PRAYAS

JEE 2025

Lecture - 03

Physics

Oscillations

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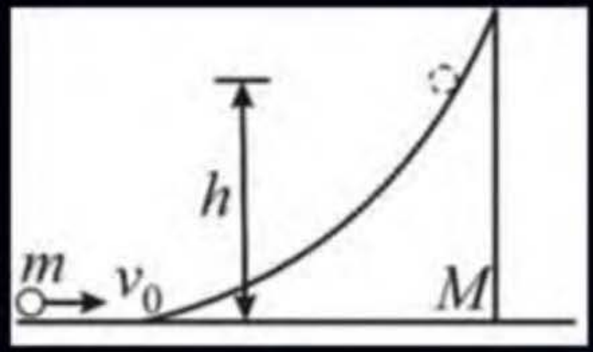
Topics to be covered

1. Com H.w Discussion (till 50 mint)
2. Eq^ of SHM
3.
4.

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



13. The final velocity of the wedge v_2 is:

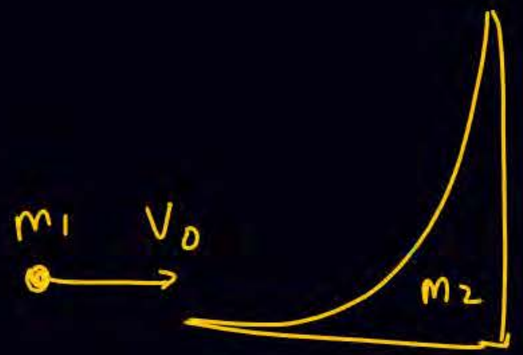
(1) $\frac{mv_0}{M}$

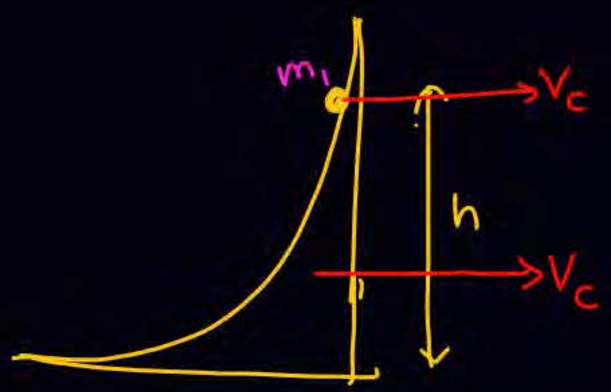
(2) $\frac{mv_0}{M+m}$

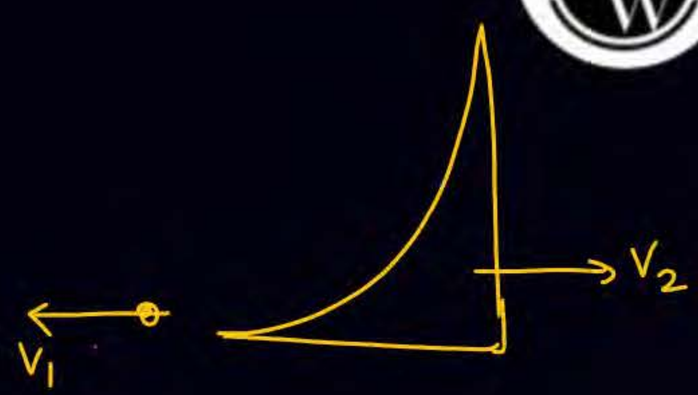
(3) v_0

(4) insufficient data

Ans. (2)







$$m_1V_0 + 0 = (m_1+m_2)V_c = -m_1V_1 + m_2V_2$$

$$0 + \frac{1}{2}m_1V_0^2 = m_1gh + \frac{1}{2}(m_1+m_2)V_c^2 = 0 + \frac{1}{2}m_1V_1^2 + \frac{1}{2}m_2V_2^2$$

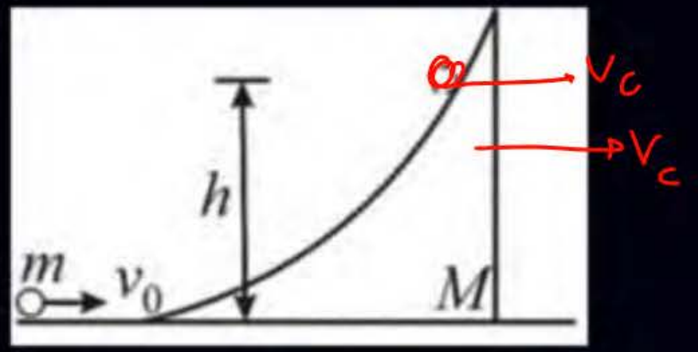
V_c = ✓

$\frac{1}{2}m_1V_1^2$ ✓

$\frac{1}{2}m_2V_2^2$ ✓

$$V_c = \frac{m_1V_0}{m_1+m_2}$$

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



14. When the particle has risen to a height h on the wedge, then choose the correct alternative(s)

(1) The particle is stationary with respect to ground

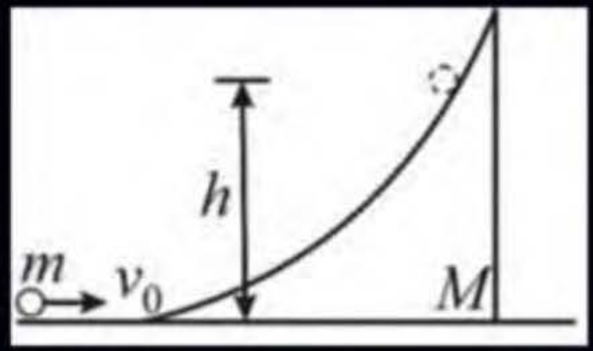
(2) Both are stationary with respect to the centre of mass

(3) The kinetic energy of the centre of mass remains constant

(4) The kinetic energy with respect to centre of mass is converted into potential energy

Ans. (2, 4)

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



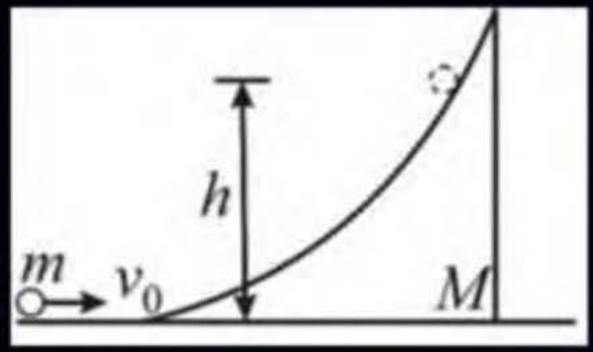
15. The maximum height h attained by the particle is:

(1) $\left(\frac{m}{m+M}\right)\frac{v_0^2}{2g}$ (2) $\left(\frac{m}{M}\right)\frac{v_0^2}{2g}$

(3) $\left(\frac{M}{m+M}\right)\frac{v_0^2}{2g}$ (4) None of these

Ans. (3)

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



16. Identify the correct statement(s) related to the situation when the particle starts moving downward

(1) The centre of mass of the system remains stationary

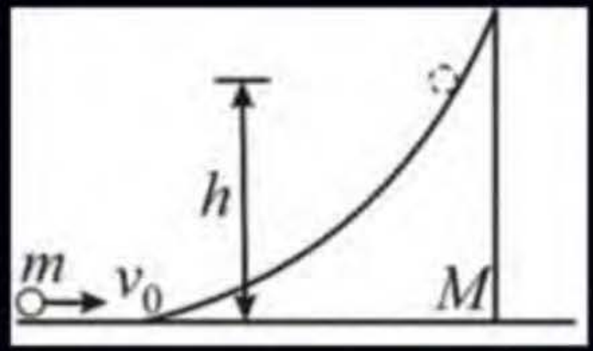
(2) Both the particle and the wedge remain stationary with respect to centre of mass

(3) When the particle reaches the horizontal surface its velocity relative to the wedge is v_0

(4) None of these

Ans. (3)

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



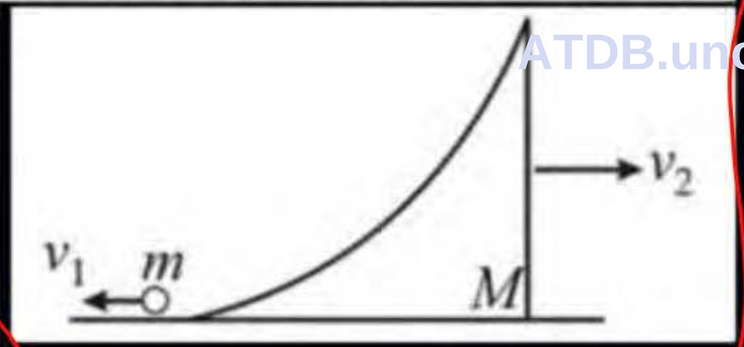
17. Suppose the particle when reaches the horizontal surfaces, its velocity with respect to ground is v_1 and that of wedge is v_2. Choose the correct statement (s)

(1) $mv_1 = Mv_2$

(2) $Mv_2 - mv_1 = mv_0$

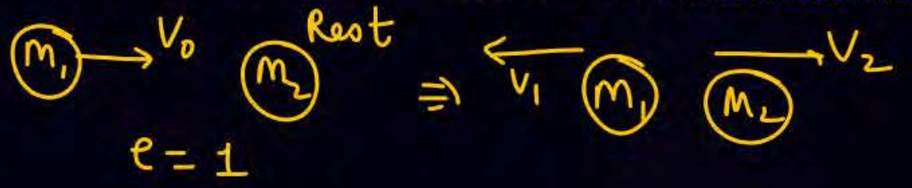
(3) $v_1 + v_2 = v_0$

(4) $v_1 + v_2 < v_0$



$$mV_0 = -mV_1 + MV_2$$

$$\frac{1}{2}mV_0^2 = \frac{1}{2}mV_1^2 + \frac{1}{2}MV_2^2$$



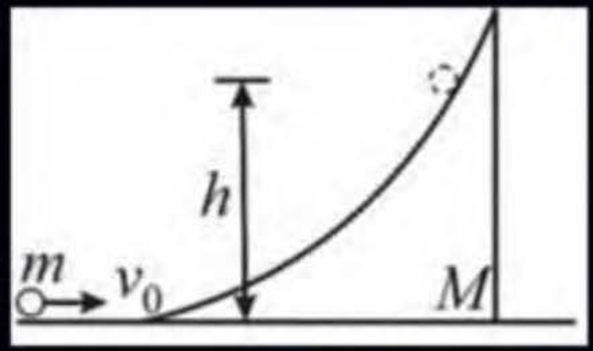
$$m_1V_0 = -m_1V_1 + m_2V_2$$

$$e = 1 = V_2 + V_1 / V_0$$

$$\frac{1}{2}m_1V_0^2 = \frac{1}{2}m_1V_1^2 + \frac{1}{2}m_2V_2^2$$

Ans. (2, 3)

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



18. From above Q. 17 choose the correct statement(s) related to particle m.

(1) Its kinetic energy is $K_f = \left(\frac{mM}{m+M}\right)gh$

(2) $v_1 = v_0\left(\frac{M-m}{M+m}\right)$

(3) The ratio of its final kinetic energy to its initial kinetic energy is $\frac{K_f}{K_i} = \left(\frac{M}{m+M}\right)^2$

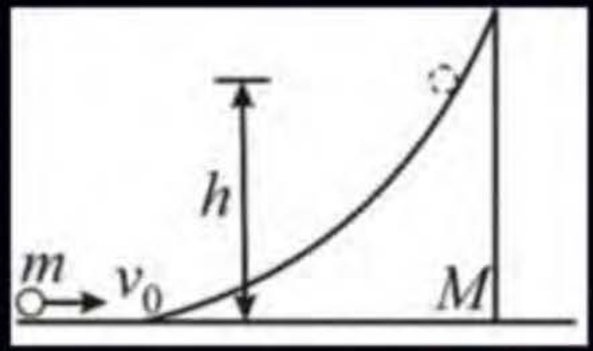
(4) It moves opposite to its initial direction of motion.

put

$\frac{1}{2}mV_i^2$

Ans. (2, 4)

Comprehension (Q. 13 to 19): A particle of mass m moving horizontal with v_0 strikes a smooth wedge of mass M, as shown in fgure. After collision, the ball starts moving up the inclined face of the wedge and rises to a height h.



19. Choose the correct statement related to the wedge M.

(1) Its kinetic energy is $K_f = \left(\frac{4m^2}{m+M}\right)gh$

(2) $v_2 = \left(\frac{2m}{m+M}\right)v_0$

(3) Its gain in kinetic energy is $\Delta K = \left(\frac{4mM}{(m+M)^2}\right)\left(\frac{1}{2}mv_0^2\right)$

(4) Its final velocity is more that the velocity of centre of mass.

$\frac{1}{2}m_2V_2^2$ = (A), (C)

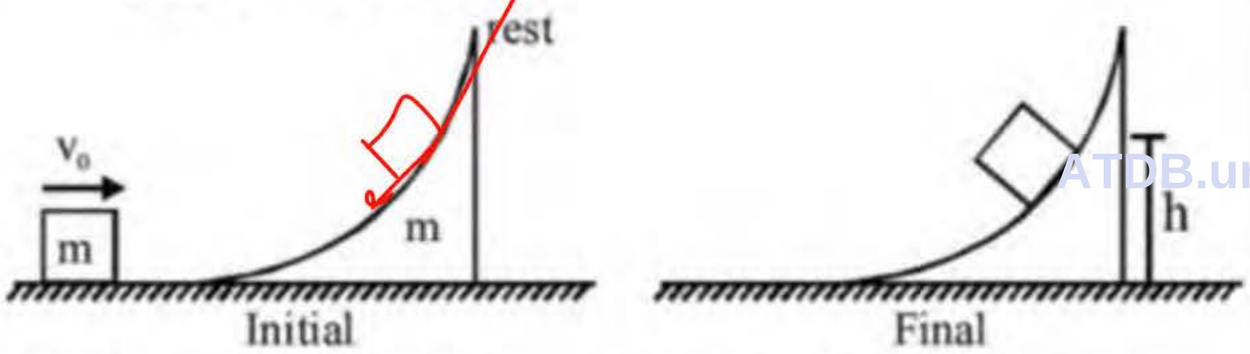
$\frac{4m_1^2}{m_1+m_2} \times g \times \frac{m_2V_0^2}{2g(m_1+m_2)}$

$\frac{1}{2} \times \frac{4m_1^2 m_2V_0^2}{(m_1+m_2)^2} = \frac{4m_1m_2}{(m_1+m_2)^2}\left(\frac{1}{2}m_1V_0^2\right)$

Same

Ans. (1, 2, 3, 4)

42. In the arrangement shown, horizontal surface is smooth, but friction is present between the block and the surface of the wedge. Block is given velocity v_0 at $t = 0$. After achieving height 'h' on the wedge, block comes to rest with respect to wedge at $t = t_0$. Then from $t = 0$ to $t = t_0$:



(1) Work done by friction on the block is negative

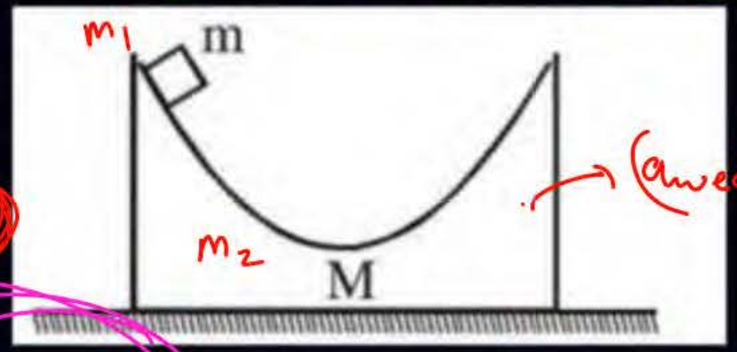
(2) Work done by friction on the wedge is negative

(3) Work done by block on the wedge is positive

(4) Work done by wedge on the block is positive

Ans. (1, 3)

43. Figure shows a wedge on which a small block is released from rest. All the surfaces are smooth system comprises of wedge and blocks. Mark the correct statement(s) regarding motion of block on wedge till block attains maximum height on wedge.



$p_i = p_f$ $0 = m_1 v_c + m_2 V_c$ $V_c = 0$

$(a_{wedge})_y = 0$

a_{com} ⊥ to

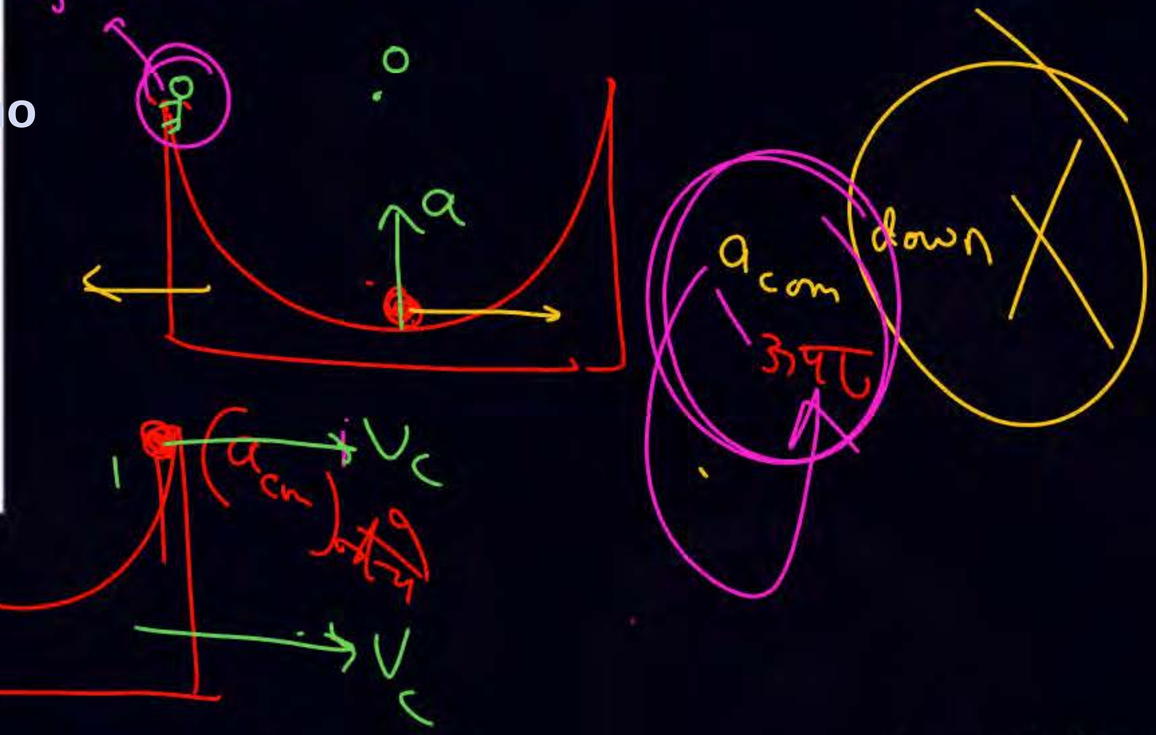
$(a_{xc})_{com} = 0$ (always)

(1) Acceleration of centre of mass of system is initially vertically down then vertically up.

(2) Initially centre of mass moves down and then up.

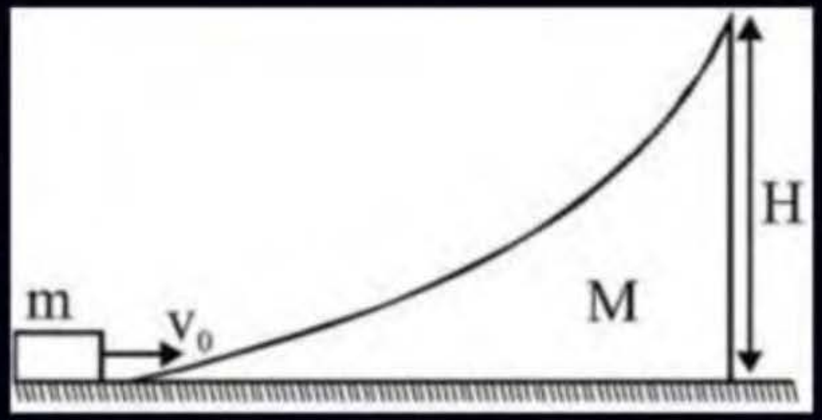
(3) At the maximum height block and wedge move with common velocity. $= 0$

(4) Centre of mass of wedge moves towards left then right.



Ans. (2, 3)

44. Figure shows a block of mass m projected with velocity v_0 towards a wedge. Consider all the surfaces to be smooth. Block does not have sufficient energy to negotiate (over come) wedge. Mark the correct option(s):



(1) when block is at the maximum height on wedge, block and wedge have velocity equal to velocity of centre of mass of block wedge system

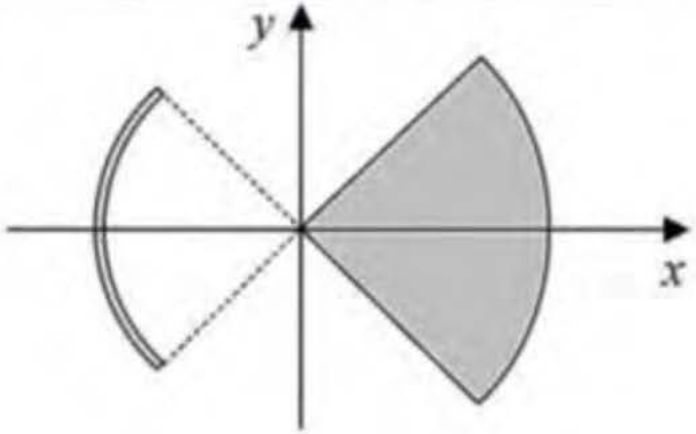
(2) wedge acquires maximum speed with respect to ground when block returns to lowest point on wedge.

(3) momentum of wedge and block is conserved at all times

(4) centre of mass of wedge and block remains stationary

Ans. (1, 2)

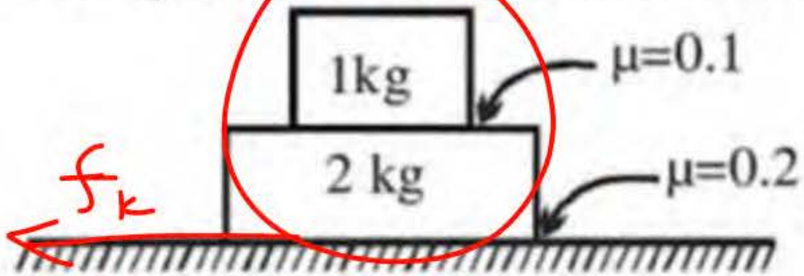
45. A sector cut from a uniform disk of radius 12 cm and a uniform rod of the same mass bent into shape of an arc are arranged facing each other as shown in the figure. If center of mass of the combination is at the origin, what is the radius of the arc?



(1) 8 cm
(2) 9 cm
(3) 12 cm
(4) 18 cm

Ans. (1)

46. If both the blocks as shown in the given arrangement are given together a horizontal velocity towards right. If a_{cm} be the subsequent acceleration of the centre of mass of the system of blocks then a_{cm} equals.



$a_{cm} = \frac{f_k}{m_1 + m_2}$

(1) $0\ m/s^2$

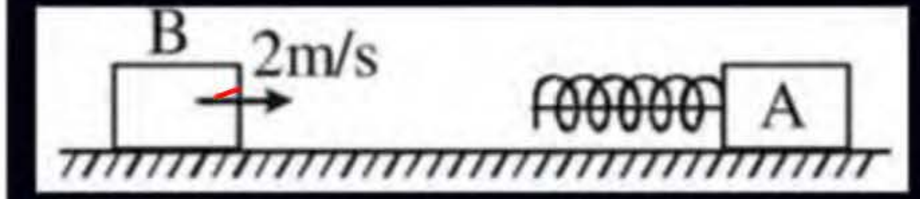
(2) $\frac{5}{3} m/s^2$

(3) $\frac{7}{3} m/s^2$

(4) $2\ m/s^2$

Ans. (4)

53. Figure shows a block A of mass 5 kg kept at rest on a horizontal smooth surface. A spring ($K = 200$ N/m) which is compressed by 10 cm and tied with the help of a string to maintain the compression is attached to block A as shown in figure. Block B also of mass 5 kg moving with 2 m/s collides with A, as shown. During the collision the string breaks and after the collision the spring is in its natural state. Assume the bodies to be elastic and let the velocities of A and B be v_1 and v_2 respectively assuming positive direction towards right, after collision. Then



(1) $v_1 + v_2 > 2$

(2) Initial kinetic energy of system = final kinetic energy of system

(3) $v_1^2 + v_2^2 = 4.4\ (\text{m/s})^2$

(4) $v_1 - v_2 = 2$

$2 + 0 = -v_1 + v_2$

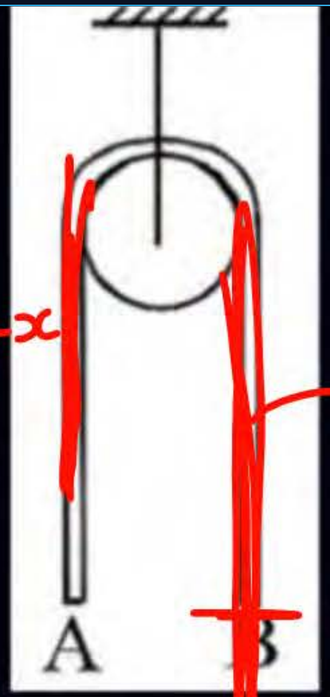
$(m\varepsilon)_i = (m\varepsilon)_f$

$\frac{1}{2}mv_0^2 + \frac{1}{2}kx^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$

Ans. (*)

Paragraph for Question No. 55 and 56

A uniform chain of length $2L$ is hanging in equilibrium position, if end B is given a slightly downward displacement the imbalance causes an acceleration. Here pulley is small and smooth & string is inextensible.



55. The acceleration of end B when it has been displaced by distance x, is:

(1) $\frac{x}{L}g$ (2) $\frac{2x}{L}g$

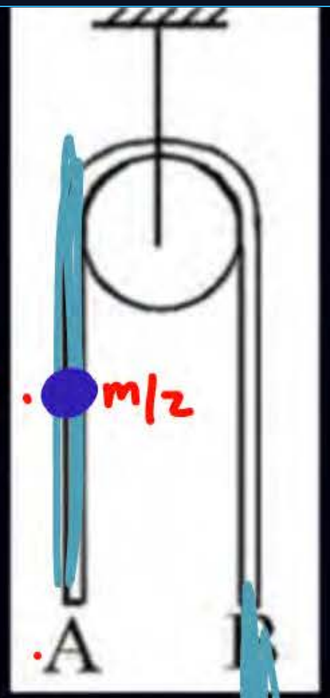
(3) $\frac{x}{2}g$ (4) g

$$a = \left(\frac{(L+x)\lambda - (L-x)\lambda}{2L\cdot\lambda}\right)g$$

Ans. (1)

Paragraph for Question No. 55 and 56

A uniform chain of length $2L$ is hanging in equilibrium position, if end B is given a slightly downward displacement the imbalance causes an acceleration. Here pulley is small and smooth & string is inextensible.



56. The velocity v of the string when it slips out of the pulley (height of pulley from floor $> 2L$).

(1) $\sqrt{\frac{gL}{2}}$ (2) $\sqrt{2gL}$

(3) $\sqrt{gL}$ (4) none of these

$\frac{m}{2}gL = \frac{1}{2}mv^2 - 0$

$v = \sqrt{gL}$

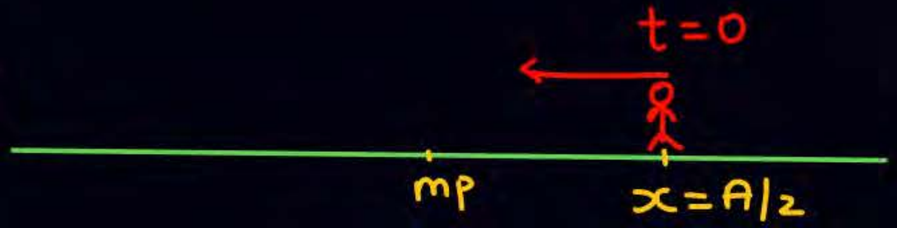
Ans. (3)

SHM

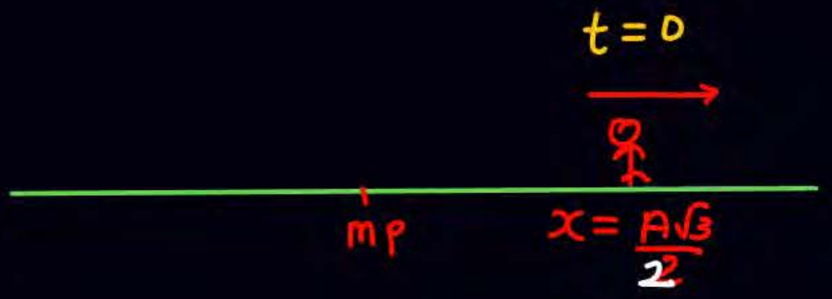
Q

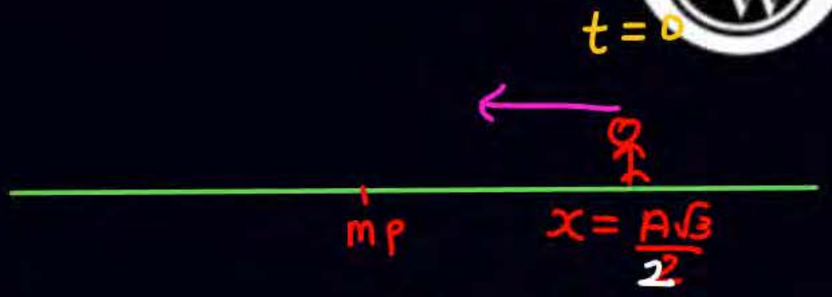
$y = A\sin(\omega t + 30^\circ)$

Q $y = A\sin(\omega t + 150^\circ)$



Q

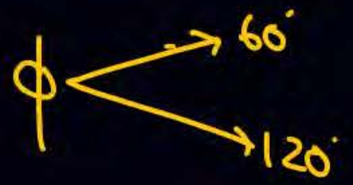




$$x = A\sin(\omega t + \phi)$$

$$t=0,\ x = \frac{A\sqrt{3}}{2} = A\sin(0+\phi)$$

$$\sin\phi = \frac{\sqrt{3}}{2}$$



$$t=0,\ v>0$$

$$v = A\omega\cos(\omega t+\phi)$$

$$v = A\omega\cos\phi > 0$$

$$\cos\phi > 0$$

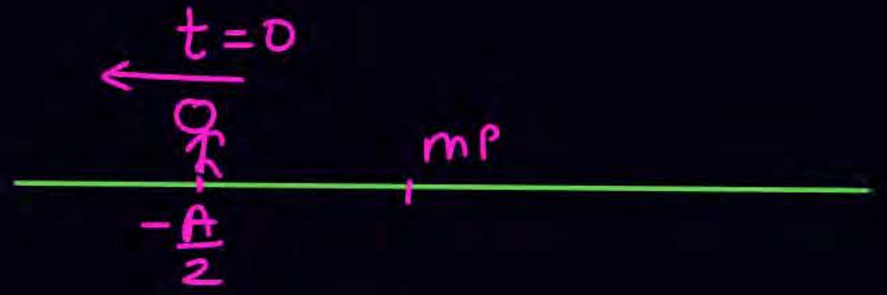
$$\phi = 60^\circ$$

$$y = A\sin(\omega t + 60)$$

$$\phi = 120^\circ$$

$$x = A\sin(\omega t + 120^\circ)$$

Q



$x = A\sin(\omega t + \phi)$

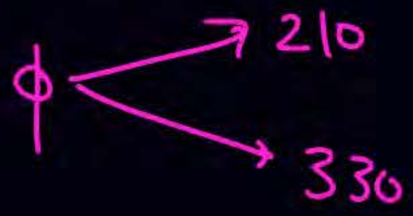
$v = A\omega\cos(\omega t + \phi) < 0$, (at $t = 0$)

$t=0,\ -\frac{A}{2} = A\sin\phi$

$\cos\phi < 0$

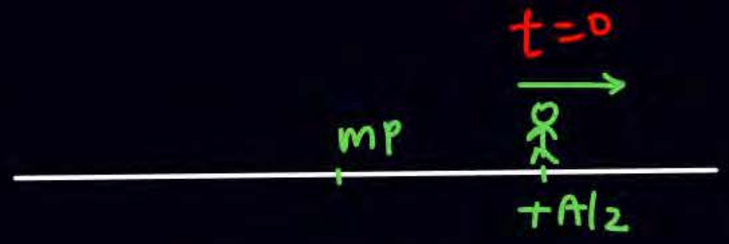
$\sin\phi = -\frac{1}{2}$

$\phi = 210$ ✓



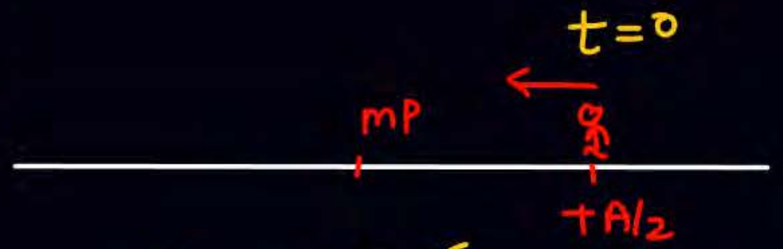
$x = A\sin(\omega t + 210)$

Q



$x = A\sin(\omega t + 30)$

Q

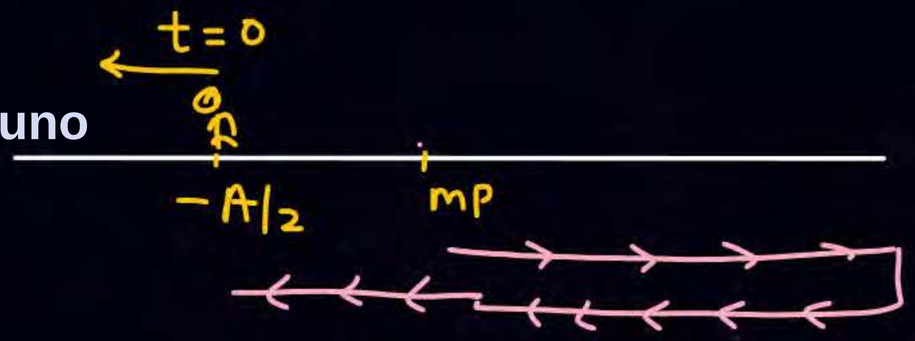


$x = A\sin(\omega t + 150)$

Q

$x = A\sin(\omega t + 45)$

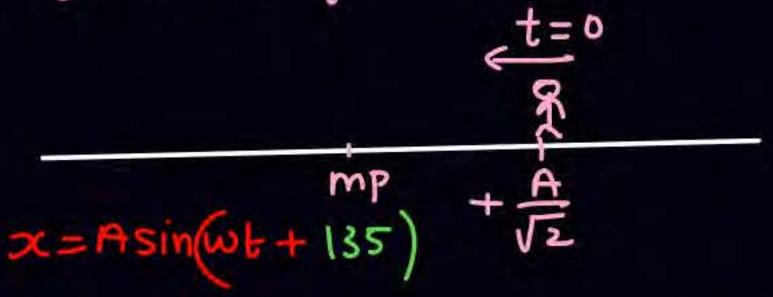
Q



$\phi = 90 + 90 + 30 = 210$

$x = A\sin(\omega t + 210)$

Q find eq^n of SHM



$x = A\sin(\omega t + 135)$

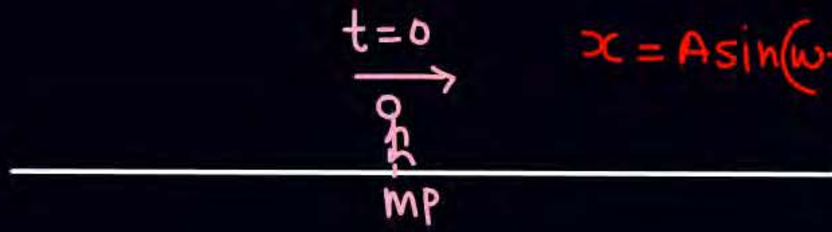
Q

$x = A\sin(\omega t + 90)$

Q

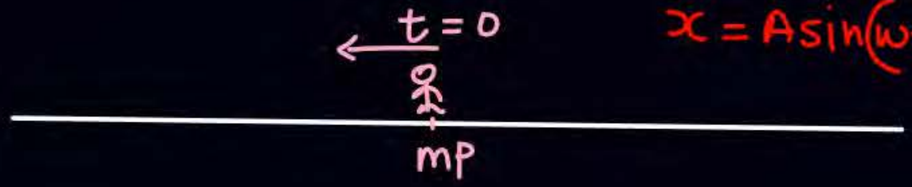
$x = A\sin(\omega t + 270)$

Q



$x = A\sin(\omega t + 0)$

Q

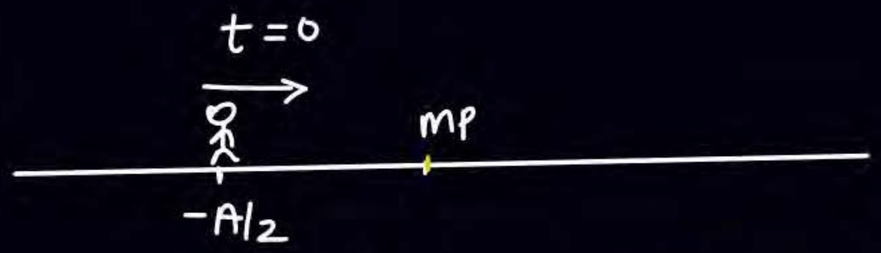


$x = A\sin(\omega t + 180)$

Q

$x = A\sin(\omega t + 225)$

Q



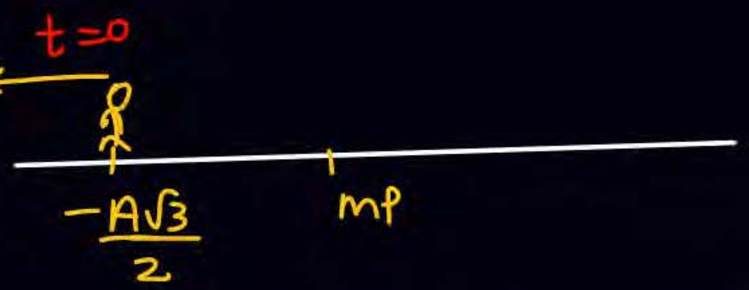
$$x = A\sin(\omega t + 330)$$

or

$$x = A\sin(\omega t - 30)$$

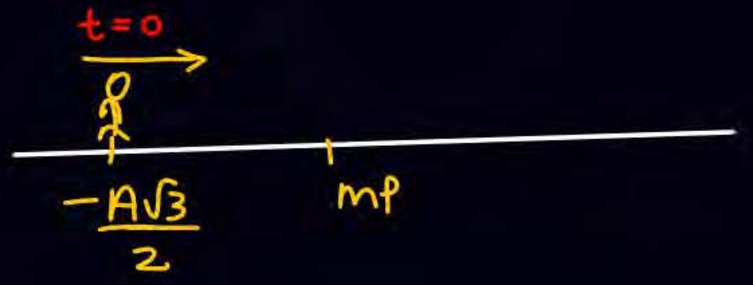
$$x = A\sin(\omega t - 30 + 360)$$

Q



$$x = A\sin(\omega t + 240)$$

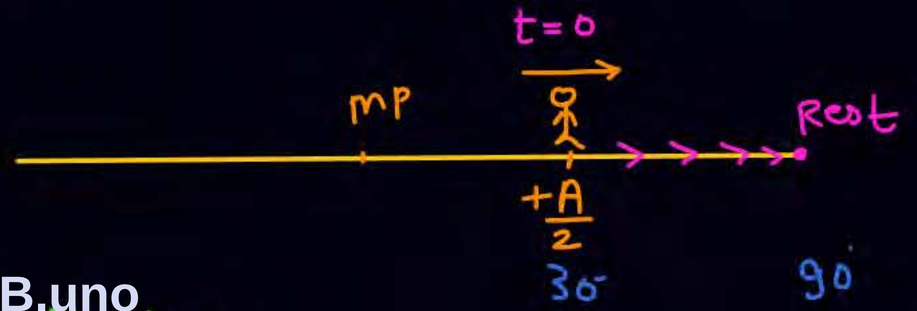
Q



$$x = A\sin(\omega t + 300)$$

Q A particle performing SHM having time period 12 sec S.t. at $t=0$ particle is at $x = +\frac{A}{2}$ moving Away from m.p. Find

$T = 12\,sec$



① eq^ of SHM

$$x = A\sin(\omega t + 30^\circ)$$

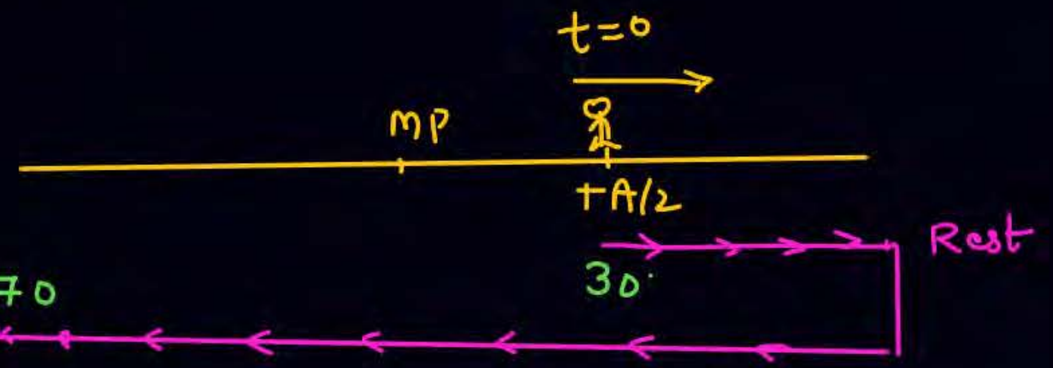
② find when particle comes to at rest 1st time.

$360^\circ \longrightarrow T$

$1 \longrightarrow \frac{T}{360}$

$60 \longrightarrow \frac{T}{360} \times 60 = \frac{T}{6}$

② find when particle comes to at rest 2nd time.



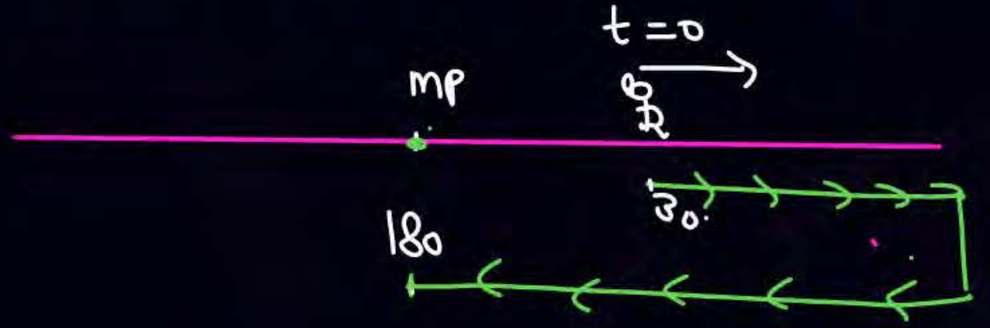
$360 \longrightarrow T$

$1 \longrightarrow \frac{T}{360}$

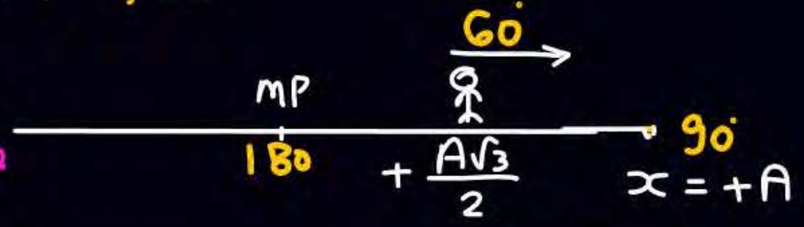
$240 \longrightarrow \frac{T}{360} \times 240 = \frac{2T}{3}$

③ find when v become max first time. or find when $a = 0$, 1st time

$\frac{T}{360} \times 150$



Q particle performing SHM with time period T s.t at $t=0$, particle is at $x = +\frac{A\sqrt{3}}{2}$ moving away from M.P. find



① when KE of particle become zero 1st time

$\frac{T}{360} \times 30 = T/12$

② (KE) become max First time

$T/3$

③ acc become zero First time

$T/3$

④ momentum become max First time

$T/3$

⑤ particle comes to at rest second time.

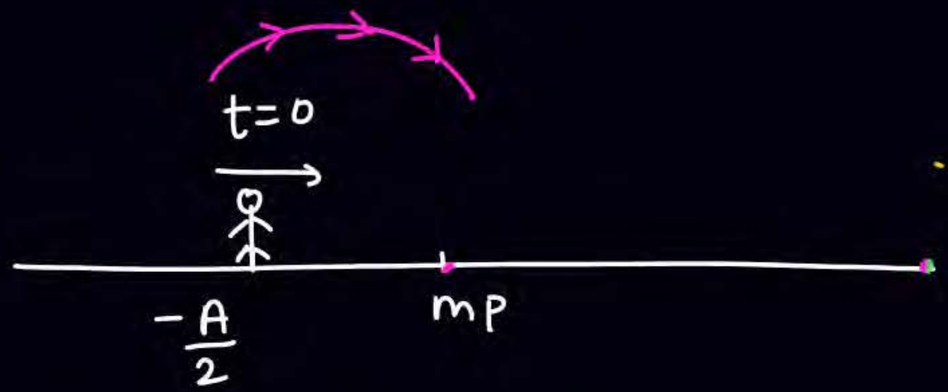
$\frac{T}{360} \times 210$

⑥ Find Avrg Velocity from $t=0$ to particle comes to at rest 1st time. & Avrg Speed

$\langle \vec{v} \rangle = \frac{(A - A\sqrt{3}/2)}{T/12} \hat{i}$

$\langle \text{speed} \rangle = \frac{(A - A\sqrt{3}/2)}{T/12}$

Q



① find when v_{max} $\frac{T}{360} \times 30 = T/12$

② find when a becom max 1st time.

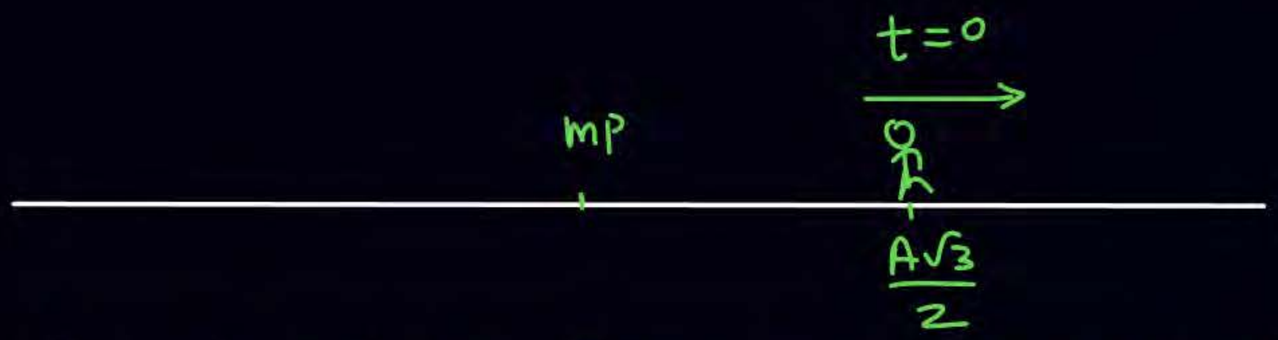
$\frac{T}{360} \times 120 = T/3$

③ Avg velocity from t=0 to particle comes to at rest

$$\langle \vec{v} \rangle = \frac{\frac{3A}{2}\hat{i}}{T/3}$$

HW

Q



① find avg velocity from $t=0$ to particle comes to at rest second time.

" Speed

(2) " " " " " acc become zero second time

.

H.W

- DPP -02
- module → 1, 2, 3, 4, 5, 6, 8, 10, 11, 22,
  (Pranavbhai)
- HCV must dry ⇒ (1-8)