# PHYSICS

## BOOKS - SHREE BALAJI PHYSICS (HINGLISH)

## IMPULSE AND MOMENTUM

Illustation

**1.** Consider ·an astronaut trapped in space, isolated from surrounding. He can reach his spacecraft if some velocity is gained by him somehow. Suddenly he realises that he has got a small pencil in his pocket. How can he acquire velocity (momentum) ?

We take the system to consist of the astronaut and the pencil as shown in Fig. 4.4. We assign the positive direction of the x-axis to be the direction of throw. The gravitational force acts on the $Y5tem, which indeed is external force. However, this force is directed along the y-axis, it will not change momentum along x-axis. we· can thus apply the conservation of momentum to this system. What happens to the force exerted by the astronaut on the pencil while throwing it?

$$m_a \overrightarrow{V}_{ai} + m_p \overrightarrow{V}_{\text{pi}} = m_a \overrightarrow{V}_{af} + m_p \overrightarrow{V}_{pf} 0 + 0 = M_a \overrightarrow{V}_{af} + m_p \overrightarrow{V}_{pf} \overrightarrow{V}_{af} = -$$

The negative sign indicates that the astronaut moves in the direction opposite. to the direction of motion of the pencil.

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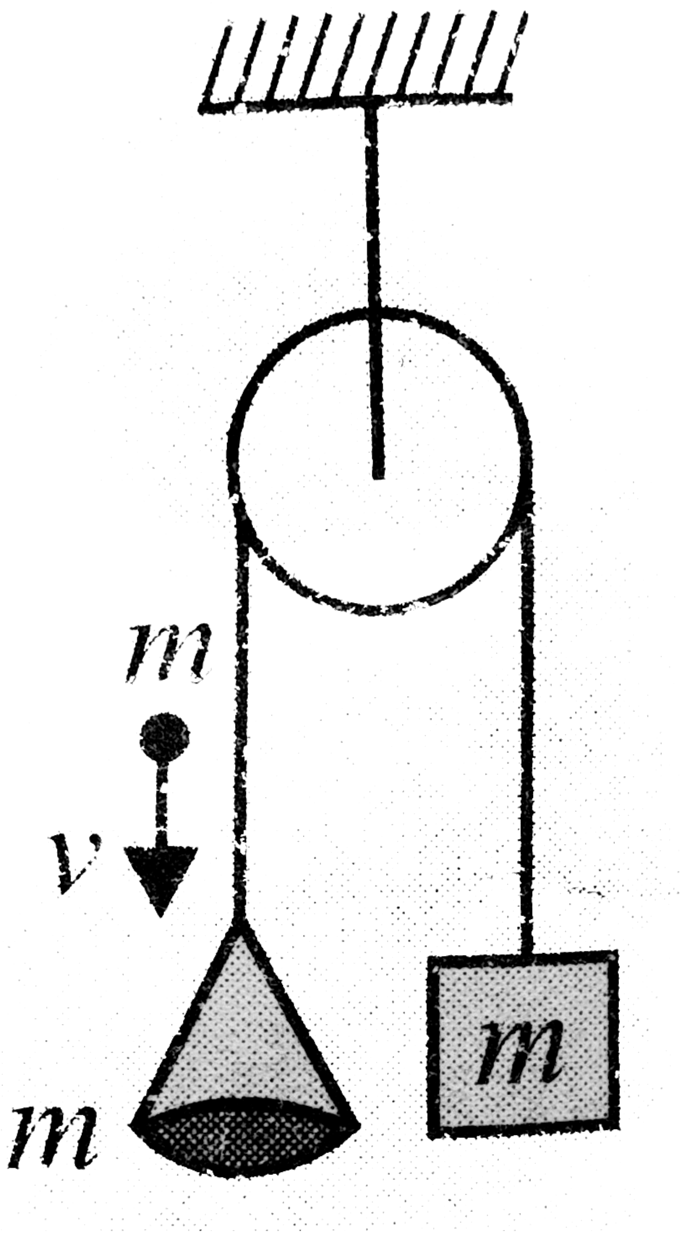
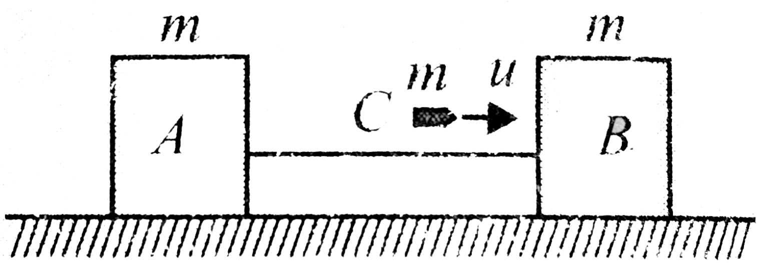
2. A block speed of mass $m$ and a pan of equal mass are connected by a string going over a smooth light pulley. Initially, the system is at rest, then a particle of mass $m$ falls on the pan ad sticks to it. If the particle strikes the pan with a speed $v$, find the speed with which the system

moves just after the collision.



**3.** 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



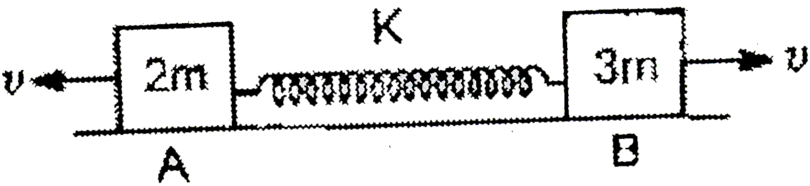

a. the velocity of $A$, $B$, $C$ after collision.

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.

**4.** In the fig 4.24 a block of mass m moves with velocity $v_0$ toward a stationaly block of a mass M on a smooth horizontal surface. Find the maximum compression in the spring of stiffnesss constant K.

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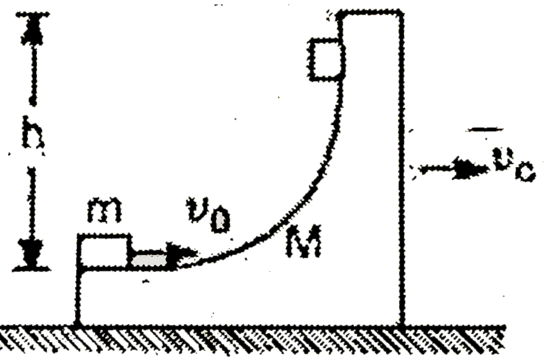
**5.** In the fig 4 .25 shown, if all the surfaces are smooth , then determine the maximum height h attained by the block on the wedge, assuming it to be very large .




At the highest position both the block and the wedge move together with the velocity of CM

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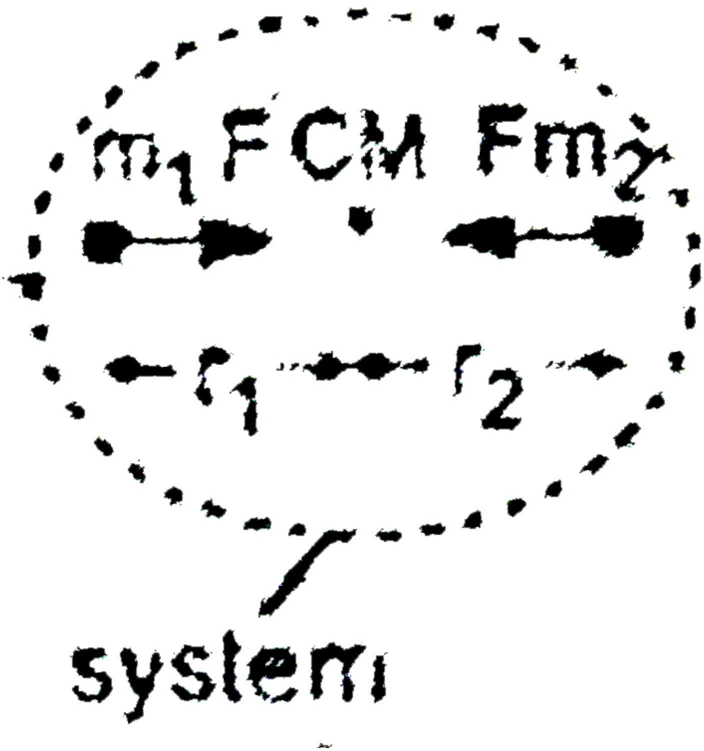
**6.** Consider a system of two particles of masses $m_1$ and $m_2$ separated by a distance r. Suppose they start to move towards each other due to their mutual attraction (attractive force may be electrical, gravitational, etc.).

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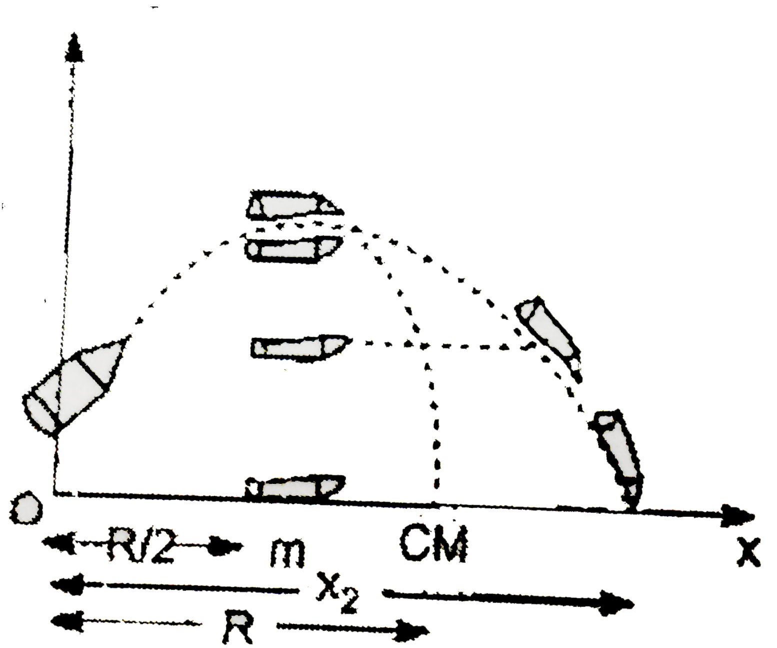
**7.** A projectile of mass mis fired with an initial velocity $v_0$ at an angle 0 to the horizontal. At its highest point, it explodes into two fragments of equal mass. One of the fragments falls vertically with zero initial speed. Since the only external force acting on the system is gravitational, the motion of centre of mass of the_ system (the fragments) follows the same parabolic path as the projectile would have followed if there had been no explosion. Force of explosion is internal, it cannot change the trajectory of the system.

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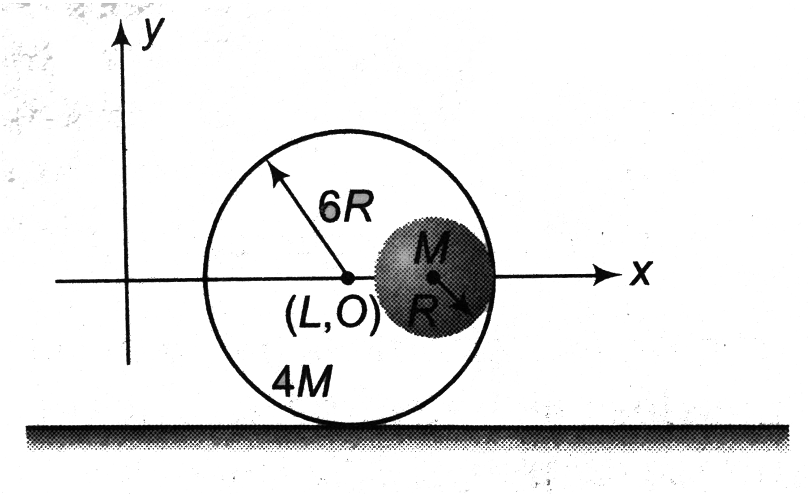
**8.** A small sphere of radius R is held against the inner surface of larger sphere of radius $6R$ (as shown in figure). The masses of large and small spheres are $4M$ and M respectivley. This arrangement is placed on a horizontal table. There is no friction between any surfaces of contact. The small sphere is now released. Find the coordinates of the centre of the large spheres, when the smaller sphere reaches the other extreme position.

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9. If some mass of area is removed from a rigid body, then the position of centre of mass of the remaining postion is obtained from the following formulae.

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10. Find the position of centre of mass of the uniform lamina shown in figure.

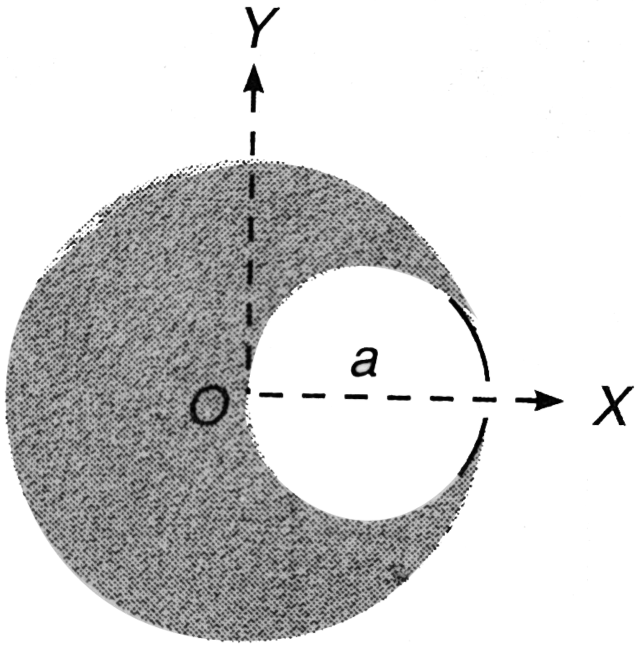

Fig. 11.12

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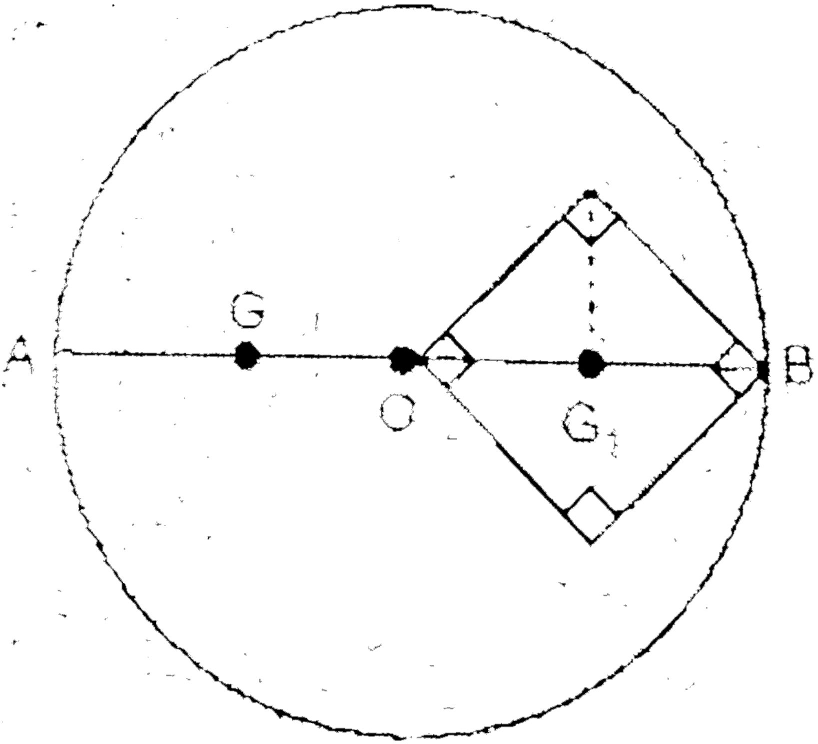
11. A square hole is punched out of a circular lamina, the diagonal of the square being the radius of the circle. If 'a' br the diameter of the circle,

find the distance of C.G. of the reamainder form the centre of the circle.

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**12.** The position vector of three particles of masses $m_1 = 1kg$.

$m_2 = 2kg$ and $m_3 = 3kg$ are $r_1 = \left(\hat{i} + 4\hat{j} + \hat{k}\right)m, r_2 = \left(\hat{i} + \hat{j} + \hat{k}\right)m$ and $r_3 = \left(2\hat{j} - \hat{j} - 2\hat{k}\right)m$ respectivley. Find the position vector of their centre of mass.

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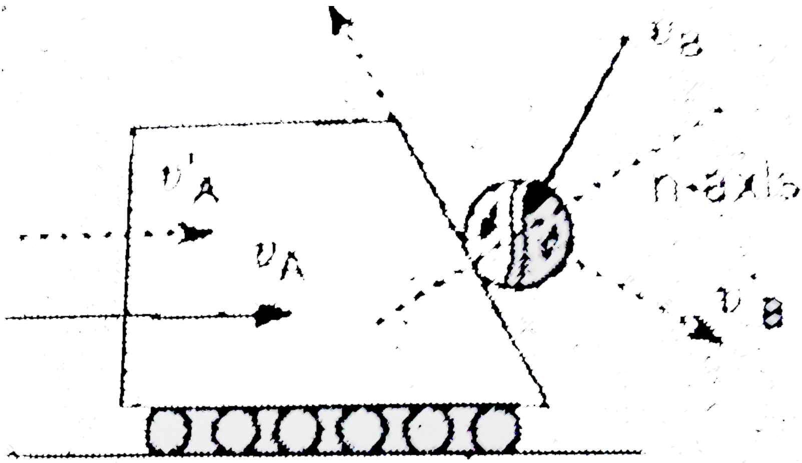
**13.** consider collision between a block A and a ball B. the block is constrained to move along a horizontal surface. Ignore friction at any of the surfaces. Impulsive. Force between block and ball is along the line of impact and the impulse of reaction exerted by ground is in vertical direction , which is an external force on the system.



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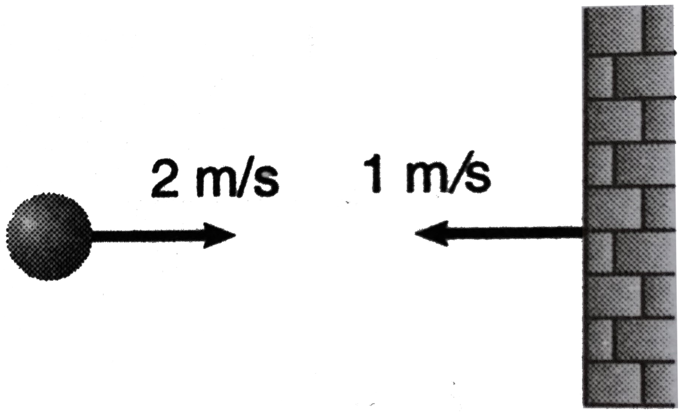
**14.** A ball is moving with velocity $2m/s$ towards a heavy wall moving towards the ball with speed $1m/s$ as shown in figure. Assuming collision to be elastic, find the velocity of ball immediately after the collision.

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**15.** A ball of mass $m$ moving at speed $v$ makes a head on collision with an identical ball at rest. The kinetic energy of the balls after the collision is $3/4th$ of the original. Find the coefficient of restitution.

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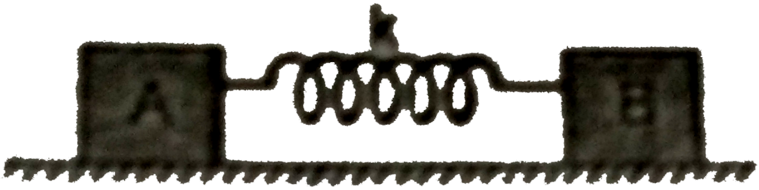
Example

**1.** In the figure shown the spring is compressed by $'x_0'$ and released . Two block $'A'$ and $'B'$ of masses $'m'$ and $'2m'$ respectively are attached at the ends of the spring. Blocks are kept on a smooth horizontal surface and released. Find the work done by the spring on $'A'$ by the time compression of the spring reduced to $\frac{x_0}{2}$.

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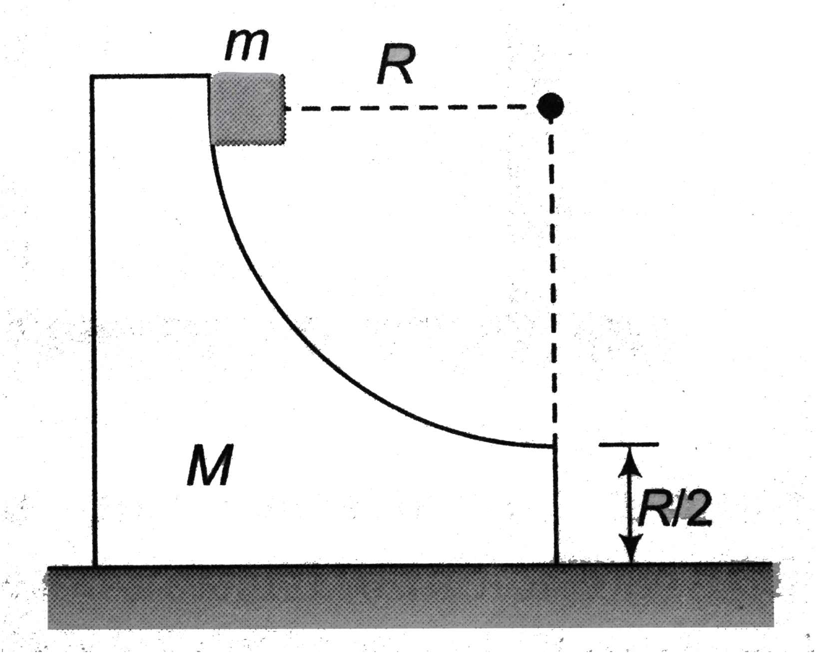
**2.** A small cube of mass $m$ slides down a circular path of radius R cut into a large block of mass M, as shown in figure. M rests on a table, and both blocks move without friction. The blocks are initially at rest, and m starts from the top of the path. Find the horizontal distance from the bottom of block where cube hits the table

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**3.** two blocks of masses m and 2m are connected by a relaxed spring with a force contant k. the block on the left is given a sharp irnpulse "J" towards the right , and the blocks begin to slide along the table ,(see fig 4E.3) find the maximum compression in the spring .

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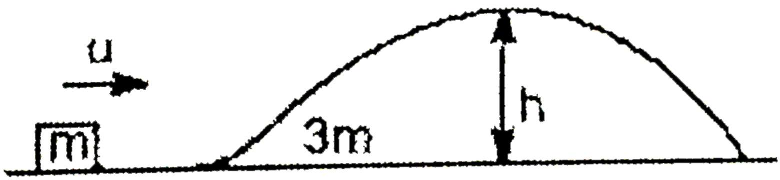
**4.** A small puck of mass m asn velcity v slider along a horizonal plane. The puck meets a "hill " of mass 3 m and height h that can also move along the plane . The puck begins to slide up the " hill" [see fig 4E.4 (a)] . If the hill is initially at rest m what value of v provides for the maxium subsequent velocity us of the " hill " ? Assume that all surface are frictionless.

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**5.** Figure shows a small body of mass m placed over a larger mass M whose surface is horizontal near the smaller mass and gradually curves to become verticle. The smaller mass is pushed on the longer on at a speed v and the system is left to itself. Assume that all the surfaces are frictionless. (a). find the speed of the larger block when the smaller block is sliding on the vertical part. (b). find the speed of the smaller mass when it breaks off the larger mass at height h. (c). find the maximum height (from the ground) that the smaller mass ascends. (d) show that the smaller mass will again land on the bigger one. Find the distane traversed by the bigger block during the time when the smaller block was in its flight under gravity.

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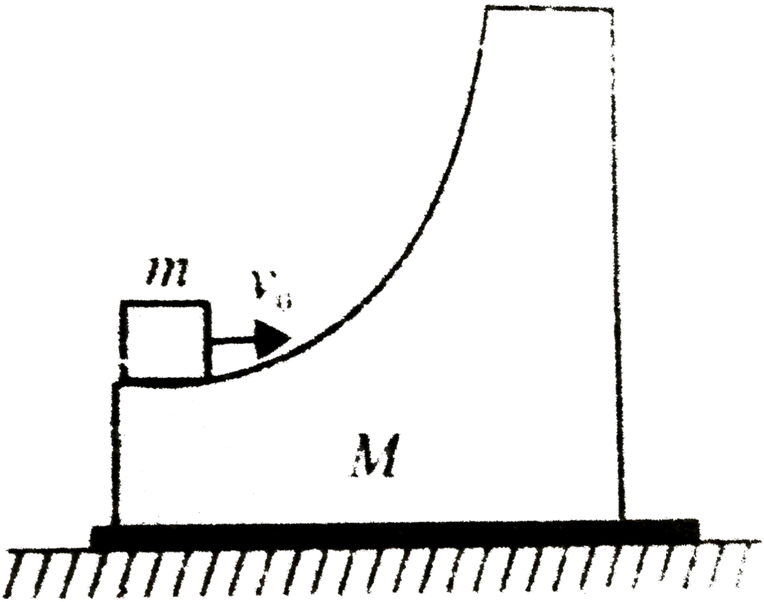
**6.** A smooth wedge of mass $M$ rests on a smooth horizontal surface. A block of mass $m$ is projected from its lowermost point with velocity $v_0$.

What is the maximum height reached by the block?

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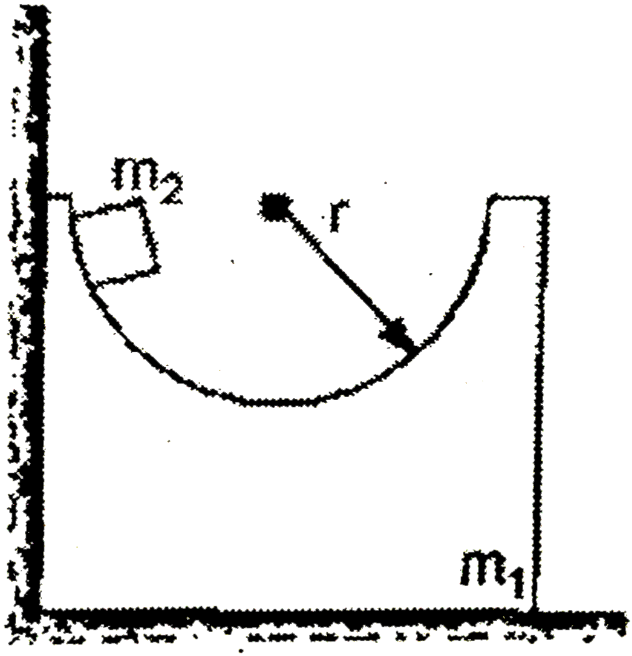
**7.** A wedge of mass m1 with its upper surface hemispherical in shape, as shown in Fig. 4E. 7 (a), rests on a smooth horizontal. surface near thewall. A small block of mass m2 slides without friction on the hemispherical surface of the wedge. What is the 'maxi.mum velocity attained by the wedge ?

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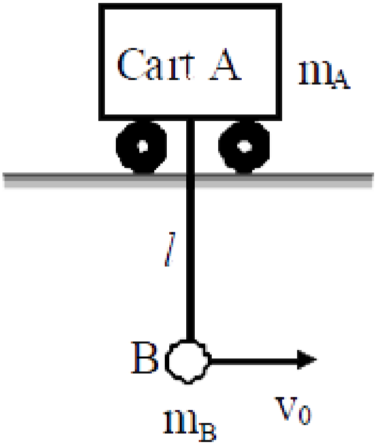
**8.** A ball B is suspended from a string of length l attached to a cart A, which may roll on a frictionless surface. Initially the cart is at rest and the ball is given a horizontal velocity $v_0$. Determine the velocity of B as it reaches the maximum height.

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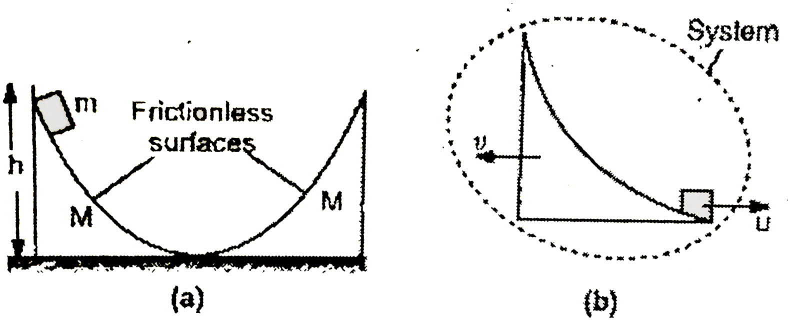
**9.** Two identical wedges of mass M are smoothly conjugated . The wedges are free to move on a smooth horizonal surface, A block of mass m is releaded from a height h on one of the wedge (See fig 4E.9)

(a) Show that the height h to which the mass m ascends the right wedge is $h_{\max} = \frac{M_2}{(M+m)^2} h$.

(b) what mass ratio (M/m) results is $h_{\max} = h/4$

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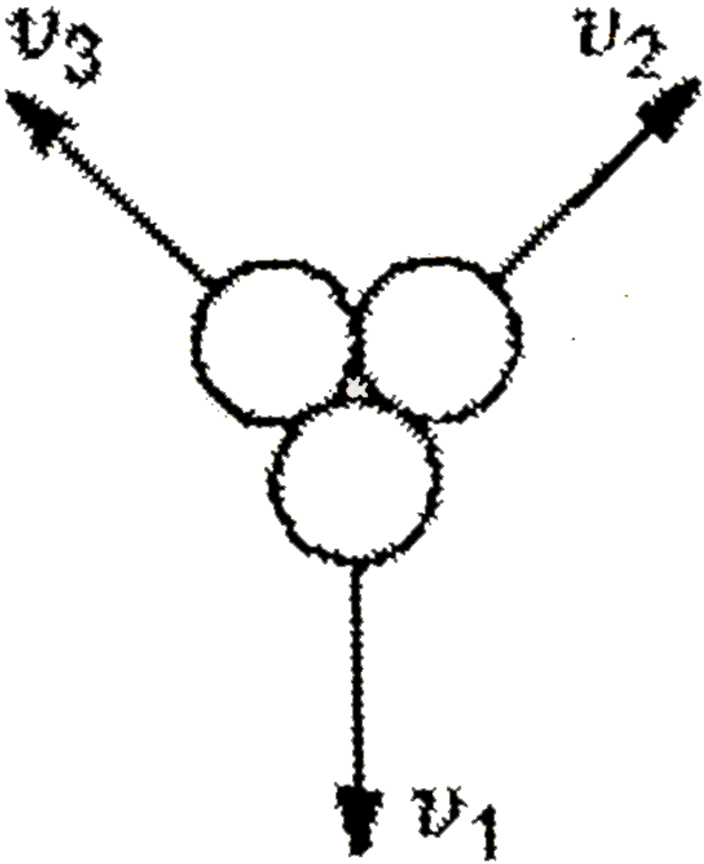
**10.** A rocket is projected vertically upwords. It explodes at the/ topmost point of its trajectory into three identical fragments . One of the fragments comes straight down in time t 1 while the1 other two land at a time $t_2$ after explosion. Find the height at which the explosion ocurred in terms of $t_1$ and $t_2$ ?

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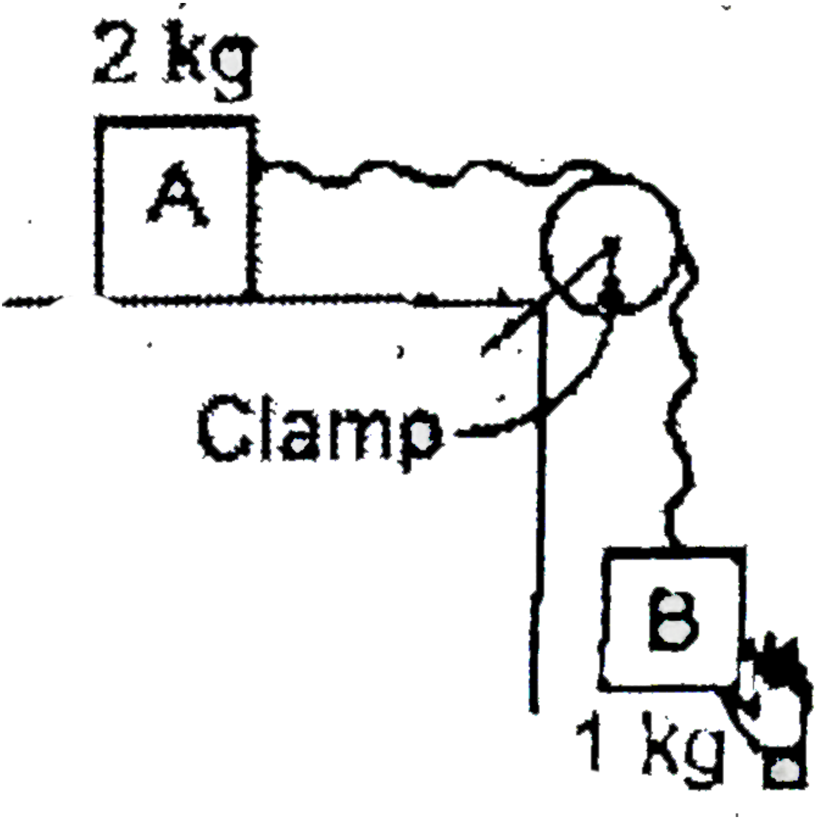
**11.** Two blocks A and B are joined by means of a slacked string passing over a massiess pulley as shown in diagam. The system is released from rest and it becouse taut when B falls a distance 0.5 m, then

(a) find the common velcoity of two blocks just after string become taut.

(b) Find the magnitude of impulse on the pulley by tyhe clamp during the small interval while string becomes taut

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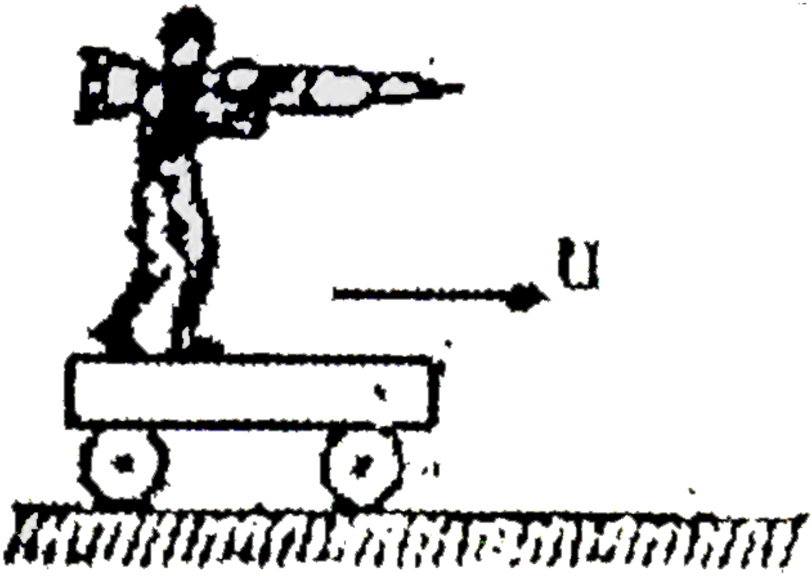
**12.** fig 4E.12 shows a, Man + Rocket Launher of total mass = m= 90 kg u= 5 m/s mass of rocket =m= 10 kg

Muzzle velcoity of Rocket $= v_0 = 30 m / s$

(a) what will be man's and rocket 's velocity's after firing .

(b) find energy of explosion .

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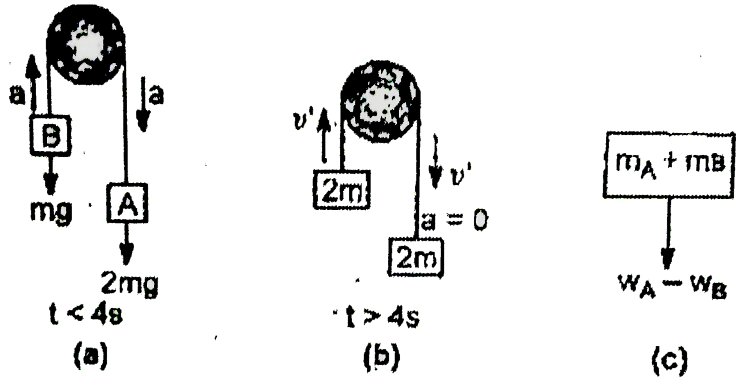
**13.** two bodies of masses m and 2m are connected by a light inextensible string passing over a smooth pulley and released After four second a mass m is suddenly joined to the ascending body . Deterinie

(a) the resulting speed ,and

(b) how much kinetic energy is lost by the descending body when the body of mass m is added.

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**14.** After falling from rest through a height $h$, a body of mass $m$ begins to raise a body of mass $M(M > m)$ connected to it through a pulley. Find the fraction of kinetic energy lost when the body of mass $M$ is jerked into motion

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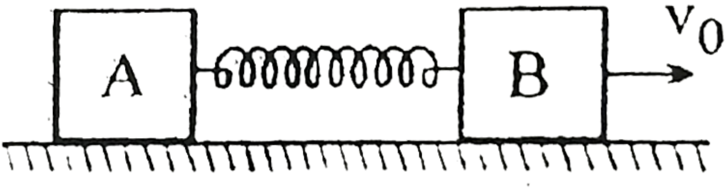
**15.** Two blocks A and B of the same mass are connected to a light spring and placed on a smooth horizontal surface B is given velocity $v_0$ (as shown in the figure) when the spring is in natural length. In the subsequent motion.

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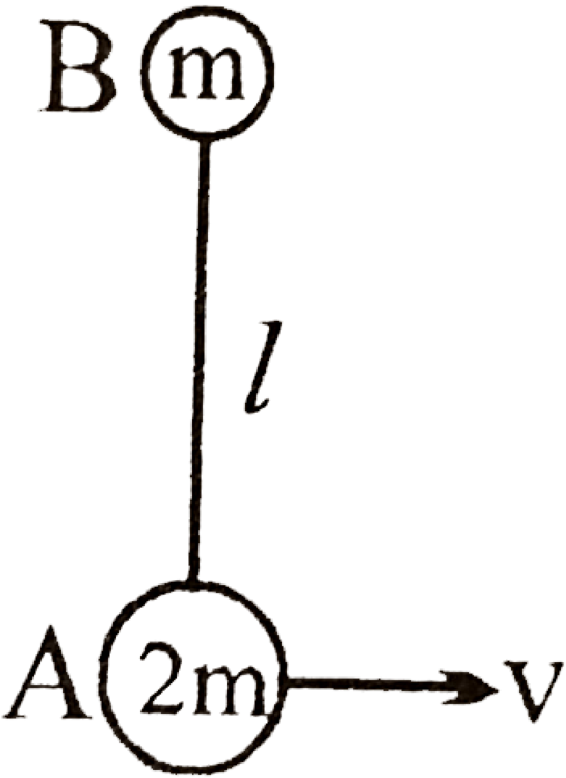
**16.** Two masses $A$ and $B$ connected with an inextensible string of length $l$ lie on a smooth horizontal plane. $A$ is given a velocity of $vm/s$ along the ground perpendicular to line AB as shown in figure. Find the tension in string during their subsequent motion

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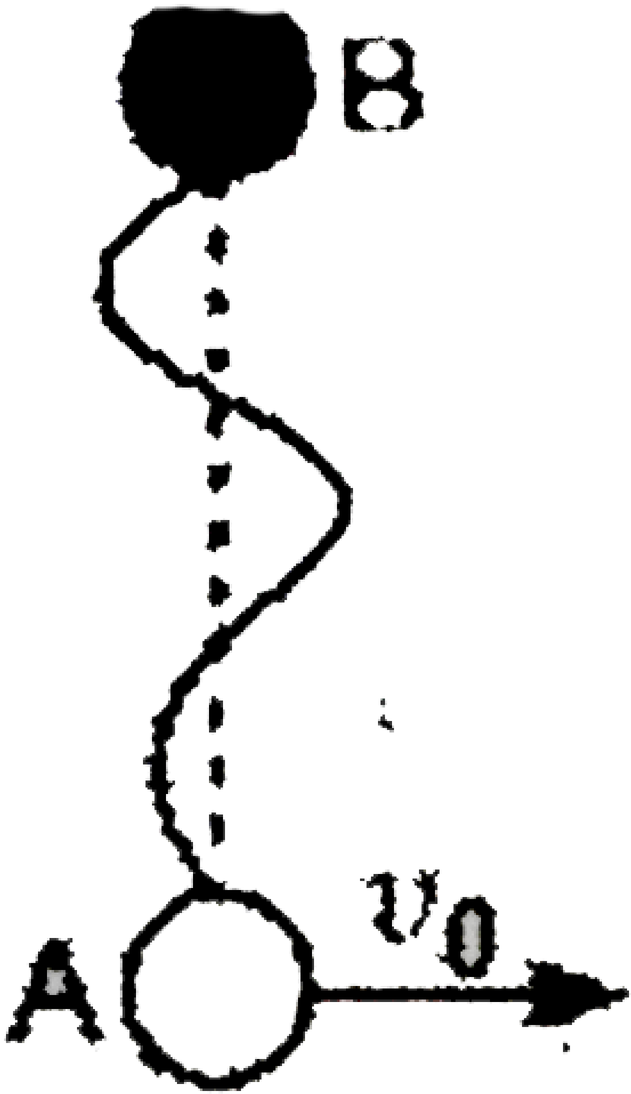
**17.** Two small balls A and B are interconnected by an inextensible string of legth L. Mass of ball A =m, mass of ball B = m. the balls are resting on a frictionlesss harixontal surgace , with the distance between them =3L.5 In this position ball A is suddenly given a harizontal velocity $v_0$ perpendicular to the line joining the two balls. (see fig 4E . 18 (a))

(a) Find the speed of ball B houst after the string becomes taut

(b) find the impulse of the tension in string when the string becomes taut.

(c) Find the steady tension in string much after the string has become taut.

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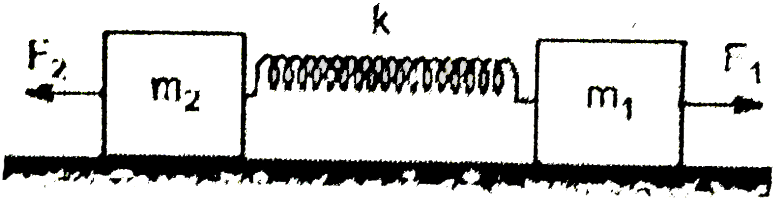
**18.** Two blocks of mass $m_1$ and $m_2$ are connected by a spring of force constant k. Block of mass $m_1$ os pulled by a constant force $f_2$ [see fig 4E.19 (a)] find the maximum elongation in the spring .

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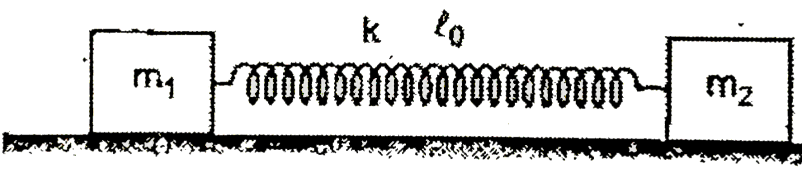
**19.** Two blocks $m_1$ and $m_2$ are connected by a spring of force constant K and are placed on a frictionless horizontal surface. Initially the spring is given extension $x_0$ when the sysetem is released from rest, find the distance moved by two blocks before they again comes to rest.

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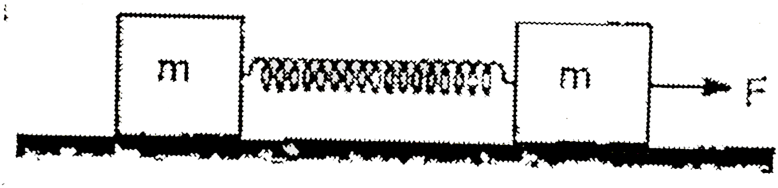
**20.** two blocks of equal mass m are connected by an unstretched· spring and the system is kept at rest on a frictionless horizontal surface. A constant force Fis applied on one of the blocks pulling it away from the other as shown in Fig. ,4E.21(a)

(a) find tyhe position of CM at time t,

(b) if the extension of the spring is $x_0$ at time t, find the displacement of the blocks at that instant.

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**21.** A frog sits on the end pf a long boord of length L. the boord rests on a fricationless horizontal table. The frog wants os the minimum takes - off speed i.e relative to ground v that allows the frog yo do the trick? The board and the frog have equal masses.

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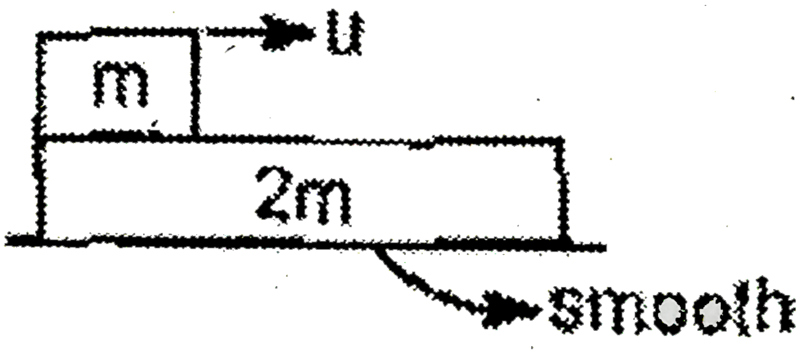
**22.** find total W.D by fricition assuming plank is sufficiently long.

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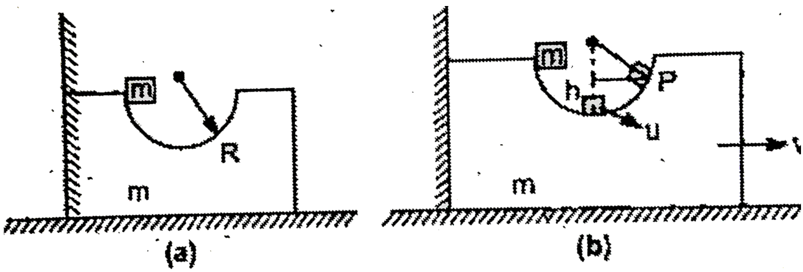
**23.** find maximum height reached by small mass m in fig 4E.24

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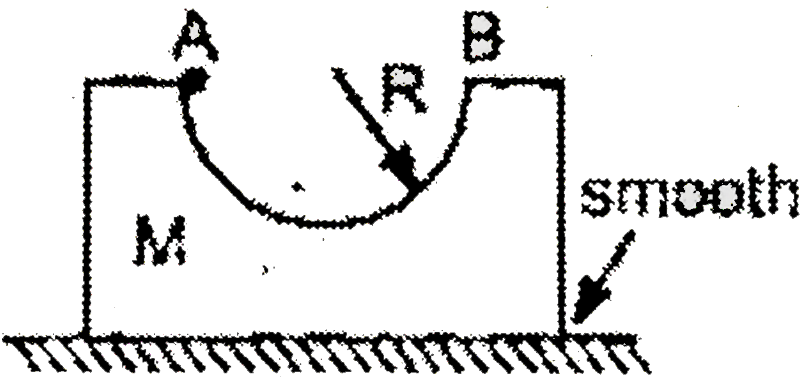
**24.** in the fig 4E.25 (a) shown the wedge of mass M has a semiciular groove. A particle of mass $m = \frac{m}{2}$ is realeased from A ,it sliders on the smooth cirular track and starts climbing cirular track and starts climbing on the right face.

(i) find the maximum value of 0 which it can subtend with vertical and also find the distance displaced by wedge at this position.

(ii) find the maximum velcoity of wedge during process of motion.

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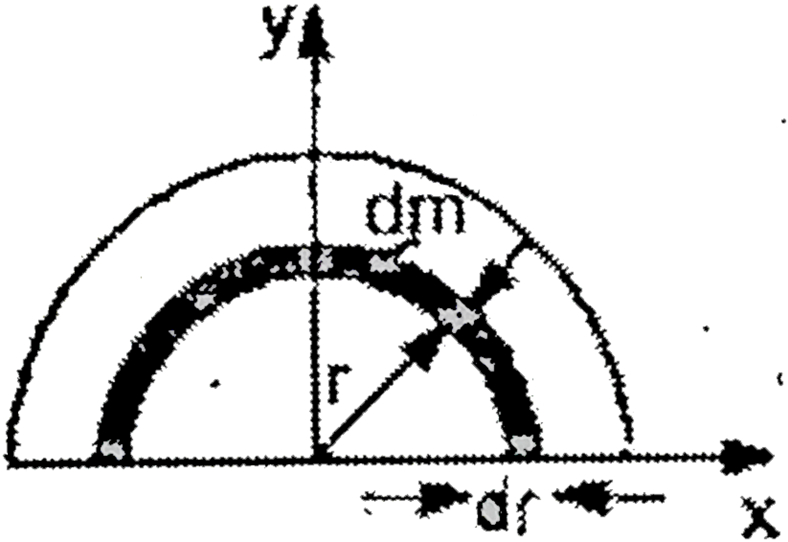
**25.** Determine the coordinates of centre of mass of a half disc. Of mass M and radius R, assuming uniform mass disribution.

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26. Determine the position of the centre of mass of a hemisphere of radius R.

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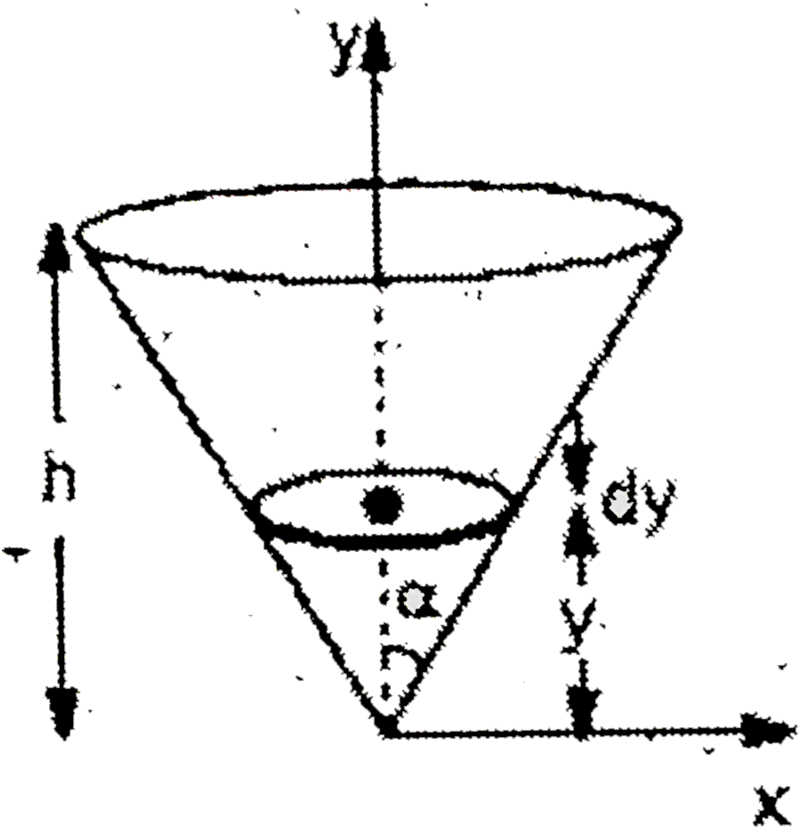
27. Determine the CM of a uniform solid cone of height h and semiangle $\infty$ as shown in fig 4E . 31

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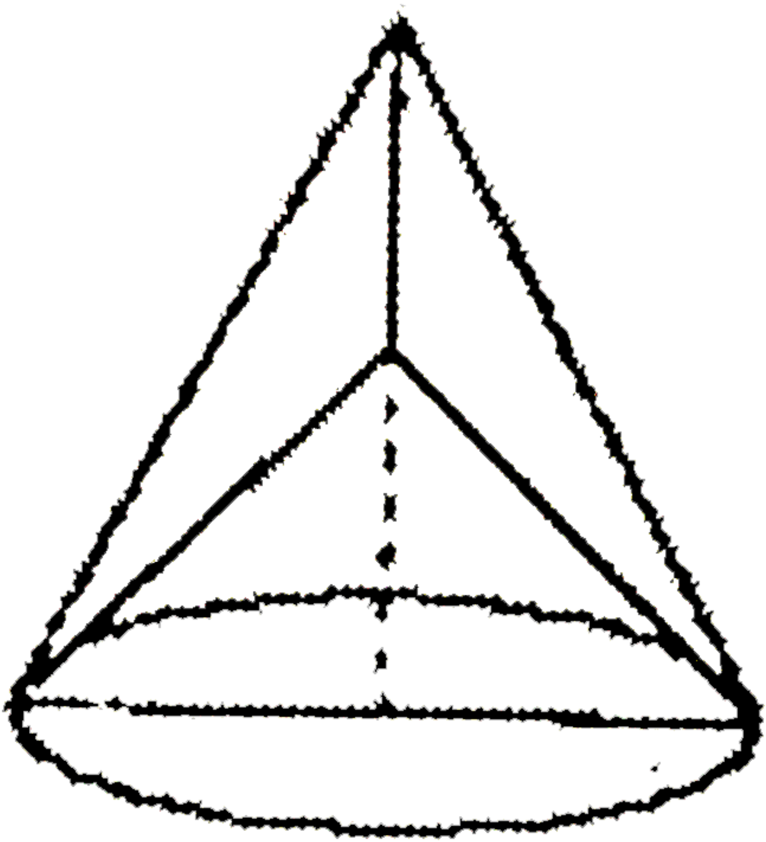
**28.** A uniform solid right circular cone has its base cut out in conical shape shown in fig 4E.32 (a) such that the hollow is a right circular cone on the same base. Find centre of mass of the remaining portion may coincide the vertex of the hollow part.



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**29.** Determine the centre of gravity of a thin homogeneous plate having the form of a rectangle with sildes r and $2r$ from which a semicircle with a radius r is cut out of figure.

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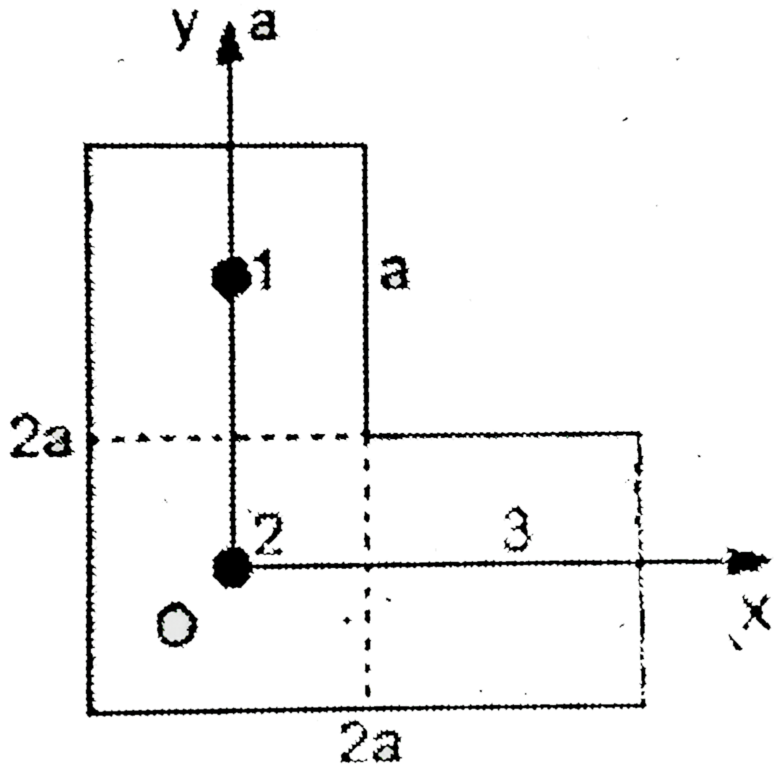
**30.** Locate the position of centre of mass of a uniform plate of Mass m as shown in fig 4E 34

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**31.** Find the centre of mass of $a$ uniform disc of radius a from which a circualr section of radius $b$ has been removed. The centre of hole is at a distance $c$ from the centre of the disc.

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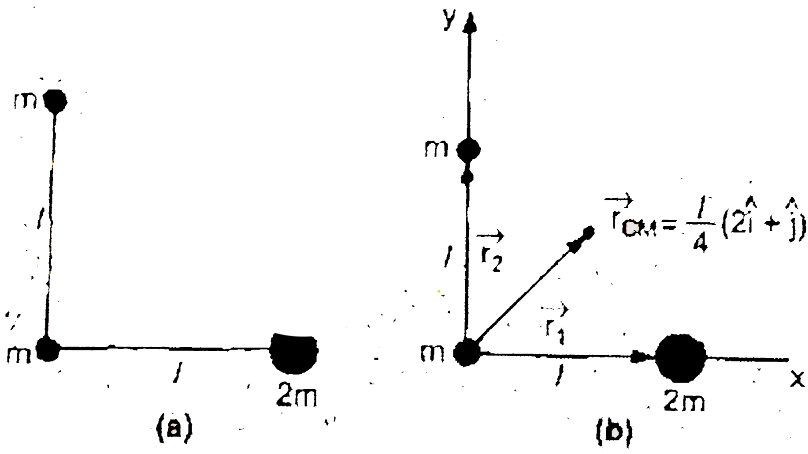
**32.** consider there particles connected by massless rods. Find the locations fo the centre of mass of the system of three particles as shown in fig 4E.36

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**33.** A rocket explods at the topmost paint of its trahectory. 550 m from the point of projection. One of the fragments is found at a location 550 m east and 120 m north of the launch point. Second fragment is found at a location 55om east and 65 m south of the launch point. first two fragments are of equal mass m and third fragment has mass 2 m . if all the three frogments struk the ground stmultaneously, what is the location of the fragments?

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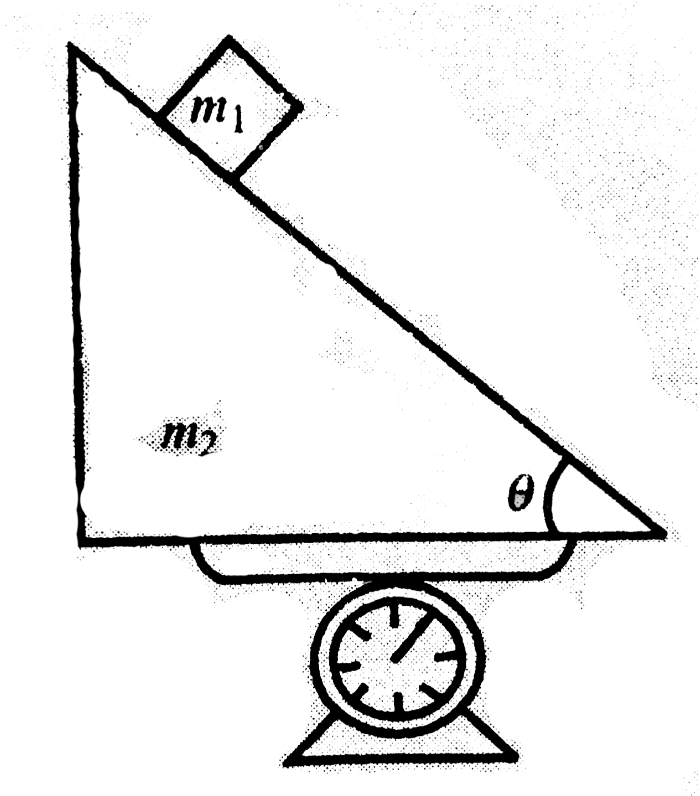
**34.** A wedge of mass $m_2$ is kept on a spring balance. A small block of mass $m_1$ can move along the frictionless incline of the wedge. What is the reading of the balance while the block slides? Ignore the recoil of the wedge.

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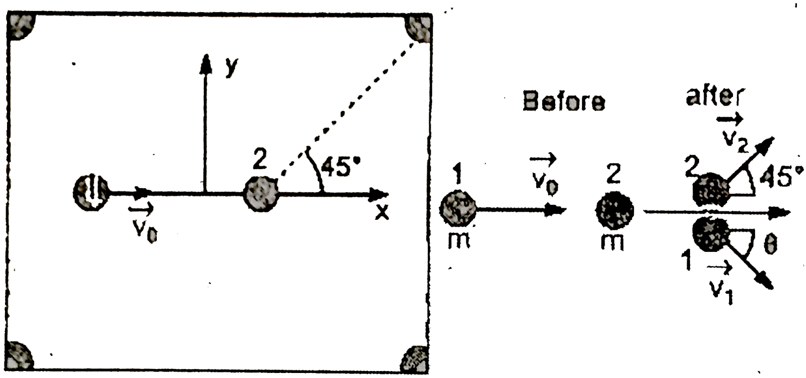
**35.** fig 4E.43 shows two discs kept on a smooth horizonal surface . Disc 1 is projected towards disc 2 with velocity $\vec{v}_0$ After collculate the magnitude of outgoing velocitites of disc, 1 and disc 2.

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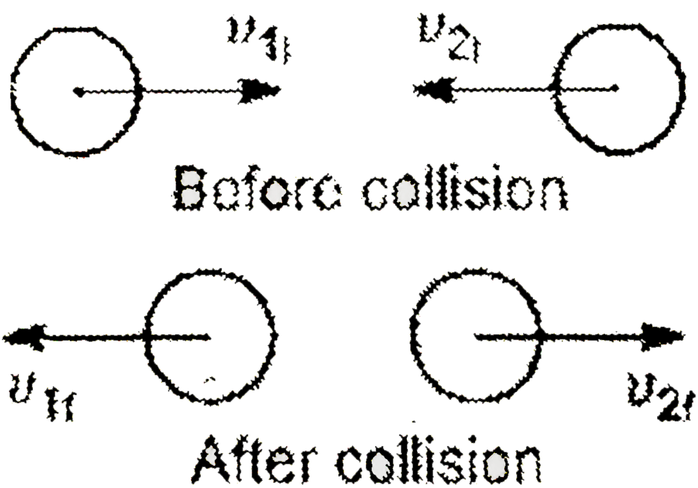
**36.** consider two particles that unedergo an elastic collision on a fricationless surface as shown in fig 4E.45 one particle of mass $m_2$ is at rest initially.



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**37.** cosider two particle $m_1$ and $m_2$ that udnergo perfectly inelastic collision .

(a) what is loss in kinetic energy during collision ?

(b) what is frictional change in kinetic energy ?

(c )Discuss the result form $m_2 > \ > m_1, \quad \text{and} \quad v_{2i} = 0$

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**38.** Consider an one dimensional elastic collision between a given incoming body A and body B, initially at rest. The mass of B in comparison to the mass of A in order that B should move with greatest kinetic energy is

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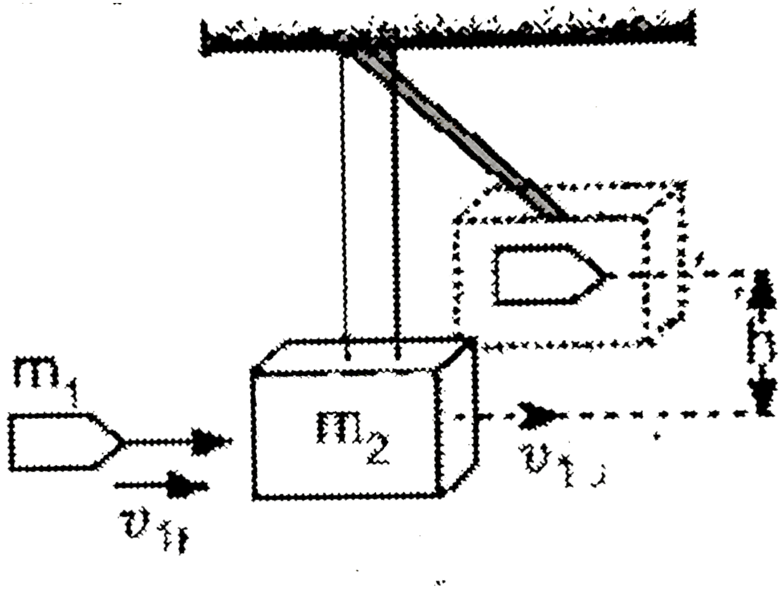
**39.** A bullet of mass $m_1$ is fired into a large block of mass $m_2$ suspended form wires. The collision is perfeclty inelastic, so that the combined system swing throug a height h

(a) what si the initial speed of the bullect ?

(b) if the bullet emerged from the block with half of its initial velocity how high did the block swing ?

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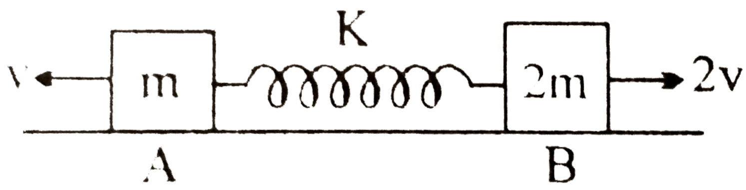
**40.** Two blocks $A$ and $B$ of masses $m$ & $2m$ placed on smooth horizontal surface are connected with a light spring. The two blocks are given velocities as shown when spring is at natural length.

(i) Find velocity of centre of mass (b) maximum extension in the spring

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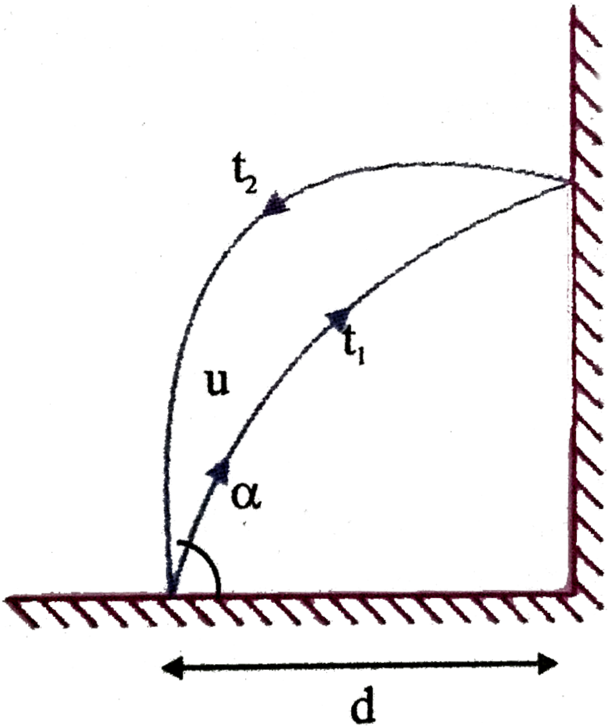
**41.** An inelastic ball is projetced with a velocity $'u'$ at an angle $'\alpha'$ to the horizontal, towards a wall distant $'d'$ from the point of projection. After collision the ball returns to the point of projection (Co-efficient of restitution between sphere and wall is $'e'$)




The horizontal distance $'d'$ from the wall is

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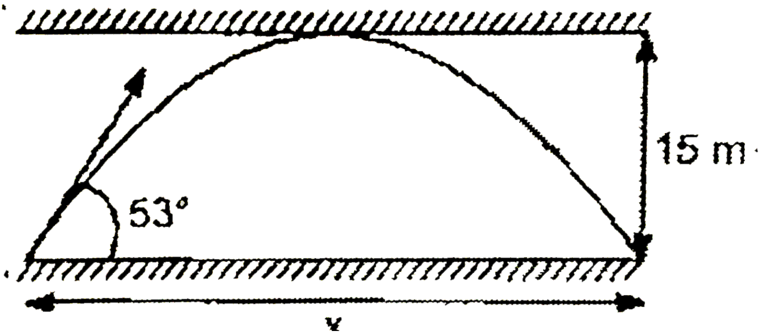
**42.** A ball is shot in a long hall having a roof at a height of 15 cm with speed of 25 m/s at angle of $53^\circ$ with the floor. The ball lands on the floor at a distance shown x=___ m form the point of projection .

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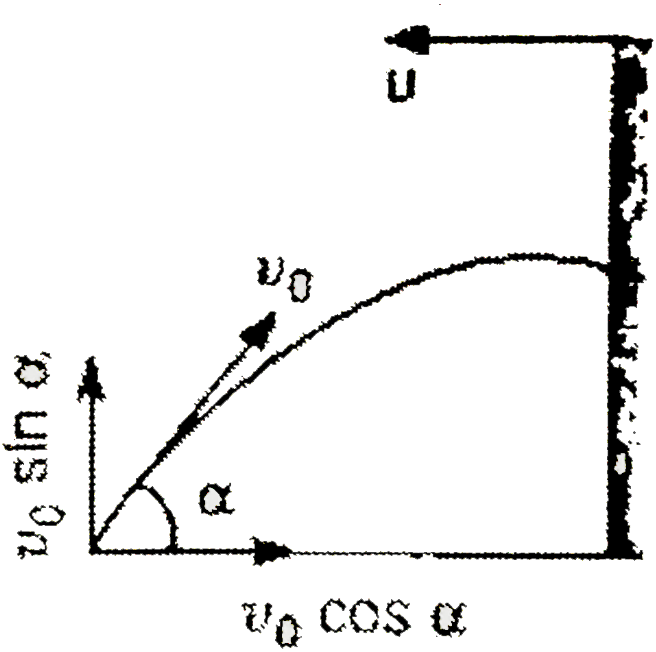
**43.** A ball is projected with velocity $v_0$ at an angle $\alpha$ to the horizonal, towards a smooth wall which appraches the ball. With velocity u. After collision the ball retraces its path to the point of projection . What is the time t taken by the ball form the instant of projection to point of impact

?

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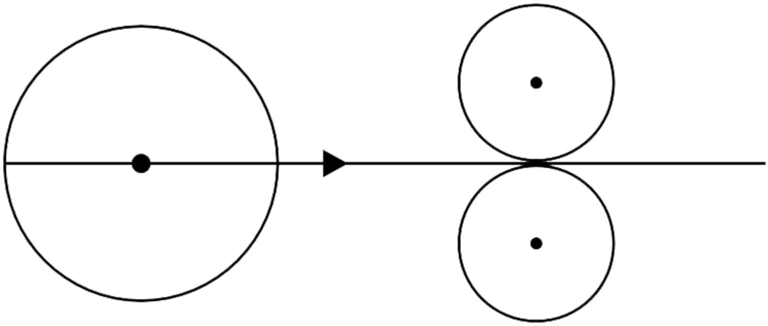
**44.** Two identical discs are initially at rest in contact on a horizontal table. A third disc of same mass but of double radius strikes them symmetrically and comes to rest after the impact.

(a) Find the coefficient of restitution for the impact.

(b) Find the minimun kinetic energy of the system (as a percentage of original kinetic energy before collision) during the process of collision.

Treat the collision to be instantaneous



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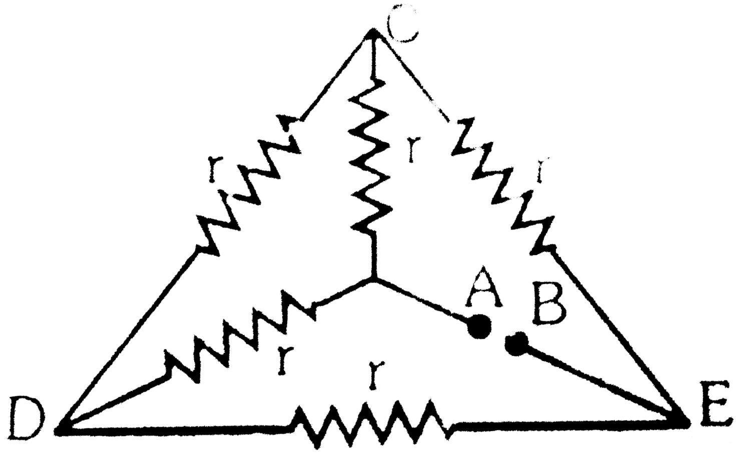
**45.** Two smooth balls A and B, each of mass m and radius R, have their centre at (0,0,R) and (5R,-R,R) respectively, in a coordinate system as shown. Ball A, moving along positive x-axis, collides with ball B. Just before the collision, speed of ball A is 4m/s and ball B is stationary. The collision between the balls is elastic. Velocity of the ball A just after the collsion is

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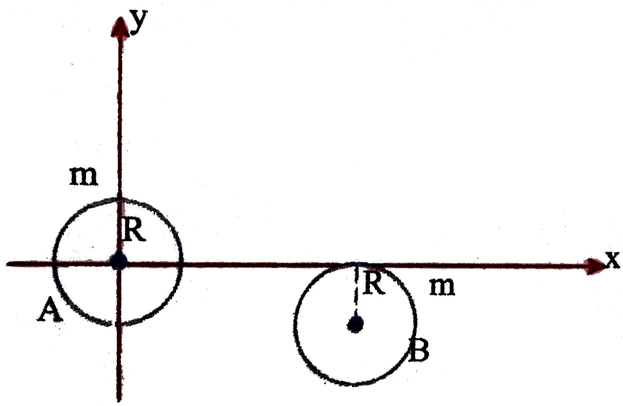
**46.** Two smooth balls $A$ and $B$, each of mass $m$ and radius $R$, have their centres as shown in fig. Ball $A$, moving along positive x-axis, collides with ball $B$. Just before the collision, speed of ball $'A'$ is $4m/s$ and ball $'B'$ is stantionary. The collision




Impluse of the force exerted by $'A'$ on $'B'$ during the collision is equal to

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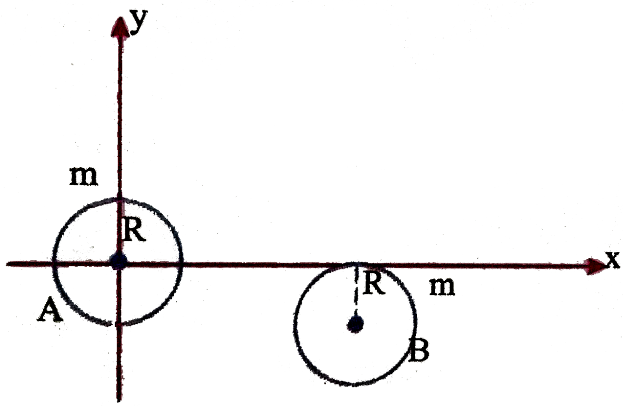
**47.** Two smooth balls $A$ and $B$, each of mass $m$ and radius $R$, have their centres as shown in fig. Ball $A$, moving along positive x-axis, collides with ball $B$. Just before the collision, speed of ball $'A'$ is $4m/s$ and ball $'B'$ is stantionary. The collision




Coefficient of restitution during the collision is changed to $\frac{1}{2}$, keeping all other parameters unchanged. What is the velocity of the ball $'B'$ after the collision.

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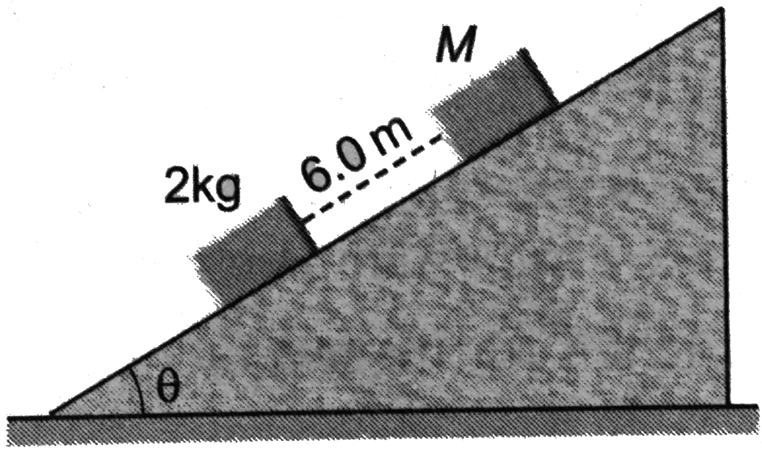
**48.** Two blocks of masses $2kg$ and M are at rest on an inclined plane and are separated by a distance of $6.0m$ as shown. The coefficient of friction between each block and the inclined plane is $0.25$. The $2kg$ block is given a velocity of $10.0m/s$ up the inclined plane. It collides with M, comes back and has a velocity of $1.0m/s$ when it reaches its initial position. The other block M after the collision moves $0.5m$ up and comes to rest. Calculate the coefficient of restitution between the blocks and the mass of the block M.

[Take $\sin\theta = \tan\theta = 0.05$ and $g = 10m/s^2$]

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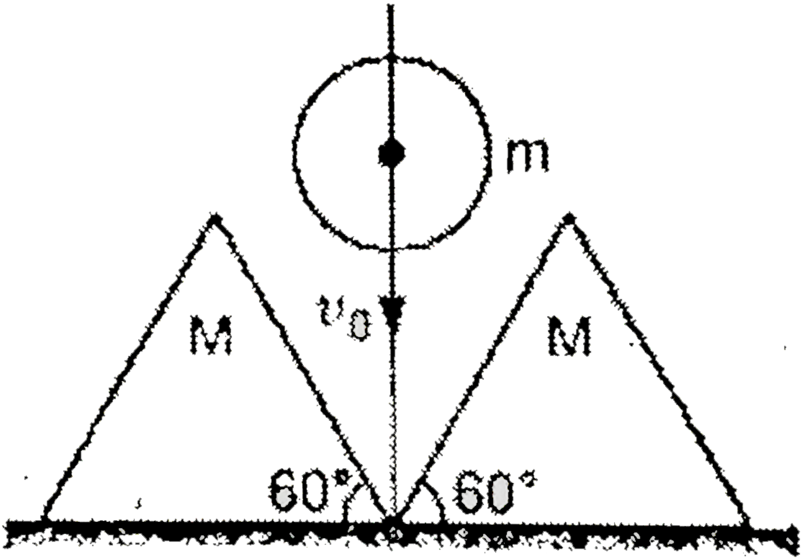
**49.** show a smooth spherical ball of mass m striking two identical equilateral triangular wedges of mass M. At the instant of impact velocity of the ball is $v_0$. Taking coefficient of restitution e, determine the velcities of the sphere and the wedges just after collision.

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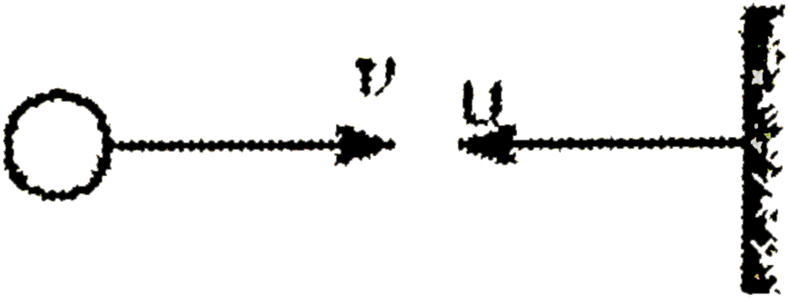
**50.** A ball moving with a velocity v strikes a wall moving toward the wall with a velocity u. An elastic impact occurs. Determine the velocity of the ball after the impact. What is the cause of the change in the kinetic energy of the ball ? Consider the mass of the wall to be infinitely great.



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## Level 1

**1.** A set of n identical cubical blocks lies at rest parallel to each other along a line on a smooth horizontal surface. The separation between the near surfaces of any two adjacent blocks is L . The block at one end is given a speed v towards the next one at time 0 t . All collisions are completely inelastic, then

A. The last block starts moving at $t = \frac{(n+1)L}{v}$

B. The last block starts moving at $t = \frac{n(n-1)L}{2v}$

C. The center of mass of the system will have the final speed v

D. The center of mass of the system will have the final speed $\frac{v}{n}$

**Answer: D**

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**2.** 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 $M < m$

**Answer: C**

Watch Video Solution

**3.** A uniform sphere is placed on a smooth horizontal surface and a horizontal force F is applied on it at a distance h above the surface. The acceleration of the centre :

A. is maximum when h=0

B. is maximum when h=R

C. is maximum when h=2R

D. is independent of h

**Answer: D**

Watch Video Solution

**4.** An open water tight railway wagon of mass $5 \times 10^3$ kg coasts at initial velocity of $1.2 m / s$ without friction on a railway track. Rain falls vertically downwards into the wagon. What change then occurred in the kinetic energy of the wagon, when it has collected $10^3$ kg of water

A. 1200 J

B. 300 J

C. 600 J

D. 900 J

**Answer: C**

Watch Video Solution

**5.** A body falling vertically downwards under gravity breaks in two parts of unequal masses. The centre of mass of the two parts taken together shifts horizontally towards

A. heavier piece

B. lighter piece

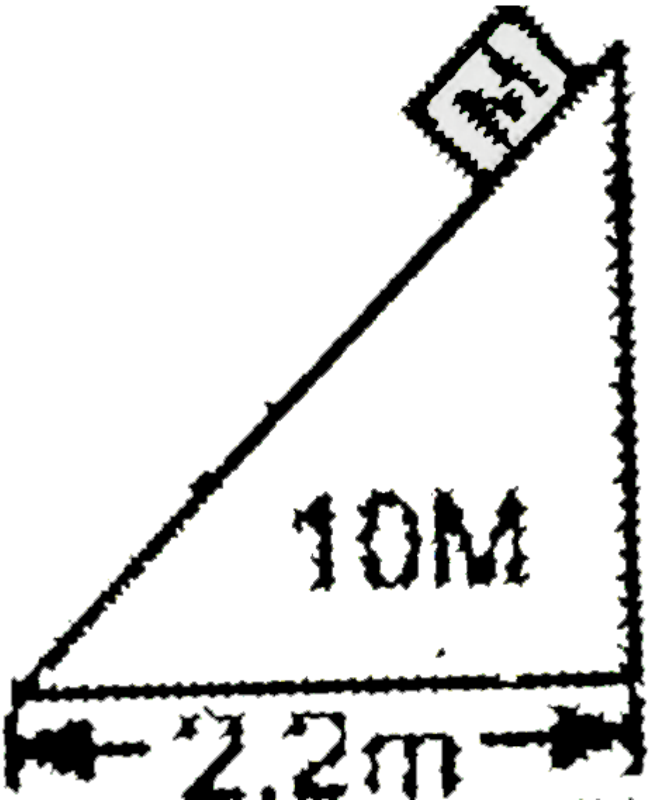
C. does not shift horizontally

D. depends on the vertical at the time of breaking

**Answer: C**

Watch Video Solution

**6.** A block of mass M is placed on the top of a bigger block of mass 10 M as shown in figure. All the surfaces are frictionless. The system is released from rest, then the distance moved by the bigger block at the instant the smaller block reaches the ground :



A. 0.22 m

B. 0.20 m

C. zero

D. 0.24 m

**Answer: B**

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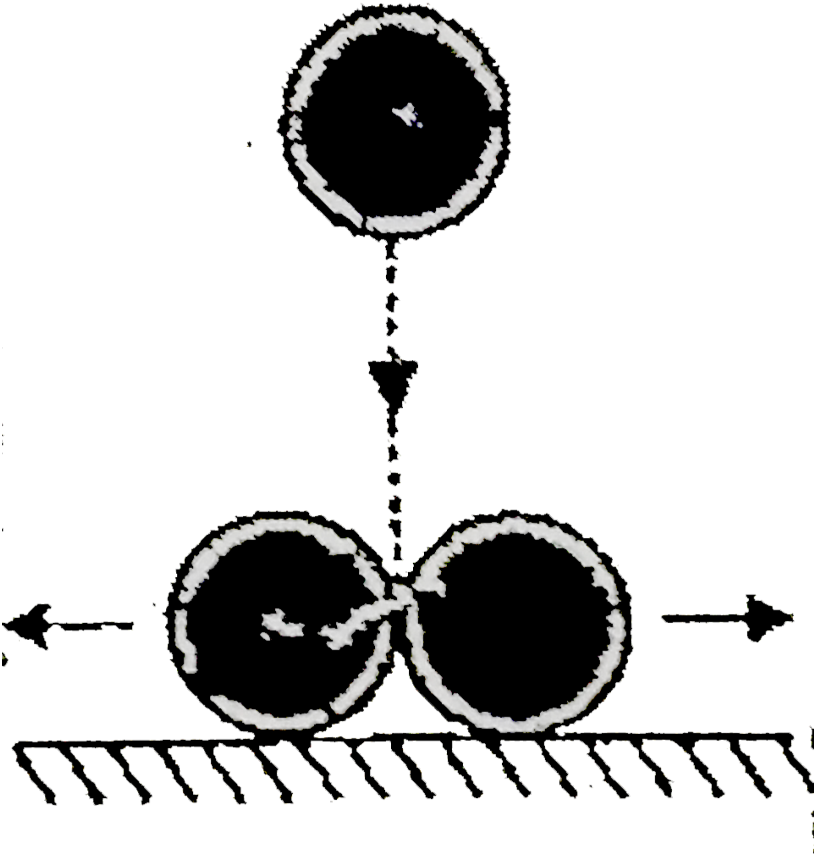
**7.** In the figure shown, the two identical balls of mass M and radius R each, are placed in contact with each other on the frictionless horizontal surface. The third ball of mass M and radius $\frac{R}{2}$, is coming down vertically and has a velocity $= v_0$ when it simultaneously hits the two balls and itself comes to rest. Then, each of the two bigger balls will move after collision with a speed equal to :



A. $\frac{4v_0}{\sqrt{5}}$

B. $\frac{2v_0}{\sqrt{5}}$

C. $\frac{v_0}{\sqrt{5}}$

D. none

**Answer: C**

Watch Video Solution

**8.** A ball kept in a closed box moves in the box making collisions with the walls. The box is kept on a smooth surface. The velocity of the centre of mass

A. of the box remains constant

B. of the box remians constant

C. of the box plus the ball remains constant

D. of the ball relative to the box remains constant

**Answer: B**

Watch Video Solution

**9.** Two identical billiard balls are in contact on a table. A third identical ball strikes them symmetrically and comes to rest after impact. The coefficient of restitution is :

A. $\frac{2}{3}$

B. $\frac{1}{3}$

C. $\frac{1}{6}$

D. $\frac{\sqrt{3}}{2}$

**Answer: A**

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**10.** A ball is projected from ground with a velocity $V$ at an angle $\theta$ to the vertical. On its path it makes an elastic collison with a vertical wall and returns to ground. The total time of flight of the ball is

A. $\frac{2v\sin\theta}{g}$

B. $\frac{2v\cos\theta}{g}$

C. $\frac{v\sin 2\theta}{g}$

D. $\frac{v\cos\theta}{g}$

**Answer: B**

Watch Video Solution

**11.** A sphere moving with velocityv strikes elastically with a wall moving towards the sphere with a velocity u. If the mass of the wall is infinitely large, the work done by the wall during collision wiHbe:

A. mu $(u+v)$

B. 2mu$(u+v)$

C. $2mv(u+v)$

D. $2m(u+v)$

**Answer: B**

Watch Video Solution

**12.** On a horizontal smooth surface a disc is placed at rest. Another disc of same mass is coming with impact parameter equal to its own radius. First disc is of radius r. What should be the radius of comping disc so that after collision first disc moves at an angle $45^\circ$ to the direction of motion of incoming disc ?

A. 2r

B. $r(\sqrt{2}-1)$

C. $\frac{r}{(\sqrt{2}-1)}$

D. $r\sqrt{2}$

**Answer: B**

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**13.** A ball is thrown vertically downwards with velocity $\sqrt{2gh}$ from a height h. After colliding with the ground it just reaches the starting point. Coefficient of restitution is :

A. $\frac{1}{\sqrt{2}}$

B. $\frac{1}{2}$

C. 1

D. $\sqrt{2}$

**Answer: A**

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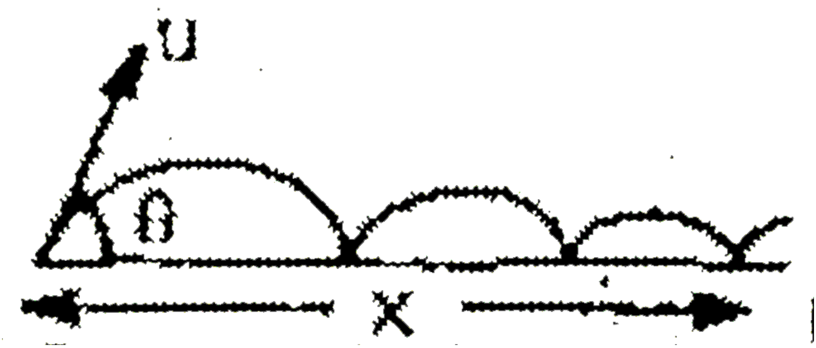
**14.** A ball is projected with initial velocity u at an angle $\theta$ to the horizontal. Then horizontal displacement covered by ball as it collides third time to the ground would be, if coefficient of restitution is e :




A. $(1+e)\frac{u^2 \sin 2\theta}{g}$

B. $e\frac{u^2 \sin 2\theta}{g}$

C. $(1-e)\frac{u^2 \sin 2\theta}{g}$

D. $(1+e+e^2)\frac{u^2 \sin 2\theta}{g}$

**Answer: D**

Watch Video Solution

**15.** A ball is dropped from a height h. As it bounces off the floor, its speed is 80 per cent 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

**Answer: C**

Watch Video Solution

**16.** Internal forces can change

A. the linear momentum but not the kinetic energy

B. the kinetic but not the linear momentum

C. linear momentum as well as kinetic energy

D. neither the linear momentum nor the kinetic energy

**Answer: B**

Watch Video Solution

**17.** In an elastic collision of two billiard balls which of the following quantities is not conserved during the short time of collision :

A. Momentum

B. Total mechanical energy

C. Kinetic energy

D. None

**Answer: C**

Watch Video Solution

**18.** A block of mass M lying on a smooth· horizontal surface is rigidly attached ·to a light horizontal ·spring of spring constant k. The other end of the spring is rigidly connected to a fixed wall. A stationary gun fires ·bullets of mass m each in horizontal direction with speed $v_0$ one after other. The bullets hit the block and get embedded to it. The first bullet hits the block at t=0, the second bullent hits at $t = 2\pi\sqrt{\frac{M+m}{k}} + 2\pi\sqrt{\frac{M+2m}{k}}$ and so on. The maximum comression in the spring after the $n^{th}$ bullet hits is :

A. $\dfrac{nmv_0\sqrt{k}}{(M+nm)^{3/2}}$

B. $\dfrac{(M+nm)^{3/2}}{nmv_0\sqrt{k}}$

C. $\frac{\sqrt{nmv_0k}}{(M+nm)^{3/2}}$

D. $\frac{nmv_0}{\sqrt{k(M+nm)}}$

**Answer: D**

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**19.** A boy hits a baseball with a bat an imparts an impulse $J$ to the ball. The boy hits the ball again with the same force, except that the ball and the bat are in contact for twice the amount of time as in the first hit.

A. half the original impulse

B. half the original impulse

C. twice. the original impulse

D. four times the original impulse

**Answer: C**

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**20.** A shell is fired from a cannon with a velocity $v(m/\text{sec.})$ at an angle $\theta$ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon and the speed (in $m/\text{sec.}$) of the other piece immediately after the explosion is

A. $v\cos\theta$

B. $2v\cos\theta$

C. $\frac{3}{2}v\theta$

D. $v\cos\theta$

**Answer: A**

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**21.** A disc of radis R is cut out from a larger disc of radius 2R in such a way that the edge of the hole touches the edge of the disc. Locate the centre of mass of the residual disc.

A. at $\frac{2R}{3}$ from center of the original disc away from the center of the hole

B. at $\frac{R}{3}$ from center of the original disc away from the center of the hole

C. at the center of the original disc

D. at the center of the hole

**Answer: B**

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**22.** There are some passengers inside a stationary railway compartment. The track is frictionless. The centre of mass of the compartment itself (without the passengers) is $C_1$, while the centre of mass of the 'compartment plus passengers' system is $C_2$. If the passengers move about inside the compartment along the track.

A. Both $C_1$ and $C_2$ will move with respect to the ground

B. Neither $C_1 \quad \text{nor} \quad C_2$ will move with respect to the ground

C. $C_1$ will move but $C_2$ will be stationary with respect to the ground

D. $C_2$ will move but $C_1$ will be stationary with respect to the ground

**Answer: C**

Watch Video Solution

**23.** All the particles of a body situated at distance $d$ from the origin. The distance of the center of mass of the body from the origin is

A. $= R$

B. $\leq R$

C. $> R$

D. $\geq R$

**Answer: B**

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**24.** Two trains A and B are running in the same direction on the parallel rails such that A is faster than B. Packets of equal weight are transfcrred from A to B. What will happen due to this :

A. A will be accelerated and B will be retarded

B. B will be accelerated and A will be retarded

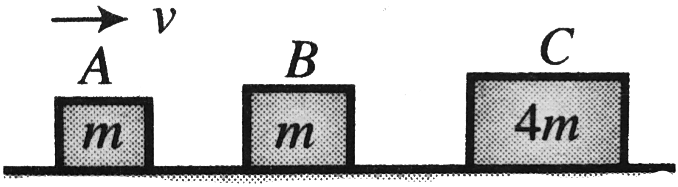
C. There will be no change in A but B will be accelerated

D. There will be no change in B but A will be accelerated

**Answer: B**

Watch Video Solution

**25.** Three blocks are initially placed as shown in the figure. Block $A$ has mass $m$ and initial velocity $v$ to the right. Block $B$ with mass $m$ and block $C$ with mass $4m$ are both initially at rest. Neglect friction. All collisions are elastic. The final velocity of blocks $A$ is




A. $0.6v$ to the left

B. $1.4v$ to the left

C. $v$ to the left

D. $0.4v$ to the right

**Answer: A**

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**26.** A square plate of edge d and a circular disc of diameter d are placed touching each other at the midpoint of an edge of the plate as shown in figure. Locate the centre of mass of the combination assuming same mass per unit area for the two plates.

A. $\frac{2d}{2+\pi}$ left to the center of the disc.

B. $\frac{2d}{2+\pi}$ right to the center of the disc

C. $\frac{4d}{4+\pi}$ right to the center of the disc

D. $\frac{4d}{4+\pi}$ left to the center of the disc

**Answer: C**

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**27.** A rocket of mass 4000 kg is set for vertical firing. How much gas must be ejected per second so that the rocket may have initial upwards acceleration of magnitude $19.6m/s^2$ ? [Exhaust speed of fuel $= 980m/s$ ]

A. $240kgs^{-1}$

B. $60kgs^{-1}$

C. $120 kgs^{-1}$

D. None

**Answer: C**

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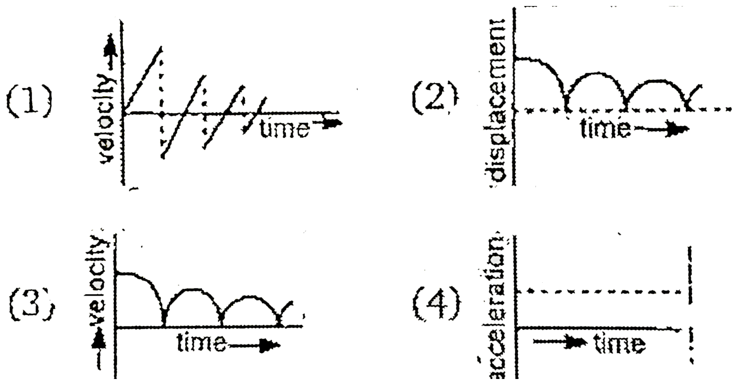
**28.** Select the graph (s) which best represent the graph of bouncing ball. Assume ball dropped from height and it losses certain part of energy in each impact,




A. 1,2,3,4

B. 1,2,4

C. 3,2

D. 3,4

**Answer: B**

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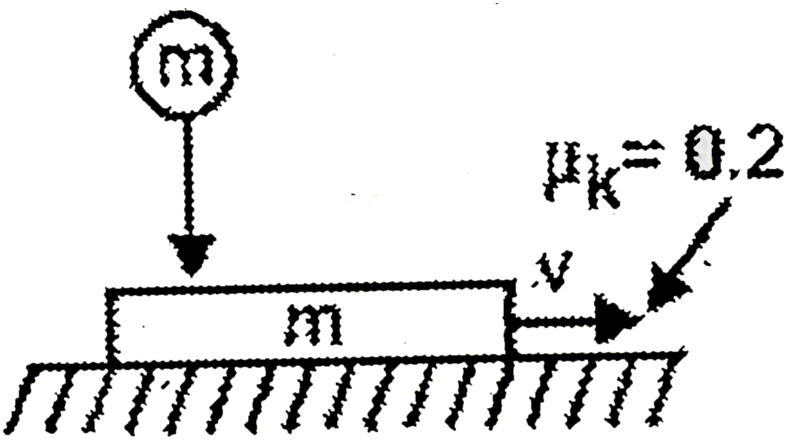
**29.** A ball of mass m falls vertically from a height h and collides with a block of equal mass m moving horizontally with a velecity $v$ on a surface. The coefficient of kinetic friction between the block and the surface is 0.2, while the coefficient of restitution e between the ball and the block is 0.5. There is no friction acting between the ball and the block. The velocity of the blockdecreases by :



A. 0

B. $0.1\sqrt{2gh}$

C. $0.3\sqrt{2gh}$

D. can't be said

**Answer: D**

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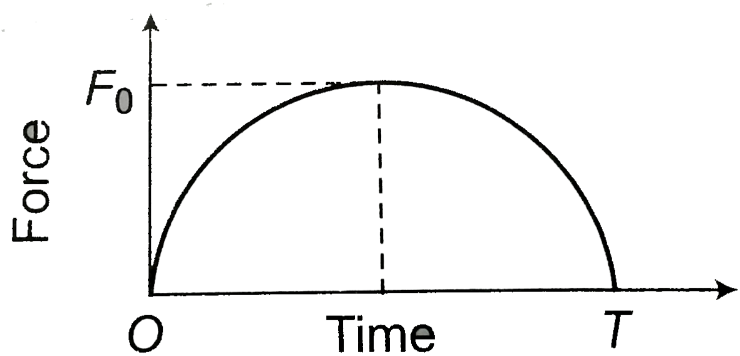
**30.** A particle of mass $m$, initially at rest, is acted upon by a variable force $F$ for a brief interval of time $T$. It begins to move with a velocity $u$ after the force stops acting. $F$ is shown in the graph as a function of time. The curve is a semicircle.



A. $u = \dfrac{\pi F_0^2}{2m}$

B. $u = \dfrac{\pi T^2}{8m}$

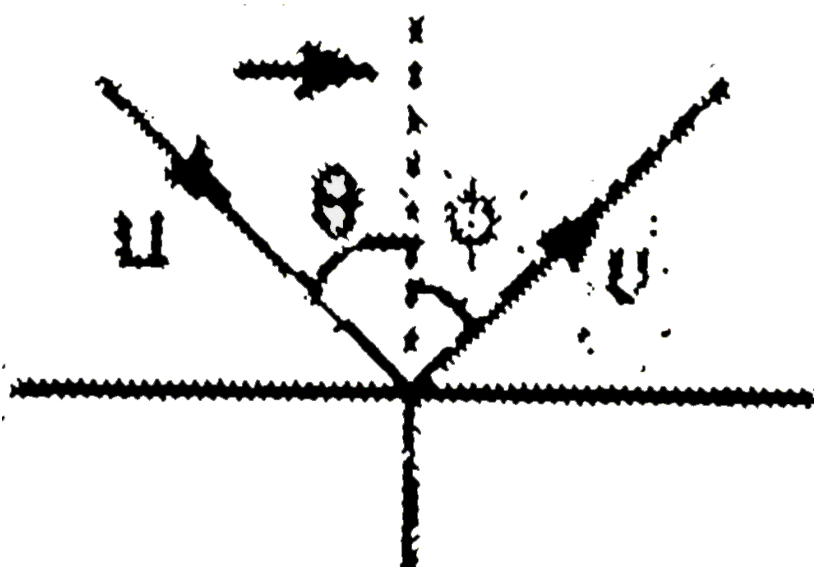
C. $u = \dfrac{\pi F_0 T}{4m}$

D. $u = \dfrac{F_0 T}{2m}$

**Answer: C**

Watch Video Solution

**31.** A particle strikes a horizontal frictionless floor with a speed u, at an angle $\theta$ with the vertical, and rebounds with a speed $v$, at an angle $\phi$ with the vertical. The coefficient of restitution between the particle and the floor is e. The angle $\phi$ is equal to :



A. $\theta$

B. $\tan^{-1}[e \tan \theta]$

C. $\tan^{-!}\left[\frac{1}{e} \tan \theta\right]$

D. $(1+e)\theta$

**Answer: C**

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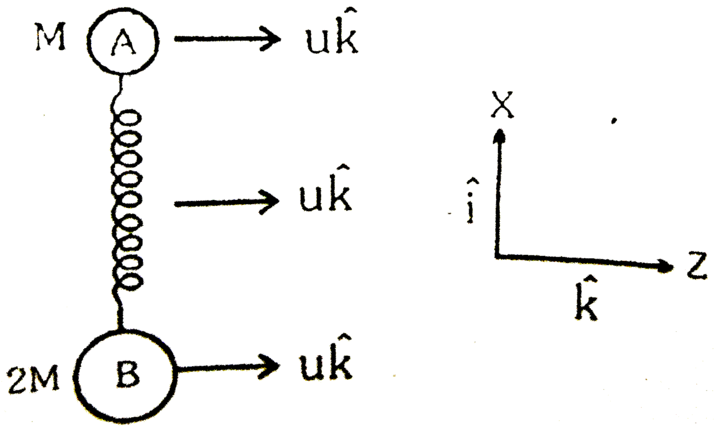
**32.** Two masses A and B of mass M and $2M$ respectively are connected by a compressed ideal spring. The system in placed on a horizontal frictionless table and given a velocity $u\hat{k}$ in the z-direction as shown in the figure. The spring is then released. In the subsequent motion the line from B to A always points along the $\hat{\imath}$ unit vector. All some instant of time mass B has an x-component of velocity as $v_x\hat{\imath}$. The velocity $\overrightarrow{v}_A$ of mass A at that instant is :-




A. $v_x\hat{\imath} + u\hat{k}$

B. $v_x\hat{\imath} + u\hat{k}$

C. $-v_x\hat{\imath} + u\hat{k}$

D. $-2v_x\hat{\imath} + u\hat{k}$

**Answer: C**

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**33.** A particle A of mass 100 g moving along +ve x-axis with $10m/\sec$, collides at origin, with particle B of mass 200 gm moving along +ve y-axis with $10m/\sec$. After collision the particle B moves along line 4x-3y=0 with speed with speed $5m/\sec$. The equation of line along which A moves after collision.

A. y-3x=0

B. 3y-x=0

C. 4y-3x=0

D. None

**Answer: C**

Watch Video Solution

**34.** An open water tight railway wagon of mass $5 \times 10^3 kg$ moves at an initial velocity $1.2m/s$ without friction on a railway track. Rain drops fall vertically downwards into the wagon. The velocity of the wagon after it has collected$10^3 kg$ of water will be :-

A. $0.5m/s$

B. $2m/s$

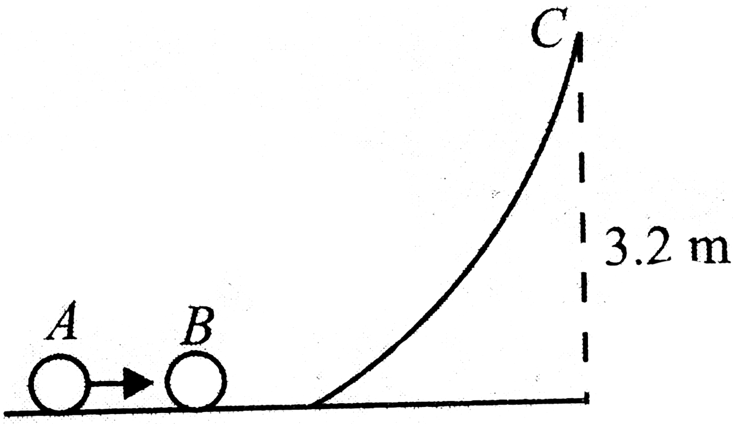
C. $1m/s$

D. $1.5m/s$

**Answer: A**

Watch Video Solution

**35.** Two identical balls $A$ and $B$ lie on a smooth horizontal surface, which gradually merges into a curve to a height $3.2m$. Ball $A$ is given a velocity of $10m/s$, to collide head-on with ball $B$, which then takes up the curved path. What is the minimum coefficient of restitution, $e$, for the collision between $A$ and $B$ in order that ball $B$ reaches the highest point $C$ of the curve.




A. $\frac{1}{2}$

B. $\frac{3}{5}$

C. $\frac{1}{4}$

D. $\frac{3}{4}$

**Answer: B**

Watch Video Solution

**36.** If collision takes place between 2 particles then which of the following statement is/are true :

A. kinetic energy is conserved during collision

B. momentum is conserved during collision

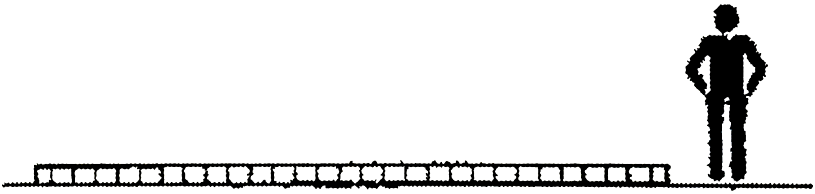
C. momenutm is conserved only before and after collison

D. conservation of momentum during collision depends on the type of collision

**Answer: B**

Watch Video Solution

**37.** On a smooth horizontal plane, a uniform string of mass M and length L is lying in the state of rest. A man of the same mass M is standing next to one end of the string. Now, the man starts collecting the string. Finally the man collects all the string and puts it in his pocket. What is the displacement of the man with respect to earth in the process of collection ?



A. $\frac{L}{2}$

B. $\frac{L}{4}$

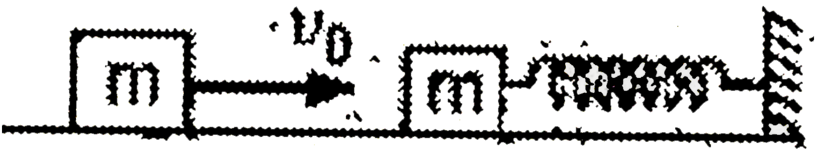
C. $\frac{L}{8}$

D. none

**Answer: B**

Watch Video Solution

**38.** In the figure shown surface is frictionless and spring is in natural condition. If $x_1, x_2$ and $x_3$ are the maximum compression in spring for elastic, completely inelastic and inelastic (e=0.5) respectively then :




A. $x_1 > x_2 > x_3$

B. $x_2 > x_3 > x_1$

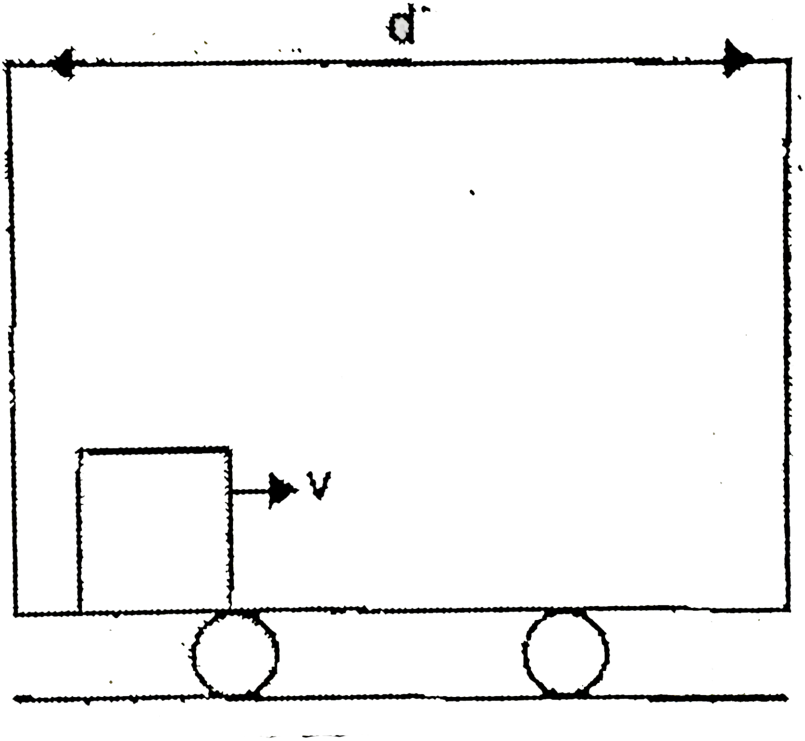
C. $x_1 > x_3 > x_2$

D. $x_2 > x_1 > x_3$

**Answer: C**

Watch Video Solution

**39.** In a smooth stationary cart of length d, a small block is projected along it's length with velocity $v$ towards front. Coefficient of restitution for each collision is e. The cart rests on a smooth ground and can move freely. The time taken by block to come to rest w.r.t. cart is :




A. $\dfrac{ed}{(1-e)v}$

B. $\dfrac{ed}{(1+e)v}$

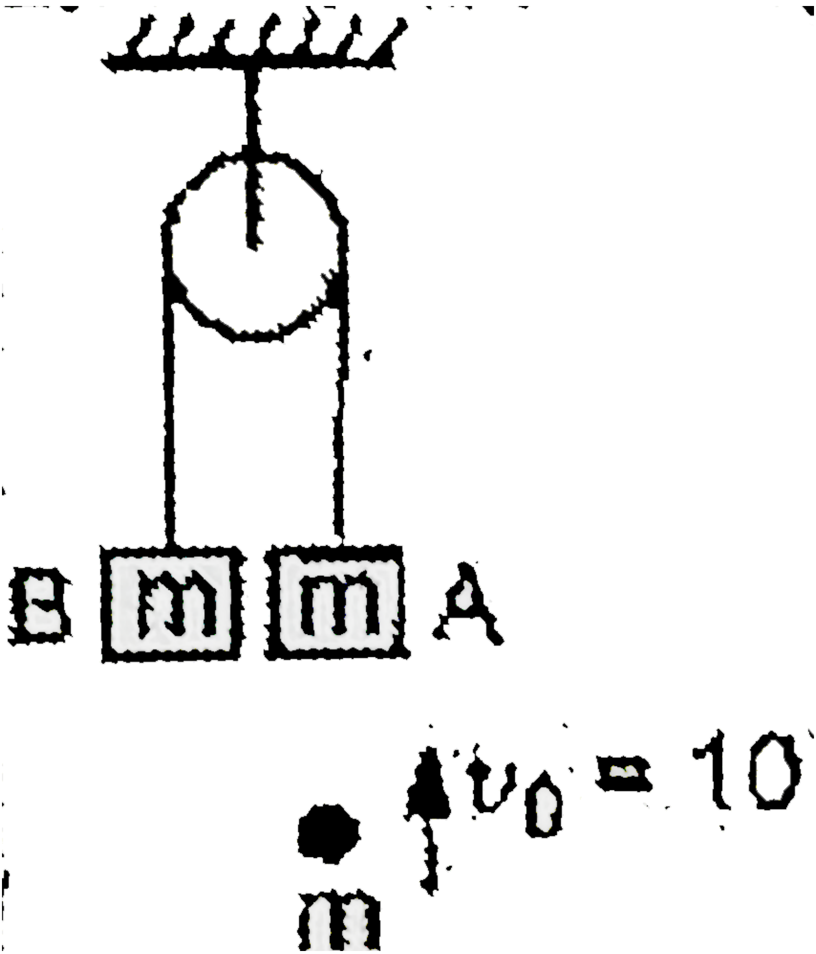
C. $\dfrac{d}{e}$

D. infinite

**Answer: D**

Watch Video Solution

**40.** In the shown figure both blocks are in equilibrium m=1 kg. a bullet of mass m moves with velocity $10m/s$ and get embedded into the block A, then just after collision :




A. $v_A = \frac{v_0}{2}, v_B = 0$

B. $v_A = v_B = \frac{v_0}{2}$

C. $v_A = v_B$=zero

D. $v_A = v_B = \frac{v_0}{3}$

**Answer: A**

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**41.** In the previous question the string will be tight again after 't' seconds from collision then t=

A. $\frac{1}{2}\text{sec}$

B. 1 sec

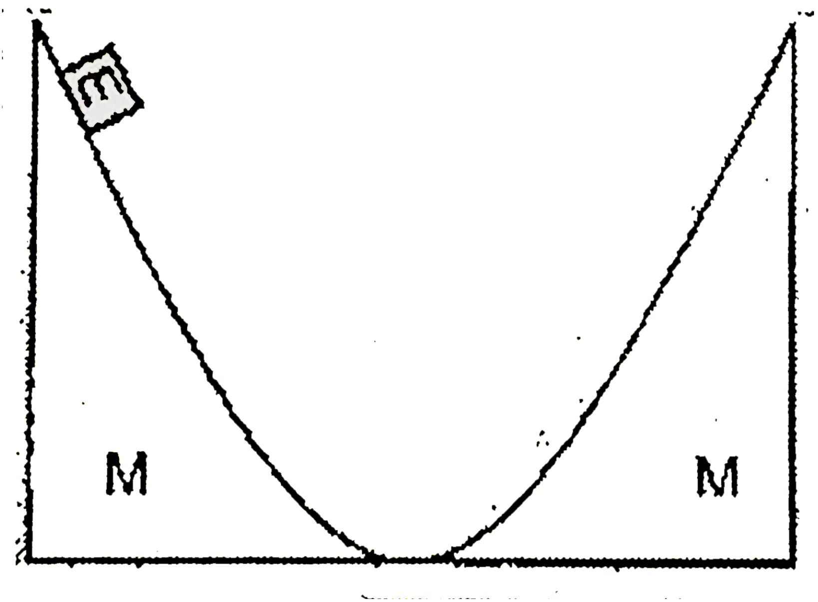
C. 2 sec

D. string will never be tight again

**Answer: A**

View Text Solution

**42.** The inclined sufaces of two movable wedges of same mass M are smoothly conjugated with the horizontal plane as shown in figure. A washer of mass m slides down the left wedge from a height h. To what maximum height will the washer rise along the right wedge ? Neglect friction.




A. $\dfrac{h}{(M+m)^2}$

B. $\dfrac{hM}{(M+m)^2}$

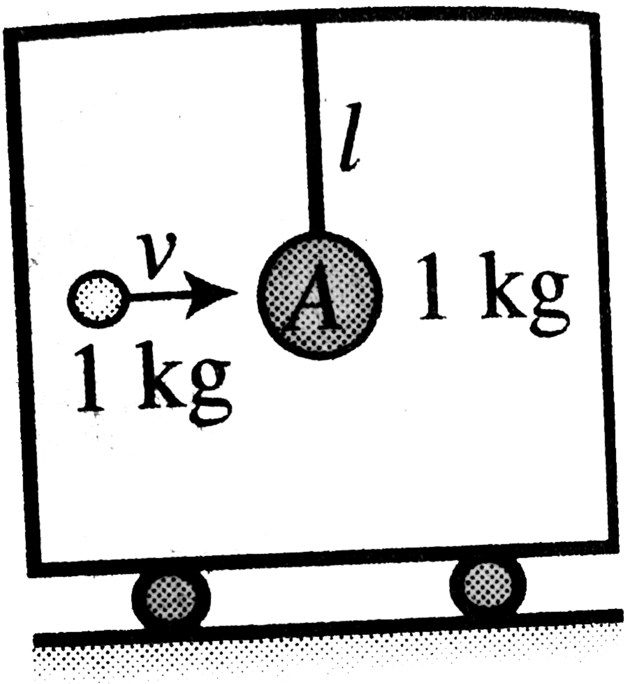
C. $h\left(\dfrac{M}{M+m}\right)^2$

D. $h\left(\dfrac{M}{M+m}\right)$

**Answer: C**

View Text Solution

**43.** In the arrangements shown in the figure masses of each ball is $1kg$ and mass of trolley is $4kg$. In the figure, shell of mass $1kg$ moving horizontally with velocity $v = 6ms^{-1}$ collides with the ball and get stuck to it then its maximum deflection of the thread (length $1.5m$) with vertical



A. $53^\circ$

B. $37^\circ$

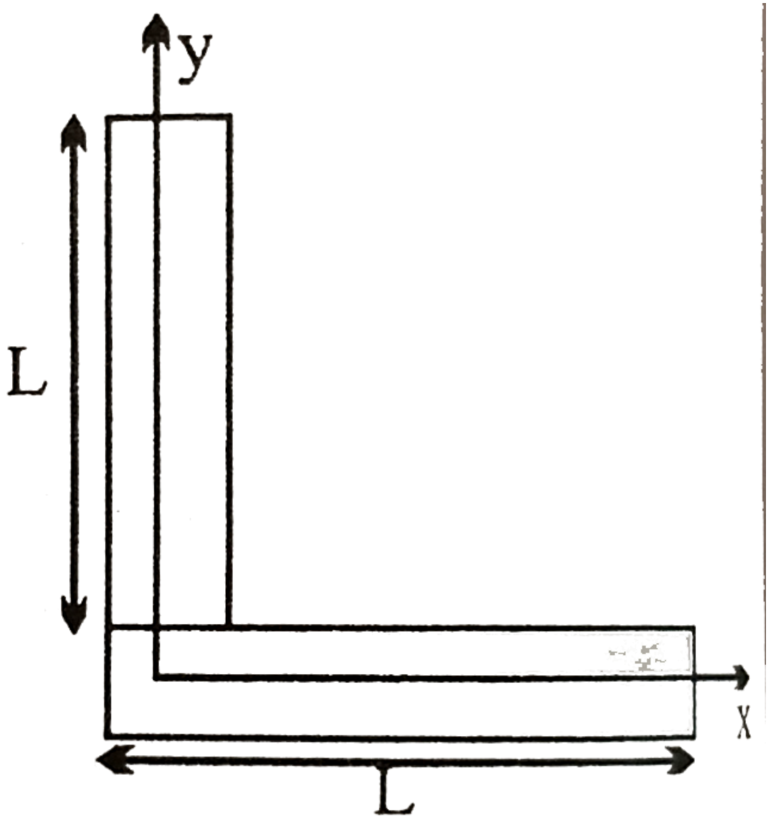
C. $30^\circ$

D. $60^\circ$

**Answer: B**

Watch Video Solution

**44.** Center of mass of two thin uniform rods of same length but made up of different materials. & kept as shown, can be, if the meeting point is the origin of co-ordinated




A. $\left(\frac{L}{2}, \frac{L}{2}\right)$

B. $\left(\frac{2L}{3}, \frac{L}{2}\right)$

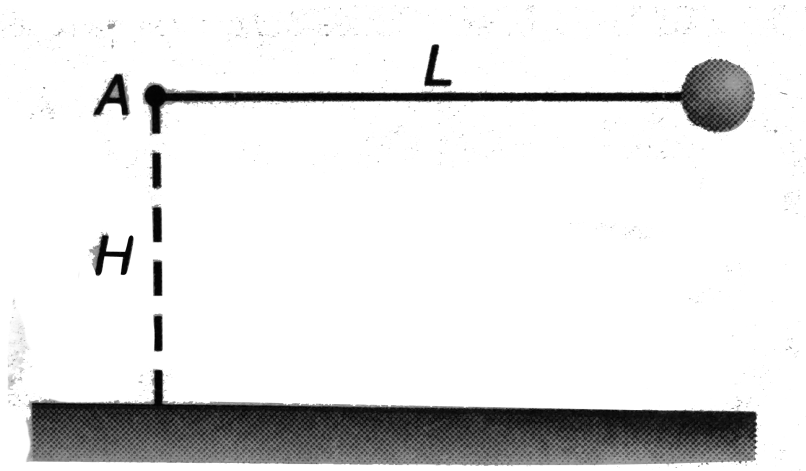
C. $\left(\frac{L}{3}, \frac{L}{3}\right)$

D. $\left(\frac{L}{3}, \frac{L}{6}\right)$

**Answer: D**

Watch Video Solution

**45.** A is a fixed point at height H above a perfectly inelastic smooth horizontal plane. A light inextesnsible string of length $L( > H)$ has one end attached to A and other to a heavy particle. The particle is held at the level of A with string just taut and released from rest. Find the height of the particle above the plane when it is next instaneously at rest .




A. velocity of particle on the surface is $= \sqrt{2gh} \cos \theta$

B. velocity of particle when it leaves surface $= \sqrt{2gh} \cos^2 \theta$

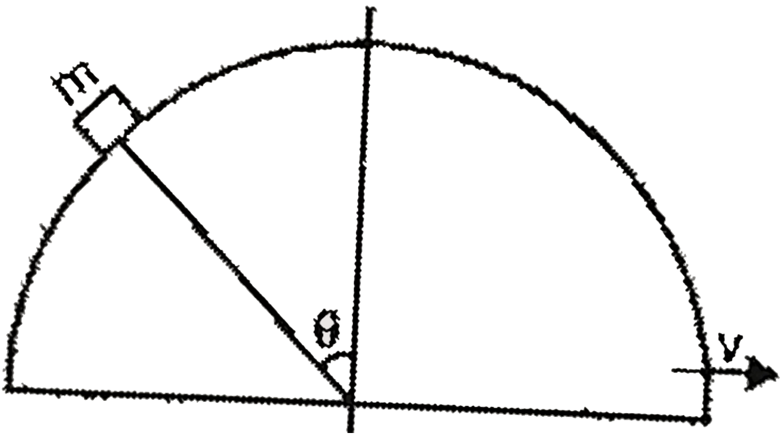
C. $S = \frac{h^5}{l^4}$

D. None of these

**Answer: D**

Watch Video Solution

**46.** A hemisphere of mass 3m and radius R is free to slide with its base on a smooth horizontal table. A particle of mass m is placed on the top of the hemisphere. If particle is displaced with a negligible velocity, then find the anuglar velocity of the particle relative to the centre of the hemisphere at an angular displacement $\theta$, when velocity of hemisphere is $v$.



A. $\frac{4v}{R\cos\theta}$

B. $\frac{3v}{R\cos\theta}$

C. $\frac{5v}{R\cos\theta}$

D. $\frac{2v}{R\cos\theta}$

**Answer: A**

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**47.** Two balls with masses in the ratio of 1:2 moving in opposite direction have a head-on elastic collision. If their velocities before impact were in the ration of 3:1, then velocities after impact will have the ratio :

A. $5:3$

B. $7:5$

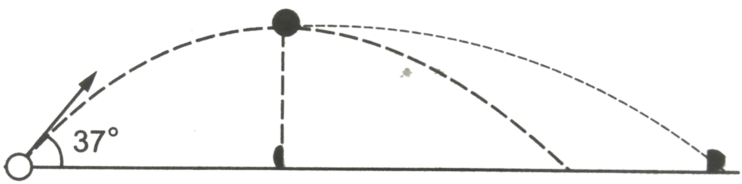
C. $4:5$

D. $2:3$

**Answer: B**

Watch Video Solution

**48.** A projectile is fired at a speed of 100 m/s at an angel of $37^{0}$ above the horizontal. At the highest point, the projectile breaks into two parts of mass ratio 1:3 the smaller coming to rest. Find the distance from the launching point to the where the heavier piece lands.




A. 480 m

B. 960 m

C. 1120 m

D. 640 m

**Answer: C**

Watch Video Solution

**49.** Two sphere $A$ and $B$ of equal masses lie on the smooth horizontal circular groove at opposite ends of diameter and at the end of time 't','A' impings on 'B' . If 'e' is the coefficient of restitution, the second impinge will occur after a time

A. $\frac{2t}{e}$

B. $\frac{t}{e}$

C. $\frac{\pi t}{e}$

D. $\frac{2\pi t}{e}$

**Answer: A**

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**50.** Two blocks of masses 10 kg and 4 kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of $14m/s$ to the heavier block in the direction of the lighter block. The velocity of the centre of mass is

A. $30m/s$

B. $20m/s$

C. $10m/s$

D. $5m/s$

**Answer: C**

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**51.** A stationary pulley carries a rope whose one end supports a ladder with a man and the other end the counterweight of mass M. The man of mass m climbs up a distance $l'$ with respect to the ladder and then stops. Neglecting the mass of the rope and the friction in the pulley axle, find the displacement $I$ of the centre of inertia of this system.

A. $\frac{ml}{M+m}$

B. $\frac{ml}{2M}$

C. $\frac{ml}{M+2m}$

D. $\frac{ml}{2M+m}$

**Answer: B**

Watch Video Solution

**52.** Consider the following two statements:

A The linear momentum of a particle is independent of the frame of reference.

B. The kinetic energy of a particle is independent of the frame of reference

A. Both (i) and (ii) are true

B. (i) is true but (ii) is false

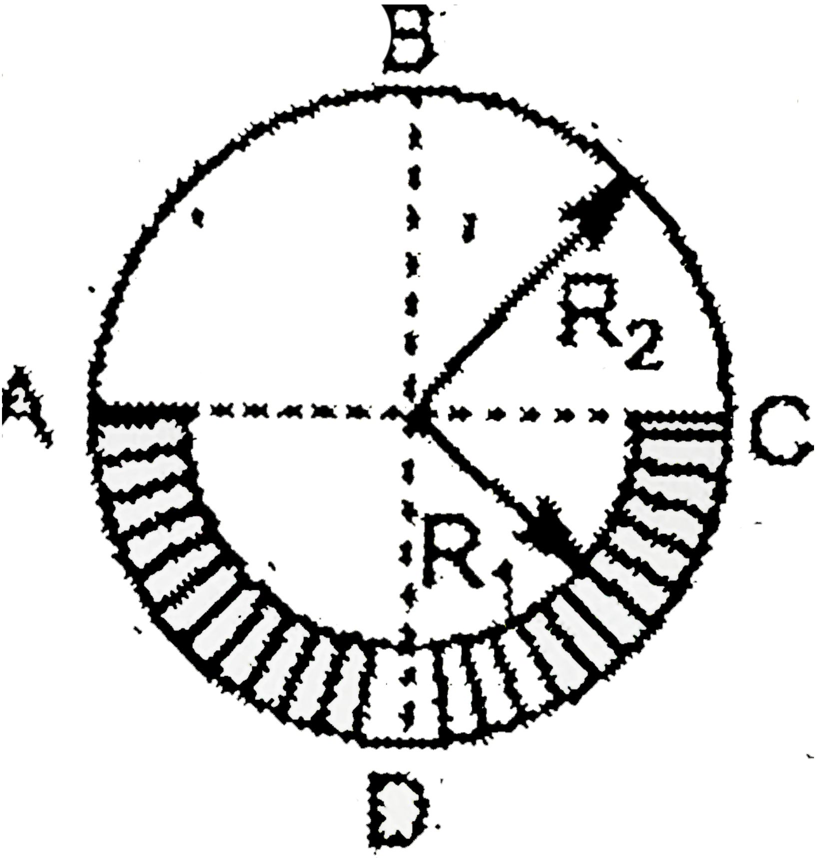
C. (i) is false but (ii) is true

D. both (i) and (ii) are false

**Answer: D**

Watch Video Solution

**53.** ABC is a part of ring having radius $R_2$ and ADC is a part of disc having inner radius $R_1$ and outer $R_2$. Part ABC and ADC have same mass. Then center of mass will be located, from the centre.



A. $\frac{(R_2 - R_1)(2R_1 + R_2)}{3\pi(R_1 + R_2)}$(above)

B. $\frac{(R_2 - R_1)(2R_1 + R_2)}{3\pi(R_1 + R_2)}$(below)

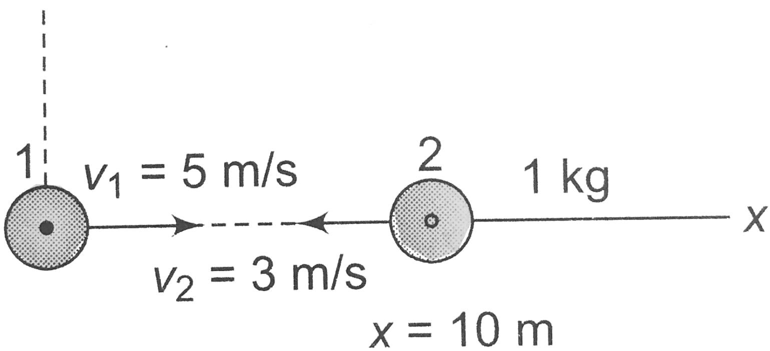
C. $\frac{2R_1 + R_2}{3\pi}$(above)

D. $\frac{2R_1 + R_2}{3\pi}$(below)

**Answer: A**

Watch Video Solution

**54.** 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=5m

B. X=7m

C. X=3m

D. X=2m

**Answer: B**

Watch Video Solution

**55.** Two identical balls are dropped from the same height onto a hard surface, the second ball being released exactly when the first ball bollides with the surface. If the first ball has made two more collisions by the time the second one collides. Then the coefficient of restitution between the ball and the surface satisfies :

A. $e > 0.5$

B. e=0.5

C. $e = \frac{\sqrt{3}-1}{2}$

D. $e < \frac{\sqrt{3}-1}{2}$

**Answer: D**

Watch Video Solution

**56.** A bullet of mass 20 g travelling horizontally with a speed of 500 m/s passes through a wooden block of mass 10.0 kg initially at rest on a level surface. The bulet emerges with speed of 100 m/s and the block slides 20 cm on the surface before coming to rest. Find the friction cioefficient between the block and the surface figure.


A. 0.8

B. 0.16

C. 0.32

D. 0.24

**Answer: B**

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**57.** A gun is mounted 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 the 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.

A. $\frac{200}{49}m/s$

B. $200\left(\frac{1}{48}+\frac{1}{48}\right)m/s$

C. $200\frac{1}{48}+\frac{1}{49}\Big)m/s$

D. $200\left(\frac{1}{48}+\frac{1}{48\times49}\right)m/s$

**Answer: C**

Watch Video Solution

**58.** A man of mass 60 kg can throw a stone of mass 1 kg up to a height 5 m. If he is standing on ice skates of negligible mass, the maximum velocity that he can generate in same stone if he throus it with same force in the horizontal direction :

A. $v_{\max} = 9.9m/s$

B. $v_{\max} - 12m/s$

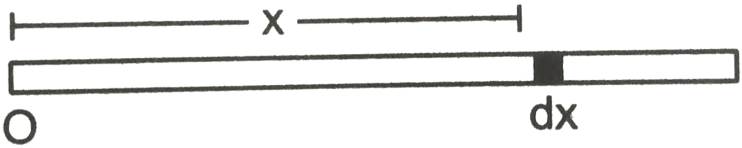
C. $v_{\max} = 7m/s$

D. $v = 10m/s$

**Answer: A**

Watch Video Solution

**59.** The density of a linear rod of length L varies as $\rho = A + Bx$ where x is the distance from the left end. Locate the centre of mass.




A. $\dfrac{2AL + 3BL^2}{3(2A + BL)}$

B. $\dfrac{AL + 3BL^2}{(2A + BL)}$

C. $\dfrac{3AL + 2BL^2}{(2A + BL)}$

D. $\dfrac{3AL + 2BL^2}{3(2A + BL)}$

**Answer: D**

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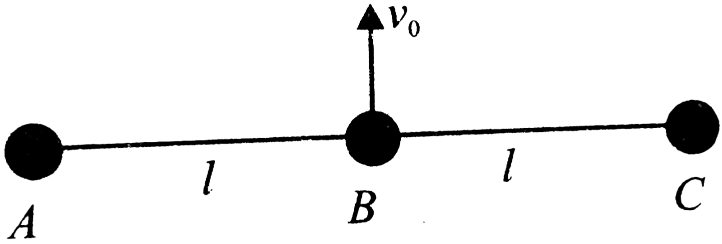
**60.** Three identical balls are connected by light inextensible strings with each other as shown and rest over a smooth horizontal table. Length of each string is $l$.

At moment $t = 0$, ball $B$ is imparted a velocity $v_0$ perpendicular to the strings and then the system is left on its own.




Calculate the velocity of $B$ just before $A$ collides with ball $C$.

A. $9m/s$

B. zero

C. $3m/s$

D. $6m/\sec$

**Answer: C**

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**61.** In above question 60 the velocity with which A colliides with C is :

A. $6m/\sec$

B. $9m/\sec$

C. $3m / \sec$

D. $\frac{9}{2}m / \sec$

**Answer: A**

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**62.** A box is put on a scale which is adusted to read zero when box is empty. A stream of pebbles is poured into the box from a height h above it's bottom at a rate $\mu$ pebbles/sec. each pebble has a mass m. Consider the collision between pebble and box to be completely inelastic. Find the reading of scale after t seconds of falling of pebbles.

A. $\mu tmg$

B. $\mu mt\sqrt{2gh}$

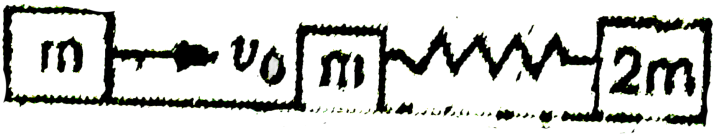
C. $\mu m( > \ - \sqrt{2gh})$

D. $\mu m( > \ + \sqrt{2gh})$

**Answer: D**

Watch Video Solution

**63.** Initially spring is at it's natural length and collision is elastic. Then find maximum compression of spring during motion :




A. $\sqrt{\frac{2m}{3k}}v_0$

B. $\sqrt{\frac{3m}{2k}}v_0$

C. $\sqrt{\frac{m}{2k}}v_0$

D. $\sqrt{\frac{m}{k}}v_0$

**Answer: A**

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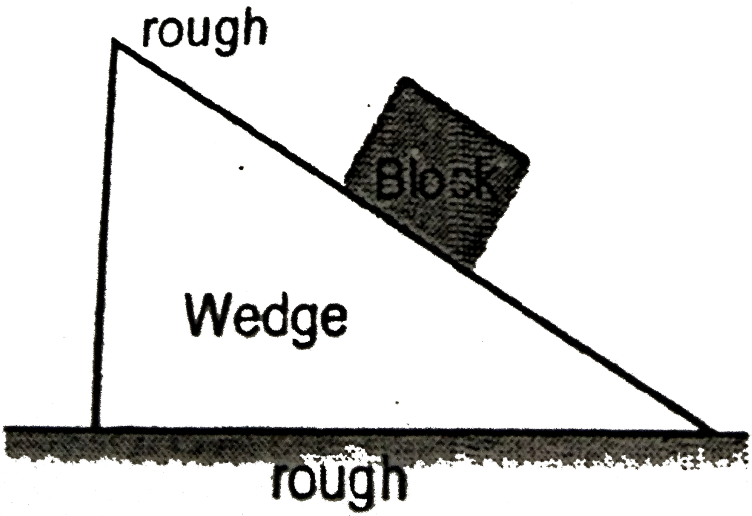
**64.** When a block is placed on a wedge as shown in figure, the block starts sliding down and the wedge also start sliding on ground. All surfaces are rough. The centre of mass of ( wedge + block ) system will move.




A. upwards

B. downwards

C. leftwards

D. rightwards

**Answer: B**

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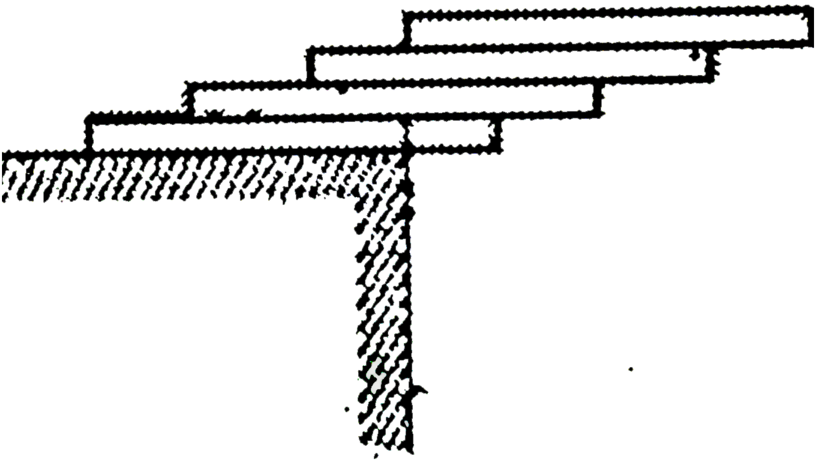
**65.** Four identical rods of mass M and length L are placed on one another on the table so as to produce the maximum overhang as shown in figure. The maximum total overhang will be :



A. $\frac{3L}{4}$

B. $\frac{24L}{25}$

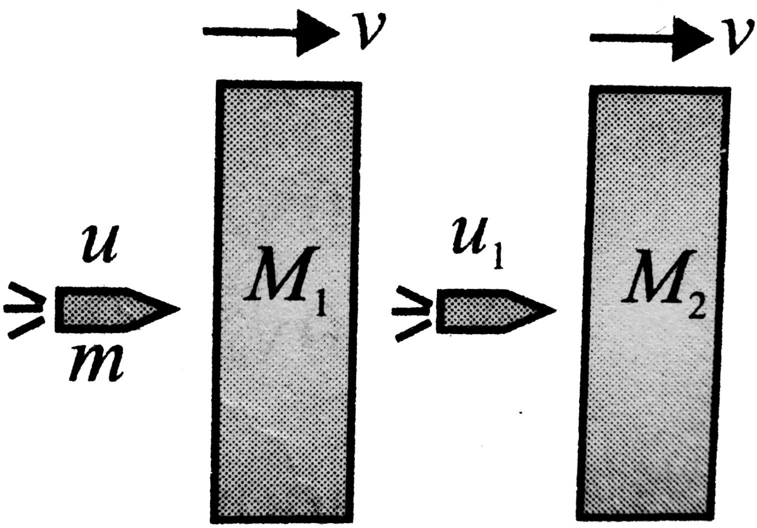
C. $\frac{25L}{24}$

D. $\frac{4L}{3}$

**Answer: C**

Watch Video Solution

**66.** A $20g$ bullet pierces through a plate of mass $M_1 = 1kg$ and then comes to rest inside a second plate of mass $M_2 = 2.98kg$ as shown in Fig. It is found that the two plates, initially at rest, now move with equal velocities. Find the percentage loss in the initial velocity of the bullet when it is between $M_1$ and $M_2$. Neglect any loss of material of the plates due to the action of bullet.




A. 0

B. 0.5

C. 0.75

D. 0.25

**Answer: D**

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**67.** Two particles of masses $m_1$ and $m_2$ in projectile motion have velocities $\vec{v}_1$ and $\vec{v}_2$, respectively, at time $t = 0$. They collide at time $t_0$. Their velocities become $\vec{v'}_1$ and $\vec{v'}_2$ at time $2t_0$ while still moving in air. The value of $\left|\left(m_1\vec{v'}_1 + m_2\vec{v'}_2\right) - \left(m_1\vec{v}_1 + m_2\vec{v}_2\right)\right|$

A. zero

B. $(m_1 + m_2)gt_0$

C. $2(m_1 + m_2)gt_0$

D. $\frac{1}{2}(m_1 + m_2)gt_0$

**Answer: C**

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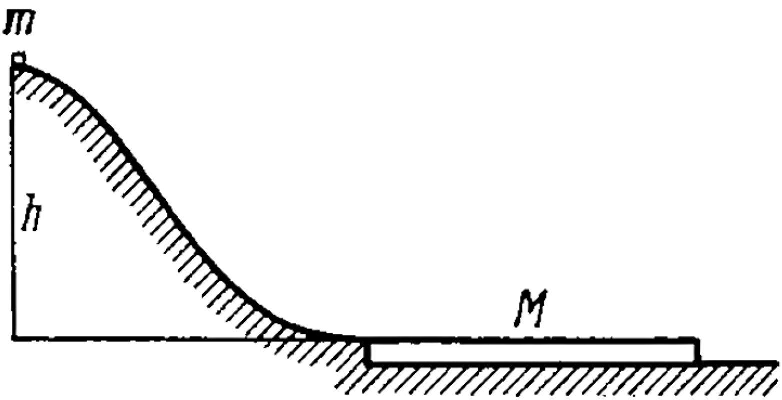
**68.** A small disc of mass m slides down a smooth hill of height h without initial velocity and gets onto a plank of mass M lying on the horizontal plane at the base of the hill. (figure). Due to friction between the disc and the plank the disc slows down and, beginning with a certain moment, moves in one piece with the plank.

(1) Find the total work performed by the friction forces in this process.

(2) Can it be stated that the result of obtained does not depend on the

choice of the reference frame?




A. zero

B. $\frac{mM}{m+M}gh$

C. $\frac{M}{m}gh$

D. $\frac{mM}{M-m}gh$

**Answer: B**

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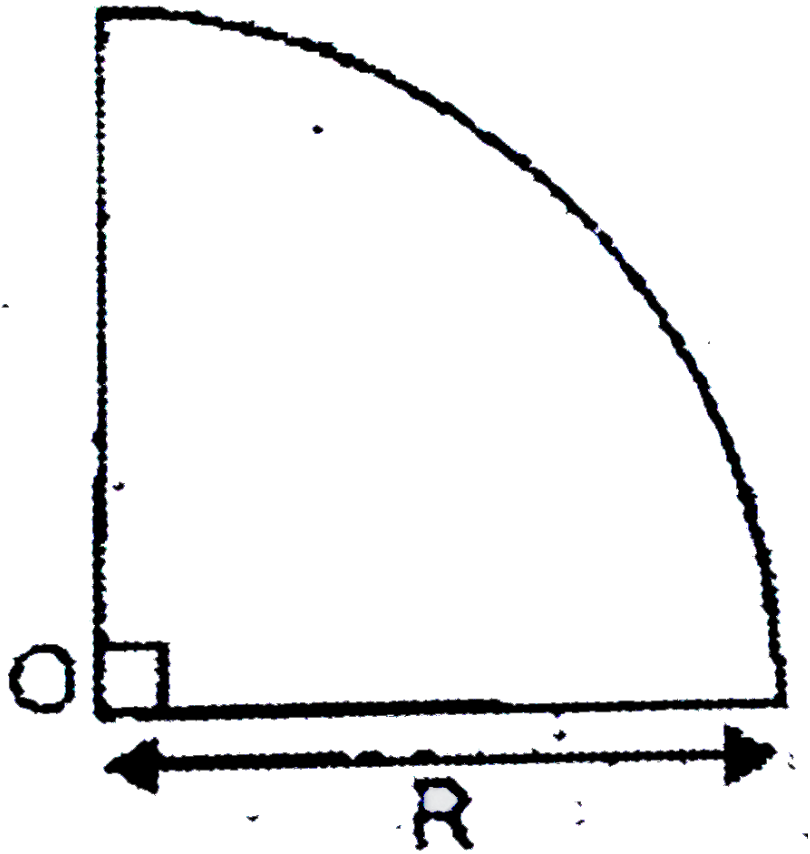
**69.** In the figure one fourth part of a uniform disc of radius R is shown. The distance of the centre of mass of this object from centre 'O' is :




A. $\frac{4R}{3\pi}$

B. $\frac{2r}{3\pi}$

C. $\sqrt{2}\frac{4R}{3\pi}$

D. $\sqrt{2}\frac{2R}{3\pi}$

**Answer: C**

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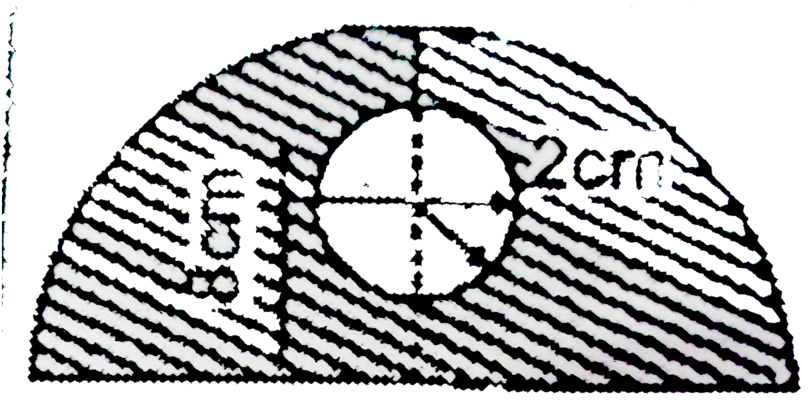
**70.** In the figure shown a hole of radius 2 cm is made in a semicircular disc of radius $6\pi$ at a distance 8 cm from the centre C of the disc. The distance of the centre of mass of this system from point C is :




A. 4 cm

B. 8cm

C. 6 cm

D. 12 cm

**Answer: B**

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**71.** When the momentum of a body increases by 100%, its K.E. increases by

:

A. 4

B. 1

C. 3

D. none

**Answer: C**

Watch Video Solution

**72.** A small sphere is moving at a constant speed in a vertical circle. Below is list of quantities that could be used to describe some aspect of the motion of the sphere.

I-kinetic energy

II- gravitational potential energy

III- momentum

Which of these quantities will change as this sphere moves around the circle ?

A. I and II only

B. I and III only

C. III only

D. II and III only

**Answer: D**

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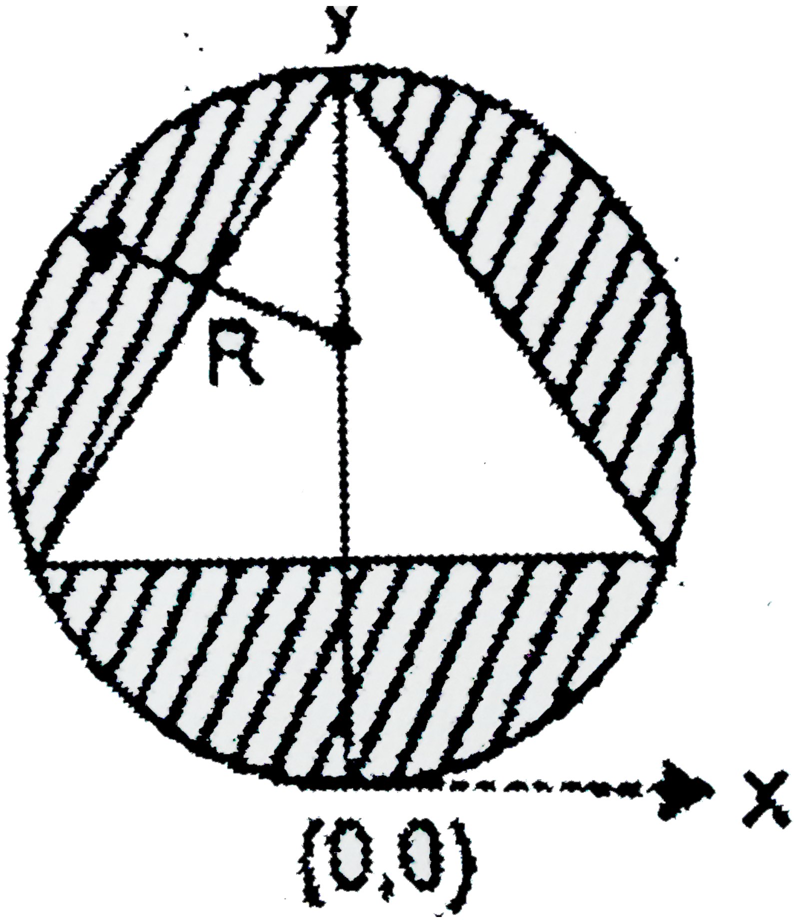
**73.** From a uniform disc of radius R, an equilateral triangle of side $\sqrt{3}R$ is cut as shown in the figure. The new position of centre of mass is :




A. (0,0)

B. (0,R)

C. $\left(0, \frac{\sqrt{3}R}{2}\right)$

D. none of these

**Answer: B**

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**74.** A truck moving on horizontal road towards east with velocity $20ms^{1}$ collides elastically with a light ball moving with velocity $25ms^{-1}$ along west. The velocity of the ball just after collision

A. $65ms^{-1}$ towards east

B. $25ms^{-1}$ towards west

C. $65ms^{-1}$ towards west

D. $20ms^{-1}$ towards east

**Answer: A**

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**75.** From a circle of radius a, an isosceles right angles triangle with the hypotenuse as the diameter of the circle is removed. The distance of the centre of mass of the remaining portion from the centre of the circle is

A. $3(\pi - 1)a$

B. $\frac{(\pi - 1)a}{6}$

C. $\frac{a}{3(\pi - 1)}$

D. $\frac{a}{3(\pi + 1)}$

**Answer: C**

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**76.** A particle of mass $4m$ 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 $3m$, respectively, such that the smaller mass comes to rest. The larger mass finally falls at a distance $x$ from the point of projection, where $x$ is equal to

A. $\frac{3R}{4}$

B. $\frac{3R}{2}$

C. $\frac{5R}{4}$

D. 3R

**Answer: C**

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**77.** Two ball $A$ and $B$ having masses 1kg and 2kg, moving with speeds $21m/s$ amd $4m/s$ receptively in opposite direction, collide head on. After collision $A$ moves with a speed of $1m/s$ in the same direction, then correct statements is:

A. $0.1$

B. $0.2$

C. $0.4$

D. none

**Answer: B**

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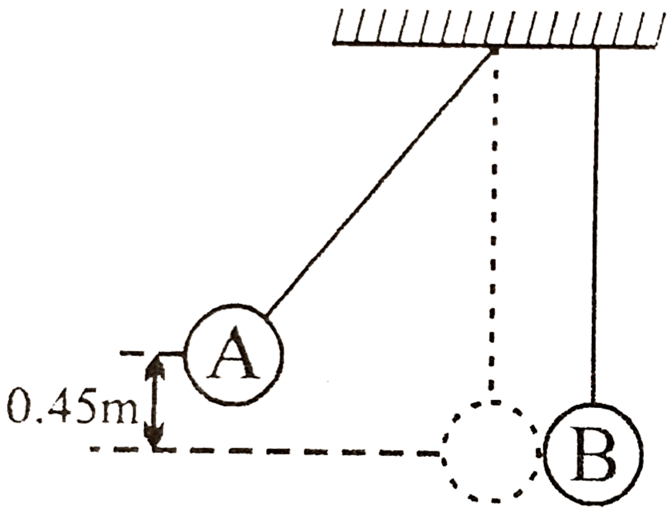
**78.** Two massless string of length 5 m hang from the ceiling very near to each other as shown in the figure. Two balls $A$ and $B$ of masses $0.25kg$ and $0.5kg$ are attached to the string. The ball $A$ is released from rest at a height $0.45m$ as shown in the figure. The collision between two balls is completely elastic. Immediately after the collision, the kinetic energy of ball $B$ is $1J$ The velocity of ball $A$ just after the collision is



A. $5ms^{-1}$ to the right

B. $5ms^{-1}$ to the left

C. $1ms^{-1}$ to the right

D. $1ms^{-1}$ to the left

**Answer: D**

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**79.** An ice block is melting at a constant rate $\left|\frac{dm}{dt}\right| = \mu$. Its initial mass is $m_0$ and it is moving with velocity on a frictionless horizontal surface. The distance travelled by it till it melts completely is :

A. $\frac{2m_0v}{\mu}$

B. $\frac{m_0v}{\mu}$

C. $\frac{m_0v}{2\mu}$

D. can't be said

**Answer: B**

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**80.** A ball strikes a smooth horizontal ground at an angle of $45^\circ$ with the vertical. What cannot be the possible angle of its velocity with the vertical after the collisioin. (Assume $e \leq 1$).

A. $45^\circ$

B. $30^\circ$

C. $53^\circ$

D. $60^\circ$

**Answer: B**

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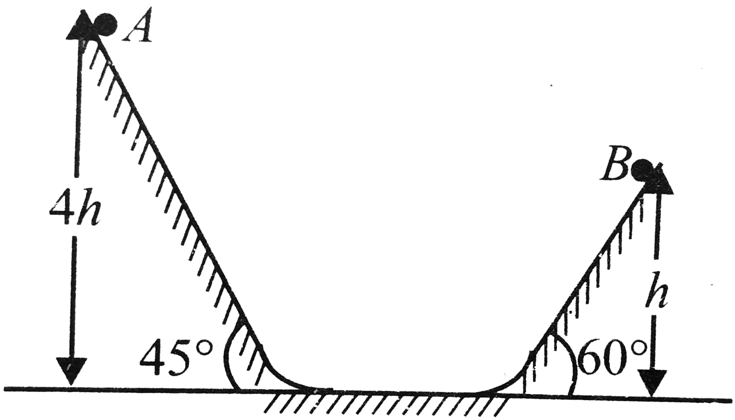
**81.** Two identical balls $A$ and $B$ are released from the position shown in Fig. They collide elastically with each other on the horizontal portion. The ratio of heights attained by $A$ and $B$ after collision is (neglect friction)




A. $1:4$

B. $2:1$

C. $4:13$

D. $2:5$

**Answer: C**

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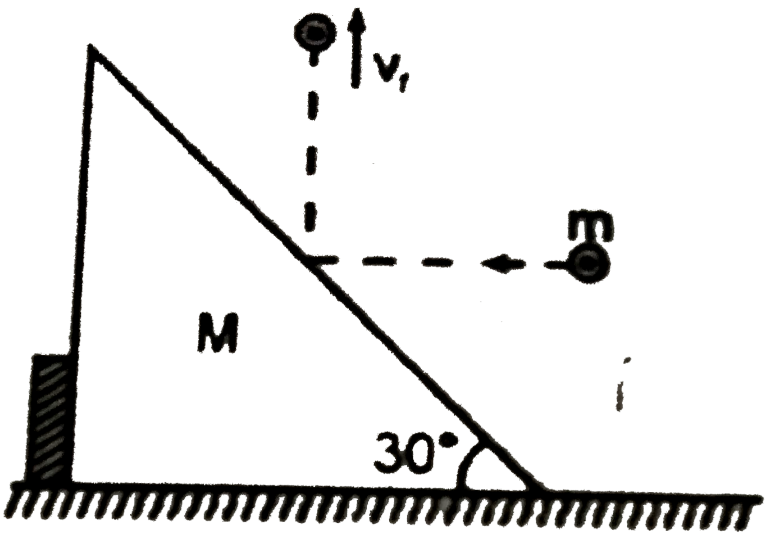
**82.** As shown in the figure a body of mass $m$ moving horizontally with speed $\sqrt{3}m/s$ hits a fixed smooth wedge and goes up with a velocity $1v_t$ in the vertical direction. If $\angle$ of wedge is $30^\circ$, the velocity $v_f$ will be :




A. $3m/s$

B. $\sqrt{3}m/s$

C. $\frac{1}{\sqrt{3}}m/s$

D. this is not possible

**Answer: B**

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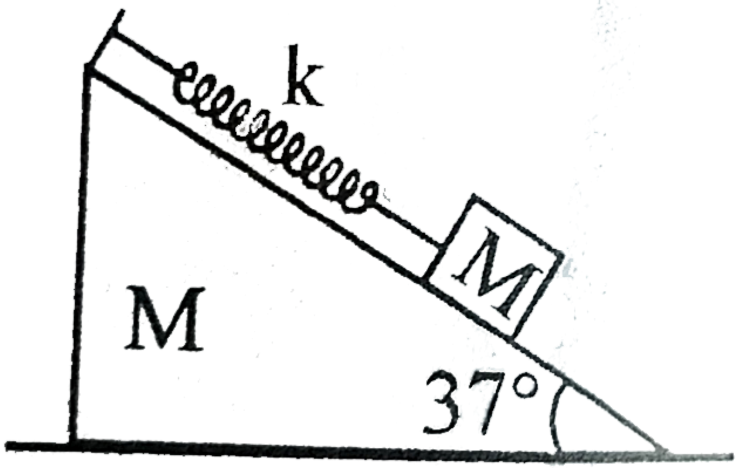
**83.** The system of the wedge and the block connected by a massless spring as shown in the figure is released with the spring in its natural length. Friction is absent. Maximum elongation in the spring will be




A. $\frac{3Mg}{5k}$

B. $\frac{6Mg}{5k}$

C. $\frac{4Mg}{5k}$

D. $\frac{8Mg}{5k}$

**Answer: B**

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**84.** A sphere is moving with velocity vector $2\hat{i} + 2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ and the coefficient of restitution of the sphere and the wall is $e = \frac{1}{2}$. Find the velocity of the sphere after it hits the wall?

A. $\hat{i} - \hat{j}$

B. $-\hat{i} + 2\hat{j}$

C. $-\hat{i} - \hat{j}$

D. $2\hat{i} - \hat{j}$

**Answer: B**

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**85.** A man of mass M stands at one end of a stationary plank of length L, lying on a smooth surface. The man walks to the other end of the plank. If the mass of the plank is $M/3$, the distance that the man moves relative to the ground is

A. $\frac{3L}{4}$

B. $\frac{L}{4}$

C. $\frac{4L}{5}$

D. $\frac{L}{3}$

**Answer: B**

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**86.** Two particles of equal mass have velocities $2\hat{i}ms^{-1}$ and $2\hat{j}ms^{-1}$. First particle has an acceleration $\left(\hat{i}+\hat{j}\right)ms^{-2}$ while the acceleration of the second particle is zero. The centre of mass of the two particles moves in ?

A. circle

B. parabola

C. ellipse

D. straight line

**Answer: D**

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**87.** A man weighing 80 kg is standing at the centre of a flat boat and he is 20 m from the shore. He walks 8 m on the boat towards the shore and then halts.The boat weight 200 kg. How far is he from the shore at the end of this time ?

A. 11.2 m

B. 13.8 m

C. 14.3 m

D. 15.4 m

**Answer: C**

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**88.** A sphere strikes a wall and rebounds with coefficient of restitution $\frac{1}{3}$. If it rebounds with a velocity of $0.1m/\sec$ at an angle of $60^\circ$ to the normal to the wall, the loss of kinetic energy is :

A. $50\%$

B. $33\frac{1}{3}\%$

C. $40\%$

D. $66\frac{2}{3}\%$

**Answer: D**

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**89.** A spaceship travelling along $+y$ axis with speed $v_0$ suddenly shoots out one fourth of its parts with speed $2v_0$ along $+x$-axis. $xy$ axes are fixed with respect to ground. The velocity of the remaining part is

A. $\frac{2}{3}v_0$

B. $\frac{\sqrt{20}}{3}v_0$

C. $\frac{\sqrt{5}}{3}v_0$

D. $\frac{\sqrt{13}}{3}v_0$

**Answer: B**

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**90.** If linear density of a rod of length 3m varies as $\lambda = 2 + x,$ them the position of the centre of gravity of the rod is

A. $\frac{7}{3}m$

B. $\frac{12}{7}m$

C. $\frac{10}{7}m$

D. $\frac{9}{7}m$

**Answer: B**

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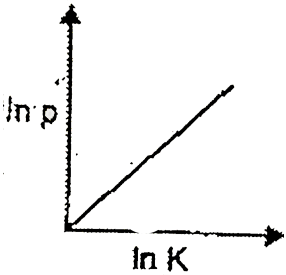
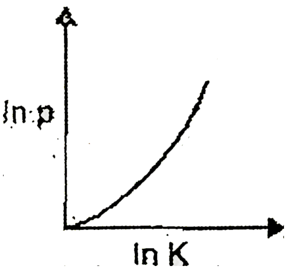
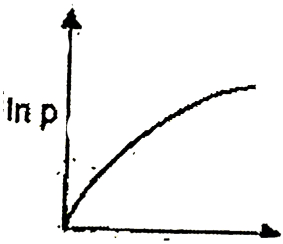
**91.** Which of the following graphs represents the graphical relation between momentum (p) and kinetic energy (K) for a body in motion?

A. 


B. 


C. 


D. None

**Answer: D**

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**92.** A small bucket of mass $M$ is attached to a long inextensible cord of length $L$. The bucket is released from rest when the cord is in a horizontal position. In its lowest position the bucket scoops up m of water, what is the height of the swing above the lowest position?

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**93.** A buggy of mass 100 kg is free to move on a frictionless horizontal track. Two men, each of mass 50 kg, are standing on the buggy, which is initially stationary. The men jump off the buggy with velocity =10m/s relative to the buggy. In one situation, the men jump one after the other. in another situation, the men jump simultaneously. what is the ratio of the velocities of the buggy in two cases?

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**94.** Two men, of masses 60 kg and 80 kg are sitting at the ends of a boat of mass 60 and length 4 m. the boat is stationary. If the men now exchange their position, then:

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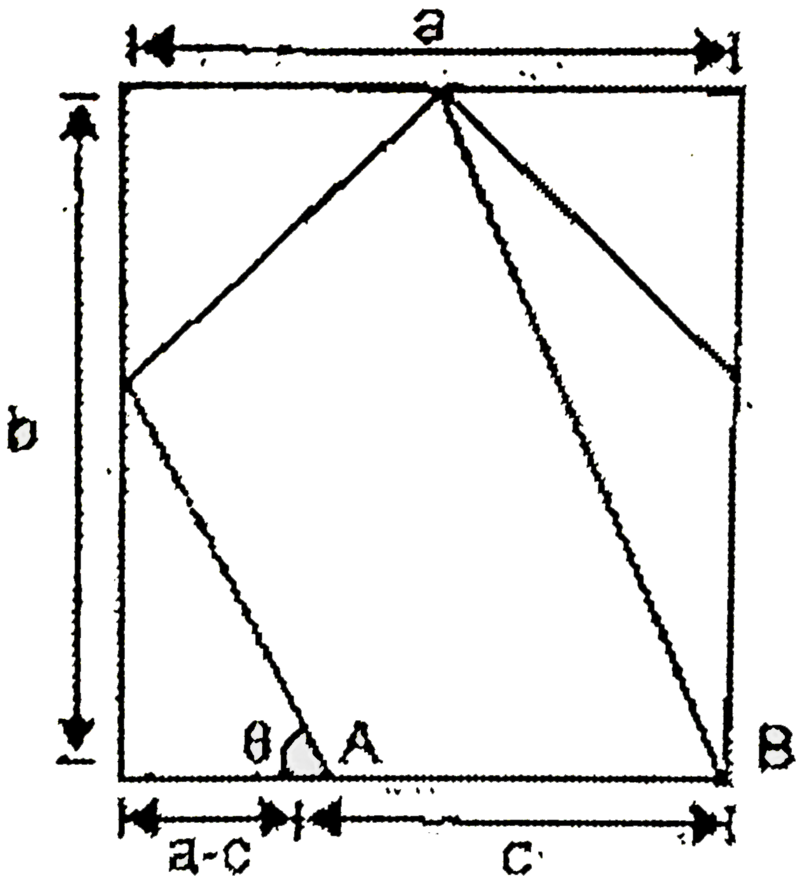
**95.** A billiard table whose length and width are as shown in the figure. A ball is placed at point A. at what angle $\theta$ the ball be projected so that after colliding with two walls, the ball will fall in the pocket B? assume that all collisions are perfectly elastic: (neglect friction)

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**96.** In the above, suppose that the smaller ball does not stop after collision, but continues to move downwards with a speed $= \frac{v_0}{2}$ after the collision. Then, the speed of each bigger ball after collision is

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**97.** A body of mass $m$ is dropped from a height of $h$. Simultaneously another body of mass $2m$ is thrown up vertically with such a velocity $v$ that they collide at height $\frac{h}{2}$. If the collision is perfectly inelastic, the velocity of combined mass at the time of collision with the ground will be

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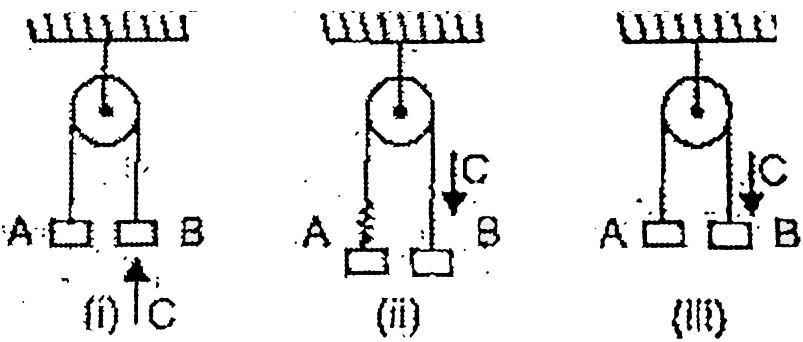
**98.** In the figure (i), (ii) and (iii) shown the objects, A,B and C are of same mass. String, spring and pulley are massless. C strikes B with velocity $u$ in each case and stricks to it. The ratio of velocity of B in case (i) to (ii) to (iii) is-



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**99.** A force exerts an impulse Ion a particle changing its speed from initial velocity $u$ to final velocity $2u$. The applied force and the initial velocity are oppositely oriented along the same line. The work done by the force is

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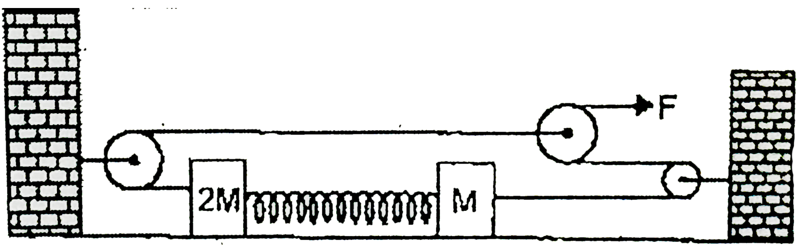
**100.** In the diagram shown, no friction at any contact surface. Initially, the spring has no deformation what will be the maximum deformation in the spring? Consider all the strings to be sufficiency large. Consider the spring constant to be K.

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**101.** A flexible chain of length 2m and mass 1 kg initially held in vertical position such that its lower end just touches a horizontal surface, is released from rest at time t=0. Assuming that any part of chain which strikes the plane immediately comes to rest and that the portion of chain lying on horizontal surface does not from any heap, the height of its centre of mass above surface at any instant $t = \frac{1}{\sqrt{5}}$ (before it completely comes to rest) is

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**102.** A parallel beam of particles of mass $m$ moving with velocity $v$ impinges on a wall at an angle $\theta$ to its normal. The number of particles per unit volume in the beam is $n$. If the collision of particles with the wall is elastic, then the pressure exerted by this beam on the wall is

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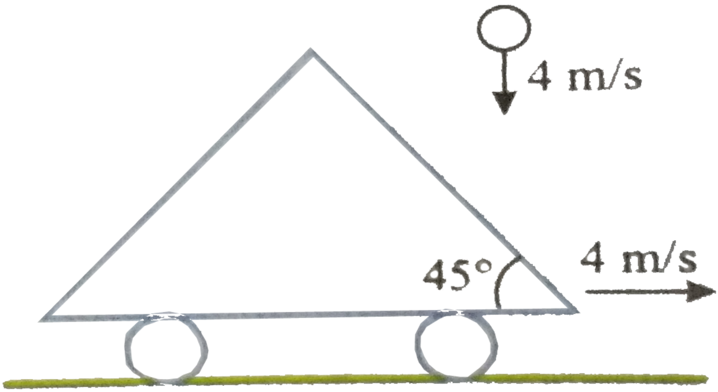
**103.** A small ball falling vertically downward with constant velocity $4m/s$ strikes elastically a massive inclined cart moving with velocity $4m/s$ horizontally as shown. The velocity of the rebound of the ball is

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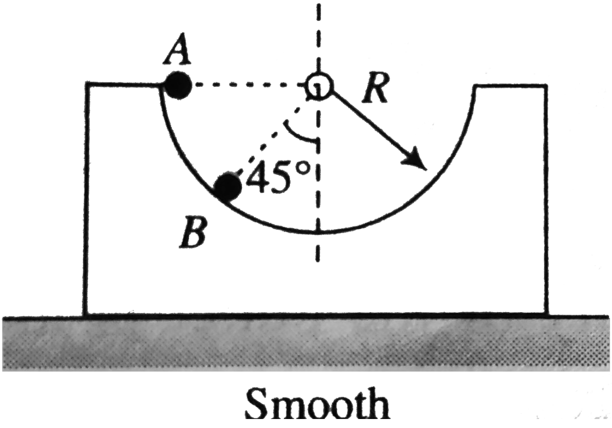
**104.** A ball of mass $m$ is released from A inside a smooth wedge of mass $m$ as shown in figure. What is the speed of the wedge when the ball reaches point B?

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**105.** Two identical spheres move in opposite directions with speeds $v_1$ and $v_2$ and pass behind an opaque screen, where they may either cross without touching (Event 1) or make an elastic head-on collision (event 2)

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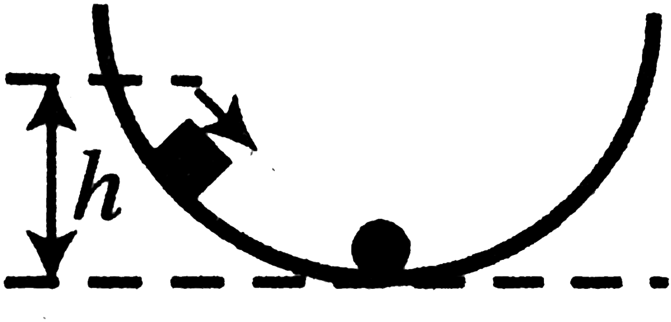
**106.** A block of mass $m$ starts from rest and slides down a frictionless semi-circular track from a height h as shown. When it reaches the lowest point of the track, it collides with a stationary piece of putty also having mass in. If the block and the putty . stick together and continue to slide, the maximum height that the block-putty system could reach is

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**107.** Two billiard balls undergo a head-on collision. Ball 1 is twice as heavy as ball 2. Initially, ball 1 moves with a speed $v$ towards ball 2 which is at rest. Immediately after the collision, ball 1 travels at a speed of $v/3$ in the same direction. What type of collision has occured?

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**108.** A 4-kg disk slides over level ice towards the eact at a velocity of 1 meter per second, as shown. The disk strikes a post and rebounds towards the north at the Same speed. The change in the magnitude of the eastward component of the momentum of the disk is:

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**109.** An isolated rail car of mass M is moving alonga straight, frictionless track at an initial speed $v_0$. The car is passing under a bridge when a crate filled with N bowling balls, each of mass m, is dropped from the bridge into the bed of the rail car. the crate splits open and the bowling balls bounce around inside the rail car, but none of them fall out.

(A). Is the momentum of the ratil car+bowling balls system conserved in this collision?

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**110.** An isolated rail car of mass M is moving alonga straight, frictionless track at an initial speed $v_0$. The car is passing under a bridge when a crate filled with N bowling balls, each of mass m, is dropped from the bridge into the bed of the rail car. the crate splits open and the bowling balls bounce around inside the rail car, but none of them fall out.

(B).What is the average speed of the rail car + bowling balls system some time after the collision?

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L 2

**1.** A uniform chain of mass M and length L is held vertically in such a way that its lower end just touches the horizontal floor. The chain is released from rest in this position. Any portion that strikes the floor comes to rest. Assuming that the chain does not form a heap on the floor, calculate the force exerted by it on the floor when a length x has reached the floor.

A. Force exerted by chain on the floor when a length x has reached the floor is $\frac{3Mgx}{L}$

B. Force exerted by chain on the floor when a length x has reached the floor is $\frac{3Mgx}{L}$

C. Force exerted on the floor by the falling part of chain at any moment is twice as great as force exerted by the part already resting on the floor.

D. Force exerted on the floor by the falling part of chain at any moment is same as foce exerted by the part already resting on the floor.

**Answer:**

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**2.** A ball strikes a wall with a velocity $\overrightarrow{u}$ at an angle $\theta$ with the normal to the wall surface. and rebounds from it at an angle $\beta$ with the surface.

Then

A. $(\theta + \beta)$ is never less than $90^\circ$ if wall is smooth

B. If wall is smooth coefficient of restitution $= \dfrac{\tan\beta}{\cot\theta}$

C. If wall is smooth coefficient of restitution $< \dfrac{\tan\beta}{\tan\theta}$

D. None of these

**Answer:**

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**3.** A ball hits the floor and rebounds after an inelastic collision. In this case

A. the momentum of the ball just after the collision is same as that just before the collision

B. the kinetic energy of the ball remains same during the collision

C. the total momentum of the ball and the earth is conserved

D. the total energy of the ball and the earth remains the same

**Answer:**

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**4.** Two identical buggies move one after the other due to inertia (without friction) with the same velocity $v_0$. A man of mass m rides the rear buggy. At a certain moment the man jumps into the front buggy with a velocity u relative to his buggy. Knowing that the mass of each buggy is equal to M, find the velocities with which the buggies will move after that.

A. $v_{\text{rear}} = v_0 + \frac{m}{m+M}u$

B. $v_{\text{rear}} = v_0 - \frac{m}{m+M}u$

C. $v_{\text{front}} = v_0 + \frac{m}{(m+M)^2}u$

D. $v_{\text{front}} = v_0 - \frac{m}{(m+M)^2}u$

**Answer:**

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**5.** A nonzero external force on a system of particles. The velocity and the acceleration of the cente of mass are found to be $v_0$ and $a_0$ at an instant t. It is possible that

A. $v_0 = 0, a_0 = 0$

B. $v_0 = 0, a_0 \ne 0$

C. $v_0 \ne 0, a_0 = 0$

D. $v_0 \ne 0, a_0 \ne 0$

**Answer:**

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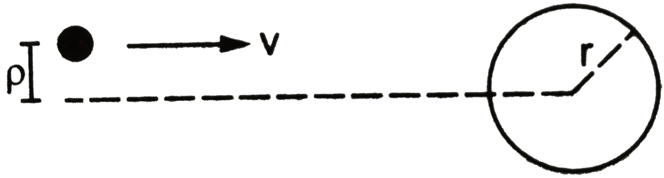
**6.** A small particle travelling with a velocity v collides elastically with a spbereical body of equal masss and of radius r initially kept at rest. The centre of this spherical body is located a distnce $\rho( < r)$ away from the direction of motion of the particle figure. Find the final velocities of the two particles.




A. particle stops and spherical body move in the direction of particle

B. both particle and spherical body move perpendicular to each other

C. Velocity of particle after collision is $\frac{v\rho}{r}$

D. Velocity of the spherical body after collision is $\frac{v}{r}\sqrt{r^2 - p^2}$

**Answer:**

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**7.** Two particles A and B of equal size but of masses m kg and 2 m kg are moving directly towards each other with speeds 21 m/s and 4 m/s respectively. After collision, A moves with a speed of 1 m/s in the original direction. Then:

A. After collision , B moves with a speed of $6m/s$ in a direction opposite to its motion before collision.

B. After collision, B moves with a speed of $6m/s$ in the original direction.

C. The coefficient of restitution is 0.2

D. The impulse of the collision is $20m$ N-S

**Answer:**

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**8.** Two friends A and B (each weighing 40 kg) are sitting on a frictionless platform some distance d apart. A rolls a ball of mass 4 kg on the platform towards B which B catches. Then B rolls the ball towards A and A catches it. The ball keeps on moving back and forth between A and B. The ball has a fixed speed of 5 m/s on the platform. a. Find the speed of A after he rolls the ball for the first time. b. Find the speed of A after he catches the ball for the first time. c. Find the speed s of A and B after the ball has made 5 round trips and is held by A. d. How many times can A roll theball? e. where is the centre of mas the system A+B+ ball at the end of the nth trip?

A. speed of A after he catches the ball for the first is $\frac{10}{11}$ m/s

B. speed of A after he catches the ball for the first is $\frac{10}{9}$ m/s

C. The center of mass of the system will remain stationary irrespective of the direction of motion of the ball

D. A can rolls the ball for 6 times

**Answer:**

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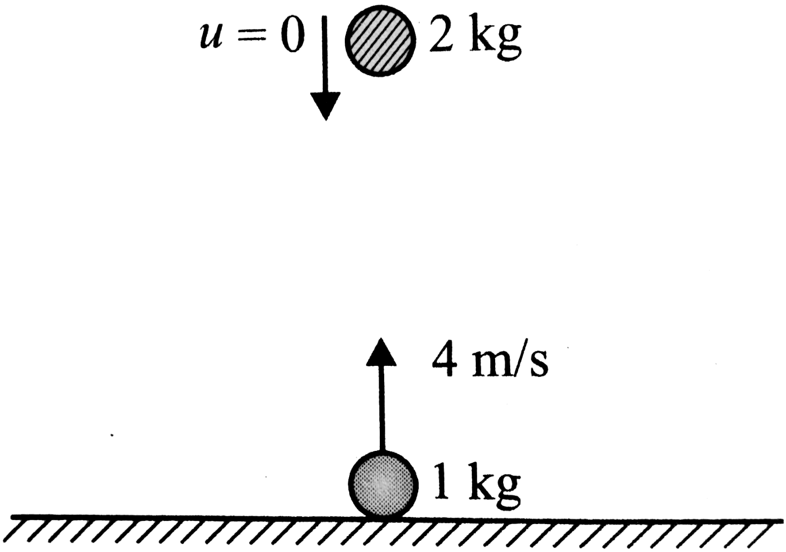
**9.** A ball of mass $1kg$ is thrown up with an initial speed of $4m/s$. A second ball of mass $2kg$ is released from rest from some height as shown in Fig.

Choose the correct statement (s).




A. The center of mass of the two balls comes down with· an acceleration of $\frac{g}{3}$

B. The center of mass first moves up and then comes down

C. The acceleration of the ,center of mass is g downwards

D. The center of mass of the two balls remains stationary

**Answer:**

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**10.** A cannon shell is fired to hit a target at a horizontal distance R. However, it breaks into two equal parts at its highest point. One part (A) returns to the cannon. The other part is:

A. will fall at a distance $R$ beyond the target

B. will fall at a distance $2R$ beyond the target

C. will fall at a distance $3R$ beyond the target

D. have nine times the kinetic energy of $A$

**Answer:**

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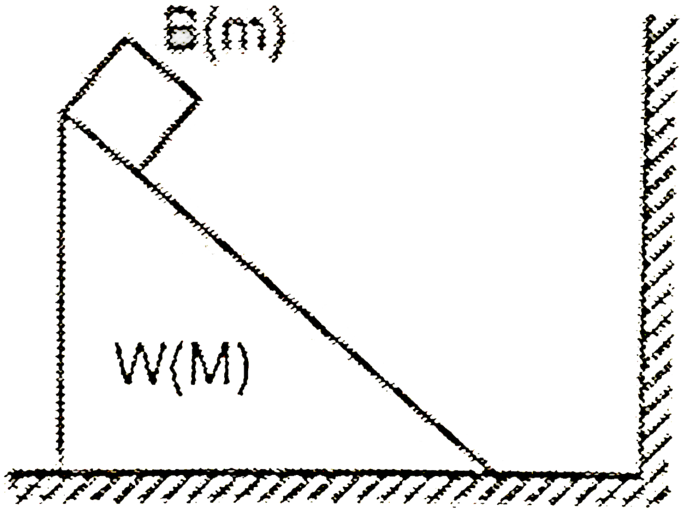
11. 


In the figure, the block B of mass m starts from rest at the top of a wedge W of mass M. All surfaces are without friction. W can slide on the ground. B slides down onto the ground, moves along it with a speed v, has an elastic collision with the wall, and climbs back two W.

A. B will reach the top of W again

B. From the beginning, till the collision with the wall, the center of mass of 'B plus W' is stationary

C. After the collsion, the center of mass of 'B plus W' moves with a velocity $\frac{2mv}{m+m}$

D. When B reaches its highest position on W, the speed of W is $\frac{2mv}{m+M}$

**Answer:**

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**12.** A strip of wood of mass M and length l is placed on a smooth" horizontal surface. An insect of mass m starts at one end of the strip and walks to the other end in time t,moving with a constant speed :

A. the speed of the insect as seen from the ground is $< \frac{l}{t}$

B. the speed of the strip as seen from the ground is $\frac{l}{t}\left(\frac{M}{M+m}\right)$

C. the speed of the strip as seen from the ground is $\frac{l}{t}\left(\frac{m}{M+m}\right)$

D. the total kinetic energy of the system is $\frac{1}{2}(m+M)\left(\frac{l}{t}\right)^2$

**Answer:**

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**13.** A sphere $A$ moving with speed $u$ and rotating With angular velocity $\omega$ makes a head-on elastic collision with an identical stationary sphere $B$. There is no friction between the surfaces of $A$ and $B$. Choose the conrrect alternative(s). Disregard gravity.

A. A will stop moving but continue to rotate with an _ angular speed $\omega$

B. A will come to rest and stop rotating

C. B will move with a speed u without rotating

D. B will move with a speed u and rotate with. an angular velocity $\omega$

**Answer:**

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**14.** In an elastic collision between spheres A and B of equal mass but unequal radii, A moves along the x-axis and B is stationary before impact. Which of the following is possible after impact ?

A. A comes to rest

B. The velocity of B relative to A remains the same in magnitude but reverse in direction

C. A and B move with equal speeds, making an angle of $45^\circ$ each with the x-axis

D. A and B move with unequal speeds, making angle of $30^\circ$ and $60^\circ$ with the x-axis respectively

**Answer:**

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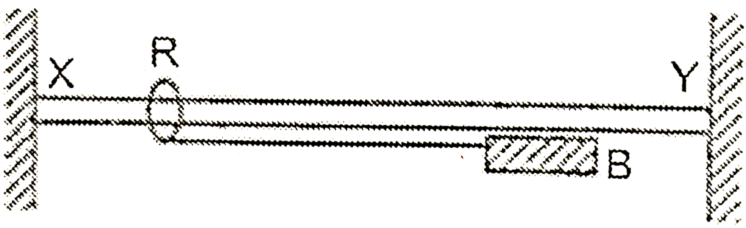


**15.**

The ring R in the arrangement shown can slide along a smooth, fixed, horizontal rod XY. If is attached to the block B by a light sring. The blocks is released from rest, with the string horizontal.

A. One point in the string will have only vertical motion

B. R and B will always have momenta of the same magnitude

C. When the string becomes vertical, the speeds of R and B will be inversely proportional to their masses

D. R will lose contact with the rod at some point

**Answer:**

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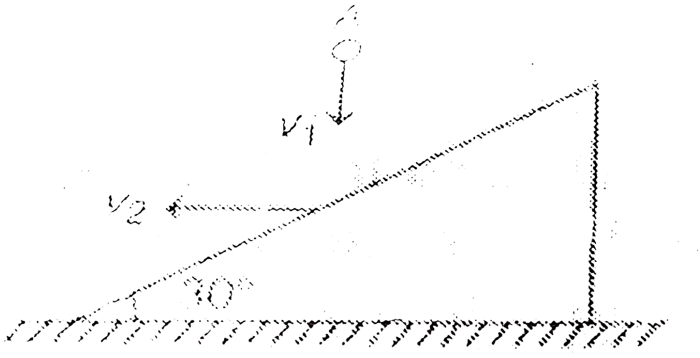
**16.** A ball A is falling vertically downwards with velocity $v_1$ . It strikes elastically with a wedge moving horizontally with velocity $v_2$ as shown in figure . What must be the ratio $\frac{v_1}{v_2}$ , so that the ball bounces back in vertically upward direction relative to the wedge



A. $\sqrt{3}$

B. $\frac{1}{\sqrt{3}}$

C. 2

D. $\frac{1}{2}$

**Answer:**

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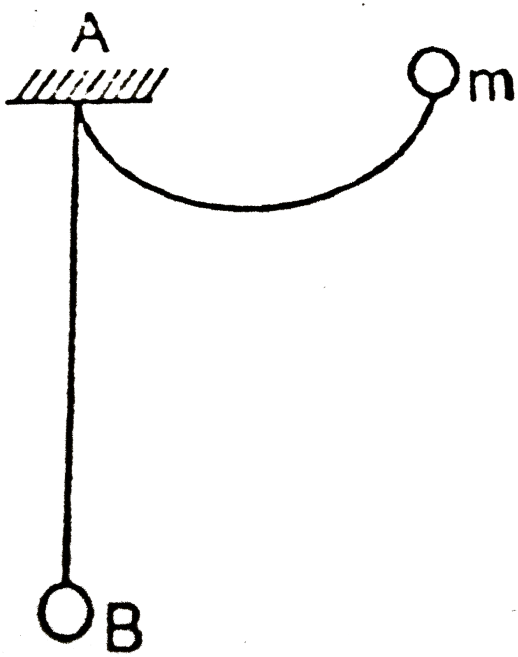
**17.** A ball of mass $m = 200gm$ is suspended from a point $A$ by an inextensible string of length $L$. Ball is drawn to a side and held at same level as $A$ but at a distance $\frac{\sqrt{3}}{2}L$ from $A$ as shown. Now the ball is released. Then :( assume string applies only that much jerk which is required so that velocity along string becomes zero ).




A. velocity of ball just before experiencing jerk is $\sqrt{gl}$

B. velocity of ball just after experiencing jerk is $\sqrt{\frac{3gl}{2}}$

C. impulse.ap,plied by string $\sqrt{\frac{gl}{20}}$

D. ball will experience jerk after reaching to point B

**Answer:**

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**18.** A charged particle X moves directly towards another charged particle Y. For the X plus Y system, the ,total momentum is p and the· total energy is E. ,

A. p and E are conserved if both X and Y are free to move

B. (a) is true only if X and Y have similar charges

C. If Y is fixed, E is conserved but not p

D. If Y is fixed, neither E nor p is conserved

**Answer:**

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**19.** In a one-dimensional collision between two particles, their relative velocity is $\vec{v}_1$ before the collision and $\vec{v}_2$ after the collision

A. $\overrightarrow{v_1} = \overrightarrow{v_2}$ if the collision is elastic

B. $\overrightarrow{v_1} = -\overrightarrow{v_2}$ if the collision is elastic

C. $\left|\overrightarrow{v_1}\right| = \left|\overrightarrow{v_2}\right|$ in all cases

D. $\overrightarrow{v_1} = -k\overrightarrow{v_2}$ in all cases, where $k \geq 1$

**Answer:**

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**20.** In a one dimensional collision between two identical particles A and B, B is stationary and A has momentum p before impact. During impact, B gives impulse J to A.

A. The total momentum of the 'A plus B' system is p before and after the impact, and (p -J) during the impact

B. During the impact, A giyes impulse J to B

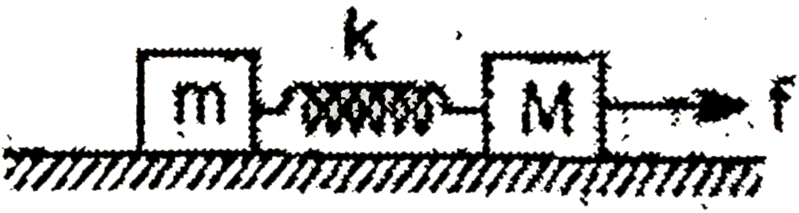
C. The coefficient of restitution is $\frac{2J}{p} - 1$

D. The coefficient of restitution is $\frac{J}{P} + 1$

**Answer:**

Watch Video Solution

**21.** A block of mass m is connected to another .block of mass M by a massless spring of spring constant k. A constant force f starts action as shown in figure, then:




A. as observed from ground both blocks ,will come to momentarily rest simultaneously

B. as observed from their centre of mass blocks will come to momentarily rest simultaneously

C. maximum extension in spring will $\frac{2mf}{k(m+M)}$

D. maximum extension in spring will $\frac{mf}{k(m+M)}$

**Answer:**

Watch Video Solution

## L3P1

**1.** While dealing with collision between particles, you must have deal from and Inertial reference frame Often we choose that frame to be fixed in the Laboratary in which the collision is observed. So it is called the Laboratary reference frame or Lab frame From Lab frame we define an elastic collision as a collision in which KE before and after collision is conserved and a perfectly inelastic collision as a collision in which after collision the two colliding bodies have same velocity vector along the line of action of impulse during collision.

If we discusss the head-on collsion between two particles from center of mass reference frame, then the velocity of center of mass (CM) will be taken to be zero in any type of collision i.e. velocity of CM before and after collision will both be zero. Since before collsion velocity of CM was zero (as our frame is fixed to CM) and no external impulse acts, it will remain zero forever

From CM frame, after a head-on elastic collision:

A. velocity of particles change in direction but not in magnitude

B. velocity of particles gets. interchanged

C. velocity remains unchanged

D. momentum of each particle remains conserved

**Answer:**

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**2.** While dealing with collision between particles, you must have deal from and Inertial reference frame Often we choose that frame to be fixed in the Laboratary in which the collision is observed. So it is called the Laboratary reference frame or Lab frame From Lab frame we define an elastic collision as a collision in which KE before and after collision is conserved and a perfectly inelastic collision as a collision in which after collision the two colliding bodies have same velocity vector along the line of action of impulse during collision.

If we discusss the head-on collsion between two particles from center of mass reference frame, then the velocity of center of mass (CM) will be taken to be zero in any type of collision i.e. velocity of CM before and after collision will both be zero. Since before collsion velocity of CM was zero (as our frame is fixed to CM) and no external impulse acts, it will remain zero forever

From CM frame, after a perfectly inelastic head-on collision:

A. velocity of particles change in direction but not in magnitude

B. velocity of particles gets interchanged

C. velocity remains unchanged

D. momentum of each particle becomes zero

**Answer:**

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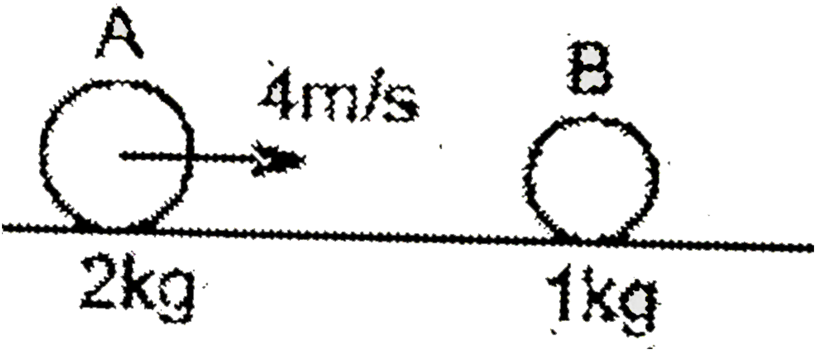
**3.** While dealing with collision between particles, you must have deal from and Inertial reference frame Often we choose that frame to be fixed in the Laboratary in which the collision is observed. So it is called the Laboratary reference frame or Lab frame From Lab frame we define an elastic collision as a collision in which KE before and after collision is conserved and a perfectly inelastic collision as a collision in which after collision the two colliding bodies have same velocity vector along the line of action of impulse during collision.

If we discusss the head-on collsion between two particles from center of mass reference frame, then the velocity of center of mass (CM) will be taken to be zero in any type of collision i.e. velocity of CM before and after collision will both be zero. Since before collsion velocity of CM was zero (as our frame is fixed to CM) and no external impulse acts, it will remain zero forever

Two particles of mass 2 kg and 1kg as shown in the figure make a perfectly inelastic collision. Then if we are dealing with center of mass reference frame, the velocity of B before collision is:




A. zero

B. 8 m/s leftwards

C. 4 m/s rightwards

D. $\frac{8}{3}$ m/s leftwards

**Answer:**

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**4.** While dealing with collision between particles, you must have deal from and Inertial reference frame Often we choose that frame to be fixed in the Laboratary in which the collision is observed. So it is called the Laboratary reference frame or Lab frame From Lab frame we define an elastic collision as a collision in which KE before and after collision is conserved and a perfectly inelastic collision as a collision in which after collision the two colliding bodies have same velocity vector along the line of action of impulse during collision.

If we discusss the head-on collsion between two particles from center of mass reference frame, then the velocity of center of mass (CM) will be taken to be zero in any type of collision i.e. velocity of CM before and after collision will both be zero. Since before collsion velocity of CM was zero (as our frame is fixed to CM) and no external impulse acts, it will remain zero forever

After collision, the velocity of B in CM reference frame will be

A. zero

B. 4 m/s leftwards

C. $\frac{8}{3}$ m/s rightwards

D. $\frac{8}{3}$ m/s leftwards

**Answer:**

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**5.** While dealing with collision between particles, you must have deal from and Inertial reference frame Often we choose that frame to be fixed in the Laboratary in which the collision is observed. So it is called the Laboratary reference frame or Lab frame From Lab frame we define an elastic collision as a collision in which KE before and after collision is conserved and a perfectly inelastic collision as a collision in which after collision the two colliding bodies have same velocity vector along the line of action of impulse during collision.

If we discusss the head-on collsion between two particles from center of mass reference frame, then the velocity of center of mass (CM) will be taken to be zero in any type of collision i.e. velocity of CM before and after collision will both be zero. Since before collsion velocity of CM was zero (as our frame is fixed to CM) and no external impulse acts, it will remain zero forever

If collision were elastic in above question then velocity of B after collision in CM reference frame will be:

A. zero

B. $\frac{8}{3}$ m/s leftwards

C. $\frac{8}{3}$ m/s rightwards

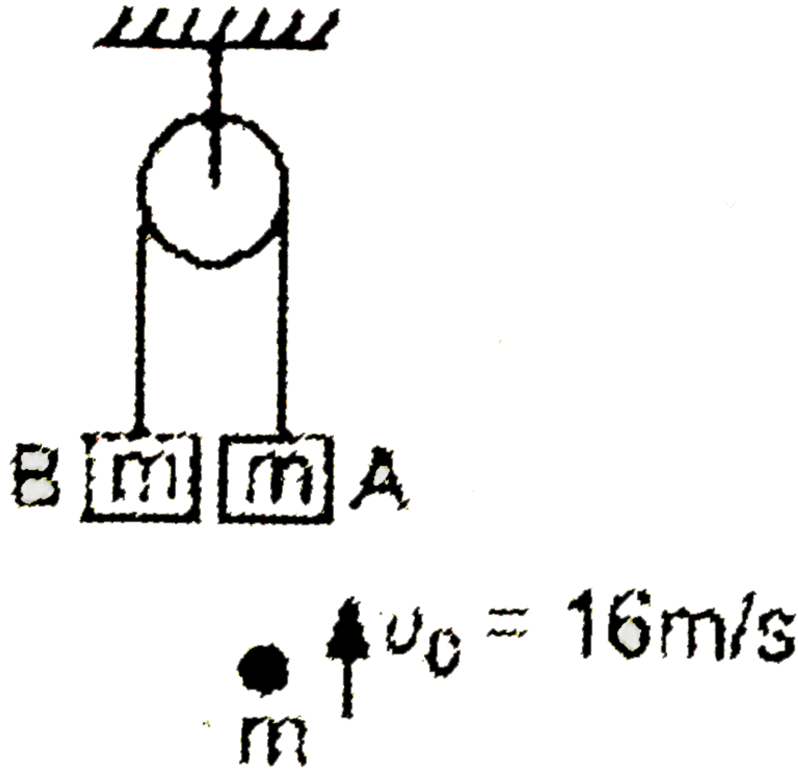
D. 8 m/s leftwards

**Answer:**

Watch Video Solution

## P 2

**1.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




The velocity of blocks just after collision in m/sec is:

A. $v_A = 16, v_B = 0$

B. $v_A = 8, v_B = 0$

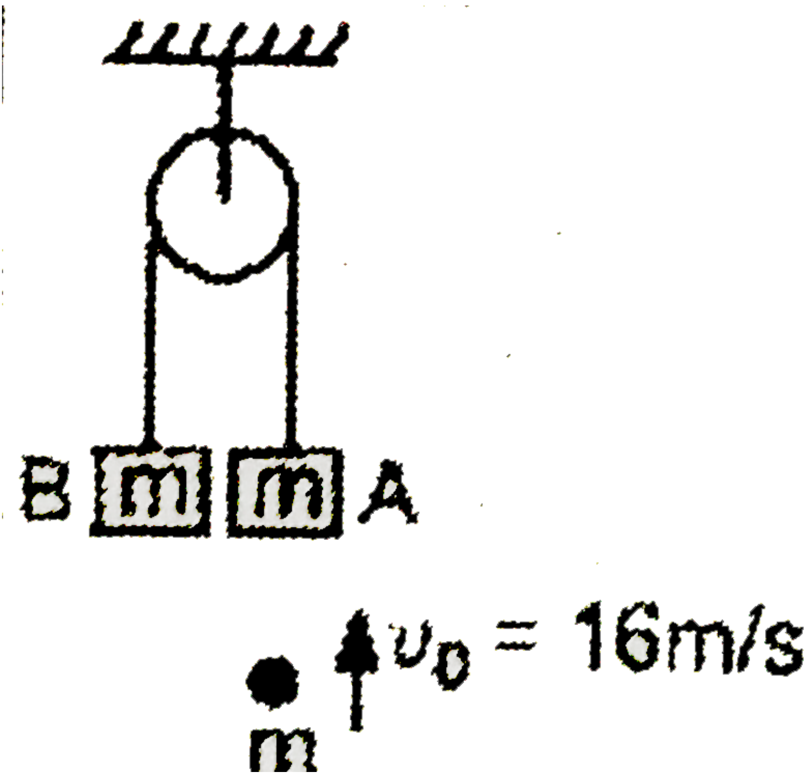
C. $v_A = 16, v_B = 16$

D. $v_A = 0, v_B = 16$

**Answer:**

Watch Video Solution

**2.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




The acceleration of both the blocks just after collision in $m/\sec^2$ is:

A. $a_A = \frac{2g}{3}, a_B = \frac{g}{3}$

B. $a_A = a_B = \frac{g}{3}$

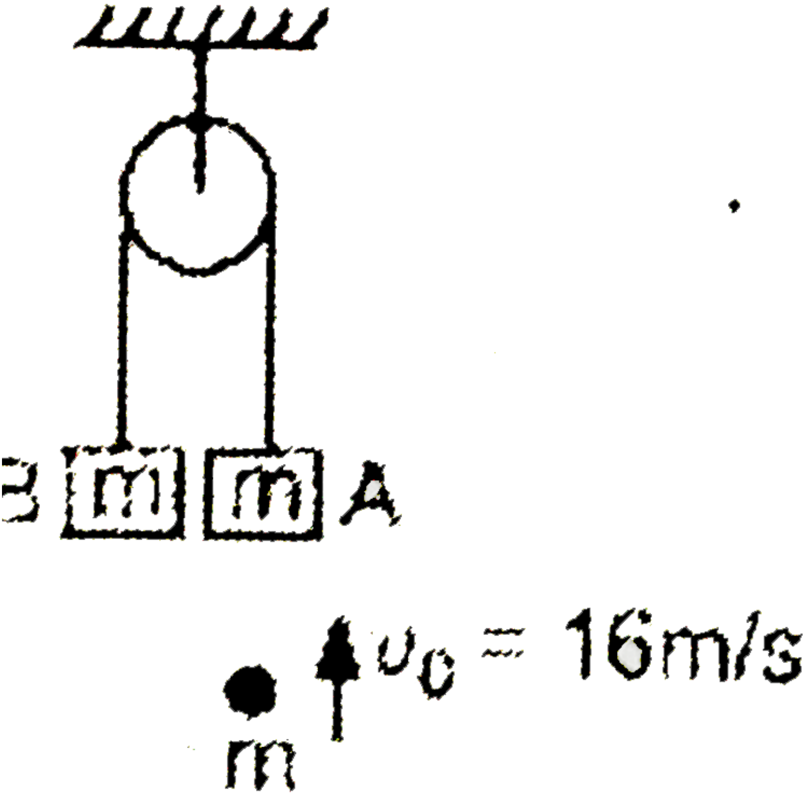
C. $a_A = \frac{g}{3}, a_B = \frac{2g}{3}$

D. $a_A = a_B = g$

**Answer:**

Watch Video Solution

**3.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




The time after which string become tight is at t = ......... seconds:

A. $\frac{3}{5}$

B. 1

C. $\frac{4}{5}$

D. $\frac{3}{4}$

**Answer:**

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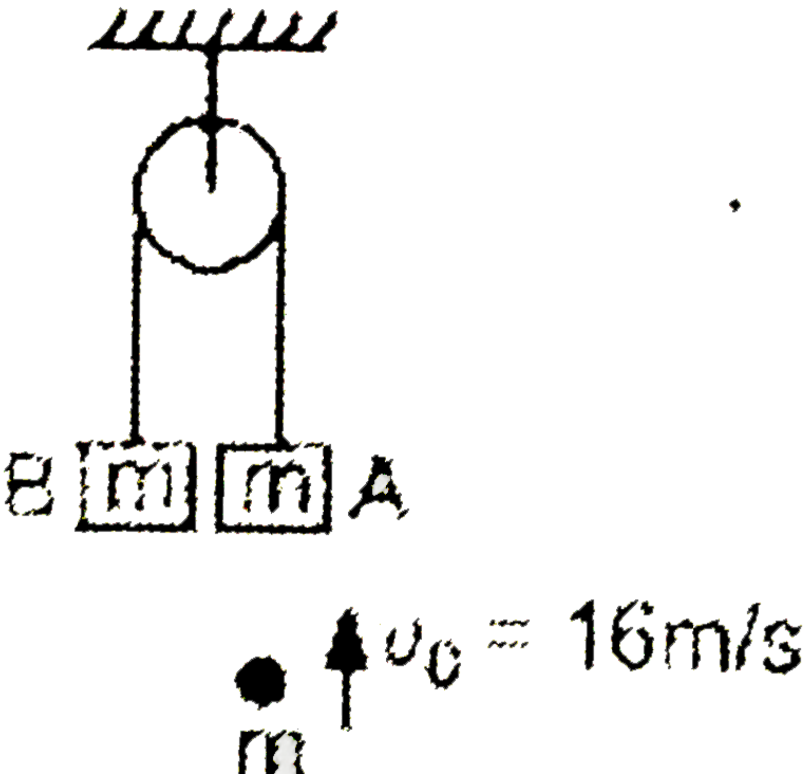
**4.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




Velocity of block A just before string becomes tight will:

A. always be zero

B. may be greater than zero depending on v 0 (initial velocity of ball)

C. may be greater than zero depending on mass of ball

D. may be greater than zero depending on masses of blocks

**Answer:**

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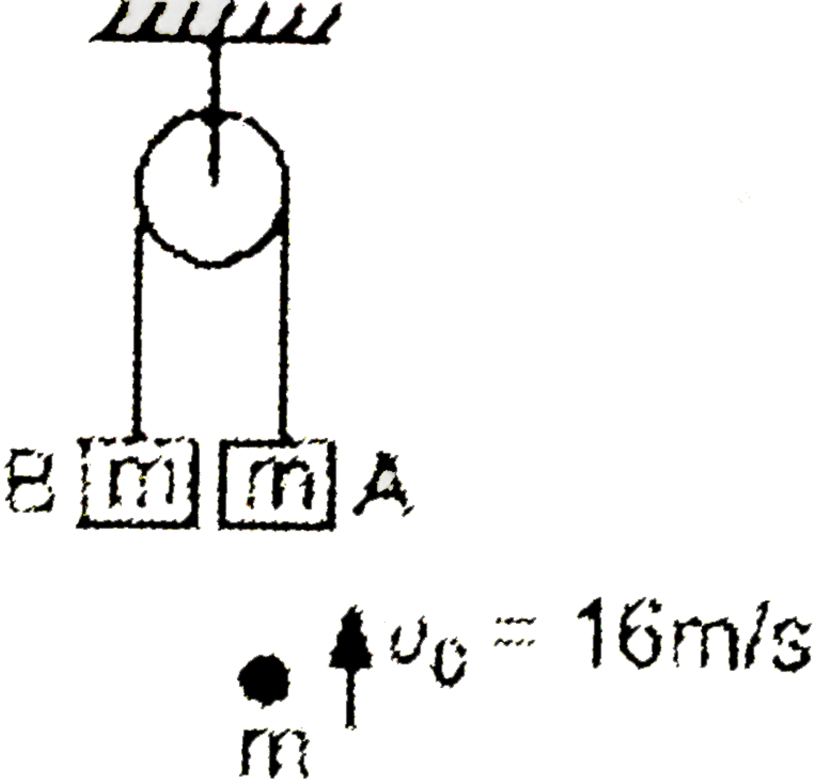
**5.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




The maximum height up to which blockA reaches is:

A. $\frac{16}{5}$m

B. $\frac{64}{15}$m

C. $\frac{5}{16}$m

D. $\frac{16}{15}$m

**Answer:**

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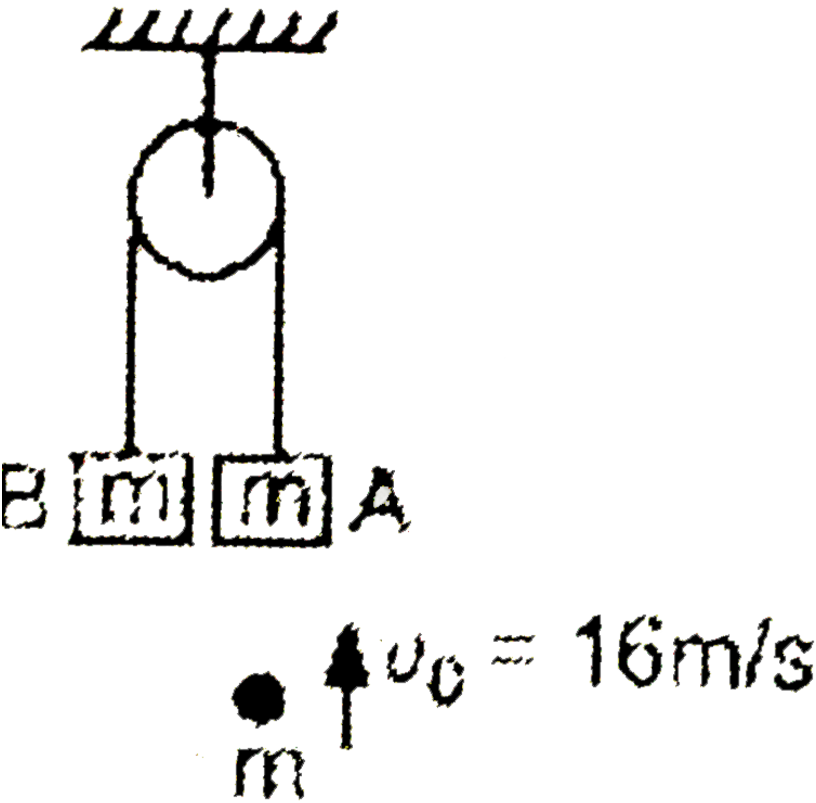
**6.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




The velocity of both the blocks just after string become tight in m/sec.

A. $v_A = v_B = 8$

B. $v_A = v_B = \frac{8}{3}$

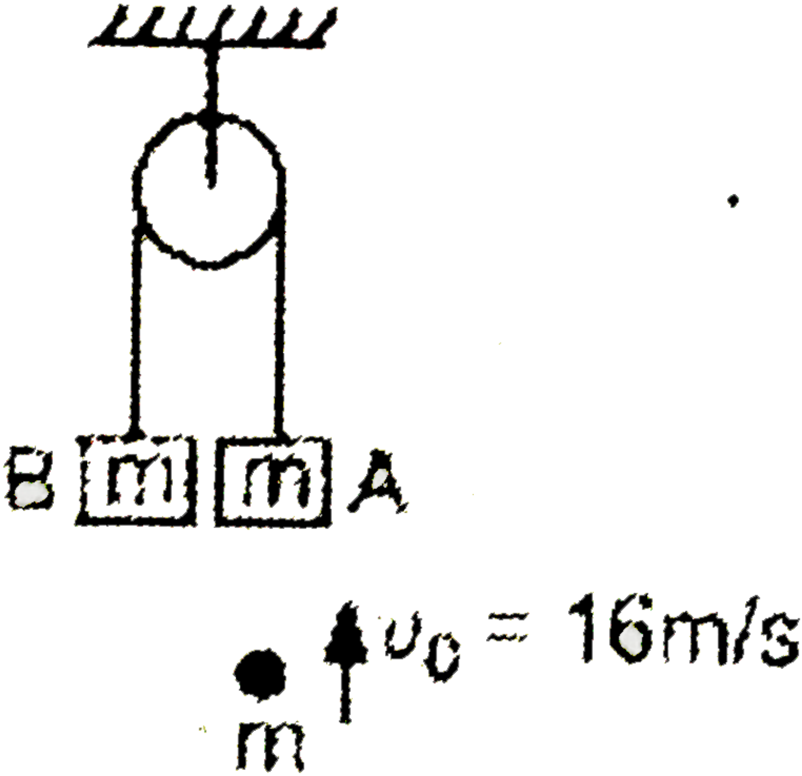
C. $v_A = 4, v_B = 6$

D. $v_A = 6, v_B = 4$

**Answer:**

Watch Video Solution

**7.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




Acceleration of the two blocks just after string become tight in $m/\sec^2$:

A. $v_A = v_B = \frac{g}{3}$

B. $v_A = v_B = g$

C. $v_A = \frac{2g}{3}, v_B = \frac{g}{3}$

D. $v_A = \frac{g}{3}, v_B = \frac{2g}{3}$

**Answer:**

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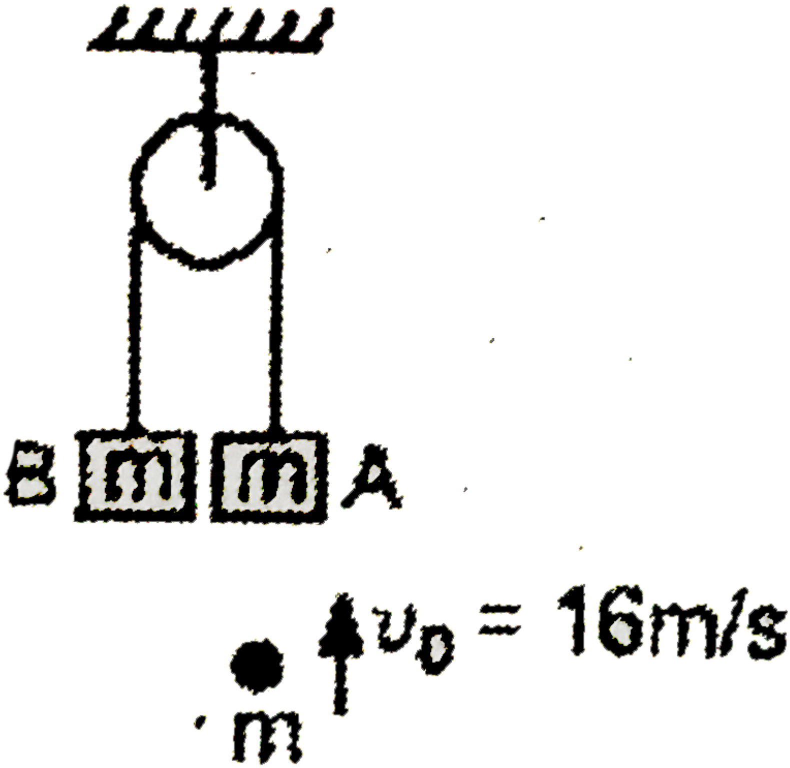
**8.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.




Energy loss due to the impulse applied by string in joule is :

A. $\frac{64}{9}$

B. $\frac{64}{6}$

C. $\frac{64}{3}$

D. zero

**Answer:**

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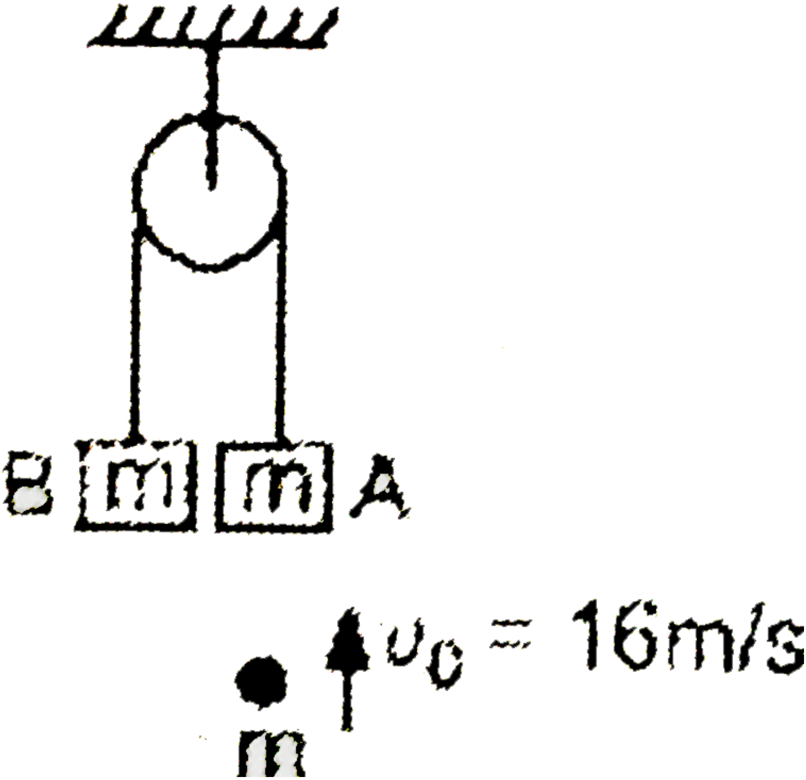
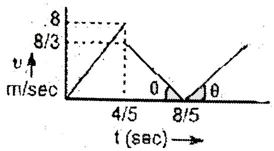
**9.** Two blocks each of, mass m=1 kg are connected with each other by a flexible light and frictionless pulley. At t = 0 an inelastic ball of, mass 'm'=1 collides from bottom with the block A with velocity $v_0$=16 m/sec vertically upwards, On the basis of above information. Answer the following questions.

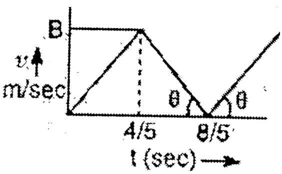


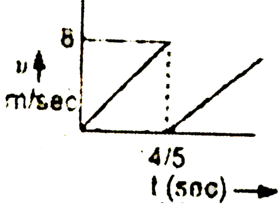

The graphical representation of modulus of velocity of block B is correctly shown in:

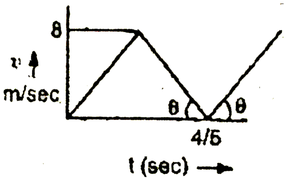
A.




B.



C. 


D. 


**Answer:**

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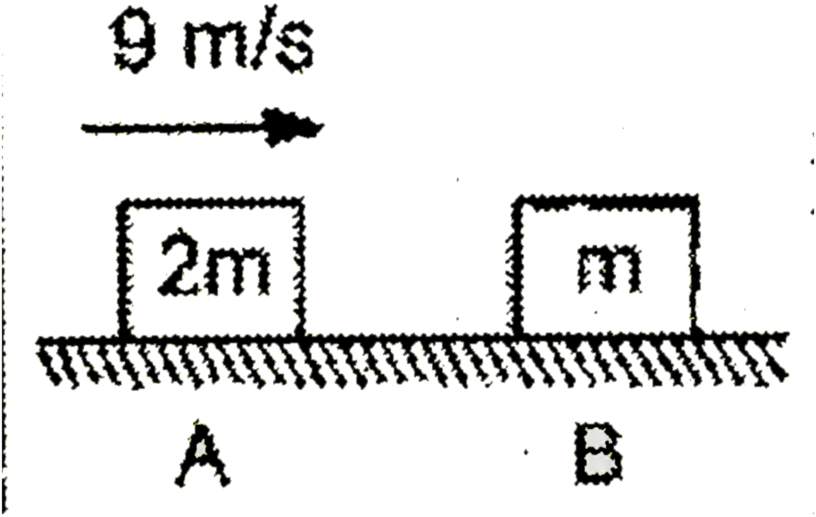
## P 3

**1.** A block of mass 2 m collides,elastically with a masss m kept at rest. Friction exists between the block B ,and surface with coefficient$\mu = 0.3$, whereas no.friction exists between block A and the surface.




The velocity of the blocks just after the first collision will be:

A. 12 m/s, 3m/s

B. 0, 9 m/s

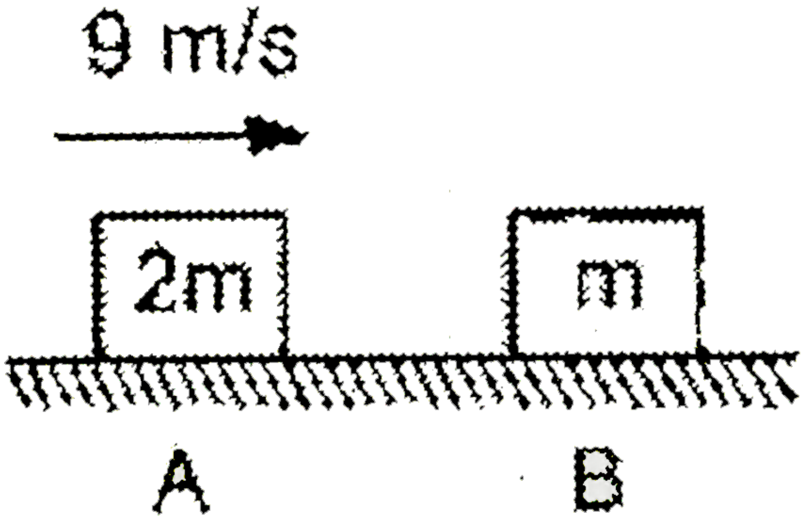
C. 3 m/s, 12 m/s

D. 0, 18 m/s

**Answer:**

Watch Video Solution

**2.** A block of mass 2 m collides,elastically with a masss m kept at rest. Friction exists between the block B ,and surface with coefficient$\mu = 0.3$, whereas no.friction exists between block A and the surface.




The blocks will again collide after time:

A. 6 sec

B. 4 sec

C. 8 sec

D. $\infty$

**Answer:**

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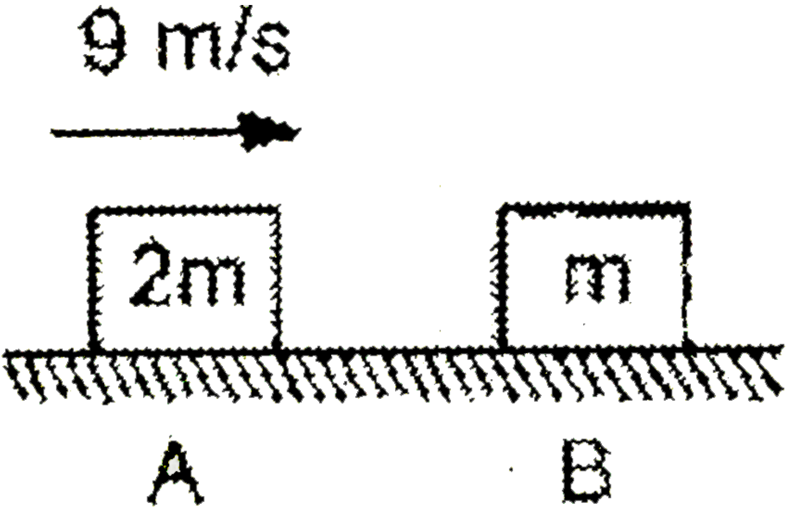
3. A block of mass 2 m collides,elastically with a masss m kept at rest. Friction exists between the block B ,and surface with coefficient$\mu = 0.3$, whereas no.friction exists between block A and the surface.




How many collision are possible between the blocks?

A. 2

B. 4

C. 27

D. Inifinite

**Answer:**

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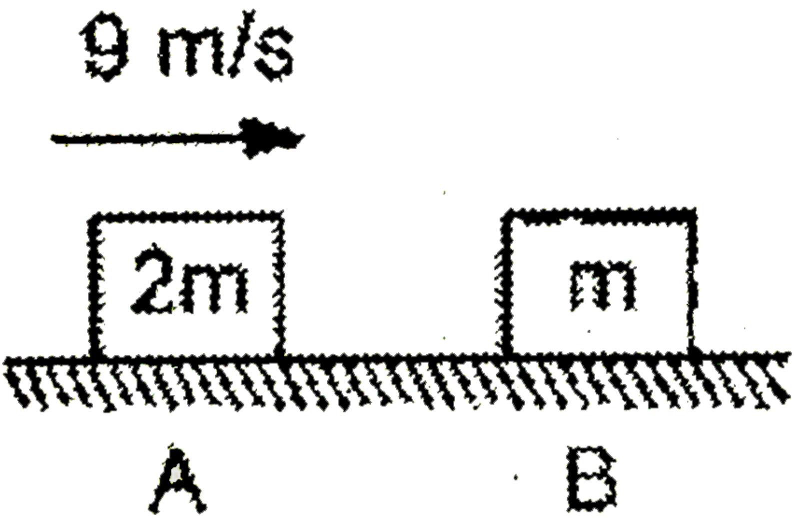
**4.** A block of mass 2 m collides,elastically with a masss m kept at rest. Friction exists between the block B ,and surface with coefficient$\mu = 0.3$, whereas no.friction exists between block A and the surface.




After how much time collision between the blocks will not take place practically:

A. 8 sec

B. 16 sec

C. 12 sec

D. Inifinite

**Answer:**

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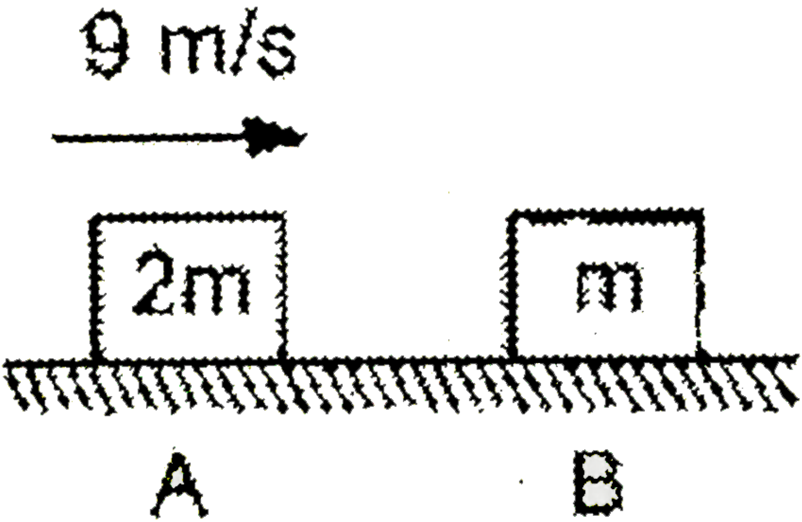
**5.** A block of mass 2 m collides,elastically with a masss m kept at rest. Friction exists between the block B ,and surface with coefficient$\mu = 0.3$, whereas no.friction exists between block A and the surface.



Maximum distance between the blocks during the time interval between first and second collision is:

A. 12m

B. 13.5m

C. 20m

D. 9m

**Answer:**

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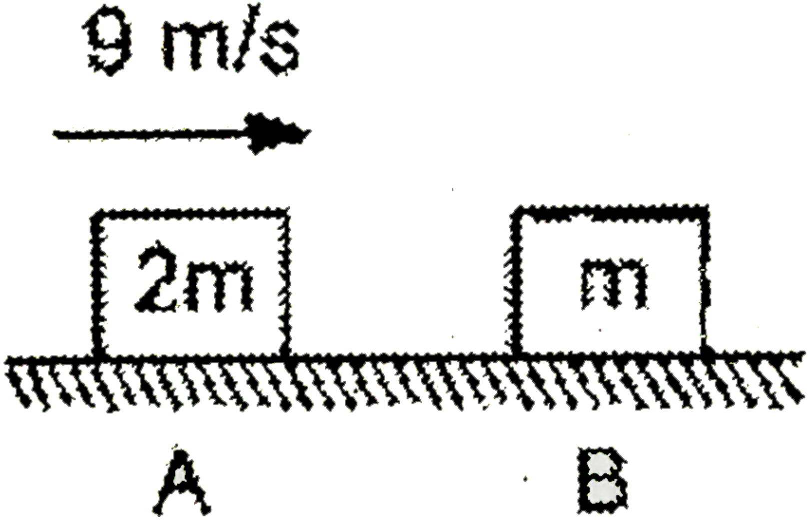
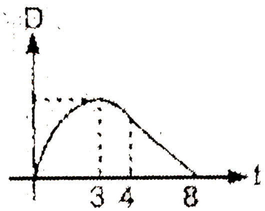
**6.** A block of mass 2 m collides,elastically with a masss m kept at rest. Friction exists between the block B ,and surface with coefficient$\mu = 0.3$, whereas no.friction exists between block A and the surface.

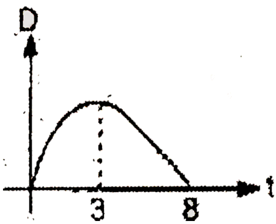



Which of the following graphs best represent the distance between the blocks between first and second collision?

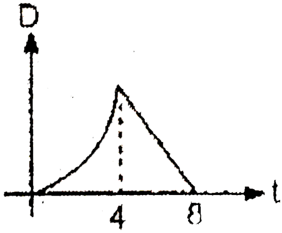
A.

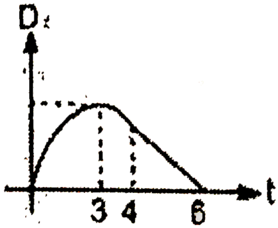



B.




C.



D. 


**Answer:**

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P 4

**1.** Comprehension # 5

One particle of mass $1kg$ is moving along positive x-axis with velocity $3m/s$. Another particle of mass $2kg$ is moving along y-axis with $6m/s$. At time $t = 0$, $1kg$ mass is at $(3m, 0)$ and $2kg$ at $(0, 9m)$, $x - y$ plane is the horizontal plane. (Surface is smooth for question 1 and rough for question 2 and 3)

The centre of mass of the two particles is moving in a straight line for which equation is :

A. y = x+ 2

B. y = 4x+ 2

C. y = 2x-4

D. y = 2x+4

**Answer:**

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**2.** Comprehension # 5

One particle of mass $1kg$ is moving along positive x-axis with velocity $3m/s$. Another particle of mass $2kg$ is moving along y-axis with $6m/s$. At time $t=0$, $1kg$ mass is at $(3m, 0)$ and $2kg$ at $(0, 9m)$, $x-y$ plane is the horizontal plane. (Surface is smooth for question 1 and rough for question 2 and 3)

If both the particles have the same value of coefficient of friction $\mu=0.2$. The centre of mass will stop at time $t=$ ..........s :-

A. 1.5

B. 4.5

C. $3.0$

D. $2.0$

**Answer:**

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**3.** Comprehension # 5

One particle of mass $1kg$ is moving along positive x-axis with velocity $3m/s$. Another particle of mass $2kg$ is moving along y-axis with $6m/s$. At time $t=0$, $1kg$ mass is at $(3m, 0)$ and $2kg$ at $(0, 9m)$, $x-y$ plane is the horizontal plane. (Surface is smooth for question 1 and rough for question 2 and 3)

Co-ordinates of centre of mass where it will stop finally are :-

A. (20m, 14.25m)

B. (2.25m, 10m)

C. (3.25m, 9m)

D. (1.75m, 12m)

**Answer:**

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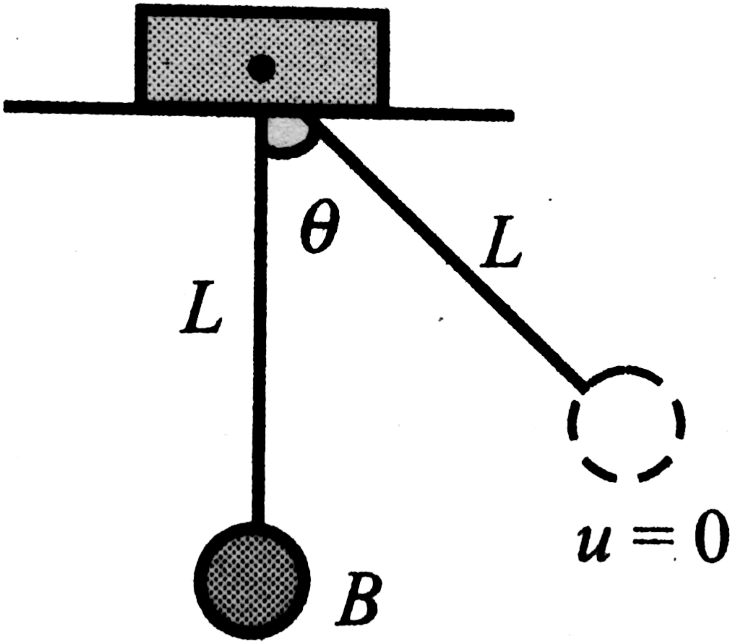
P 6

**1.** A small ball $B$ of mass $m$ is suspended with light inelastic string of length $L$ from a block $A$ of same mass in which can move on smooth horizontal surface as shown in the figure. The ball is displaced by angle $\theta$ from equilibrium position and then released.




The displacement of block when equilibrium position is

A. $\frac{L\sin\theta}{2}$

B. $L\sin\theta$

C. L

D. None of these

**Answer:**

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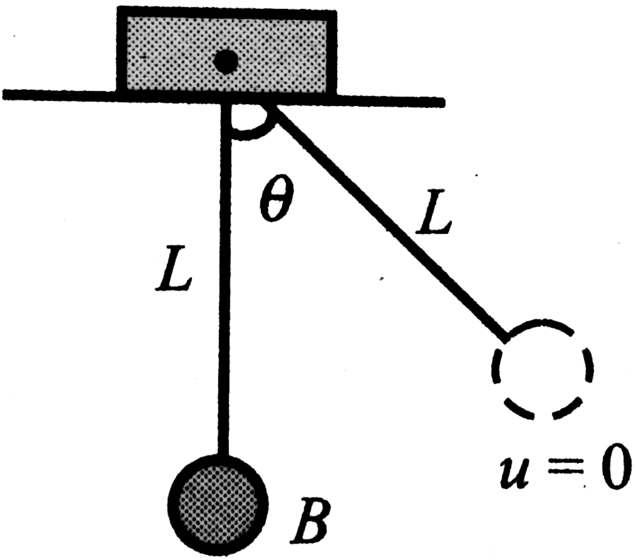
**2.** A small ball $B$ of mass $m$ is suspended with light inelastic string of length $L$ from a block $A$ of same mass in which can move on smooth horizontal surface as shown in the figure. The ball is displaced by angle $\theta$ from equilibrium position and then released.




Tension in string when it is vertical, is

A. mg

B. mg(2-cos $\theta$)

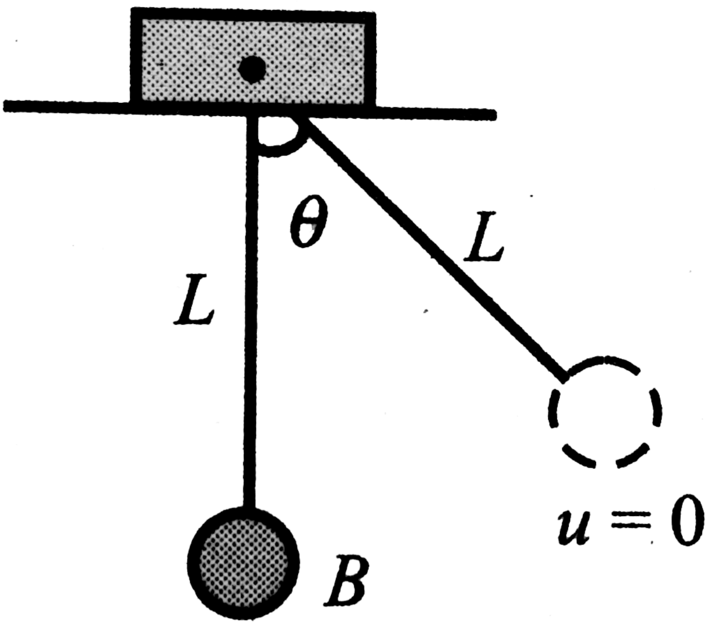
C. mg(3-2cos $\theta$)

D. None of these

**Answer:**

Watch Video Solution

**3.** A small ball $B$ of mass $m$ is suspended with light inelastic string of length $L$ from a block $A$ of same mass in which can move on smooth horizontal surface as shown in the figure. The ball is displaced by angle $\theta$ from equilibrium position and then released.




Maximum velocity of block during subsequent motion of the system after release of ball is

A. $[gl(1-\cos\theta)]^{1/2}$

B. $[2gl(1-\cos\theta)]^{1/2}$

C. $[gl\cos\theta]^{1/2}$

D. informations are insufficient to decide

**Answer:**

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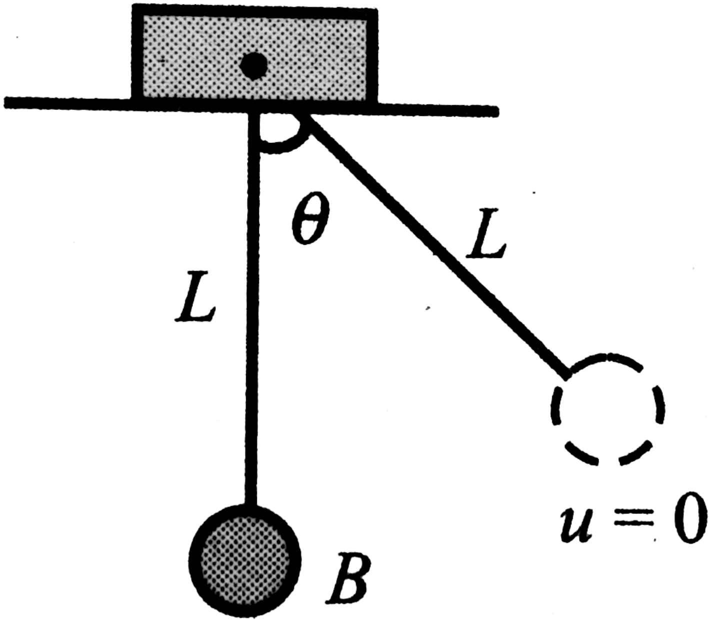
**4.** A small ball $B$ of mass $m$ is suspended with light inelastic string of length $L$ from a block $A$ of same mass in which can move on smooth horizontal surface as shown in the figure. The ball is displaced by angle $\theta$ from equilibrium position and then released.




The displacement of centre of mass of $A + B$ system till the string becomes vertical is

A. zero

B. $\frac{L}{2}(1 - \cos\theta)$

C. $\frac{L}{2}(1 - \sin\theta)$

D. None of these

**Answer:**

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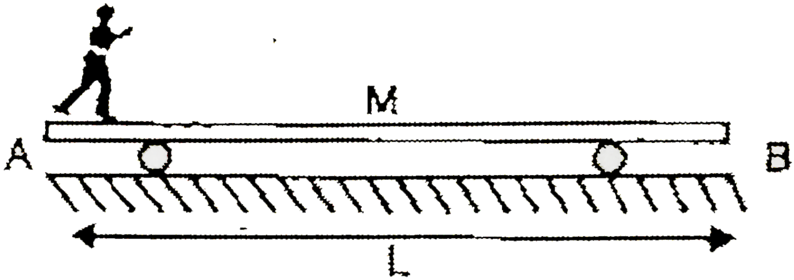
P 8

**1.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




When the man starts moving, then the velocity of the trolley $v_2$ with respect to ground will be:

A. $\frac{Mu_{rel}}{m+M}$

B. $m\frac{u_{rel}}{m+M}$

C. $\frac{m}{M}u_{rel}$

D. $\frac{M}{m}u_{rel}$

**Answer:**

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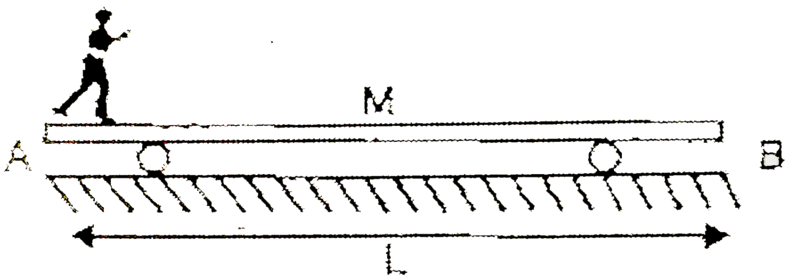
**2.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




The velocity of the man with respect to ground $v_1$ will be:

A. $\dfrac{Mu_{rel}}{m+M}$

B. $\dfrac{\mu_{rel}}{m+M}$

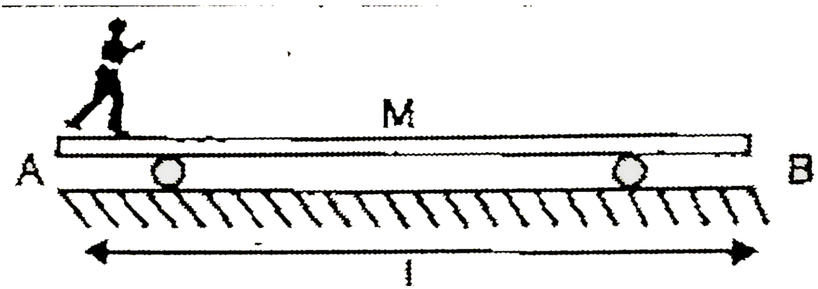
C. $\dfrac{m}{M}u_{rel}$

D. $\dfrac{M}{m}u_{rel}$

**Answer:**

Watch Video Solution

**3.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




The time taken by the man to reach the other end is:

A. $\left(\frac{m+M}{M}\right)\frac{L}{u_{\text{rel}}}$

B. $\left(\frac{m+M}{m}\right)\frac{L}{u_{\text{rel}}}$

C. $\frac{L}{u_{\text{rel}}}$

D. none of these

**Answer:**

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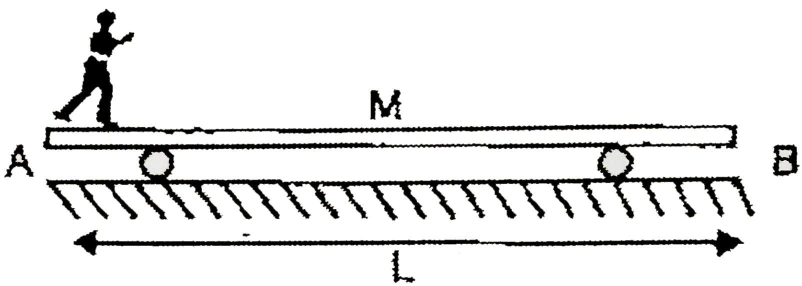
**4.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




As the man walks on the trolley, the centre of mass of the system (man+ trolley) :

A. accelerates towards left

B. accelerates towards right

C. moves with $u_{\text{rel}}$

D. remains stationary

**Answer:**

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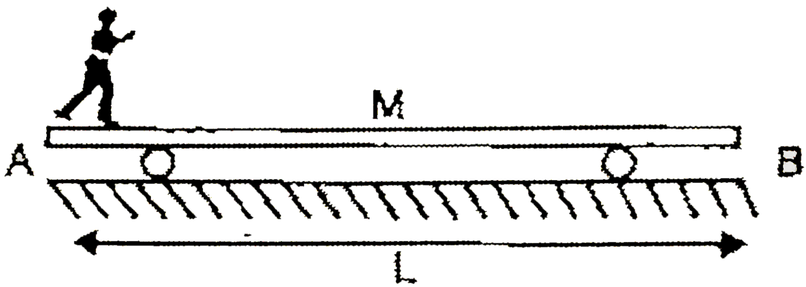
**5.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




When the man reaches the end B, the distance moves . by the trolley with respect to ground is:

A. $\dfrac{mL}{m+M}$

B. $\dfrac{ML}{m+M}$

C. $\frac{m}{M}L$

D. $\frac{M}{m}L$

**Answer:**

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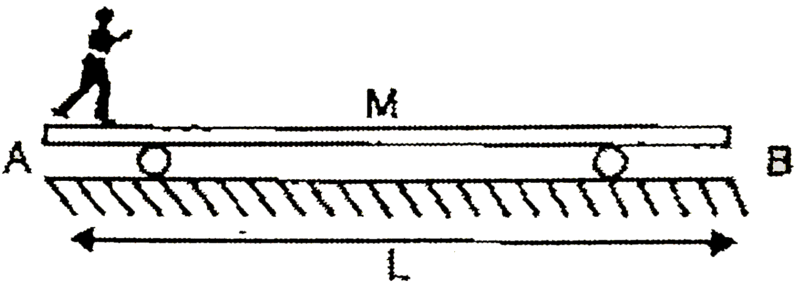
**6.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




Choose the correct statement:

A. $\frac{mL}{m+M}$

B. $\frac{ML}{m+M}$

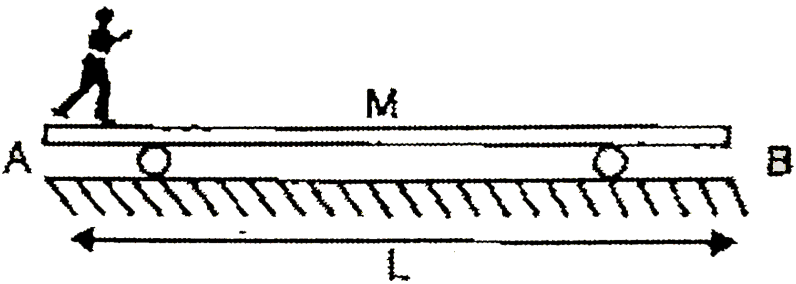
C. $\frac{m}{M}L$

D. $\frac{M}{m}L$

**Answer:**

Watch Video Solution

**7.** The figure shows a man of mass m standing at the end A of a trolley of maas M placed at rest on a smooth horizontal surface. The man starts moving towards the end B with a velocity $u_{rel}$ with respect to the trolley. The length of the trolley is L.




Choose the correct statement:

A. As the man starts moving the trolley must move backward

B. The distance moved by the trolley is independent of the speed of the man

C. The distance moved by the trolley can never exceed L

D. All of the above

**Answer:**

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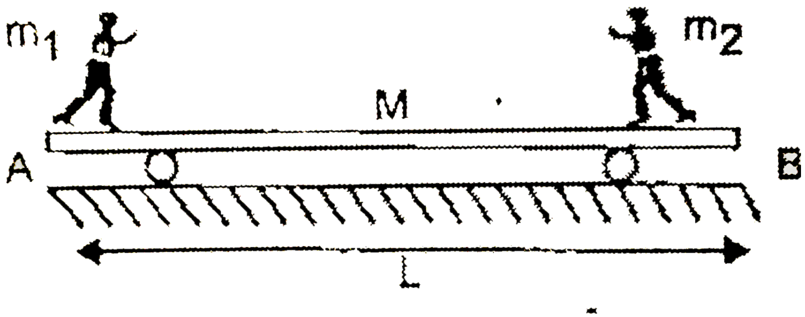
P 9

**1.** Two persons of mass $m_1$ and $m_2$ are standing at the two ends A and B respectively, of a trolley of mass M as shown.



When the person standing at A jumps from the. trolley towards left with $u_{\text{rel}}$ with respect to the trolley, then

A. the trolley moves towards right

B. the trolley rebounds with velocity $\frac{m_1 u_{\text{rel}}}{m_1 + m_2 + M}$

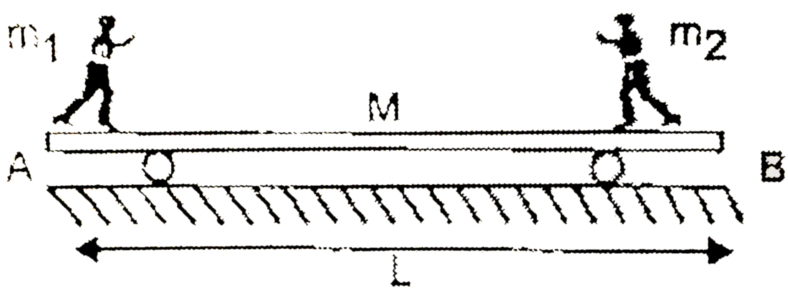
C. the centre of mass of the system remains stationary

D. all of the above

**Answer:**

Watch Video Solution

**2.** Two persons of mass $m_1$ and $m_2$ are standing at the two ends A and B respectively, of a trolley of mass M as shown.



When only the person standing at B jumps· from the trolley towards right while the person at A keeps standing, then:

A. the trolley moves towards left

B. the trolley moves with velocity $\frac{m_2 u_{\text{rel}}}{m_1 + m_2 + M}$

C. the centre. of mass of the system remains stationary

D. all of the above

**Answer:**

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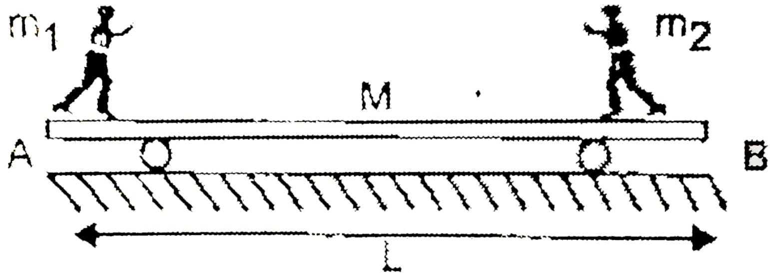
**3.** Two persons of mass $m_1$ and $m_2$ are standing at the two ends A and B respectively, of a trolley of mass M as shown.




When both the persons jump simultaneously with same speed then:

A. the centre of mass of the system remains stationary

B. the trolley remains stationary

C. the trolley moves toward the end where the person with heavier mass is standing

D. none of these

**Answer:**

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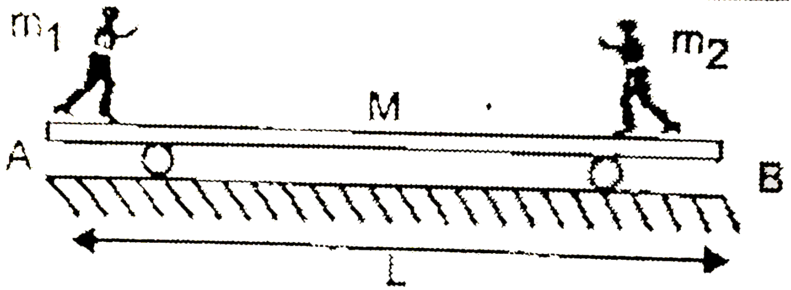
**4.** Two persons of mass $m_1$ and $m_2$ are standing at the two ends A and B respectively, of a trolley of mass M as shown.




When both the persons jump simultaneously with $u_{\text{rel}}$ with respect to the trolley, then the velocity of the trolley is

A. $\frac{|m_1 - m_2| u_{\text{rel}}}{m_1 + m_2 + M}$

B. $\frac{|m_1 - m_2| u_{\text{rel}}}{M}$

C. $\left(\left|\frac{m_1 u_{\text{rel}}}{M + m} - \frac{m_2 u_{\text{rel}}}{m_1 + M}\right|\right.$

D. none of these

**Answer:**

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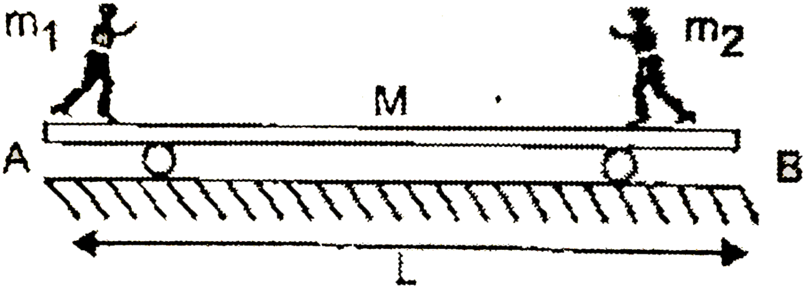
**5.** Two persons of mass $m_1$ and $m_2$ are standing at the two ends A and B respectively, of a trolley of mass M as shown.




Choose the incorrect statement, if $m_1 = m_2 = m$ and both the persons jump one by one, then:

A. the centre of mass of the system remains stationary

B. the final velocity of the trolley is in the direction of the person who jumps first

C. the final velocity of the trolley is $\left(\frac{\mu_{\text{rel}}}{M+m} - \frac{\mu_{\text{rel}}}{M+2m}\right)$

D. none of these

**Answer:**

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P 10

**1.** A projectile of mass $3kg$ is projected with velocity $50m/s$ at $37^{\circ}$ from horizontal. After $2s$, explosion takes place and the projectile breaks into two parts of masses $1kg$ and $2kg$. The first part comes to rest just after explosion.

Find,

(a) the velocity of second part just after explosion.

(b) maximum height attained by this part. Take $g = 10m/s^{2}$

A. $1:4$

B. $1:3$

C. $2:3$

D. $4:9$

**Answer:**

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**2.** A projectile of mass "m" is projected from ground1 with a speed of 50 m/s at an angle of $53^\circ$ 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

**Answer:**

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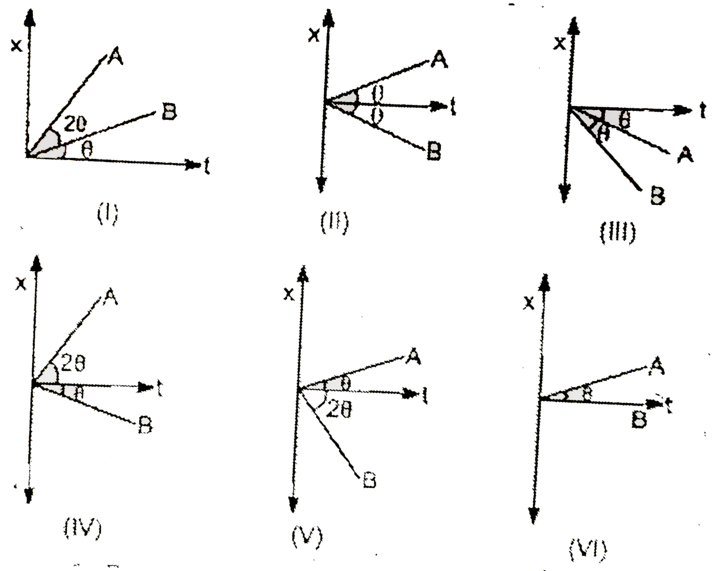
**1.** An initially stationary box on a frictionless floor explodes into two pieces, piece A with mass $m_A$ and piece B with mass $m_B$. Two pieces then move across the floor along x-axis. Graph of position versus time for the two pieces are given



Which graphs pertain to physically possible explosios?

A. II,IV and V

B. I,III,VI

C. I,III,V

D. II,III,VI

**Answer:**

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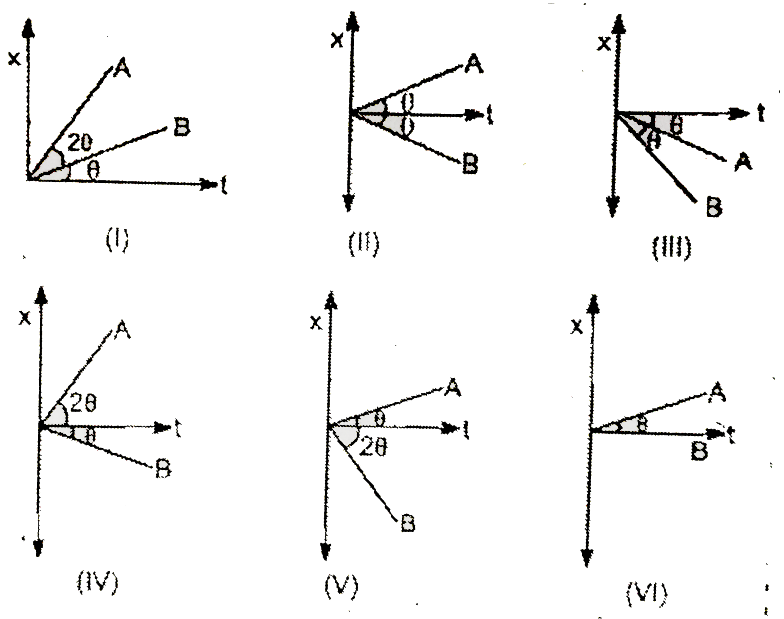
**2.** An initially stationary box on a frictionless floor explodes into two pieces, piece A with mass $m_A$ and piece B with mass $m_B$. Two pieces then move across the floor along x-axis. Graph of position versus time for the two pieces are given



Based on the above question. Match column A with the column B.

| Column-A | | Column-B (Graph number) |
|---|---|---|
| (A) $m_A = m_B$ | (P) | I |
| (B) $m_A > m_B$ | (Q) | II |
| (C) $m_A < m_B$ | (R) | III |
| | (S) | IV |
| | (T) | V |
| | (U) | VI |

A. A-U,B-R,C-P

B. A-Q,B-T,C-S

C. A-Q,B-S,C-T

D. A-U,B-T,C-S

**Answer:**

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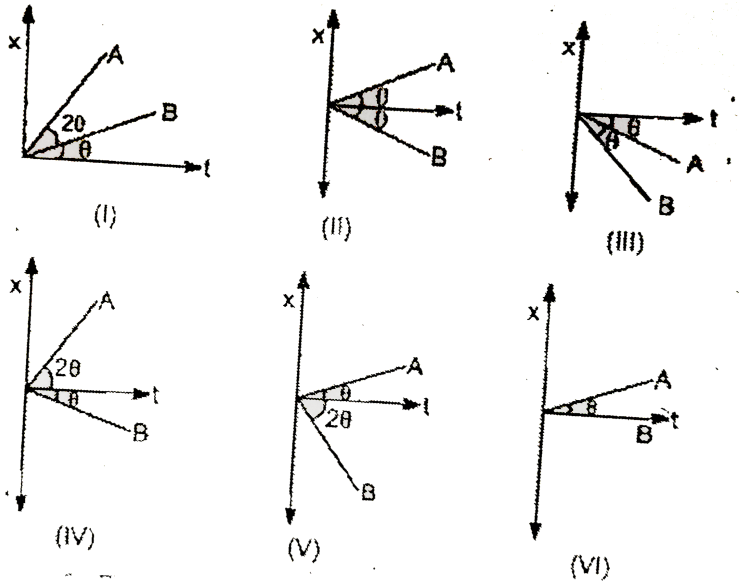
**3.** An initially stationary box on a frictionless floor explodes into two pieces, piece A with mass $m_A$ and piece B with mass $m_B$. Two pieces then move across the floor along x-axis. Graph of position versus time for the two pieces are given




If following graphs are possible then, in which of the following cases external impulse must be acting on the box?

A. II

B. IV

C. V

D. VI

**Answer:**

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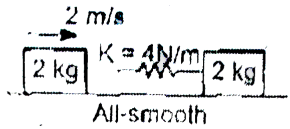
## Matching

**1.** In the arrangement shown in figure match the following:




| Column-1 | | Column-2 | |
|---|---|---|---|
| (A) | Velocity of centre of mass | (P) | 2 SI unit |
| (B) | Velocity of combined mass when compression in the spring is maximum | (Q) | 1 SI unit |
| (C) | Maximum compression in the spring | (R) | 4 SI unit |
| (D) | Maximum potential energy stored in the spring | (S) | 0.5 SI unit |

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**2.** A particle of mass $m$, kinetic energy $K$ and momentum $p$ collides head on elastically with another particle of mass $2m$ at rest. After collision, :

| | Column I | | Column II |
|---|---|---|---|
| $(A)$ | Momentum of first particle | $(p)$ | $3/4p$ |
| $(B)$ | Momentum of second particle | $(q)$ | $-K/9$ |
| $(C)$ | Kinetic energy of first particle | $(r)$ | $-p/3$ |
| $(D)$ | Kinetic energy of second particle | $(s)$ | $\frac{8K}{9}$ |
| | | $(t)$ | None |

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**3.** Match the following: (P = momentum of particle, K = kinetic energy of particle)

| | Column-1 | | Column-2 |
|---|---|---|---|
| (A) | $P$ is increased by 200%, corresponding change in $K$ | (P) | 800% |
| (B) | $K$ is increased by 300%, corresponding change in $P$ | (Q) | 200% |
| (C) | $P$ is increased by 1%, corresponding change in $K$ | (R) | 0.5% |
| (D) | $K$ is increased by 1%, corresponding change in $P$ | (S) | 2% |
| | | (T) | None |

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