec{a} = 0$$

$$-Ta_2 + Ta_1 = 0$$

$$\boxed{a_1 = a_2} \quad -①$$



$$T = m_1 a \quad -②$$



$$m_2 g - T = m_2 a \quad -③$$

$$m_2 g - m_1 a = m_2 a$$

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

ⓑ

$$T_R = \sqrt{2}T$$

$$N = T_R = \sqrt{2}T$$

By the clamp on the pully $N = \left(\frac{\sqrt{2}\, m_1 m_2 g}{m_1 + m_2}\right)$

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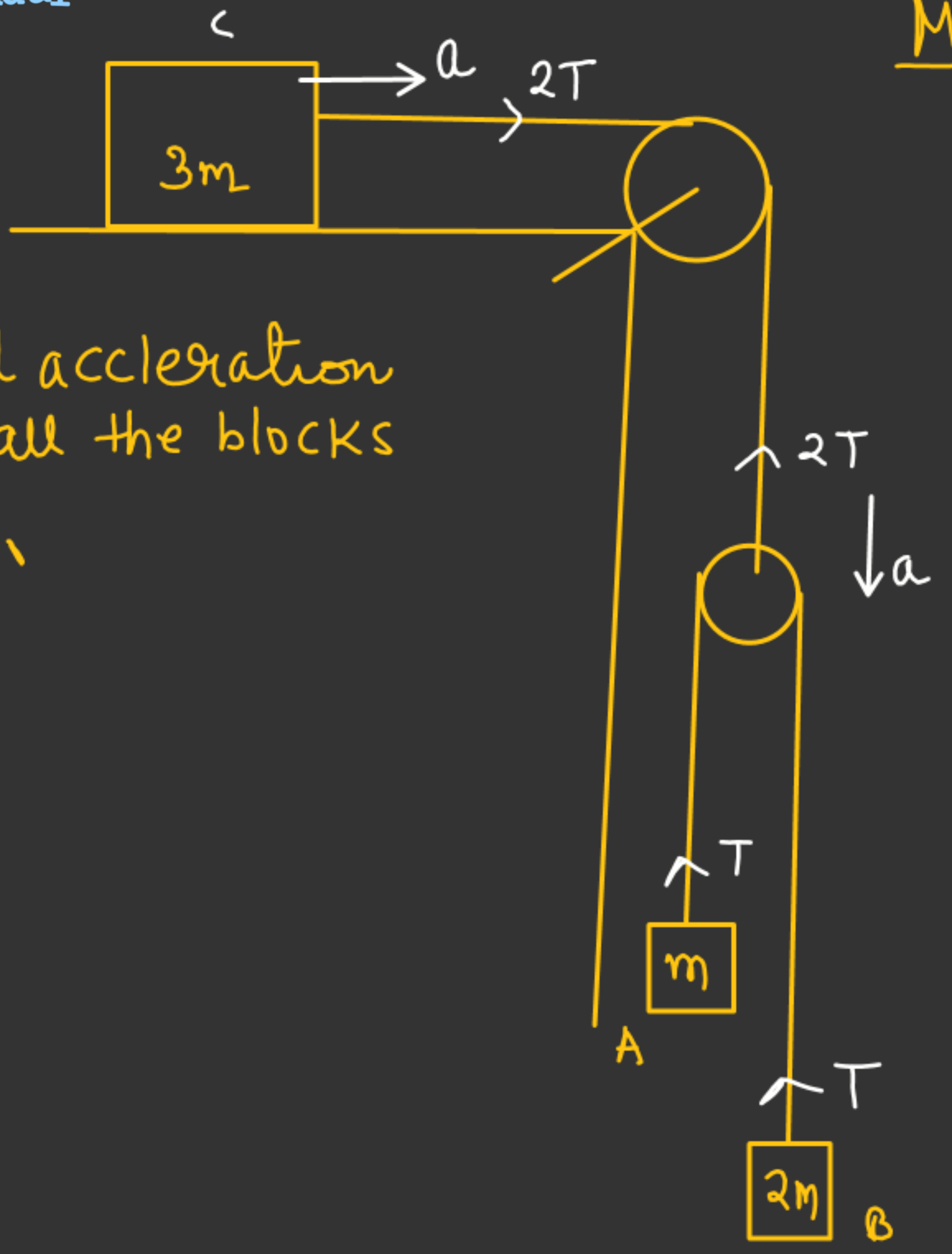


Find accleration of all the blocks

M-1 Normal Method

For block B

$$2mg - T - 2ma = 2ma_r$$

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

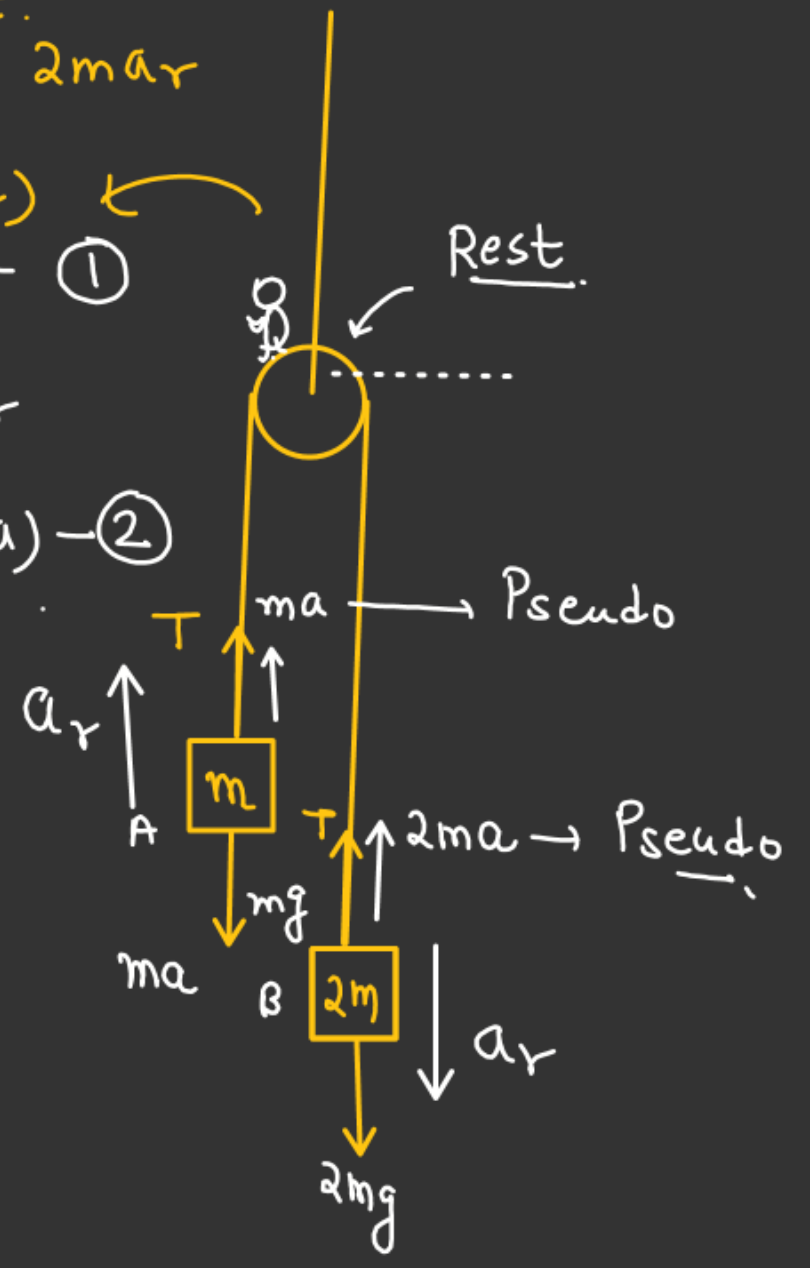
For block A — ①

$$T + ma - mg = ma_r$$

$$T - mg = m(a_r - a) \quad -②$$

For block C

$$2T = 3ma \quad -③$$



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☆☆ M-2

2^{nd} Approach.

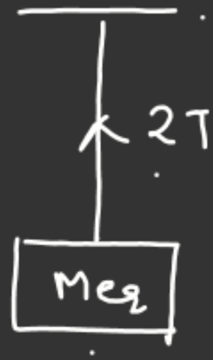
$$T = \left(\frac{m_1 m_2 g}{m_1 + m_2}\right)$$

$$2T = M_{eq} \cdot g$$

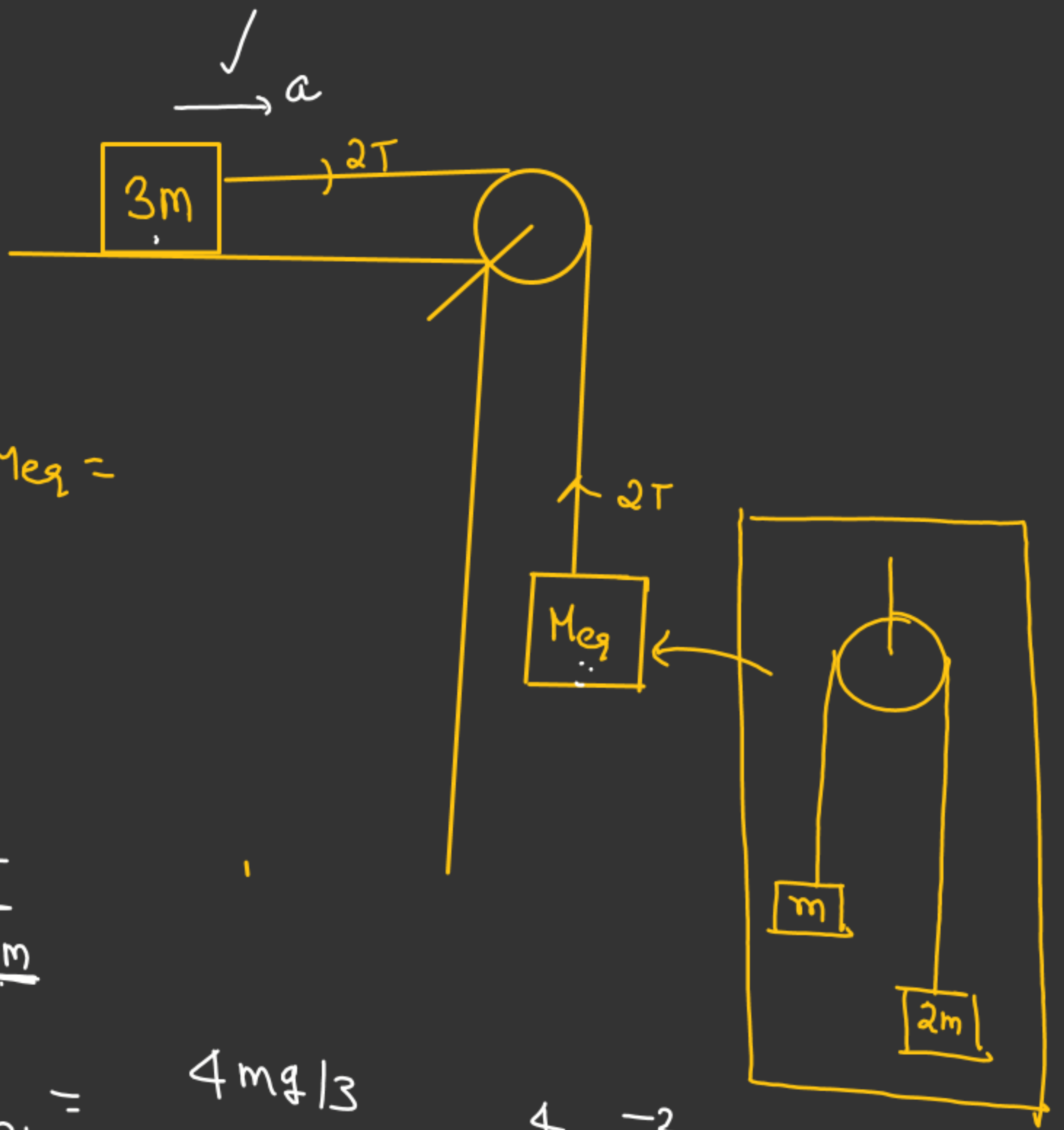
$$T = \left(\frac{M_{eq} \cdot g}{2}\right)$$

$$\frac{M_{eq}\, g}{2} = \frac{m_1 m_2 g}{m_1 + m_2}$$

$$M_{eq} = \left(\frac{2 m_1 m_2}{m_1 + m_2}\right) \checkmark$$



$M_{eq} =$



$$M_{eq} = \frac{2 \times m \times 2m}{3m}$$

$$= \left(\frac{4m}{3}\right) \checkmark$$

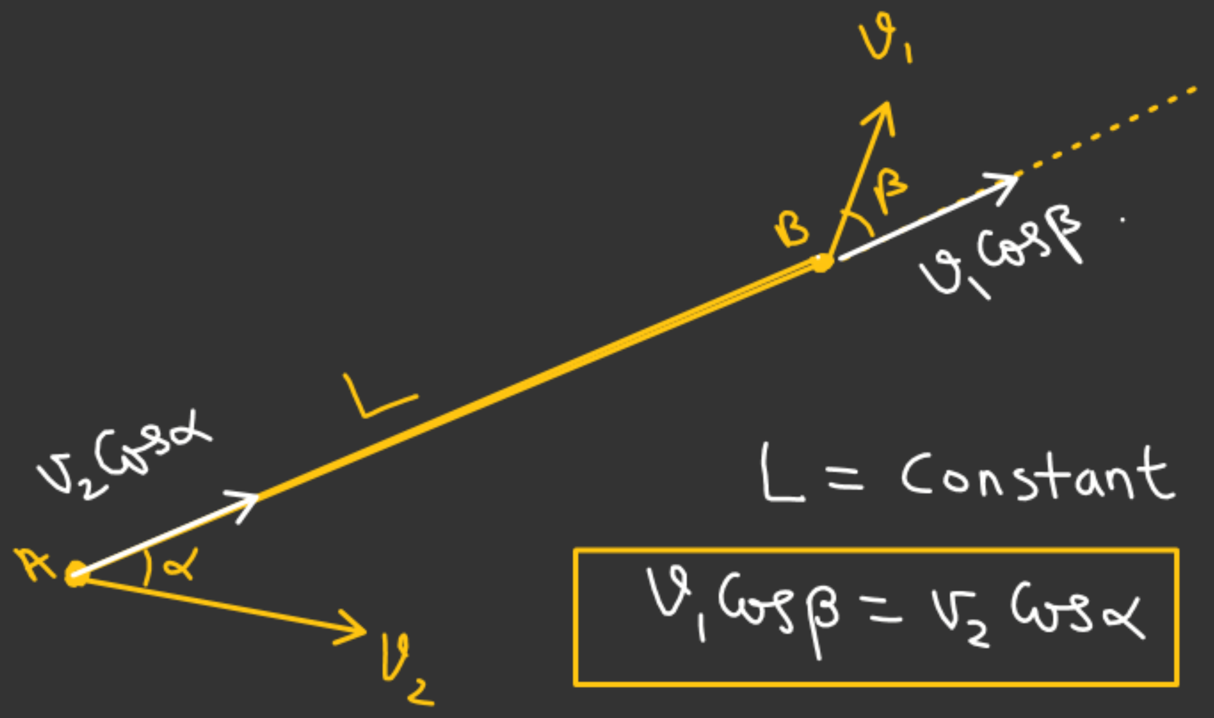
$$a = \frac{M_{eq} \cdot g}{M_{eq} + 3m}$$

$$a = \frac{4mg/3}{4m/3 + 3m} = \frac{4mg/3}{13mg/3} = \frac{4}{13}\, ms^{-2} \checkmark$$

Nishant Jindal

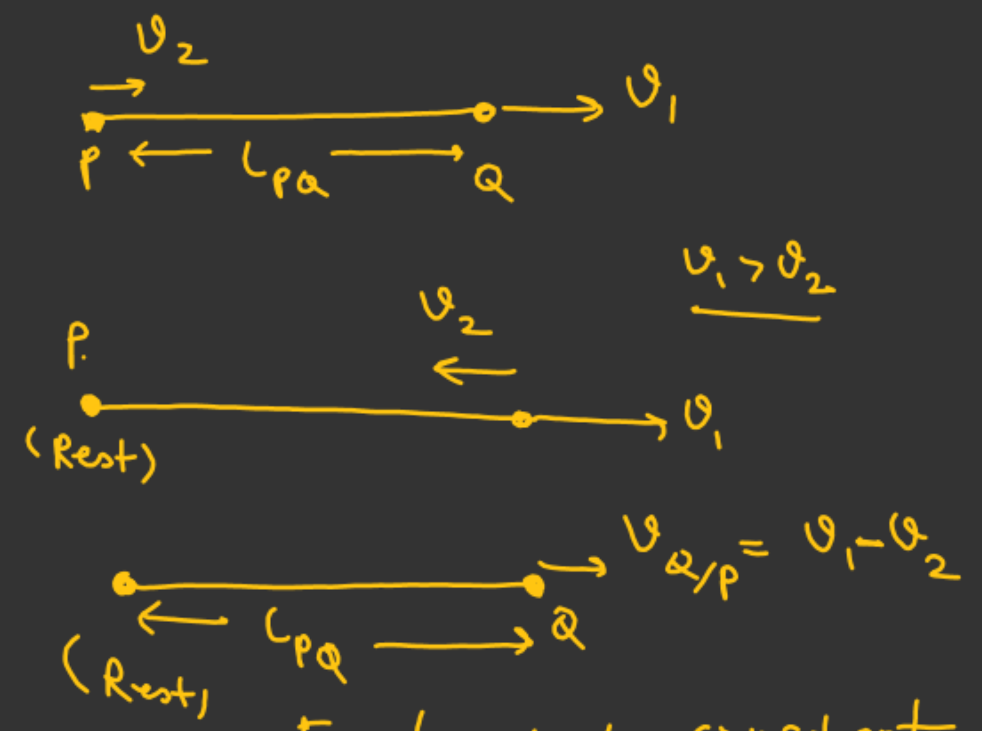
⇒ String Constrain

↳ String is always inextensible.
So, Length of string always constant.
⇒ [Along the string velocities of any two points on the string must be same]



L = Constant

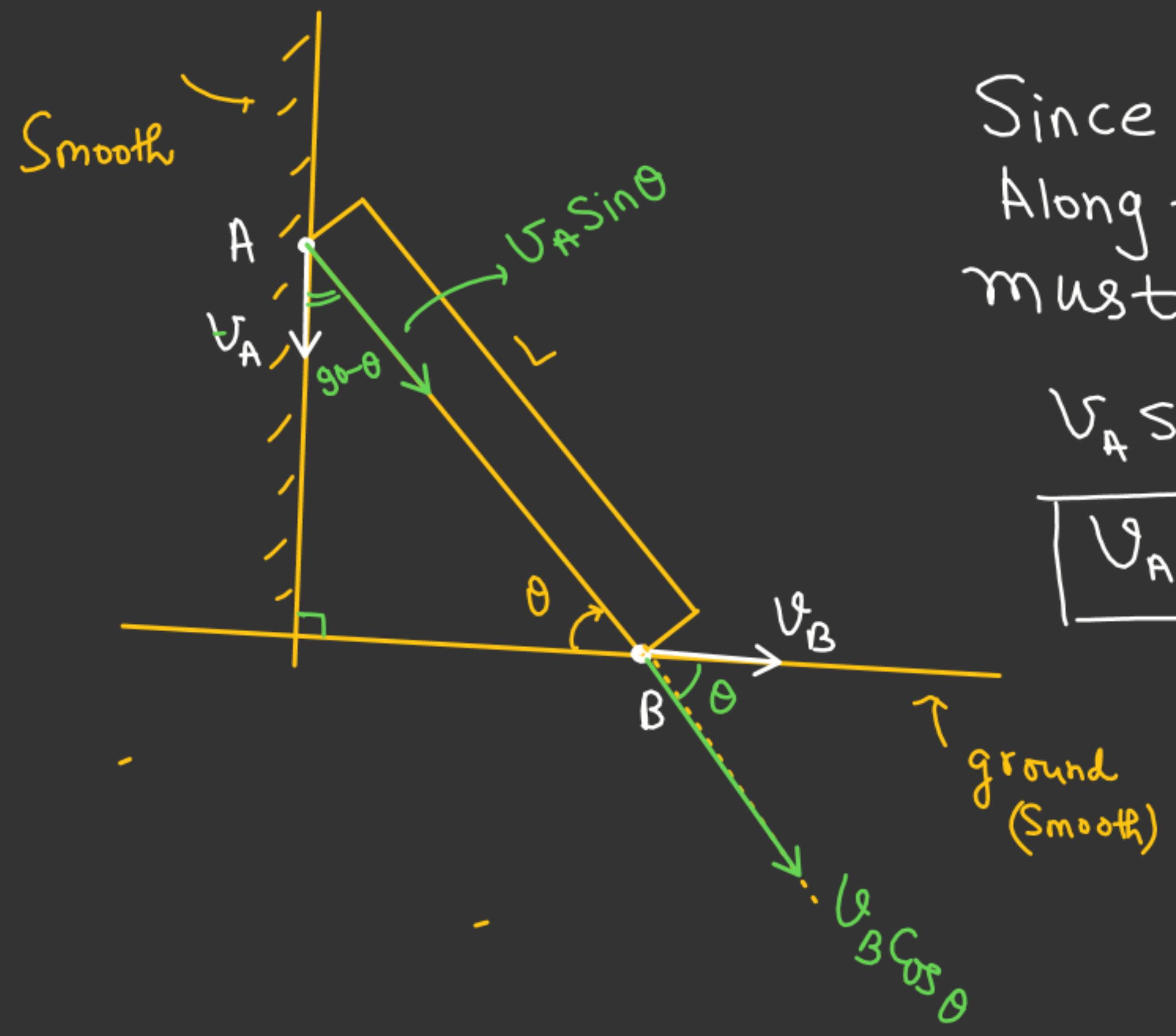
$$\boxed{v_1 \cos\beta = v_2 \cos\alpha}$$



For L_{PQ} to be constant
$v_{Q/P} = 0 \Rightarrow v_1 = v_2$

Rigid body

Find relation b/w V_A and V_B when angle is θ.



Since Rod is rigid so.
Along the rod velocity of any two point must be same.

$$V_A \sin\theta = V_B \cos\theta$$

$$\boxed{V_A = V_B \cot\theta}$$

Nishant Jindal

String - Pully constrain

Law of Motion

Q.1 In Fig., a ball of mass m_1 and a block of mass m_2 are joined together with an inextensible string. The ball can slide on a smooth horizontal surface. If v_1 and v_2 are the respective speeds of the ball and the block, then determine the constraint relation between the two.

M-1

$$\sum \vec{T} \cdot \vec{v} = 0$$

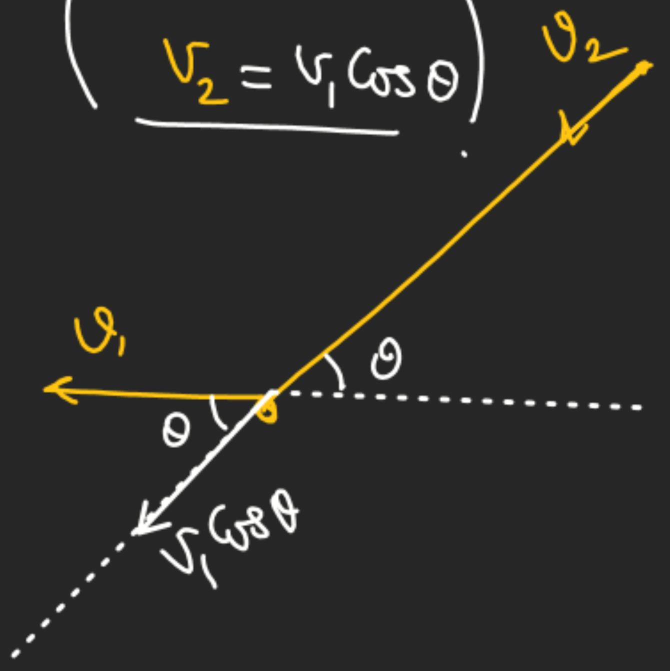
$$T v_1 \cos(\pi-\theta) + T V_2 = 0$$

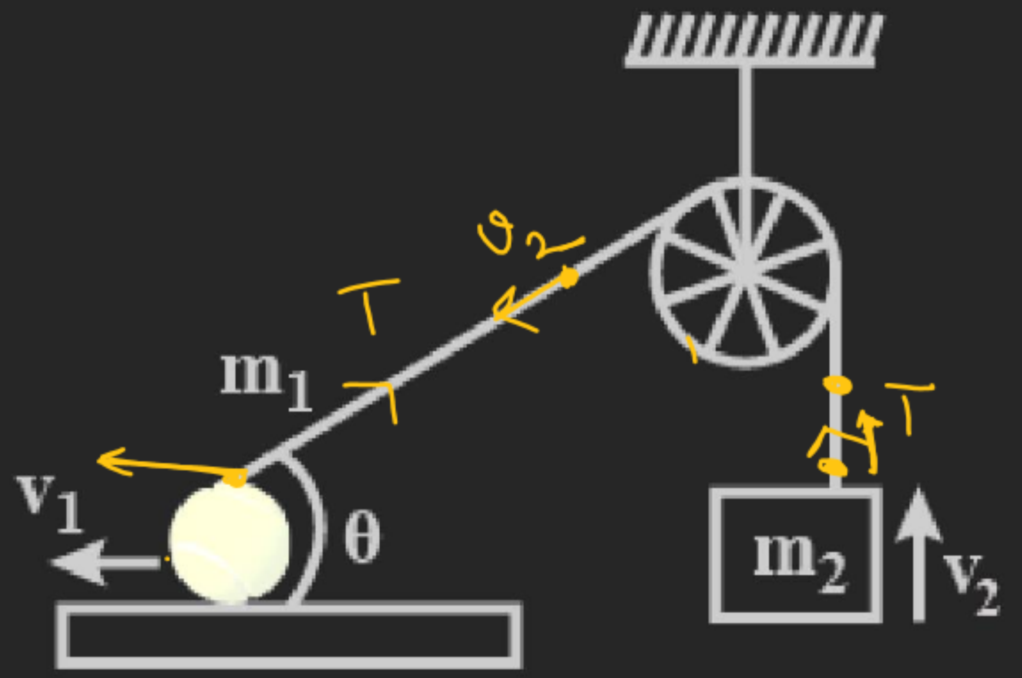
$$-T v_1 \cos\theta + T V_2 = 0$$

$$V_2 = v_1 \cos\theta$$

M-2

$$V_2 = v_1 \cos\theta$$



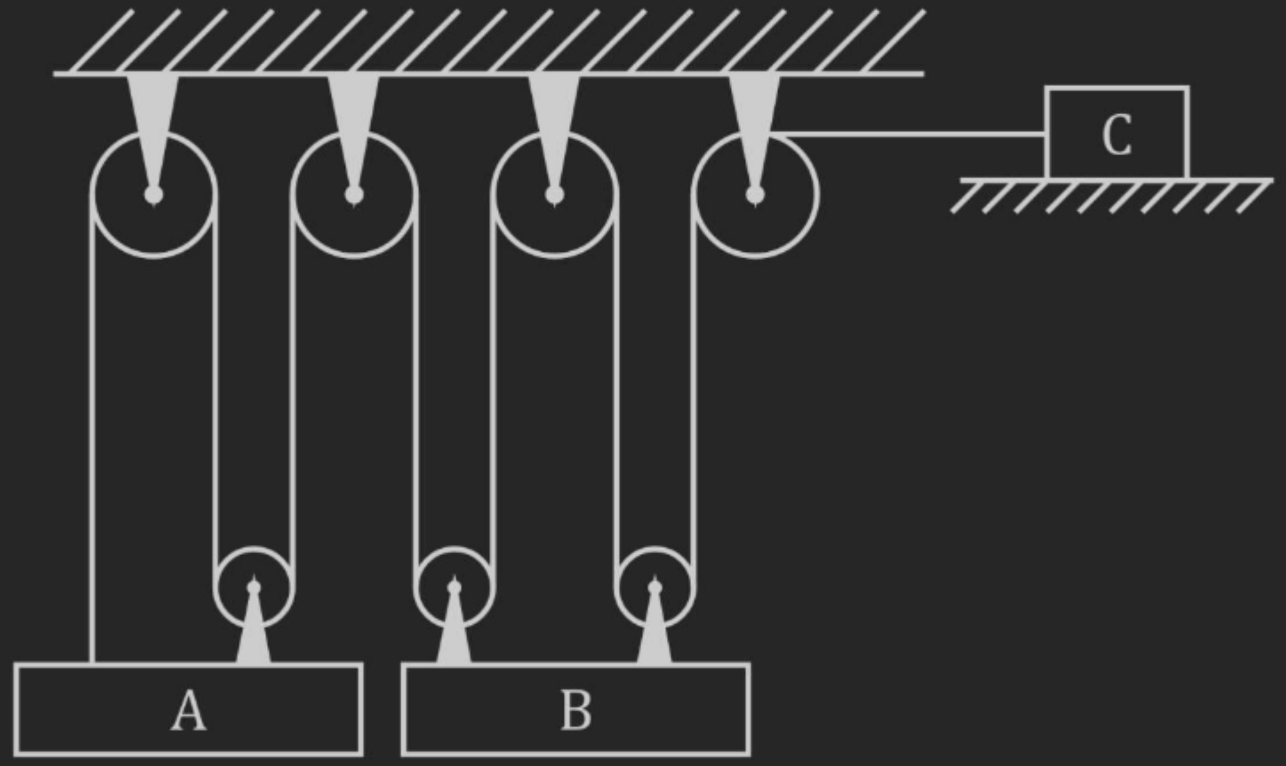


Law of Motion

Q.2 Block B shown in figure., moves downward with a constant velocity of $20\ \text{cm/s}$. At $t = 0$, block A is moving upward with a constant acceleration, and its velocity is $3\ \text{cm/s}$. If at $t = 3\ \text{s}$ blocks C has moved $27\ \text{cm}$ to the right, determine the velocity of block C at $t = 0$ and the acceleration of A and C.

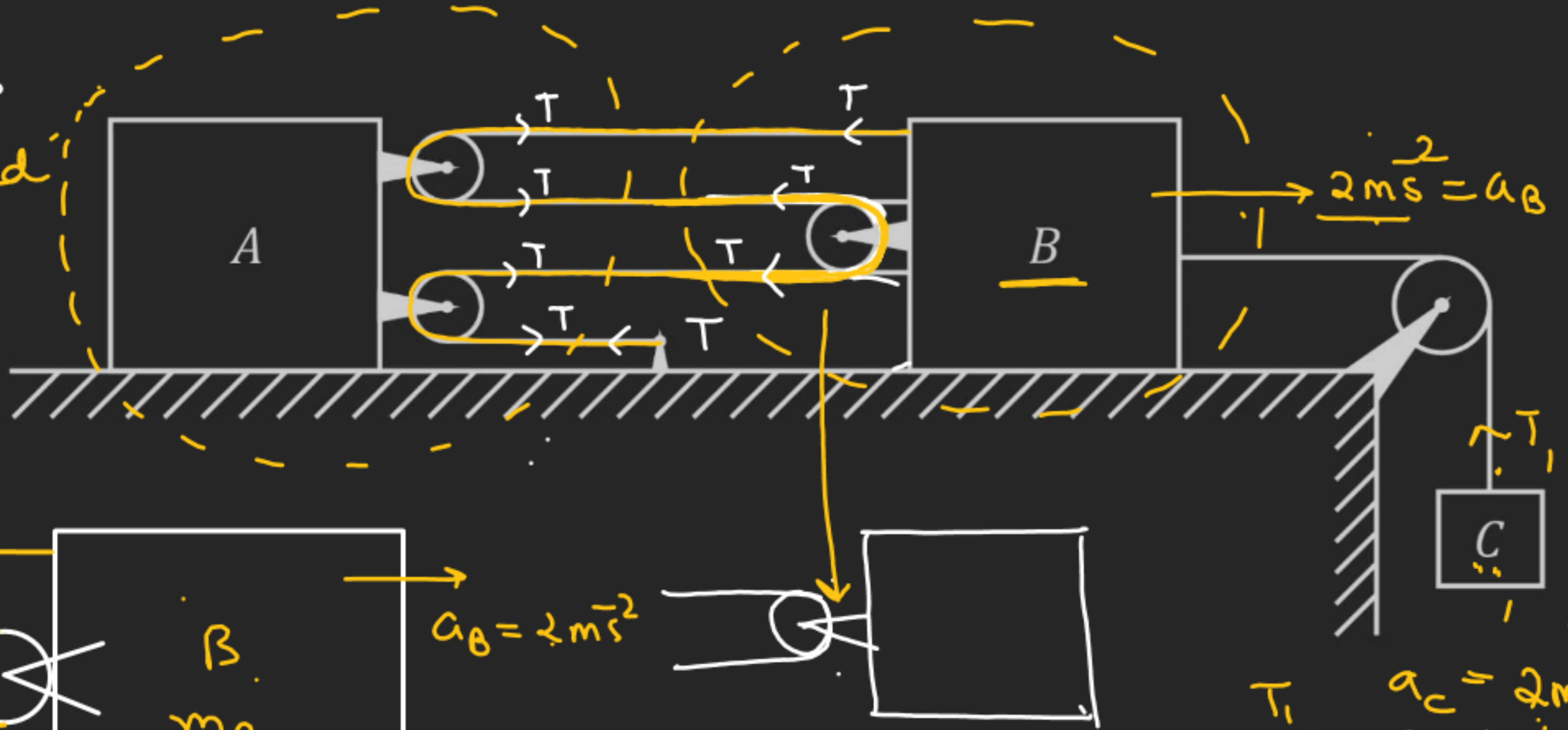
HW

$\left[a_A = 20\ \text{cm/s}^2 \uparrow; a_C = 60\ \text{cm/s}^2 \rightarrow; v_C = 71\ \text{cm/sec} \leftarrow\right]$



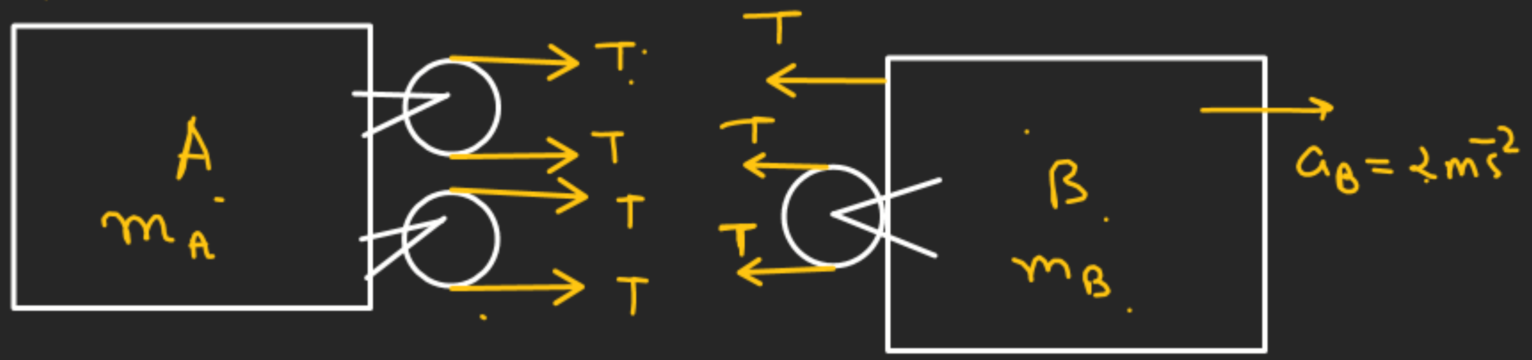
Nishant Jindal

Q.3 Block C shown in figure is going down at acceleration $2\ m/s^2$. Find the acceleration of blocks A and B.



Note :- If pully is attached with the block it will be part of block

$\longrightarrow a_A$



$a_c = 2ms^{-2}$

$4T = m_A \cdot a_A$

$\sum \vec{T}\cdot\vec{a} = 0$

$4Ta_A - 3Ta_B = 0$

$4a_A = 3a_B$

$a_A = \frac{3}{4} a_B$

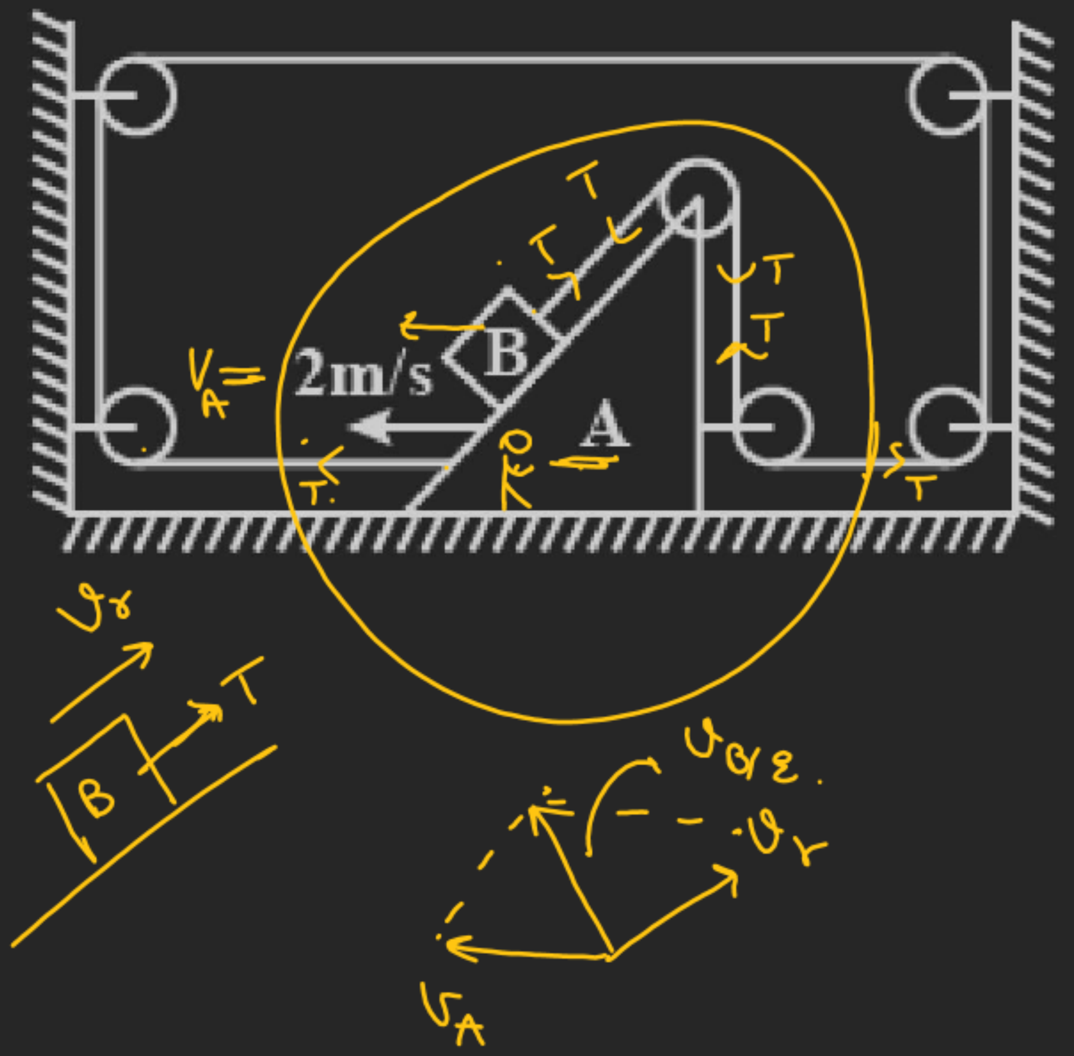
$a_A = \frac{3}{4} \times 2 = \frac{3}{2} ms^{-2}$

$m_c g - T_1 = m_c a_c$

String - Pully constrain

Law of Motion

Q.4 System is shown in Fig. and wedge is moving toward left with speed 2 m s^{-1}. Find the velocity of the block B.



$v_{B/E} = 2 m s^{-2}$

$(T_A)_{net} = 0$

$0v + Tv_r = 0$

$\boxed{v_r = 0}$

$v_{B/A} = 0$

Nishant Jindal

Law of Motion

Q.5 For the system as shown in Fig., find the acceleration of C. The accelerations of A and B with respect to ground are marked.

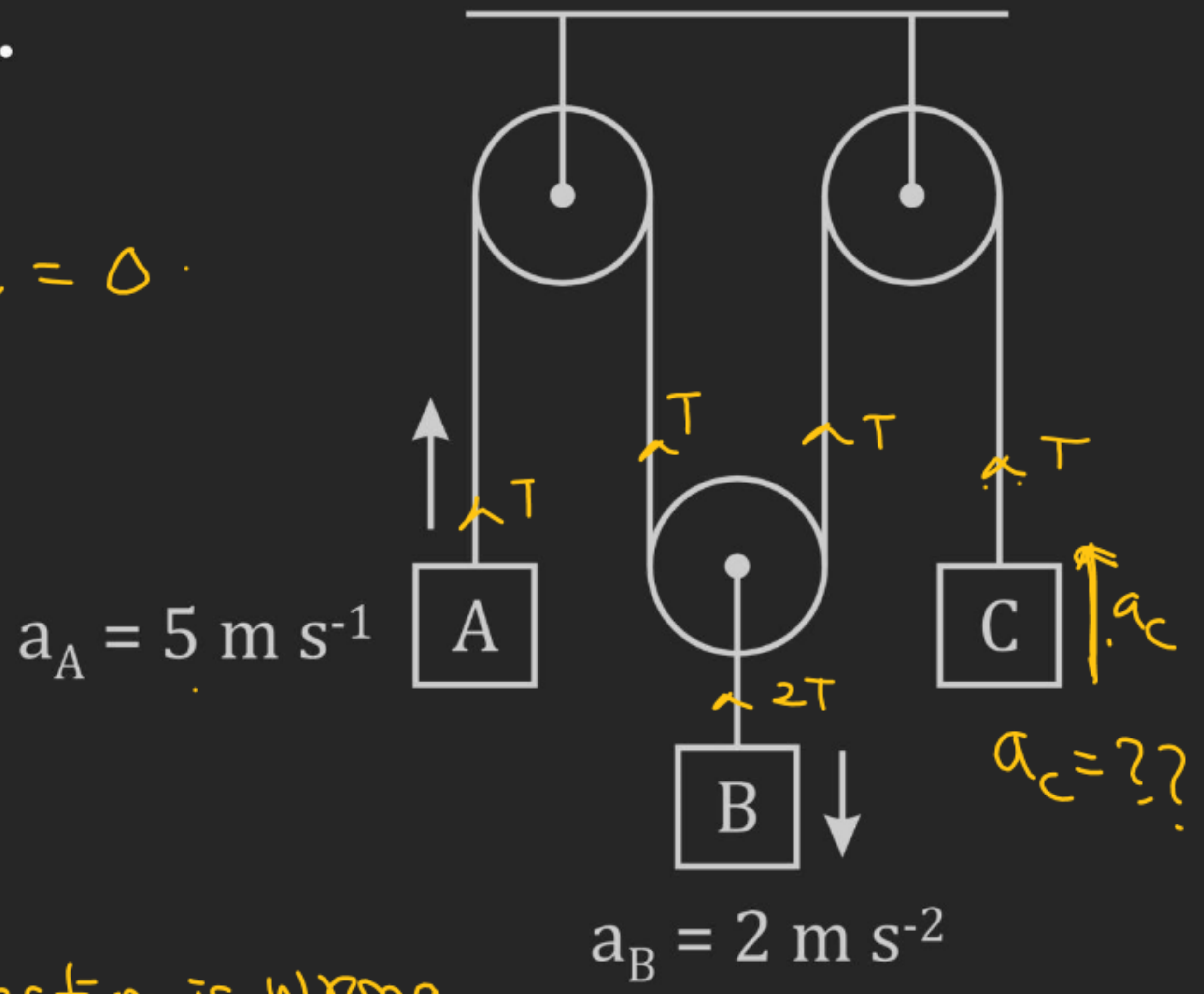
$$T \cdot a_A - 2T a_B + T \cdot a_C = 0$$

$$a_C = 2a_B - a_A$$

$$a_C = 2 \times 2 - 5$$

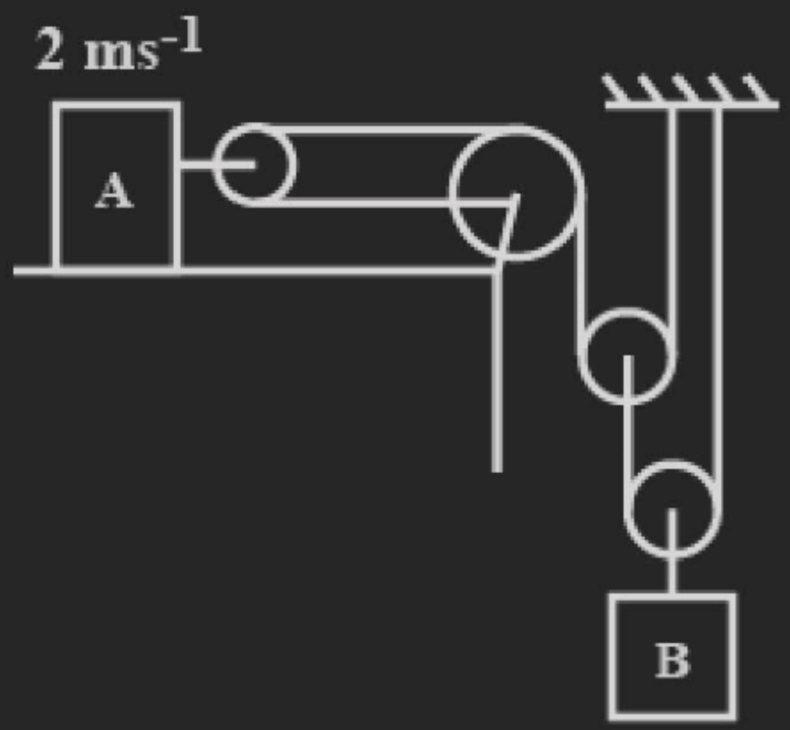
$$a_C = -1 \, m\, s^{-2}$$

Assumed direction is wrong



Q.6 In Fig., find the acceleration of B, if the acceleration of A is 2 m s^{-2}.

H-W



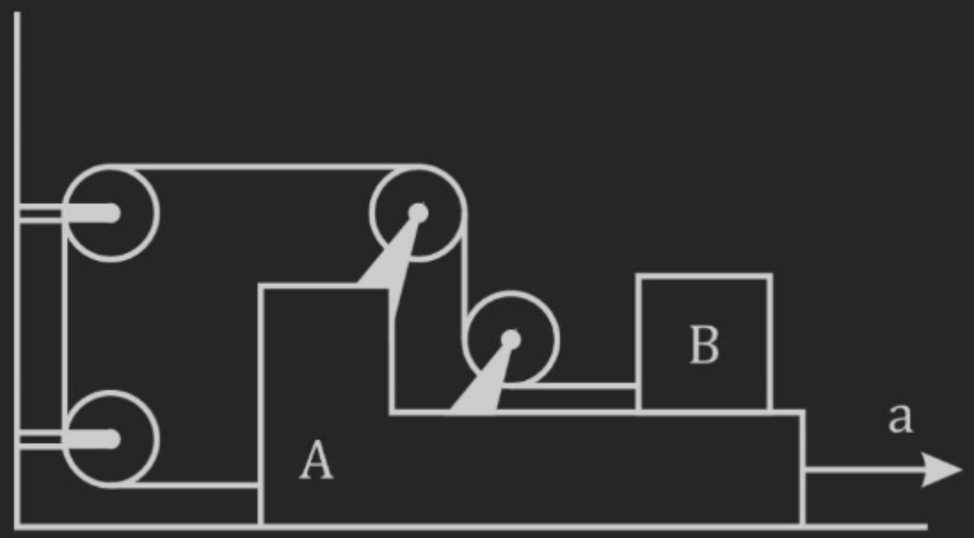
Nishant Jindal

String - Pully constrain

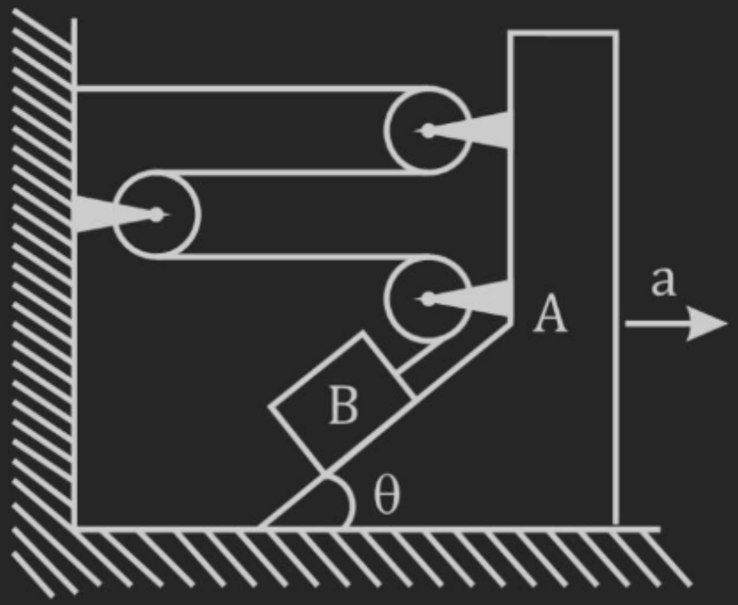
Law of Motion

Q.7 Find the acceleration of block B as shown in Fig. (a) and (b) relative to block A and relative to ground if block A is moving toward right with acceleration a.

H.W.



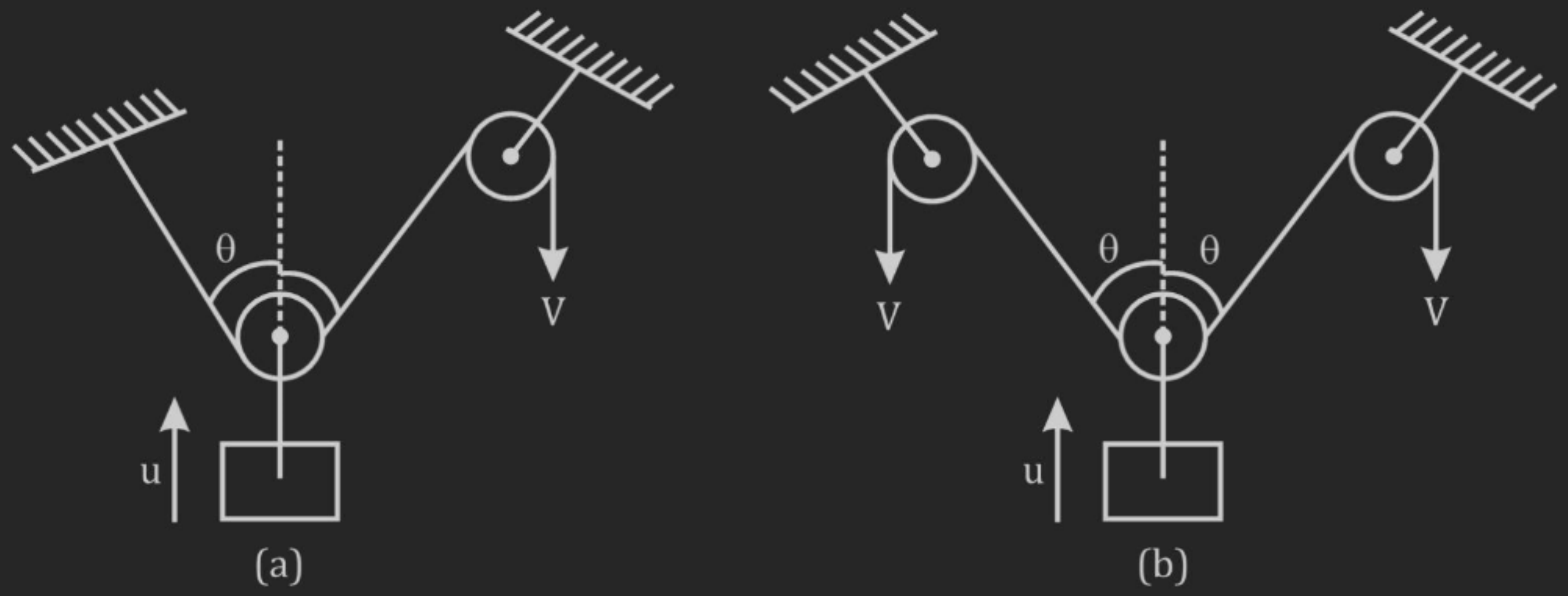
(a)



(b)

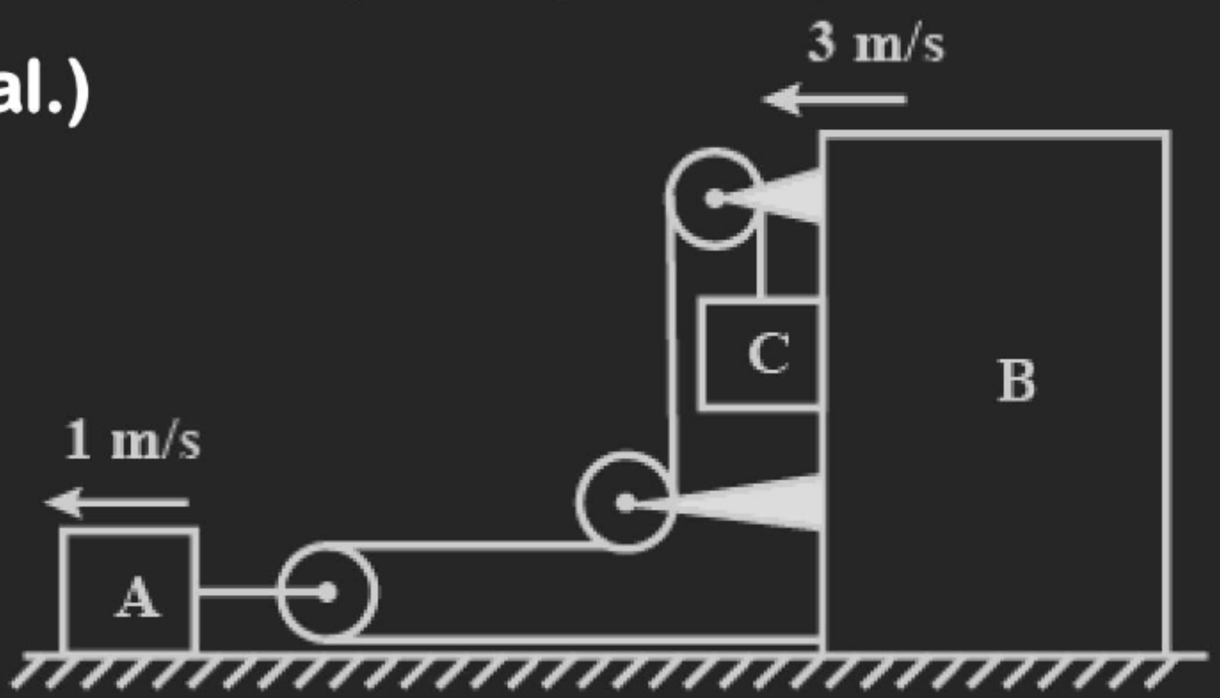
Q.8 If the string is inextensible, determine the velocity u of each block in terms of v and θ.

H.W.



Q.9 The velocities of A and B are shown in Fig. Find the speed (in m s^{-1}) of block C. (Assume that the pulleys and string are ideal.)

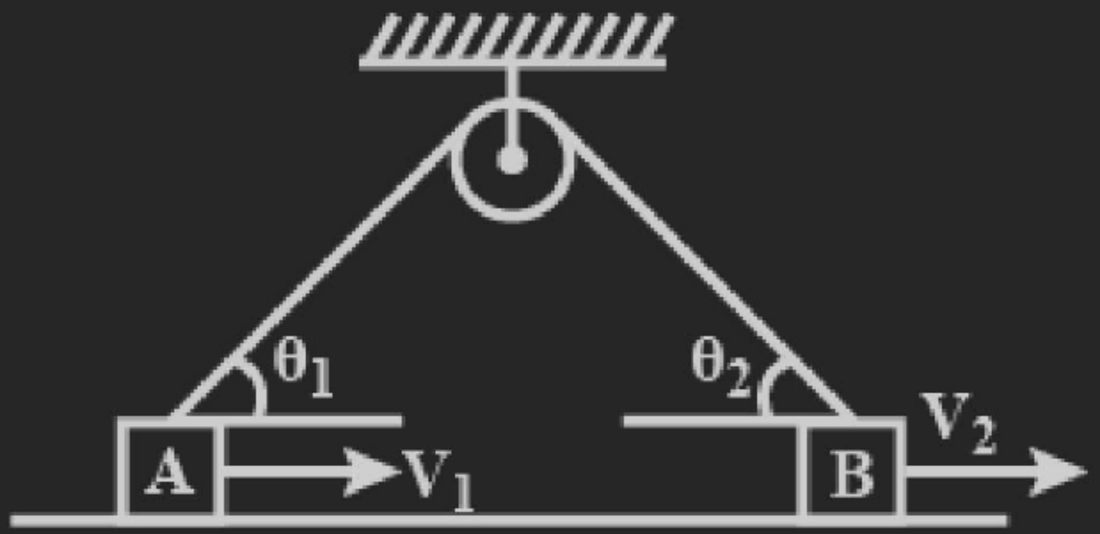
H.W.



Q.10 In Fig., blocks A and B move with velocities v_1 and v_2 along horizontal direction.

H-W

Find the ratio of v_1 / v_2.



(A) $\frac{\sin \theta_1}{\sin \theta_2}$

(B) $\frac{\sin \theta_2}{\sin \theta_1}$

(C) $\frac{\cos \theta_2}{\cos \theta_1}$

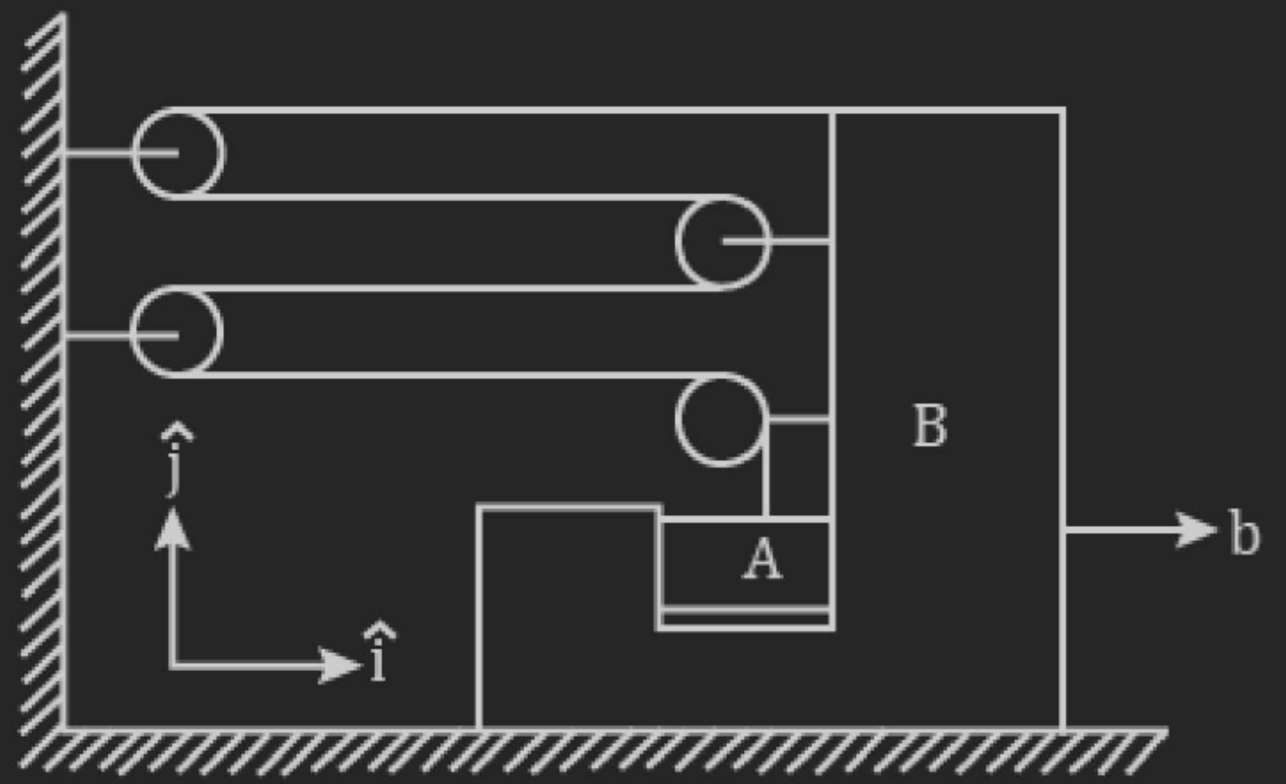
(D) $\frac{\cos \theta_1}{\cos \theta_2}$

Nishant Jindal

Law of Motion

Q.11 If block B moves towards right with acceleration b, find the net acceleration of block A.

H.W.



(A) $b\hat{i} + 4b\hat{j}$

(B) $b\hat{i} + b\hat{j}$

(C) $b\hat{i} + 2b\hat{j}$

(D) None of these

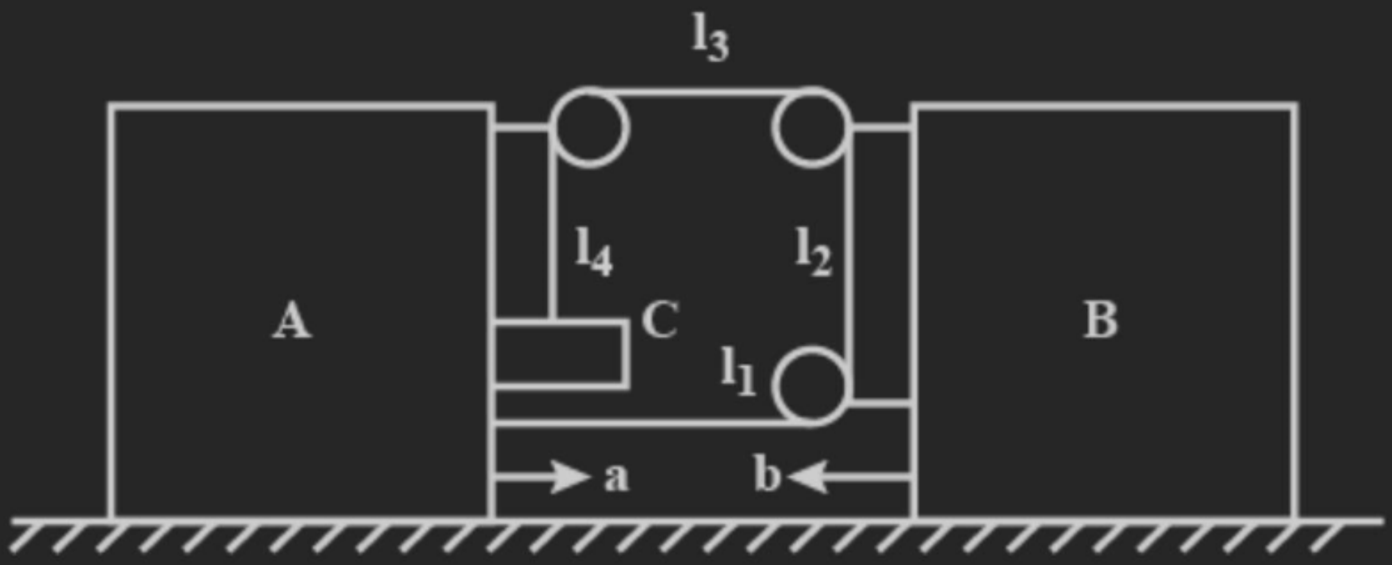
Nishant Jindal

String - Pully constrain

Law of Motion

Q.12 If the blocks A and B are moving towards each other with accelerations a and b as shown in Fig., find the net acceleration of block C.

H.W.



(A) $a\hat{i} - 2(a + b)\hat{j}$

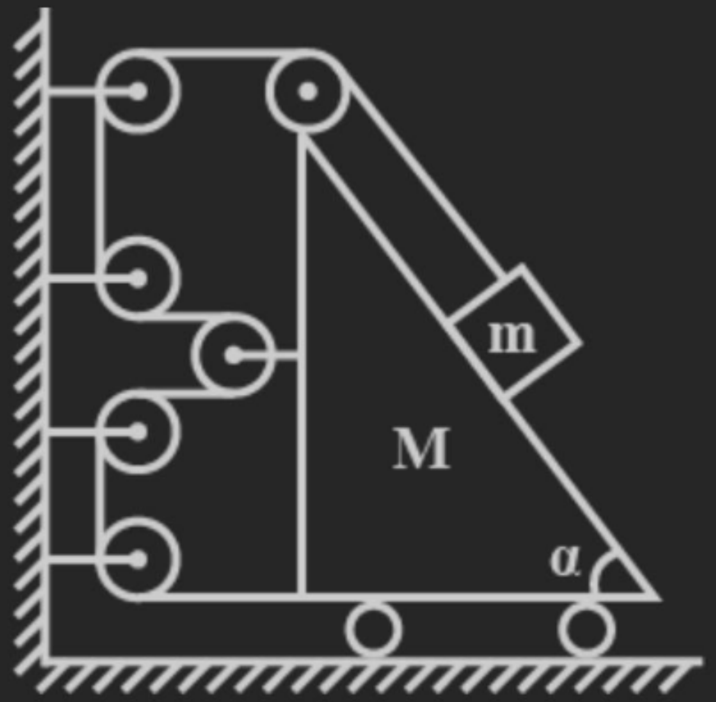
(B) $-(a + b)\hat{j}$

(C) $a\hat{i} - (a + b)\hat{j}$

(D) None of these

Q.13 If the acceleration of wedge in the shown arrangement is a m s^{-2} towards left, then at this instant, acceleration of the block (magnitude only) would be

H.W.



(A) $4a\ ms^{-2}$

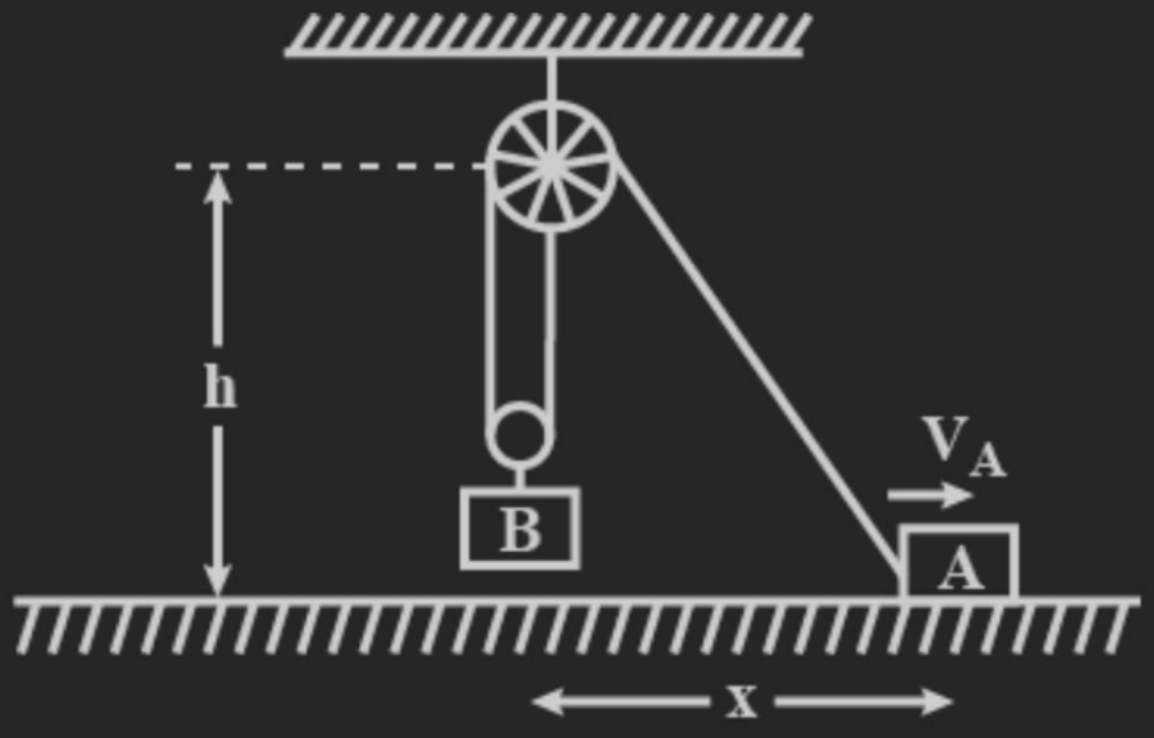
(B) $a\sqrt{17-8\cos\alpha}\ m\ s^{-2}$

(C) $(\sqrt{17})a\ m\ s^{-2}$

(D) $\sqrt{17}\cos\frac{\alpha}{2}\times a\ m\ s^{-2}$

Q.14 If block A is moving horizontally with velocity v_A, then find the velocity of block B at the instant as shown in Fig.

H-W



(A) $\frac{hv_A}{2\sqrt{x^2+h^2}}$

(B) $\frac{xv_A}{\sqrt{x^2+h^2}}$

(C) $\frac{xv_A}{2\sqrt{x^2+h^2}}$

(D) $\frac{hv_A}{\sqrt{x^2+h^2}}$

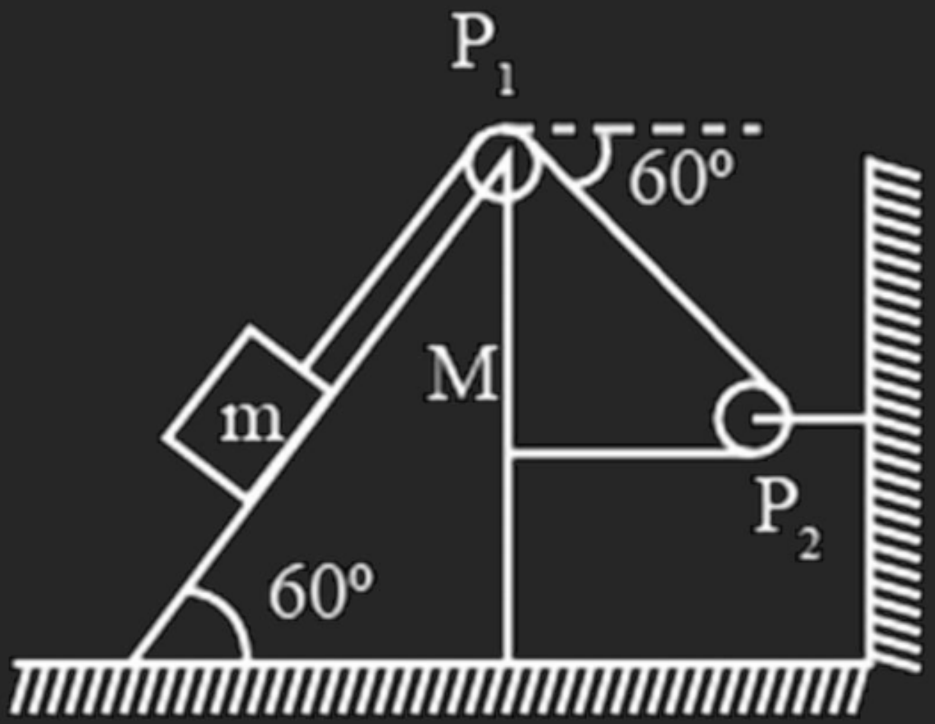
Nishant Jindal

String - Pully constrain

Law of Motion

Q.15 In the arrangement shown in Fig., the block of mass m = 2 kg lies on the wedge of mass M = 8 kg. The initial acceleration of the wedge, if the surfaces are smooth, is

H.W



(A) $\frac{\sqrt{3}g}{23}\,ms^{-2}$

(B) $\frac{3\sqrt{3}g}{23}\,ms^{-2}$

(C) $\frac{3g}{23}\,m\,s^{-2}$

(D) $\frac{g}{23}\,m\,s^{-2}$

Nishant Jindal

String - Pully constrain

Law of Motion

Q.16 Seven pulleys are connected with the help of three light strings as shown in Fig. Consider P_3, P_4, P_5 as light pulleys and pulleys P_6 and P_7 have masses m each. For this arrangement, mark the correct statement(s).

H.W.

(A) Tension in the string connecting P_1, P_3, and P_4 is zero.

(B) Tension in the string connecting P_1, P_3 and P_4 is $mg/3$.

(C) Tensions in all the three strings are same and equal to zero.

(D) Acceleration of P_6 is g downwards and that of P_7 is g upwards.