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- . Interviewed by International media.



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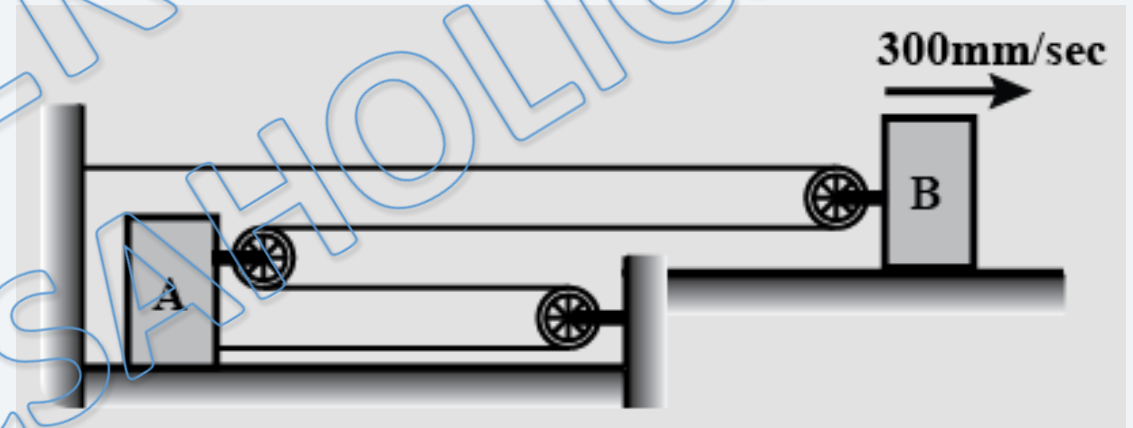
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Physics DPP

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:

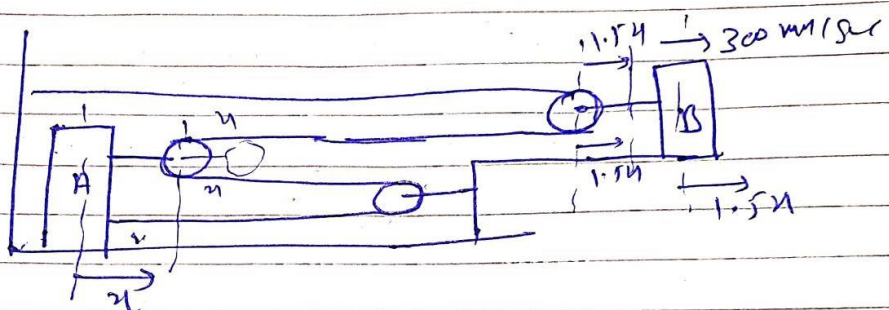
- (a) 100 mm/sec
- (b) 200 mm/sec
- (c) 300 mm/sec
- (d) 400 mm/sec



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Ans. b



$$3x_A = x$$

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

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

$$2x_B = 3x_A$$

$$2V_B = 3V_A$$

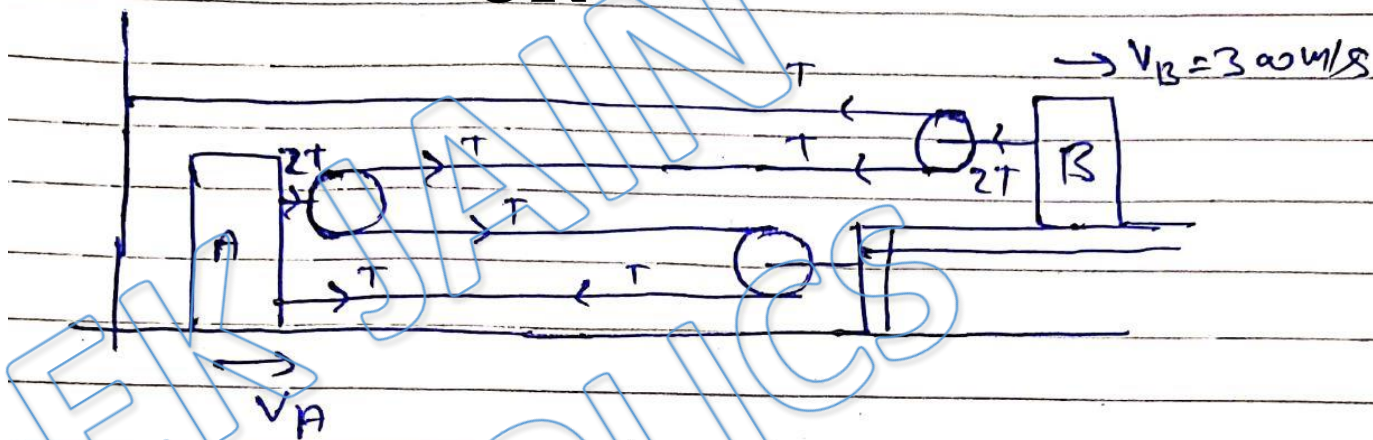
$$V_B = \frac{3}{2} V_A$$

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

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

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

OR



$$P_A + P_B = 0$$

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

$$3V_A - 2V_B = 0$$

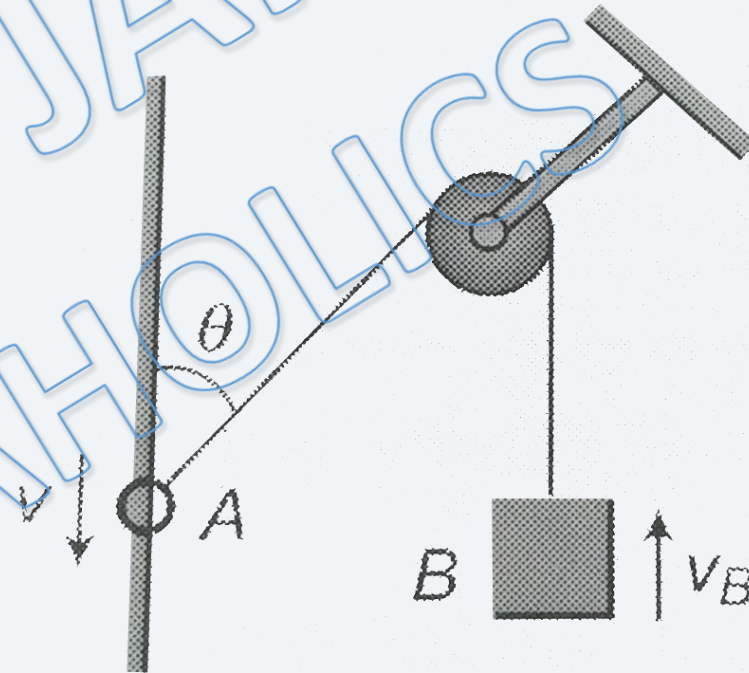
$$3V_A = 2V_B$$

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

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

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

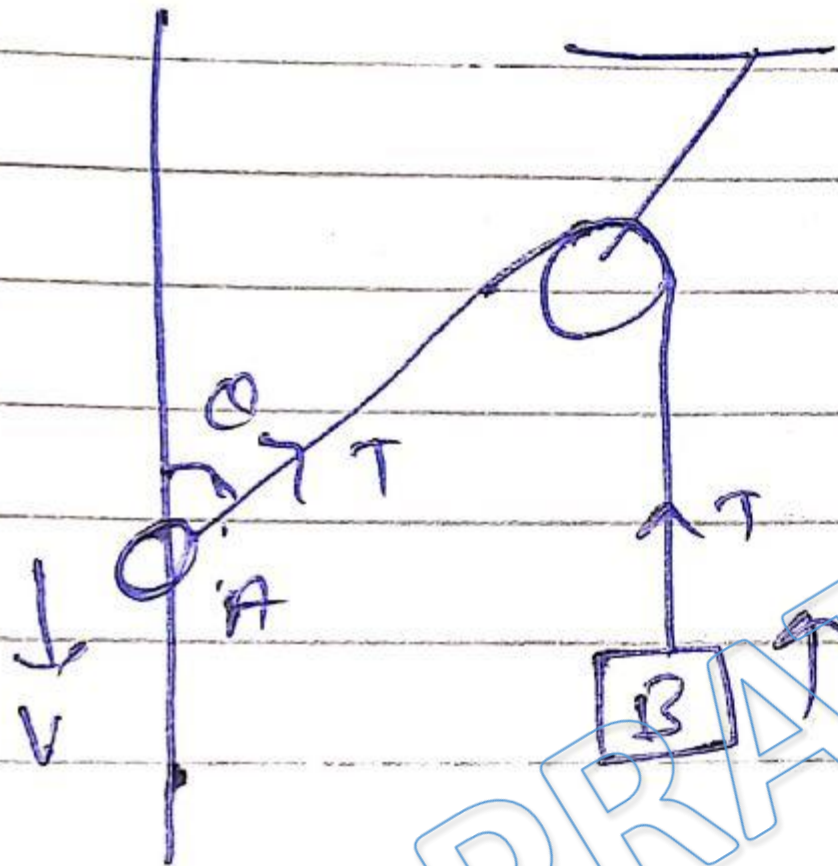
- (a) $v \sin \theta$
- (b) $\frac{v}{2} \sin \theta$
- (c) $v \cos \theta$
- (d) $\frac{v}{2} \cos \theta$



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Ans. c



$$P_A + P_B = 0$$

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

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

$$V_B = V_A \cos 0$$

$$V_A = v$$

$$\therefore V_B = v \cos 0$$

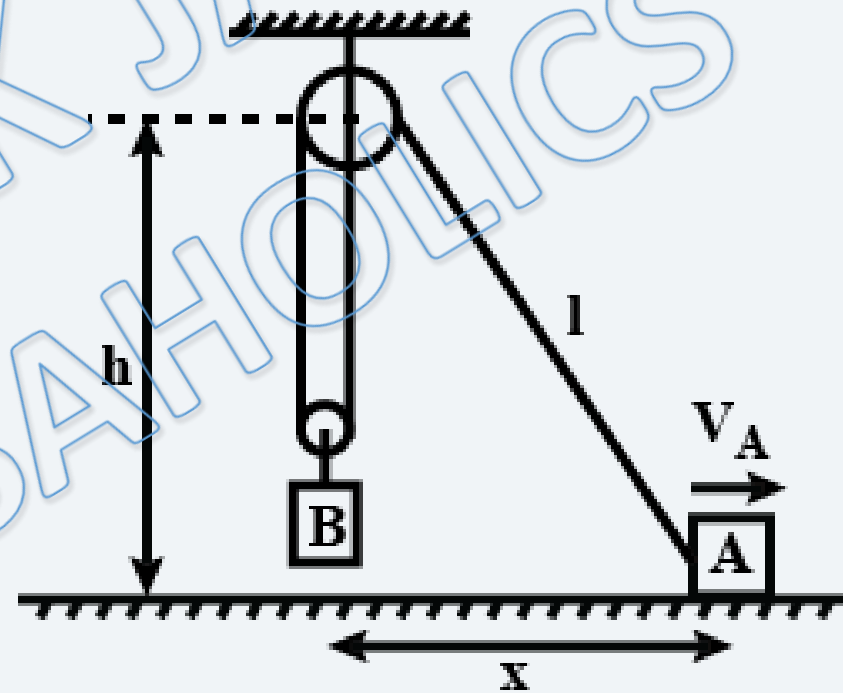
Q) If block A is moving horizontally with velocity V_A , then find the velocity of block B at the instant as shown in fig:

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

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

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

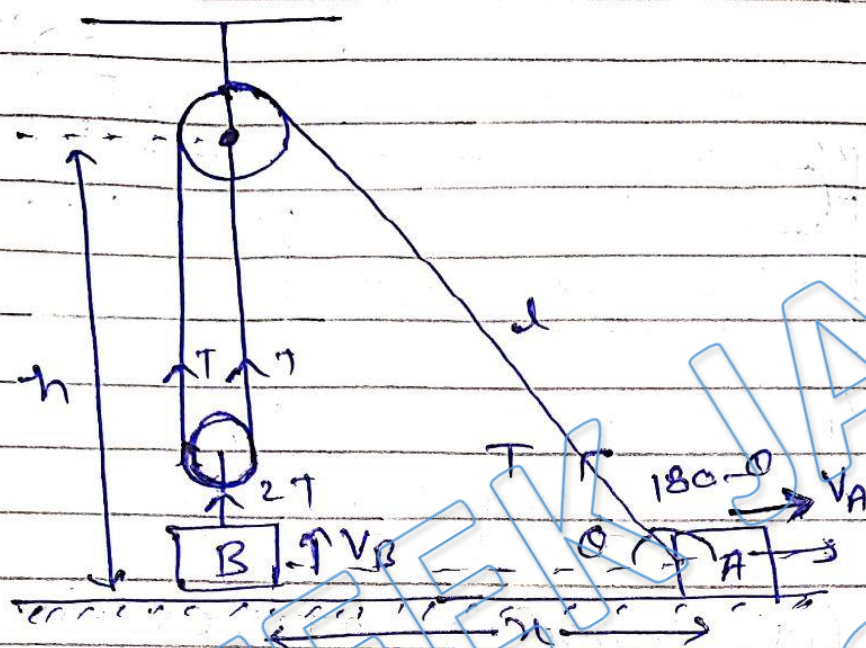
(d) $\frac{hV_A}{\sqrt{x^2+h^2}}$



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Ans. c



$$P_A + P_B = 0$$

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

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

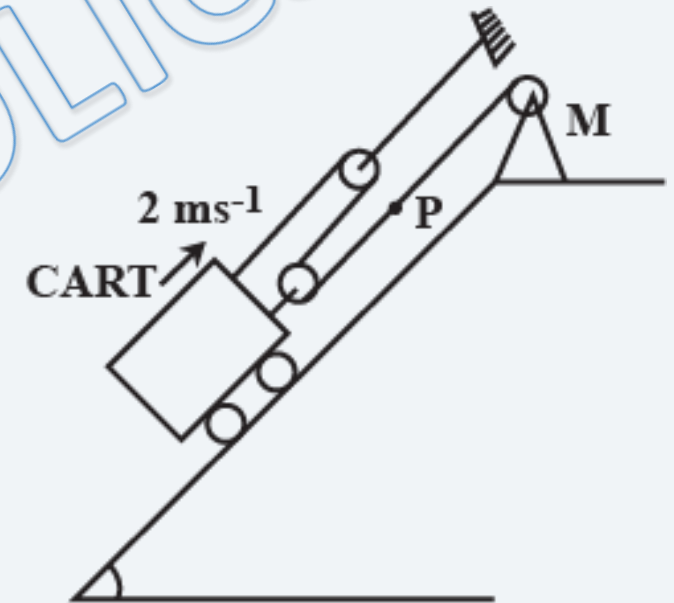
$$V_B = \frac{V_A \cos\theta}{2}$$

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

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

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 $V_{cart} = 2 \text{ m/s}$ is (Incline is at rest):

- (a) 12 m/s (b) 3 m/s
(c) 5 m/s (d) 6 m/s



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Ans. d

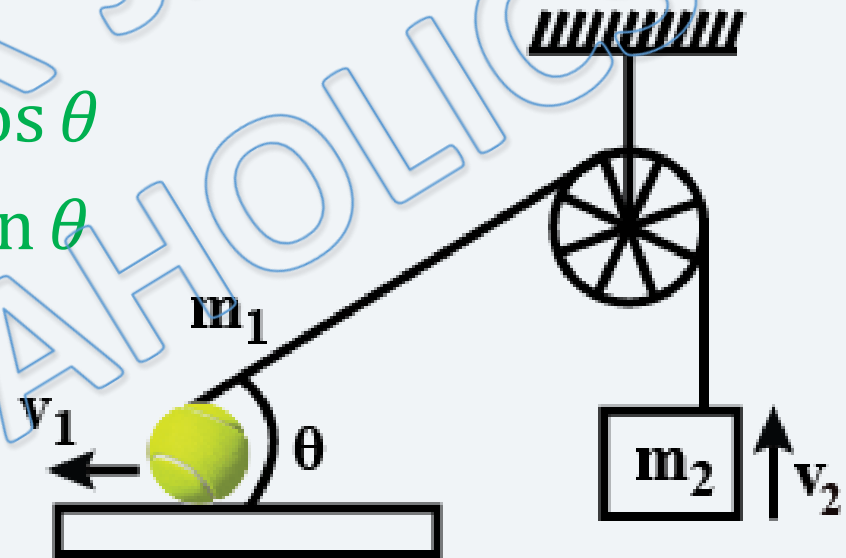
Q) In *Fig.* a ball of mass m_1 and a block of mass m_2 are joined together with an inextensible string. The ball can slide on a smooth horizontal surface. If V_1 and V_2 are the respective speeds of the ball and the block, then determine the constraint relation between velocities of the two.

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

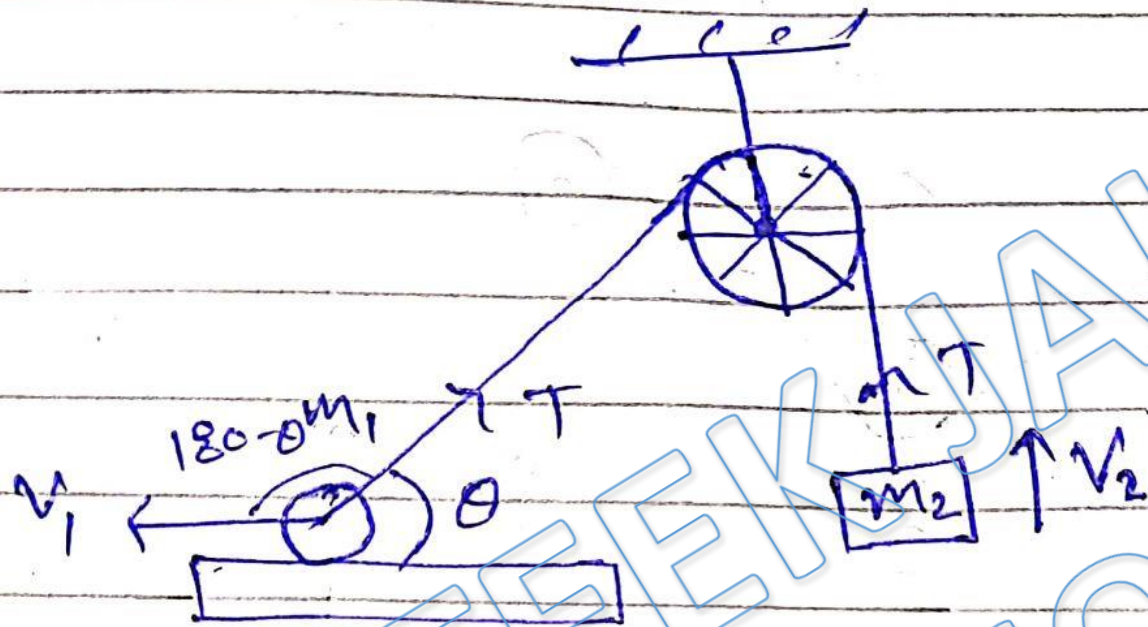
(b) $V_1 = V_2 \cos \theta$

(c) $V_1 = V_2$

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



Ans. a



$$P_1 + P_2 = 0$$

$$T \cdot v_1 \cos(180 - \theta) + T v_2 = 0$$

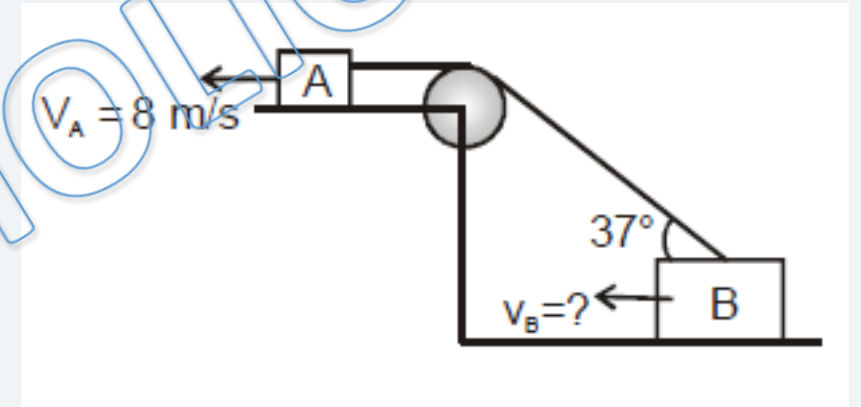
$$-T v_1 \cos \theta + T v_2 = 0$$

$$v_2 = v_1 \cos \theta$$

Q) Find $V_B = ?$

- (a) 10 m/s
(c) 14 m/s

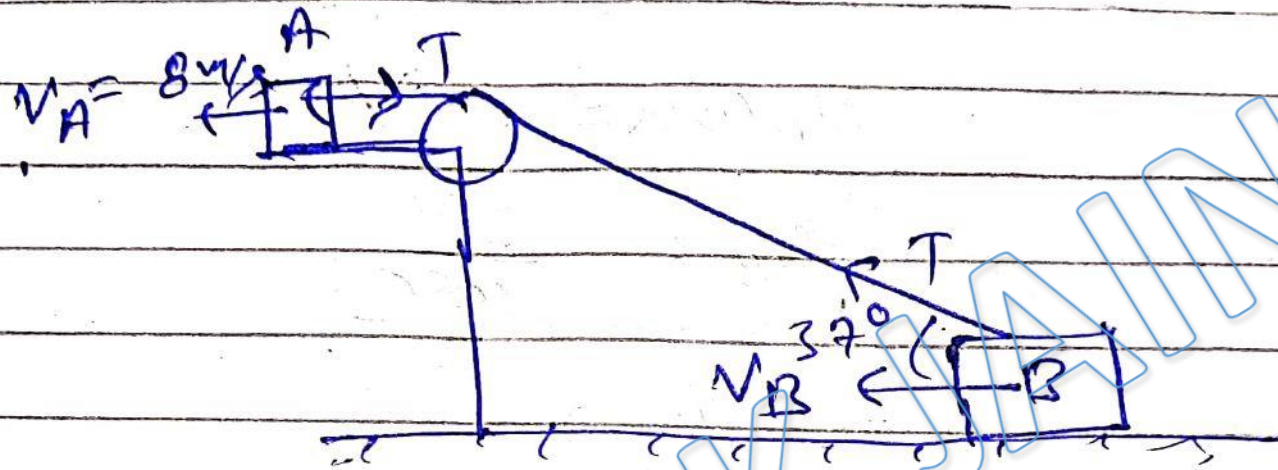
- (b) 8 m/s
(d) 6 m/s



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Ans. a



$$P_A + P_B = 0$$

$$T v_A (\cos(180^\circ)) + T v_B (\cos(37^\circ)) = 0$$

$$-v_A + v_B (\cos 37^\circ) = 0$$

$$v_B \left(\frac{4}{5} \right) = v_A$$

$$v_B = v_A \frac{5}{4} = 8 \times \frac{5}{4}$$

$$v_B = 10 \text{ m/s}$$

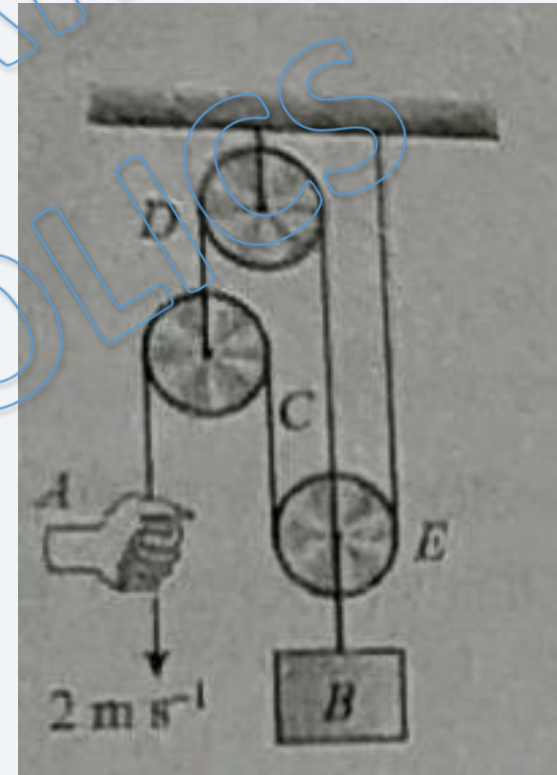
Q) Determine the speed with which block B rises in Fig. if the end of the cord at A is pulled down with a speed of 2 m/s .

(a) 4 m/s

(b) 3 m/s

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

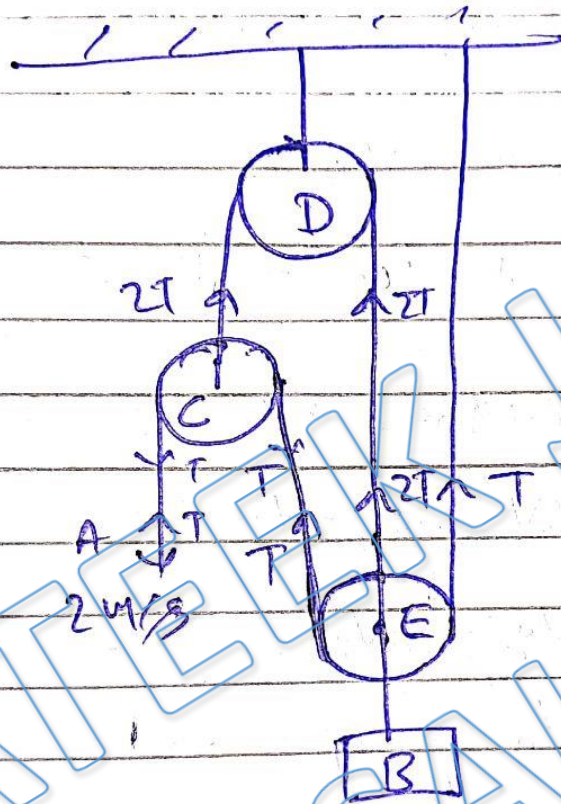
(d) $\frac{1}{2} \text{ m/s}$



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Ans. d



$$P_A + P_B = 0$$

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

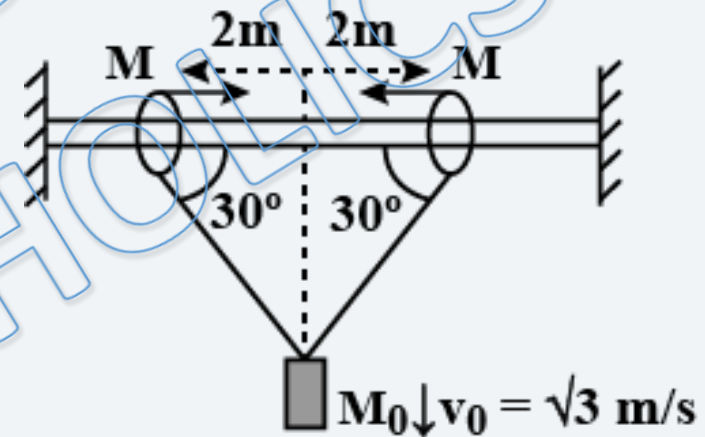
$$-T(2) - 4T V_B = 0$$

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

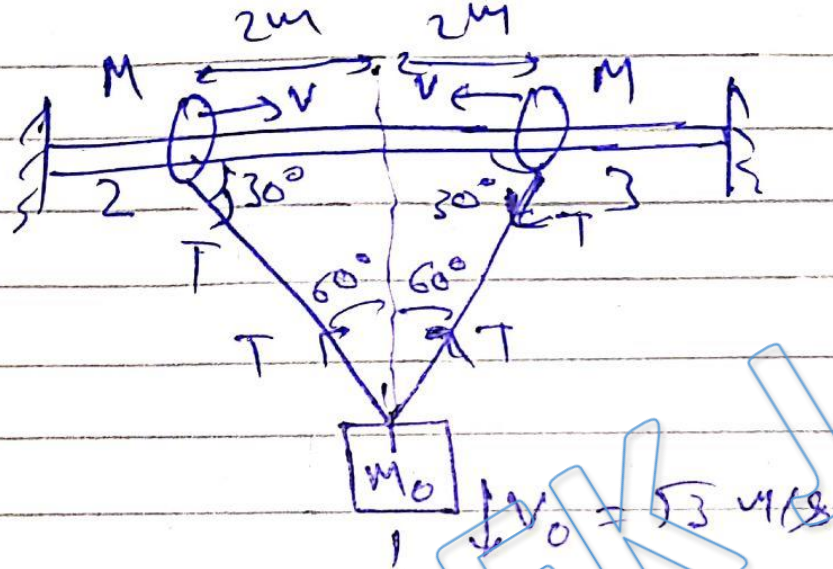
$$\boxed{V_B = \frac{1}{2} \text{ m/s}} \text{ upward,}$$

Q) Two rings each of mass $M = 100 \text{ gm}$ are constrained to move along a fixed horizontal rod. An ideal string is connected with rings and block of mass $M_0 = 200 \text{ gm}$ is connected to the mid point of string. At a certain moment the mass m is moving downward with velocity $\sqrt{3} \text{ m/s}$. 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



$$P_1 + P_2 + P_3 = 0$$

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

$$-2 \times V_0 \cos 60^\circ + 2TV \cos 30^\circ = 0$$

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

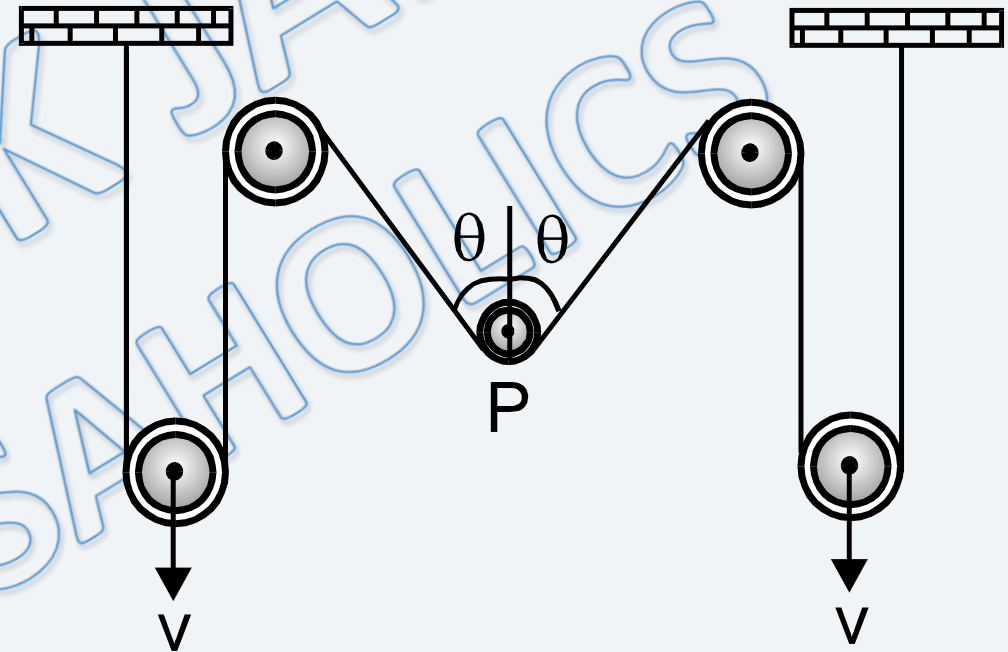
$$V = \frac{V_0}{\sqrt{3}} = \frac{\sqrt{3}}{\sqrt{3}}$$

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

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

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

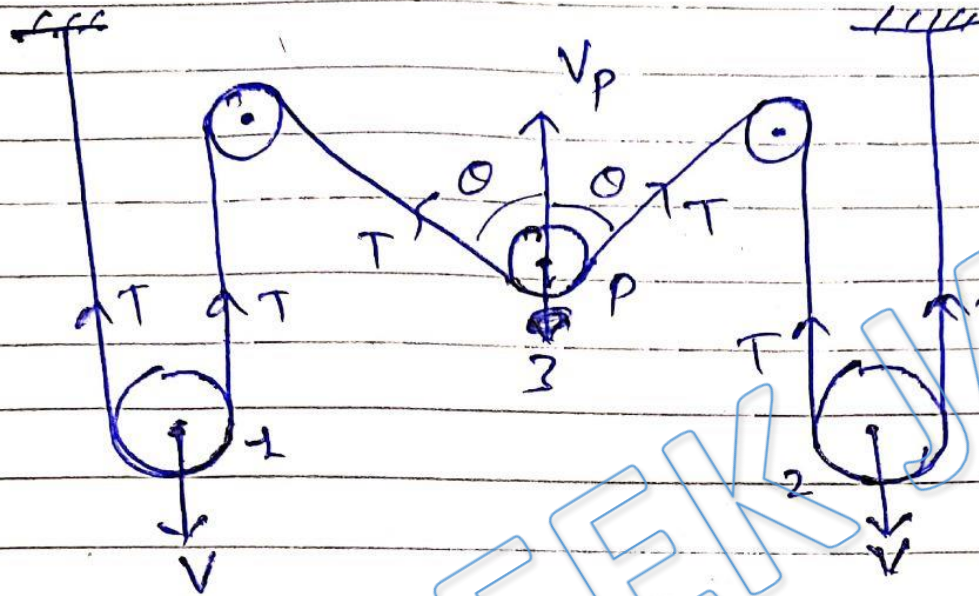
(b) $2V \cos \theta$
 (d) $\frac{V}{2 \sin \theta}$



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Ans. c



$$P_1 + P_2 + P_3 = 0$$

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

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

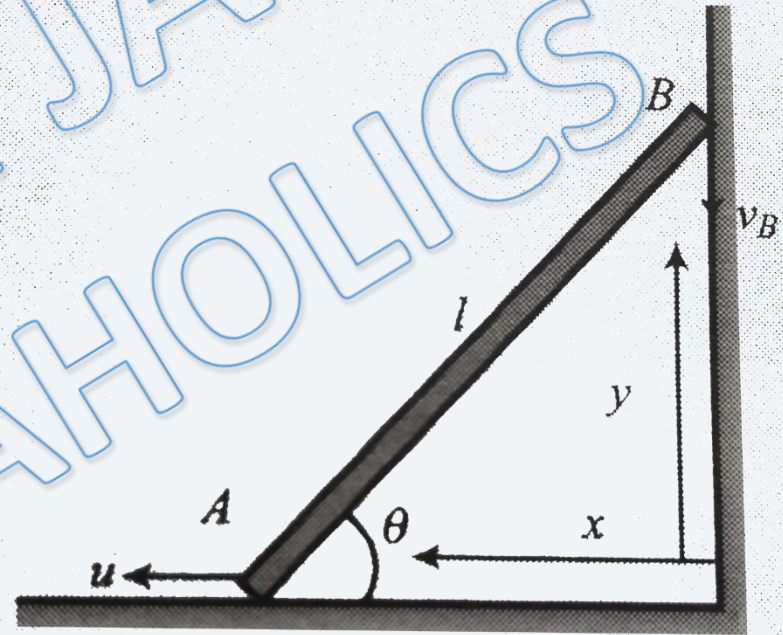
$$-2V + V_p \cos \theta = 0$$

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

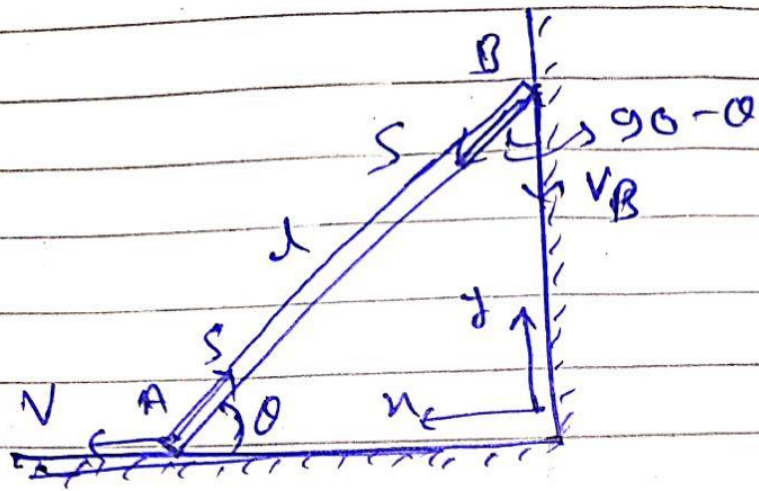
$$\boxed{V_p = \frac{2V}{\cos \theta}}$$

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 $P_A + P_B = 0$

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

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

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

$$V_B = V_A \cot \theta \quad \text{downward.}$$

$$V_A = u$$

$$V_B = u \cot \theta$$

(or)

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

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

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

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

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

$$V_B = V_A \cot \theta = u \cot \theta$$

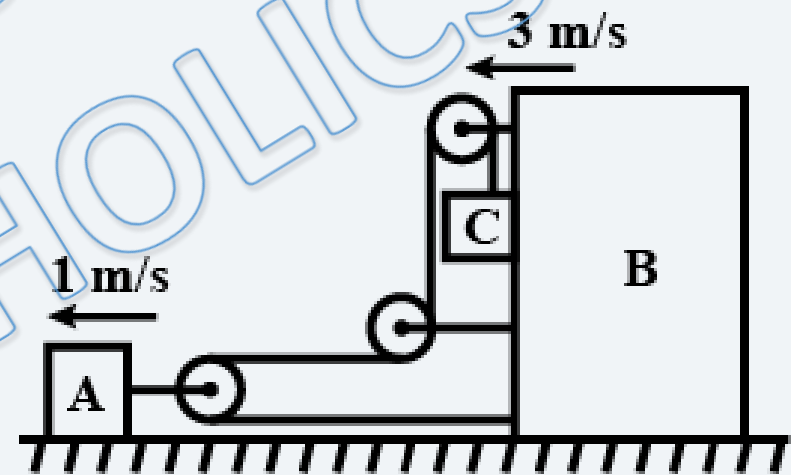
Q) The velocities of A and B are marked in the figure. Find the velocity of block C (assume that the pulleys are ideal and string inextensible)

(a) 2 m/s

(b) 4 m/s

(c) 5 m/s

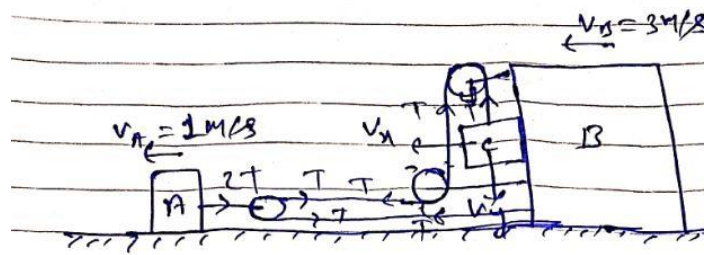
(d) $\sqrt{10}$ m/s



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Ans. c



v_x of block will be equal to v_B (\because both are in contact and moving together in a direction)

$$\therefore v_x = 3 \text{ m/s}$$

Now for v_y .

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

$$v_A(2T) \cos(180^\circ) + 2T v_B \cos 0^\circ + T v_y \cos 180^\circ = 0$$

$$-2v_A + 2v_B - v_y = 0$$

$$v_y = 2v_B - 2v_A$$

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

$$v_y = 4 \text{ m/s}$$

$$v = \sqrt{v_x^2 + v_y^2}$$

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

$$v = \sqrt{25} \text{ m/s}$$

$$v = 5 \text{ m/s}$$

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