Revise Most Important Questions to Crack NEET 2020

Q-1 - 14527440

A ball of mass 50 gm is dropped from a height h=10m. It rebounds losing 75 percent of its kinetic energy. If it remains in contant with the ground for $\Delta t = 0.01$ sec. the impulse of the impact force is (take $g = 10 m / s^2$)

(A) 1.3 N-s

(B) 1.06 N-s

(C) 1300 N-s

(D) 1.05

CORRECT ANSWER: B

SOLUTION:

$$v_1 = \sqrt{2gh}$$
$$= \sqrt{2 \times 10 \times 10}$$
$$= 10\sqrt{2}$$

$$k_2 = \frac{1}{4}k_1 \Rightarrow v_2^2$$
$$= \frac{1}{4}v_1^2$$

$$\therefore v_2 = \frac{v_1}{2} = 5\sqrt{2}$$
$$|\Delta P| = | - mv_2$$
$$- (mv_1)| = m| - v_2$$
$$- v_1|$$

$$|\Delta P| = 50 \times 10^{-3}$$
$$\times \frac{3}{2} \times 10\sqrt{2}$$
$$= \frac{15 \times 10^{-1}}{\sqrt{2}}$$

$$J = \Delta P = 1.05N - s$$

Q-2 - 14627121

A ball of mass $1kg$ drops vertically on to the floor wit a speed of $25m/s$. It rebounds with an initial velocity of $10m/s$. What impulse acts on the ball during contact ?

(A) $35kgm/s$ downwards

(B) $35kgm/s$ upwards

(C) $30kgm/s$ downwards

(D) $30kgm/s$ upwards

CORRECT ANSWER: B

SOLUTION:

Impulse

$$= P_f - P_1 = 1 \times 10$$
$$- 1 \times (- 25)$$
$$= 35kgm / s \uparrow$$

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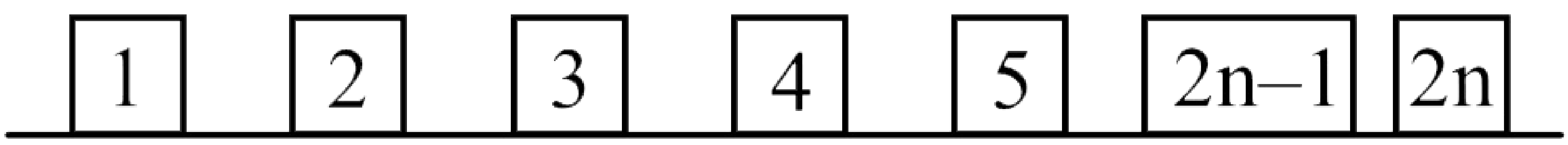
Q-3 - 15085195

2n identical cubical blocks are kept in a straight line on a horizontal smooth surface. The separation between any two consecutive blocks is same. The odd numbered blocks $1, 3, 5, \ldots . (2n1)$ are given velocity v to the right whereas blocks $2, 4, 6, \ldots 2n$ are given velocity v to the left. All collisions between blocks are perfectly elastic. Calculate the total number of collisions that will take place.



CORRECT ANSWER: $\dfrac{N(N+1)}{2}$

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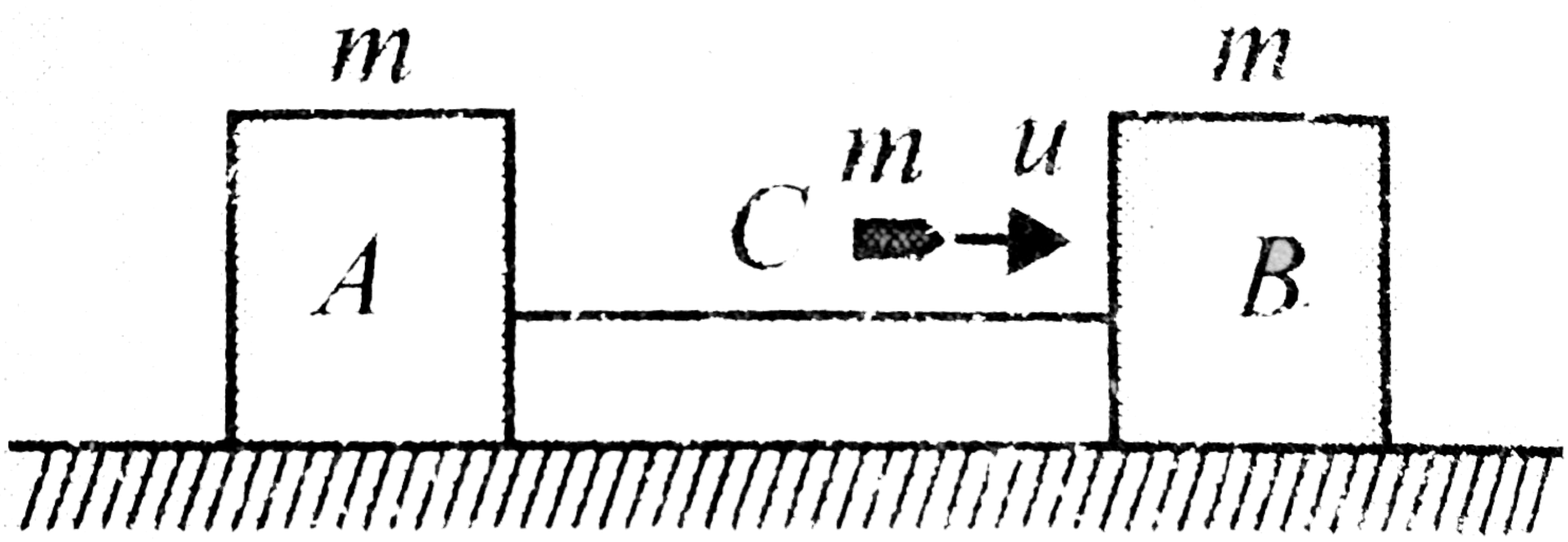
Q-4 - 11300514

Two identical blocks A and B connected by massless string, are placed on a frictionless horizontal plane. A bullet havig the same mass, moving with speed u strickes block B from behind as shown. If the bullet gets embedded into block B then find



a. the velocity of A, B, C after collision.

b. impulse on A due to tension in the string,

c. impulse on C due to normal force of collision,

d. impulse on B due to normal force of collision.

SOLUTION:

a. By a conservstion of linear momentum, $v = u/3$

b. $\int T dt = \frac{\text{mu}}{3}$

c. $\int N dt$

$= m\left(\frac{u}{3} - u\right)$

$= \frac{-2\text{mu}}{3}$

(-ve sign indicates left direction)

d.

$\int (N - T) dt =$

$\int N dt - \int T dt$

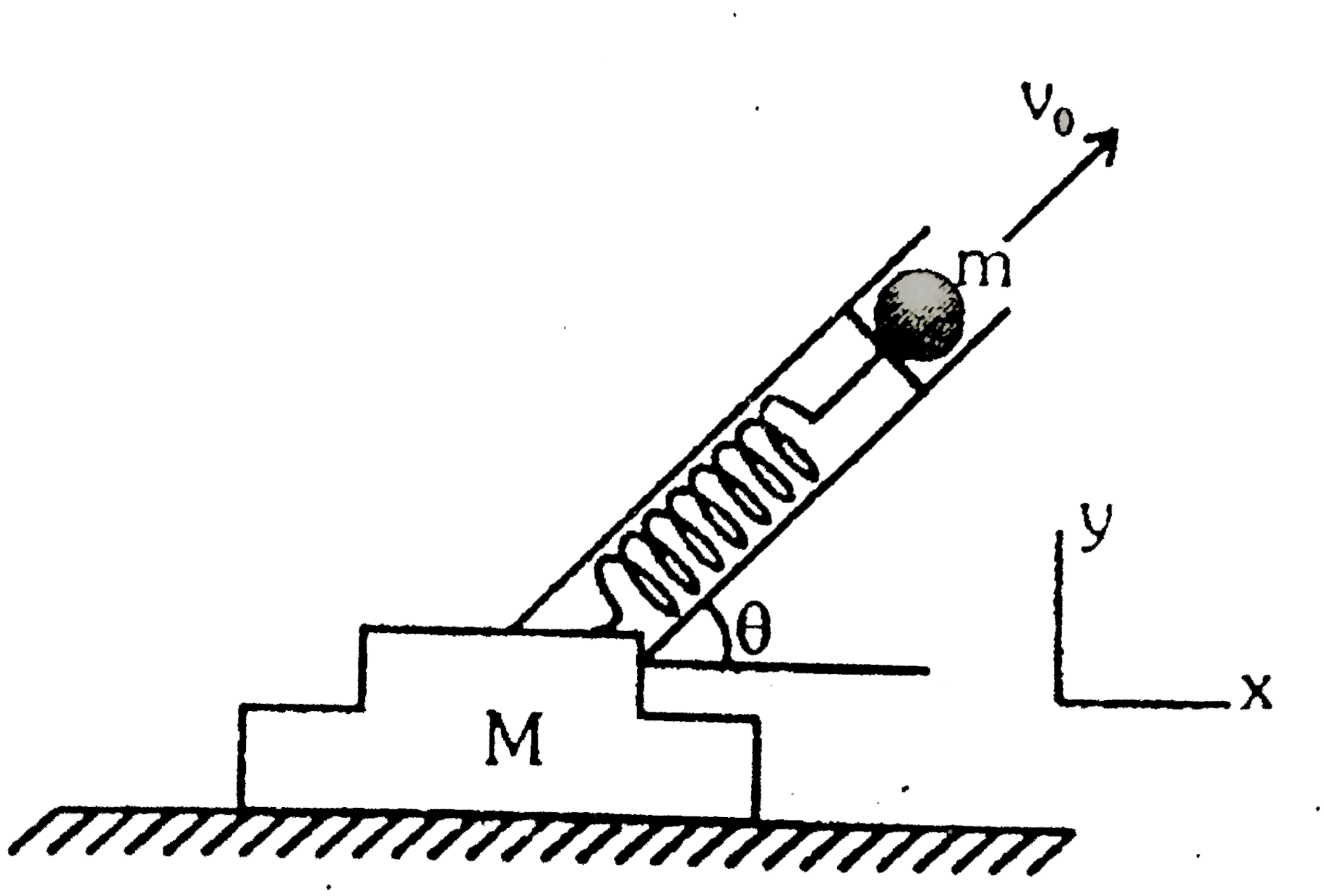
$= \frac{\text{mu}}{3} \Rightarrow \int N dt$

$= \frac{2\text{mu}}{3}$

Q-5 - 14627039

Spring Gun Recoil

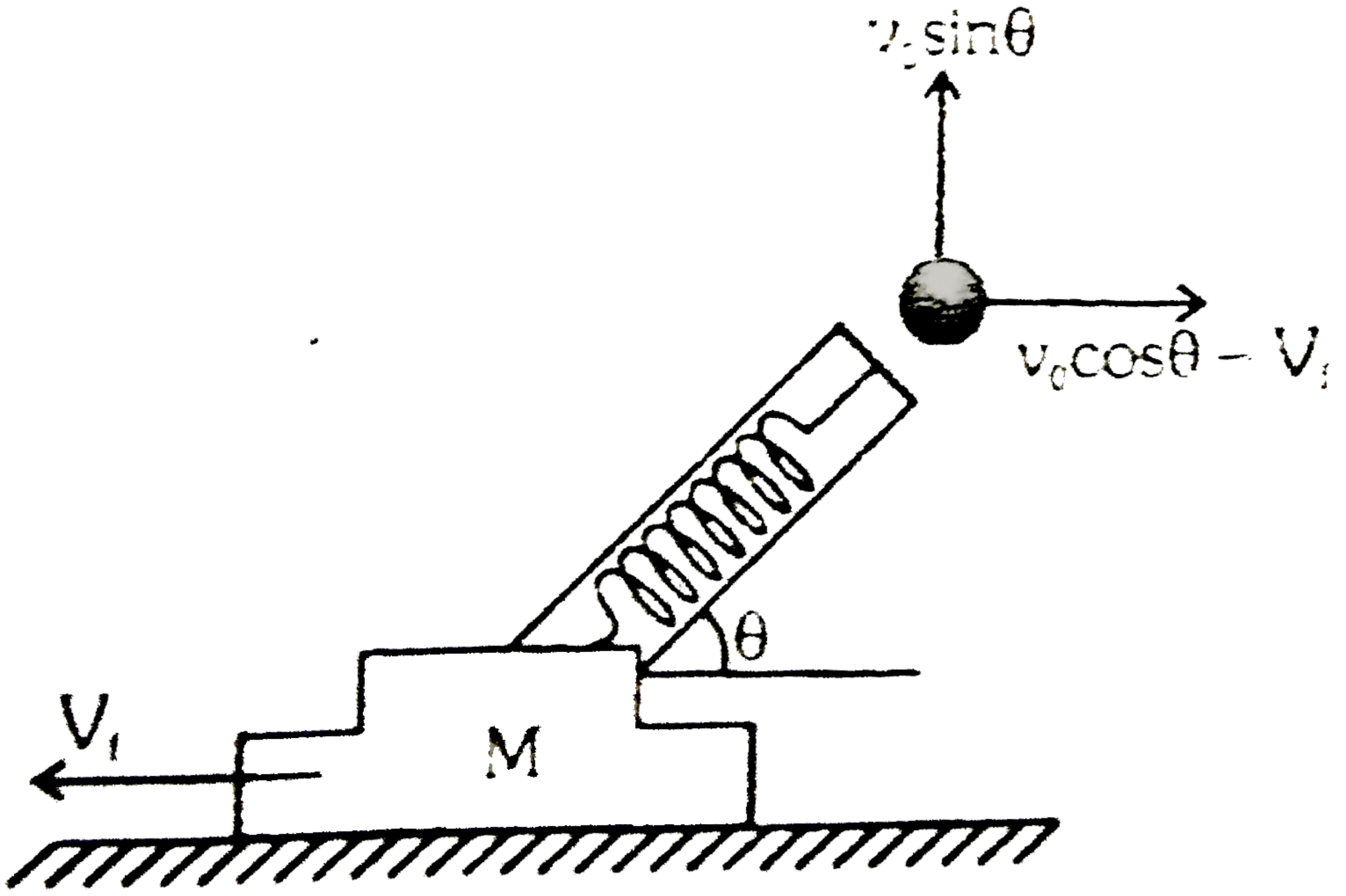
A loaded spring gun, initially at rest on a horizontal frictionless surface, fires a marble at angle of elevation theta. The mass of the gun is M, the mass of the marble is m, and the muzzle velocity of the marble is v_0. What is the final motion of the gun ?



SOLUTION:

Take the physical system to be the gun and marble. Gravity and the normal force of the table act on the system. Both these forces are vertical. Since there are no horizontal external forces, the x component of the vector equation $F = d\frac{P}{dt}$ is $0 = d\frac{P_x}{dt}$ According to equation (1), P_x is conserved:

$P_{x\,.\,\text{initial}} = P_{x\,.\,\text{final}}$



Let the initial time be prior to firing the gun. Then $P_{x\,.\,\text{initial}} = 0$, since the system is initially at rest. After the marble has left the muzzle, the gun recoils with some speed V_1, and its final horizontal momentum is MV_1, to the left. FInding the final velocity of the marble involves a subtle point, however. Physically, the marble's accelaration is due to the force of the gun, and the gun's recoil is due to the reaction force of the marble. The gun stops accelerating once the marble leaves the barrel, so that at the instant the marble and the gun part company, the gun has its final speed V_f. At that same instant the speed of the marble relative to the gun is v_0. Hence, the final horizontal speed of the marble relative to the tablet is $v_0 \cos\theta - V_f$. By conservation of horizontal momentum, we therefore have

$$0 = m\left(v_0 \cos\theta - V_f\right) - MV_f$$

or $V_f = \dfrac{mv_0 \cos\theta}{M+m}$

By using conversation of momentum we found the final motion of the system in a few steps. To show the advantage of this method, let us repeat the problem using Newton's laws directly. Let v(t) be the velocity of marble at time t and let $V(t)$ be the velocity of the gun. While the marble is going fired, it is acted on by the spring, by gravity, and by friction forces with the muzzle wall. Let the net force on the marble be f(t). The x equation of motion for the marble is

$m\frac{dv_x}{dt} = f_x(t)$ Formal integration of equation (3) gives

$mv_x(t) = mv_z(0) + \int_0^t f_x dt$

The external forces are all vertical, and therefore the horizontal force f_x on the marble is due entirely to the gun. By newton's third law, there is a reaction force- f_x on the gun due to the marble. No other horizontal forces acts on the gun, and the horizontal equation of motion for the gun is therefore $M\frac{dV_x}{dt} = -f_x(t)$, which can be integrated to give

$MV_x(t) = MV_x(0) - \int_0^t f_x dt$

we can eliminate the integral by combining equation (4) and (5).

$$MV_x(t) + mv_x(t)$$
$$= MV_x(0) + mv_z(0)$$

we have rediscovered that the horizontal component of momentum is conserved. What about the motion of the center of mass? Its horizontal velocity is

$$R_x(t)$$
$$= \frac{MV_x(t) + mv_x(t)}{M + m}$$

Using equation (6), the numerator can be rewritten to give

$$R_x(t)$$
$$= \frac{MV_x(0) + mv_x(0)}{M + m}$$
$$= 0$$

SInce the system is initially at rest. R_x is constant, as we expect.

We did not include the small force of air friction. Would the center of mass remain at rest if we had included it? The essential step in our derivation of the law of conservation of momentum was to use Newton's third law. Thus, conservation of momentum appears to be natural consequence of newtonian mechanics. It has been found, however, that conservation of momentum holds true even in areas where newtonian mechanics proves inadequate, including the realms of quantum mechanics and relativity. In addition, conservation of momentumcan be generalized to apply to systems like the electromagnetic field, which possess momentum but not mass. For these reasons, conservation of momentum is generally regarded as being more fundamental than newtonian mechanics. From the point of view, Newton's thitd law is a simple consequance of conservation of momentum for interacting particles. For our present purposes it is purely a matter of taste whether we wish to regard Newton's third law or conservation of momentum as more fundamental.

Q-6 - 17456533

A man of mass m moves with a constant speed on a plank of mass M and length l kept initially at rest on a frictionless horizontal surface, from one end to the other in time t. The speed of the plank relative to grounud while man is moving, is

(A) $\frac{l}{t}\left(\frac{M}{m}\right)$

(B) $\frac{l}{t}\left(\frac{m}{m+M}\right)$

(C) $\frac{l}{t}\left(\frac{M}{M+m}\right)$

(D) None of these

CORRECT ANSWER: B

SOLUTION:

$v_r = \frac{l}{t}$, Now , $m(v_r - v) = Mv$ (v= speed of plank)

$v = \left(m\frac{v_r}{M + m}\right.$ = l/t(m/(M +m)`

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Q-7 - 11300544

A rocket with an initial mass of $1000kg$, is launched vertically upward from rest under gravity. The rocket burns fuel at the rate of $10kg$ per second. The burnt matter is ejected vertically downwards with a speed of $2000m/s$ relative to the rocket . Find the velocity of the rocket after 1 min of start.

SOLUTION:

The velocity equation is given by

$v = u - \text{gt}$
$+ v_r In\left(\frac{m_0}{m}\right)$

Here

$u = 0, t = 60s, g$
$= 10m/s^2 v_r$
$= 2000m/s, m_0$
$= 1000kg$

and

$m = 1000 - 10 \times 60$
$= 400kg$

Putting these values we get

$v = 0 - 600$
$+ 2000In\left(\frac{1000}{400}\right)$

or

$= 2000In2.5 - 600$
$= 1232.6m/s$

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Q-8 - 9519518

A gun si monted on a railroad car. The mass of the car, the gun, the shells and the operator is 50m where m is the mass of one shell. If the velocity of het shell with respect to the gun (in its state before firing) is 200 m/s, what is the recoil speed of the car after the second shot? Neglect friction.

SOLUTION:

A gun is mounted on a railroad car. The mass of the car, the gun, the shells and the operator is 50 m where m is th mass of one shell. The muzzle velocity of the shells is 200 m/s.

$$\therefore Initial V_{cm} = 0$$

$$0 = 49 \times V + m$$

$$\times 200$$

$$\rightarrow V = -\frac{200}{49} \text{ m/s}$$

$\frac{200}{49}\frac{m}{s}$ towards left.

When another shell is fired, then the velocity of the car with respect to the platform is

$\rightarrow V = \frac{200}{49}$ m/s towards let ltbRgt When another shell is fired, then teh velocity of the car with respect to the platform is,

$\therefore$ Velocity o the car w.r.t the earth is

$$= 200\left(\frac{1}{49} + \frac{1}{48}\right)\frac{m}{s}$$

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Q-9 - 10963819

Four particles of masses $1kg$, $2kg$, $3kg$ and $4kg$ are placed at the four vertices A,B,C and D of a square of side $1m$. Find square of distance of their centre of mass from A.

CORRECT ANSWER: B::D

SOLUTION:

x_{CM}

$$= \frac{m_A x_A + m_B x_B + m_C x_C + m_D x_D}{m_A + m_B + m_C + m_D}$$

$$= \frac{(1)(0) + 2(1) + 3(1) + 4(0)}{1 + 2 + 3 + 4}$$

$$= 0.5m$$

$$y_{CM}$$

$$= \frac{m_A y_A + m_B y_B + m_C y_C + m_D y_D}{m_A + m_B + m_C + m_D}$$

$$= \frac{(1)(0) + 2(0) + 3(1) + 4(1)}{1 + 2 + 3 + 4}$$

$$= 0.7m$$

$$\therefore d^2 = x_{CM}^2 + y_{CM}^2$$

$= 0.7 cm^2$

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Q-10 - 11300723

Two blocks of masses $5kg$ and $2kg$ are placed on a frictionless surface and connected by a spring. An external kick gives a velocity of $14m/s$ to the heavier block in the direction of lighter one. The magnitudes of velocities of two blocks in the centre of mass frame after the kick are, respectively,

(A) $4m/s, 4m/s$

(B) $10m/s, 4m/s$

(C) $4m/s, 10m/s$

(D) $10m/s, 10m/s$

CORRECT ANSWER: C

SOLUTION:

$$v_{CM} = \frac{5 \times 14}{5+2} = 10m / s$$

velocity of the $5kg$ block w.r.t

$$CM = 14 - 10 = 4m / s$$

Velocity of the $2kg$ block w.r.t

$$CM = 0 - 10 = -10m / s$$

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Q-11 - 13651986

A body of mass $4kg$ moving with velocity $12m / s$ collides with another body of mass $6kg$ at rest. If two bodies stick together after collision , then the loss of kinetic energy of system is

(A) zero

(B) $288J$

(C) $172.8J$

(D) $144J$

CORRECT ANSWER: C

SOLUTION:

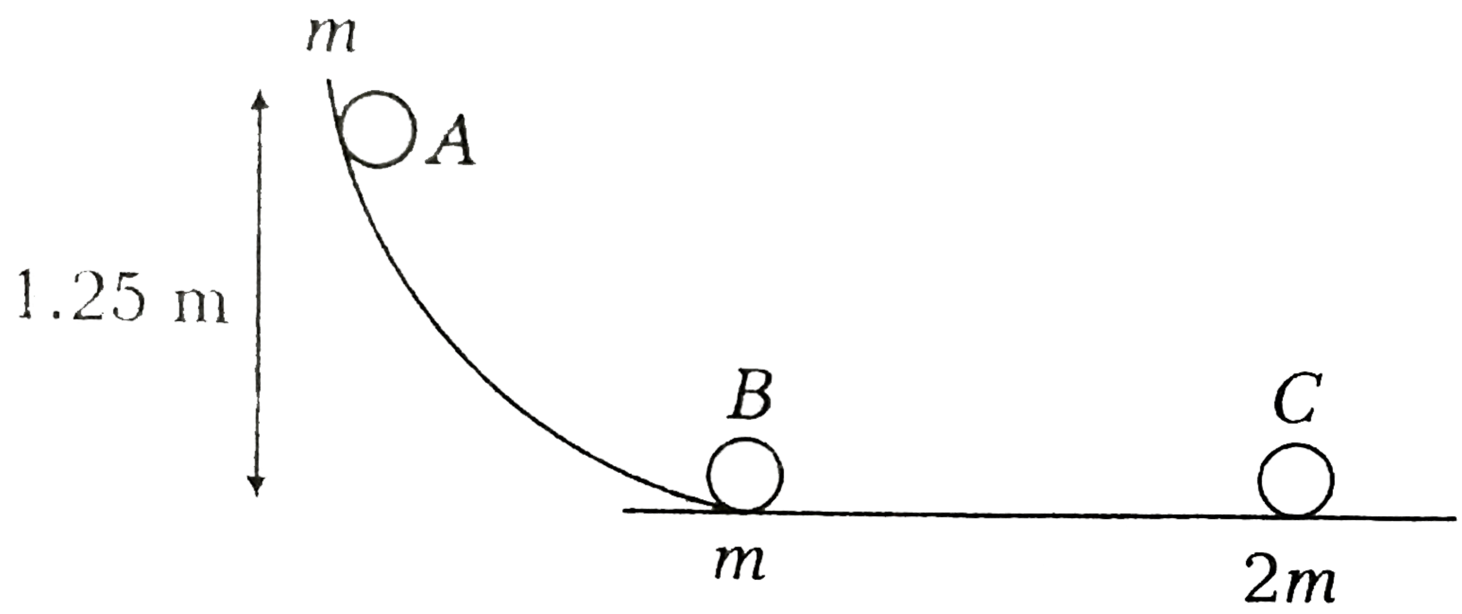
Loss in

$$K.E. = \frac{1}{2}\frac{m_1 m_2}{m_1 + m_2}(u_1 - u_2)^2$$

$$= \frac{1}{2}.\frac{4 \times 6}{4+6}(12-0)^2 = 172.8J$$

Q-12 - 17456535

A particle A of mass m initially at rest slides down a height of 1.25 m on a frictionless ramp, collides with and sticks to an identical particles B of mass m at rest as shown in the figure.



Then, particles A and B together collide elastically with particle G of mass 2m at rest. The speed of particle G after the collision with combined body (A+B) would be (Take, g $= 10ms^{-2}$)

(A) $2ms^{-1}$

(B) $1.25ms^{-1}$

(C) $2.5ms^{-1}$

(D) $5ms^{-1}$

CORRECT ANSWER: C

SOLUTION:

Velocity of A just before collision

$$= \sqrt{2gh}$$

$$= \sqrt{2 \times 10 \times 1.25}$$

= $5ms^{-1}$

Velocity of $(A + B)$ just after collision = 5/2 =

2/5ms^(-1)

(From conservation of linear momentum)

In elastic collision between two bodies of equal masses

velocities are interchanged.

Hence, velocity of C will becomes $2.5ms^{-1}$

Q-13 - 14627024

[If alpha,beta are roots of x^(2)-px+q=0 and alpha-2,beta+2 are roots of x^(2)-px+r=0 ,then prove that 16q+(r+4-q)^(2)=4p^(2).]

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Q-14 - 18253894

A 600 kg rocket is set for a vertical fliring. If the exhaust speed is $100m/s$, the mass of the gas ejected per second to supply the thrust needed to overcome the weight of rocket is

(A) $117.6kgs^{-1}$

(B) $58.6kgs^{-1}$

(C) $6kgs^{-1}$

(D) $46.4kgs^{-1}$

CORRECT ANSWER: C

SOLUTION:

Thrust $= u\frac{dm}{dt} = Mg$

or $\frac{dm}{dt} = \frac{Mg}{u}$

$= \frac{600 \times 9.8}{1000}$

$= 6kgs^{-1}$

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Q-15 - 13398727

A ball is dropped from a height 'h' on to a floor of coefficient of restitution 'e'. The total distance covered by the ball just before second hit is

(A) $h(1 - 2e^2)$

(B) $h(1 + 2e^2)$

(C) $h(1 + e^2)$

(D) he^2

CORRECT ANSWER: B

SOLUTION:

$$h_n = he^{2n}, h_{\text{total}}$$
$$= h(1 + 2e^2)$$

.

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Q-16 - 15634111

A ball is dropped from a height h. As it bounces off the floor, its speed is 80 percent of what it was just before it hit the floor. The ball will then rise to a height of most nearly

(A) $0.80h$

(B) $0.75h$

(C) $0.64h$

(D) $0.50h$

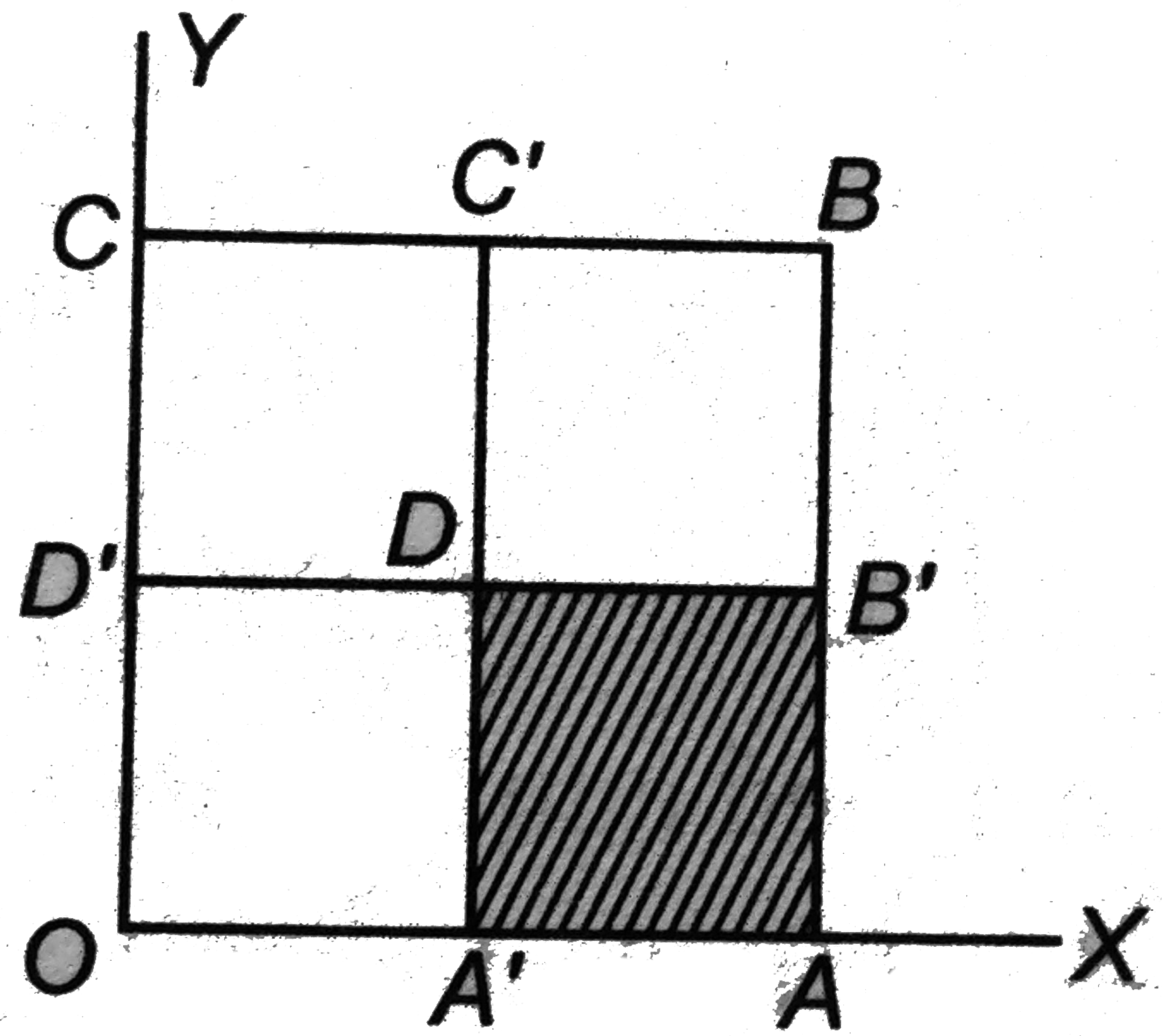
CORRECT ANSWER: C

SOLUTION:

$$H = \frac{v^2}{2g} \propto e^2$$

Q-17 - 10963913

A square of side $4cm$ and uniform thickness is divided into four squares. The square portion $A'AB'D$ is removed and the removed portion is placed over the portion $DB'BC'$. The new position of centre of mass is



(A) (a) $(2cm, 2cm)$

(B) (b) $(2cm, 3cm)$

(C) (c) $(2cm, 2.5cm)$

(D) (d) $(3cm, 3cm)$

CORRECT ANSWER: C

SOLUTION:

$$x_{CM} = \frac{A_1x_1 + A_2x_2 + A_3x_3 + A_4x_4}{A_1 + A_2 + A_3 + A_4}$$

$$= \frac{(4)(1) + (4)(1) + (4)(3) + (4)(3)}{16}$$

$$= 2cm$$

$$y_{CM} = \frac{A_1y_1 + A_2y_2 + A_3y_3 + A_4y_4}{A_1 + A_2 + A_3 + A_4}$$

$$= \frac{(4)(1) + 4(3) + 4(3) + 4(3)}{16}$$

$$= 2.5cm$$

Q-18 - 11747987

The velocity of the CM of a system changes from

$\overrightarrow{v}_1 = 4\hat{i} m / s \rightarrow \overrightarrow{v}_2 = 3\hat{j} m$
$/ s$

during time $\Delta t = 2s$. If the mass of the system is $m = 10kg$, the

constant force acting on the system is :

(A) 25 N

(B) 20 N

(C) 50 N

(D) 5 N

CORRECT ANSWER: A

SOLUTION:

(a)

$$\vec{F} = m\frac{\Delta \vec{v}_{cm}}{\Delta t}$$

$$= \frac{10\left(3\hat{j} - 4\hat{i}\right)}{2}$$

$$= 5\left(3\hat{j} - 4\hat{i}\right)$$

$$\left|\vec{F}\right| = 5\sqrt{3^2 + 4^2}$$

$$= 25N$$

.

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Q-19 - 10058797

A body A of mass M while falling wertically downwards under gravity brakes into two parts, a body B of mass $\frac{1}{3}$ M and a body C of mass $\frac{2}{3}$ M. The center of mass of bodies B and C taken together shifts compared to that of body A towards

(A) does not shift

(B) depends on height of breaking

(C) body B

(D) body C

CORRECT ANSWER: A

SOLUTION:

(a) Does not shift as no external force acts. The centre

of

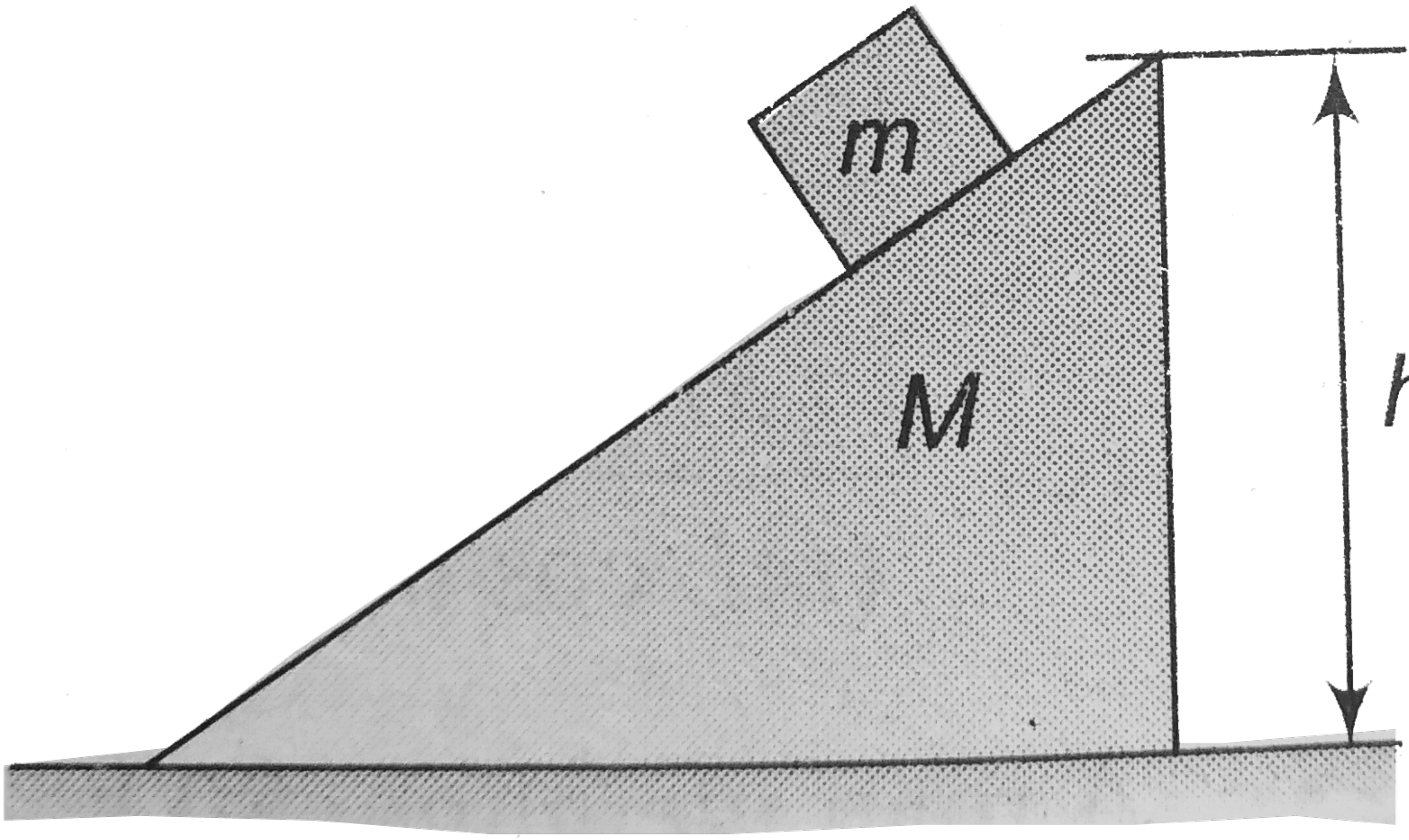
mass of the system continues its original path. It is only

the internal forces which comes inot play while breaking

Q-20 - 11747989

A mass m is rest on an inclined plane of mass M which is further

resting on a smooth horizontal plane. Now if the mass starts moving the position of $C.\ M.$ Of mass of system will :



(A) remain unchanged

(B) change along the horizontal

(C) move up in the vertical direction

(D) move down in the vertical direction the vertical along the horizontal.

CORRECT ANSWER: C

SOLUTION:

(c) The mass move under the influence of gravitational pull which acts along the vertical. Thus CM changes along vertical while it remains unchanged in the horizontal direction.

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Q-21 - 11300724

In a system of particles $8kg$ mass is subjected to a force of $16N$ along + ve x-axis and another $8kg$ mass is subjected to a force of $8N$ along + ve y-axis. The magnitude of acceleration of centre of mass and the angle made by it with x-axis are given, respectively, by

(A) $\frac{\sqrt{5}}{2}ms^2, \theta = 45^\circ$

(B)

$3\sqrt{5}ms^2, \theta$

$$= \tan^{-1}\left(\frac{2}{3}\right)$$

(C)

$$\frac{\sqrt{5}}{2}ms^2, \theta$$

$$= \tan^{-1}\left(\frac{1}{2}\right)$$

(D) $1ms^2, \theta = \tan^{-1}\sqrt{3}$

CORRECT ANSWER: C

SOLUTION:

$$\vec{a}_{CM} = \frac{\vec{F}}{m_1 + m_2}$$

$$= \frac{16\hat{i} + 8\hat{j}}{8 + 8} = \hat{i}$$

$$+ \frac{1}{2}\hat{j}$$

$$\left|\overrightarrow{a}(CM)\right|$$

$$=\sqrt{1^2\left(\frac{1}{2}\right)^2}$$

$$=\frac{\sqrt{5}}{2}m/s^2$$

$$\tan\theta=\frac{a_y}{a_x}=\frac{\frac{1}{2}}{1}$$

$$=\frac{1}{2}\Rightarrow\theta$$

$$=\tan^{-(1)}\left(\frac{1}{2}\right)$$

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Q-22 - 11765415

A non-uniform thin rod of length L is palced along X-axis so that one of its ends is at the origin. The linear mass density of rod is $\lambda=\lambda_0 x$. The centre of mass of rod divides the length of the rod in the ratio:

CORRECT ANSWER: $(2/1)$

SOLUTION:

As shown in Fig. mass of small element of length dx is

$$dm = \lambda dx = \lambda_0 x dx$$

$$\therefore x_{cm} = \frac{\int_0^L x dm}{\int dm}$$

$$= \frac{\int_0^L x(\lambda_0 x dx)}{\int_0^L \lambda_0 x dx}$$

$$x_{cm} = \frac{\left[x^3/3\right]_0^L}{\left[x^2/2\right]_0^L}$$

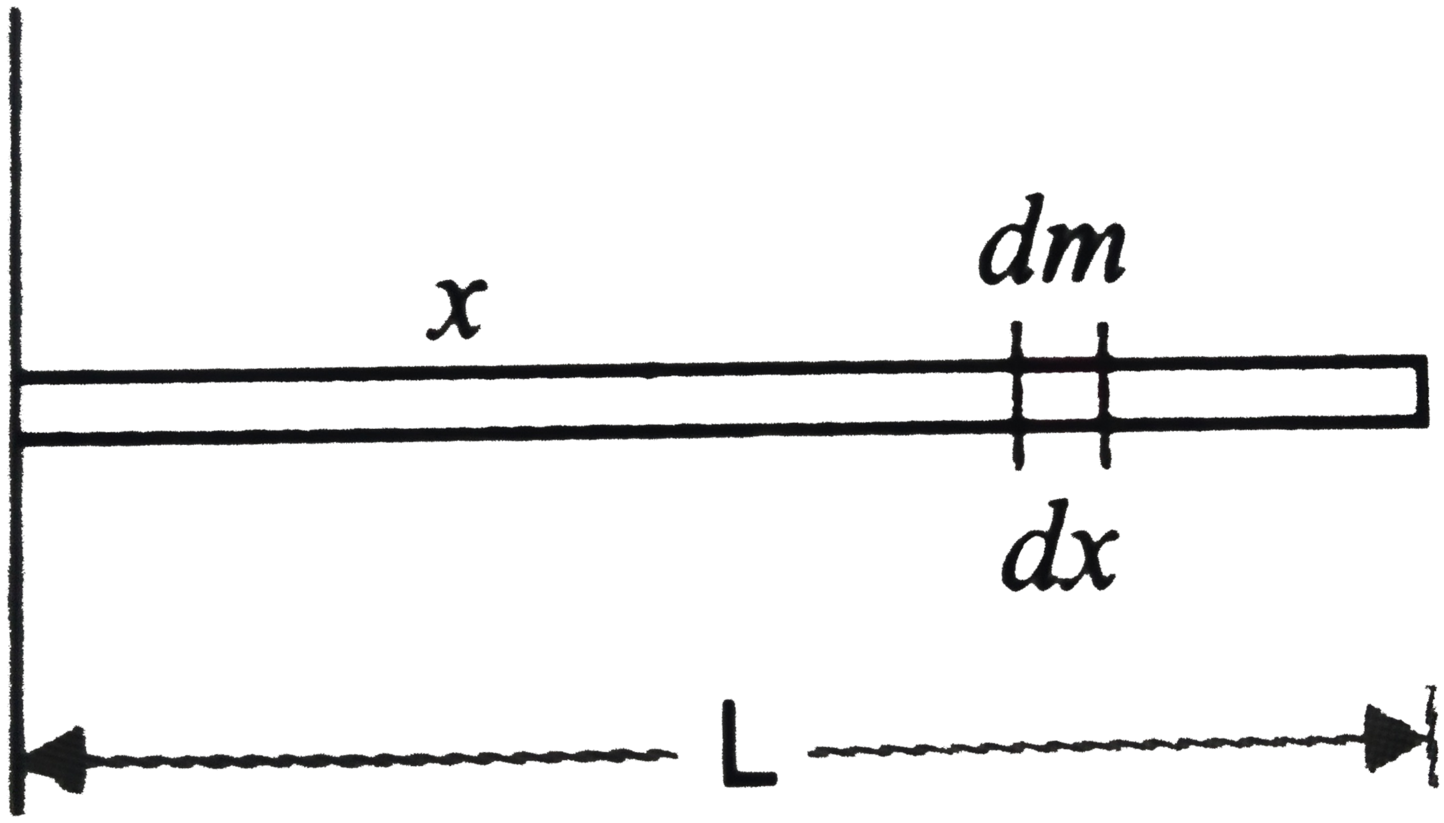
$$= \frac{L^3/3}{L^2/2} = \frac{2L}{3}$$

If

$$x_1 = \frac{2L}{3}, x_2 = L$$

$$- \frac{2L}{3} = \frac{L}{3}$$

$$\frac{x_1}{x_2} = \frac{2L/3}{L/3} = \frac{2}{1}$$



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Q-23 - 17666044

A particle of mass 3m is projected from the ground at some angle with horizontal. Its horizontal range is R. At the highest point of its path it breaks into two pieces of masses m and 2m respectively. The smallar mass comes to rest. The larger mass finally falls at a distance x from the point of projection where x is equal to

(A) $\frac{4}{3}R$

(B) $\frac{3}{2}R$

(C) $\frac{5}{4}R$

(D) $2.5R$

Q-24 - 16969062

A projectile of mass "m" is projected from ground1 with a speed of 50 m/s at an angle of 53 with the horizontal. It breaks up into two equal parts at the highest point of the trajectory. One particle coming to rest immediately after the explosion.

The distance between the pieces of the projectile when they reach the ground are :

(A) 240

(B) 360

(C) 120

(D) none

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Q-25 - 17456419

One projectile moving with velocity v in space, gets burst into 2 parts of masses in the ratio $1:3$. The smaller part becomes stationary. What is the velocity of thhe other part?

(A) 4v

(B) v

(C) $4\frac{v}{3}$

(D) $3\frac{v}{4}$

CORRECT ANSWER: C

SOLUTION:

$$mv = \left(\frac{3}{4}m\right)v' \quad \therefore \quad = \frac{4v}{3}$$

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Q-26 - 13164086

The kinetic energy of a projectile at the highest point of its path is found to be $3/4^{th}$ of its initial kinetic energy. If the body is projected from the ground, the angle of projection is

(A) 0°

(B) 30°

(C) 60°

(D) 40°

CORRECT ANSWER: B

SOLUTION:

$$K.E_{\text{top}} = \frac{3}{4}(K.E_i),$$

$$\frac{1}{2}m(u\cos\theta)^2$$

$$= \frac{3}{4}\left(\frac{1}{2}mu^2\right)$$

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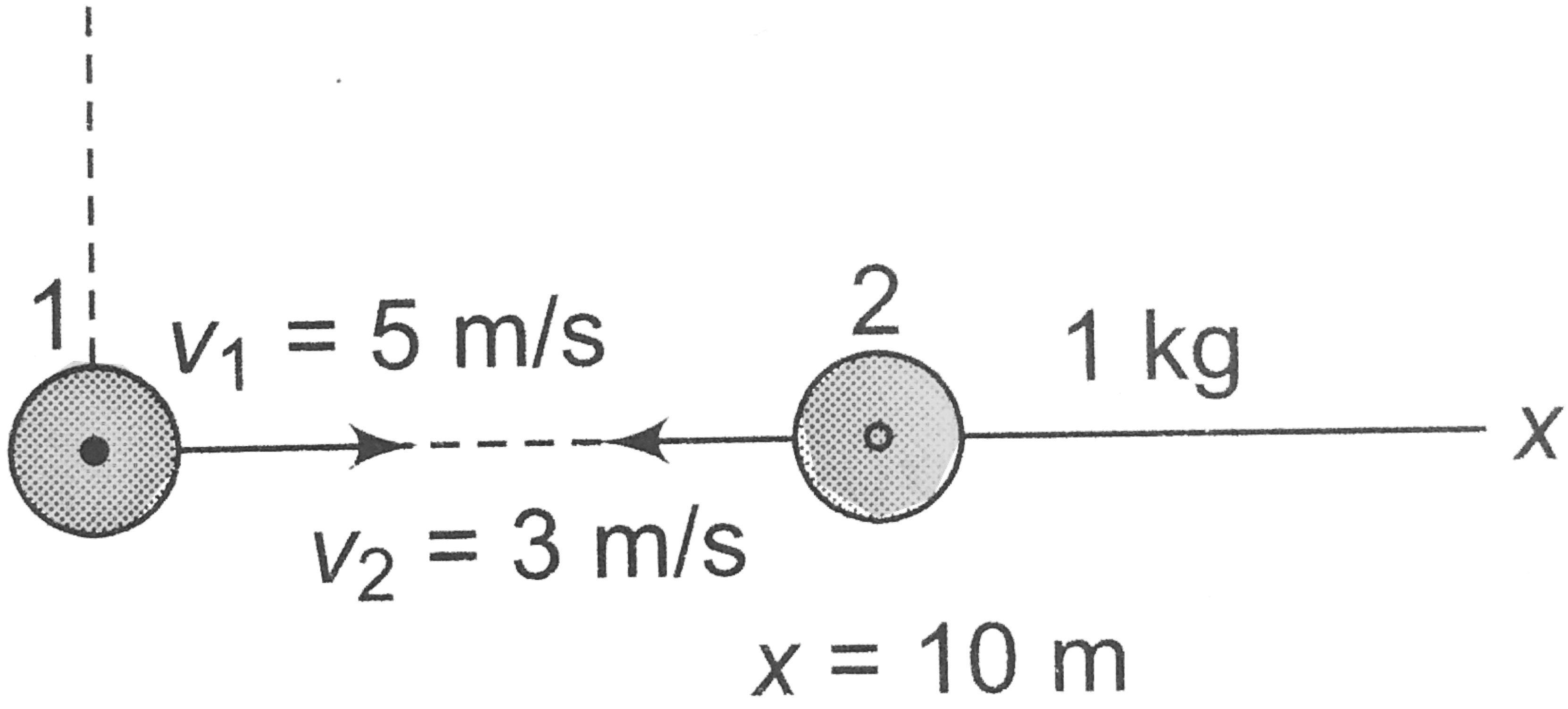
Q-27 - 11748013

At $t = 0$, the positions and velocities of two particles are as shown in the figure. They are kept on a smooth surface and being mutually attracted by gravitational force. Find the position of centre of mass at $t = 2s$.



(A) X = 5 m

(B) X = 7 m

(C) X = 3 m

(D) X = 2 m

CORRECT ANSWER: B

SOLUTION:

(b) As no external force are acting on the system. The velocity of centre of mass will be constant.

$$v_{cm} = \frac{1 \times 5 - 1 \times 3}{1+1}$$
$$= 1m/s$$

Displacement of centre of mass $\Delta x_{cm} = 1 \times 2 = 2m$

Hence position of centre of mass

$\Delta x_{cm} = 5 + 2 = 7m.$

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Q-28 - 15822037

A particle P moving with speed v undergoes a head -on elastic collision with another particle Q of identical mass but at rest. After the collision the collision

(A) Both P and Q move forward with speed $\frac{v}{2}$

(B) Both P and Q move forward with speed $\frac{v}{\sqrt{2}}$

(C) P comes of rest and Q moves forward with speed v

(D) P and Q move in opposite direction with speed $\frac{v}{\sqrt{2}}$.

CORRECT ANSWER: C

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Q-29 - 17091548

A ball P of mass $2kg$ undergoes an elastic collision with another ball Q at rest. After collision, ball P continues to move in its original direction with a speed one-fourth of its original speed. What is the mass of ball Q ?

(A) 0.9 kg

(B) 1.2 kg

(C) 1.5 kg

(D) 1.8 kg

CORRECT ANSWER: B

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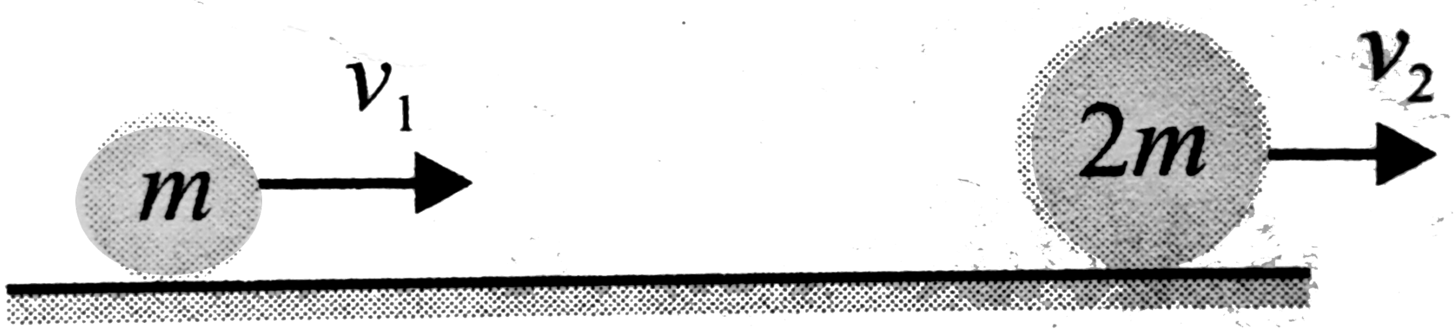
Q-30 - 11300529

Two particles of masses m and $2m$ moving in opposite directions collide elastically with velocity $2v$ and v, respectiely. Find their velocities after collision.

SOLUTION:

Let the final velocities of mass m and $2m$ be v_1 and v_2 respectively as shown in figure.



By conservation of momentum, we get

$m(2v) + 2m(-v)$
$= m(v_1) + 2m(v_2)$

or $0 = mv_1 + 2mv_2$

or $v_1 + 2v_2 = 0$

and since the collision is elastic

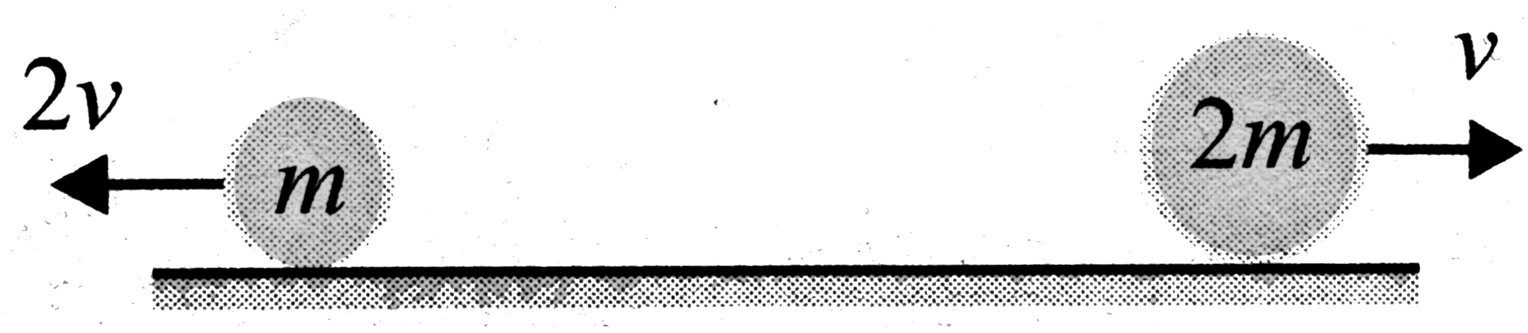
$v_2 - v_1 = 2v - (-v)$

or $v_2 - v_1 = 3v$

Solving the above two equations we get

$v_2 = v$ and $v_1 = -2v$

That is mass $2m$ returns with velocity v while mass m returns with velocity $2v$ in the direction shown in figure.



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Q-31 - 13076485

Two particles of masses $2kg$ and $3kg$ are projected horizontally in opposite directions from the top of a tower of height $39.2m$ with velocities $5m/s$ and $10m/s$ respectively. The horizontal range of the centre of mass of two particles is

(A) $8\sqrt{2}m$ in the direction of $2kg$

(B) $8\sqrt{2}m$ in the direction of $3kg$

(C) $\sqrt{8}m$ in the direction of $2kg$

(D) $\sqrt{8}m$ in the direction of $3kg$

CORRECT ANSWER: B

SOLUTION:

Range of $C.M. = v_{cm}\sqrt{\frac{2h}{g}}$

But $v_{cm} = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$

Q-32 - 13651990

A particle of mass m moving eastward with a speed v collides with another particle of the same mass moving coalesce on collision. The new particle of mass $2m$ will move in the north - easterly direction with a velocity

(A) $v/2$

(B) $2v$

(C) $v/\sqrt{2}$

(D) v

CORRECT ANSWER: C

SOLUTION:

Momentum conservation :

$$x : mv = 2mv_0 \cos\theta$$

$$\Rightarrow v_0 \cos\theta = \frac{v}{2}$$

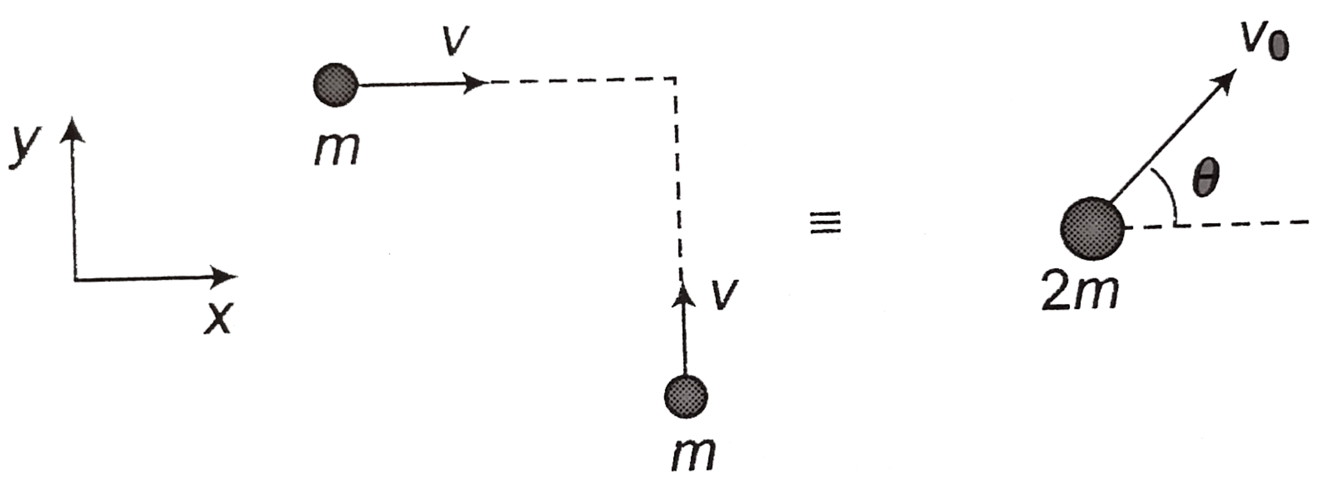
$$y : mv = 2mv_0 \sin\theta$$

$$\Rightarrow v_0 \sin\theta = \frac{v}{2}$$

$$v_0$$

$$= \sqrt{(v_0 \cos\theta)^2 + (v_0 \sin\theta)^2}$$

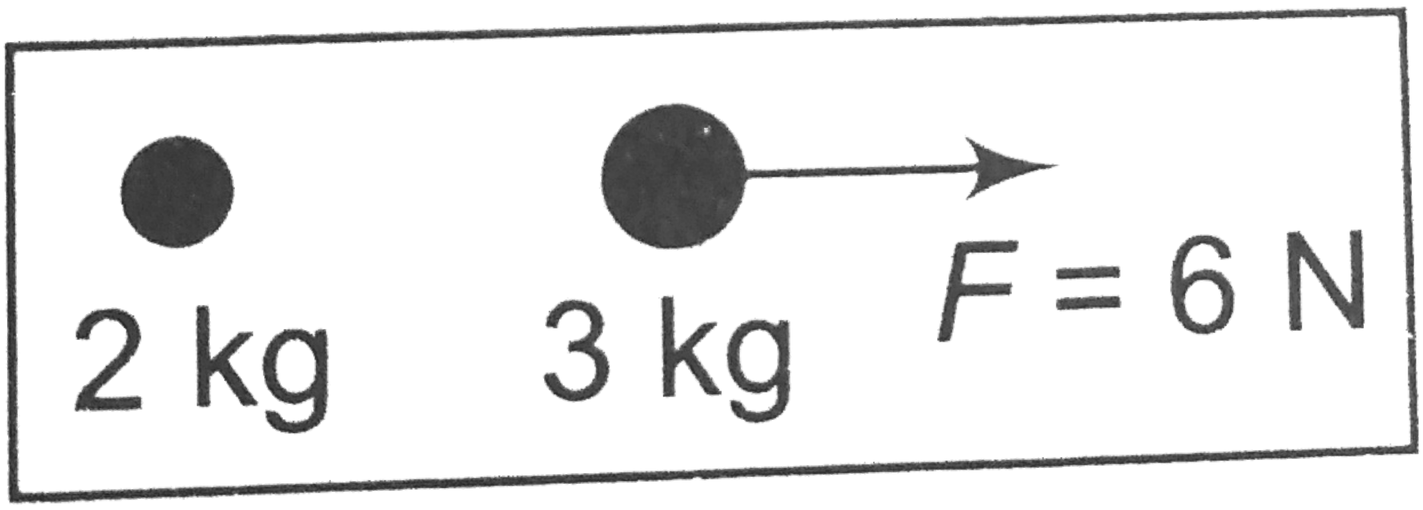
$$= \sqrt{2}\frac{v}{2} = \frac{v}{\sqrt{2}}$$



Q-33 - 11748010

Two particles are shown in figure. At $t = 0$ a constant force

$F=6N$ starts acting on $3kg$. Find the velocity of circle of mass of these particle at $t=5s$.



.

(A) $5m/s$

(B) $4m/s$

(C) $6m/s$

(D) $3m/s$

CORRECT ANSWER: C

SOLUTION:

(c) $2kg$ particle remains at rest. So $v_1=0$

for $3kg$ particle :

$a_2 = \frac{F}{m} = \frac{6}{3} = 2m / s^2$

Velocity at $t = 5s$:

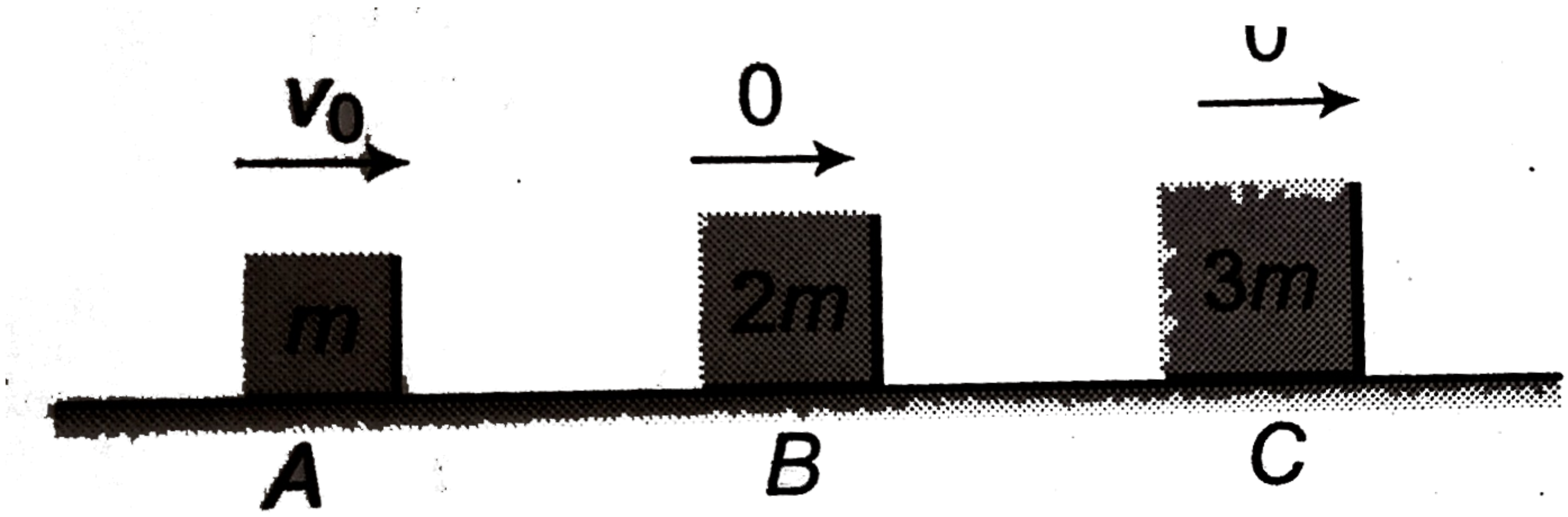
$v_2 = at = 2 \times 5 = 10m / s$

$v_{cm} = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} = \frac{2 \times 0 + 3 \times 10}{2 + 3} = 6m / s$

.

Q-34 - 13652000

Three objects A ,B and C are kept in a straight line on a smooth horizontal surface. These have masses m, $2m$ and $3m$, respectively . The head - on elastic collision takes place between A and B and then B makes completely inelastic collision with C. All motions occur on the same straight line. The final speed of C will be



(A) $\frac{v_0}{15}$

(B) $\frac{2v_0}{15}$

(C) $\frac{3v_0}{15}$

(D) $\frac{4v_0}{15}$

CORRECT ANSWER: D

SOLUTION:

The head - on elastic collision between A and B

$mv_0 = mv_1 + 2mv_2$ (i)

$v_1 + v_0 = v_2 + 0$ (ii)

Solving, $v_2 = \frac{2v_0}{3}$

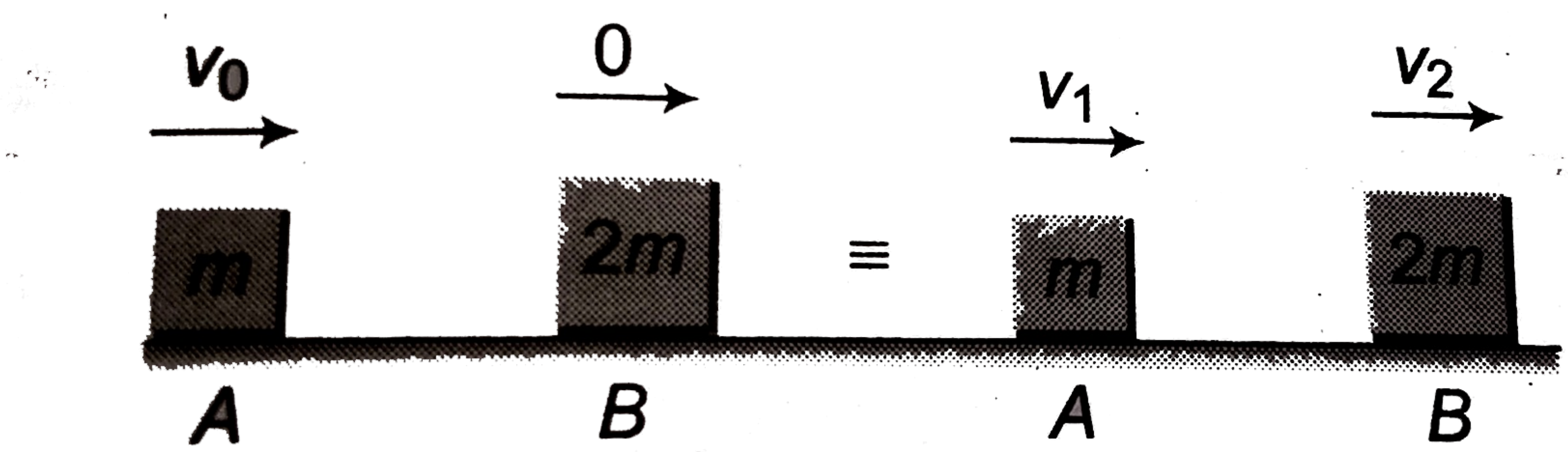
Completely inelastic , the head - on collision between B and C

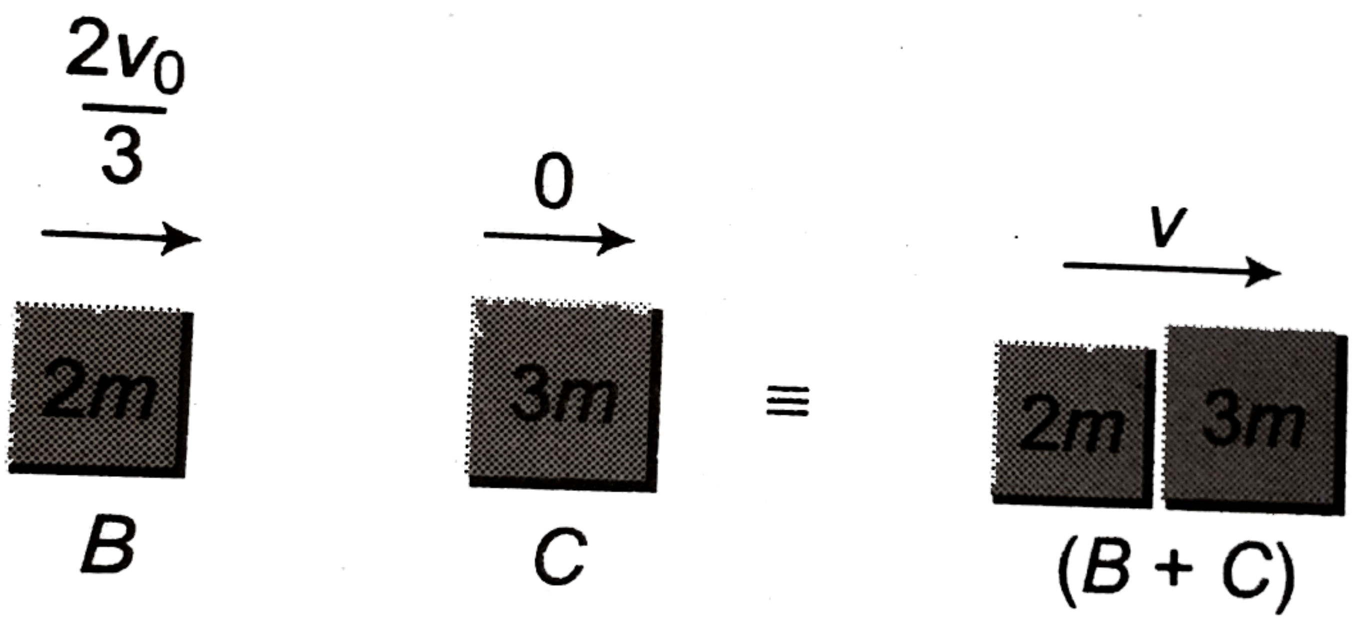
$2m \times \frac{2v_0}{3}$

$= (2m + 3m)v \Rightarrow v$

$= \frac{4v_0}{15}$

Final speed of $C = \frac{4v_0}{15}$





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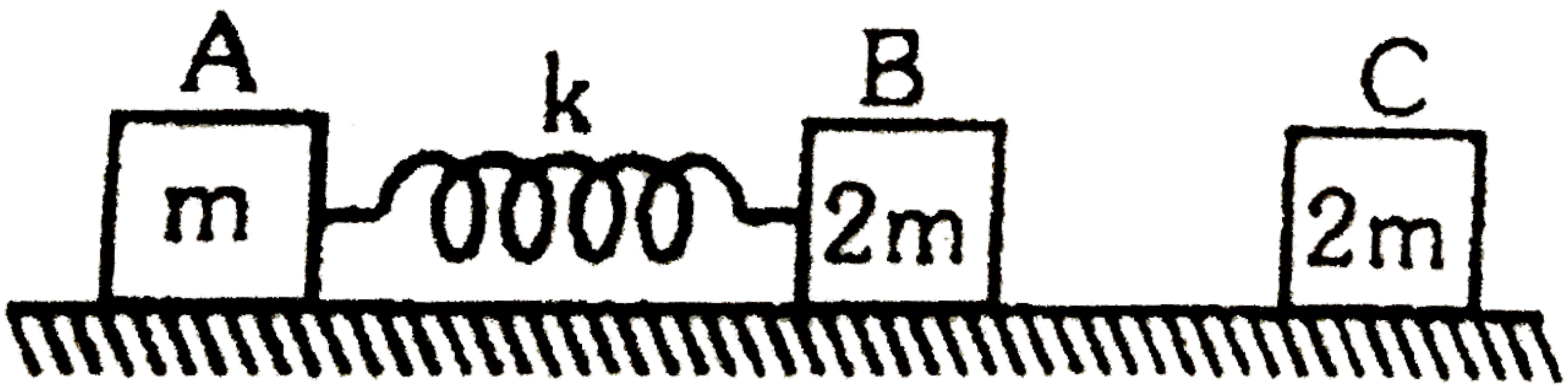
Q-35 - 14627091

Two block A and B of masses m and $2m$ respectively are connected by a spring of spring cosntant k. The masses are moving to the right with a uniform velocity v_0 each, the heavier mass leading the lighter one. The spring is of natural length during this motion. Block B collides head on with a thrid block C of mass $2m$. at rest, the collision being completely inelastic.



The maximum compression of the spring after collision is -

(A) $\sqrt{\frac{mv_0^2}{12k}}$

(B) $\sqrt{\frac{mv_0^2}{5k}}$

(C) $\sqrt{\frac{mv_0^2}{10k}}$

(D) None of these

CORRECT ANSWER: (B)

SOLUTION:

At maximum compression, velocity of all block are same

& equal to velocity of centre of mass.

$$\frac{1}{2}kx_m^2 = \left[\frac{1}{2}mv_0^2\right.$$

$$\left.+\frac{1}{2}(4m)\left(\frac{v_0}{2}\right)^2\right]$$

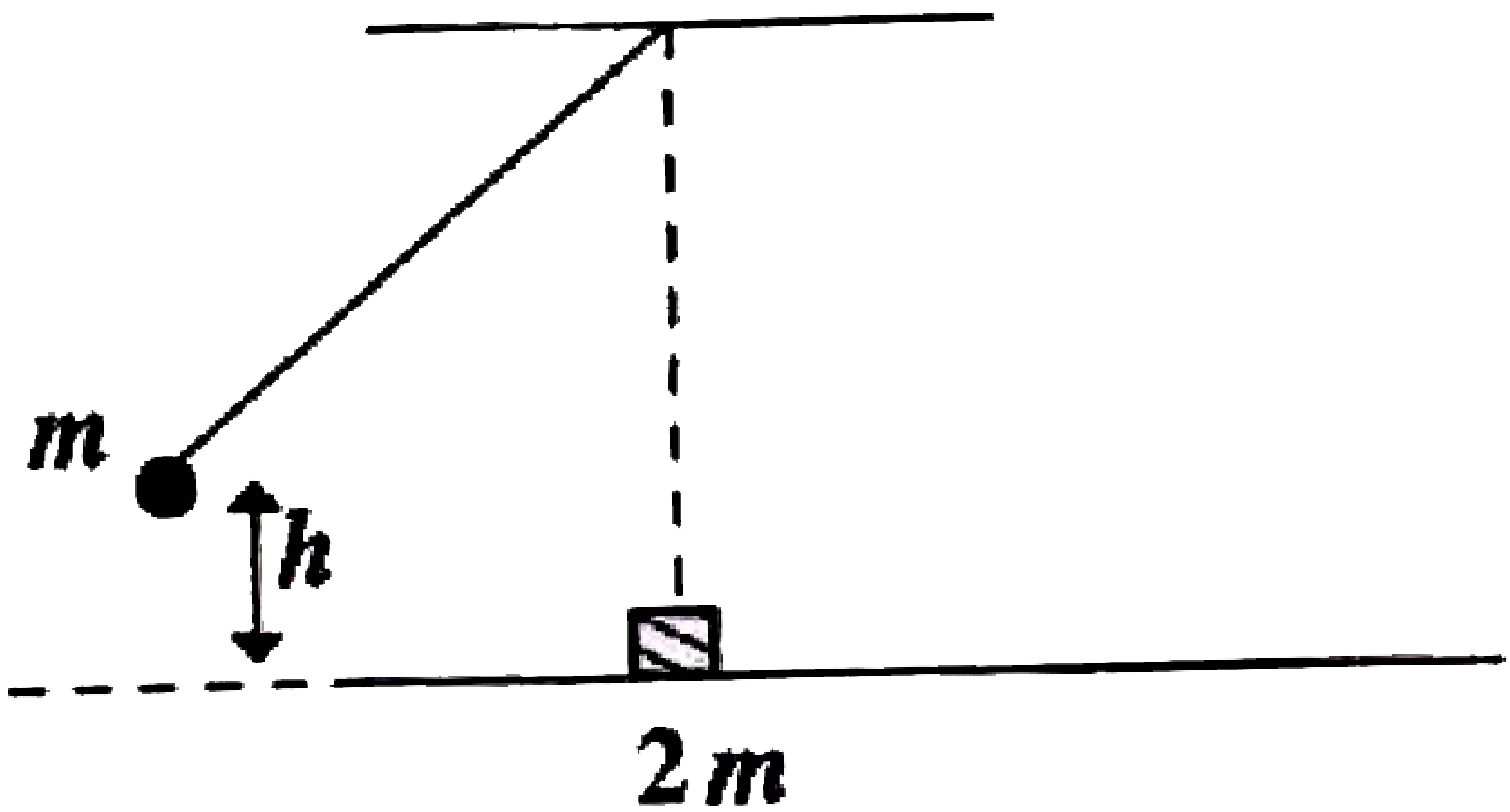
$$-\frac{1}{2}(5m)\left(\frac{3v_0}{5}\right)^2$$

$$\Rightarrow \frac{1}{2}kx_m^2 = \frac{1}{10}mv_0^2$$

$$\Rightarrow x_m = \sqrt{\frac{mv_0^2}{5k}}$$

Q-36 - 16464360

A ball of mass m suspended from a rigid support by an inextensible massless string is released from a height h above its lowest point. At its lowest point it collides elastically with a block of mass 2m at rest on a frictionless surface. Neglect the dimensions of the ball and the block. After the collision the ball rises to a maximum height of



(A) $h/3$

(B) $h/2$

(C) $h/8$

(D) $h/9$

CORRECT ANSWER: D

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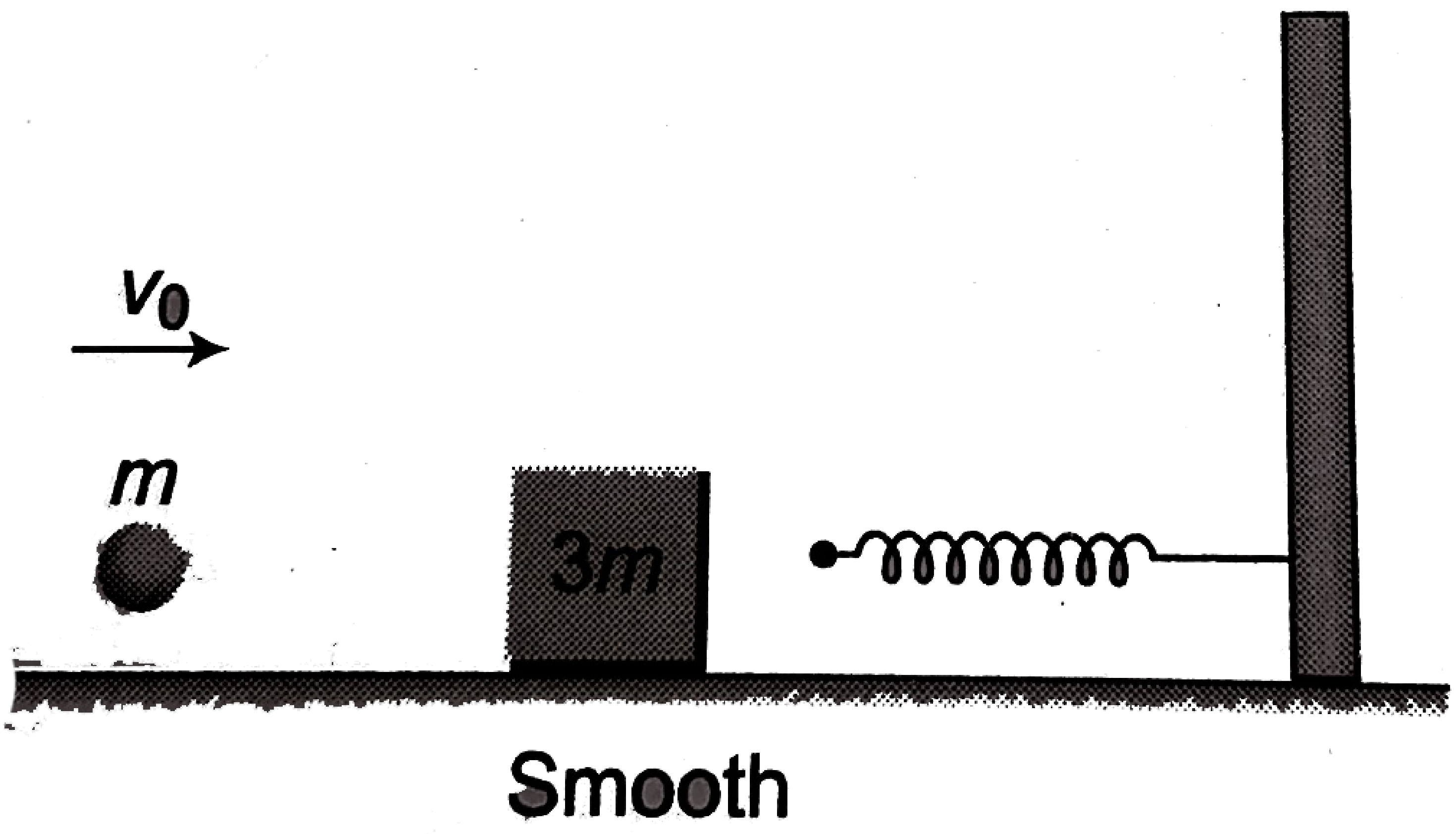
Q-37 - 13652019

A ball of mass m moving with speed v_0 strikes a block of mass $3m$ kept at rest. The collision is completely inelastic . If k is spring constant , the maximum compression of the spring is



(A) $\sqrt{\frac{mv_0^2}{k}}$

(B) $\sqrt{\frac{mv_0^2}{2k}}$

(C) $\sqrt{\dfrac{mv_0^2}{3k}}$

(D) $\sqrt{\dfrac{mv_0^2}{4k}}$

CORRECT ANSWER: B

SOLUTION:

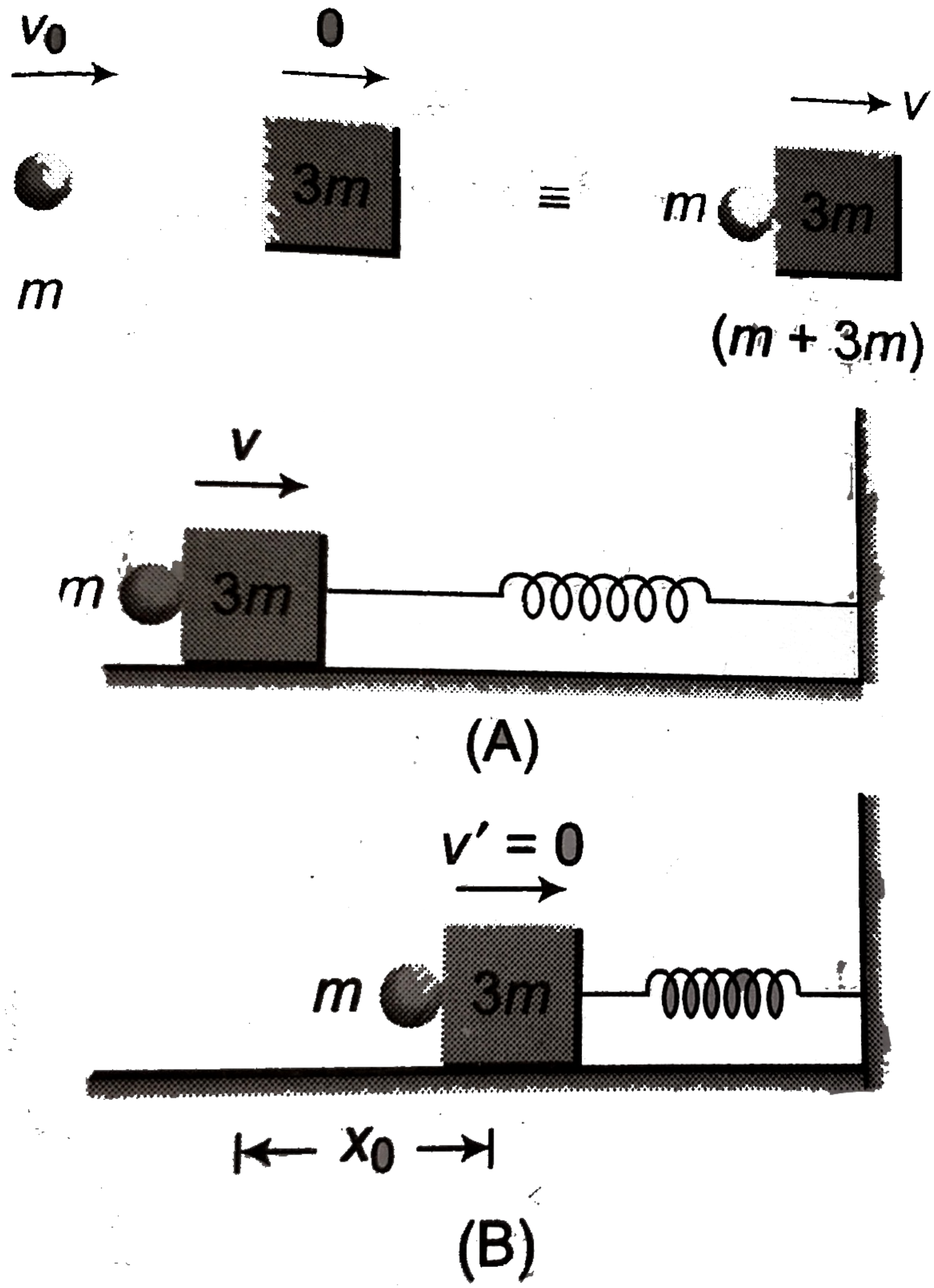
By the momentum conservation

$$mv_0 = (m + 3m)v$$
$$\Rightarrow v = \frac{v_0}{4}$$

$$\frac{1}{2}(m + 3m)v^2$$
$$= \frac{1}{2}kx_0^2$$

$$4m\left(\frac{v_0}{4}\right)^2 = \frac{mv_0^2}{4}$$
$$= kx_0^2$$

$$x_0 = \sqrt{\frac{mv_0^2}{4k}}$$



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Q-38 - 10963922

A particle moving with kinetic energy K makes a head on elastic collision with an identical particle at rest. Find the maximum elastic potential energy of the system during collision.

CORRECT ANSWER: B

SOLUTION:

At maximum elastic potential energy, velocity of both particles is same. This common velocity will be given by

v=("Total momentum")/("Total mass")

$$= \frac{\sqrt{2Km}}{2m} = \sqrt{\frac{K}{2m}}$$

$$E_i = E_f$$

$$K = \frac{1}{2}$$

$$\times 2m\left(\sqrt{\frac{K}{2m}}^2\right)$$

$$+ v_{\max}$$

$$\therefore v_{\max} = \frac{K}{2}$$

Q-39 - 17091621

A particle moving with kinetic energy=3 J makes an elastic head-on collision with a stationary particle which has twice its mass. During the impact:

(A) The minimum kinetic energy of the system is 1 J

(B) The maximum elastic potential energy of the system is 2J

(C) Momentum and total energy are conserved atevery instant

(D) The ratio of kinetic energy to potential energy of the system first decreases and' then increases.

CORRECT ANSWER: A::B::C::D

Q-40 - 11747868

A shell of mass $200g$ is ejected from a gun of mass $4kg$ by an explosion that generate $1.05kJ$ of energy. The initial velocity of the shell is

(A) $100ms^{-1}$

(B) $80ms^{-1}$

(C) $40ms^{-1}$

(D) $120ms^{-1}$

SOLUTION:

In the given problem conservation of linear momentum and energy hold good.

Conservation of energy yields

$m_1 v_1 + m_2 v_2 = 0$

or $4v_1 + 0.2v_2 = 0$ (i)

Conservation of energy yields

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = 1050$$

or

$$\frac{1}{2} 4v_1^2 + \frac{1}{2} \times 0.2 \times v_2^2 = 1050$$

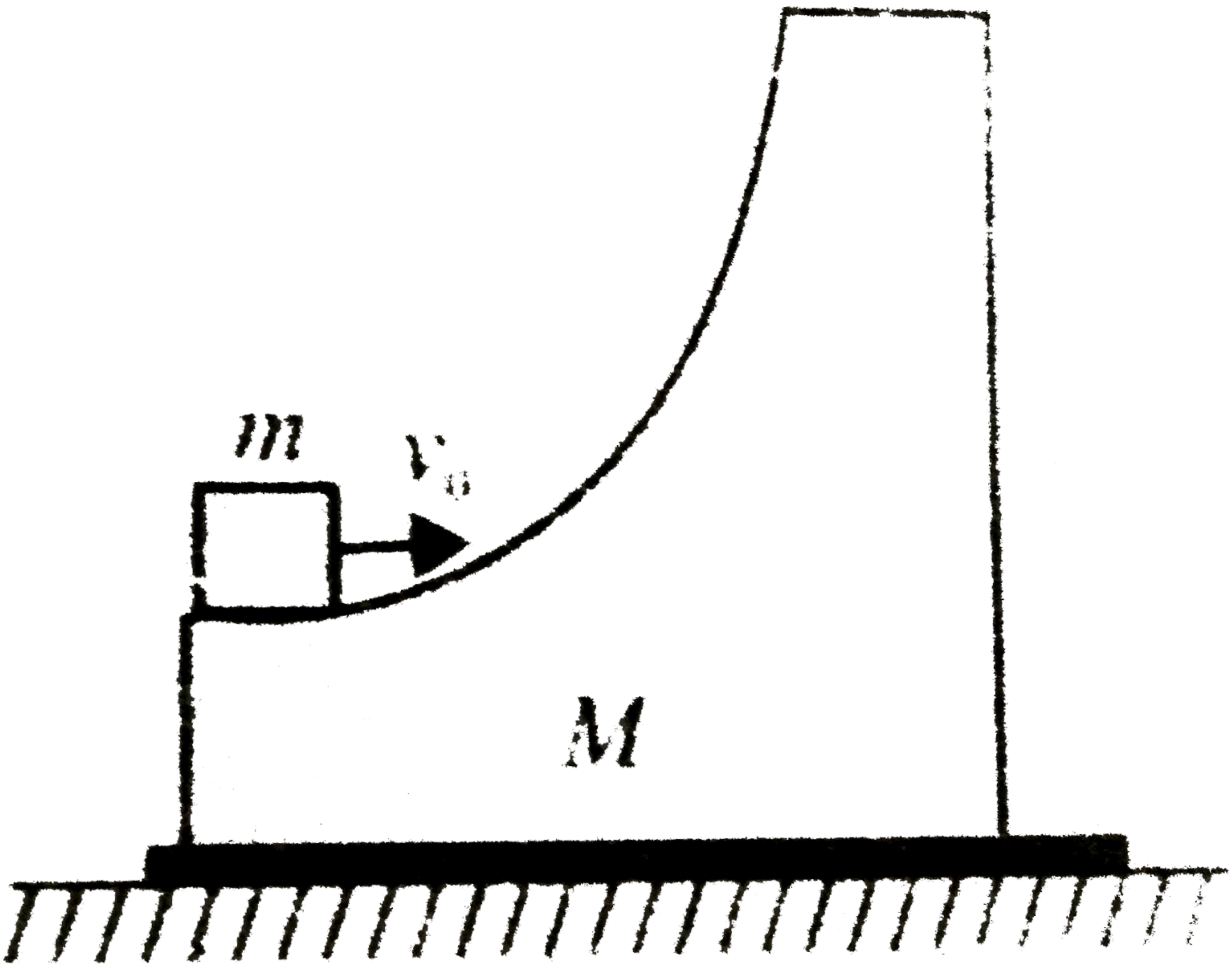
or $2v_1^2 + 0.1v_2^2 = 1050$ (ii)

Solving Eqs , (i) and (ii) , we have

$v_2 = 100 m / s$

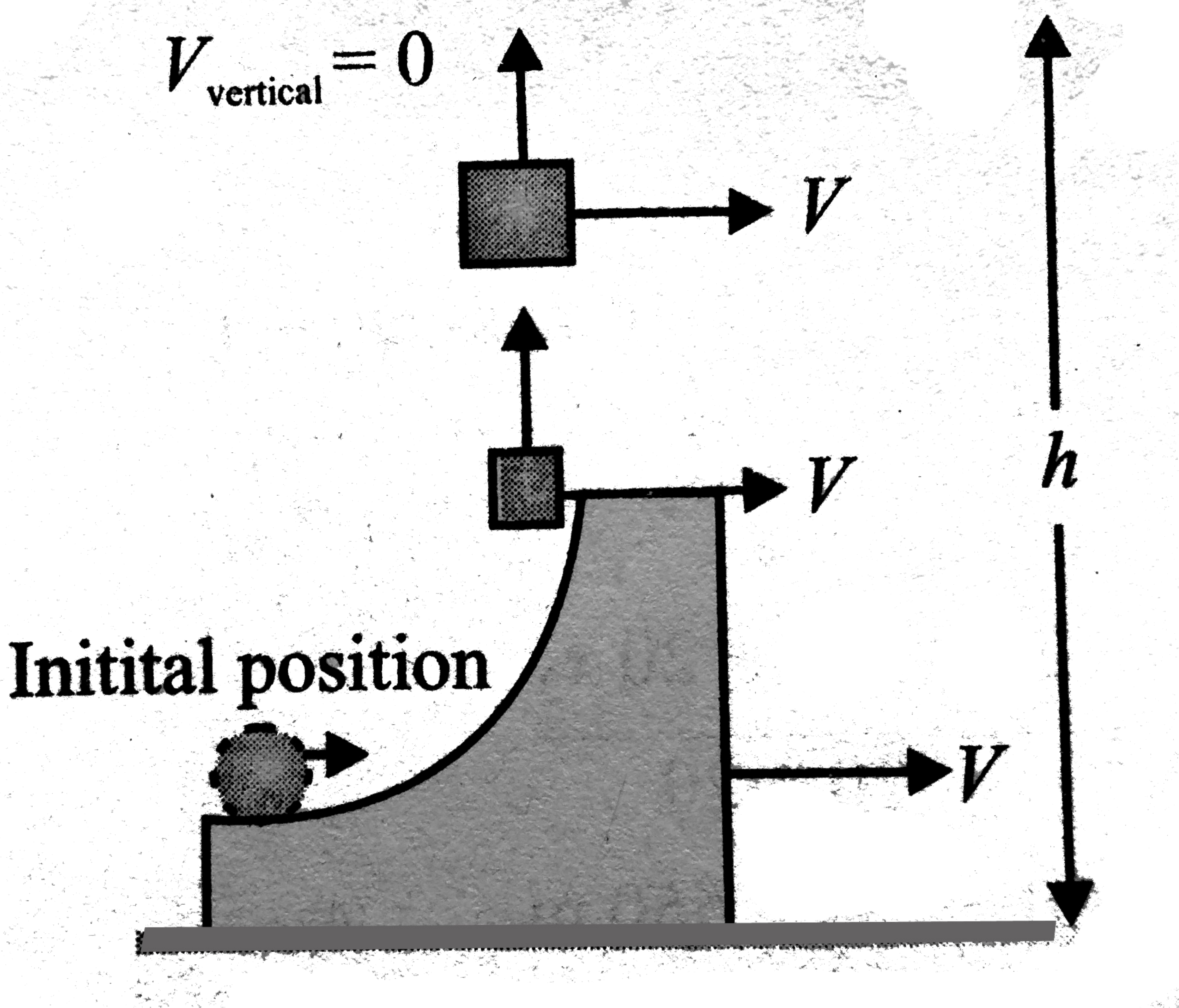
Q-41 - 11300590

A smooth wedge of mass M rests on a smooth horizontal surface. A block of mass m is projected from its lowermost point with velocity v_0. What is the maximum height reached by the block?



SOLUTION:

At the instant the block breaks contact with the wedge, they have common x-component of velocity. In addition, the block has a vertical component of velocity.



Due to this vertical component, the block rises upwards till the verical component of velocity vanishes.

From momentum conservation along x-axis.

$mv_0 = (m + M)V$..........i

$V = \dfrac{mv_0}{(m + M)}$...........ii

From energy conservation between initial and final positions of the block,

$$\frac{1}{2}mv_0^2 = \frac{1}{2}(m+M)V^2 + mgh$$

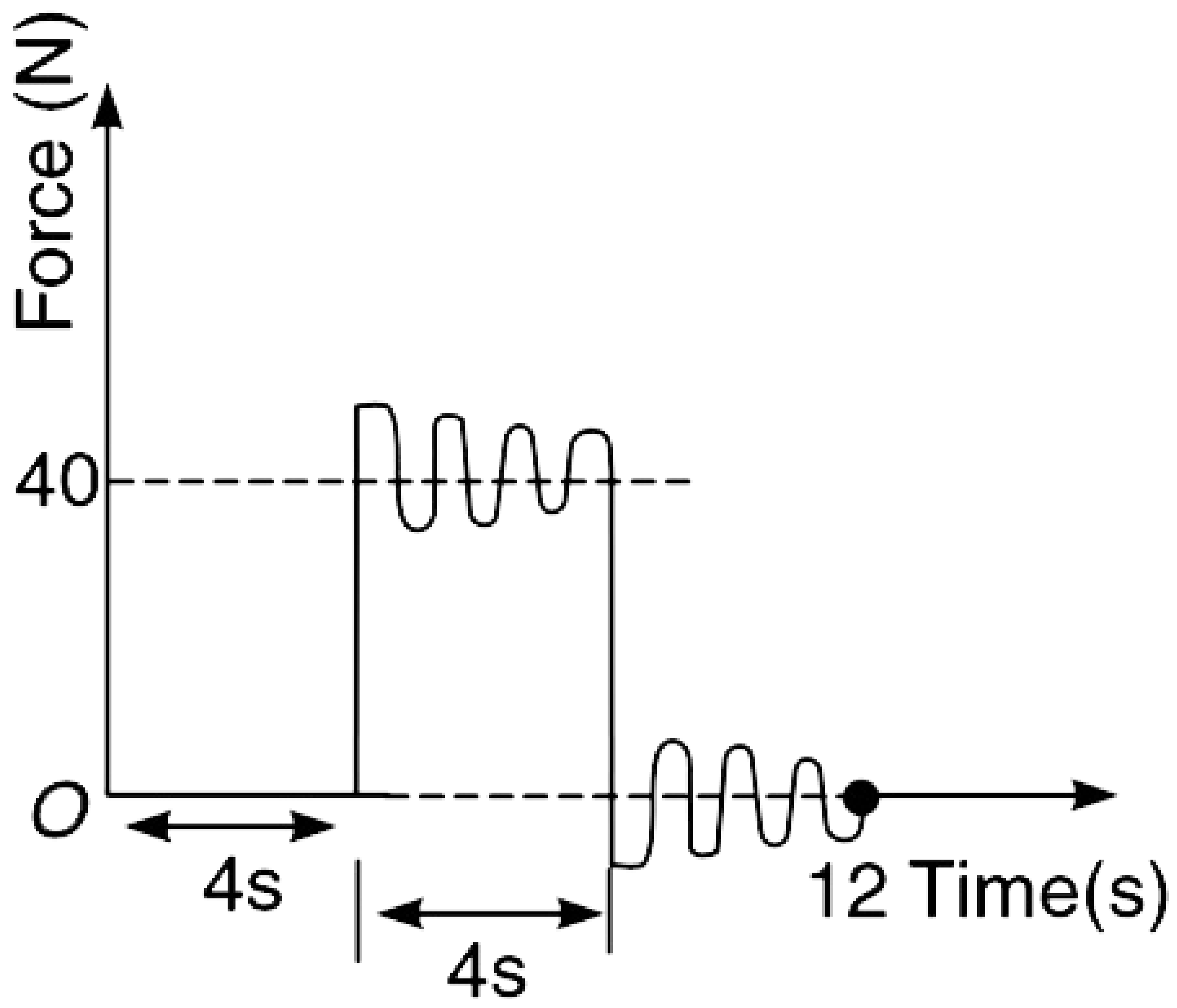
............iii

$$\frac{1}{2}mv_0^2 = \frac{1}{2}\left(\frac{m^2}{m+M}\right)v_0^2 + mgh$$

$$h = \frac{v_0^2}{2g}\left[\frac{M}{m+M}\right]$$

Q-42 - 15085230

A particle of mass $1kg$ is moving with a velocity of 200 m/s. An impulsive force of 4 s duration acts on the particle in a direction opposite to its motion. The force fluctuates a little bit around 40 N magnitude and then it dies out in next 4s showing small fluctuations. An oscilloscope records the force as shown. The two oscillating components in the graph are identical except that one is mirror image of the other. Find the magnitude of velocity of particle after the force stops acting.



CORRECT ANSWER: 40 M/S

Q-43 - 17456542

From a circular disc of radius R, a square is cut out with a radius as its diagonal. The center of mass of remaining portion is at a distance from the center)

(A) $\frac{R}{4\pi - 2}$

(B) $\frac{R}{2\pi}$

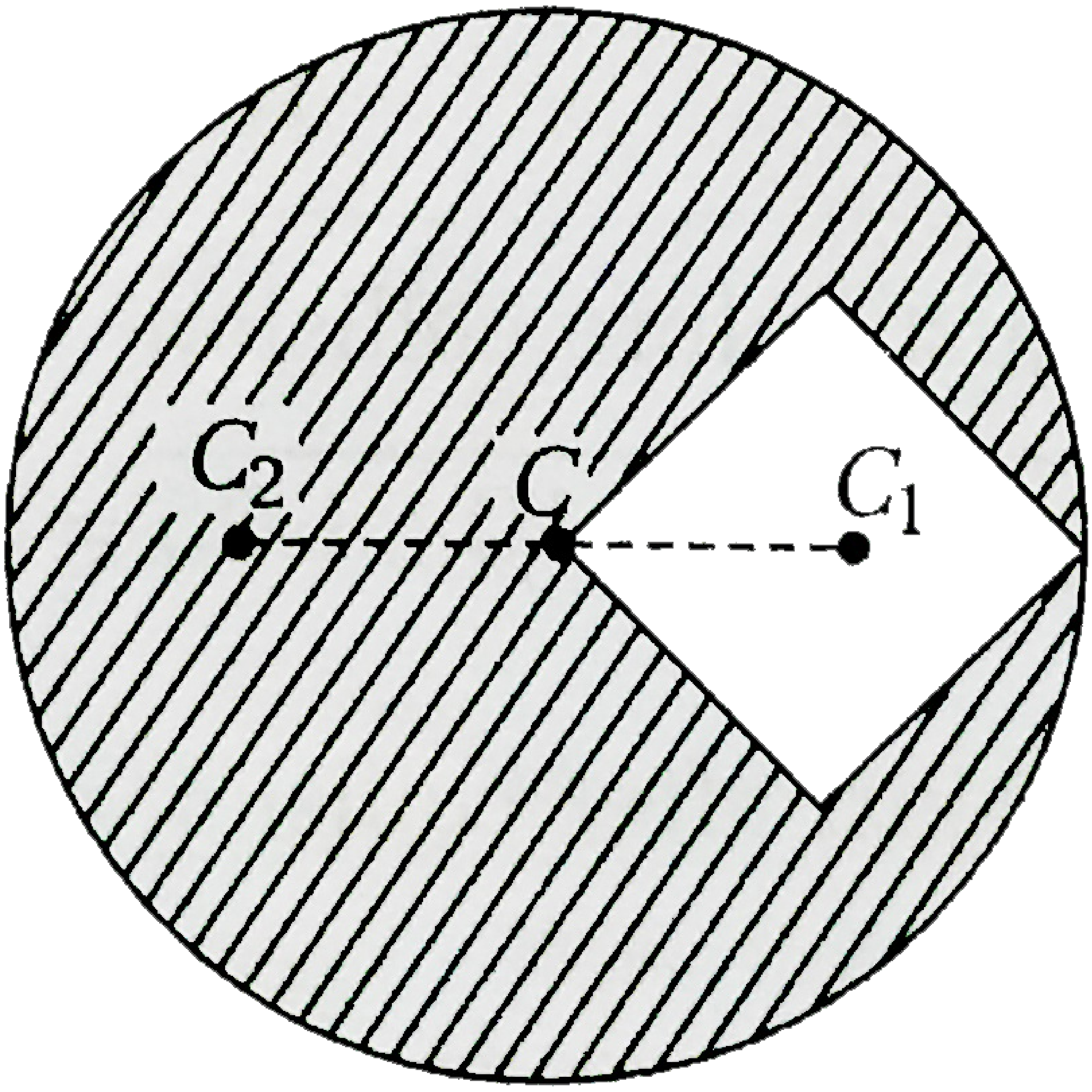
(C) $\frac{R}{\pi - 2}$

(D) $\frac{R}{2\pi - 2}$

CORRECT ANSWER: A

SOLUTION:

$$A_1(\mathbb{C}_1) = A_2(\mathbb{C}_2)$$



side of square will be $\frac{R}{\sqrt{2}}$

$$\therefore \mathbb{C}_2 = \frac{A_1}{A_2} \Bigg(\mathbb{C}_1$$

$$= \frac{\left(\frac{R}{\sqrt{2}}\right)^2}{\pi R^2 - \left(R/\sqrt{2}\right)^2 \left(\frac{R}{2}\right)}$$

$$= \frac{R}{4\pi - 2}$$

Q-44 - 10058806

A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the cirucmferences of the discs coincide. The centre of mass of the new disc is $\frac{\alpha}{R}$ from the center of the bigger disc. The value of α is

(A) $\frac{1}{4}$

(B) $\frac{1}{3}$

(C) $\frac{1}{2}$

(D) $\frac{1}{6}$

CORRECT ANSWER: B

SOLUTION:

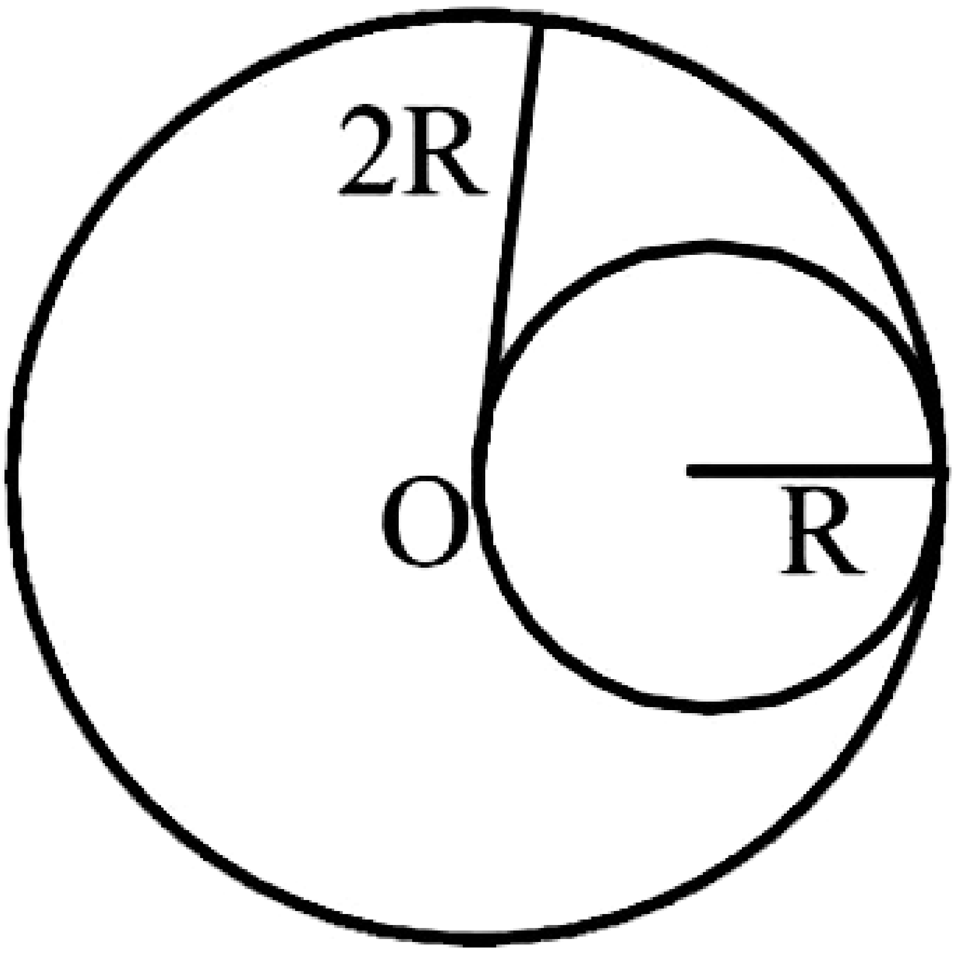
(b) Let the mass per unit area

be σ.

Then the mass of the

complete disc

`=sigma [pi(2R)^2] = 4pisigma R^2



The mass of the removed disc

$$= simga\left(\pi R^2\right)$$

$$= \pi simga R^2$$

Let us consider the above situation to be a complete

disc of radius 2R on which a disc of radius R of negative

mass is superimpose. Let O be the origin. Then the above figure can be redrawn keeping in mind the

concept of centre of mass as:

$$x_{c.m} = \frac{\left(\left(\left(4\pi\sigma R^2\right)\right) \times 0 + \left(\left(-\pi\sigma R^2\right)\right)R\right)}{4\pi\sigma R^2 - \pi\sigma R^2}$$

:. x_(c.m) = (-pisimgaR^2xxR)/(3pisigmaR^2) :. x_(c.m) =

-(R)/(3)rArr alpha =(1)/(3)`

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Q-45 - 11300774

A ball is projected in a direction inclined to the vertical and bounces on a smooth horizontal plane. The range of one rebound is R. If the coefficient of restitution is e, then range of the next rebound is

(A) $R' = eR$

(B) $R' = e^2 R$

(C) $R' = \dfrac{R}{e}$

(D) R'=R`

CORRECT ANSWER: A

SOLUTION:

$$R = \frac{2u\cos\theta.\,u\sin\theta}{g}$$

After impact horizontal component remains the same

$= u\cos\theta$ the vertical component becomes

$$V = e(u\sin\theta)$$

New range $R' = \dfrac{2u\cos\theta.\,eu\sin\theta}{g}$

$$R' = eR$$

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Q-46 - 15218435

The displacement of a particle of mass 2kg moving in a straight line varies with times as $x = (2t^3 + 2)m$. Impulse of the force acting on the particle over a time interval between t = 0 and t = 1 s is

(A) 10 Ns

(B) 12 Ns

(C) 8 Ns

(D) 6 Ns

CORRECT ANSWER: A

SOLUTION:

Using conservation of angular momentum about centre of ring.

$$MR^2\omega = (MR^2 + 2mR^2)\omega'$$

$$\omega' = \frac{\omega M}{M + 2m}$$

Q-47 - 16968831

A boy of mass m is standing on a block of mass M kept on a rough surface. When the boy walks from left to right on the block, the centre of mass (boy + block) of the system :

(A) remains stationary

(B) shifts towards left

(C) shifts towards right

(D) shifts toward right if $M > m$ and toward left if $M < m$

CORRECT ANSWER: C

Q-48 - 15220331

in which fo the following cases the centre of mass of a rod is certainly not at its centre?

(A) The density continuously increases from left ot right

(B) The density continuously decreases from left to right

(C) The density decreases from left to right up to the centre and then increases

(D) The density increases from left to right up to the centre and then decreases

Select correct alternative.

(A) Only (A)

(B) Only (A) and (B)

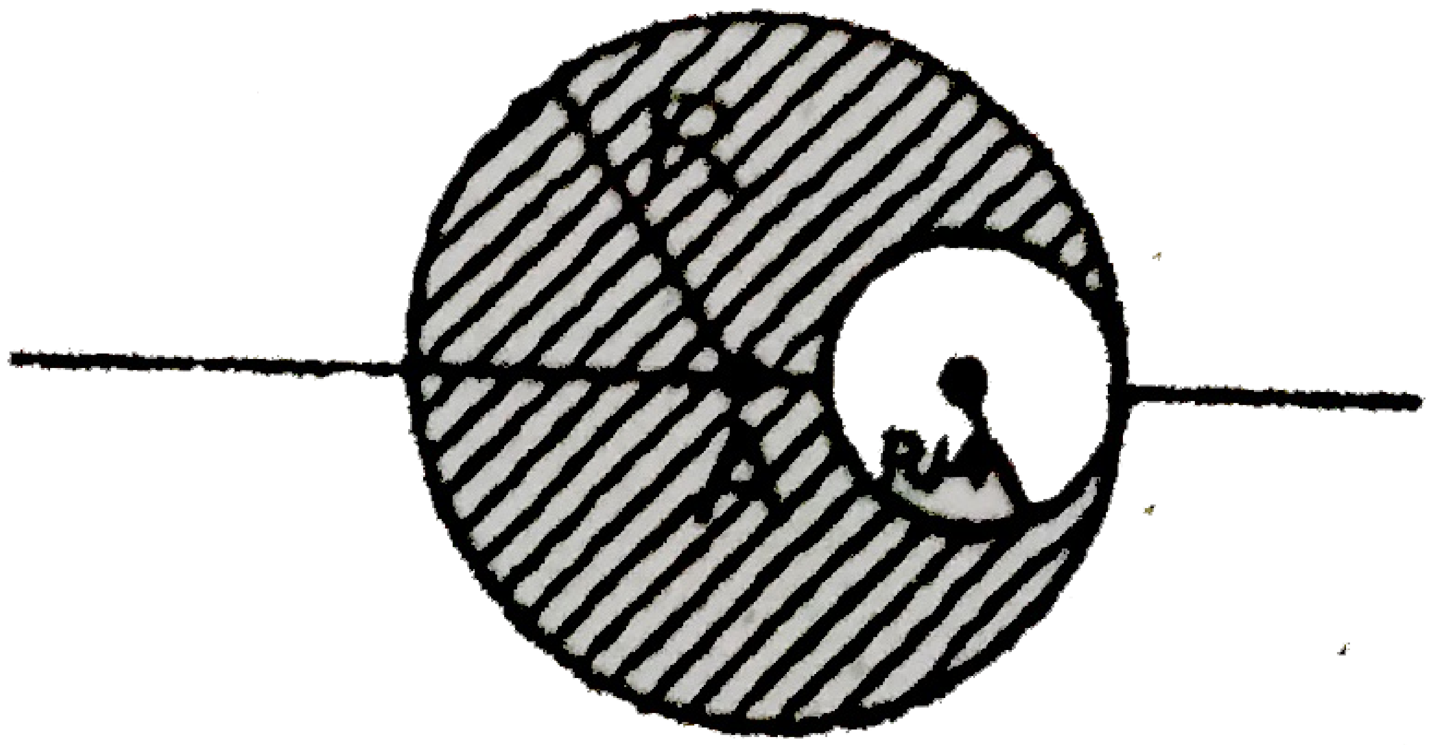
(C) Only (B)

(D) Only (C) and (D)

CORRECT ANSWER: B

Q-49 - 14527431

The centre of mass of the shaded portion of the disc is: (The mass is uniformly distributed in the shaded portion).



(A) $\frac{R}{20}$ to the left of A

(B) $\frac{R}{12}$ to the left of A

(C) $\frac{R}{20}$ to the right of A

(D) $\frac{R}{12}$ to the right of A

CORRECT ANSWER: A

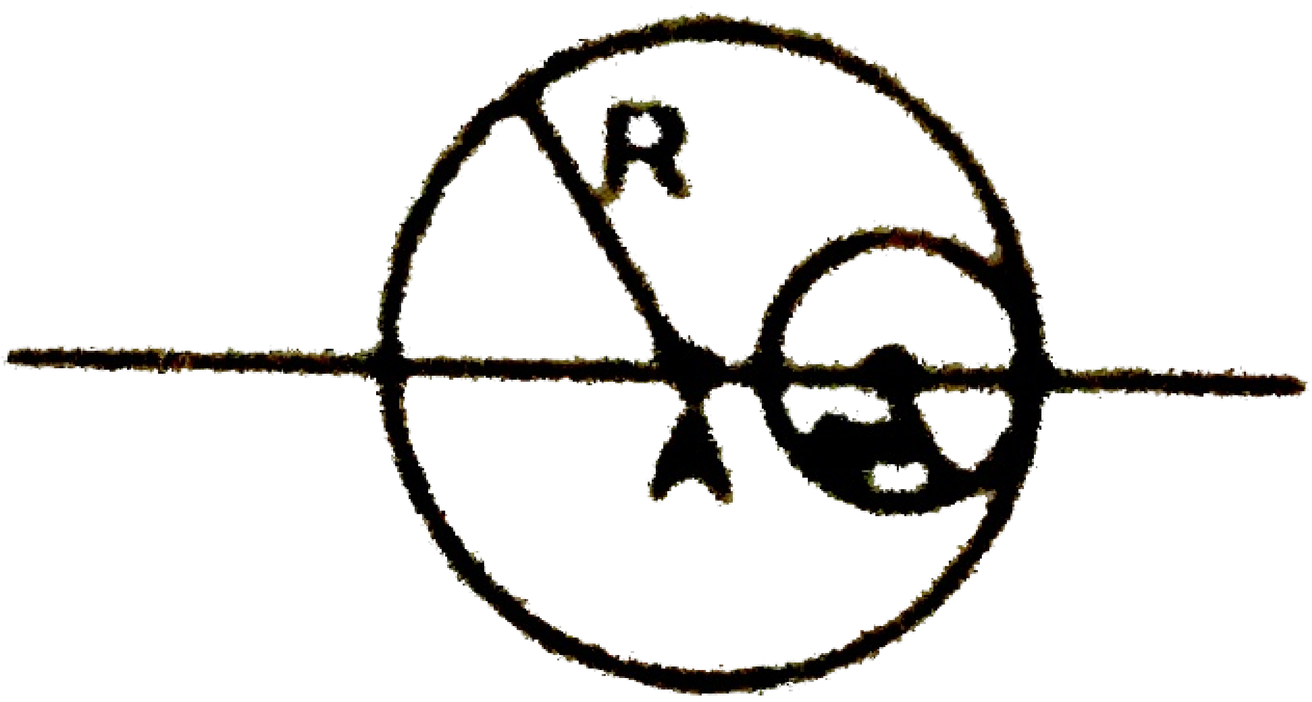
SOLUTION:

$$A_1 = \pi R^2, A_2 = \frac{\pi R^2}{16}$$

$$x_1 = 0, x_2 = \frac{3R}{4}$$

$$x_{cen} = \frac{0 - \frac{\pi R^2}{16} \times \frac{3R}{4}}{\pi R^2 - \frac{\pi R^2}{16}}$$

$$= -\frac{R}{20}$$



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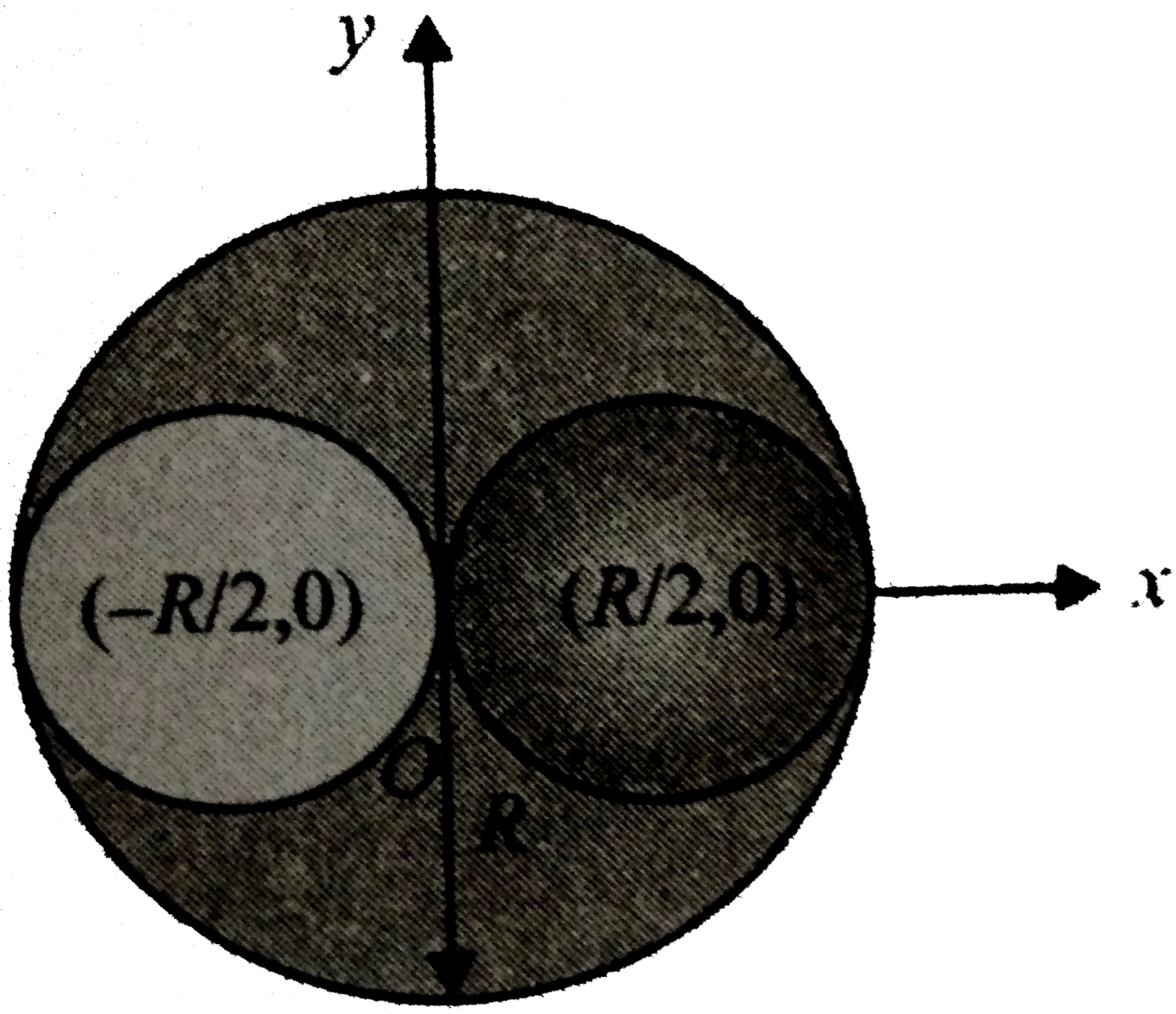
Q-50 - 11300480

Figure shows a uniform disc of radius R, from which a hole of radius $\frac{R}{2}$ has been cut out from left of the centre and is placed on the right of the centre of the disc. Find the CM of the resulting disc.



SOLUTION:

Mass of the cut out disc is

$$m = \frac{M}{\pi R^2} \times \pi \left(\frac{R}{2} \right)^2$$

$$= \frac{M}{4}$$

Let centre of the disc is at origin of the coordinates. Then we can write the CM of the system as

$$x_{CM} = \frac{\overrightarrow{MR} - \overrightarrow{mr} + \overrightarrow{mr}}{M + m + m}$$

$$= \frac{M \times 0 - \frac{M}{4}\left(\frac{-R}{2}\right) + \frac{M}{4}\left(\frac{R}{2}\right)}{M - \frac{M}{4} + \frac{M}{4}}$$

$$= \frac{R}{4}$$

$$y_{CM} = 0$$

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Q-51 - 17665969

A gardener waters the plants by a pipe of diameter 1 cm . The water comes out at the rate of 20 cc/s . The reactionary force exerted on the hand of the gardener is

(A) 2.54×10^{-5} N

(B) 1.62×10^{-3} N

(C) 5.1×10^{-3} N

(D) Zero

Q-52 - 14627146

A smooth sphere is moving on a horizontal surface with velocity vector $3\hat{i} + \hat{j}$ immediately before it hits a vertical wall. The wall is parallel to the vector $\hat{j}$ and the coefficient of restitution between the wall and sphere is $\frac{1}{3}$. The velocity vector of the sphere after it hits the wall is :-

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

(B) $3\hat{i} - \frac{1}{3}\hat{j}$

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

(D) $\hat{i} - \hat{j}$

CORRECT ANSWER: C

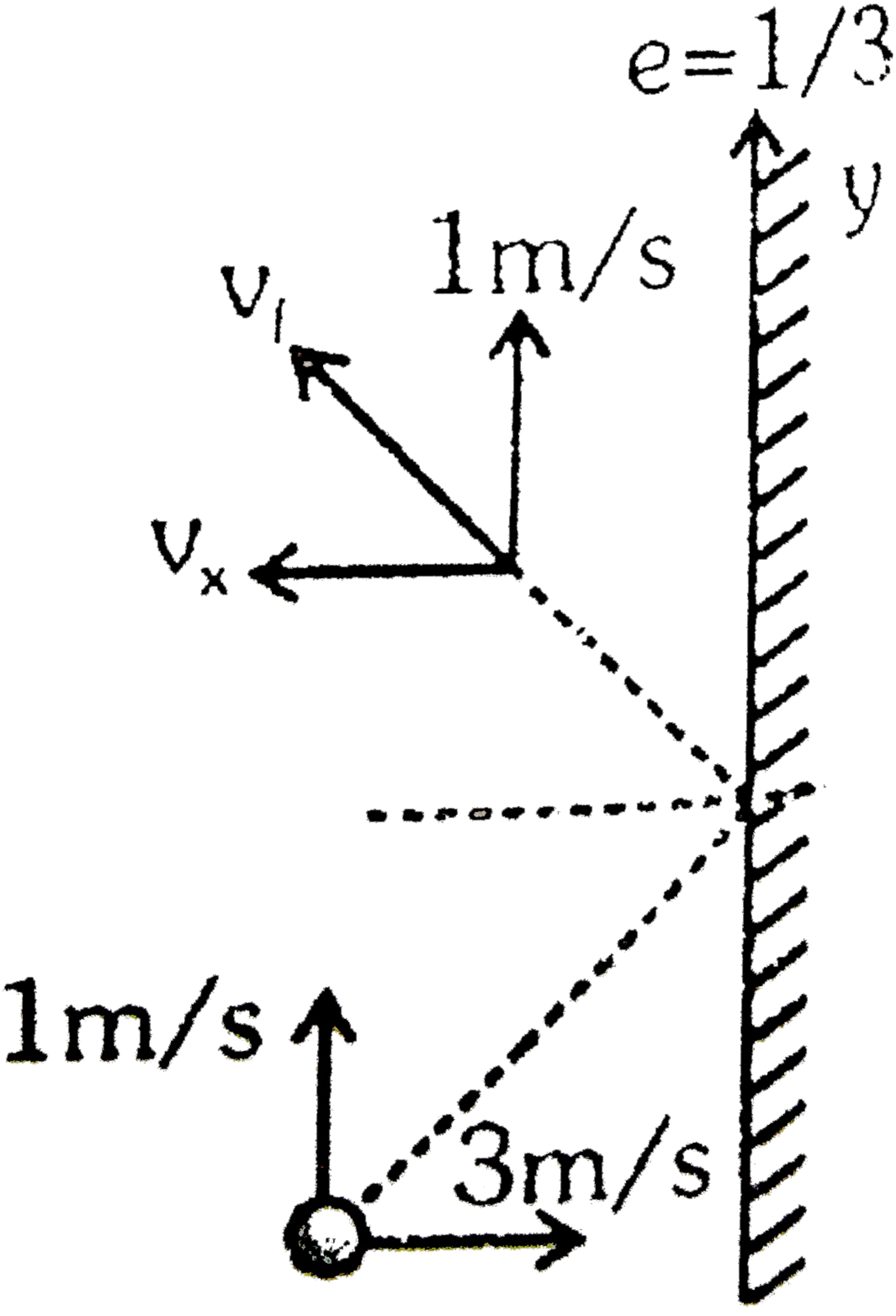
SOLUTION:

$$e \frac{\text{Rate of seperation}}{\text{Rate of approach}}$$

$$\frac{1}{3} = \frac{v_x}{3}$$

$$v_x = 1$$

$$v_f = -\hat{i} + \hat{j}$$



Q-53 - 13651908

A boy of mass $40kg$ stands on a rail road car of mass $60kg$, moving with velocity $10m/s$. Now , the boy begins to run with velocity $5m/s$, with respect to the car , in the same direction , the velocity of the car will be

(A) $6m/s$

(B) $8m/s$

(C) $10m/s$

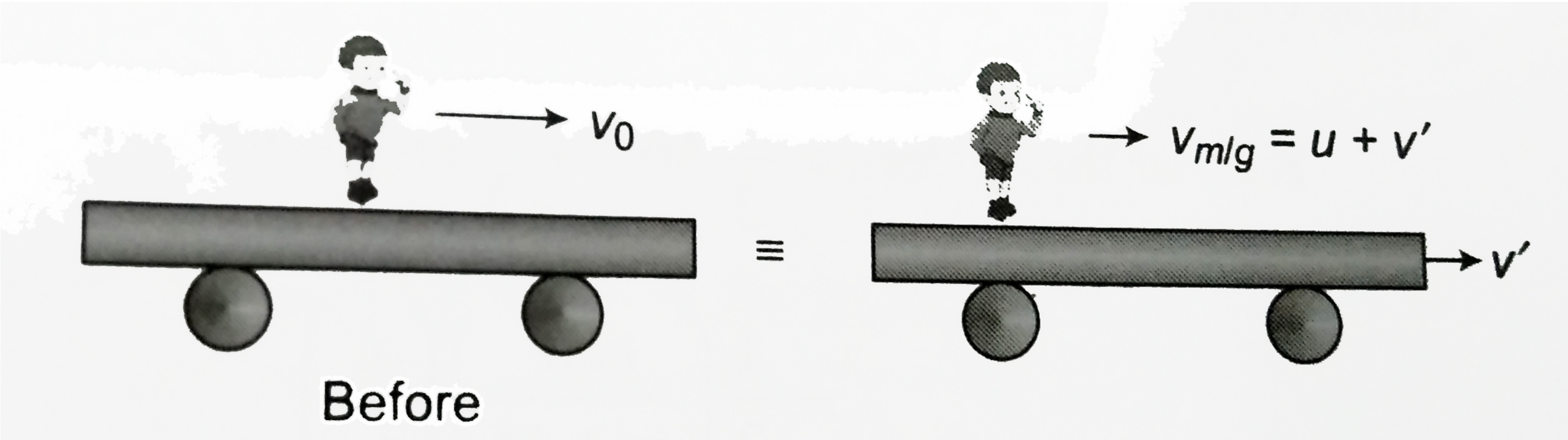
(D) $12m/s$

CORRECT ANSWER: B

SOLUTION:

$$(40+60)v_0$$
$$=40(u+v')+60v'$$

$$100\times 10=40(5+v')$$
$$+60v' \Rightarrow v'=8m/s$$



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Q-54 - 10963928

A boy of mass $60kg$ is standing over a platform of mass $40kg$ placed over a smooth horizontal surface. He throws a stone of mass $1kg$ with velocity $v = 10m/s$ at an angle of 45 with respect to the ground. Find the displacement of the platform (with boy) on the horizontal surface when the stone lands on the ground. Take $g = 10m/s^2$.

CORRECT ANSWER: A::C

SOLUTION:

Let v is the horizontal velocity of platform in opposite direction. Then from momentum conservation in opposite direction we have,

$(60 + 40)v$

$= (1)\left(10\cos 45^{\square}\right)$

$\therefore v = \frac{10}{100}\cos 45^{m} / s$

$= \frac{10}{\sqrt{2}} cm / s$

$\therefore$ Displacement of platform $= vt$

$= \frac{(v)\left(2u\sin 45^{\square}\right)}{g}$

$= \left(\frac{10}{\sqrt{2}}\right)$

$= \frac{2 \times 10 \times \frac{1}{\sqrt{2}}}{10}$

$= 10cm$

Q-55 - 17091607

A stream of water droplets, each of mass m = 0.001kg are fired horizontally at a velocity of $10m/s$ towards a vertical steel plate where they collide. The droplets one spaced equidistant with a spacing of $1cm$. What is approximate average force exerted on the plate by the water droplets. (Assuming that they do not rebound after collision.)

(A) 10N

(B) 100N

(C) 1N

(D) 0.1N

CORRECT ANSWER: A

Q-56 - 15217359

A particle of mass m_1 collides head on with a stationary particles of mass m_2. If $\frac{m_1}{m_2}$ gte, where e is the coefficient of restitution, then :

(A) m_1 will retrun back

(B) m_1 will move in same direction

(C) m_1 will stop

(D) unpredictable

CORRECT ANSWER: 2

SOLUTION:

$$m_1 V = m_1 V_1 + m_2 V_2$$
.... (1)

and $V_2 - V_1 = eV$.... (2)

On solving $V_1 = \frac{V(m_1 - em_2)}{(m_1 + m_2)}$

Given $\frac{m_1}{m_2} > e$

So, V_1 is positive and thus, m_1 will move in same direction.

Q-57 - 11300850

A particle of mass $m_1 = 4kg$ moving at $6\hat{i}ms^{-1}$perfectly elastically with a particle of mass $m_2 = 2$ moving at $3\hat{i}ms^{-1}$

(A) Velocity of centre of mass (CM) is $5\hat{i}ms^{-1}$

(B) The velocities of the particles relative to the centre of mass have same magnitude.

(C) Speed of individual particle before and after collision remains same.

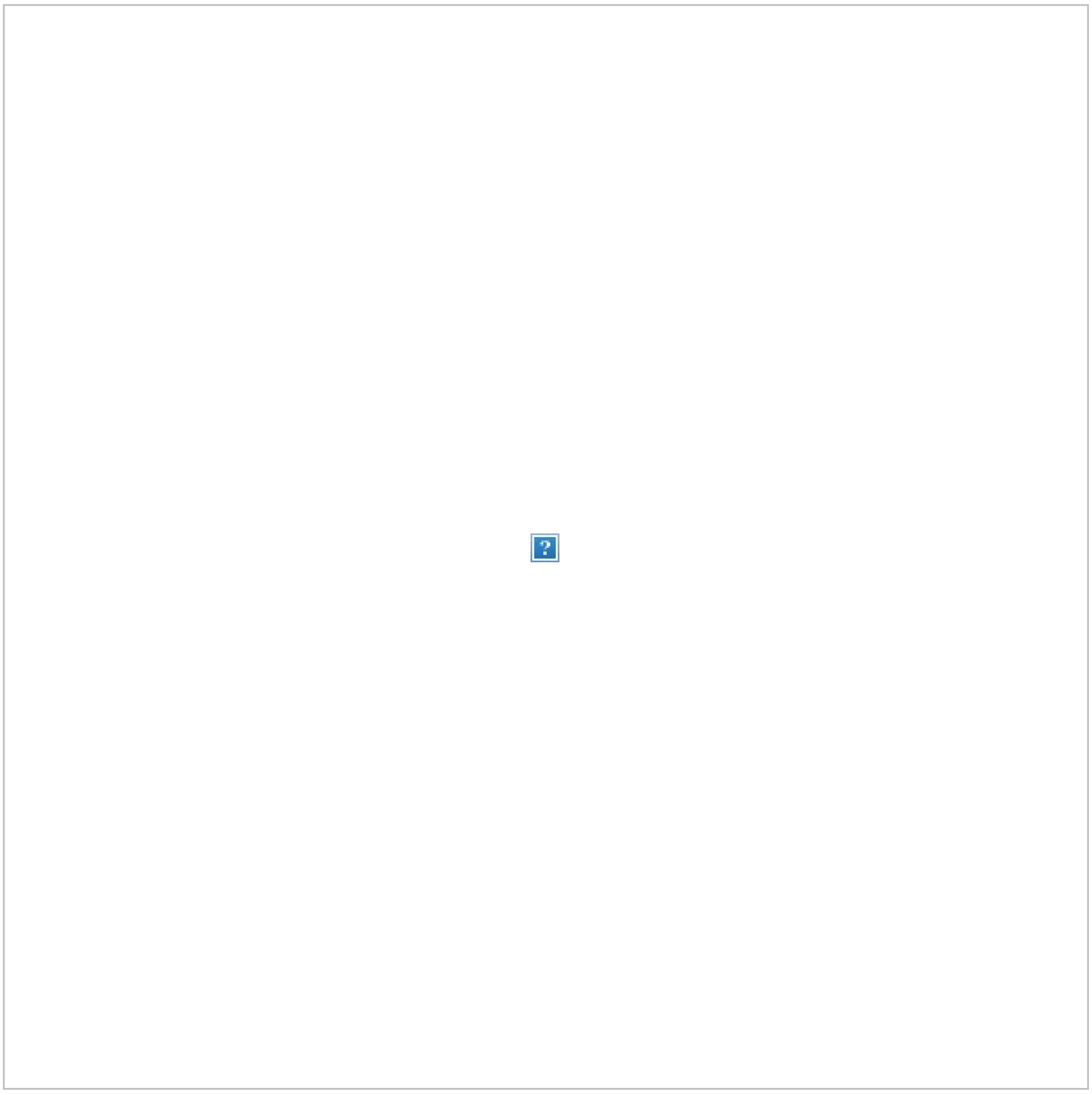
(D) The velocity of particles relative to CM after collisioin are

$$\overrightarrow{v}_{1f/cm} = -\hat{i}ms^{-1},$$

$$\overrightarrow{v}_{2f/cm} = 2\hat{i}ms^{-1}$$

CORRECT ANSWER: A::D

SOLUTION:



$$v_{cm} = \frac{4 \times 6 + 2 \times 3}{4 + 2}$$

$$= 5ms^{-1}$$

$$u_{\frac{1}{c}m} = u_1 - v_{cm} = 6$$
$$- 5 = 1ms^{-1}$$

$$v_{\frac{2}{c}m} = u_1 - v_{cm} = 6$$
$$- 5 = 1ms^{-1}$$

$$v_{\frac{2}{c}m} = u_1 - v_{cm} = 4$$
$$- 5 = -1ms^{-1}$$

Here b in incorrect.

After collision :

$$v_1 = 4ms^{-1}, v_2$$
$$= 7ms^{-1}$$

$$v_{\frac{2}{c}m} = v_2 - v_{cm} = 7$$
$$- 5 = 2ms^{-1}$$

Q-58 - 17091575

A particle of mass m_1 makes an elastic one dimensional collision with a stationary particle of mass m_2.What fraction of the kinetic energy of m_1 is carried away by m_2?

(A) $\frac{m_1}{m_2}$

(B) $\frac{m_2}{m_1}$

(C) $\frac{2m_1m_2}{(m_1+m_2)^2}$

(D) $\frac{4m_1m_2}{(m_1+m_2)^2}$

CORRECT ANSWER: D

Q-59 - 11300700

A particle of mass m_1 moving with velocity v in a positive direction collides elastically with a mass m_2 moving in opposite direction also at velocity v. If $m_2 > > m_1$, then

(A) the velocity of m_1 immediately after collision is

nearly $3v$

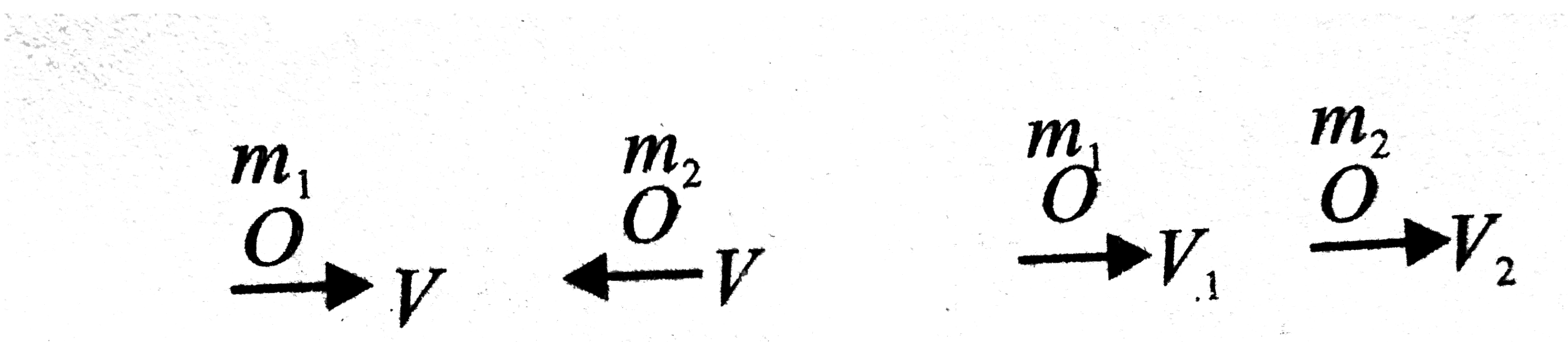
(B) the change in momentum of m_1 is nearly $4m_1v$

(C) the change in kinetic energy of m_1 is nearly $4mv_2$

(D) all of the above

CORRECT ANSWER: D

SOLUTION:



$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u_1$$

$$+ \frac{2m_2u_2}{m_1 + m_2}$$

$= -u_1 + 2u_2$ (neglecting m_1 in comparison to m_2)

Hence a is correct

change in omentum of

$m_1 = P_f - P_i = mv_1$
$- mv$

$= -m3v - mv$
$= 4mv$

hence b is correct.

Change in KE of

$m_1 = K_f - K_i$

$$= \frac{1}{2}mv_1^2 - \frac{1}{2}mv^2$$

$$= \frac{1}{2}m(3v)^2 - \frac{1}{2}mv^2$$
$$= 4mv^2$$

Hence c is correct

Q-60 - 10963908

A jet of water hits a flat stationary plate perpendicular to its motion. The jet ejects $500g$ of water per second with a speed of $1m/s$. Assuming that after striking, the water flows parallel to the plate, then the force exerted on the plate is

(A) (a) $5N$

(B) (b) $1.0N$

(C) (c) $0.5N$

(D) (d) $10N$

CORRECT ANSWER: C

SOLUTION:

$v_i = 1m/s, v_f = 0$

$$|F| = \left|\frac{\Delta p}{\Delta t}\right|$$

$$= \left(\frac{\Delta m}{\Delta t}\right)(v_i - v_f)$$

$$= 0.5 \times 1 = 0.5N$$