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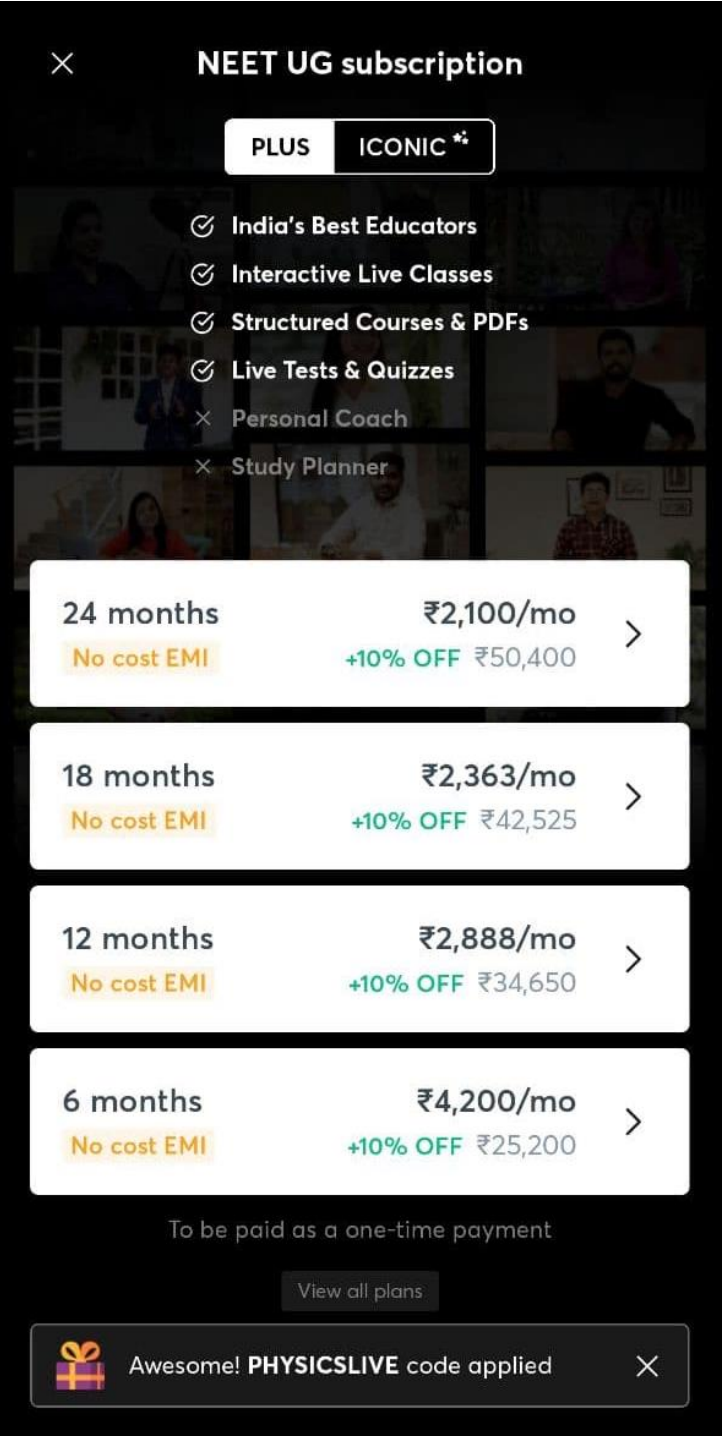

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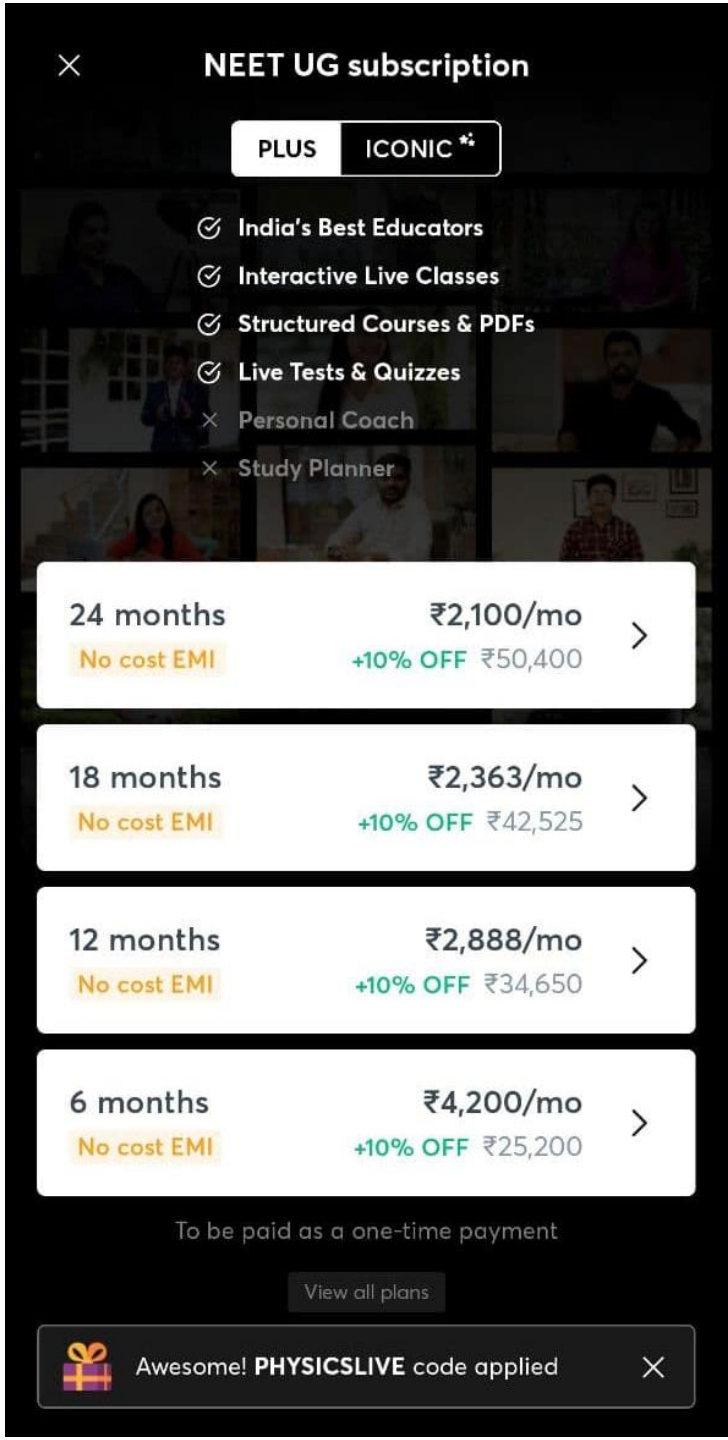

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Physics DPP

DPP-2 NLM: Constraint Relation

By Physicsaholics Team

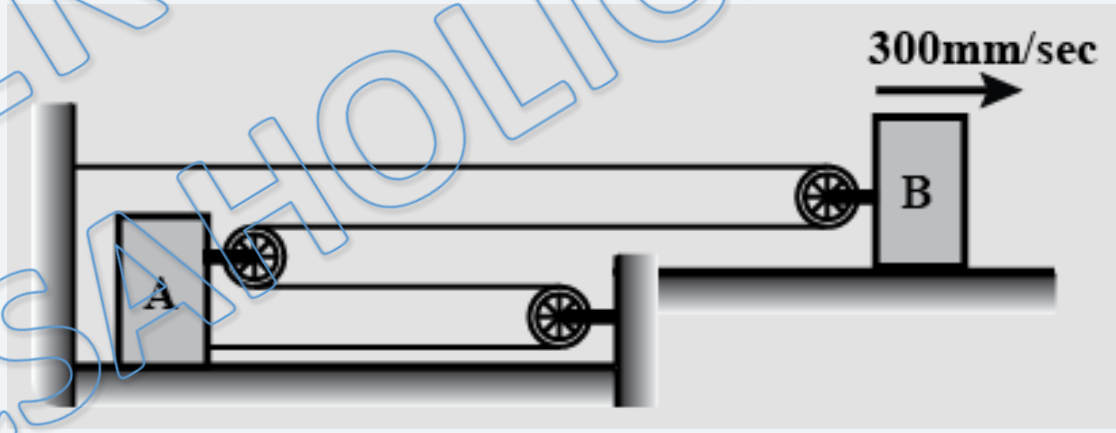
Q) If the velocity of block B in the given arrangement is 300 mm/sec towards right. Find the velocity of A:

(a) 100 mm/sec

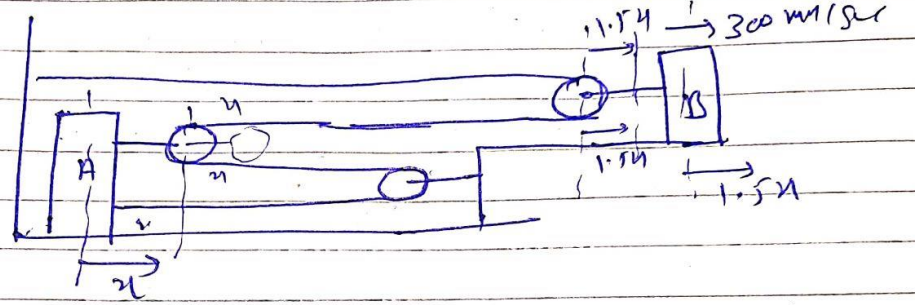
(b) 200 mm/sec

(c) 300 mm/sec

(d) 400 mm/sec



Ans. b



$3x_A = x$

$x_B = \frac{3}{2}x$

$x_B = \frac{3}{2}x_A$

$2x_B = 3x_A$

$2V_B = 3V_A$

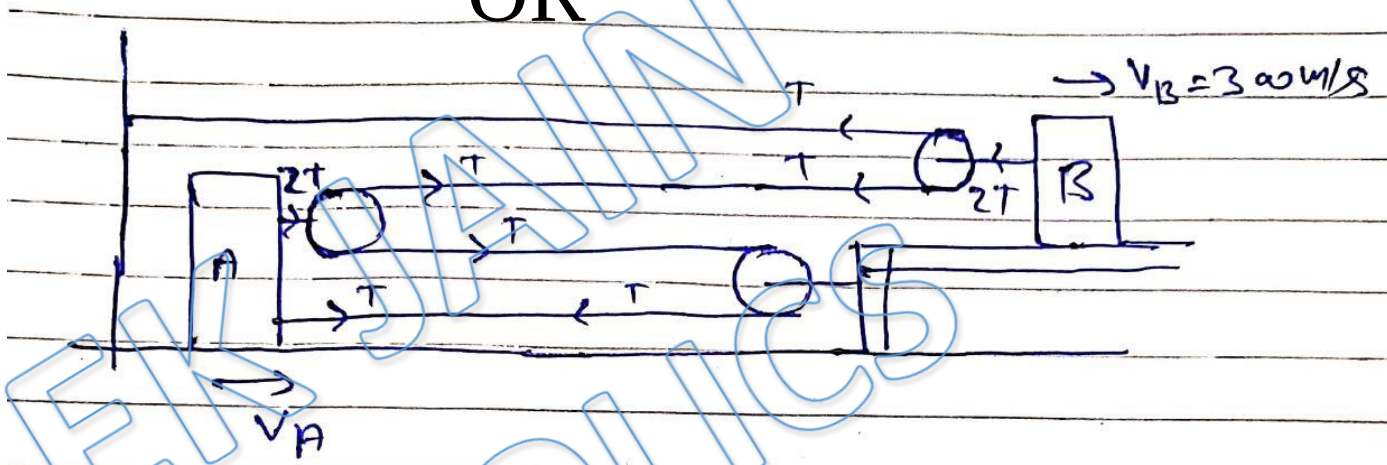
$V_B = \frac{3}{2}V_A$

$V_A = \frac{2}{3}V_B$

$V_A = \frac{2}{3}(300)$

$\boxed{V_A = 200 \text{ mm/sec}}$

OR



$P_A + P_B = 0$

$(3T)V_A \cos 0° + 2T V_B \cos(180°) = 0$

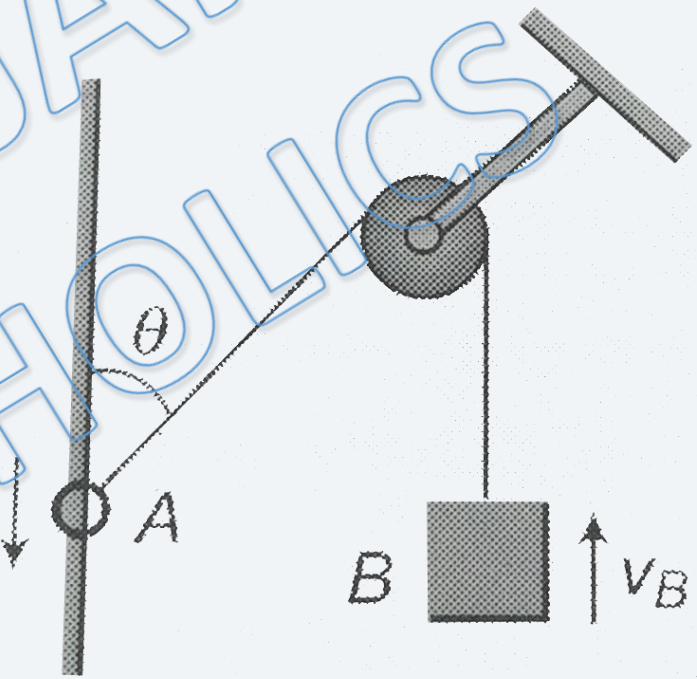
$3V_A - 2V_B = 0$

$3V_A = 2V_B$

$V_A = \frac{2}{3}V_B = \frac{2}{3} \times 300$

$\boxed{V_A = 200 \text{ m/s}}$

Q) Find the velocity of block B when ring A is moving downward with velocity v:



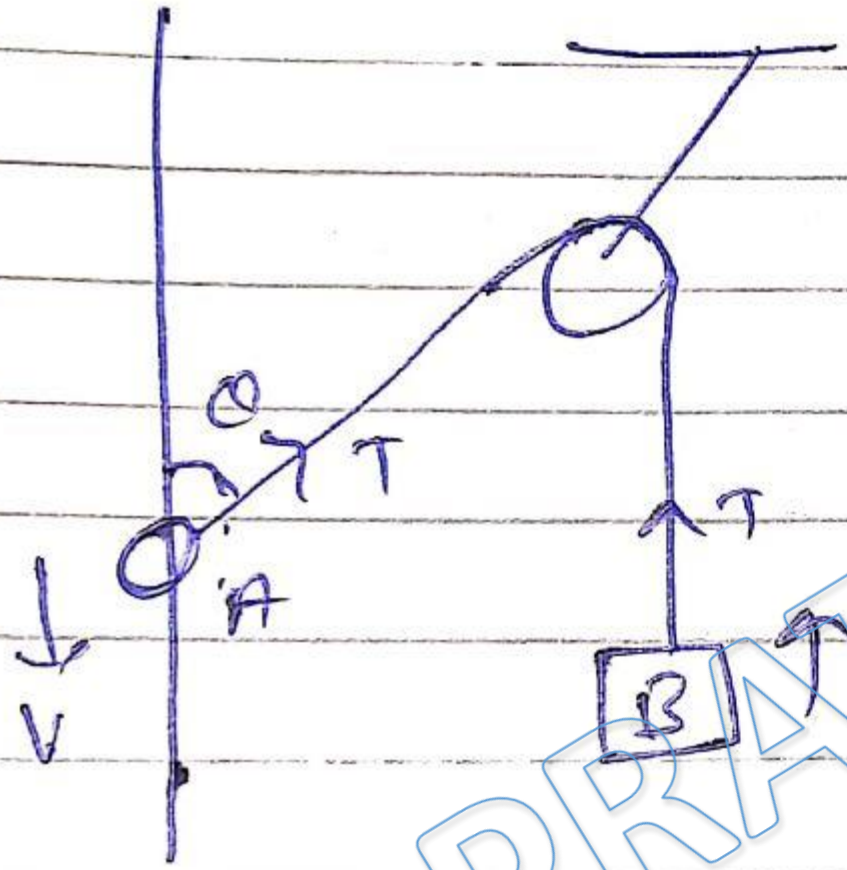
(a) $v \sin\theta$

(b) $\frac{v}{2}\sin\theta$

(c) $v \cos\theta$

(d) $\frac{v}{2}\cos\theta$

Ans. c



$$P_A + P_B = 0$$

$$T V_A \cos(180-\theta) + T V_B \cos 0^\circ = 0$$

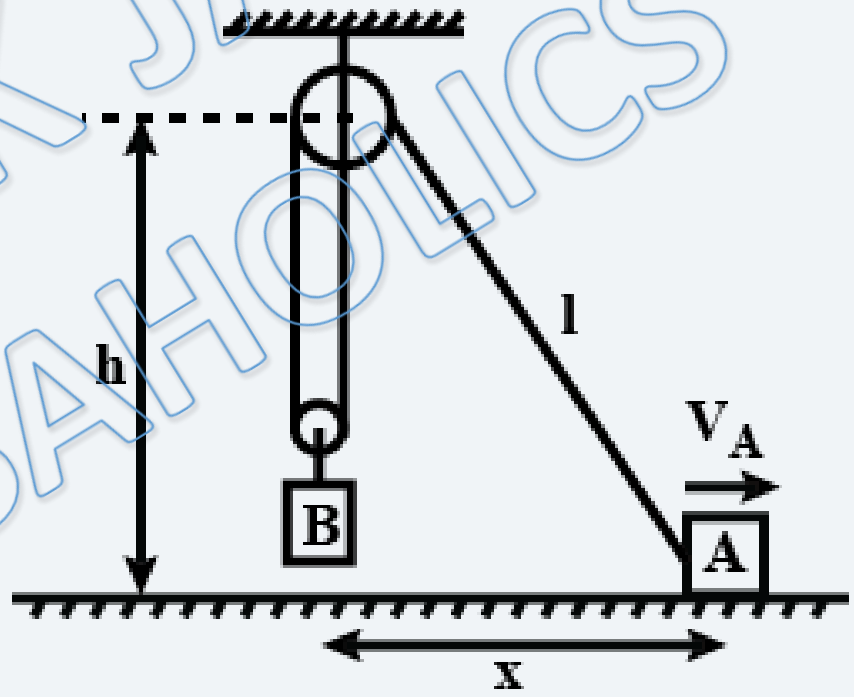
$$-T V_A \cos\theta + T V_B = 0$$

$$V_B = V_A \cos\theta$$

$$V_A = V$$

$$\therefore \boxed{V_B = V\cos\theta}$$

Q) If block A is moving horizontally with velocity V_A, then find the velocity of block B at the instant as shown in fig:



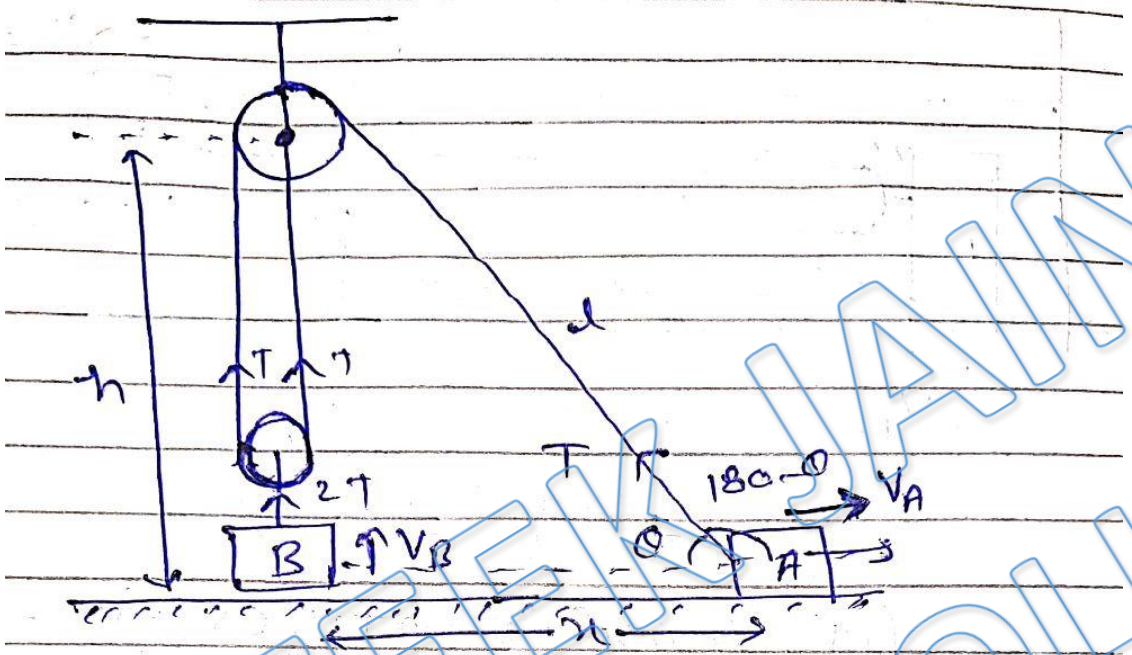
(a) $\frac{hV_A}{2\sqrt{x^2+h^2}}$

(b) $\frac{xV_A}{\sqrt{x^2+h^2}}$

(c) $\frac{xV_A}{2\sqrt{x^2+h^2}}$

(d) $\frac{hV_A}{\sqrt{x^2+h^2}}$

Ans. c



$$P_A + P_B = 0$$

$$T V_A \cos(180-\theta) + 2T V_B = 0$$

$$-T V_A \cos\theta + 2T V_B = 0$$

$$V_B = \frac{V_A \cos\theta}{2}$$

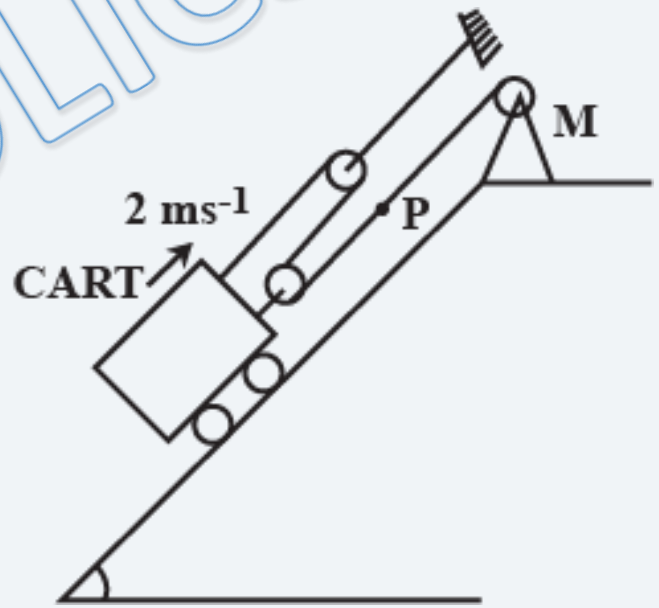
$$\cos\theta = \frac{x}{\sqrt{x^2+h^2}}$$

$$\therefore \boxed{V_B = \frac{x V_A}{2\sqrt{x^2+h^2}}}$$

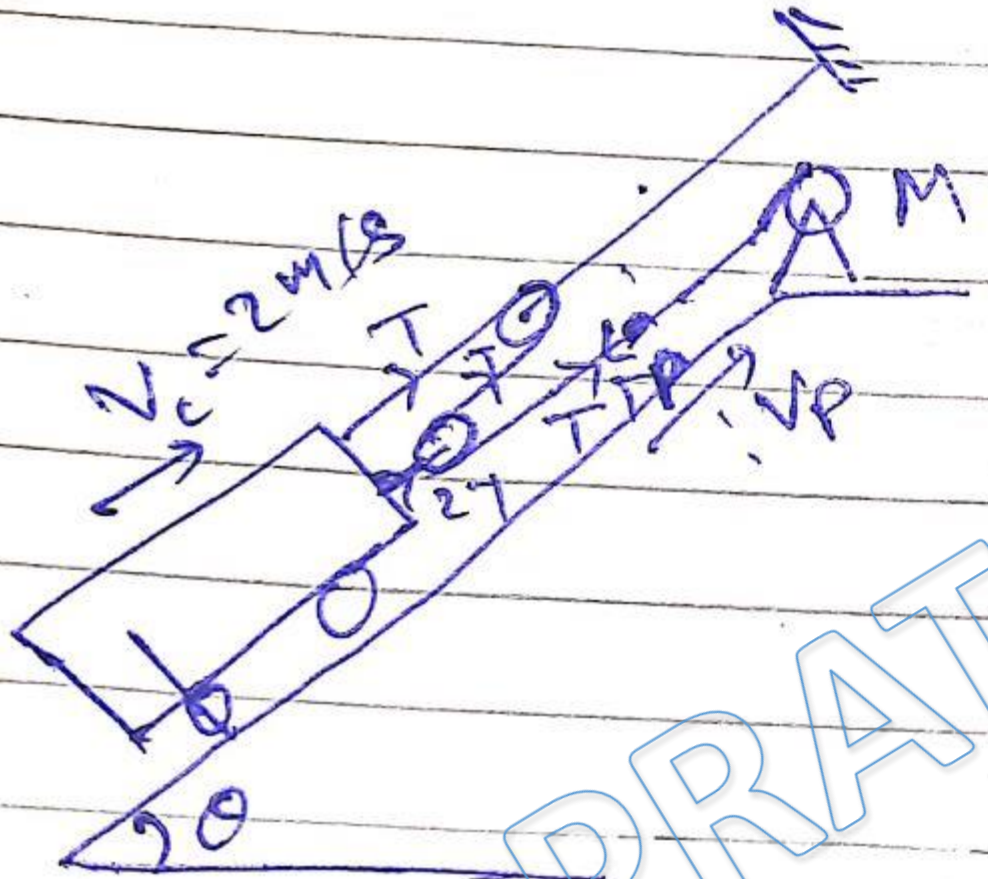
Q) A cart is being pulled up the incline, using a motor M and an ideal pulley and ideal rope arrangement as shown in figure. Then the speed of point $'P'$ of the string with which it moves so that the car moves up the inclined plane with a constant speed of $V_{cart} = 2\ m/s$ is (Incline is at rest):

(a) $12\ m/s$ (b) $3\ m/s$

(c) $5\ m/s$ (d) $6\ m/s$



Ans. d



$$P_P + P_c = 0$$

$$T V_P (\cos 180^\circ) + 3T V_c (\cos 0^\circ) = 0$$

$$-T V_P + 3T V_c = 0$$

$$V_P = 3 V_c$$

$$V_P = 3 \times 2$$

$$\boxed{V_P = 6 \text{ m/s}}$$

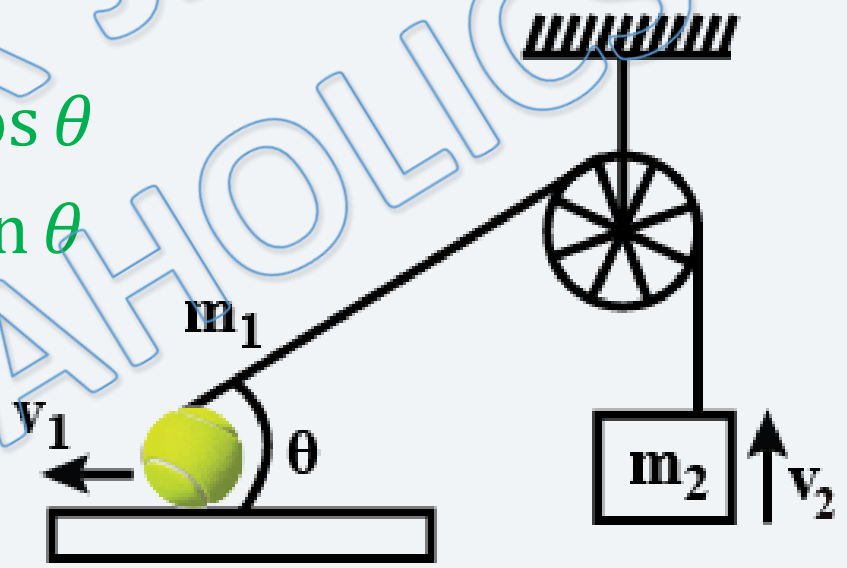
Q) In *Fig*. a ball of mass m_1 and a block of mass m_2 are joined together with an inextensible string. The ball can slide on a smooth horizontal surface.
If V_1 and V_2 are the respective speeds of the ball and the block, then determine the constraint relation between velocities of the two.

(a) $V_2 = V_1 \cos\theta$

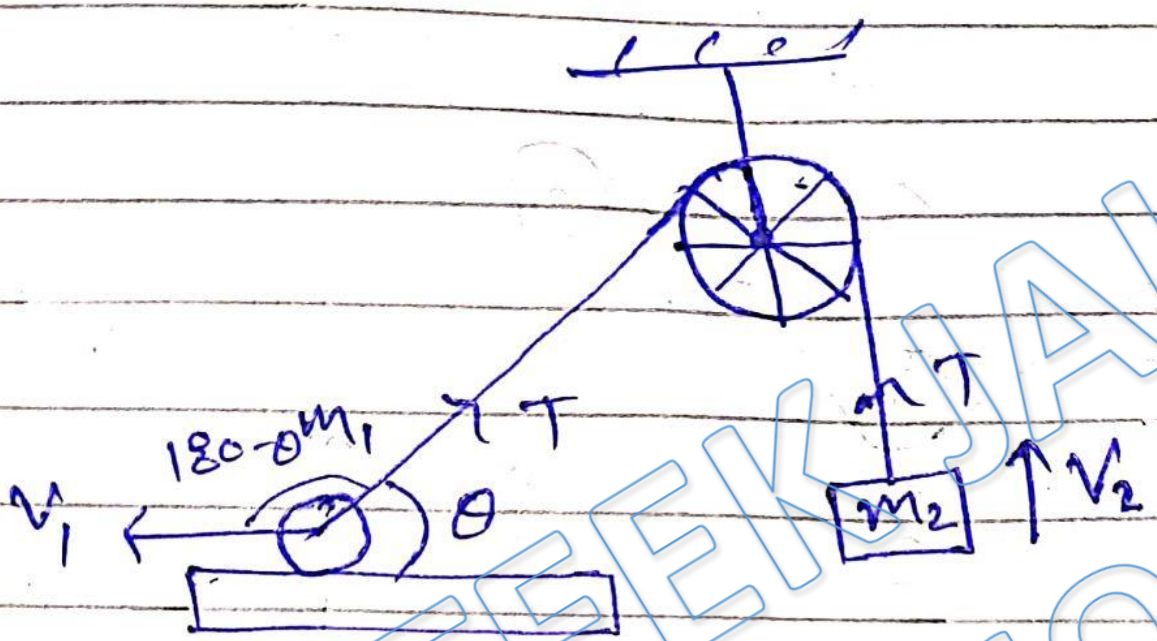
(b) $V_1 = V_2 \cos\theta$

(c) $V_1 = V_2$

(d) $V_2 = V_1 \sin\theta$



Ans. a



$$P_1 + P_2 = 0$$

$$T \cdot V_1 \cos(180-\theta) + T V_2 = 0$$

$$-T V_1 \cos\theta + T V_2 = 0$$

$$\boxed{V_2 = V_1 \cos\theta}$$

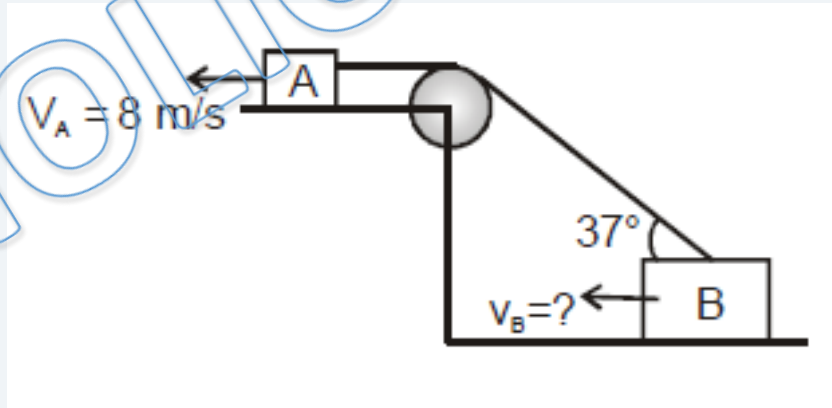
Q) Find V_B =?

(a) 10 m/s

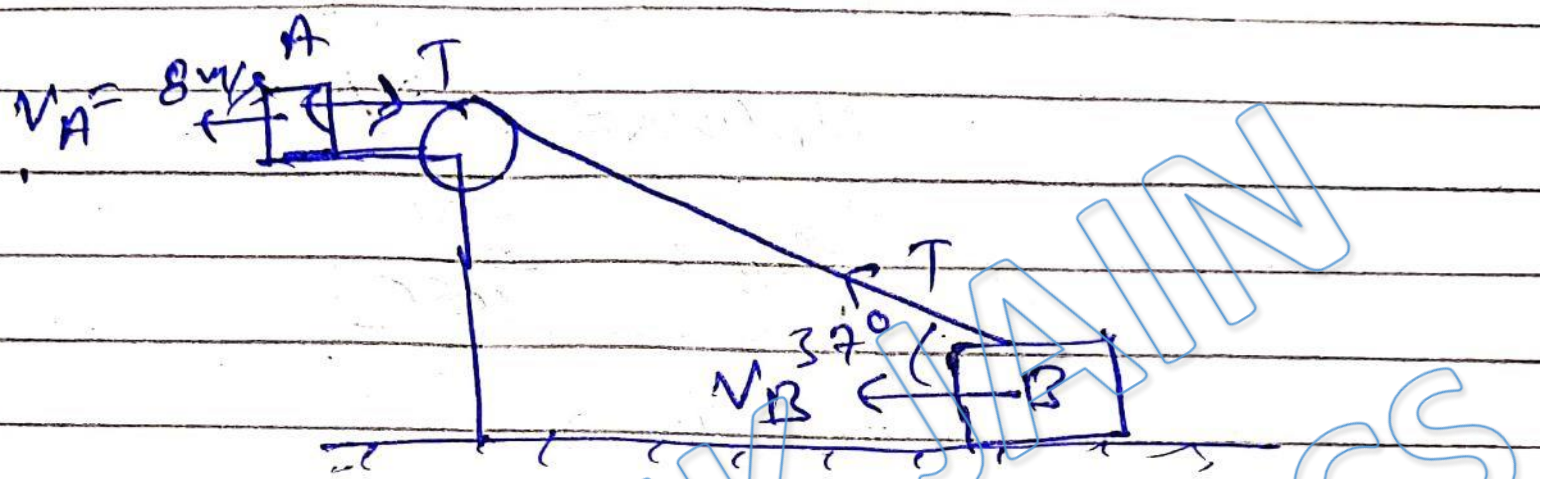
(b) 8 m/s

(c) 14 m/s

(d) 6 m/s



Ans. a



$$P_{IA} + P_B = 0$$

$$T V_A \cos(180^\circ) + T V_B \cos(37^\circ) = 0$$

$$-V_A + V_B \cos 37^\circ = 0$$

$$V_B\left(\frac{4}{5}\right) = V_A$$

$$V_B = V_A \frac{5}{4} = 8 \times \frac{5}{4}$$

$$\boxed{V_B = 10 \text{ m/s}}$$

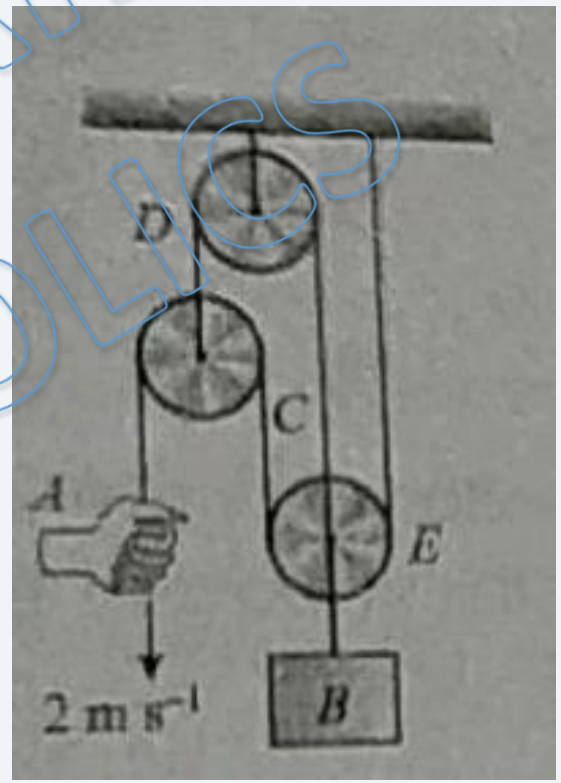
Q) Determine the speed with which block *B* rises in Fig. if the end of the cord at *A* is pulled down with a speed of 2 m/s.

(a) 4 m/s

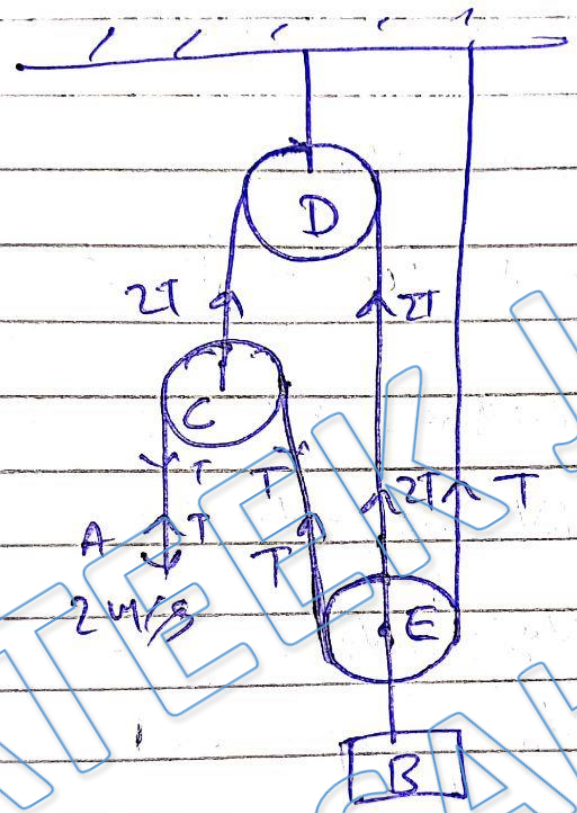
(b) 3 m/s

(c) $\frac{3}{2}$ m/s

(d) $\frac{1}{2}$ m/s



Ans. d



$P_A + P_B = 0$

$T V_A \cos 180^\circ + 4T V_B \cos 180^\circ = 0$

$-T(2) - 4T V_B = 0$

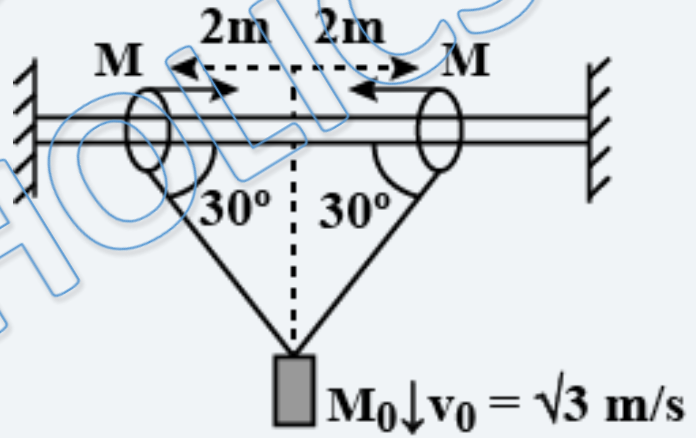
$V_B = -\frac{2}{4} = -\frac{1}{2}$ m/s

$\boxed{V_B = \frac{1}{2} \text{ m/s}}$ upward.

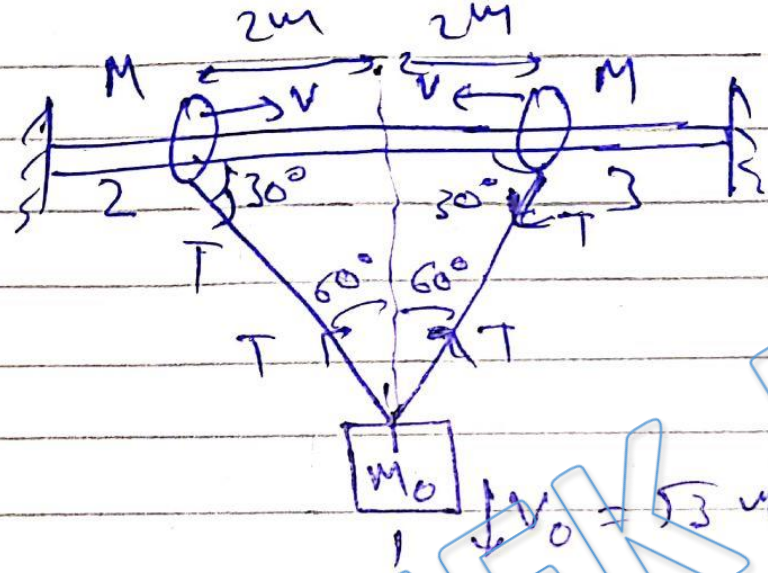
Q) Two rings each of mass M = 100 gm are constrained to move along a fixed horizontal rod An ideal string is connected with rings and block of mass $M_o = 200\ gm$ is connected to the mid point of string At a certain moment the mass m is moving downward with velocity $\sqrt{3}$ m/s. Find the speed of ring of M at the moment:

(a) $4\ m/s$ (b) $3\ m/s$

(c) $2\ m/s$ (d) $1\ m/s$



Ans. d



$V_0 = \sqrt{3}$ m/s

$P_1 + P_2 + P_3 = 0$

$V_0(T(-\cos 60^\circ) + T(\cos 60^\circ) + TV\cos 30^\circ + TV\cos 30^\circ = 0$

$-2TV_0\cos 60^\circ + 2TV\cos 30^\circ = 0$

$V = +V_0\dfrac{\cos 60^\circ}{\cos 30^\circ}$

$V = \dfrac{V_0}{\sqrt{3}} = \dfrac{\sqrt{3}}{\sqrt{3}}$

$\boxed{V = 1 \text{ m/s}}$

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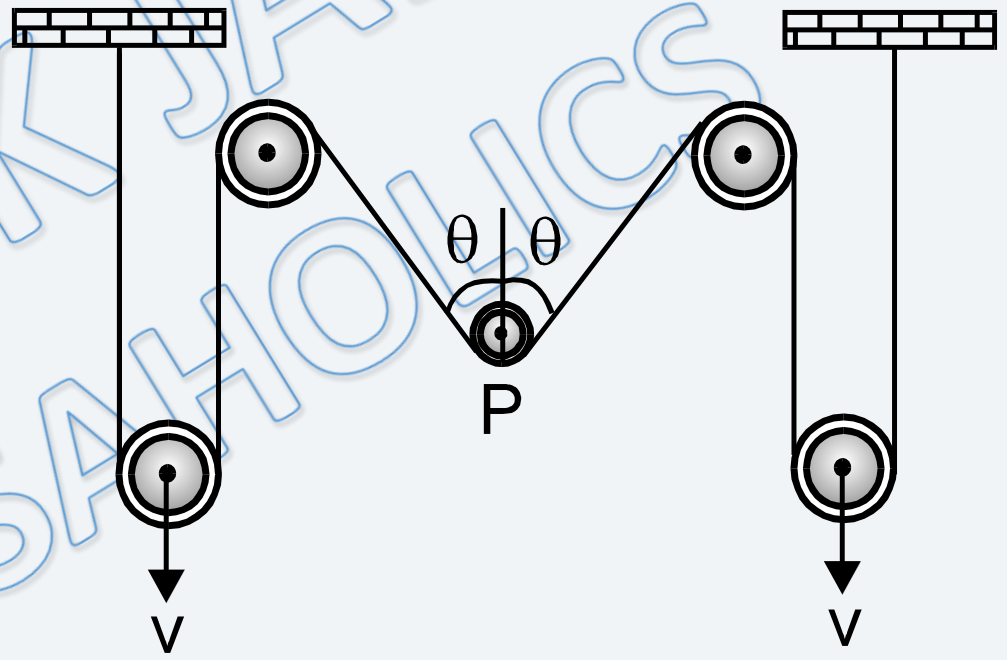
Q) In the given figure, find the speed of pulley P -



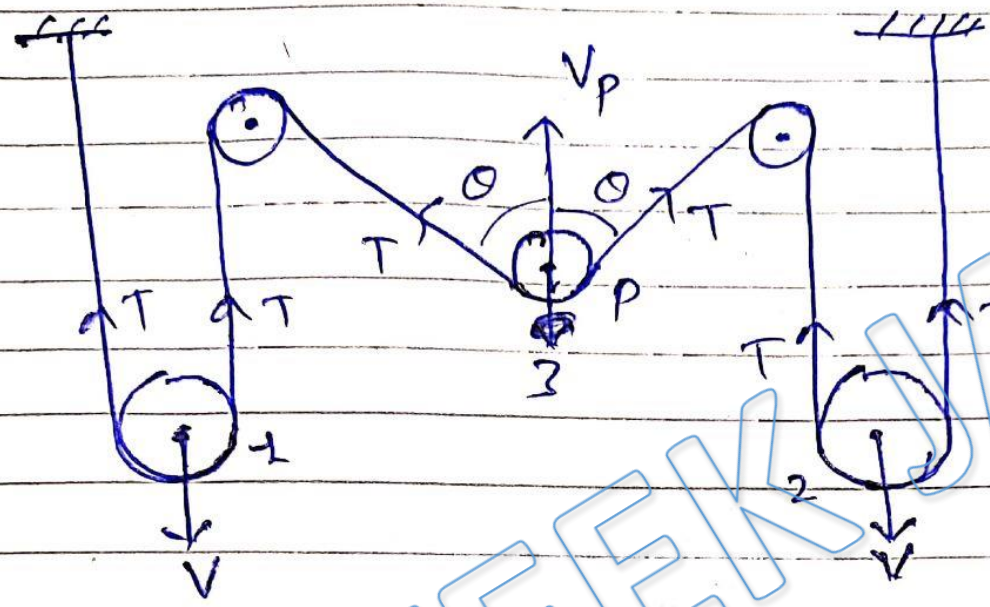
(a) $\frac{V}{2}$

(b) $2V\cos\theta$

(c) $\frac{2V}{\cos\theta}$

(d) $\frac{V}{2\sin\theta}$

Ans. c



$$P_1 + P_2 + P_3 = 0$$

$$2T(V)\cos(180^\circ) + 2T(V)\cos(180^\circ) + 2T\cos\theta\, V_p = 0$$

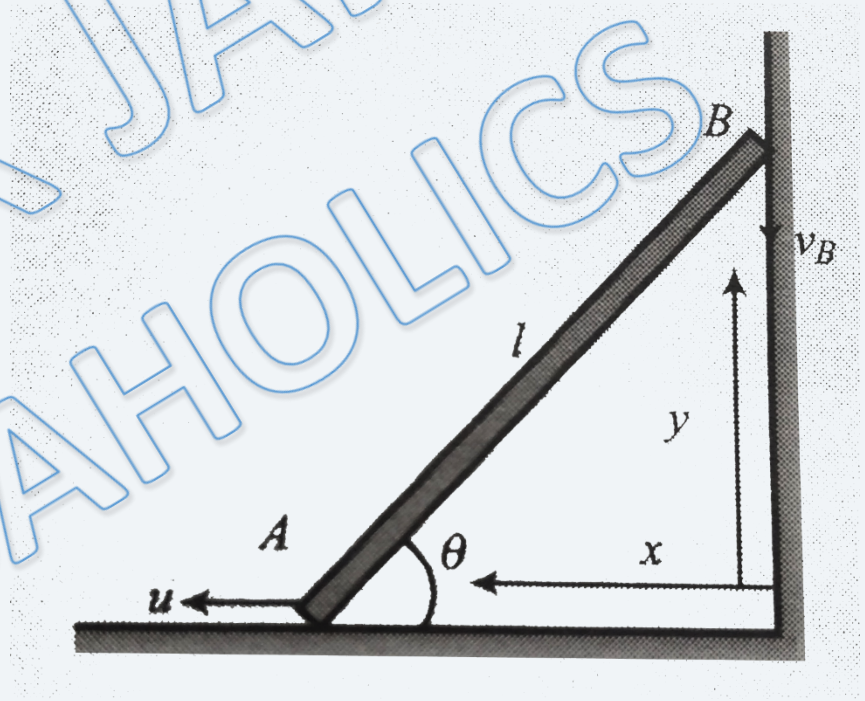
$$-2TV\cos(180^\circ) + 2TV_p\cos\theta = 0$$

$$-2V + V_p\cos\theta = 0$$

$$V_p\cos\theta = 2V$$

$$\boxed{V_p = \frac{2V}{\cos\theta}}$$

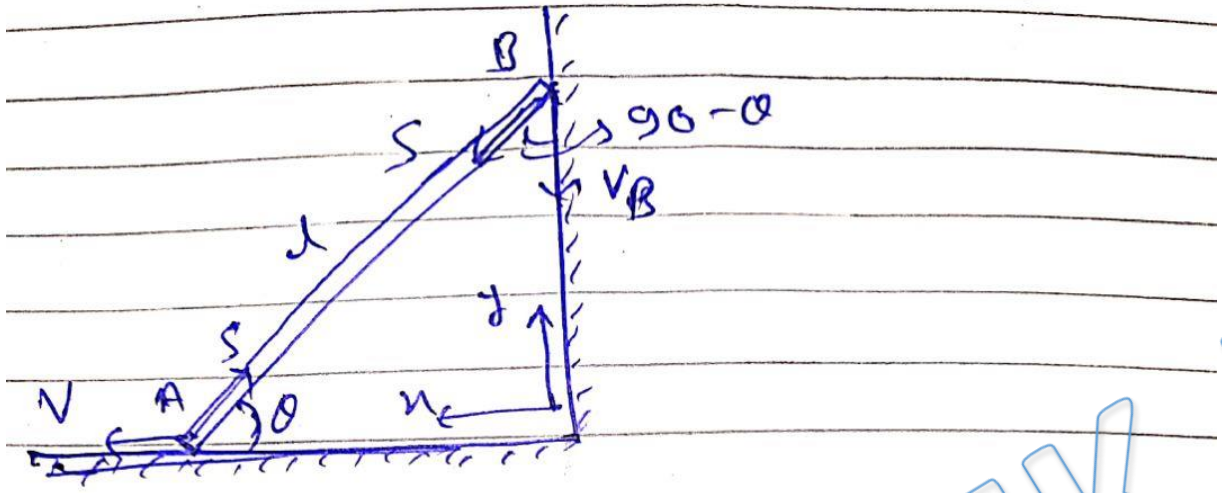
Q) Figure shows a rod of length l resting on a wall and the floor. Its lower end A is pulled towards left with a constant velocity u. As a result of this, end A starts moving down along the wall. Find the velocity of the other end B downward when the rod makes an angle θ with the horizontal:



(a) $u \tan\theta$ (b) $u \cot\theta$

(c) $u \sin\theta$ (d) $u \cos\theta$

Ans. b



Let. stress (or) Tension in rod is 'S'

then $P_A + P_B = 0$

$S V_A \cos(180-\theta) + S V_B \cos(90-\theta) = 0$

$-V_A \cos\theta + V_B \sin\theta = 0$

$V_B = \frac{V_A \cos\theta}{\sin\theta}$

$\boxed{V_B = V_A \cot\theta}$ down ward.

$V_A = u$

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

(or)

$x^2 + y^2 = l^2$

$2x\frac{dx}{dt} + 2y\frac{dy}{dt} = 0$

$x V_A + y(-V_B) = 0$

$(-V_B) = -\frac{x}{y} V_A$

$V_B = \frac{x}{y} V_A = \cot\theta V_A$

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

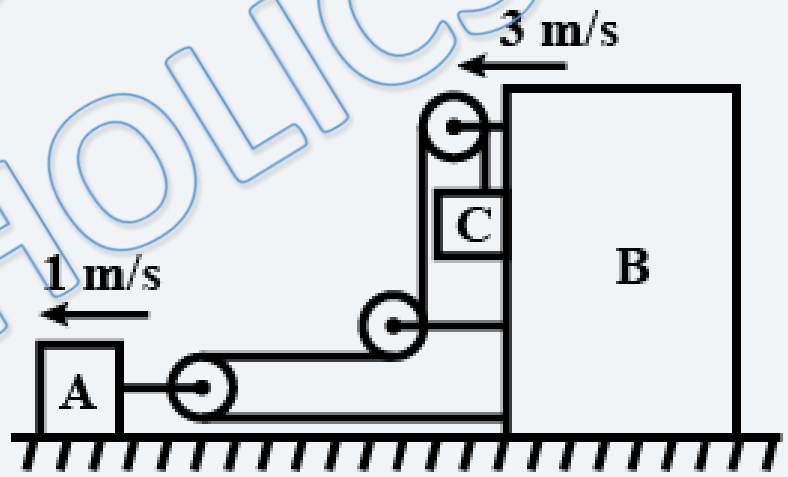
Q) The velocities of A and B are marked in the figure. Find the velocity of block C (assume that the pulleys are ideal and string inextensible)

(a) 2 m/s

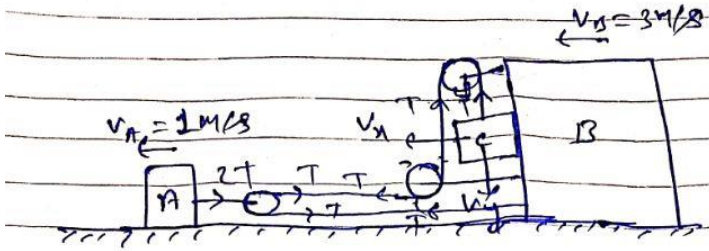
(b) 4 m/s

(c) 5 m/s

(d) $\sqrt{10}$ m/s



Ans. c



V_x of block will be equal to V_B (∵ both are in contact and moving together in x direction)

$\therefore V_x = 3\,m/s$

Now for V_y.

$$P_A + P_B + (P_J)_y = 0$$

$$V_A(2T)\cos(180^\circ) + 2T\,V_B\cos 0^\circ + T\,V_y\cos 180^\circ = 0$$

$$-2V_A + 2V_B + 0 - V_y = 0$$

$$V_y = 2V_B - 2V_A$$

$$V_y = 2\times 3 - 2(1)$$

$$V_y = 4\,m/s$$

$$V = \sqrt{V_x^2 + V_y^2}$$

$$V = \sqrt{3^2 + 4^2}$$

$$\boxed{V = \sqrt{25}\,m/s}$$

$$\boxed{V = 5\,m/s}$$

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Chalo Niklo