PHYSICS

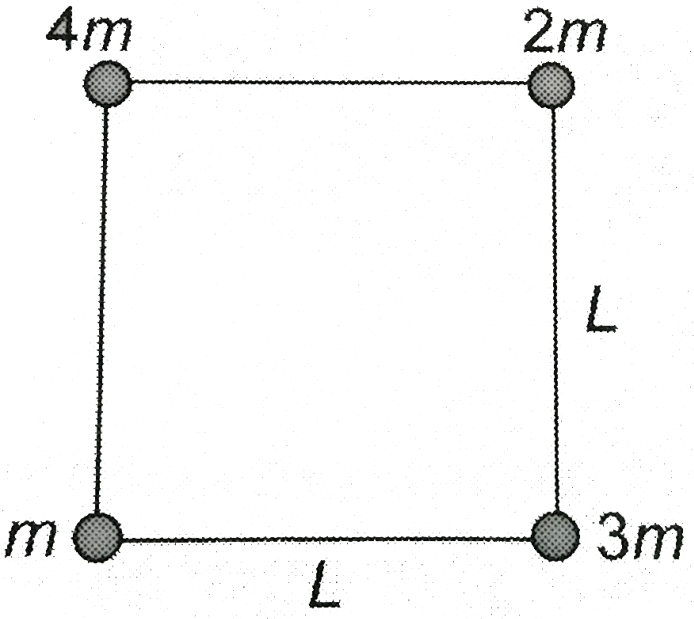
BOOKS - CP SINGH PHYSICS (HINGLISH)

CENTER OF MASS

Example

1. The four particles of masses m, $3m$, $2m$ and $4m$ are placed on the vertices of a sqare of

side L. Locate the center of mass



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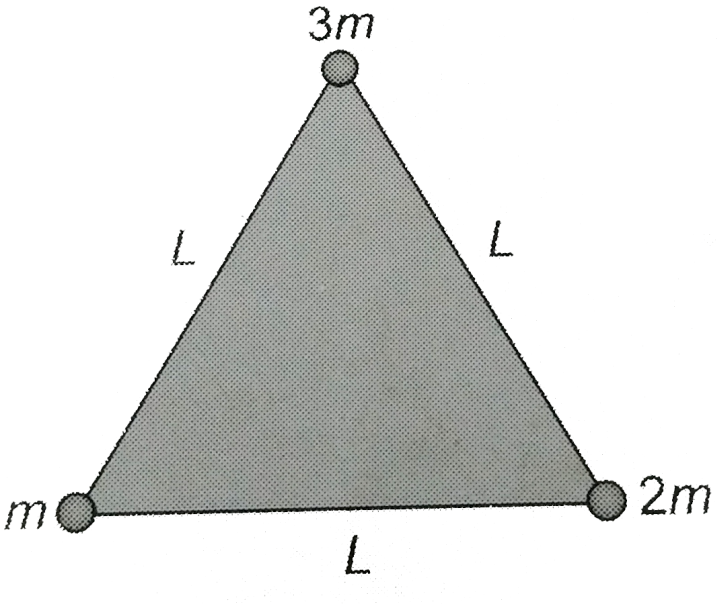
2. Consider the situation as shown in the figure. Locate the center of mass.



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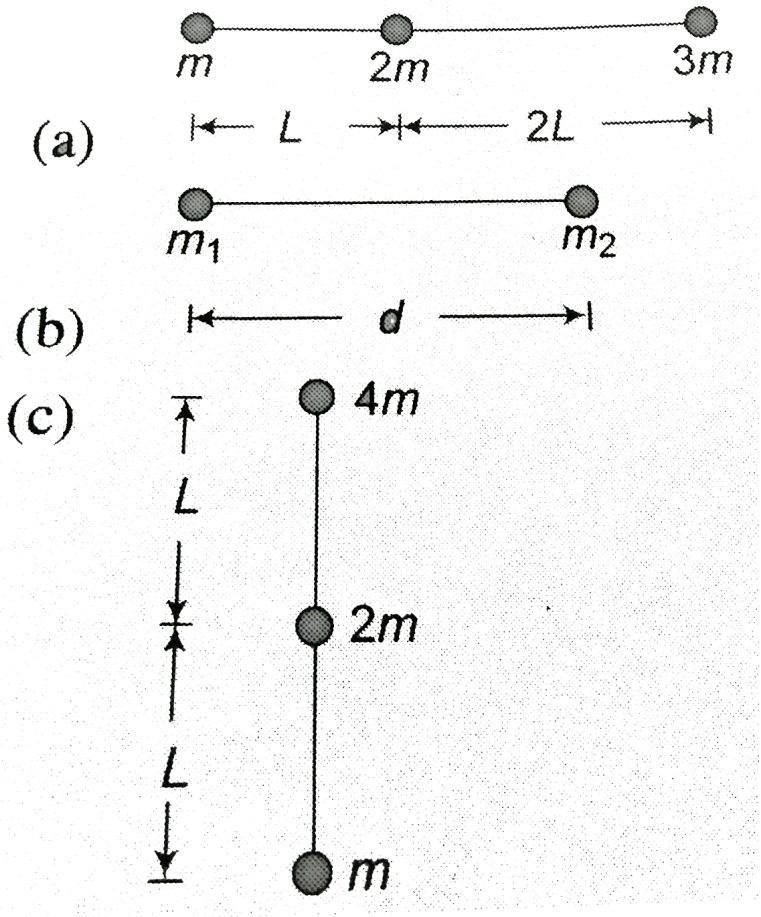
3. Locate the center of mass.



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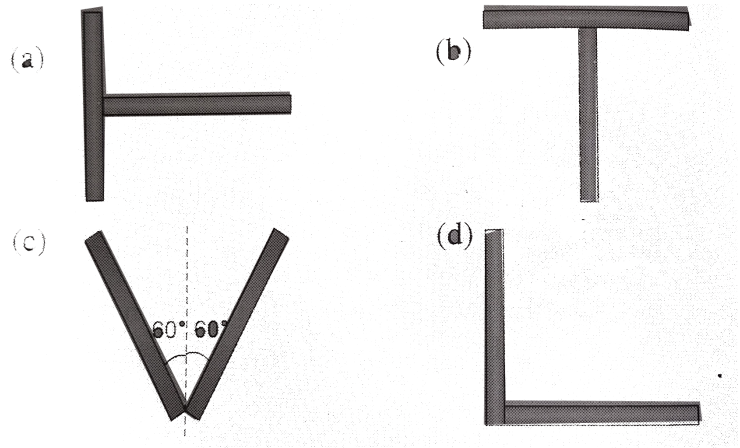
4. Two identical rods each of mass m and length are connected as shown. Locate $c.\ m.$



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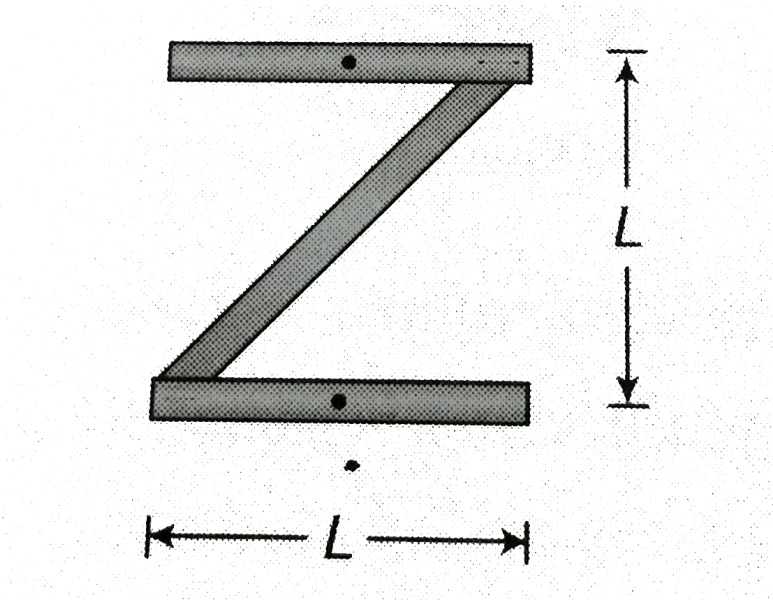
5. Three thin uniform rods made of same material are joined as shown. Locate x

coordinate of COM.



A. L/2

B. L/3

C. L/4

D. L

Answer: A

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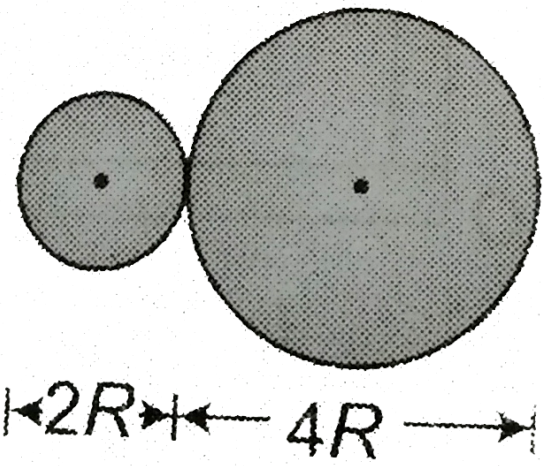
6. Two uniform discs made of same material and thickness of redii R and $2R$ are joined as shown. Locate $c.\ m.$



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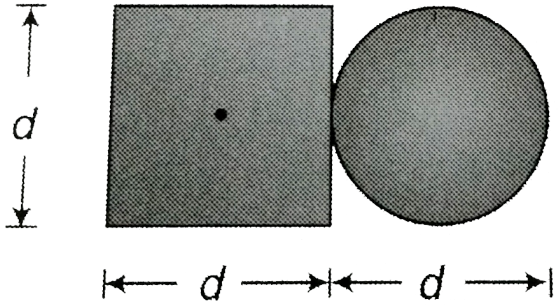
7. Two plates made of the same material and thickness are joined as shown. One plate is circular and another square in shape. The diameter of circular plate is equal to the side of the square plane. Locate $c.\ m.$



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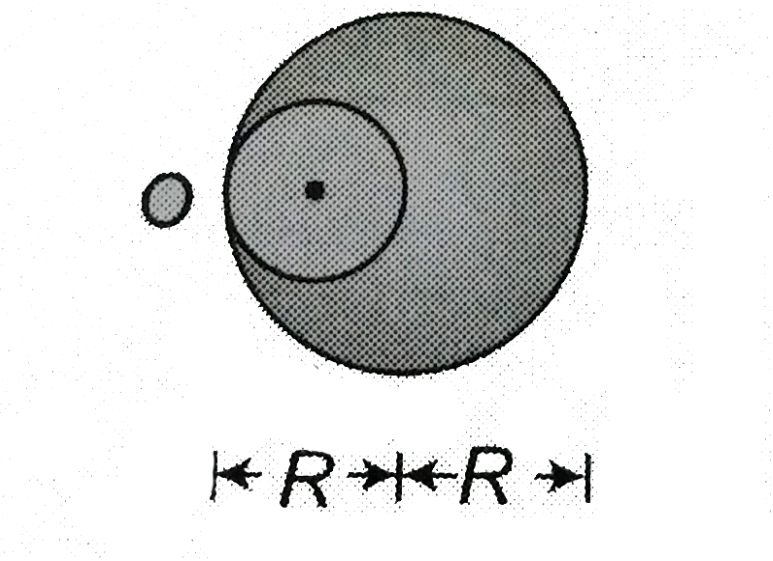
8. From a circular disc of radius R, another disc of diameter R is removed. Locate $c.\ m.$ of the remaining portion.



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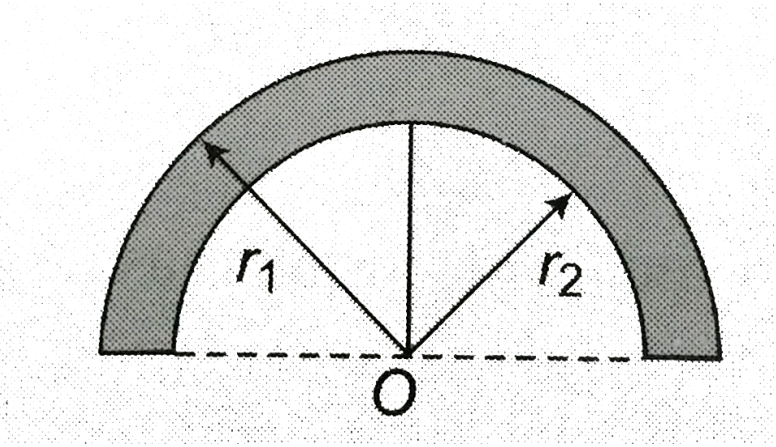
9. From a semicircular disc of radius r_1, another semicircular disc of radius r_2 is removed. Find the $c.m.$ of the remaining position.



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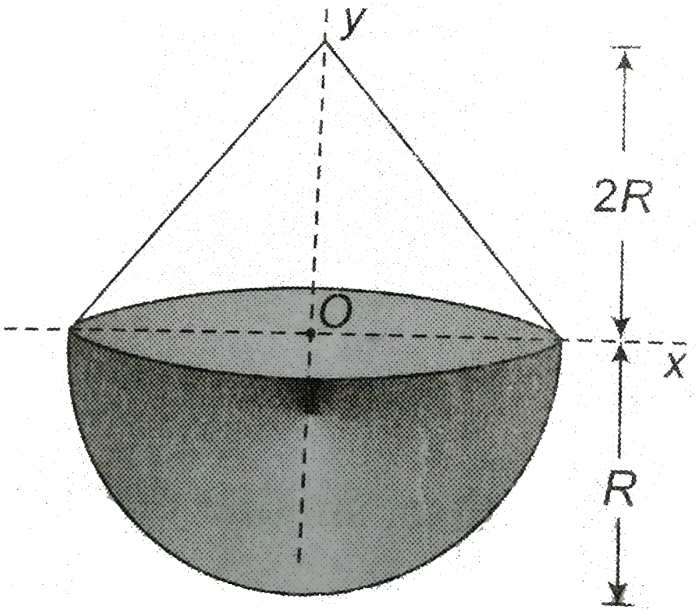
10. A right circular cone of radius R and height $2R$ is placed on a hemisphere of radius R. Locate $c.\ m.$ of the combined mass from O.



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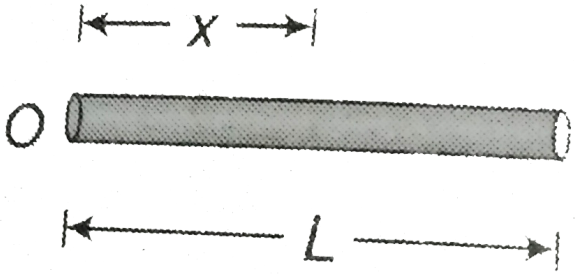
11. The linear mass density i.e. mass per unit length of a rod of length L is given by $\rho = \rho_0\left(1 + \frac{x}{L}\right)$, where ρ_0 is constant , x distance from the left end. Find the total mass of rod and locate $c.\ m.$ from the left end.



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12. Locate $c.\,m.$ of thin , uniform semicircular wire of radius R.

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13. Locate $c.\,m.$ of thin , uniform semicircular plate.

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14. The three particles of mass m, $2m$ and $3m$ are located at $(1, 2, 3)$, $(2, 3, 4)$ and $(1, 1, 1)$. Find the position vector of $c.\ m$.

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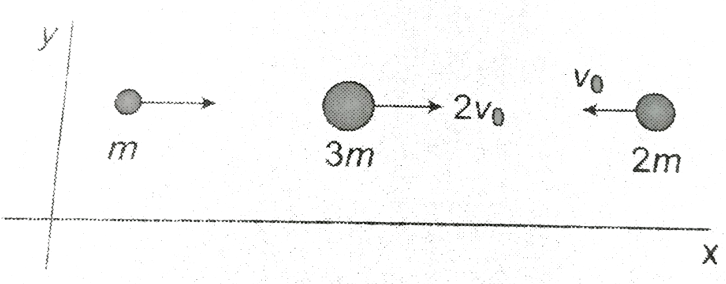
15. A system consists of three particles in motion as shown. Find the velocity of $c.\ m$.



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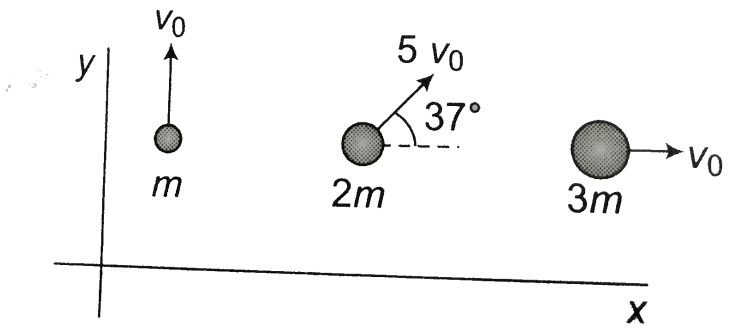
16. Find the velocity of $c.\ m$.



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17. Two particles of masses $2m$ and $3m$ are placed at separation d on a smooth surface. They move towards each other due to mutual

attractive force. Find (a) acceleration of c.m. (b) Velocity of c.m. when separation between particles becomes $d/3$. (c) At what distance from the initial position of mass $2m$, the particles collide.

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18. A $20kg$ kid is sitting in a $60kg$ boat in a lake. The distance of kid from the bank of lake is $20m$. If the kid moves $8m$ on the boat towards the bank, then find the distance of kid from

the bank. The system is initially at rest and there is no friction between boat and water.

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19. A boy of mass $40kg$ is standing at one ned of the boat (mass : 80 kg) of length 6m in a river. Now the boy reaches to other end of the boat. Find the distance moved by the boat and the distance travelled by boy as seen from the bank of river.Assume that the system is at rest

and no friction between the boat and the water.

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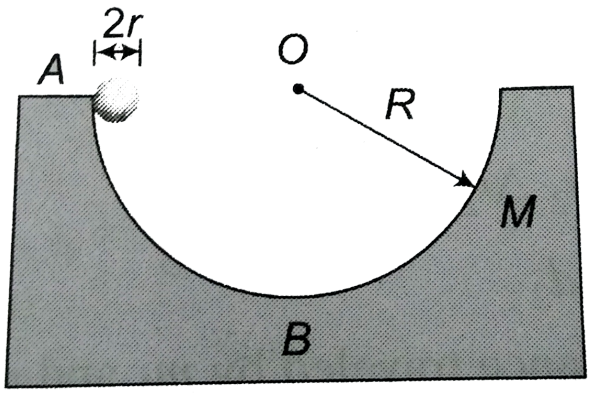
20. All surfaces are smooth. The ball of mass m is released from A. Find the distance travelled by the block of mass M.



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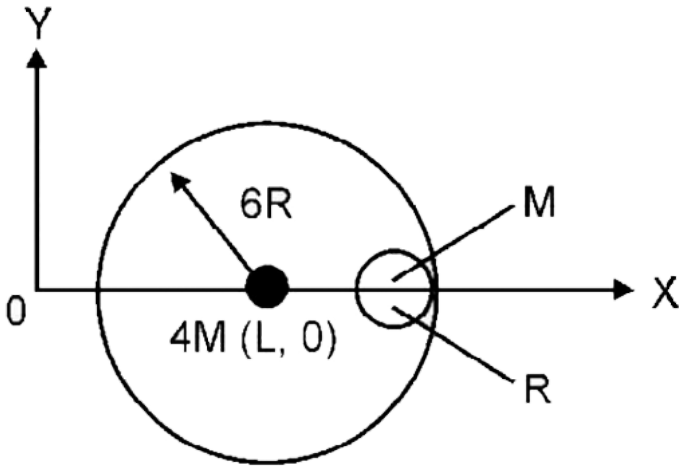
21. A small sphere of radius R is held against the inner surface of a larger sphere of radius 6R. The masses of large and small spheres are 4M and M, respectively , this arrangement is placed on a horizontal table. There is no friction between any surfaces of contact. The small sphere is now released. Find the coordinates of the centre of the larger sphere when the smaller sphere reaches the other

extreme position.



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22. A bomb is thrown at a speed $20m/s$ at an angle 45°. At the highest point , it explodes into two parts of equal mass , the one part coming to rest. Find the distance from the

origin to the point where the other part strikes the ground.

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23. A bullet of mass $50kg$ is fired with a speed of $200m/s$ from a gun of mass $2kg$. Find the recoil velocity of the gun.

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24. A bomb of mass $4m$ explodes into two parts of mass ratio $1:3$. If the $K.E.$ Of smaller fragment is K , find the $K.E.$ of the larger fragment.

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25. A shell is fired from a cannon with a velocity $v(m/\text{sec.})$ at an angle θ 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 $m/\sec.$) of the other piece immediately after the explosion is

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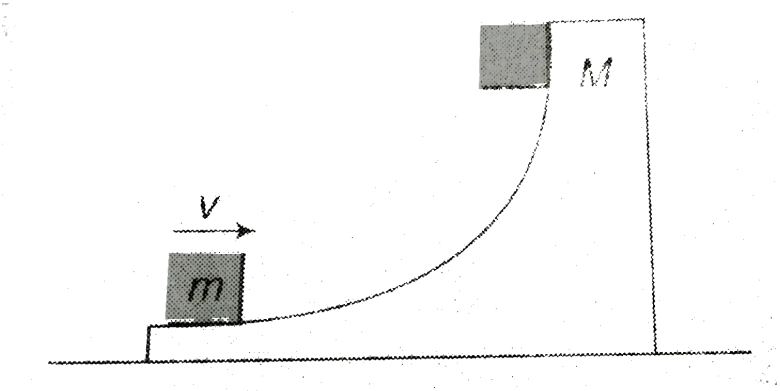
26. As shown , a small body of mass $50g$ placed over a larger mass $1950g$ whosw surface is horizontal near the smaller mass and gradually curves to become vertical. The smaller mass is pushed on the longer one at a speed $20m/s$ and the system is left to itself.

All surfaces are smooth. Find the speed of the larger block when the smaller block is moving on the vertical part.



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27. A U^{238} nucleus , initially at rests , emits an alpha particle with a speed v_0. Calculate the

recoil speed of the residual nucleus Th^{234}. Assume that the mass of a nucleus is proportional to the mass number. Also , calculate the ratio of $K.E.\ of Th^{234}$ and α - particle.

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28. A bomb of mass $5m$ initially at rest explodes and breaks into three pieces of masses in the ratio $1:1:3$. The two pieces of equal mass fly off perpendicular to each other

with a speed of v_0. What is the velocity of the heavier piece? Also , calculate the energy released in explosion.

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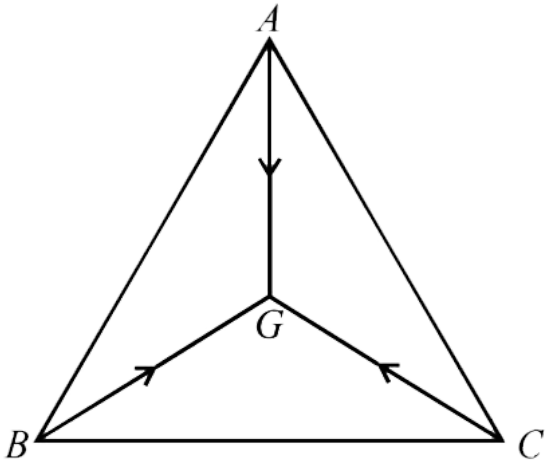
29. Three particles A, B and C of equal mass move with equal speed V along the medians of an equilateral triangle as shown in hgure. They collide at the centroid G of the triangle. After the collision, A comes to test, B retraces its path with the speed V. What is the velocity of

C ?



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30. A boy of mass m is standing on a platform of M kept on smooth floor. If the body starts moving on the platform with a speed v_0

relative to the platform , with what velocity to the floor does the platform recoil ?

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31. A cannon of mass m_1 fires a shell of mass m_2 with speed v_0 relative to the barrel which is inclined at an angle α with horizontal . Find the recoil speed of cannon if it is placed on ice.

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32. A block at rest is suddenly burst into two pieces of mass $2kg$ and $4kg$, respectively . The pieces fly apart with a relative of $30m/s$, determine the speed of each. If the coefficient of friction for surface is 0.5 , find the separation between pieces when they come at rest.

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33. A boy of mass m is riding on a trolley of mass M which is moving on smooth floor at speed v_0. He jumps off in the opposite direction of motion of trolley with velocity u relative to the trolley before the jump. Find the velocity of the trolley after jump.

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34. Two boys each of mass $40kg$ are standing on the right side of a trolley of mass $80kg$,

initially at rest on smooth floor. The boys jumps to the right with velocity $3m/s$ with respect to the trolley before the jump. Find the final velocity of the trolley if the jumps : (a) together , (b) one after the other and (c) one boy is on the left and the other on the right , the boy on the left jumps to the left and then the boy on the right jumps to the right. Each boy jumps with $3m/s$ with respect to the trolley before the jump.

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35. A boy of mass $40kg$ moves on a $10m$ long , $60kg$ railroad car on the smooth horizontal floor. Now the boy moves with speed $5m/s$. (a) Find the velocity of the car with respect to the floor. (b) If the boy starts from middle of the car and reaches to one end of the car , find the distance traveled by the car. (c) If the boy stops at the end , find the velocity of the car. (d) If the boy falls off the car at one end while walking , find the velocity of the car.

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36. Two identical buggies 1 and 2 with one man in each move without friction due to inertia along the parallel rails toward each other. When the buggies get opposite each other, the men exchange their places by jumping in the direction perpendicular to the motion direction. As a consequence, buggy 1 stops and buggy 2 keeps moving in the same direction, with its velocity becoming equal to v. Find the initial velocities of the buggies v_1 and v_2 if the mass of each buggy (without a man) equals M and the mass of each man m.

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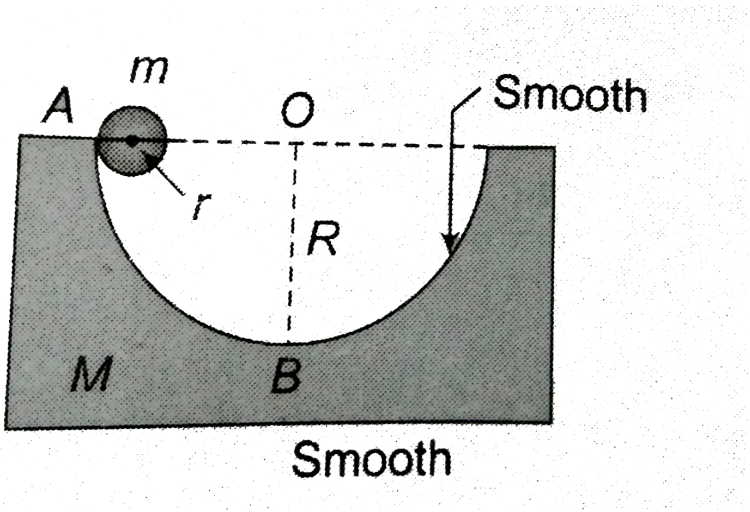
37. A block of mass M with a semi - circular track of radius R rests on a smooth floor. A sphere of mass m and radius r is released from rest from A. Find the velocity of sphere and track , when the sphere reaches B.



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38. A small block of super dense material has a mass equal to the half of the mass of the earth . It is released from the height $H(H << \text{radius of the earth})$. Find its speed when its height from the eath surface decreases by $75\ \%$.

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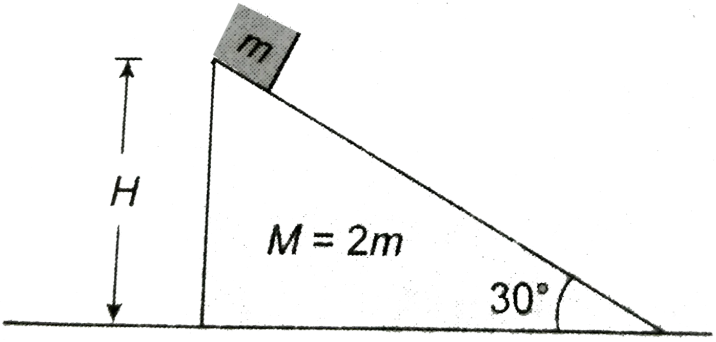
39. A block of mass m is placed on a triangular block of mass $M(M = 2m)$, as shown. All surfaces are smooth. Calculate the velocity of triangular block when the smaller block reaches at bottom.



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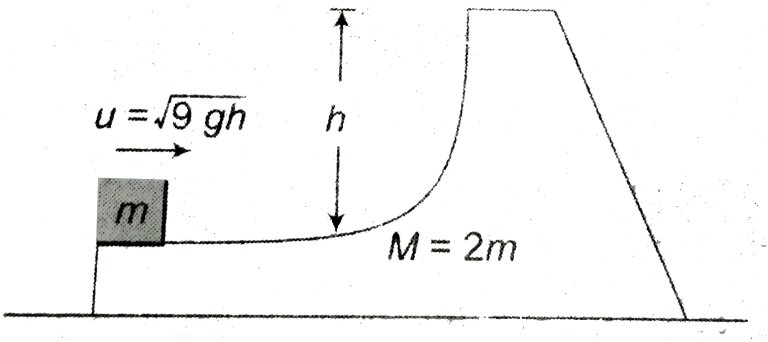
40. A block of mass $(M = 2m)$ is placed on smooth surface. Another block of mass m is given velocity $\sqrt{9gh}$ in horizontal direction , as shown. Find the speed of m when it breaks off from M. Also , calculate the maximum height attained by it from its initial level. Take $h = 2m$.



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41. A particle of mass m moving on a smooth surface with velocity $10m/s$ strikes another particle of mass $2m$ moving with $5m/s$ in the same direction . If the collision is elastic and head - on , find velocities of particles after the collision.

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42. Solve the previous problem , if particles moving in opposite direction.

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43. A particle of mass m_1 moving on a smooth surface with some velocity strikes another particle of mass m_2 at rest. The head - on elastic collision takes place. After the collision , particles move with equal speed in opposite direction . Determine the mass ratio.

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44. A particle of mass m moving with some velocity on a smooth surface strikes another particle of mass ηm at rest , elasticity head - on. What fraction of incident $K.E.$ is transferred to the particle of mass ηm.

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45. In the previous problem , find the value of η if the the particle of mass ηm should recoil

with (a) the greater $K.E.$. (b) the greatest momentum and (c) the greatest speed.

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46. A bullet of mass m moving with velocity u on smooth surface strikes a block of mass M kept at rest. The collision is completely inelastic. Find the common velocity and the fractional loss in kinetic energy.

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47. In the previous problem , the block of $massM$ is attached to a string of length L. Find the maximum angle made by the string with vertical . Take veloctiy of buller $u = 4\sqrt{gL}$. Take $M = 3m$.

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48. A bullet of mass $10kg$ moving horizontally at a speed $140m/s$ strikes a block of mass $100g$ attached to a string like a simple pendulum. The bullet penetrates the block and

emerges on the other side. If the block rises by $80cm$, find final velocity of bullet.

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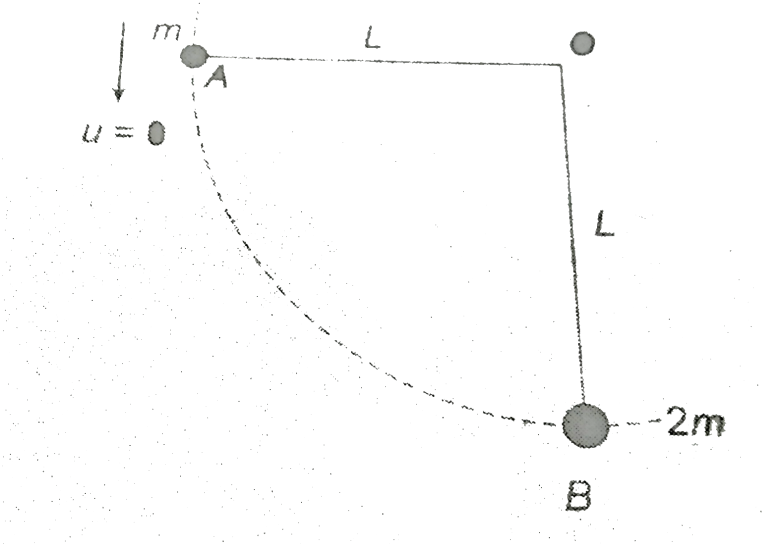
49. A ball A of mass m attached to a string of length L is released when the string is horizontal. It strikes another ball B of mass $2m$ suspended to another string of length L at rest as shown. Find the maximum angle made by the string if the collision is

completely inelastic.



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50. In the previous problem , if the collision is head - on elastic , find (a) the velocities of balls

immediately after the collision and (b) the maximum height attained by eacl ball.

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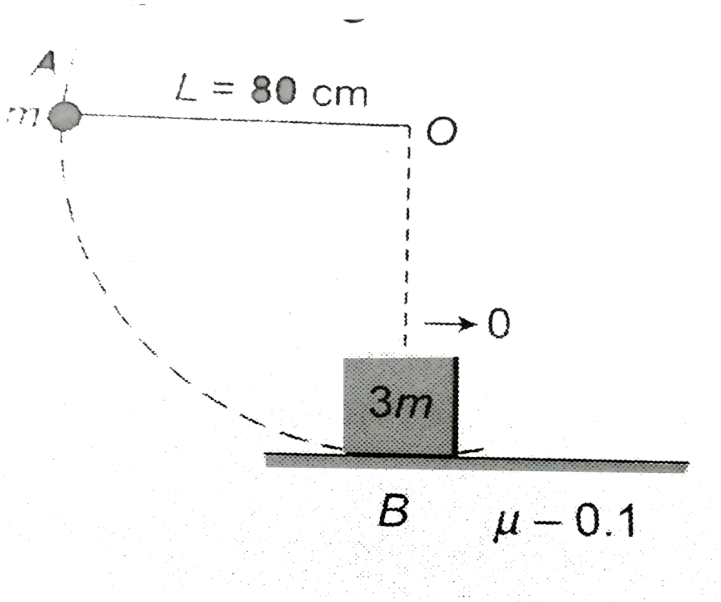
51. The ball A of mass m is released when the string is horizontal. It strikes a block B of mass $3m$ kept on a rough surface of friction coefficient $\mu = 0.1$. If a head on elastic collision takes place , find the maximum distance travelled by the block on a rough

surface.



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52. In the previous problem another block C of mass m is placed at distance $1m$ right of block B. Find (a) the distance travelled by the

combined mass if the collision is completely inelastic and (b) separation between the blocks when they stop after head - on elastic collision.

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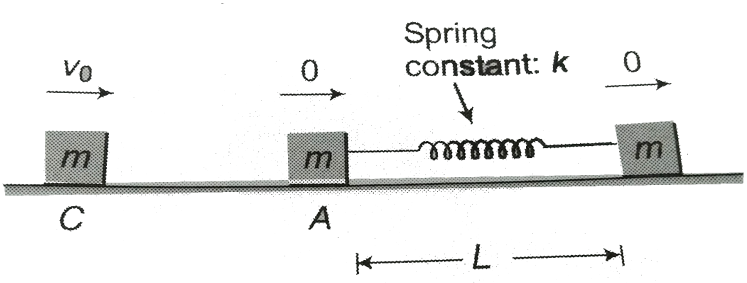
53. Two blocks A and B of masses m and $2m$ are connected by a massless spring of natural length L and spring constant k. The blocks are intially resting on a smooth horizontal floor with the spring at its natural length , as shown

. A third identical block C of mass m moves on the floor with a speed v_0 along the line joining A and B and collides elastically with A. FInd (a) the velocity of $c.m.$ of system $(blockA + B + spring)$ and (b) the minimum compression of spring.



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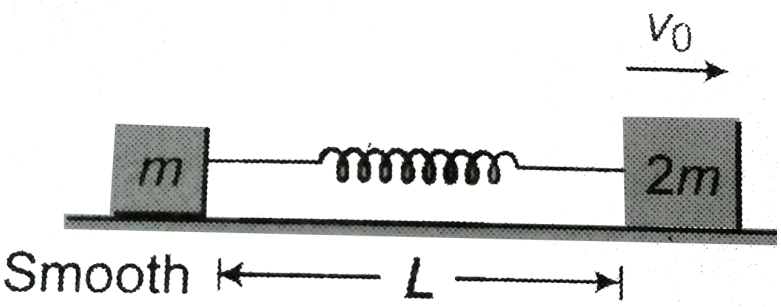
54. Block of mass $2m$ is given v_0 towards the right. If L is the natural length of spring constant k, find the maximum elongation of the spring.



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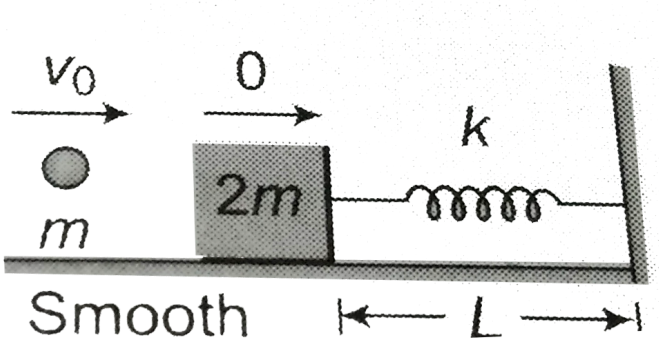
55. The ball strikes the block and sticks to it. Find the maximum compression of spring. (L: natural length of spring)



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56. A block of mass $180g$ is placed on a spring (spring constant $k = 120N/m$) fixed from

below. A ball of mass $20g$ is dropped from height $20m$ and the collision is completely inelastic. Find the maximum compression of the spring. Neglect the initial compression of the spring due to the block.

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57. A block of mass $180g$ is suspended by a massless spring. The spring extends by $1.8cm$ due to the weight of block. A particle of mass $20g$ is dropped from a height $80cm$ on the

block. The collision is completely inelastic . Find the maximum elongation of the spring.

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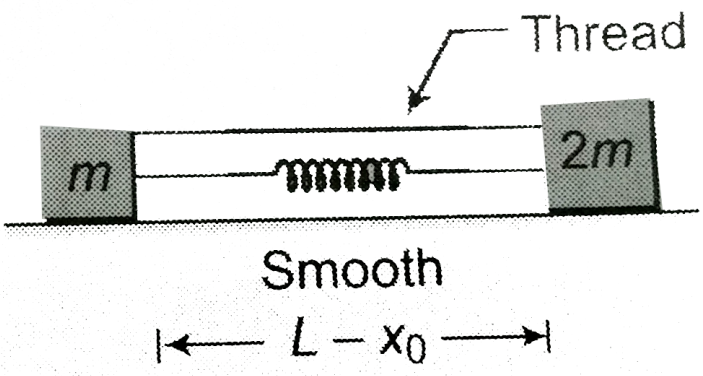
58. Two blocks of masses m and $2m$ compress a spring of spring constant k by x_0 and blocks are a connected by a thread and placed on a smooth surface as shown. Now , thread is burned. Find the speed of each block when the

spring attains its normal length L.



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59. A ball of mass m moving with speed v towards the right strikes a wall moving towards the left with speed u. Find the change in the $K.E.$ of the ball if the collision is elastic.

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60. A ball of mass m moving with velocity u strikes another identical ball at rest. Find the velocities of the balls after the collision if the coefficient of restitution is e and the collision is head -on. Also , calculate the loss in $K.E.$

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61. If in the previous problem , the final $K.E.$ is $3/5$ of the initial $K.E.$, find the value of e.

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62. A ball strikes directly upon another ball at rest and is itself reduced to rest by the impact. If half of the initial $K.E.$ is lost in collision, find the value of e.

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63. A particle of mass m experienced an elastic collision with a stationary particle of mass $2m$. What fraction of the kinetic energy does the striking particle lose if recoils at the right angles to its original motion direction.

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64. Particle 1 experiences a perfectly elastic collision with a stationary particle 2. Determine their mass ratio , if the particles fly symmetrically relative to the initial motion

direction particle 1 with angle of divergence $\theta = 60^\circ$.

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65. Particle 1 experiences a perfectly collision with a staionary particle 2. Determine their mass ratio , if the particles move perpendicularly to each other.

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66. A particle of mass m strikes another particle of same at rest. Find the angle between velocities of particles after the collision , if the collision is elastic.

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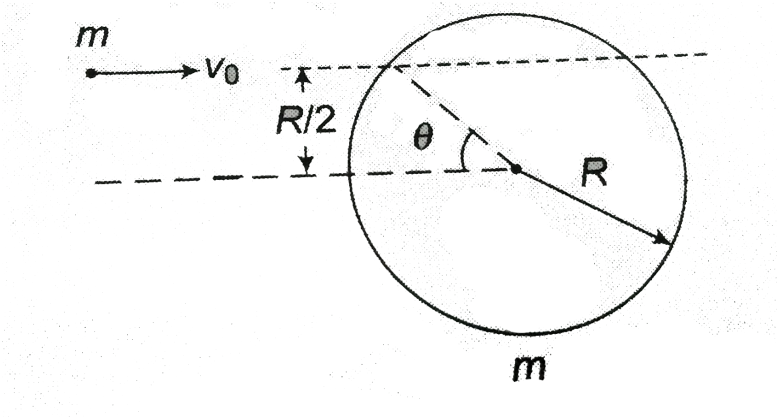
67. A particle of mass m moving with velocity v_0 collides with sphere of same mass at rest , as shown. If the surface of contact is smooth and the collision is elastic, find the velocities

of particle and sphere after the collision.



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68. A soccer ball of mass $500g$ is moving horizontally to the left with speed $14m/s$. The ball is kicked and given velocity $30m/s$ at angle 53° with horizontal in upward direction

to the right. Find the impulse of net force and average net force, assuming the collision time $0.01s$.

$(\cos 53^\circ = 3/5, \sin 53^\circ = 4/5)$

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69. A particle of mass m strikes a smooth floor with speed u at angle of incidence θ with the normal. The coefficient of resultant is e. Find the magnitude and direction of velocity with

which the particle rebounds. Also, find the impulse and loss in $K.E.$.

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70. A ball is thrown from the ground with velocity u at an angle θ with horizontal. If the coefficient of restitution is e , find the time of flight , the maximum height and the horizontal range after the first collision.

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71. A ball is dropped from the height h on an inclined plane of inclination θ. If the coefficient of restitution is e, at what distance along the plane , the ball again collides with the plane.

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72. A ball is given velocity $u = \sqrt{3gd}$ at an angle 45° with horizontal. It strikes a wall at distance d and returns to its original position. Find the coefficient of restitution e.

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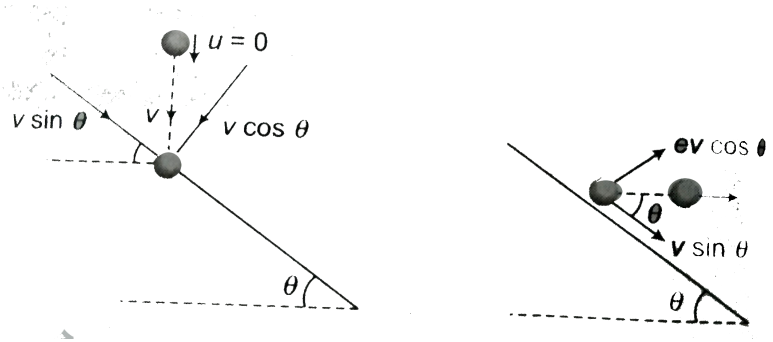
73. A ball after falling a distance collides an inclined plane of inclination θ. If after the collision , the ball moves horizontally , find the coefficient of restitution.



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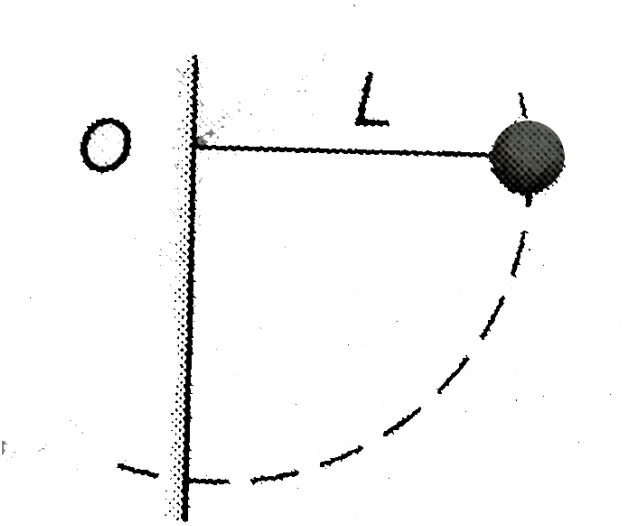
74. A ball is attached to a string of length L. The ball is released when the string is horizontal. The ball collides with wall and $e = 2/\sqrt{5}$. After how many minimum number of collisions , the amplitude of oscillation becomes less than 60°.



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75. A rocket of initial mass $6000kg$ ejects gases at constant rate of $20kg/s$ with constant relative speed of $8km/s$. What is the acceleration of the rocket after $100s$.

(a) Neglect gravity , (b) include gravity and (c) upward thrust.

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76. A rocket is set for a vertical firing . If the exhaust speed is $2000m/s$, find the rate of fuel consumption initial vertical upward acceleration of $30m/s^2$. Take mass of rocket $= 6000kg$.

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77. In the previous problem , if the mass of fuel is $5000kg$ and the rate of fuel consumption is

$50kg/s$, find the speed acquired by the rocket when all fuel is consumed .

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78. 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.

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79. A ball is dropped from a height h on a floor if the coefficient of restitution ise. Find the

(a). Speed of ball after the first second ... n^{th} collision.

(b). Maximum height attained by the ball, after the first, second ... n^{th} collision.

(c). Time taken by the ball to reach the highest

point after the first, second, ...n^{th} collision.

(d). total distance covered by the ball.

(e). totol time of journey.

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Exercises

1. Two blocks of mass $1kg$ and $3kg$ have position v ectors $\hat{i}+2\hat{j}+\hat{k}$ and $3\hat{i}-2\hat{j}+\hat{k}$, respectively . The center of mass of this system has a position vector.

A. $-2\hat{i}+2\hat{k}$

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

C. $2.5\hat{i}-\hat{j}-\hat{k}$

D. $-\hat{i}+\hat{j}+\hat{k}$

Answer: C

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2. 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. $= d$

B. $\leq d$

C. $> d$

D. $\geq d$

Answer: B

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3. Particle of masses $m, 2m, 3m, \ldots, nm$ grams are placed on the same line at distance $l, 2l, 3l, \ldots\ldots, nlcm$ from a fixed point. The

distance of centre of mass of the particles from the fixed point in centimeters is :

A. $\frac{(2n+1)L}{4}$

B. $\frac{L}{(2n+1)}$

C. $\frac{n\left(n^2+1\right)L}{2}$

D. $\frac{(2n+1)L}{3}$

Answer: D

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4. Three identical metal balls each of radius r are placed touching each other on a horizontal surface such that an equilateral triangle is formed, when the center of three balls are joined. The center of mass of system is located at the

A. horizontal surface

B. center one of the balls

C. line joining centers of any two balls

D. point of intersection of medians

Answer: D

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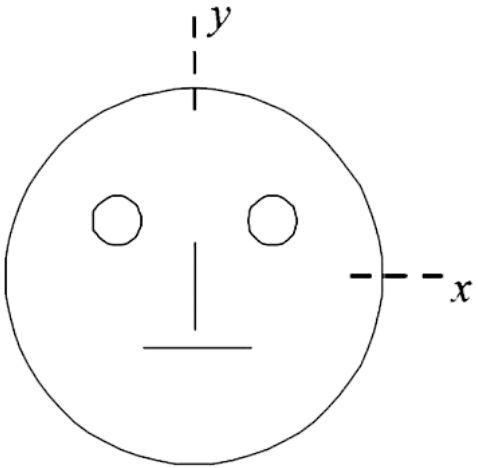
5. Look at the drawing given in the figure which has been drawn with ink of uniform line-thickness. The mass of ink used to draw each of the two inner circles, and each of the two line segments is m. The mass of the ink used to draw the outer circle is 6 m. The coordinates of the centres of the different parts are: outer cicle (0,0), left circle (-a, a),

right inner circle (a,a), vertical line (0,0) and horizontal line (0 ,-a). The y-coordinate of the centre of mass of the ink in this drawing is



A. $\frac{a}{10}$

B. $\frac{a}{8}$

C. $\frac{a}{12}$

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

Answer: A

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6. A circular disc of radius R is removed from a bigger circular disc of radius $2R$ such that the circumferences of the discs coincide. The center of mass of new disc is αR from the center of the bigger disc. The value of α is

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

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

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

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

Answer: A

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7. A hemisphere and a solid cone have a common base. The center of mass of common structure coincides with the common base. If R is the radius of hemisphere and h is the height of the cone, then h/R will be

A. $\sqrt{3}$

B. 3

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

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

Answer: A

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8. If the linear density (mass per unit length) of a rod of length $3m$ is proportional to x, where x, where x is the distance from one end

of the rod, the distance of the centre of gravity of the rod from this end is.

A. $1.5m$

B. $2m$

C. $2.5m$

D. $3.0m$

Answer: B

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9. The mass per unit length of a non - uniform rod of length L is given $\mu = \lambda x^2$, where λ is a constant and x is distance from one end of the rod. The distance of the center of mas of rod from this end is

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

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

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

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

Answer: C

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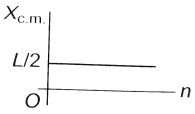
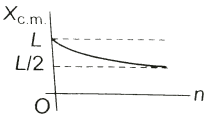
10. A thin rod of length 'L' is lying along the x-axis with its ends at x=0 and x=L its linear (mass/length) varies with $xask\left(\frac{x}{L}\right)^n$, where n can be zero of any positive number. If to position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best apporximates the dependence of x_{CM} on n?

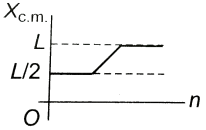
A. (1)



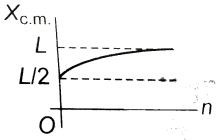
B. (2)



C. (3)



D. (4)



Answer: D

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11. Which of the following is true for center of mass ?

(i) The center of mass of a body may lie within , outside , on the surface of the body.

(ii) In the case of symmetrical bodies , the center of mass coincides with the geometrical center of the body.

(iii) In the absence of external forces , the center of mass moves with constant velocity.

(iv) If external forces are absent and system is initially at rest, then location of center of mass is fixed.

A. $(i), (ii)$

B. $(i), (ii), (ii)$

C. $(ii), (iii), (iv)$

D. all options are correct

Answer: D

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12. A cubical block of ice of maas m and edge L is placed in a large tray of maas M. If the ie melts, how far does the centre of maas of the system "ice plus tray" come down?

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

B. $\frac{mL}{2(m+M)}$

C. $\frac{mL}{M}$

D. $\frac{ML}{m}$

Answer: B

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13. Two paricle A and B initially at rest, move towards each other under mutual force of attraction. At the instant when the speed of A

is V and the speed of B is 2V, the speed of the centre of mass of the system is

A. zero

B. v

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

D. $(3y)$

Answer: A

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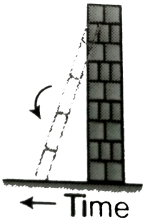
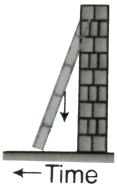
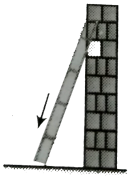
14. A ladder is leaned against a smooth wall and it is allowed to slip on a frictionless floor. Which figure represents the track of its centre of mass ?

A. 

B. 

C. 

D. (4) 

Answer: A

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15. A pulley fixed to the ceiling carries a string with blocks of mass m and $3m$ attached to its ends. The masses of string and pulley are negligible .When the system is released, its center of mass moves with what acceleration

A. 0

B. $g/4$

C. $g/2$

D. $-g/2$

Answer: B

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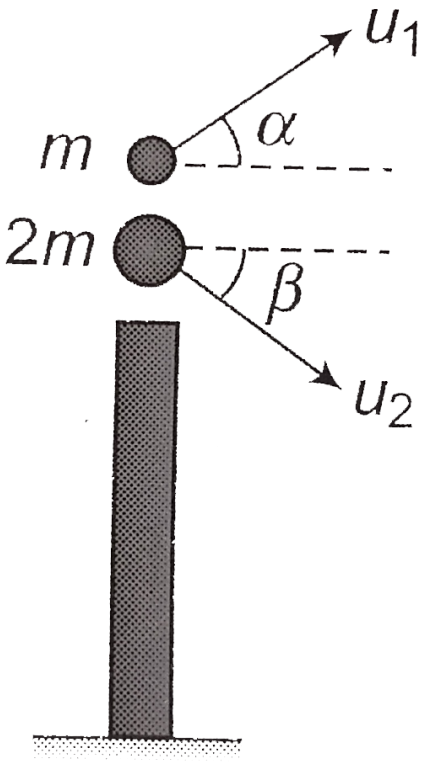
16. Two balls are thrown simultaneously from top of tower in air as shown in the figure.

(i) The acceleration of the center of mass of

two balls while in air is equal to g.

(ii) The path followed by the center of mass is parabola.

(iii) The path followed by the center of mass will change if one ball after striking the ground comes to rest.



A. $(i), (ii), (iii)$

B. $(i), (ii), (iv)$

C. $(i), (ii)$

D. all of the above

Answer: C

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17. Which of the following statements are true ?

(i) A uniform wooden plank of mass $150kg$ and

length $8m$ is floating on still water with a man of $50kg$ at one end of it. The man walks to the other end of the plank and stops. The distance covered by the plank is $2m$.

(ii) A kid of mass $15kg$ is sitting in a boat of mass $45kg$ in a lake. The distance of kid from the bank of lake is $12m$. Now the body moves inside the boat at a distance $4m$ towards the bank and stops. The distance of the kid from the bank (there is no friction between the water and the boat) is $11m$.

(iii) Two persons of masses $40kg$ and $60kg$ are sitting at the midpoint of a $12 - m$- long boat

$(140kg)$ standing still in water. Now they move to opposite ends of the boat. Neglecting the friction between boat and water, the distance traveled by the boat in water is $50cm$.

(iv) In a gravity free space , a man of mass m standing at a height h above the floor, throws a ball of mass m_0 straight down with a speed v_0. When the ball reaches the floor, the distance of the man above the floor is $\left(1+\frac{m_0}{m}\right)h$.

A. $(i), (ii)$

B. (i) ,(iii) ,(iv)`

C. $(ii), (iii), (iv)$

D. all of the above

Answer: B

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18. Which of the following statements is true ?

(i) A car of mass M is tied by one end of a massless rope of length $10m$. The other end of the rope is in the hands of a man of mass M. The entire system is on a smooth horizontal

surface.The man is at $x = 0$ and the cart at $x = 10m$. If the man pulls the cart by the rope, the man and the cart will meet at the point $x = 5m$.

(ii) Two spherical bodies of mass M and $5M$ and radii R and $2R$, respectively , are released in free space with initial separation between their centers equal to $12R$. If they attract each other due to the gravitational force only , then the distance covered by the smaller body just before collision is $7.5R$.

(iii) Two skaters A and B , having masses $40kg$ and $60kg$, respectively stand facing each

other $10m$ apart on a horizontal smooth surface. They pull on a rope stretched between them , the distance covered by A, when skaters meet is $6m$.

(iv) A ballon (mass M) is attached to light rope of length L. To the other end of the rope a boy (mass m) is hanging in air. The system is at rest. The distance travelled by the balloon (in downward direction) when the boy touches the ballon is $\frac{ML}{M+m}$.

A. $(i), (ii)$

B. $(i), (ii), (iii)$

C. $(iii), (iv)$

D. all of the above

Answer: B

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

A. $6m/s$

B. $8m/s$

C. $10m/s$

D. $12m/s$

Answer: B

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20. A boy $(massof40kg)$ is standing at one end of a boat (mass of 60 kg) in still water. The length of the boat is $10m$ and the boy takes $2s$

to reach at other end of boat moving with constant speed. Assuming no friction between the boat and the water.

(i) The distance covered by the boat is $4m$

(ii) The distance covered by the boy with respect to the ground is $6m$.

(iii) The velocity of the boy with respect to the ground is $< 5m/s$

(iv) The velocity of the boy is $3m/s$

A. $(i), (ii)$

B. $(ii), (iii)$

C. $(i), (ii), (iii)$

D. all options are correct

Answer: D

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21. Two particles A and B of masses $2m$ and m are placed on a smooth surface at separation d. They move towards each other due to the mutual attractive force.

(i) The particles will meet at distance $d/3$ from the initial position of mass $2m$.

(ii) The speed of A will be half of speed of B until the particles collide (excluding the initial speed).

(iii) The distance covered by B is always double that covered by A until the particles collide.

(iv) The velocity of center of mass is always zero.

A. $(i), (ii)$

B. $(i), (ii), (iii)$

C. $(ii), (iii), (iv)$

D. all options are correct

Answer: D

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22. A wooden plank of mass M and length L is floating in still water. A persons of mass m starts at one end of the plank and reaches to other end other end in time t_0, moving with a constant speed. Choose the correct option.

(i) The speed of the person as seen from the

ground is smaller than $\frac{L}{t_0}$.

(ii) The speed of the plank as seen from the ground is $\left(\frac{m}{m+M}\right)\frac{L}{t_0}$.

(iii) The speed of the plank as seen from the ground is $\left(\frac{M}{m+M}\right)\frac{L}{t_0}$.

(iv) The total $K.E.$ of the system is $\frac{1}{2}(m+M)\left(\frac{L}{t_0}\right)^2$.

A. $(i), (ii)$

B. $(i), (iii)$

C. $(i), (iii), (iv)$

D. $(i), (ii), (iv)$

Answer: A

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23. Themasses of $1g$ and $4g$ are moving with equal kineticc energies. Calculate the ration of the magnitudes of their linear momenta.

A. $4:1$

B. $\sqrt{2:1}$

C. $1:2$

D. $1:16$

Answer: C

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24. Two bodies with kinetix energies in the ratio of $4:1$ are moving with equal linear momentum. The ratio of their masses is

A. $1:2$

B. $1:1$

C. $4:1$

D. $1:4$

Answer: D

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25. If KE of a body increases by $300\ \%$, by what $\%$ will the linear momentum of the body increase?

A. $100\ \%$

B. $150\ \%$

C. $\sqrt{300}\ \%$

D. $175\ \%$

Answer: A

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26. If the kinetic energy of a body increases by 0.1% the percent increase of its momentum will be

A. 0.05%

B. 0.1%

C. 1.0%

D. 10%

Answer: A

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27. A body of mass $0.5kg$ is projected under the gravity with a speed of $98m/s$ at an angle of 30° with the horizontal. The change in momentum (in magnitude) of the body when it strikes the ground is

A. $98N - s$

B. $49N - s$

C. $196N - s$

D. $24.5N - s$

Answer: B

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28. A paticle of mass m is executing uniform circular motion on a path of radius r. If p is the magnitude of its linear momentum, then the radial force acting on the particle is

A. pmr

B. rm/p

C. mp^2/r

D. p^2/rm

Answer: D

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29. A ball of mass m falls vertically to the ground from a height h_1 and rebound to a

height h_2. The change in momentum of the ball on striking the ground is.

A. $mg(h_1 - h_2)$

B. $m\left(\sqrt{2gh_1} + \sqrt{2gh_2}\right)$

C. $m\sqrt{2g(h_1 + h_2)}$

D. $m\sqrt{2g}(h_1 + h_2)$

Answer: B

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30. A particle of mass M is moving in a horizontal circle of radius R with uniform speed V. When it moves from one point to a diametrically opposite point , its

A. Kinetic energy changes by $MV^2/4$

B. momentum does not change

C. Momentum changes by $2MV$

D. kinetic energy changes by MV^2

Answer: C

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31. A particle moves in the X-Y plane under the influence of a force such that its linear momentum is $\overrightarrow{p}(t) = A\left[\hat{i}\cos(kt) - \hat{j}\sin(kt)\right]$, where A and k are constants. The angle between the force and the momentum is

A. 0°

B. 30°

C. 45°

D. 90°

Answer: D

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32. Consider the following two statements:

A. Linear momentum of a system of partcles is zero.

B. Kinetic energ of a system of particles is zero.

A. 1 implies 2 and 2 implies 1

B. 1 does not imply 2 and 2 does not imply 1

C. 1 implies 2 but does not imply 1

D. 1 does not imply 2 but 2 implies 1

Answer: D

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33. Consider the following two statements :

1. Linear momentum of a system of particles is zero

2. Kinetic energy of a system of particles is zero , Then

A. v

B. $2v$

C. $\frac{3}{4}v$

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

Answer: D

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34. A stationary partical explodes into two partical of a masses m_1 and m_2 which move in opposite direction with velocities v_1 and v_2 . The ratio of their kinetic energies E_1 / E_2 is

A. m_1 / m_2

B. 1

C. $m_1 v_2 / m_2 v_1$

D. m_2 / m_1

Answer: D

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35. A shell of mass $20kg$ at rest explodes into two fragments whose masses are in the ratio $2:3$. The smaller fragment moves with a velocity of $6m/s$. The kinetic energy of the larger fragment is

A. $96J$

B. $216J$

C. $144J$

D. $360J$

Answer: A

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36. A bomb of mass $3.0kg$ explodes in air into two pieces of masses $2.0kg$ and $1.0kg$. The total energy imparted to the two fragment is

A. $1.07kJ$

B. $2.14kJ$

C. $2.4kJ$

D. $4.8kJ$

Answer: D

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37. A bomb of mass $9kg$ explodes into 2 pieces of mass $3kg$ and $6kg$. The velocity of mass $3kgis1.6m/s$. The $K.E.ofmass6kg$ is

A. $3.84J$

B. $9.6J$

C. $1.92J$

D. $2.92J$

Answer: C

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

A. $40m/s$

B. $120m/s$

C. $100m/s$

D. $80m/s$

Answer: C

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39. A body of mass $50kg$ is projected vertically upward with velocity of $100m/s$. After $5s$ this body breaks into $20kg$ and $30kg$. If the $20kg$ piece travels upwards with $150m/s$, then the velocity of other block will be

A. $15m/s$ downwards

B. $15m/s$ upward

C. $51m/s$ downwards

D. $50/3m/s$ downwards

Answer: D

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40. A shell is fired from a cannon with a velocity $v(m/\sec.)$ at an angle θ 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 $m/\sec.$) of the other piece immediately after the explosion is

A. $3v\cos\theta$

B. $2v\cos\theta$

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

D. $\frac{\sqrt{3}}{2}v\cos\theta$

Answer: A

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41. At high altitude , a body explodes at rest into two equal fragments with one fragment receiving horizontal velocity of $10m/s$. Time taken by the two radius vectors connecting of explosion to fragments to make 90° is

A. $10s$

B. $4s$

C. $2s$

D. $1s$

Answer: C

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42. A bomb explodes in air when it has a horizontal speed of $10m/s$. It breaks into two pieces A and B of mass ratio $1:2$. If A goes vertically up at a speed of $40m/s$, the speed of B is

A. $20m/s$

B. $25m/s$

C. $30m/s$

D. $50m/s$

Answer: B

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43. A body at rest breaks up into 3 parts. If 2 parts having equal masses fly off perpendicularly each after with a velocity of $12m/s$ when the velocity of the third part which has $3\times$ mass of each part is

A. $4\sqrt{2}m/s$ at an angle of 45° from each body

B. $24\sqrt{2}m/s$ at an angle of 135° from each body

C. $4\sqrt{2}m/s$ at 90° from each body

D. $4\sqrt{2}m/s$ at 135° from each body

Answer: D

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44. An explosion blows a rock into three parts. Two parts go off at right angles to each other . These two are $1kg$ first part moving with a

velocity of $12ms^{-1}$ and $2kg$ second part moving with a velocity of $8ms^{-1}$. If the third part flies off with a velocity of $4ms^{-1}$. Its mass would be

A. $5kg$

B. $7kg$

C. $17kg$

D. $3kg$

Answer: A

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45. An object , initially at rest , explodes in three fragments. The momentum of two pieces are $-3p\hat{i}$ and $-4p\hat{j}$ where p is a positive number. The momentum of the third piece

(i) will have magnitude $5p$

(ii) will make an angle $\tan^{-1}(4/3)$ with the x-axis

(iii) will make an angle $\tan^{-1}(3/4)$ with the x-axis

(iv) will have magnitude $7p$

A. $(i), (iii)$

B. $(i), (ii)$

C. $(ii), (iv)$

D. $(iii), (iv)$

Answer: B

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46. A shell is fired from a cannon with a velocity $20m/s$ at an angle 60° with the horizontal. At the highest point it explodes

into three pieces of equal masses . One of the pieces retraces its path to the cannon , the second piece moves vertically up with speed $40m/s$, the third piece will move with velocity (immediately after the explosion)

A. $20m/s$ in a horizontal direction

B. $40m/s$ at an angle 45° with horizontal in an upward direction

C. $40\sqrt{2}m/s$ at an angle 45° with horizontal in an upward direction

D. $40\sqrt{2}m/s$ at an angle 45° with horizontal in the downward direction

Answer: D

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47. When an expolsive shell travelling in a parabolic path under the effect of gravity explodes in the mid air, the centre of mass of the fragments will move.

A. vertically downwards

B. vertically upwards

C. along the original parabolic path

D. horizontally

Answer: C

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48. 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 masses of parts

D. depends on masses of parts

Answer: C

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49. A bomb of mass $4m$, while moving on a parabolic path, explodes at highest point of its path. If breaks into two parts of mass ratio $1:3$, smaller part coming to rest. The range of this projectile was $60m$ in the absence of explosion. The distance of the second part from the point of projection when it strikes the ground is

A. $60m$

B. $70m$

C. $80m$

D. $90m$

Answer: B

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50. In the previous problem , if a bomb explodes into three parts of mass ratio $1:1:2$, one smaller part retraces its path, the second smaller part coming to rest, the distance from the point of projection , where the heavier part strikes the ground is

A. $75m$

B. $95m$

C. $105m$

D. $120m$

Answer: C

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51. A ball is released from height $80m$. When the ball is at height $60m$, it explodes in two parts of mass ratio $1:2$. One of them moves

horizontally with speed $20m/s$. The distance between the two pecies on the ground is

A. $20m$

B. $40m$

C. $60m$

D. $80m$

Answer: C

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52. A cannon shell is fired to hit a target at a horizontal distance d. However , it breaks into two parts of mass ratio $1:2$ at its height point. The smaller part returns to cannon. The other part

(i) will fall at a distance $d/2$ beyond the target

(ii) have eight times the kinetic energy of smaller part

(iii) the increase in kinetic energy of system after explosion is $200\,\%$

(iv) after explosion , heavier part will take more

time as compared to smaller part , to strike the ground

A. $(i), (ii)$

B. $(i), (ii), (iii)$

C. $(i), (iii)$

D. all options are correct

Answer: B

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53. A man is standing at the center of frictionless pond of ice. How can he get himself to the shore ?

A. By throwing his shirt in vertically upward direction

B. By spitting horizontally

C. He will wait for the ice to melt in pond

D. Unable to get at the shore

Answer: B

Watch Video Solution

54. A bullet is fired fram a riffie . If the rifle recoils freely determine whether the kinetic energy of the rifle is greater then , equal or less then that of the bullet .

A. less than that of the bullet

B. more than that of the bullet

C. same as that of the bullet

D. equal or less than that of the bullet

Answer: A

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55. Two particles having position vectors $\vec{r}_1 = \left(3\hat{i} + 5\hat{j}\right) meters$ and $\vec{r}_2 = \left(-5\hat{i} - 3\hat{j}\right) metres$ are moving with velocities $\vec{v}_1 = \left(4\hat{i} + 3\hat{j}\right) m/s$ and $\vec{v}_2 = \left(\alpha\hat{i} + 7\hat{j}\right) m/s$. If they collide after $2s$, the value of α is

A. 2

B. 4

C. 6

D. 8

Answer: D

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56. which a U^{238} nucleus original at rest , decay by emitting an alpha particle having a speed u , the recoil speed of the residual nucleus is

A. $-4u/234$

B. $v/4$

C. $-4v/238$

D. $4v/238$

Answer: D

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57. In a head on elastic collision of two bodies of equal masses

A. $(i), (ii)$

B. $(i), (ii), (iii)$

C. $(i), (ii), (iv)$

D. all options are correct

Answer: D

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58. Which of the following statements is correct ?

(i) In the elastic collsions , the final $K.E.$ is

equal to the initial $k.E.$

(ii) In an inelastic collision , the final $K.E.$ may be smaller or greater than the initial $K.E.$

(iii) In every collision ,momentum is conserved.

(iv) In completely inelastic collision , colliding particles stick to each other and move with same velocity. There will be loss of $K.E.$

A. $(i), (ii)$

B. $(i), (ii), (iii)$

C. $(i), (iii), (iv)$

D. all options are correct

Answer: D

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

A. Both P and Q move forward with speed

$$\frac{v}{2}$$

B. Both P and Q move forward with speed

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

C. P comes to rest and Q moves forward with speed v

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

Answer: C

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60. A body of mass m_1 moving with a velocity $3m/s$ collides with another body at rest of m_2 . After collision the velocities of the two bodies are $2m/s$ and $5m/s$, respectively , along the direction of motion of m_1. The ratio m_1/m_2 is

A. $\frac{5}{12}$

B. 5

C. $\frac{1}{15}$

D. $\frac{12}{5}$

Answer: B

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61. A body of mass $2kg$ makes an elastic head - on collision another body at rest and continues to move in the original direction with one fourth of its original speed . The mass of the second body which collides with the first body is

A. $2kg$

B. $1.2kg$

C. $3kg$

D. $1.5kg$

Answer: B

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62. Two equal masses m_1 and m_2 moving along the same straight line with velocites $+3m/s$ and $-5m/s$ respectively collide

elastically. Their velocities after the collision will be respectively.

A. $+4m/s$ for both

B. $-3m/s$ and $+5m/s$

C. $-4m/s$ and $+4m/s$

D. $-5m/s$ and $+3m/s$

Answer: D

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63. A steel ball of radius $2cm$ is at rest on a frictionless surface. Another ball of radius $4cm$ moving at a velocity of $81cm/see$ collides elast cally with first ball. After collision the smaller ball moves with speed of

A. $81cm/s$

B. $63cm/s$

C. $144cm/s$

D. None of these

Answer: C

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64. A neutron collides head-on and elasticity with an atom of mass number A, which is initially at rest. The fraction of kinetic energy retained by neutron is

A. $\left(\frac{A}{A+1}\right)^2$

B. $\left(\frac{A-1}{A+1}\right)^2$

C. $\left(\frac{A-1}{A}\right)^2$

D. $\left(\frac{A+1}{A-1}\right)^2$

Answer: B

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65. A neutron makes a head-on elastic collision with a stationary deuteron. The fraction energy loss of the neutron in the collision is

A. $16/18$

B. $8/9$

C. $8/27$

D. $2/3$

Answer: B

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66. A ball of mass m_1 makes an elastic , one-dimensional collision with a stationary particle of mass m_2. The fraction of the kinetic energy of m_1 transferred to m_2 is

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

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

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

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

Answer: B

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67. In the previous problem

A. The transfer of energy will be maximum

if $m_1 = m_2$

B. The transfer of velocity will be maximum

if $m_2 > > m_1$

C. The transfer of velocity will be maximum

if $m_1 > > m_2$

D. All options are correct

Answer: D

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68. A body of mass M moves with velocity v and collides elasticity with another body of mass $m(M > > m)$ at rest , then the velocity of the body of mass m is

A. v

B. $2v$

C. $v/2$

D. Zero

Answer: B

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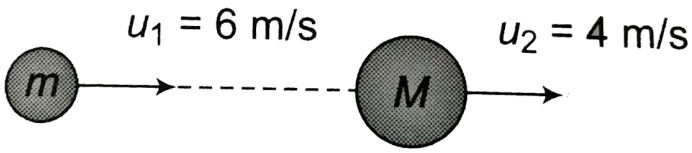
69. A particle of mass m moving with horizontal speed $6m/s$ as shown in the figure. If $m << M$ then for one - dimensional

elastic collision , the speed of lighter particle after collision will be



A. $2m/s$ in original direction

B. $2m/s$ opposite to the original direction

C. $4m/s$ opposite to the original direction

D. $4m/s$ in original direction

Answer: A

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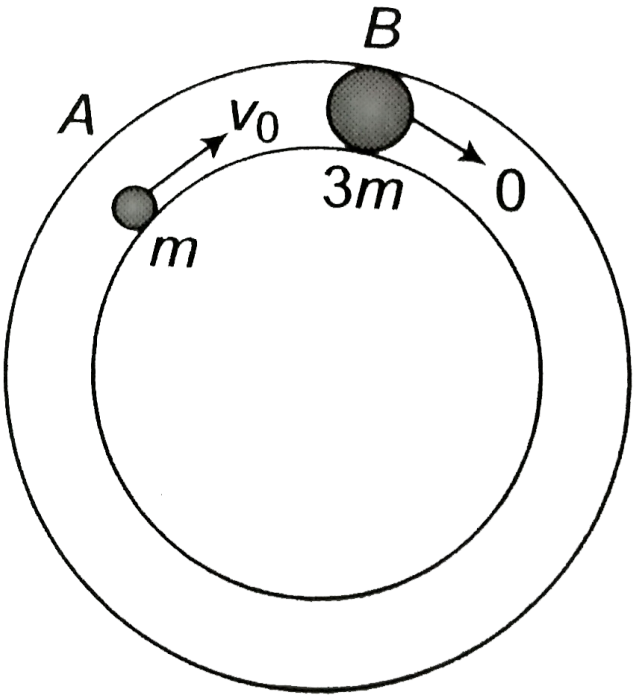
70. In a smooth circular tube of radius R , a particle of mass m moving with speed V_0 hits another particle of mass $3m$ at rest as shown. The time after which the next collision takes place (assume elastic collision)



A. $\frac{\pi R}{v_0}$

B. $\frac{2\pi R}{v_0}$

C. $\frac{\pi R}{2v_0}$

D. $\frac{\pi R}{4v_0}$

Answer: B

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71. A point mass of 1kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1kg mass reverses its direction

and moves with a speed of $2ms^{-1}$. Which of the following statements (s) is (are) correct for the system of these two masses?

A. $(i), (ii)$

B. $(ii), (iii)$

C. $(i), (iv)$

D. $(i), (iii)$

Answer: D

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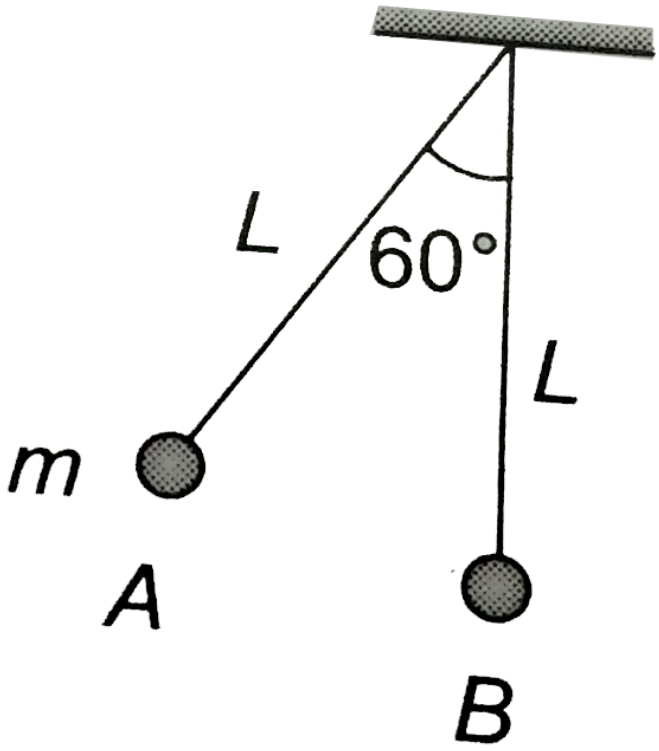
72. The ball A is reached and it makes head on collision with B. The masses of A and B are same



A. After collision , A comes to rest and B moves with velocity of A just before collision

B. The maximum height attained by ball $BisL/2$

C. The maximum angle made by string attached to $Bis60^\circ$

D. All options are correct

Answer: D

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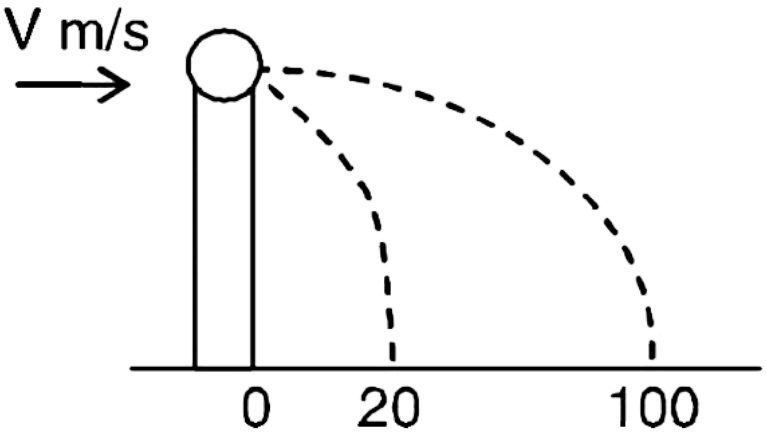
73. A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg, travelling with a velocity Vm/s in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The

velocity V of the bullet is



A. $250m/s$

B. $250\sqrt{2}m/s$

C. $400m/s$

D. $500m/s$

Answer: D

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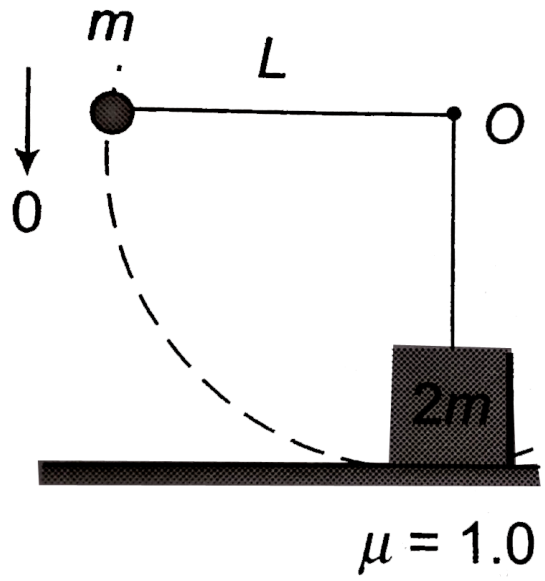
74. The ball is released when the string is horizontal. The collision between the ball and the block is head - on elastic. The velocities of the ball and the block immediately after

collision



A. $\frac{2}{3}\sqrt{2gL}, \frac{1}{3}\sqrt{2gL}$

B. $-\frac{2}{3}\sqrt{2gL}, \frac{1}{3}\sqrt{2gL}$

C. $\frac{2}{3}\sqrt{2gL}, -\frac{1}{3}\sqrt{2gL}$

D. $-\frac{2}{3}\sqrt{2gL}, -\frac{1}{3}\sqrt{2gL}$

Answer: B

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75. In the previous problem , the maximum height attained by the ball and the distance traveled by the block , after collision will be

A. $\frac{2L}{9}, \frac{4L}{9}$

B. $\frac{4L}{3}, \frac{L}{3}$

C. $\frac{4L}{9}, \frac{L}{9}$

D. $\frac{L}{9}, \frac{2L}{9}$

Answer: C

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76. Two sphere A and B of masses m_1 and m_2 respectivelly colides. A is at rest initally and B is moving with velocity v along x-axis. After collision B has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass A moves after collision in the direction.

A. same as that B

B. opposite to that of B

C. $\theta = \tan^{-1}(1/2)$ to the x-axis

D. $\theta = \tan^{-1}(-1/2)$ to the x-axis

Answer: D

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77. A ball , moving with a speed of $10\sqrt{3}m/s$, strikes an identical stationary ball such that after the collision , the direction of each ball

makes an angle of 30° with the original line of motion. The speeds of two balla after the collision are , respectively.

A. $5m/s, 10m/s$

B. $10m/s, 5m/s$

C. $5m/s, 5m/s$

D. $10m/s, 10m/s$

Answer: D

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78. A ball A of mass $1kg$, moving with a speed of $12m/s$, collides obliquely and elasticity with another ball B which was initially at rest. Ball A then moves off at the right angle to its initial direction with a speed of $5m/s$. The momentum of ball B after the collision is

A. $5kgm/s$

B. $11kgm/s$

C. $13kgm/s$

D. $17kgm/$

Answer: C

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79. In elastic collision between spheres P and Q of equal mass but unequal radii , move along a straight line. Which of the following may be correct after the collisions ? (i) P comes to rest and Q moves with velocity of P. (ii) P and Q move with equal speeds making an angle of 45° each with original line of motion.

(iii) P and Q move with unequal speeds , making angles of 30° and 60° with the original line of motion , respectively.

(iv) P comes to rest:

A. (i) only

B. (iv) only

C. (iii) only

D. `None

Answer: C

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80. A sphere has a elastic obique collision with another identical sphere which is initially at rest. The angle between their velocities after the collision is

A. 30°

B. 45°

C. 60°

D. 90°

Answer: D

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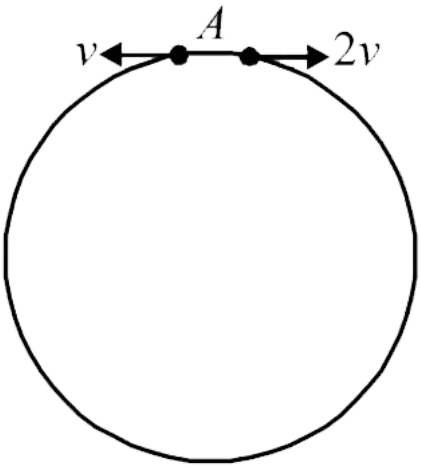
81. Two small particles of equal masses stant moving in opposite direction from a point A in a burtizonetal circule orbic their tangention velocity are V and $2V$, respectively as shown in the figure between collsions , the particals move with constant speed After making how many elastic collition , other the then that at A these two partical will again reach the point

A ?



A. 4

B. 3

C. 2

D. 1

Answer: C

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82. Which of the following is not a perfectly inelastic collision ?

A. Striking of two glass balls

B. A bullet striking a bag of sand

C. An electron captured by a proton

D. A man jumping onto a moving cart

Answer: A

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83. A neutron having a mass of $1.67 \times 10^{-27} kg$ and moving at $10^{8} m/s$ collides with a deuteron at rest and sticks to it. If the mass of the deuteron is $3.33 \times 10^{-27} kg$ then the speed of the combination is

A. $2.56 \times 10^{3} m/s$

B. $2.98 \times 10^{5} m/s$

C. $3.33 \times 10^{7} m/s$

D. $5.01 \times 10^9 m/s$

Answer: C

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

A. zero

B. $288J$

C. $172.8J$

D. $144J$

Answer: C

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85. A bullet of mass m moving with velocity v strikes a block of mass M at rest and gets embedded into it. The kinetic energy of the composite block will be

A. $\frac{1}{2}mv^2 \times \frac{m}{(m+M)}$

B. $\frac{1}{2}mv^2 \times \frac{M}{(m+M)}$

C. $\frac{1}{2}mv^2 \times \frac{(M+m)}{M}$

D. $\frac{1}{2}mv^2 \frac{(M+m)}{m}$

Answer: A

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86. A shere of mass m , moving with velocity V , enters a hanging bag of sand and stop. If the

mass of the bag is M and it is reised by height h, then the velocity of the sphere will be

A. $\frac{M+m}{m}\sqrt{2gh}$

B. $\frac{M}{m}\sqrt{2gh}$

C. $\frac{m}{M+m}\sqrt{2gh}$

D. $\frac{m}{M}\sqrt{2gh}$

Answer: A

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

A. $v/2$

B. $2v$

C. $v/\sqrt{2}$

D. v

Answer: C

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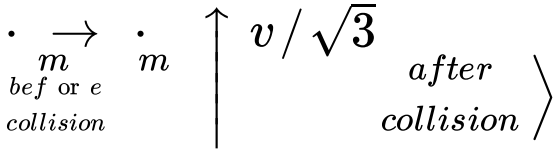
88. A mass 'm' moves with a velocity 'v' and collides inelastieally with another identical mass . After collision the 1^{st} mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2^{nd} mass after collision.



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

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

C. v

D. $\sqrt{3}v$

Answer: A

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89. A bullet of mass $10g$ moving horizontally with a speed of $400m/s$ a block of mass $390g$ and remains in it. The block slides $10m$ on

rough surface before coming to rest. The friction coefficient is

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

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

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

D. 1

Answer: B

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90. In the previous problem , the bullet penetrates the block and emerges with speed v_0.If the block travels $2.5m$ on the rough surface , the value of v_0 is

A. $155m/s$

B. $205m/s$

C. $310m/s$

D. $100m/s$

Answer: B

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91. A bullet of mass $20g$ moving horizontally strikes a block of mass $480g$ suspended by a string of length $2m$. If the collision is completely inelastic , the minimum velocity of bullet , so that the combined mass complete vertical circle should be

A. $100m/s$

B. $150m/s$

C. $200m/s$

D. $250m/s$

Answer: D

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92. In the previous problem. If the bullet is moving with velocity $50\sqrt{2}m/s$, the maximum angle made by string with vertical is

A. 60°

B. 45°

C. $\sin^{-1}\left(\frac{4}{5}\right)$

D. $\cos^{-1}\left(\frac{4}{5}\right)$

Answer: D

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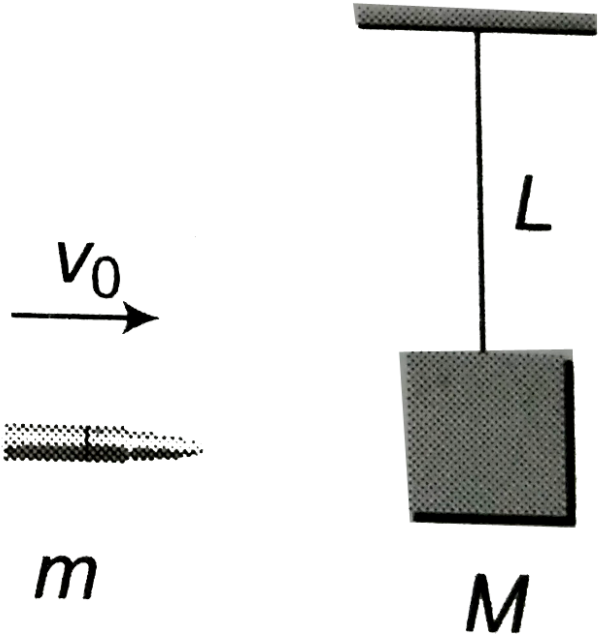
93. Consider the situation as shown in the diagram. The bullet penetrates the block and emerges with speed $v_0/3$. If after collision ,

the string becomes horizontal , v_0 will be



A. $\frac{m}{M}\sqrt{2gL}$

B. $\frac{2}{3}\frac{m}{M}\sqrt{2gL}$

C. $\frac{3}{2}\frac{M}{m}\sqrt{2gL}$

D. $\frac{M}{m}\sqrt{2gL}$

Answer: C

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94. A block of mass $2m$ is attached to a string of length $L = 5m$. The block is released when the string is horizontal , it picks up a particle of $2m$ kept at rest at the lowest point. The maximum height attached by the combined mass is

A. $1m$

B. $1.25m$

C. $1.5m$

D. $2.0m$

Answer: B

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95. In the previous problem , if the horizontal surface is rough with friction coefficient 0.5

and collision is elastic , head - on , the distance travelled by the block on the rough surface

A. $5m$

B. $10m$

C. $15m$

D. $20m$

Answer: B

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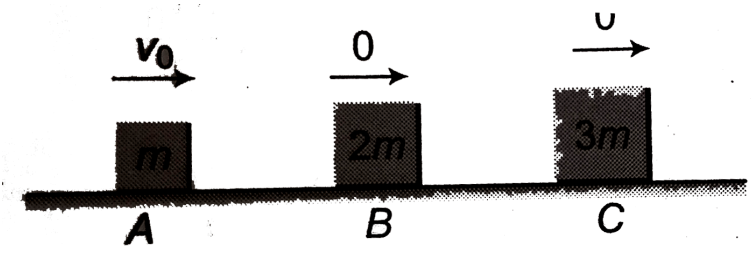
96. Three objects A ,B and C are kept in a straight line on a smooth horizontal surface. These have masses m, $2m$ and $3m$, respectively . The head - on elastic collision takes place between A and B and then B makes completely inelastic collision with C. All motions occur on the same straight line.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



A. $\frac{v_0}{15}$

B. $\frac{2v_0}{15}$

C. $\frac{3v_0}{15}$

D. $\frac{4v_0}{15}$

Answer: D

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97. A set of a identical cubical blocks lies at rest parallel to each other along a line on a smooth horizontal surface. The separation between the near surface of any two adjacent

blocks is L. The block at one and is given a speed v towards the next one at time $t = 0$. All collision are completely inelastic , then the last block starts moving at

A. $(i), (iii)$

B. $(i), (iv)$

C. $(ii), (iii)$

D. $(ii), (iv)$

Answer: D

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98. A ball moving with velocity $2ms^{-1}$ collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in ms^{-1}) after collision will be

A. $0, 2$

B. $0, 1$

C. $1, 1$

D. $1, 0.5$

Answer: B

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99. A sphere A impinges directly on an identical sphere B at rest. If coefficient of restitution is e , the ratio of velocities of A and B after collision is

A. $\frac{1-e}{1+e}$

B. $\frac{1+e}{1-e}$

C. $\frac{e}{1+e}$

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

Answer: A

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100. In the previous problem , sphere A is moving with speed u_1 and sphere B with speed u_2 in opposite direction. After the collision , sphere A comes to rest , then u_1/u_2 is

A. $\frac{1-e}{1+e}$

B. $\frac{1+e}{1-e}$

C. $\frac{e}{1+e}$

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

Answer: B

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101. Two balls of masses $2m$ and m are moving with speed $2v_0$ and v_0 towards each other. If the coefficient of restitution $e = 1/3$, the speed of balls , if collision is head - on

A. $\frac{v_0}{3}, \frac{4v_0}{3}$

B. $\frac{2v_0}{3}, \frac{5v_0}{3}$

C. $\frac{2v_0}{3}, \frac{4v_0}{3}$

D. $\frac{v_0}{3}, \frac{2v_0}{3}$

Answer: B

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102. A block of mass m moving with speed v_0 strikes another particle of mass $2m$ at rest. If collision is head - on and the coefficient of

restitution $e = 1/2$, then the loss in kinetic energy will be

A. $\frac{1}{2}mv_0^2$

B. $\frac{1}{3}mv_0^2$

C. $\frac{2}{3}mv_0^2$

D. $\frac{3}{4}mv_0^2$

Answer: B

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103. In the previous problem , the maximum loss in $K.E.$ will be

A. $\frac{1}{2}mv_0^2$

B. $\frac{1}{3}mv_0^2$

C. $\frac{2}{3}mv_0^2$

D. $\frac{3}{4}mv_0^2$

Answer: B

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104. A $2kg$ ball , moving at $10m/s$, collides head - on with a $3kg$ ball moving in the opposite direction at $20m/s$. If the coefficient of restitution is $1/3$, then the energy lost in the collision is

A. $120J$

B. $240J$

C. $360J$

D. $480J$

Answer: D

Watch Video Solution

105. 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.

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

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

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

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

Answer: C

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106. A ball is dropped from a height h onto a floor and rebounds to a height $h/6$. The coefficient of restitution between the ball and the floor is

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

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

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

D. $\frac{1}{\sqrt{6}}$

Answer: B

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107. A body falling from a height of $10m$ rebounds from the hard floor . It

A. 0.89

B. 0.56

C. 0.23

D. 0.18

Answer: A

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108. A ball is dropped from a height of $20m$ on a floor for which $e = 1/2$. The height attained by the ball after the second collision

A. $1.25m$

B. $2.5m$

C. $5m$

D. $10m$

Answer: C

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109. In the previous problem , time taken by the ball up to the third collision

A. $3s$

B. $4s$

C. $5s$

D. $6s$

Answer: A

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110. A partical falls from a height h upon a fixed horizontal plane and rebounds. If e is the coefficient of restitution, the total distance travelled before rebounding has stopped is

A. $h\left(\frac{1+e^2}{1-e^2}\right)$

B. $h\left(\frac{1-e^2}{1+e^2}\right)$

C. $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$

D. $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

Answer: D

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

A. $(i), (ii)$

B. $(i), (iv)$

C. $(ii), (iii)$

D. $(iii), (iv)$

Answer: D

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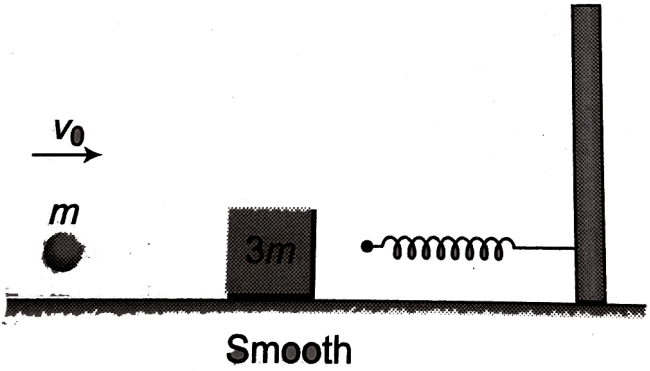
112. A ball of mass m moving with speed v_0 strikes a block of mass $3m$ kept at rest. The collision is completely inelastic . If k is spring

constant , the maximum compression of the spring is



A. $\sqrt{\frac{mv_0^2}{k}}$

B. $\sqrt{\frac{mv_0^2}{2k}}$

C. $\sqrt{\frac{mv_0^2}{3k}}$

D. $\sqrt{\frac{mv_0^2}{4k}}$

Answer: B

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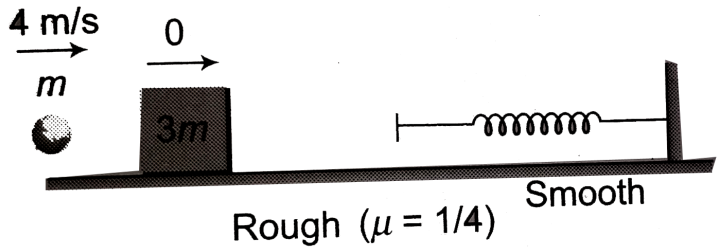
113. In the previous problem , mass of the ball is $10g$ and it is moving with $4m/s$. The surface from the block to free end of spring is rough with friction coefficient $\mu = 1/14$ and of length $10cm$. The maximum compression of

spring $(k = 50N/m)$ is



A. $1cm$

B. $2cm$

C. $3cm$

D. $4cm$

Answer: B

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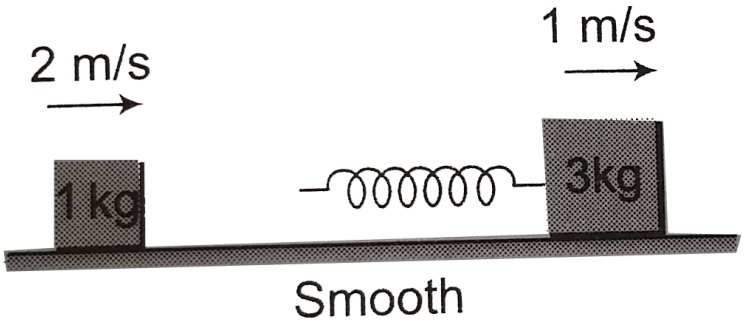
114. Two blocks of masses $1kg$ and $3kg$ are moving with velocities $2m/s$ and $1m/s$, respectively , as shown. If the spring constant is $75N/m$, the maximum compression of the spring is



A. $5cm$

B. $2cm$

C. $3cm$

D. $4cm$

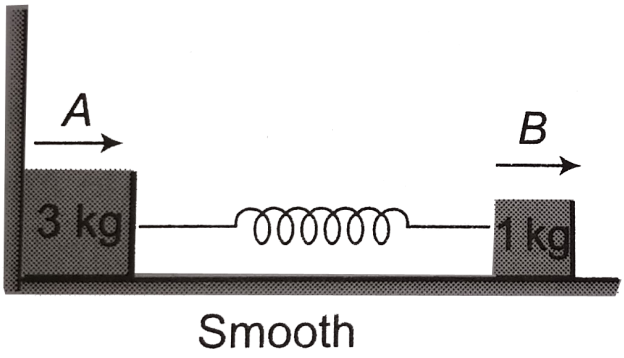
Answer: B

Watch Video Solution

115. Initially spring is in its natural length . The block of mass $3kg$ in contact with rigid wall . The block of mass $1kg$ is pushed through a distance $4cm$ towards the wall and then released. The velocity of the center of mass

when the block of mass $3kg$ breaks off the wall

is $(k = 100N/m)$



A. $0.1m/s$

B. $0.2m/s$

C. $0.3m/s$

D. $0.4m/s$

Answer: A

Watch Video Solution

116. In the previous problem , the maximum elongation of the spring is

A. $2cm$

B. $3cm$

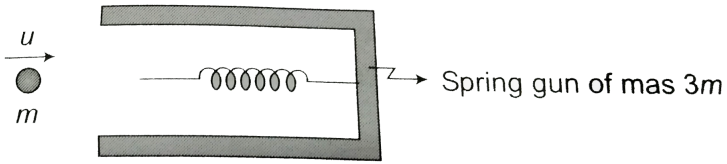
C. $2\sqrt{3}cm$

D. $2\sqrt{5}cm$

Answer: C

Watch Video Solution

117. When the spring is compressed to maximum , what fraction of incidetn the kinetic energy is stored in spring ?



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

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

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

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

Answer: C

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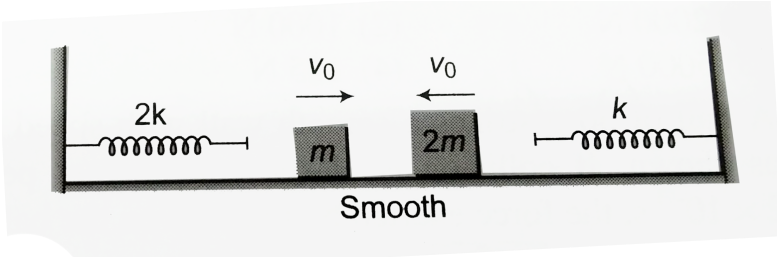
118. If blocks collide elastically head - on , the ratio of maximum compression of the left spring and the right spring will be



A. $3:5$

B. $2:3$

C. $5:4$

D. $5:2$

Answer: D

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119. Two identical blocks A and B , each of mass m resting on smooth floor are connected by a light spring of natural length L and spring constant k, with the spring at its natural length. A third identical block C (mass

m) moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is

A. $v\sqrt{\frac{m}{2k}}$

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

C. $\sqrt{\frac{mv}{k}}$

D. $\frac{mv}{2k}$

Answer: A

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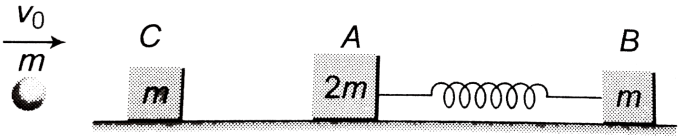
120. The ball sticks to block C, then block C collides elastically , head - on with A. If the maximum compression is x_0, the spring constant k is



A. $\frac{2}{3}\frac{mv_0^2}{x_0^2}$

B. $\frac{mv_0^2}{2x_0^2}$

C. $\frac{mv_0^2}{3x_0^2}$

D. $\frac{mv_0^2}{6x_0^2}$

Answer: D

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121. A particle of mass m moving with kinetic energy K, makes a head - on elastic collision with a stationary particle of mass ηm. The maximum potential energy stored in the system during the collision is

A. $\frac{\eta}{\eta+1}K$

B. $\frac{\eta+1}{\eta}K$

C. $(\eta - 1)K$

D. $(\eta - 1)K$

Answer: A

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122. Two trolleys of mass m and $3m$ are attached by a spring. The spring was compressed and then released , they move off in opposite direction and comes to rest after covering distances s_1 and s_2 respectively.

Assuming the coefficient of friction to be uniform , the ratio of distances $s_1 : s_2$ is

A. $1:9$

B. $1:3$

C. $3:1$

D. $9:1$

Answer: D

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123. A ball of mass $0.5kg$ moving with a velocity of $2m/s$ strikes a wall normally and bounces back with the same speed . If the time of contact between the ball and the wall is 1 millisecond , the average force exerted by the wall on the ball is

A. $2000N$

B. $1000N$

C. $5000N$

D. $125N$

Answer: A

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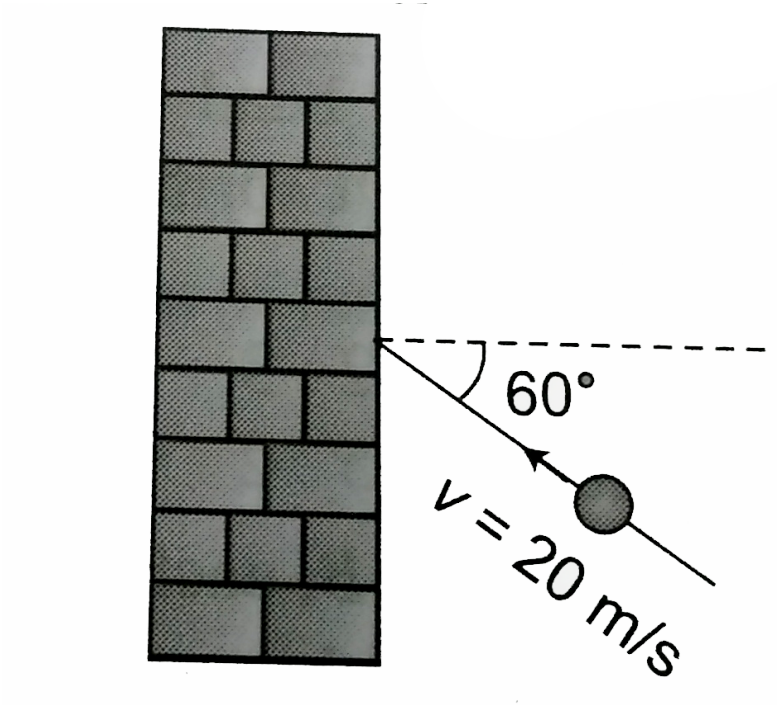
124. A ball of $50g$ strikes a smooth wall with speed $20m/s$ as shown. If collision is elastic and contact period is as shown . If collision is elastic and contact period is $2 \times 10^{-3}s$, the

force exerted by the wall on the ball is



A. $250N$ to right

B. $250N$ to left

C. $500N$ to right

D. $500N$ to left

Answer: C

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125. In the previous problem , if the collision is inelastic and $e = 1/2$

A. After collision , the ball moves with $5\sqrt{13}m/s$ at angle $\tan^{-1}\left(2\sqrt{3}\right)$ with horizontal

B. Force by wall on the ball is $375N$ to right

C. Change in momentum of ball is

$0.75kgm/s$

D. All options are correct

Answer: D

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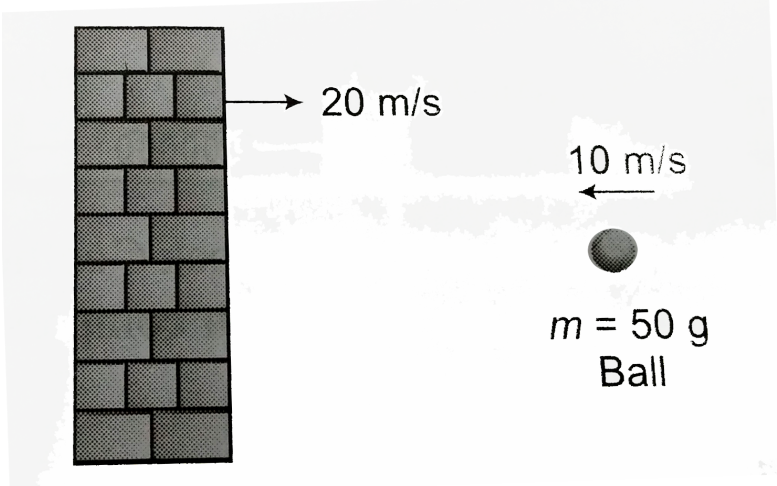
126. Consider the situation as shown in the diagram , the ball strikes the wall normally and the collision is elastic , the change in the

kinetic energy of the ball is



A. $30J$

B. $60J$

C. $90J$

D. $120J$

Answer: B

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127. In the previous problem , if the collision is inelastic and the coefficient of restitution is $e = 1/2$, the momentum imparted to the way by the wall is

A. $0.25 kgm/s$

B. $0.50 kgm/s$

C. $0.75 kgm/s$

D. $1 kgm/s$

Answer: C

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128. In head - on collision between two particles A and B of same mass , A is moving with momentum $15kgm/s$, B is stationary . During the impact , B gives impulse $10N - s$ to A . The coefficient of restitution is

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

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

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

D. $\frac{1}{5}$

Answer: B

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129. A ball of mass m is dropped onto a floor from a certain height. The collision is perfectly elastic and the ball rebounds to the same height and again falls. Find the averge force

exerted by the ball on the floor during a long time interval.

A. $2mg$

B. mg

C. $3mg$

D. $4mg$

Answer: B

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130. A metal ball and a rubber ball , both having the same mass , strike a wall normally with the same velocity. The rubber ball rebounds and the metal ball does not rebound. It can be concluded that

A. the rubber ball suffers greater change in momentum

B. The metal ball suffers greater change in momentum

C. Both suffer same change in momentum

D. The initial momentum of the rubber ball is greater than that of metal ball.

Answer: A

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131. n balls each of mass m impinge elastically each second on a surface with velocity u. The average force experienced by the surface will be

A. mnu

B. $2mnu$

C. $4mnu$

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

Answer: B

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132. A disc of mass $10g$ is kept floating horizontally by throwing $10\text{marbles}/\text{second}$ against it from below.If the mass of each

marble is $5g$, the velocity with which marbles are striking the disc (the marbles strike the disc normally and rebound downward with the same speed)

A. $3m/s$

B. $2m/s$

C. $1m/s$

D. $4m/s$ in original direction

Answer: C

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133. If two balls each of mass $0.06kg$ moving in opposite directions with speed $4m/s$ collide and rebound with the same speed , then the impulse imparted to each ball due to other is

A. $0.48kgm/s$

B. $0.24kgm/s$

C. $0.81kgm/s$

D. Zero

Answer: A

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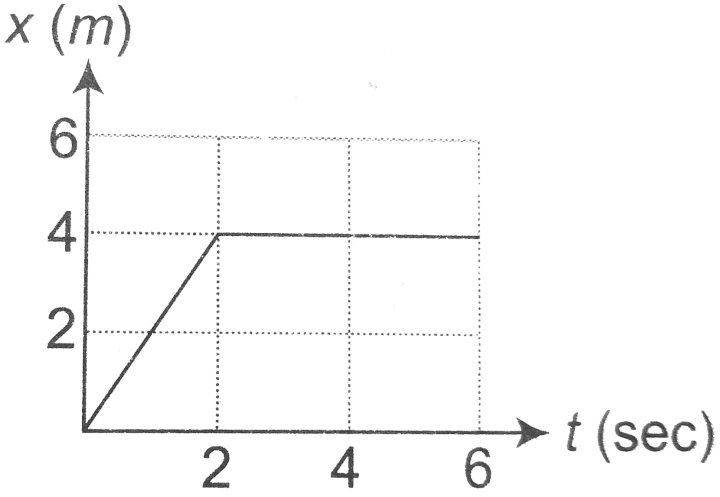
134. In the figure given below, the position-time graph of a particle of mass $0.1kg$ is shown. The impuslse at $t = 2$ sec is



A. $0.2kgm/s$

B. $-0.2kgm/s$

C. $0.1kgm/s$

D. $-0.4kgm/s$

Answer: B

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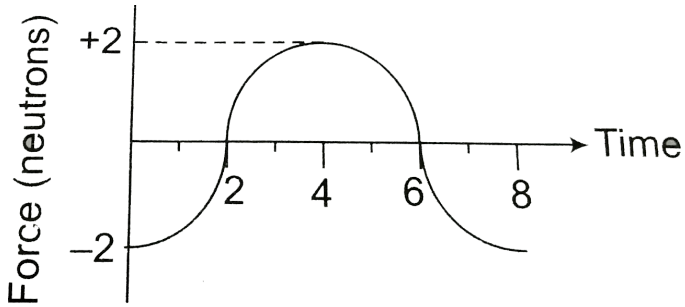
135. A force - time graph for a linear motion is shown in the figure where the segments are circular. The linear momentum gained

between zero and $8s$ is



A. $-2\pi N - s$

B. Zero

C. $-4\pi N - s$

D. $-6\pi N - s$

Answer: B

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136. A bullet is fired from a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5$ t, where F is in newtons and t in seconds. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

A. $9N - s$

B. zero

C. $0.9N - s$

D. $1.8N - s$

Answer: C

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137. A particle of mass $2kg$ is initially at rest. A force starts acting on it in one direction whose magnitude changes with time. The force time graph is shown in figure. Find the

velocity of the particle at the end of $10s$.

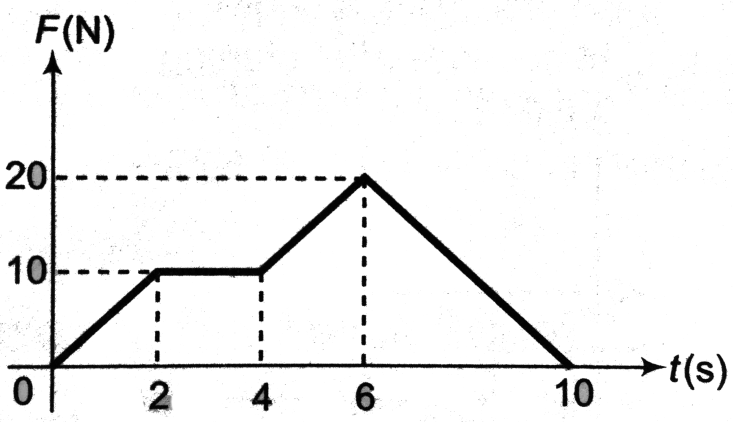

Fig. 11.29

A. $20m/s$

B. $10m/s$

C. $75m/s$

D. $50m/s$

Answer: D

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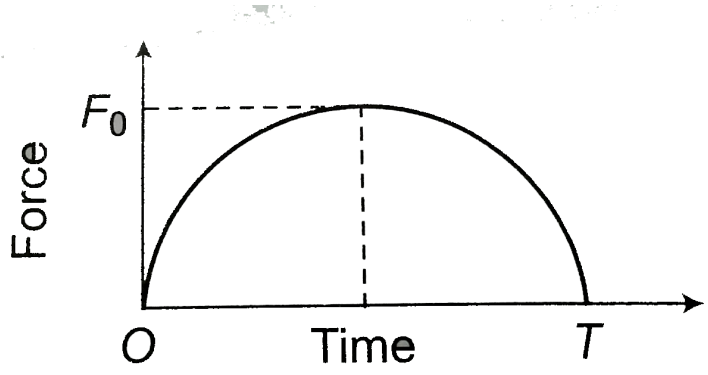
138. A particle of mass m , initially at rest , is acted upon by a variable force F for a brief interval of time T. It begins to move with a velocity u after the forrce stops acting . F is shown in the graph as a function of time. The curve is a semicircle.



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

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

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

D. $\frac{F_0 T}{2m}$

Answer: C

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139. 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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140. Consider a rubber ball freely falling from a height $h = 4.9m$ onto a horizontally elastic plate. Assume that the duration of collision is negligible and the collisions with the plate is totally elastic .

Then the velocity as a function of time and the height as a function of time will be :

A. 

B. 

C. 

D. 

Answer: C

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141. Two balls , having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$, undergo a collision in free space. There is no external force acting on the balls. Let $\vec{p}_1$ and $\vec{p}_2$, be their final momenta. The following option(s) is (are) NOT ALLOWED for any non -zero value of $p, a_1, a_2, b_1, b_2, c_1$ and c_2

(i) $\vec{p}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}, \vec{p}_2 = a_2\hat{i} + b_2\hat{j}$

(ii) $\overrightarrow{p}_1 = c_1\overrightarrow{k}, \overrightarrow{p}_2 = c_2\hat{k}$

(iii)

$\overrightarrow{p}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}, \overrightarrow{p}_2 = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$

(iv) $\overrightarrow{p}_1 = a_1\hat{i} + b_1\hat{j}, \overrightarrow{p}_2 = a_2\hat{i} + b_1\hat{j}$

A. $(i), (ii)$

B. $(ii), (iii)$

C. $(iii), (iv)$

D. $(i), (iv)$

Answer: D

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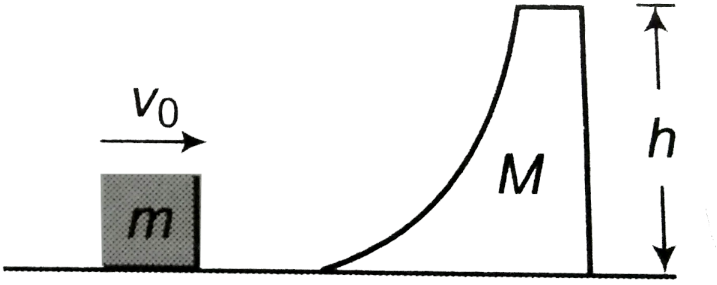
142. A block of mass m is pushed towards the movable wedge of mass M and height h, with a velocity v_0. All surfaces are smooth . The minimum value of v_0 for which the block will reach the top of the wedge is



A. $\sqrt{2gh}$

B. $\sqrt{\frac{2ghm}{M}}$

C. $\sqrt{\frac{2gh(m+M)}{M}}$

D. $\sqrt{\frac{2ghm}{(m+M)}}$

Answer: C

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143. Rocket works on the principle of coservation of

A. mass

B. linear momentum

C. energy

D. angular momentum

Answer: B

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144. Rocket propulsion is associated with

A. The conservation of the angular momentum

B. The conservation of the mass

C. The conservation of the mechanical energy

D. Newton's III law of motion

Answer: D

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145. The rate of mass of the gas emitted from the rear of a rocket is initially $0.1kg/s$. If the speed of the gas relative to the rocket is

$50m/s$ and the mass of the rocket is $2kg$, then the acceleration of the rocket in m/s^2 is

A. 5

B. 5.2

C. 2.5

D. 25

Answer: C

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146. A 500kg rocket is set for verticle firing. The exhaust speed is 800ms^{-2} . To give an initial upward acceleration of 20ms^{-2} , the amount of gas ejected per second to supply the needed thrust will be (g=10 ms^{-2})

A. $127.5kg/s$

B. $187.5kg/s$

C. $85kg/s$

D. $137.5kg/s$

Answer: B

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147. A satellite in a force - free space sweeps stationary interplanetary dust at a rate $dM/dt = \alpha v$, where M is the mass , $v$is the velocity of the satellite and α is a constant. What is the deacceleration of the satellite ?

A. $-2\alpha v^2/M$

B. $-\alpha v^2/M$

C. $+\alpha v^2/M$

D. $-\alpha v^2$

Answer: C

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148. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other . The first part of mass $1kg$ moves with a speed of $12m/s$ and the second part of mass $2kg$ moves with

$8m/s$. If the third part flies off with $4m/s$ the speed , then its mass is

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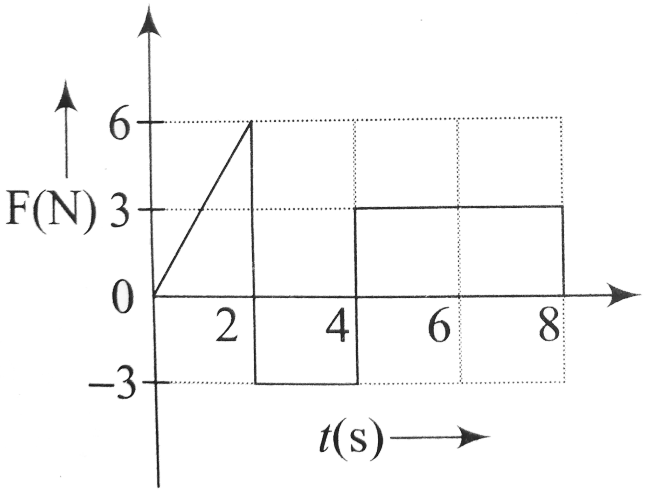
149. The force F acting on a partical of mass m is indicated by the force-time graph shown below. The change in momentum of the

particle over time interval from zero to 8 s is.



A. $20Ns$

B. $12Ns$

C. $6Ns$

D. $24Ns$

Answer: B

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150. A particle of mass 4 m which is at rest explodes into three fragments. Two of the fragments each of mass m are found to move with a speed v each in mutually perpendicular directions. The total energy released in the process of explosion is .....

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

B. $2mv^2$

C. $4mv^2$

D. mv^2

Answer: A

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