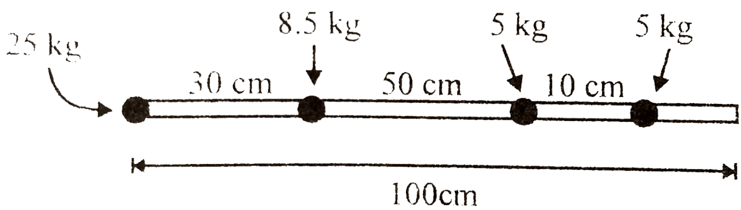
PHYSICS

BOOKS - GK PUBLICATIONS PHYSICS (HINGLISH)

LINEAR MOMENTUM & ITS CONSERVATION

Illustrative Example

1. Figure shows a rod of mass 10 kg of length 100cm with some masses tied to it at different position. Find the point on the rod at which if the rod is picked over a knife edge, it will be in equilibrium about that knife edge.



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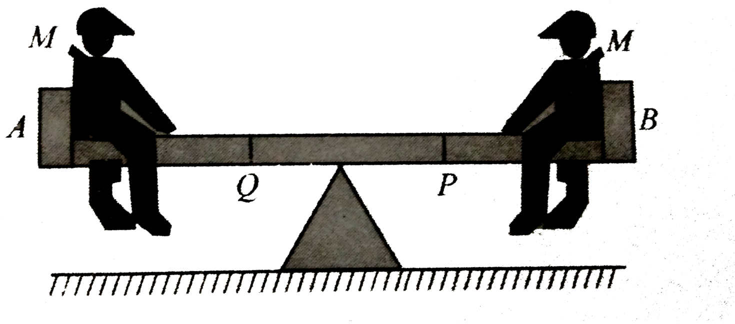
2. Two children A and B of same mass (including their caps) M are sitting On a see-saw as shown in Fig. Initially, the beam is horizontal. At once, child B throws away his cap (mass $\frac{M}{25}$) which falls at point Q, midpoint of the left half of the beam, due to this the balance of beam is disturbed. To balance it again what is the mass in required to be put at point P on the right half of the beam?



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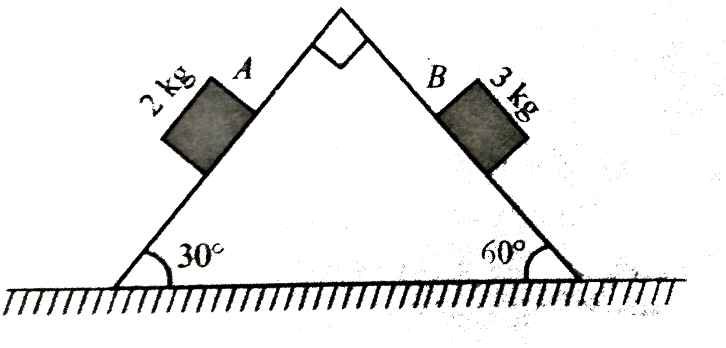
3. Figure shows a fixed wedge on which two blocks of masses $2kg$ and $3kg$ are placed on its smooth inclined surfaces. When the two blocks are released from rest, find the acceleration of centre of mass of the two blocks.



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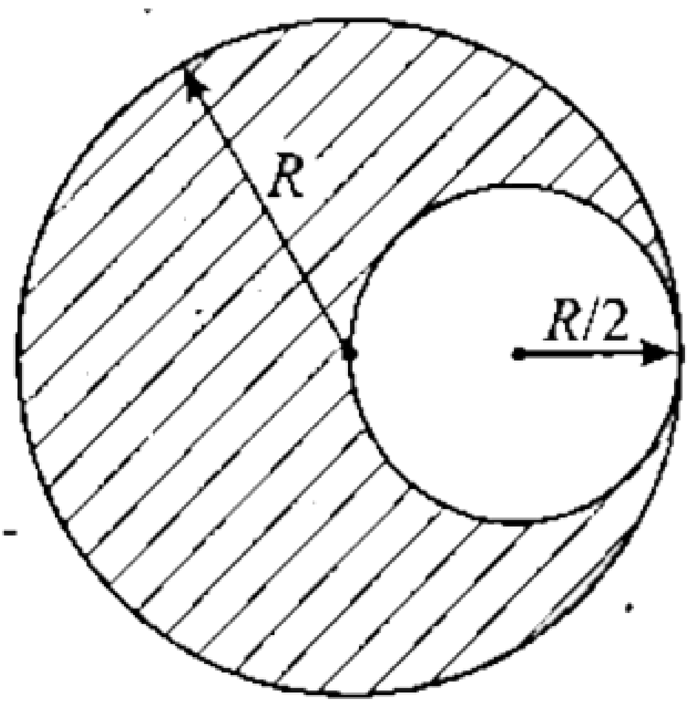
4. Figure-4.11 shows a circular a disc of radius R from which a small disc is cut such that the periphery of the small disc touch the large disc and whose radius is $R/2$. Find the centre of mass of the remaining part of the disc.



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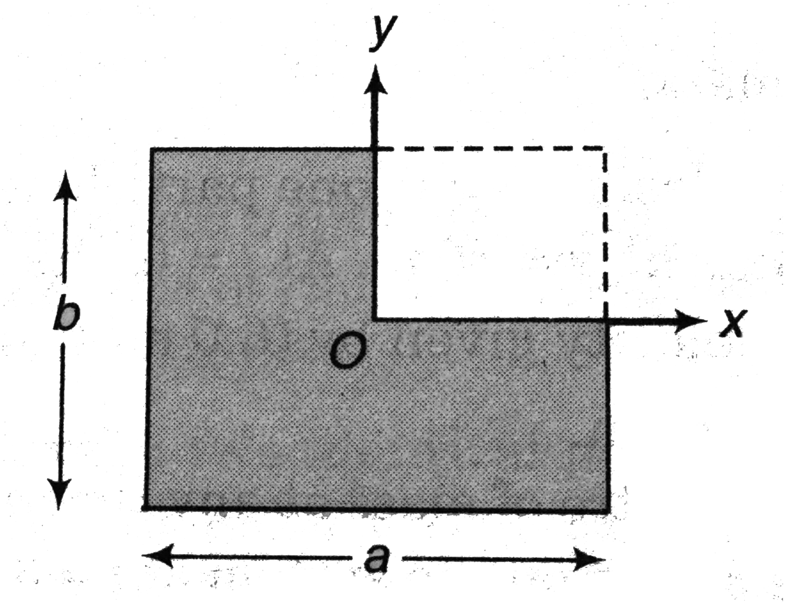
5. Consider a rectangular plate of dimensions $a \times b$. If this plate is considered to be made up of

four rectangles of dimensions $\frac{a}{2} \times \frac{b}{2}$ and we now remove one out of four rectangles. Find the position where the centre of mass of the remaining system will lie?



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6. There are two masses m_1 and m_2, placed at a distance l apart, let the centre of mass of this system is at a point named C. If m_1 is displaced by l_1 towards C and m_2 is displaced by l_2 away from C, find the distance from (C) where the new centre of mass will be located.

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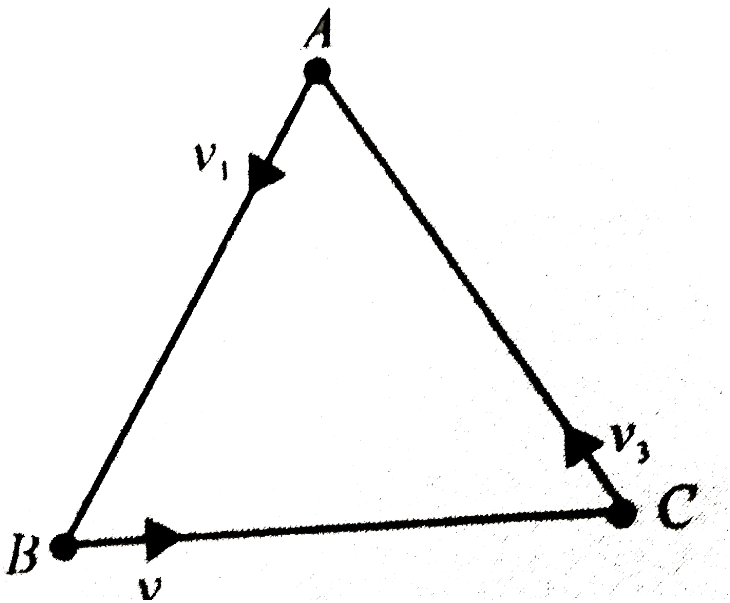
7. Let there are three equal masses situated at the vertices of an equilateral triangle, as shown in Fig. Now particle A starts with a velocity v_1

towards line AB, particle B starts with the velocity v_2, towards line BC and particle C starts with velocity v_3 towards line CA. Find the displacement of the centre of mass of the three particles A, B and C after time t. What would it be if $v_1 = v_2 = v_3$?



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8. AB is a uniformly shaped rod of length L and cross sectional are S, but its density varies with distance from one end A of the rod as $\rho = px^2 + c,$ where p and c are positive constants. Find out the distance of the centre of mass of this rod from the end A.

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9. Find out the centre of mass of an isosceles triangle of base length a and alititude b. Assume that the mass of the triangle is uniformly distributed over its area.

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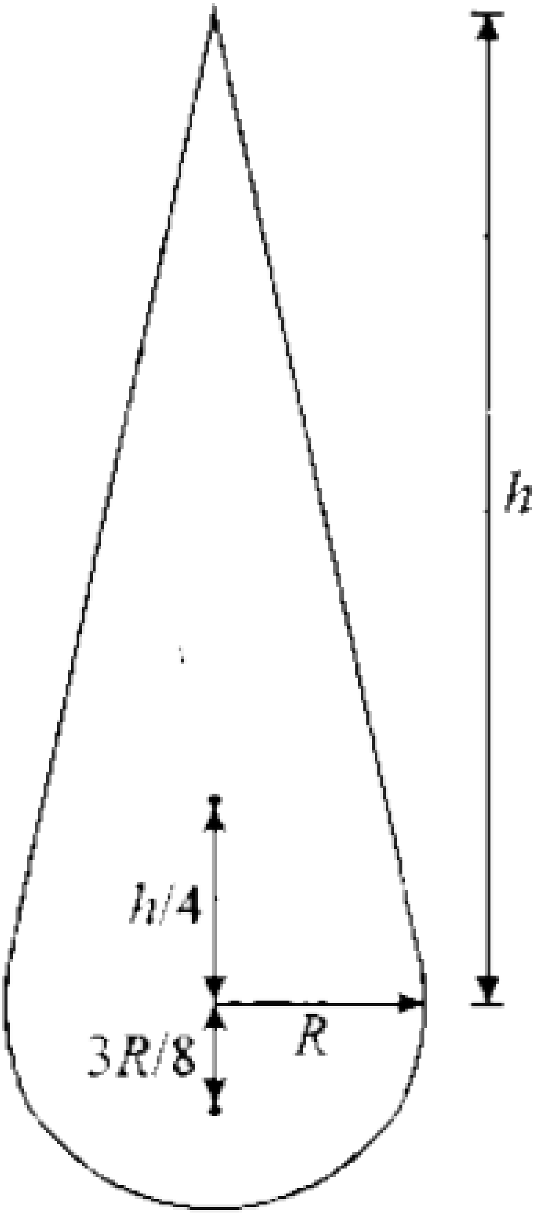
10. Find out the centre of mass of a composite object shown in figure-4.28. Object consists of a cone with its base joint with the base of a hemisphere. The dimensions of the object are shown in figure. Assume uniform density of the system, find the centre of mass of this system.



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11. A table has a heavy circular top of radius 1 m and mass 20 kg. It has four light legs of lengths 1 m fixed symmetrically on its circumference. (a) What is the maximum mass that may be placed any where on this table without toppling the table ? (b) What is the area of the table tope over which any weight may be placed without toppling it ?

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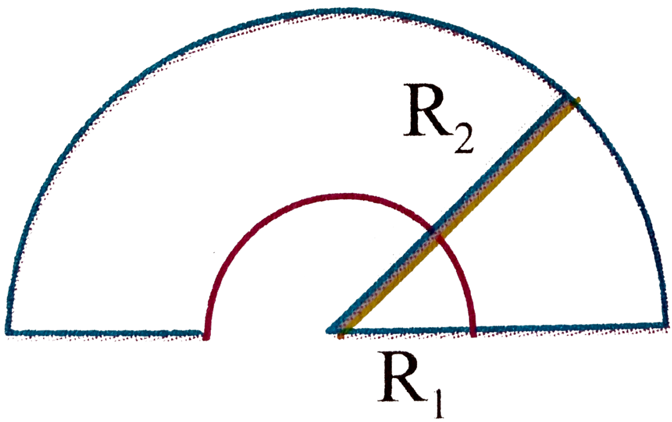
12. Find moment of inertia of half disc of radius R_2 and mass M about its centre. A smaller half disc of radius R_1 is cut from this disc



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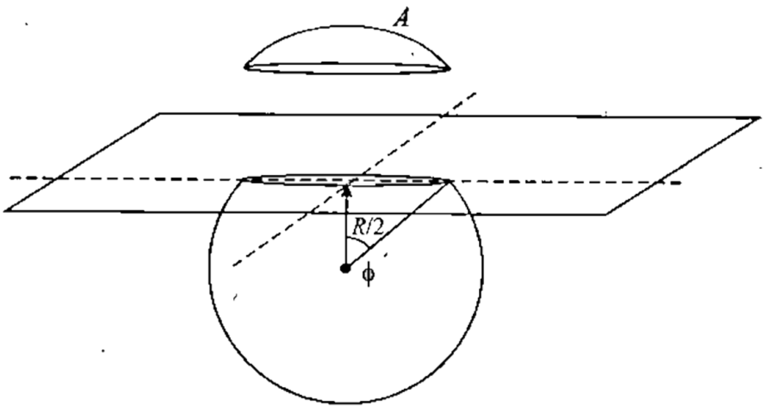
13. From a solid sphere a small part A is cut by a plane at a distance $R/2$ from the centre as shown in figure-4.32. Find the centre of mass of object A.



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14. A plank of mass M and length L is at rest on a frictionless floor. At one end of it a child of mass m is standing as shown in figure-4.41. If child walks towards the other end, find the distance, which the plank moves (a) till the child reaches the centre of the plank, (b) till the child reaches the other end of the plank.

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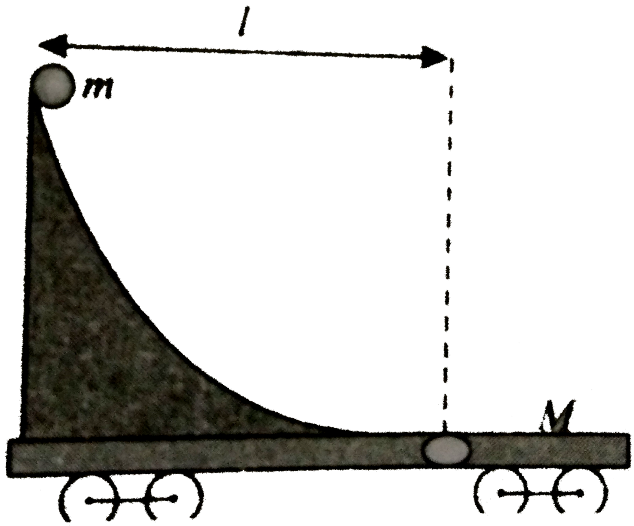
15. Figure shows a flat car of mass M on a frictionless road. A small massless wedge is fitted on it as shown. A small ball of mass m is released from the top of the wedge, it slides over it and falls in the hole at distance l from the initial position of the ball. Find the distance the flat car moves till the ball gets into the hole.



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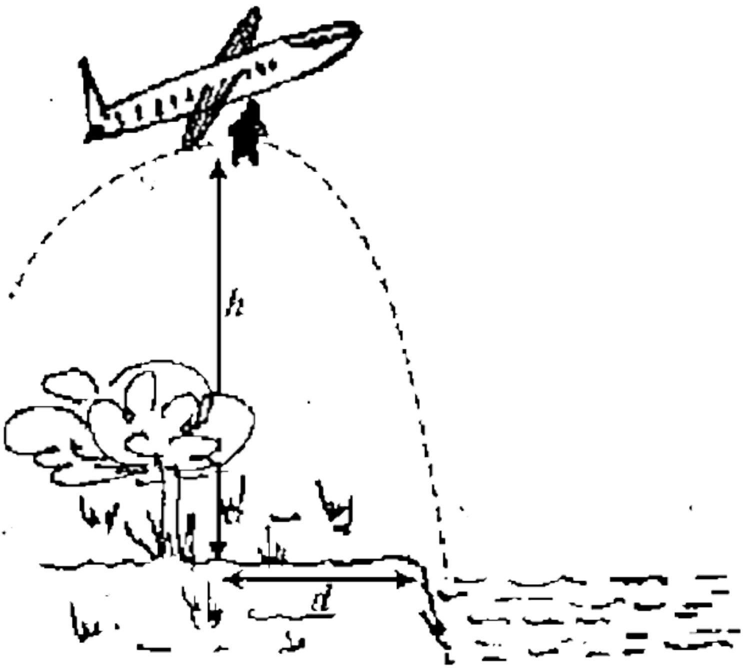
16. A man of mass M jumps from an aeroplane as shown in figure-4.43. He sees the hard ground below him and a lake at a distance d from the point directly below him. He immediately put off

his jacket (mass=m) and throws it in a direction directly away from the lake. If he just fail to strike the ground, find distance he should walk know to pick his jacket. (Neglect air resistance and take the velocity of man at the time of jump with respect to earth is zero.)



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17. Two men of same mass m hold the two ends of a rope and start pulling each other on a friction less plane. Find the position where they will meet. Is there any difference, if masses of men are not equal.

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18. A flat car of mass m is at rest on a frictionless floor with a child of mass m standing at its edge. If the child jumps off from the car towards right with an initial velocity u, with respect to the car, find the velocity of the car after its jump.

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19. A flat car of mass M with a child of mass m is moving with a velocity v_1. The child jumps in the direction of motion of car with a velocity u with respect to the car. Find the final velocities of the child and that of the car after jump.

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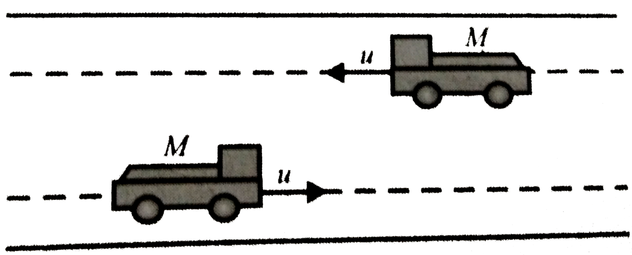
20. Two trucks of mass M each are moving in opposite direction on adjacent parallel tracks with same velocity u. One is carrying potatoes and other is carrying onions, a bag of potatoes has a mass m_1 and a bag of onions has a mass m_2 (included i the mass of truck M). When trucks get close to each other while passing the drivers exchange a bag with the other one by throwing the other one. Find the final velocities of the trucks after exchange of the bags.



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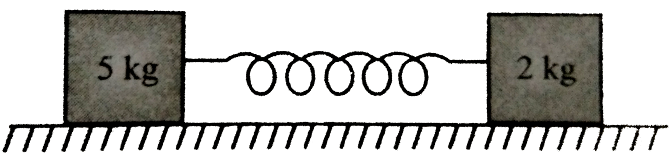
21. Figure shows two blocks of masses $5kg$ and $2kg$ placed on a frictionless surface and connected with a spring. An external kick gives a velocity of $14m/s$ to the heavier block in the direction of lighter one. Deduce (a) velocity gained by the centre of mass and (b) the separate velocities of the two blocks in the centre of mass coordinates just after the kick.



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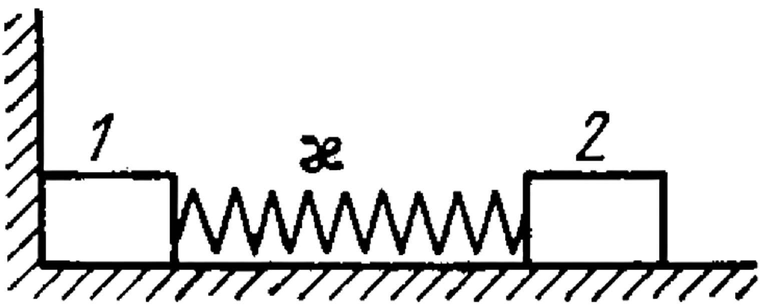
22. Two bars of masses m_1 and m_2 connected by a weightless spring of stiffness $\varkappa$ (figure) rest on a smooth horizontal plane.



Bar 2 is shifted a small distance x to the left and then released. Find the velocity of the centre of inertia of the system after bar 1 breaks off the wall.

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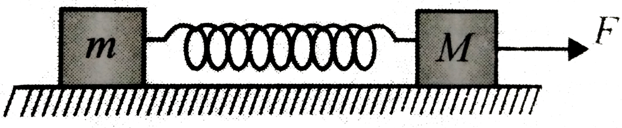
23. A block of mass m is connected to another block of mass M by a massless spring of spring constant k. the blocks are kept of a smooth horizontal plane and are at rest. The spring is unstretched when a constant force F starts acting on the block of mass M of pull it. Find the maximum extension of the spring



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24. A shell is fixed from a cannon with a speed of $100m/s$ at an angle 60° with the horizontal (positive x-direction). At the highest point of its trajectory, the shell explodes into two equal fragments. One of the fragments moves along the negative x-direction with a speed of $50m/s$.

What is the speed of the other fragment at the time of explosion.

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25. A shell is fired from a cannon with a speed of $100m/s$ at an angle 30° with the vertical (y-direction). At the highest point of its trajectory, the shell explodes into two fragments of masses in the ratio $1:2$. The lighter fragment moves vertically upwards with an initial speed of $200m/s$. What is the speed of the heavier fragment at the time of explosion?

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26. A body of mass 10 kg is pulled with a time varying horizontal force $F = 2t^2$ N on a rough surface having friction coefficient $\mu = 0.2$. Find the speed of block after 6 seconds.

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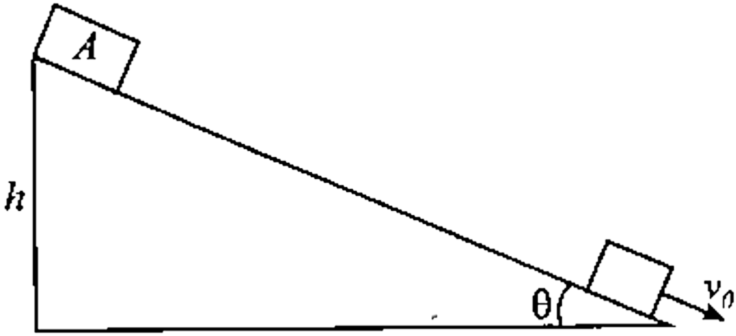
27. A block of A is released from rest from the top of wedge block of height h shown in figure-4.55. If velocity of block when it reaches the bottom of inclive is v_0, find the time os sliding.



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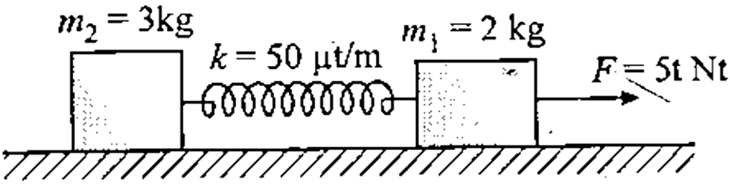
28. On a spring block system shown in figure-4.56, a time varying force F=5t N is applied on 2 kg mass. After 10 s, velocity of 3 kg mass is $30m/\sec$.

Find velocity of 2 kg mass at this instant.



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29. A tank-car of mass M is at rest on a road. At t=0, a force F starts acting on the tank-car also the rain fall starts, in vertical direction, as shown in figure-4.57. The rain is falling with a velocity v_r with respect to earth and the rate of collection of water in the tank is rkg/s. find the velocity of the tank-car as a function of time t.

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30. A cart loaded with sand moves along a horizontal floor due to a constant force F coinciding in direction with cart's velocity vector. In the process, the sand spills through a hole in the bottom with a constant rate $\mu kg/s$. Find the acceleration and velocity of the cart at the moment t, if at the initial moment $t=0$ the cart with loaded sand had mass m_0 and its velocity was equal to zero. Friction is to be neglected.

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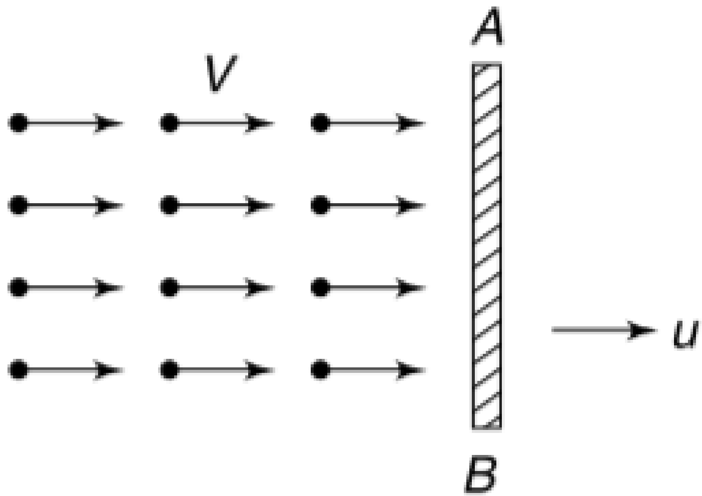
31. A beam of gas molecules is incident normally on a plate AB. Each gas molecule has mass m and velocity V. The incident beam falls on an area A on the plate and all the molecule strike the plate elastically. Number of molecules in unit volume of the beam is n. When the plate is moved to right (see fig.) a force F_1 is needed to keep it moving with constant velocity u $(> V)$. When the plate is moved to left with constant velocity u, an external force F_2 is needed. Find $F_2 - F_1$.



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32. A ball is dropped on a floor from a height h. If the coefficient of restitution is e, find the height to which the ball will rise after touching the floor and the time it will take to come to rest again.

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33. An elevator platform is going up at a speed of $20m/s$ and during its upward motion a small ball of $50g$ mass, falling in downward direction, strikes the platform at speed $5m/s$. Find the speed with which the ball rebounds.

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34. A neutron moving at a speed v undergoes a head-on elastic collision with a nucleus of mass number A at rest. The ratio of the kinetic energies of the neutron after and before collision is :

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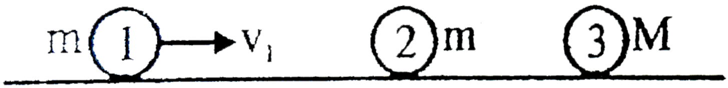
35. Two balls marked 1 and 2 of the same mass m and a third ball marked 3 of mass M are arranged over a smooth horizontal surface as shown in the figure. Ball 1 moves with a velocity v_1 towards ball 2. All collisions are assumed to be elastic. If $M < m$, the number of collisions between the balls will be.



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36. Two balls approaching each other along two perpendicular directions and collide at the intersection. After the collision, they stick together. If one ball has a mass of 14.5 kg and an initial speed of $11.5 m / s$ and the other has a mass of 17.5 kg and an initial speed of $15.5 m / s$, what will be their speed and direction immediately after impact ?

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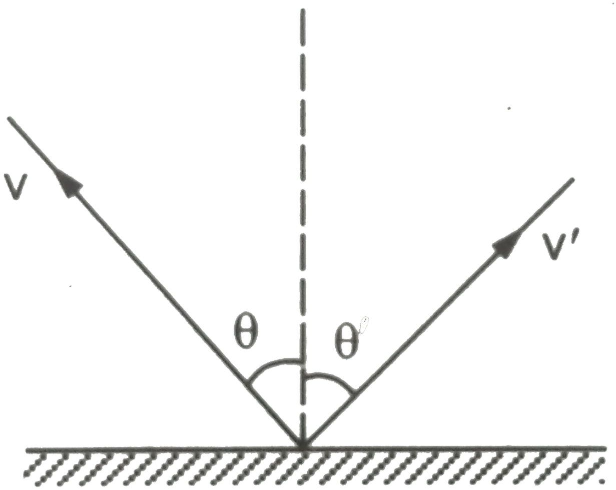
37. A ball of a mass m hits the floor with as speed v making an angle of incidence θ with the normal. The coefficient of restitution is e. Find the speed of the reflected ball and the angle of reflection of the ball.



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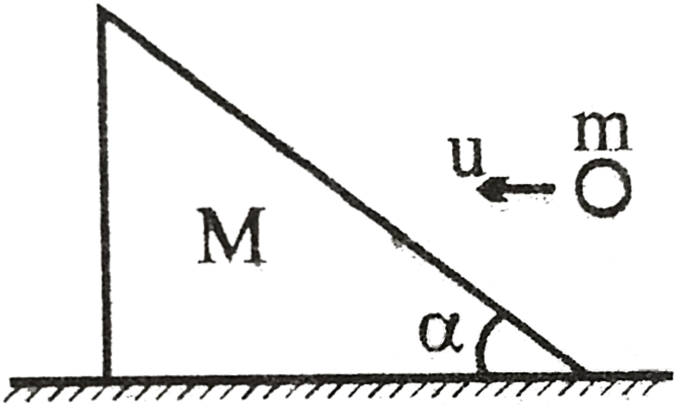
38. A wedge mass m rest on horizontal surface. The inclination of the wedge is α. A ball of mass m moving horizontal with speed u hits the inclined face of the wedge inelastically and after hitting slides up the inclined face of the wedge. Find the velocity of the wedge just after collision. Neglect any friction.



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39. A ball of mass m is just disturbed from the top of a fixed smooth circular tube in a vertical plane and falls impinging on a ball of mass 2 m at the bottoom. The coefficient of restituion is $1/2$. Find the heights to which the balls rise after a second impact.

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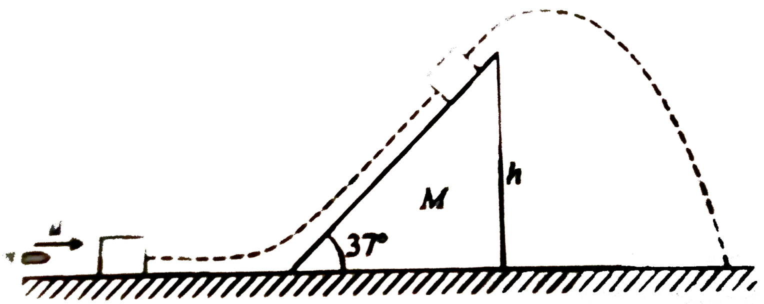
40. A mass M=1 kg lies on a smooth horizontal base of a rough inclined plane at an angle 37° with the horizontal as shown in figure-4.81. A bullet of mass m=0.1 kg is fired horizontally with a velocity $u = 110m/s$ and gets embeded in it almost immediately. The impluse imparted carries the combined mass up the incline and finally lands on the horizontal level with the horizontal base.



If the length of the incline is l=1.8 m and the incline offers a coefficient of kinetic friction 0.5 to the sliding of the mass, find the horizontal distance from the base of the incline to the point of landing of the combined mass. Assume the contact of the incline with the horizontal plane is smooth and mass is not jerked when starts up on incline plane.

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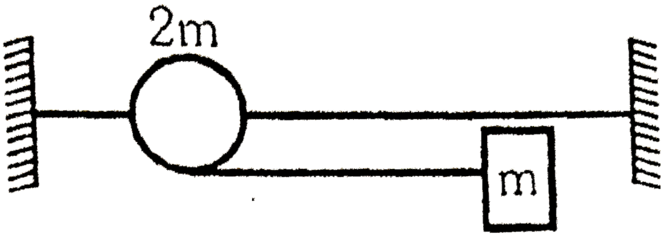
41. A bead can slide on a smooth straight wire and a particle of mass m attached to the bead by a light string of length L. The particle is held in contact with the wire and with the string taut and is then let fall. If the bead has mass $2m$ then when the string makes an angle θ with the wire, the bead will have slipped a distance.



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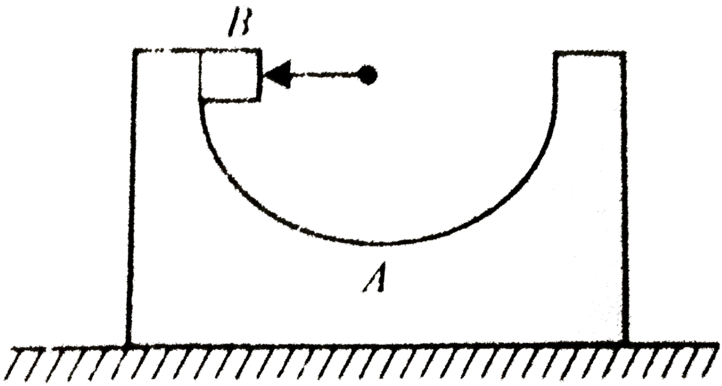
42. Figure shows a block A of mass $6m$ having a smooth semicircular groove of radius a placed on a smooth horizontal surface. A block B of mass m is released from a position in groove where its radius is horizontal. Find the speed of the bigger block when the smaller block reaches its bottom most position.



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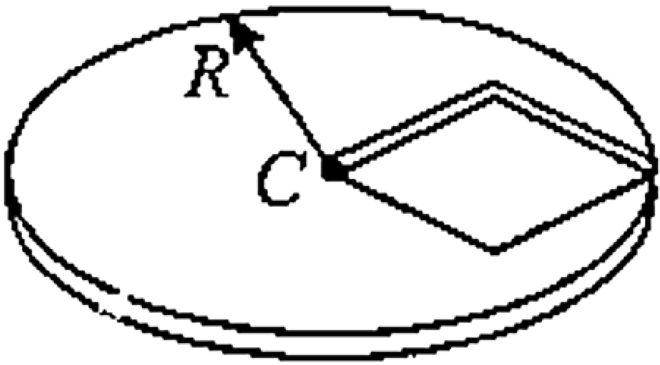
Practive Exercise

1. Find the centre of mass of the disc shown in figure. . A square is removed from the disc as shown



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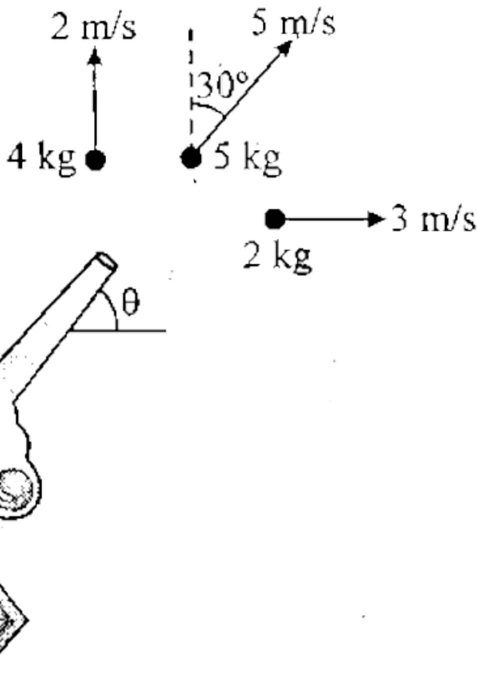
2. From a gun whose barrel is inclined at an angle θ to horizontal fires 3 small balls of mass 2 kg, 5 kg and 4 kg which move in different directions as shown in figure. It is given that the centre of mass of the three shells moes in the direction of barrel of gun find θ.



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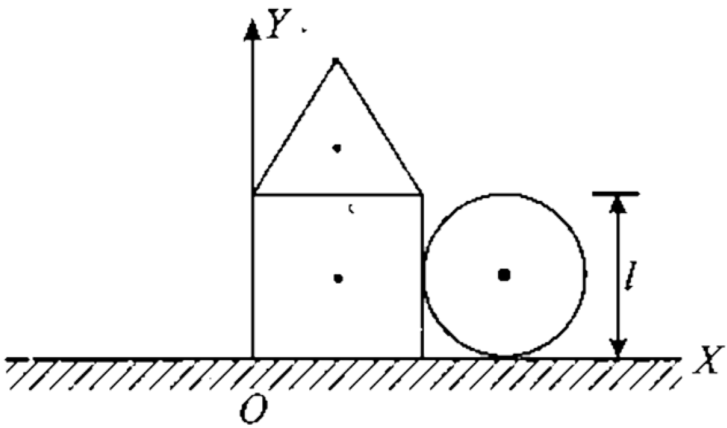
3. Three laminar bojects of uniform density a square, a disc and an equilateral triagle are placed as shown fig. find the coordinates of centre of mass of the three bodies.



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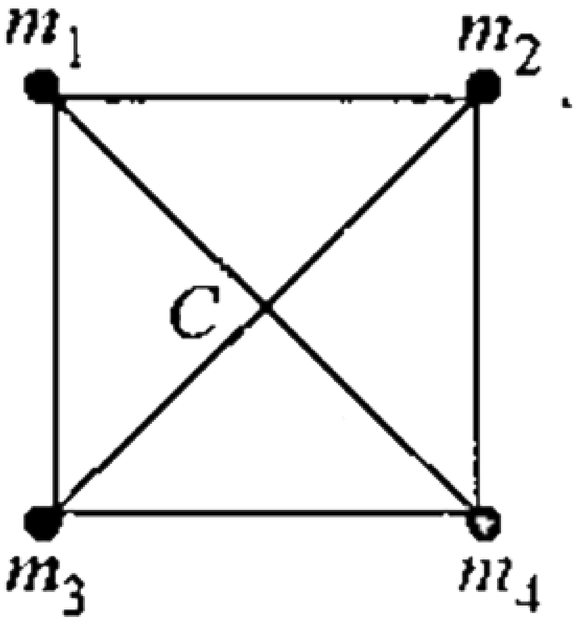
4. Four particle of masses $m_1 = 2kg, m_2 = 4kg, m_3 = 1kg$ and m_4 are placed at four corners of a square as shown in figure. Can mass of m_4 be adjusted I such a way that the centre of mass of system will be at the centre of the square C.



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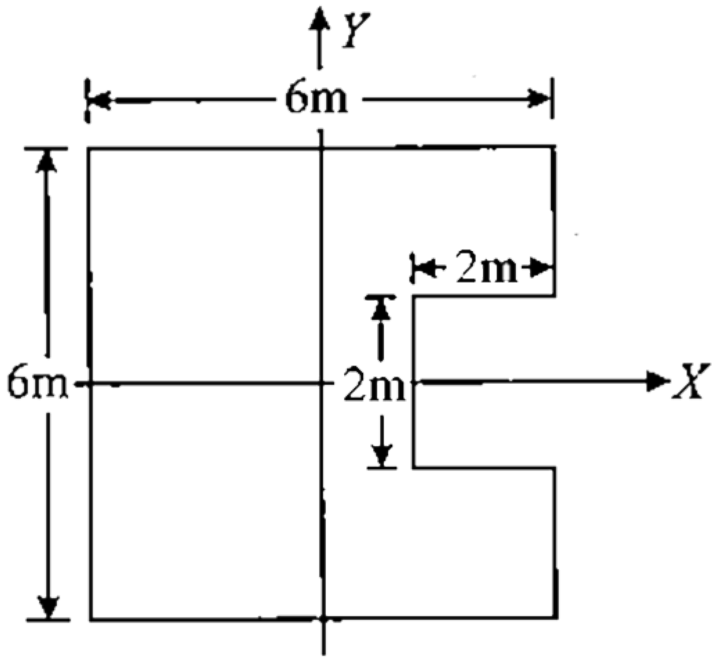
5. Find x and y coordinats of the centre of mass of the plate shown in figure from which a square of side 2 m is cut out.



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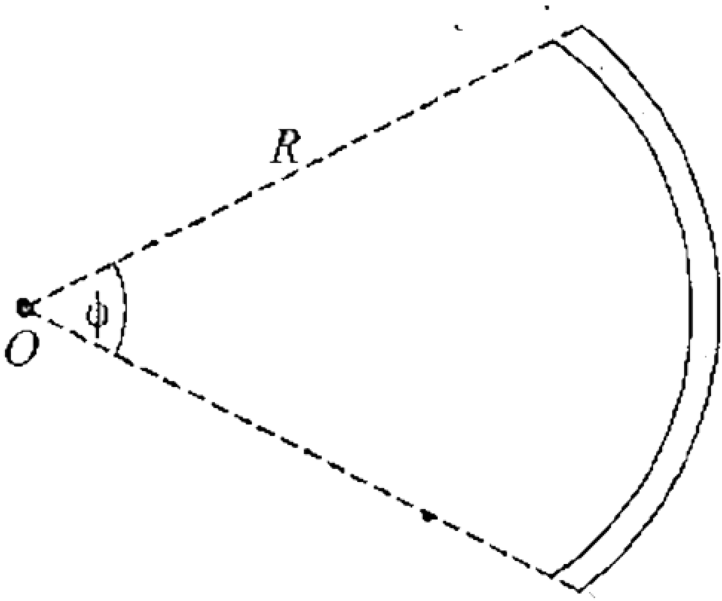
6. Find centre of mass distance from point O of the uniiform circualr arc shown in figure.



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7. Mass Center of a sector of a uniform circular plate

Find location of mass center of a sector of a thin uniform plate.

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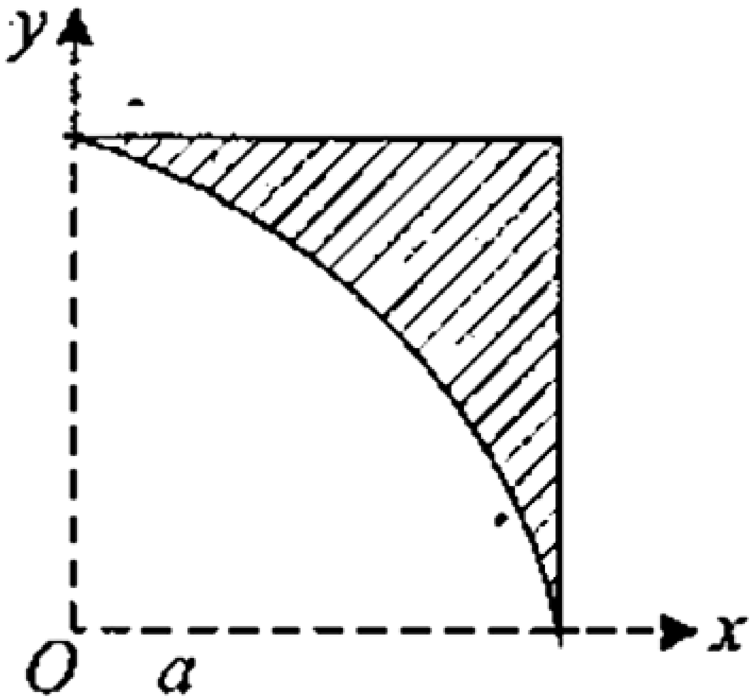
8. Fron a sqaure plate of side a,a quarter circular disc of radius a is removed as shown in figure. Find the coordinates of centre of mass of the remaining part.



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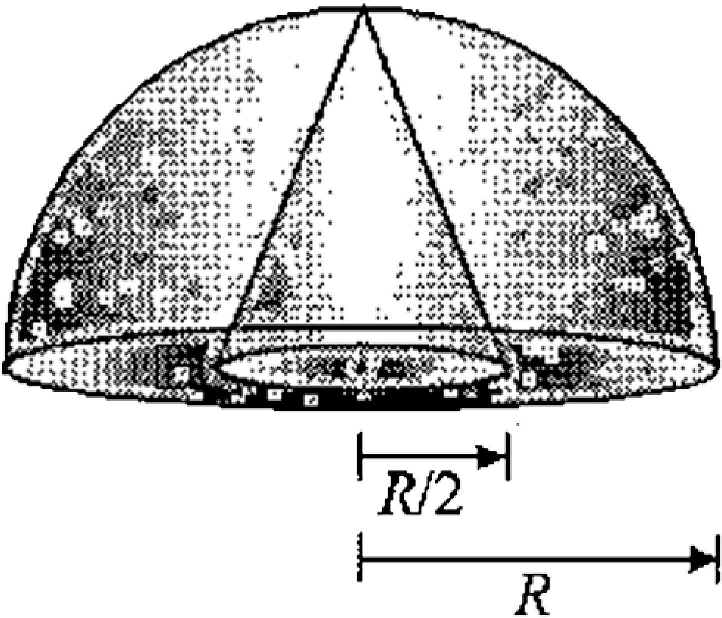
9. From a hemisphere of radius R a cone of base radius R/w and height R is cut as shown in figure.

Find the height of centre of mass of the remaining object.



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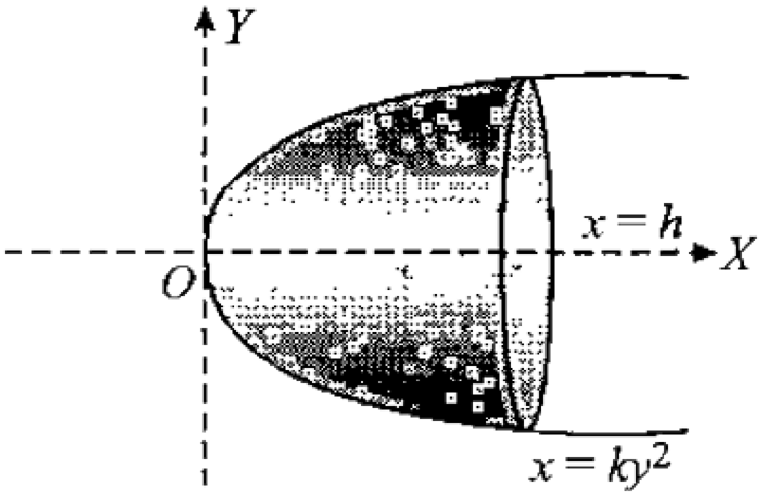
10. Find centre of mass of an object (Paraboloid) which is formed by rotating a parabola $x = ky^2$

about x-axis and height of object is h as shown in figure. Assume the object is of uniform density.



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11. In a boat of mass 4 M and length l on a frictionless water surface. Two men A (mass=M0 and B(mass 2 M) are standing on the two opposite ends. Now A travels a dsitance l/4 relative to boat towards its centre and B moves a distance 3l/4 relative to boat and meet A. find the distance travelled by the boat on water till A and B meet.

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12. A shell of mass m is fired from a gun of mass km which can reecoil freely on a horizontal plane, the elevation of the gun is 45°. Find the ratio of te energy of the shell to that of the gun.

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13. A gun in mounted on a railroad car. Themass of the car with all of its components is 80 m mass of each shell to be fired is 5m. The muzzle velocity of the shells is 100m/s horizontally, what is the recoil speed of the car after seconds shot? Consider car to be at rest initially.

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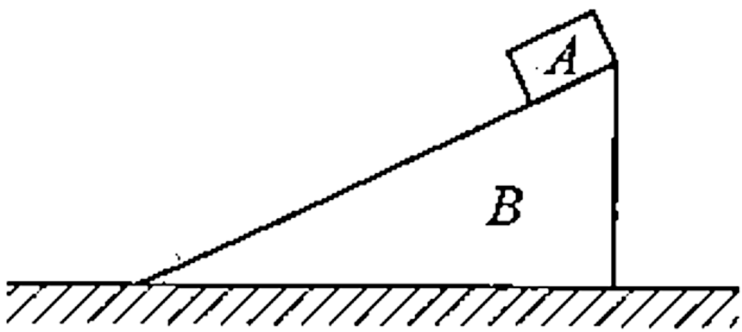
14. A block A (mass 4M) is placed on the top of a wedge block B of base length l (mass=20M) as shown in figure. When the system is released from rest. Find the distance moved by the block B till the block A reaches ground Assume all surfaces are frictionless.



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15. A space shuttle of mass M, moving at 4000 kph relative to earth ejects a capsule backward of mass M/5. if speed of ejection of capsule is 120 kph relative to state of shuttle before ejection, find the final velocity of the shuttle.

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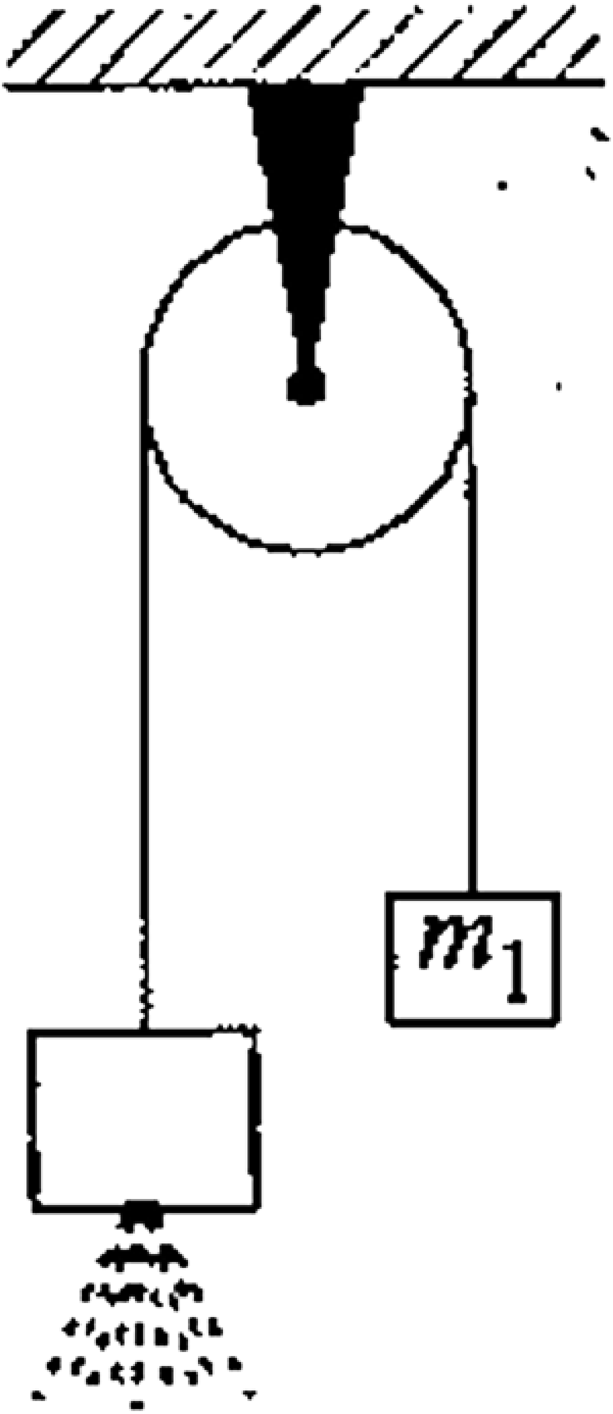
16. A mass m_1 is connected by a weghtless cable of water, whose mass is m_0 at $t = 0$. If the container efects water in downward directiona t a constant rate bkg/s. with a velocity v_0 relative to the container, determine the acceleration of

m_1 as a function of time.


m_1

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17. A rocket with initial mass M is launched by emitting, gas wil velocity v_0 (relative to the rocket body) downwards. The mass of the gas emitted per seconds is k. (k is constant and obeys $kv_0 < Mg$). Find time when rocket start to lift.

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18. A double stage rocket has an initial mass M_i, gas is exhausted front he rocket at a constant rate of dm/dt and with an exhaust velocity u relative to the rocket. When the mass of the rocket reaches the value μ, the first stage of mass m of

Which fuel is exhausted is disengaged from the rocket and then the rocket continues to the second stage at teh same rate and exhaust velocity as int eh first stage, until it reaches a mass M_f

(a). Calculate the rocket velocity at the end of the first stage, given that it is started at rest.

(b). Calculat ethe rocket velocity at the end of the second stage. ltbr. (c). What is the final velocity of a one stage rocket of the same initial M_i mass and the same amount of fuel ? it is greater or less than final velocity of the double stage rocket?

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19. A particle of mass M is initially at rest starts moving under the action of a constant force $F\hat{i}$. It encounters the resistance of a stream of fine dust movingwith velocity $-v_0\hat{i}$, which deposits matter on it at a constant rate ρ, show that its mass will be m when it has travelled a distance-

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20. A balloon having mass m is filled with gas and is held in hands of a boy. Then suddenly it gets released and gas starts coming out of it with a constant rate. The velocity of the ejected gas is $2m/s$ with respect to the balloon. Find out the velocity of the balloon when the mass of gas is reduced to half :-

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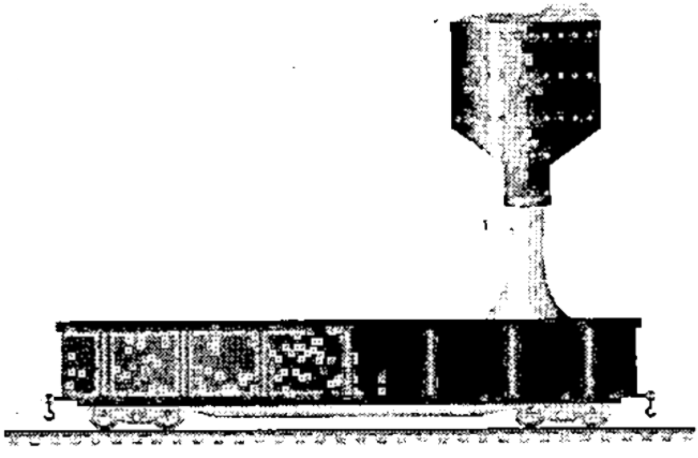
21. A railroad car of length L aned mass m_0 when empty is moving freely on a horizontal track while being loaded with sand from a stationary chute at a rate dm/dt=q. knowing that the car was approaching the chute a speed v_0, determine

(a). The mass of the car and its load after the car has cleared the chute.

(b). The speed of the car at that time.



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22. A piece of wood of mass 0.03 kg is dropped from the top of a building 100 m high. At the same time, a bullet of mass 0.02 kg is fired vertically upward with a velocity of 100 m/s from the ground the bullet gets embedded in the wooded piece after striking. find the height to which the combination rises above the building before it starts falling take $g = 10m/s^2$

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23. Two balls A and B having different but unknown masses, collide elastically. A is initially at rest when B has a speed v. After collisio B has a speed v/2 and moves at right angles to its original motion. (a) find the direction in which ball A moves after collision (b) Determine the speed of A.

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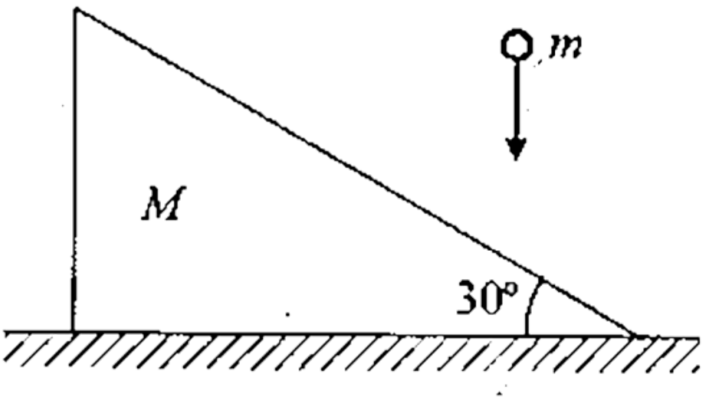
24. A ball of mass m=1kg falling vertically with a velocity $v_0 = 2m/s$ strikes a wedge of mass M=2kg kept o a smooth, horizontal surface as shown in figure. The coefficient of resitution between the ball and the wege is $e = 1/2$. Find the velocity of the wedge is e=1/2. find the velocity of the wedge and the ball immediately after collison.



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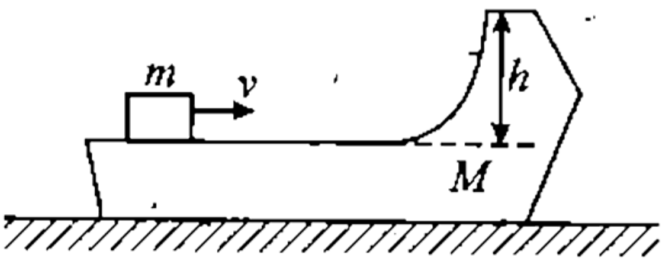
25. A body of mass M with a small box of mass m placed on it rests on a smooth horizontal surface. The box is set in motion in the horizontal direction with a velocity u as shown in figure. To what height relative to the initial level will the box rise after breaking off from the body M? Assume all surfaces are frictionless.



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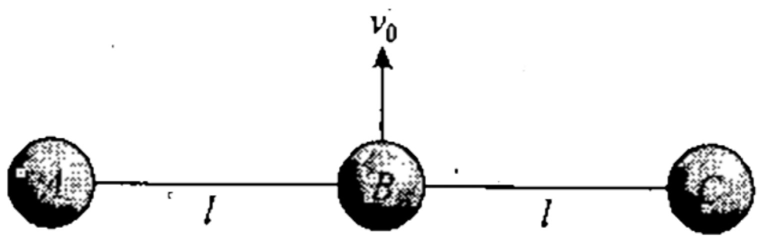
26. Three identical balls eah of mass m=0.5 kg are connected with each other as shown in figure and rest over a smooth horizontal table At moment t=0, ball B is imparted a horizontal velocity $v_0 = 9ms^{-1}$ calculate velocity of A just before it collides with ball C.



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27. Two particle, each of mass m, are connected by a light inextensible string of length 2l. Initially they lie on a smooth horizontal table at points A ad B distant l apart the particle at A is projectd across the table with velocity u. find th speed with which the second particle begins to move if the direction. of u is :

(a). along BA

(b). at an angle of 120° with AB

(c) perpendicular to AB

In each case also calculate (in terms of ma nd u) the impulsive tension in the string.

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28. A sphere of mass m_1 in motion hits directly another sphere of mass m_2 at rest and sticks to it, the total kinetic energy after collision is $2/3$ of their total K.E. before collision. Find the ratio of $m_1 : m_2$.

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Discussio Q

1. A helium filled balloon has more potential energy at hgiher altitues. Is the statement correct? Explain.

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2. In had on collision of equal masses, the velocities are interchanged. Can velocities in a head on collision be interchanged if the masses are not equal ?

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3. Explain why an egg thrown against a wall will break, while an egg thrown against a loose vertical sheet will not.

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4. When a balloon filled with air released so that the air escapes, the balloon shoots off into the air. Explain would the same happen if the balloon were released in a vacuum?

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5. Does doubling the thrust of a rocket by doubling the rate of which mass is thrown backward double the final speed of the rocket? Why or why not.?

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6. A base ball player has a nightmare. He is accidentally locked in a railroad boxcar. Fortunately, he has his ball and bat along. To start the car moving, he stands at one end bats the ball towards the other end. The impulse exerted by the ball as it hits the end wall, gives the car a forward motion. Sice the ball always rebounds and rolls along the floor back to him, the player repeats this process over and over. Eventually the car attains a very high speed, and the player is killed as the boxcar collides with another car sitting at rest on the track. Analyze this dream and the physics concepts involved in it.

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7. Can the coefficient of restitution ever be greater than 1 ?

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8. Explain, on the basis of conservation of momentum, how a fish propels it self forward using its tail.

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9. The shorter the impact time of an impulse, the greater the force must be for the same momentum change and hence the greater the deformation of the object on which the foce acts. Wxplain on this basis the value of air bags which are intended to inflate during an automobile collision and reduce the possibility of fracture or death.

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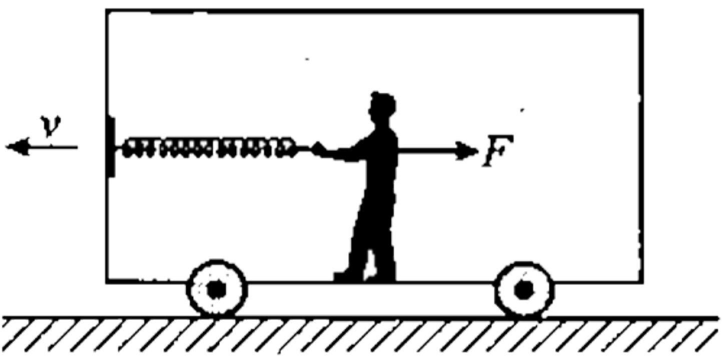
10. A man stretches a spring attached to the front wall of railway carriage over a distance l in a uniformly moving train. During this time the trai covers a distance L. Does the work done by the man depend on the coordinate system related to the earth or the train? the man moves opposite to the direction of motion of the train as he stretches the spring.



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11. It is possible for a body to receive a larger impulse from a small force than from a large force.

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12. A truck driver carrying chickens to market is stopped at weighing station. He bangs on te side of the truck to frighten the chickens so that they will fly up and make the truck lighter. Will his scheme work? Does it make any difference if the truck is open or closed? Explain.

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13. A ball dropped onto a hard floor has a downward momentum, and after it rebounds, its momentum is upward the ball's momentum is not conserved in the collision explain.

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14. A ball is dropped from a height h onto a hard floor, from which it rebounds at very nearly its original speed. Is the process? If we consider the ball and earth as our system during what parts of the process is momentum conserved? If we use a piece of clay that falls and strikes teh floor, then what will be the answers of previous questions.

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15. Sometimes when extinguishing a fire o a burning ship, a fireboat will have some of its nozzles pointing away from the fire why?

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16. A rocket following a parabolic path through the air suddenly explodes into many pieces. What can you say about the motion of this system of pieces?

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17. A gum ball is shot at a block of wood. In which case dows the gum exert the larger impulse on the blok when it sticks or when it rebounds?

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18. If only an external force can change the momentum of the centre of mass of an object, how can be internal force of an engine accelerate a car?

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19. It is said that in ancient times a rich man with a bag of gold coins was frozen to death stranded

on the surface of a frozen lake. Because the ice was frictionless, he could not push himself to shore. What could he have done to save himself, had he not been so miserly?

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20. Discuss the possibility of a particular type of collision ini which the particles have more kinetic energy after the collision than before. It is known as super elastic collision. Will momentum remain conserved in such a collision

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21. In a collision between two cars, which would you expect to be more damaging to the occupants, if the cars collide expect to be more damaging to the occupants, if the cars collide and ramain together, or if the two rebound backward ? Explain.

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22. The velocity of a bullet fired from a rifle held against the chooter's shoulder is measured very carefully. The rifle is then clamped to a massive rock so that it has no measurable recoil. How does that affect the velocity of the bullet?

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23. A high jumper successully clears the bar. Is it possibel that his centre of mass crosse dthe bar from eblow it? Try it with appropriate figures.

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24. Most of the skid mearks left at the scence of an automobile accident are left by the car tires after the collision occurs. How can measuring the direction and length of these skid marks. After the collision reveal whether either of the cars involved was speeding before the collision?

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25. IN a headon collision between two particles, is it necessary that the particles will acquire a common velocity at least for one instant?

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26. In the early age of rocket motion it was assumed by many peope that a rocket would not work in outer space becaue there was no air for the exhaust gases to push against. Explain why the rocket does work in outer space.

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27. An hourglass with a valve that starts the flow of sand is being weighed on a sensitive balance.

Compare the momentum of the sand before the valve is turned when sand is being dropped in a steady stream from the upper to the lower falf, and when all the sand is in the bottom. What are the scale readings at these three times. does the scale read differently when the momentum of the sand is changing?

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28. Explain on the basis of impulse equation, why it is unwise to hold your legs rigidly straight when you jump to the gound from a wall. How is this related to the commonly held belief that a drunken person has less chance of beinig injured in a fall than one who is sober.?

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Conceptual Mcq S Single Option Correct

1. Rocket works on the principle of coservation of

A. Mass

B. Kinatic energy

C. Linear momentum

D. Angular momentum

Answer:

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2. Choose the only incorrect statement from the following

A. the position of the centre of mass of a system of particles does not depend upon the internal forces between particles

B. The centre of mass of a solid may lie outside the body of the solid

C. A body tied to a string is suddenly cut, the angular momentum of the body will not change from its initial value.

D. The angular momentum of a comet revolving around a massive star, remains constant over the entire orbit.

Answer:

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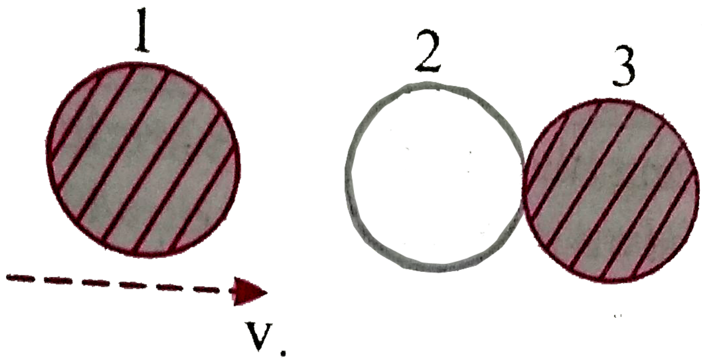
3. Two identical ball bearings in contact with each other and resting on a frictionless table are hit heat-on by another ball bearing of the same mass moving initially with a speed V as shown in figure.



If the collision is elastic, which of the following (figure) is a possible result after collision ?

A. ball 1 comes to rest and balls 2 and 3 rolls out with speed $\frac{v}{2}$ each

B. balls 1 and 2 come to rest and ball 3 rolls out with speed

C. balls 1,2 and 3 rolls out with speed v/3 each

D. balls 1,2 and 3 come to rest.

Answer:

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4. Which one of the following is true in the case of inelastic callisions?

A.

Total energy conserved	Kinetic energy conserved	Momentum conserved

B.

Total energy conserved	Kinetic energy not conserved	Momentum conserved

C.

Total energy conserved	Kinetic energy conserved	Momentum not conserved

D.

Total energy not conserved	Kinetic energy not conserved	Momentum conserved

Answer:

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5. A ball is dropped from height 10 m . Ball is embedded in sand 1 m and stops, then

A. Only momentum is conserved

B. Only kinetic energy is conserved.

C. Both momentum and kinetic energy are conserved.

D. Neither momentum nor kinetic energy is conserved.

Answer:

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6. A bullet is fired from a rifle which recoils after firing. The ratio of the kinetic energy of the rifle to that of the bullet is

A. zero

B. one

C. less than one

D. more than one

Answer:

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7. A bullet hits and gets embedded in a solid block resting on a frictionless surface. In this process, which of the following is correct ?

A. Momentum and kinetic energy

B. kinetic energy alone

C. momentum alone

D. neither momentum nor kinetic energy

Answer:

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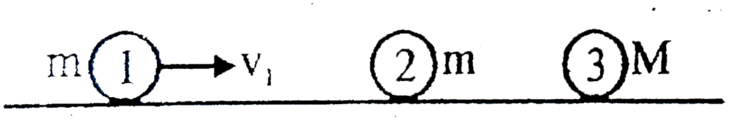
8. Two balls marked 1 and 2 of the same mass m and a third ball marked 3 of mass M are arranged over a smooth horizontal surface as shown in the figure. Ball 1 moves with a velocity v_1 towards ball 2. All collisions are assumed to be elastic. If $M < m$, the number of collisions between the balls will be.



A. One

B. two

C. three

D. four

Answer:

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9. Four particle, each of mass m, are placed at corners of a square of side a in the x-y plane. If the origin of the co-ordinate system is taken at the point fo intersection of the diagonals of the square, the co-ordinates of the centre of mass of the system are:

A. (a, a)

B. $(-a, a)$

C. $(a, -a)$

D. $(0, 0)$

Answer:

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10. Which one of the following statemetns is correct with reference to elastic collision between two bodies?

A. Momentum and total energy are conserved but kinetic energy may be changed into some ther form of energy

B. Kinetic energy and total energy are both conserved but momentum is only if the two bodies have equal masses momentum is only if the two bodies have equal masses.

C. Momentum, kinetic energy and total energya re all conserved.

D. Neither momentum nor kinetic energy need to be conserved but total energy must be conserved.

Answer:

11. The velocities in a head on elastic collision be interchanged"

A. If masses are equal only

B. it may be possible if masses are not equal

C. it is always possible.

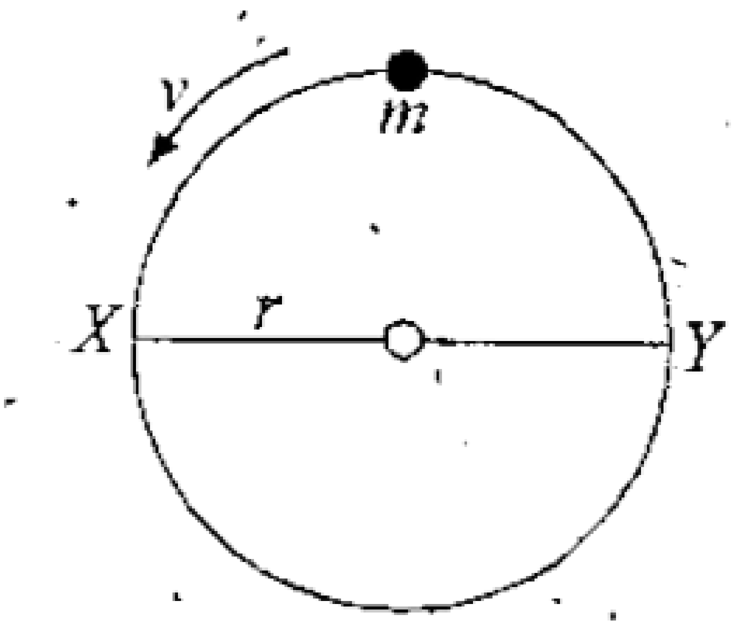
D. it is never possible.

Answer:

12. A body of mass m moves in a horizontal circle of radius r at contact speed v. which pair of values carrectly gives:

(i). The work done by the centripetal force

(ii). The change in linear momentum of the body when it moves from X to Y (where Xyy is a diameter)?



A. $2mv^2$ $2mv$

B. πmv^2 $2mv$

C. 0 0

D. 0 2mv

Answer:

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13. For a particle moving in a horizontal circle with constant angular velocity:

A. The linear momentum is constant but the energy varies

B. The energy is constant but the linear momentum varies

C. both energy and linear momentum are constant

D. Neither the linear momentum nor the energy is constant.

Answer:

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14. In a system of particles, internal forces can change:

A. the linear momentum but nt the kinetic energy

B. the kinetic energy but not the linear momentum

C. Linear momentum as well as kinetic energy

D. Neither the linearmomentum nor the kinetic energy

Answer:

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15. Three particles each of mass m are located at the vertices of an equilateral triangle ABC. They start moving with equal speeds each along the medians of the triangle and collide at its centroid G. If after collision, A comes to rest and B retraces its path along GB, then C (A) also comes

A. Also comes to rest

B. Moves with a speed v along CG

C. Moves with a speed v along BG

D. Moves with a speed along AG

Answer:

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

A. Of the box remains constant

B. of the box plus the ball system remains constant.

C. Of the ball remains constant

D. of the ball relative to the box remains constant.

Answer:

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17. A strip of wood of length l is placed on a smooth horizontal surface. An insect starts from one end of the strip, walks with constant velocity and reaches the other end in time t_1. It then flies off vertically. The strip moves a further distance l in time t_2.

A. $t_2 = t_1$

B. $t_2 < t_1$

C. $t_2 > t_1$

D. Either (B) or (C) depending on the masses of the insect and the strip.

Answer:

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18. The centre of mass of a system of particle is at the origin the number of particle to the left

A. The number of particle to the right of the origin is equal to the number of particle to the left

B. The total mass of the particles to the right of the origin is same as the total mass to the left of the origin

C. The number of particle on X-axis should be equal to the number of particles on Y-axis

D. none of these

Answer:

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19. Six steel balls of identical size are lined up along a straight frictionless groove. Two similar balls moving with speed v along the groove collide with this row on the extreme left end. Then

A. one marble from the right rolls out with speed 2v, the remaining marbles do not move

B. two marbles from the right roll out with a spweed v each, the remaining marbles do not move

C. all six marbles in the row will roll out with a speed v/6 each, the two incident marbles will come to rest

D. all eight marbles will start moving to the right, each with a speed of v/8

Answer:

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20. 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. $\frac{1}{2}m\nu$

Answer:

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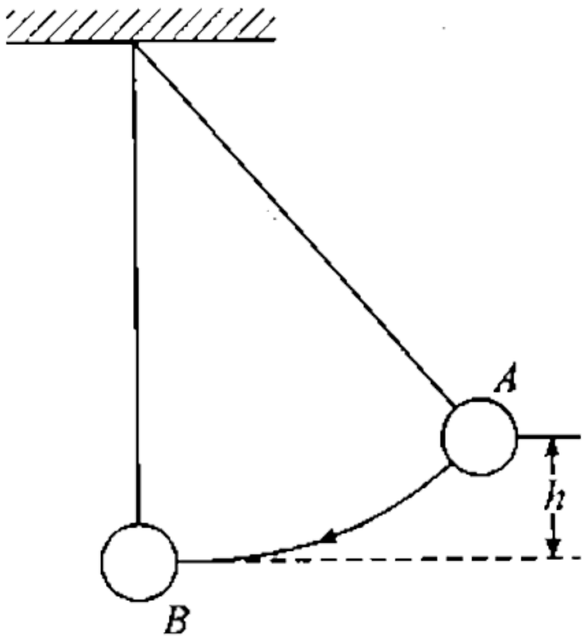
21. The bob A of a pendulum released from a height h hits head-on another bob B of the same mass of an identical pendulum initially at rest. What is the result of this collision? Assume the collisio to be elastic (see figure).



A. Bob A comers to rest at B and bob B moves

to the left attaining a maximum height h

B. Bobs A and B both move to the left, each

attaining a maximum height $\frac{h}{2}$

C. Bob B moves to the left and bob A moves to the right, each attaining a maximum height $\frac{h}{2}$

D. Both bob come to rest.

Answer:

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22. A nucleus moving with velocity $\bar{v}$ emits an α-particle. Let the velocities of the α-particle and the remaining nucleus be $\bar{v}_1$ and $\bar{v}_2$ and their masses be m_1 and (m_2) then,

A. $\vec{v}, \vec{v}_1$ and $\vec{v}_2$ must be parallel to each other

B. None of the two of $\vec{v}, \vec{v}_1$ and $\vec{v}_2$ should be parallel to each other

C. $\vec{v}_1 + \vec{v}_2$ must be parallel to $\vec{v}$

D. $m_1 \vec{v}_1 + m_2 \vec{v}_2$ must be parallel to $\vec{v}$

Answer:

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

A. Is maximum when $h = 0$

B. Is maximum when $h = R$

C. Is maximum when $h = 2R$

D. Is independent of h

Answer:

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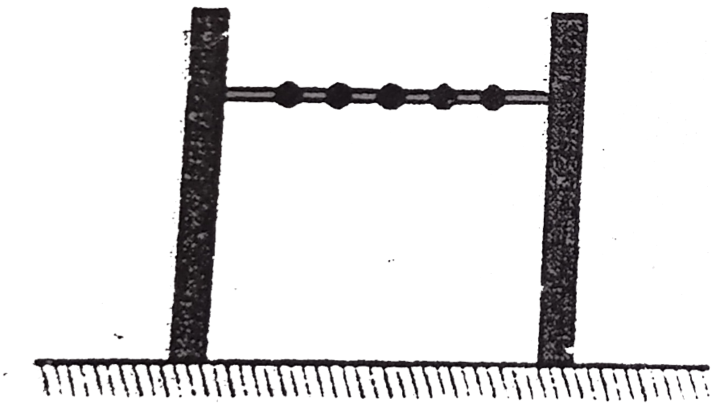
24. Five identical balls each of mass m and radius r are string like beads at random and at rest along a smooth rigid horizontal thin rod of length L mounted between immovable supports Assume $10r \leq L$ and that the collision between balls or between balls and supports are elastic if one ball is struck horizontally so as to acquire a speed v the average force felt by the support is



A. $\dfrac{5mv^2}{L-5r}$

B. $\dfrac{mv^2}{L-10r}$

C. $\dfrac{5mv^2}{L-10r}$

D. $\dfrac{mv^2}{L-5r}$

Answer:

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25. The end of a chain of length L and mass per unit length ρ, which is piled up on a horizontally platform is lifted vertically with a constant velocity u by a variable force F. Find F as a function of height x of the end above platform:

A. $\rho\left(gx + 2u^2\right)$

B. $\rho\left(2gx + \rho u^2\right)$

C. $\rho\left(gx + u^2\right)$

D. $\rho\left(u^2 - gx\right)$

Answer:

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26. Which of the following is correct about principle of conservation of momentum ?

A. Conservation of momentum can be applied only in absence of external forces

B. Conservation of momentum can be applied only during collisions of bodies

C. Conservation of momentum can be applied in a process even in the presence of external forces

D. Conservation of momentum is not applicable in rocket propulsion

Answer:

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27. A uniform rod AB of mass m and length l is at rest on a smooth horizontal surface. An impulse J is applied to the end B perpendicular to the rod in horizontal direction. Speed of the point A of the rod after giving impulse is:

A. $2\frac{J}{m}$

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

C. $\frac{J}{m}$

D. $\sqrt{2}\frac{J}{m}$

Answer: A

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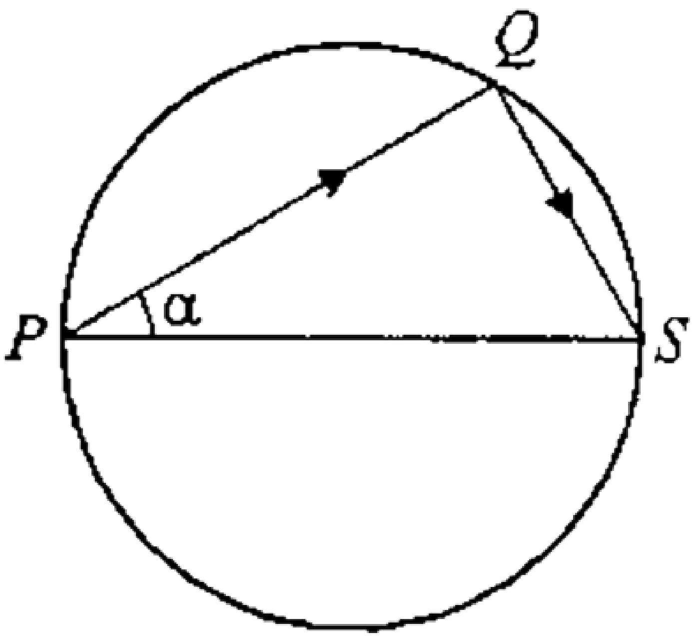
28. A body is fired from point P and strikes at Q inside a smooth circular wall as shown in the figure. It rebounds to point S (diametrically opposite to P). The coefficient of restitution will be:



A. $\cot \alpha$

B. 1

C. $\tan \alpha$

D. $\tan^2 \alpha$

Answer:

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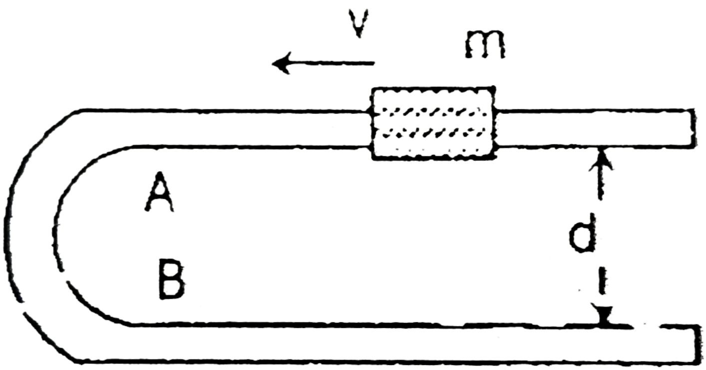
29. A fixed U-shaped smooth wire has a semi-circular bending between A and B as shown in the figure. A bead of mass $'m'$ moving with uniform speed v through the wire enters the semicircular bend at A and leaves at B. The magnitude of average force exerted by the bead on the part AB of the wire is



A. 0

B. $\frac{4mv^2}{\pi d}$

C. $\frac{2mv^2}{\pi d}$

D. none of these

Answer:

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30. A collision occurs between two identical balls each of mass m, moving with velocities $\vec{u}_1$ and $\vec{u}_2$, colliding head-on. The coefficient of restitution is 0.5. The energy lost in the collision is:

A. $\frac{1}{4}m\left(\vec{u}_1+\vec{u}_2\right)^2$

B. $\frac{1}{4}m\left(\vec{u}_1-\vec{u}_2\right)^2$

C. $\frac{3}{16}m\left(\vec{u}_1+\vec{u}_2\right)^2$

D. $\frac{3}{16}m\left(\vec{u}_1 - \vec{u}_2\right)^2$

Answer:

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Numerical Mcq S

1. Three particles of the same mass lie in the x-y plane. The (x,y) coordinates of their positions are (1,1),(2,2) and (3,3) respectively. The (x-y) coordinates of the centre of mass are:

A. (1,2)

B. (2,2)

C. (4,2)

D. (6,6)

Answer:

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2. In the HCI molecule, the separation between the nuclei of the two atoms is about $1.27\text{Å}\left(1\text{Å} = 10^{-10}m\right)$. Find the approximate location of the c.m of the molecule, given that a chlorine atom is about 35.5 times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus ?

A. $\frac{35.5 \times 1.27}{36.6}$ Å from the hydrogen atom

B. $\frac{35.5 \times 1.27}{36.6}$ Å from the chlorine atom

C. $\frac{1.27}{36.6}$ ÅA from the hydrogen atom

D. $\frac{1.27}{36.6}$ Å from the chlorine atom

Answer:

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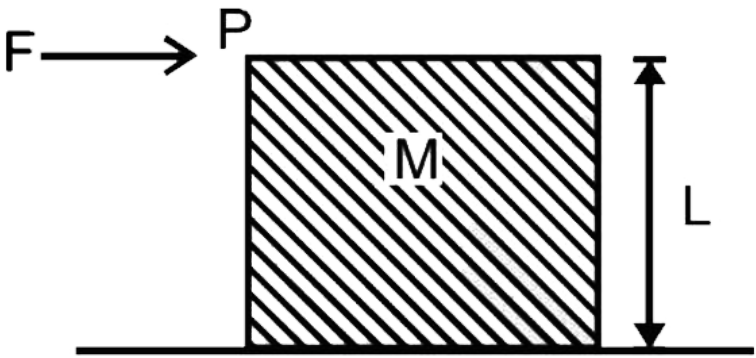
3. A cubical block of side L rests on a rough horizonta surface with coefficient of friction μ. A horizontal force F is applied on the block as shown. If the coefficient of friction is sufficiently high so that the block does not slide before toppling, the minimum force required to topple the block is



A. Infinitesimal

B. $mg/4$

C. $mg/2$

D. $mg(1-\mu)$

Answer:

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4. A boy of mass m stands on one end of a wooden plank of length L and mass M. The plank is floating on water. If the boy walks from one end of the plank to the other end at a constant speed, the resulting displacement of the plank is given by :

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

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

C. $\frac{mL}{(M-m)}$

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

Answer:

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5. A neutron moving at a speed v undergoes a head-on elastic collision with a nucleus of mass number A at rest. The ratio of the kinetic energies of the neutron after and before collision is :

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

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

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

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

Answer:

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6. A wooden block of mass $0.9kg$ is suspended from the ceiling of a room by thin wires. A bullet of mass $0.1kg$ moving horizontally with a speed of $10ms^{-1}$ strikes the block and sticks to it. What is the height to which the block rises ? Take $g = 10ms^{-2}$:

A. $2.5m$

B. $5.0m$

C. $7.5m$

D. $10.0m$

Answer:

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7. In what is the loss in kinetic energy of the system due to impact ?

A. 450 J

B. 400 J

C. 350 J

D. 300 J

Answer:

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8. A shell of mass 2m fired with a speed u at an angle θ to the horizontal explodes at the highest point of its trajectory into two fragments of mass m each. If one fragment falls vertically, the distance at which the other fragment falls from the gun is given by :

A. $\dfrac{u^2 \sin 2\theta}{g}$

B. $\dfrac{3u^2 \sin 2\theta}{2g}$

C. $\dfrac{2u^2 \sin 2\theta}{g}$

D. $\dfrac{3u^2 \sin 2\theta}{g}$

Answer:

Watch Video Solution

9. A rubber ball is dropped from a height of $5m$ on a plane, where the acceleration due to gravity is not shown. On bouncing it rises to $1.8m$. The ball loses its velocity on bouncing by a factor of

A. $\dfrac{16}{25}$

B. $\dfrac{2}{5}$

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

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

Answer:

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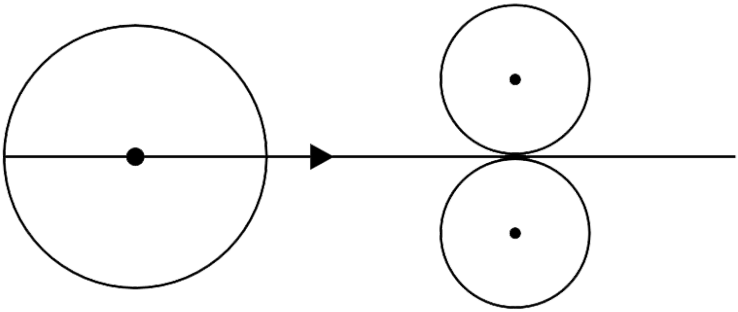
10. Two identical discs are initially at rest in contact on a horizontal table. A third disc of same mass but of double radius strikes them symmetrically and comes to rest after the impact.

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

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

Treat the collision to be instantaneous



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

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

C. $\frac{9}{16}$

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

Answer:

Watch Video Solution

11. 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. $2 \times 10^6 ms^{-1}$

B. $4 \times 10^6 ms^{-1}$

C. $6 \times 10^6 ms^{-1}$

D. $8 \times 10^6 ms^{-1}$

Answer:

Watch Video Solution

12. In , if the collision were perfectly elastic, what would be the speed of deuteron after the collision ?

A. $2 \times 10^6 \mathrm{ms}^{-1}$

B. $4 \times 10^6 \mathrm{ms}^{-1}$

C. $6 \times 10^6 \mathrm{ms}^{-1}$

D. $8 \times 10^6 \text{ms}^{-1}$

Answer: D

Watch Video Solution

13. A loaded spring gun of mass M fires a bullet of mass m with a velocity v at an angle of elevation θ. The gun is initially at rest on a horizontal smooth surface. After firing, the centre of mass of the gun and bullet system

A. Moves with a velocity v m / M

B. Moves with velocity $\frac{vm}{M}$ cos 0 in the horizontal direction

C. Remains at rest

D. Moves with a velocity $\frac{\text{vmsin0}}{M}$ in the vertical direction

Answer: C

Watch Video Solution

14. A shell of mass m is at rest initially. It explodes into three fragments having masses in the ratio

$2:2:1$. The fragments having equal masses fly off along mutually perpendicular directions with speed v. What will be the speed of the third (lighter) fragment ?

A. v

B. $\sqrt{2v}$

C. $2\sqrt{2v}$

D. $3\sqrt{2v}$

Answer: C

Watch Video Solution

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

A. 0.9 kg

B. 1.2 kg

C. 1.5 kg

D. 1.8 kg

Answer: B

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16. (a) A rocket set for vertical firing weighs $50kg$ and contains $450kg$ of fuel. It can have a maximum exhaust velocity of $2km/s$. What should be its minimum rate of fuel consumption

(i) to just lift off the launching pad?

(ii) to give it an initial acceleration of $20m/s^2$?

(b) What will be the speed of the rocket when the rate of consumption of fuel is $10kg/s$ after whole of the fuel is consumed? (Take $g = 9.8m/s^2$)

A. $2.5 kg s^{-1}$

B. $5 kg s^{-1}$

C. $7.5 kg s^{-1}$

D. $10 kg s^{-1}$

Answer: A

Watch Video Solution

17. (a) A rocket set for vertical firing weighs $50 kg$ and contains $450 kg$ of fuel. It can have a maximum exhaust velocity of $2 km/s$. What should be its minimum rate of fuel consumption

(i) to just lift off the launching pad?

(ii) to give it an initial acceleration of $20m/s^2$?

(b) What will be the speed of the rocket when the rate of consumption of fuel is $10kg/s$ after whole of the fuel is consumed? (Take $g = 9.8m/s^2$)

A. $2.5kgs^{-1}$

B. $5kgs^{-1}$

C. $7.5kgs^{-1}$

D. $10kgs^{-1}$

Answer: C

Watch Video Solution

18. A bullet of mass $50kg$ is fired by a gun of mass $5kg$ .If the muzzle speed of the bullet is$200ms^{-1}$, what is the recoil speed of the gun?

A. $1ms^{-1}$

B. $2ms^{-1}$

C. $3ms^{-1}$

D. $4ms^{-1}$

Answer: B

Watch Video Solution

19. A particle is projected with a velocity $200m/s$ at an angle of 60°. At the highest point it explodes into three particle of equal masses. One goes vertically upward with a veloctiy $100m/s$ the second particle goes vertically downwards at same speed. What is the velocity of the third particle?

A. $200m/s$ horizontally

B. $200m/s$ with 30° angle

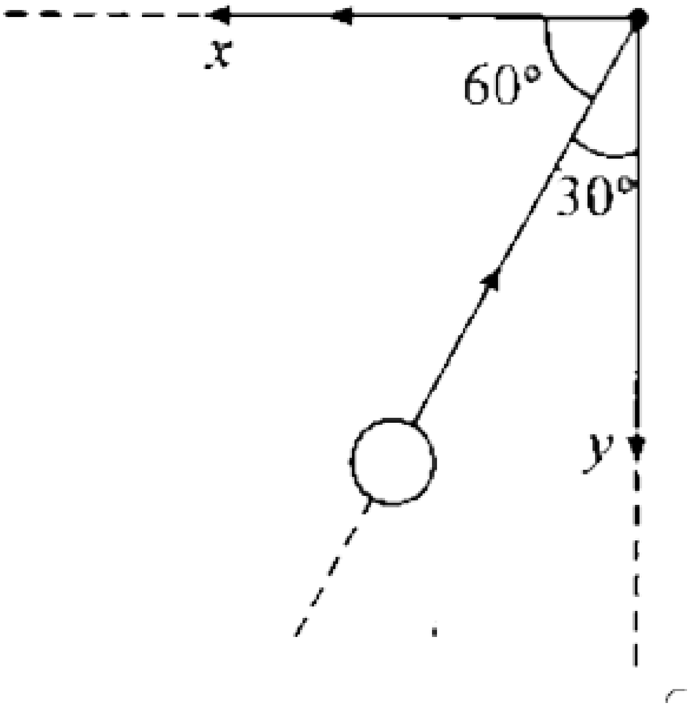
C. $200m/s$ horizontally

D. $300m/s$ horizontally

Answer: D

Watch Video Solution

20. A hockey player receives a corner shot at a speed of $15m/s$ at an angle of 30° with the y-axis and then shoots the ball along the x-axis with a speed of $30m/s$ If the mass of the ball is $100gm$ and it remains in contact with the hockey stick for $0.01s$, the force imparted to the ball in the x-direction is :



A. 281.25 N

B. 187.5N

C. 562.5N

D. 375 N

Answer: D

Watch Video Solution

21. A shell is fired from a cannot with a speed of $100ms^{-1}$ at an anlge 60° with the horizontal (x-direction). At the highest point of its trajectory the shell explodes into two equal fragments. One of the fragments moves along the negative x-direction with a speed of $50ms^{-1}$. What is the speed of the other fragment at the time of explosion ?

A. $150ms^{-1}$

B. $50ms^{-1}$

C. $100ms^{-1}$

D. $200ms^{-1}$

Answer: A

Watch Video Solution

22. Four particles of masses $1kg, 2kg, 3kg$ and $4kg$ are placed at the corners of a square of side 2m in the x-y plane If the origin of the co-ordinate system is taken at the mass of $1kg,$ the (x,y) co-ordinates of the enter of mass expressed in metre are :

A. $\left(1, \frac{7}{5}\right)$

B. $\left(2, \frac{7}{5}\right)$

C. $\left(3, \frac{7}{5}\right)$

D. $\left(4, \frac{7}{5}\right)$

Answer: A

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23. A child is standing at one end of a long trolley moving with a speed v on a smooth horizontal track. If the child starts running towards the other end of the trolley with a speed u, the centre of mass of the system (trolley + child) will move with a speed :

A. Zero

B. $(v + u)$

C. $(v - u)$

D. v

Answer: D

Watch Video Solution

24. A blacksmith carries a hammer on his shoulder and holds in at the other end of its light handle in his hand. If he changes the point of support of the handle and x is the distance between the point of support and his hand , then the pressure on his hand varies with x as :

A. x

B. x^2

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

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

Answer: C

Watch Video Solution

25. A ball of mass m moving with a velocity v undergoes an oblique elastic collision with another ball of the same mass m but at rest.

After the collision if the two balls move with the same speeds , the angle between their directions of motion will be:

A. 30°

B. 60°

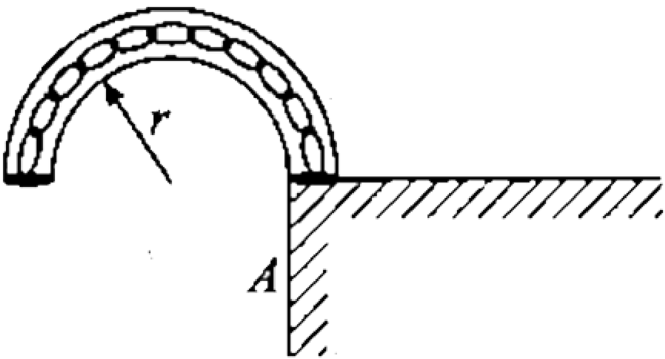
C. 120°

D. 90°

Answer: D

Watch Video Solution

26. A smooth semicircular tube AB of radius r is fixed in a vertical plane and contains a heavy flexible chain of length πr and weight $W\pi r$ as shown. Assuming a slight disturbance to start the chain in motion, the velocity v with it will emerge from the open end B of the tube is:



A. $\dfrac{4gr}{\pi}$

B. $\dfrac{2gr}{\pi}$

C. $\sqrt{2gr\left(\frac{2}{\pi}+\pi\right)}$

D. $\sqrt{2gr\left(\frac{2}{\pi}+\frac{\pi}{2}\right)}$

Answer: D

Watch Video Solution

27. A ball of mass m moving horizontally at a speed v collides with the bob of a simple pendulum at rest. The mass of the bob is also m. If the collision is perfectly inelastic and both balls sticks, the height to which the two balls rise after the collision will be given by:

A. $\dfrac{v^2}{g}$

B. $\dfrac{v^2}{2g}$

C. $\dfrac{v^2}{4g}$

D. $\dfrac{v^2}{8g}$

Answer: D

Watch Video Solution

28. If a man of ,mass M jumps to the ground from a height h and his centre of mass noves a distance x in the time taken by him to 'hit' the ground the average force acting on him (assuming his retardation to be constant during his impact with the ground) is :

A. Mgh / x

B. Mgx / h

C. $Mg(h / x)^2$

D. $Mg(x / h)^2$

Answer: A

Watch Video Solution

29. A radioactive nucleus of mass number A, initially at rest, emits an $\alpha -$ particle with a speed v. What will be the recoil speed of the daughter nucleus ?

A. $\frac{2v}{A-4}$

B. $\frac{2v}{A+4}$

C. $\frac{4v}{A-4}$

D. $\frac{4v}{A+4}$

Answer: C

Watch Video Solution

30. A cart of mass M is tied to 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

A. x=0

B. x=5 m

C. x=10 m

D. They will never meet

Answer: B

Watch Video Solution

31. A bomb at rest explodes into three fragments of equal massses Two fragments fly off at right angles to each other with velocities of $9m/s$ and $12/s$ Calculate the speed of the third fragment .

A. $9ms^{-1}$

B. $12ms^{-1}$

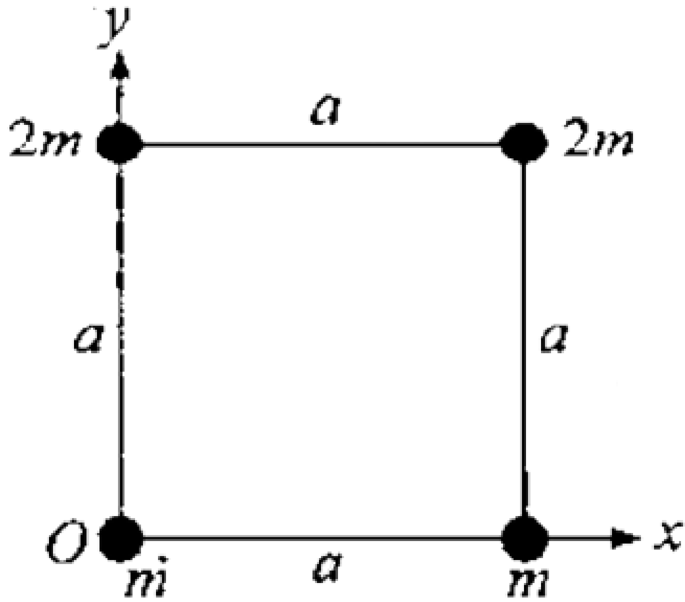
C. $15ms^{-1}$

D. $18ms^{-1}$

Answer: C

Watch Video Solution

32. Four particles of masses m,m 2 m and 2m are placed at the four corner of a squre of side a as shown in figure -4. 107. The (x,y) coordinates of the centre of mass are:



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

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

C. $\left(\frac{a}{2}, \frac{2a}{3}\right)$

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

Answer: C

Watch Video Solution

33. A small coin is placed at a distance r from the centre of a gramophone record.The rotational speed of the record is gradually increased. If the coefficient of friction between the coin and the record is μ, the minimum angular frequency of the record for which the coin will fly off is given by :

A. $\sqrt{\frac{2\mu g}{r}}$

B. $\sqrt{\frac{\mu g}{2r}}$

C. $\sqrt{\frac{\mu g}{r}}$

D. $2\sqrt{\frac{\mu g}{r}}$

Answer: C

Watch Video Solution

34. Sphere A of mass 'm' moving with a constant velocity u hits another stationary sphere B of the same mass. If e is the co-efficient of restitution, then ratio of velocities of the two spheres $v_A : v_B$ after collision will be :

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

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

C. $\dfrac{e-1}{1-e}$

D. $\dfrac{e-1}{1+e}$

Answer: A

Watch Video Solution

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

A. $3\hat{i} - \frac{1}{3}\hat{j}$

B. $-\hat{i} + \widehat{J}$

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

D. $-\hat{i} - \frac{1}{3}\hat{j}$

Answer: B

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36. From a point on smooth floor of a room a toy ball is shot to hit a wall. The ball then returns back to the point of projection. If the time taken by ball in returining is twice the time taken in reaching the wall find the coefficient of restitution:

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

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

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

D. $e = 0.2$

Answer: A

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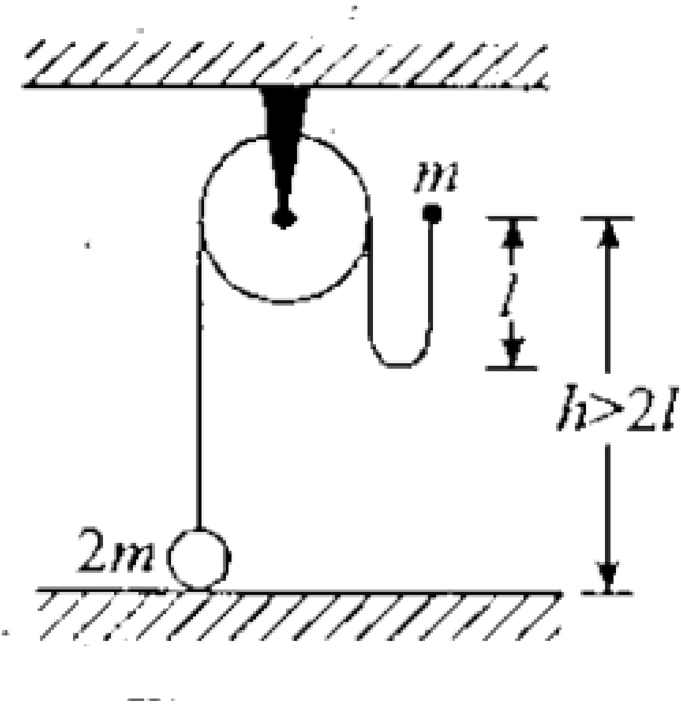
37. In the figure shown, the heacvy ball of mass 2m rests on the horizontal surface and the lighter balls of mass m is dropped from a height $h > 2l$. At the instant the string gets taut, the upward velocity of the heavy ball will be :



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

B. $\frac{4}{3}\sqrt{gl}$

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

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

Answer: A

Watch Video Solution

38. A shell is fired from a connot with a velocity V at an angle 0 with the horizontal direction .At the highest point in its path it explodes into two pieces of equal masses. One of the pieces retraces its path to the cannon.The speed of the other piece immediately after the explosion is :

A. $3V \cos 0$

B. $2V \cos 0$

C. $\frac{3}{2}V\cos 0$

D. $V\cos 0$

Answer: A

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39. A bullet moving with a velcity u passes through a plank which is free to move. The two are of equal mass. After pssing through the plank, the velocity of the bullet becomes fu. Its velocity relative to the plank now is

A. fu

B. $(1 - f)u$

C. $(2f - 1)u$

D. $(2 - f)u$

Answer: C

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

A. $\frac{m_1}{m_2}$

B. $\frac{m_2}{m_1}$

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

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

Answer: D

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

A. $5:3$

B. $7:5$

C. $4:5$

D. $2:3$

Answer: B

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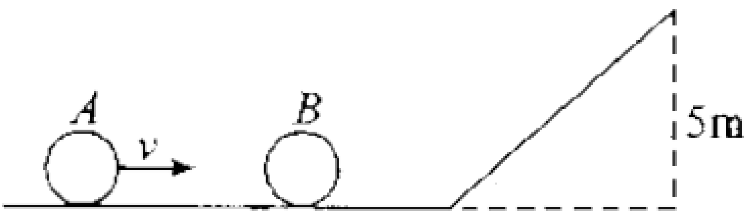
42. Two identical balls of equal masses A and B , are lying on a smooth surface as shown in figure Ball A hits the ball B (which is at rest) with a velocity v=16m/s What should be the minimum value of coefficient of restitution e beteeen A and B so that B just reaches the highest point of inclined plane:

$\left(\text{Take} g = 10m/s^2\right)$



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

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

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

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

Answer: B

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43. Two blocks of mass $m_1 \text{and} m_2$ are connected by light inextensible string passing over a smooth fixed pulleuy of negligible mass. The acceleration of the centre of mass of the system

when blocks move under gravity is :

A. $\left(\frac{m_2 - m_1}{m_1 + m_2}\right)g$

B. $\left(\frac{m_1 + m_2}{m_1 - m_2}\right)g$

C. $\left(\frac{m_1 + m_2}{m_1 - m_2}\right)g$

D. $\left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 g$

Answer: D

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44. A girl throws a ball with an initial velocity v at an angle 45°. The ball strikes a smooth vertical wall at a horizontal distance d from the girl and after rebound returns to her hands. What is the coefficient of restitution between wall and ball ?

$(v^2 > dg)$

A. $v^2 - gd$

B. $\frac{gd}{v^2 - gd}$

C. $\frac{gd}{v^2}$

D. $\frac{v^2}{gd}$

Answer: B

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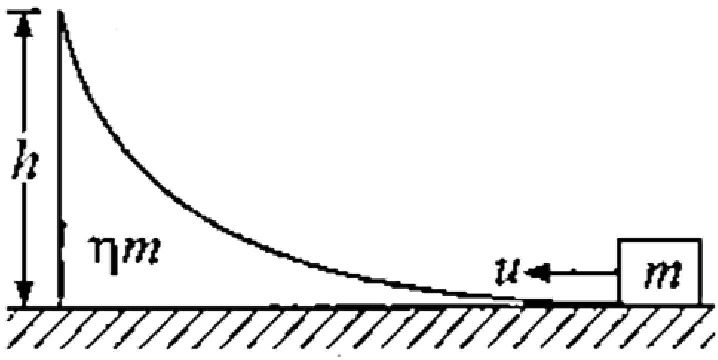
45. A small block of mass m is pushed towards a movable wedge of mass ηm and height h with initial velocity u.All surface are smooth. The minimum value of u for which the block will reach the top of the wedge:



A. $\sqrt{2gh}$

B. $\eta\sqrt{2gh}$

C. $\sqrt{2gh\left(1+\frac{1}{\eta}\right)}$

D. $\sqrt{2gh\left(1-\frac{1}{\eta}\right)}$

Answer: C

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46. A heavy ring fo mass m is clamped on the periphery of a light circular disc.A small particle having equal mass is clamped at the centre of the disc. The system is rotated in such a way that the centre of mass moves in a circle of radius r with a uniform speed v. We conclude that an external forec :

A. $\frac{mv^2}{r}$ must be acting on the central particle

B. $\frac{2mv^2}{r}$ must be acting on the central particle

C. $\frac{2mv^2}{r}$ must be acting on the system

D. $\frac{2mv^2}{r}$ must be acting on the ring

Answer: C

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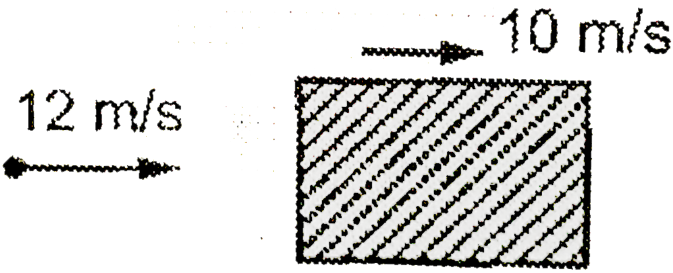
47. A light particle moving horizontally with a speed of $12 m / s$ strikes a very heavy block moving in the same direction at $10 m / s$. The collision is one-dimensional and elastic. After the collision, the particle will



A. Move at $2 m / s$ in its original direction

B. Move at $8 m / s$ in its original direction

C. Move at $8m/s$ opposite to its original direction

D. Move at $12m/s$ opposite to its original direction

Answer: B

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48. 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 $\overrightarrow{v'}_1$ and $\overrightarrow{v'}_2$ at time $2t_0$ while still moving in air. The value of

$$\left|\left(m_1\overrightarrow{v'}_1 + m_2\overrightarrow{v'}_2\right) - \left(m_1\overrightarrow{v}_1 + m_2\overrightarrow{v}_2\right)\right|$$

A. zero

B. $(m_1 + m_2)\mathrm{gt}_0$

C. $2(m_1 + m_2)\mathrm{gt}_0$

D. $\frac{1}{2}(m_1 + m_2)\mathrm{gt}_0$

Answer: C

Watch Video Solution

49. A chain of length l is placed on a smooth spherical surface of radius R with one of its ends fixed at the top of the sphere. What will be the acceleration w of each element of the chain when its upper end is released? It is assumed that the length of the chain $l < \frac{1}{2}\pi R.$

A. $\frac{Rg}{l}\left(1 - \sin\frac{l}{R}\right)$

B. $\frac{Rg}{l}\left(1 - \cos\frac{l}{R}\right)$

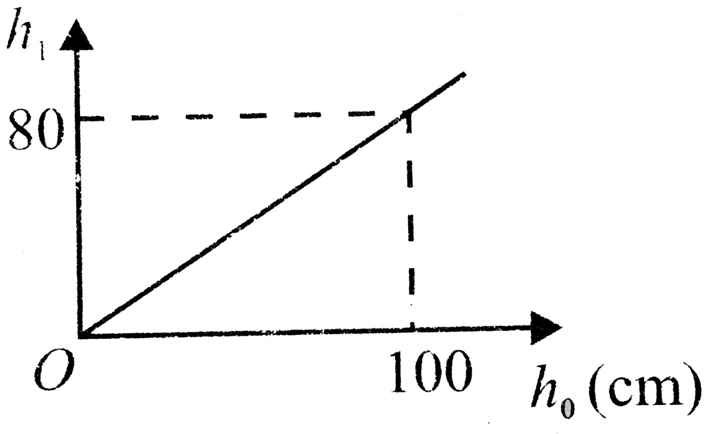
C. $\frac{Rg}{l}\left(1 - \tan\frac{l}{R}\right)$

D. $\frac{Rg}{l}\left(1 - \cot\frac{l}{R}\right)$

Answer: B

Watch Video Solution

50. A ball released from a height ho above a horizontal surface rebounds to a height h_1, after one bounce. The graph that relates h_0 to h_1 is shown Fig. If the ball (of the mass m) was dropped from an initial height h and made three bounces, the kinetic energy of the ball immediately after the third impact with the surface was



A. $(0.8)^3 \mathrm{mgh}$

B. $(0.8)^2 \mathrm{mgh}$

C. $0.8\mathrm{mg}(m/3)$

D. $\left[\left(1-(0.8)^3\mathrm{mgh}\right]\right.$

Answer: A

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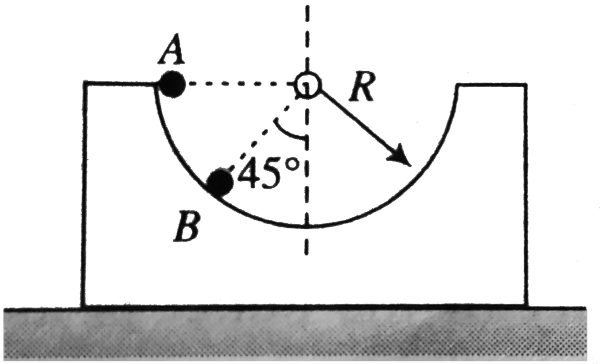
51. A ball of mass m is released from A inside a smooth wedge of mass m as shown in figure. What is the speed of the wedge when the ball reaches point B?



A. $\left(\dfrac{gR}{3\sqrt{2}}\right)^{1/2}$

B. $\sqrt{2gR}$

C. $\left(\frac{5gR}{2\sqrt{3}}\right)^{1/2}$

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

Answer: A

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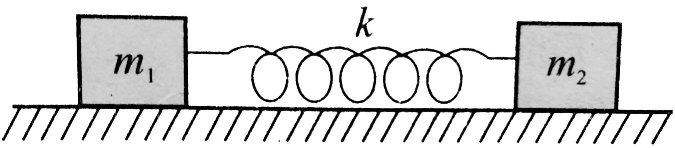
52. Two blocks m_1 and m_2 are pulled on a smooth horizontal surface, and are joined together with a spring of stiffness k as shown in Fig. Suddenly, block m_2 receives a horizontal velocity v_0, then the maximum extension x_m in the spring is



A. $v_0\sqrt{\dfrac{m_1m_2}{m_1+m_2}}$

B. $v_0\sqrt{\dfrac{2m_1m_2}{(m_1+m_2)k}}$

C. $v_0\sqrt{\dfrac{m_1m_2}{2(m_1+m_2)k}}$

D. $v_0\sqrt{\dfrac{m_1m_2}{(m_1+m_2)k}}$

Answer: D

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53. The centre of mass of a, non uniform rod of length L whose mass per unit length p varies as p $=\frac{kx^2}{L}$ where k: is a constant and x is the distance of any point from one end, is (from the same end):

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

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

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

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

Answer: A

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54. Two objects move in the same direction in a straight line. One moves with a constant velocity V_1.The other starts at rest and has constant acceleration a. They collide when the second object has velocity $2V_1$. The distance between the two objects when the second one starts moving is :

A. Zero

B. $\frac{V_1^2}{2a}$

C. $\frac{V_1^2}{a}$

D. $\frac{2V_1^2}{a}$

Answer: A

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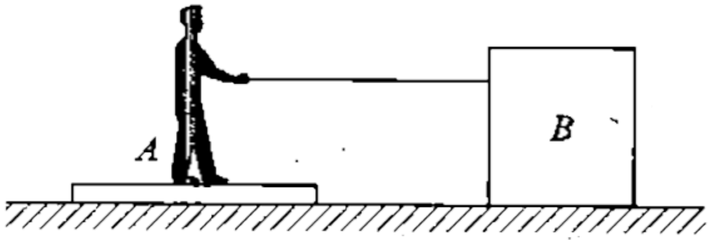
55. Figure shows a boy on a horizontal platform A on a smooth horizontal surface, holding a rope attached to a box B. Boy pulls the rope with a constant force of 50 N. The combined mass of platform A and boy is $250kg$ and that' of box B is $500kg$. The velocity of A relative to the box B 5 s after the boy on A begins to pull ,the rope,will be:



A. $1m / s$

B. $1.5m / s$

C. $2m / s$

D. $0.5m / s$

Answer: B

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56. A wind - powered generator convets and energy into electrical energy . Assume that the generator convents a fixed fraction of the wind energy intercepited by to blades into electrical energy for wind speed V , the electrical power output will be propertional to

A. v

B. v^2

C. v^3

D. v^4

Answer: C

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57. A ball falls vertically onto a floor with momentum p, and then bounces repeatedly. If the coefficient of restitution is e, then the total momentum imparted by the ball on the floor till the ball comes to rest is

A. $p(1+e)$

B. $\dfrac{p}{1-e}$

C. $p\left(1+\dfrac{1}{e}\right)$

D. $p\left(\dfrac{1+e}{1-e}\right)$

Answer: D

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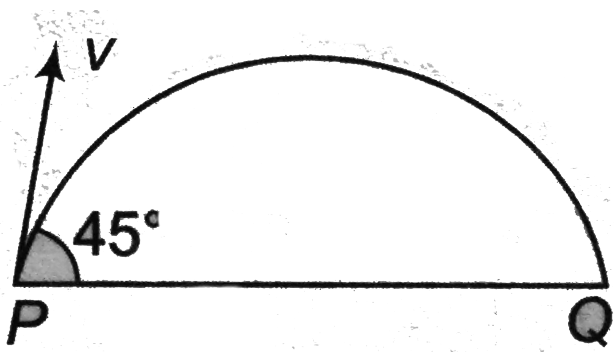
58. A projectile of mass m is fired with a velocity v from point P at an angle 45°. Neglecting air resistance, the magnitude of the change in momentum leaving the point P and arriving at Q is



A. Zero

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

C. $mv\sqrt{2}$

D. $2mv$

Answer: C

Watch Video Solution

59. Two balls of equal mass have a head-on collision with speed $6m/s$. If the coefficient of restitution is $\frac{1}{3}$, find the speed of each ball after impact in m / s

A. $18m / s$

B. $2m / s$

C. $6m / s$

D. $4m / s$

Answer: B

Watch Video Solution

60. An alpha particle collides elastically with a stationary nucleus and continues on at an angleof 60° with respect to the original direction of motion. The nucleus recoils at an angle of 30° with respect to this direction. Mass number of nucleus is

A. 2

B. 4

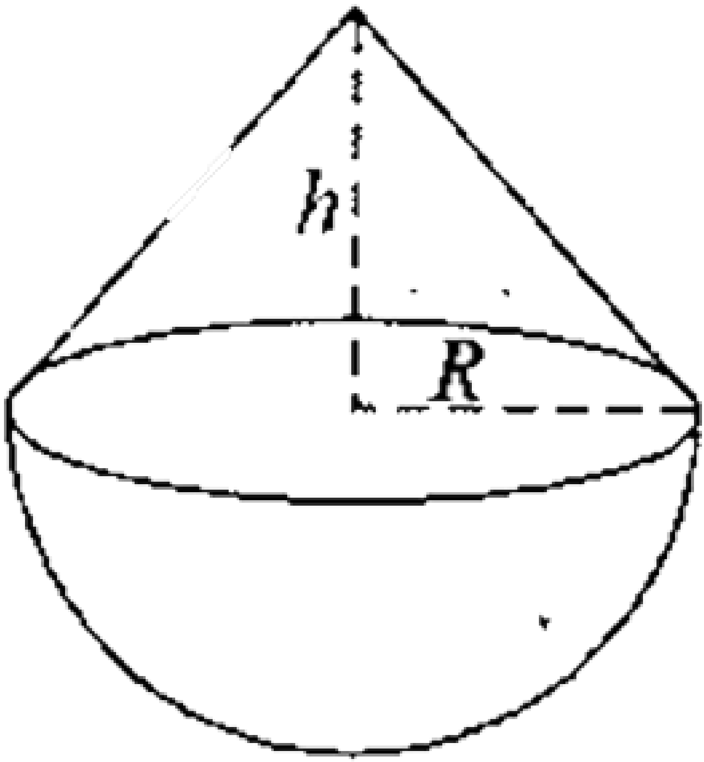
C. 8

D. 6

Answer: B

Watch Video Solution

61. A uniform solid right circular cone of base radius R is joined to a uniform solid hemisphere of radius R and of the same density, so as to have a common face. The centre of mass of the composite solid lies on the common face. The height of the cone is:



A. 1.5R

B. $\sqrt{3}R$

C. $3R$

D. $2\sqrt{3}R$

Answer: B

Watch Video Solution

62. A Sphere moving with velocity v strikes a wall moving towards the sphere with a velocity u. If the mass of the wall is infinitely large the work done by the wall during collision will be:

A. $mu(v+u)$

B. $2mu(v+u)$

C. $2mv(v+u)$

D. $2m(v+u)$

Answer: B

Watch Video Solution

63. A projectile of mass 20 kg is fired with a velocity of $400m/s$at an angle of 45° with the horizontal .At the highest point of the trajectocy the projectile explodes into two fragments of equal mass,one of which falls vertically downward with zero initial speed, The distance of the point where the other fragment falls from the point offiring is:

A. 24000 m

B. 16000 m

C. 32000 m

D. 8000 m

Answer: A

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64. A ball falls vertically for 2 seconds and hits a plane inclined at 30° to horizon. If the coefficient of restitution is $\frac{3}{4}$, find the time that elapses before it again hits the plane :

A. 3 seconds

B. 2 seconds

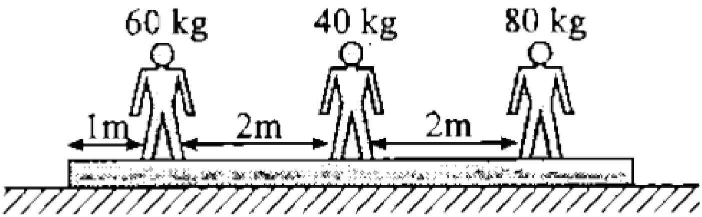
C. 5 seconds

D. 4 seconds

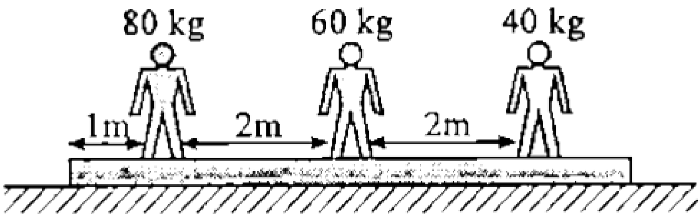
Answer: A

Watch Video Solution

65. Three boys are standing on a horizontal platform of mass 170kg as shown in figure. The exchange their position as shown inthe figure. Distance moved by the platform is:



(a)



(b)

A. 0.35 m

B. 0.55 m

C. 0.45 m

D. 0.25 m

Answer: A

Watch Video Solution

66. A platform of infinite mass is moving upward with velocity $5m/s$. At time t = 0, a ball which is at height 100 m above the platform starts falling freely. The velocity of ball just after the collision will be (Assume elastic collision) $(g = 10m/s^2)$:

A. $40m/s$

B. $50m/s$

C. $20m/s$

D. None

Answer: B

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

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

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

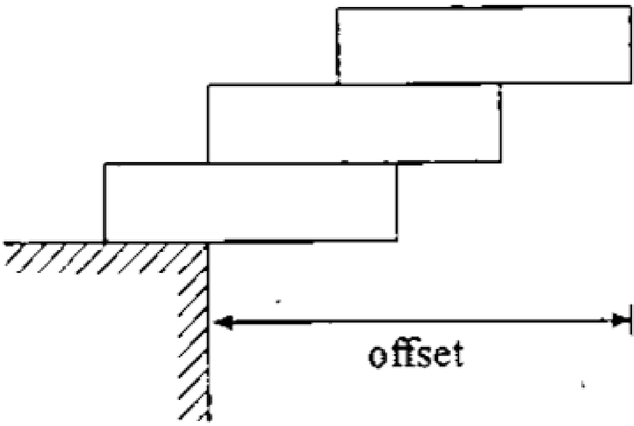
C. IU

D. $2IU$

Answer: B

Watch Video Solution

68. What is the maximum off set that one can obtained by piling up three identical bricks of length l :



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

B. $\frac{4}{3}l$

C. $\frac{5}{6}l$

D. $\frac{11}{12}l$

Answer: D

Watch Video Solution

69. When the KE of a particle is increased by 300%, the momentum of the body si increased by :

A. $20\ \%$

B. $50\ \%$

C. $100\ \%$

D. $200\ \%$

Answer: C

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70. Two astronauts, each of mass $75kg$ are floating next to each other in space, outside the space shuttle one of them pushes the other through a distance of 1m (an arms length) with a force of $300N$. What is the final relative velocity of the two ?

A. $2.0m/s$

B. $2.83m/s$

C. $5.66m/s$

D. $4m/s$

Answer: D

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

A. 10N

B. 100N

C. 1N

D. 0.1N

Answer: A

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72. A bowler tbrows a ball horizontally along east direction with speed of $144\mathrm{km}/\mathrm{hr}$. The batsman hits the ball such that it deviates from its initial direction of motion by 74° north of east direction, without changing its speed. If mass of the ball is $\frac{1}{3}kg$ and time of contact between bat and ball is 0.02 s. Average force applied by batsman on ball is:

A. $800N$, 53° East of Noth

B. $800N$, 53° North of East

C. $800N$, 53° North of West

D. $800N, 53^\circ$ West of North

Answer: D

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73. A small ball rolls off the top landing of a staircase. It strikes the mid point of the first step and then mid point of the second step. The steps are smooth & identical in height & width. The coefficient of restitution between the ball & the first step is :

A. 1

B. $3/4$

C. $1/2$

D. $1/4$

Answer: B

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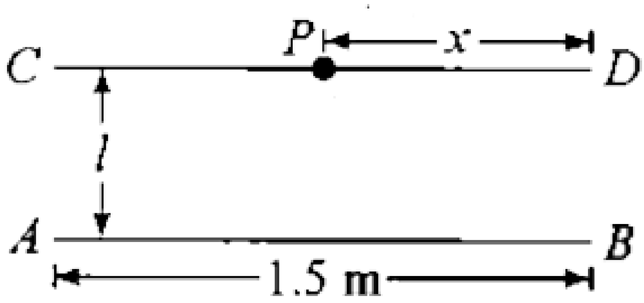
74. AB and CD are two smooth parallel walls. A child rolls a ball along ground from A towards point P find PD so that ball reaches point B after striking the wall CD. Given coefficient of restitution e = 0.5 :



A. 0.5 m

B. 1.2 m

C. 1m

D. None of these

Answer: C

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75. A sphere of mass m_1 in motion hits directly another sphere of mass m_2 at rest and sticks to it, the total kinetic energy after collision is $2/3$ of their total K.E. before collision. Find the ratio of $m_1 : m_2$.

A. $1:1$

B. $1:2$

C. $2:1$

D. $2:3$

Answer: C

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Advance Mcq

1. In which o the following cases the centre of mass of a rod is certainly not at its centre?

A. The density continuously increases-from left to right.

B. The density continuously decreases from left to righ.

C. The density decreases from left to right upto the centre and then increase

D. The density increases from left to right upto the centre and then decrease.

Answer: A::B

Watch Video Solution

2. When two blocks connected by a spring move towards each other under mutual interaction

A. Their velocities are equal and opposite.

B. Their accelerations are equal and oppposite.

C. The force acting on them are equal and opposite.

D. their momentum are equal and opposite.

Answer: C::D

Watch Video Solution

3. A body has its centre of maas at the origin. The x-coordinates of the particles

A. May be all positive

B. May be all negative

C. May be all non-negative

D. May be positive for some case and negative in other cases

Answer: C::D

Watch Video Solution

4. A body moving towards a finite body at rest collides with it. It is possible that

A. Both the bodies come to rest

B. Both the bodies move after collision

C. The moving body comes to rest and the'stationaiy body starts moving

D. The stationary body remains stationary, the moving body changes its velocity.

Answer: B::C

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5. In an elastic collision between smooth balls :

A. The kinetic energy remain constant

B. The linear momentum remains constant

C. The final kinetic energy is equal to the initial kinetic energy

D. The final linear momentum is equal to the initial linear momentum

Answer: B::C::D

6. A system of particles is acted upon by a constant nonzero external force. If v and a are instantaneous velocity and acceleration of the centre of mass, then it is possible that at a given instant

A. $v_0 = 0, a_0 = 0$

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

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

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

Answer: B::D

Watch Video Solution

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

A. A comes to rest

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

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

D. A and B move with unequal speeds, making angles of 30° and 60° with the x-axis respectively.

Answer: A::B::C::D

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

A. The minimum kinetic energy of the system is 1 J

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

C. Momentum and total energy are conserved atevery instant

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

Answer: A::B::C::D

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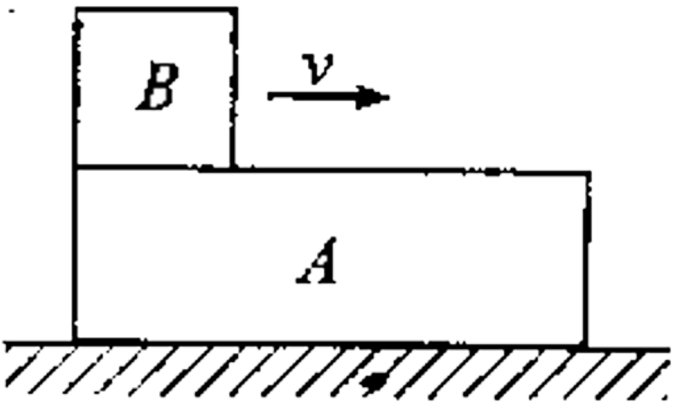
9. A long block A is at rest on a smooth horizontal surface. A small block B, whose mass is half of A, is placed on A at one end and projected along A with some velocity u. The coefficient of friction between the blocks is μ:



A. The blocks will reach the final common velocity $\frac{u}{3}$

B. the work done against friction is two-thirds of the initial kinetic energy of B

C. before the block reach a common velocity the acceleration of A relative to B is $\frac{2}{3}\mu g$.

D. Before the blocks reach a common velocity the acceleration of A relative to B is $\frac{3}{2}\mu g$.

Answer: A::B::D

Watch Video Solution

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

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

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

C. the speed of the strip as seen from the ground is $\frac{l}{1}\left(\frac{m}{M+m}\right)$

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

Answer: A::C

Watch Video Solution

11. In one-dimensional collision between two identical particles A and B,B is stationary and A has momentum p before and after the impact, and(P-J) during the impact:

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

B. During the impact A gives impules J to B

C. the coefficient of restitution is $\frac{2J}{P} - 1$

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

Answer: A::C

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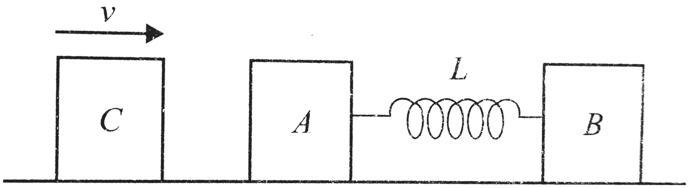
12. Two blocks A and H. each of mass m, are connected by a massless spring of natural length I. and spring constant K. The blocks are initially resting in a smooth horizontal floor with the spring at its natural length, as shown in Fig. A third identical block C, also of mass m, moves on the floor with a speed v along the line joining A

and B. and collides elastically with A. Then



A. The KE of the AB system at max. compression of the spring is zero

B. The KE of AB system is at max compression is $(1/4)mv^2$

C. the max compression of spring is $v\sqrt{(m/K)}$

D. the maximum compression of spring is $v\sqrt{(m/2k)}$

Answer: B::D

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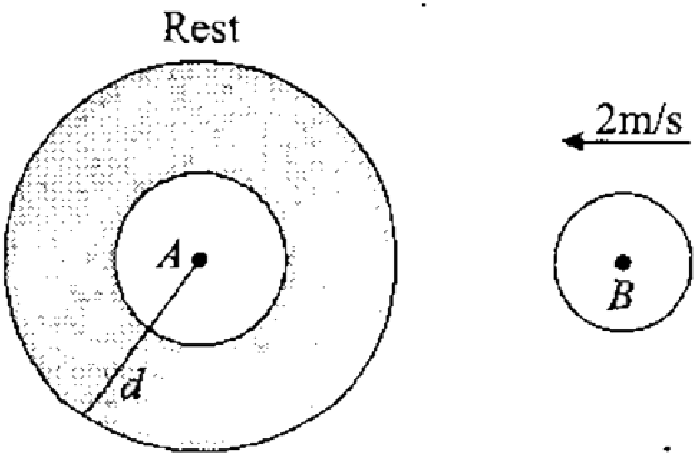
13. The elastic collision between two bodies, A and B can be considered using the following model. A and B are free to move along a common line with out friction. When separation between the surfaces is greater then d= 1m,the interacting force is zero, when their distance less than d, a constant repulsive force F= 6N is present. The mass of body A ism_(A) = 1kg and it is initially at rest. The mass of body B ism_B = 3kg and it is approaching towards A with a speed$v_0 = 2m/s$.

Then choose the correct option(s).



A. the common velocity attained by the bodies

are 1.5m/s

B. the minimum separation between the

bodies is 0.25m

C. the minimum separation between the bodies is 0.75m

D. the common velocitya attained by the bodies are 2.0 m/s

Answer: A::C

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14. The sum of all the external forces on a system of particles is zero. Which of the following must be true for the system of particles ?

A. the total mechanical energy is constant

B. the total potential energy is constant

C. the total kinetic-energy is constant

D. the total momentum is constant

Answer: A::D

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15. Consider a particle at rest which may decay into two (daughter) particles or into three (daughter) particles. Which of the following is / are true? (There are no external forces):

A. The velocity vectors of the daughter particles must lie in a plane.

B. Given the total kinetic energy of system and the mass of each daughter particle, it is possible to determine the speed of each daughter particle.

C. Given the speed (s) of all but one daughter particle it is possible to determine the speed of the remaining particle,

D. The total momentum of the daughter particles is zero.

Answer: A::D

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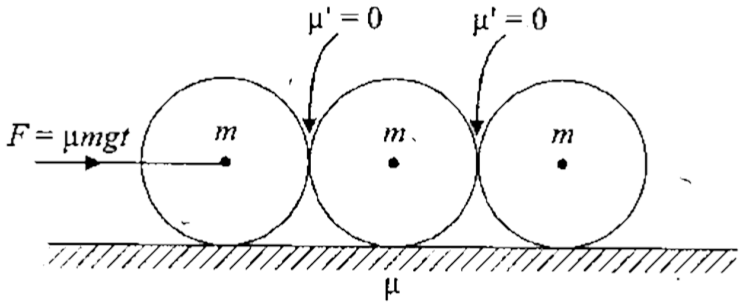
16. thee identical cylinders each of mass M and radius R are in contact and kept on a rough horizontal surface coefficient of friction between any cylinder and surface is $\mu : A \text{force} F = \mu M \text{gt}$ act on the first cylinder mark the correct statement .



A. the cylinder will start pure rolling and keep on rolling wtihout sliding

B. $Att = 9$ second slipping will start

C. Velocity of centre of mass of each sphere will keep on increasing

D. After a certain value of F angular velocity of each sphere will bcome constant

Answer: B::C::D

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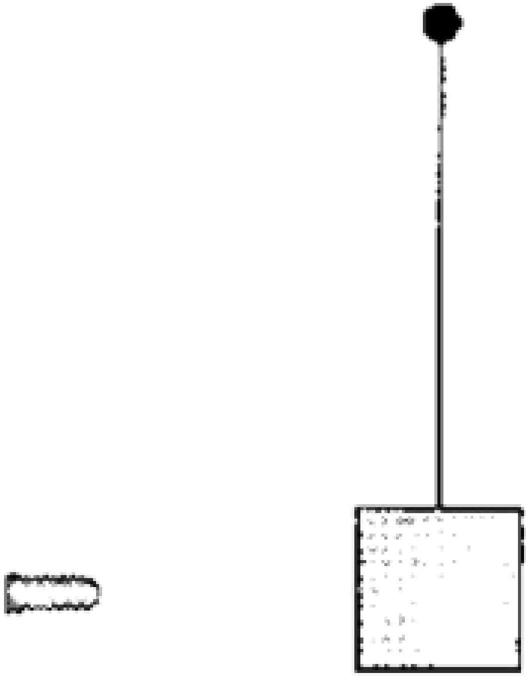
17. A wooden block (mass M) is hung from a peg by a massless string .A speeding bullet (with mass m and initial speedv_0) collides with block at time t=0 and embeds in it. Let S be the system consisting of the block and bullet. Which quantities are NOT conserved between t=-10 sec t=+10 sec?



A. the total linear momentum of S

B. the horizontal component of the linear momentum of S

C. the mechanical energy of S

D. the angular momentum of S as measured about a perpendicular axis through the peg

Answer: A::B::C::D

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18. Velocity of a particle of mass $2kg$ change from $\overrightarrow{v}_1 = -2\hat{i} - 2\hat{j}\frac{m}{s}$ to $\overrightarrow{v}_2 = (\hat{i} - \hat{j})m/s$ after colliding with as plane surface.

A. the angle made by the plane surface with the positive x-axis is $90^\circ + \tan^{-1}\left(\frac{1}{3}\right)$

B. the angle made by the plane surface with the positive x-axis is $\tan^{-1}\left(\frac{1}{3}\right)$

C. the direction of change in momentum makes an angle $\tan^{-1}\left(\frac{1}{3}\right)$ with the $+ve$ x-axis

D. the direction of change in momentum makes an angle $90^\circ + \tan^{-1}\left(\frac{1}{3}\right)$ with the plane surface

Answer: A::C

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19. Two identical particles A and B of mass m each are connected together by a light and inextensible string of length l. The particle are held at rest in air in same horizontal level at a separation l. Both particles are released simultaneously and one of them (say A) is given speed V_0 vertically upward. Choose the correct options (s). Ignore air resistance.

A. the maximum height attained by the centre of mass of the system of A and B is $\frac{v_0^2}{8g}$

B. the kinetic energy of the system of A and B when the centre of mass is at its highest point is $\frac{mv_0^2}{2}$

C. the maximum height attained by the centre of mass of the system of A and B is $\frac{v_0^2}{4g}$

D. the kinetic energy of the system of A and B when the centre of mass is its highest point is $\frac{mv_0^2}{4}$

Answer: A::D

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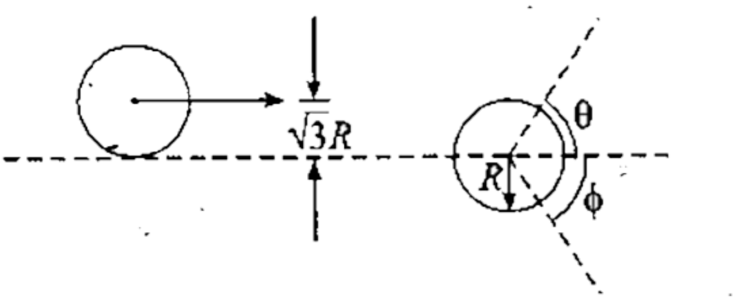
20. A disk moving on a frictionless horizontal table collides elastically y with another identical disk as shown. The directions of motion of the two disks make angles 0 and ϕ with the initial line of motion as shown. Then



A. $0 = 30^{\circ}$

B. $0 = 60^{\circ}$

C. $\phi = 30^{\circ}$

D. $\phi = 60^\circ$

Answer: A

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Unsolved

1. A projectile is fired from a gun at an angle of 45° with the 'horizontal and with a muzzle speed of $1500 ft/s$. At the highest point in its flight the projectile explodes into two fragments of equal mass. One fragment, whose initial speed is zero, falls vertically. How far from this gun does the other fragment land, assuming a level terrain ?

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2. A ball is dropped at t = 0 from a height 12 m above the ground. At the instant of release a very massive platform is at a height 4 m above the ground and moving upward with velocity $3m/s$ as shown in the figure. Find :

(a) the height reached by the ball after a perfectly elastic impact with the wall.

the time when the ball strikes the platform second time.

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3. A block of mass 200 gm is suspended through a vertical spring. The spring is stretched by 1 cm when the block is in equilibrium. A particle of mass 120 gm is dropped on the block from a height of 45 cm. The particle sticks to the block after the impact. Find the maximum extension of the spring.

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4. A ball of mass m is projected with a speed v into the barrel of a spring gun of mass M initially at rest lying on a frictionless surface. The mass sticks in the barrel at the point of maximum compression in the spring. The fraction of kinetic energy of the ball stored in the spring is

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5. A wooden block of mass $10g$ is dropped from the top of a cliff 100 m high. Simultaneously, a bullet of mass 10 g is fired from the foot of the cliff vertically upwards with a velocity of . $100m/s$

(i) Where and after what time will they meet

(ii) If the bullet after striking the block gets embedded in it how high will it rise above the cliff before it starts falling

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6. The bob of a pendulum of length 980 cm is released from rest with its string making an angle 60° with the vertical. It collides with a ball of mass 20 gm resting on a smooth horizontal surface just at the position of rest of the pendulum. With what velocity will the bob move immediately after the collision? What will be the maximum angular displacement of the bob after them collision ? The mass of the bob is 10 gm. '

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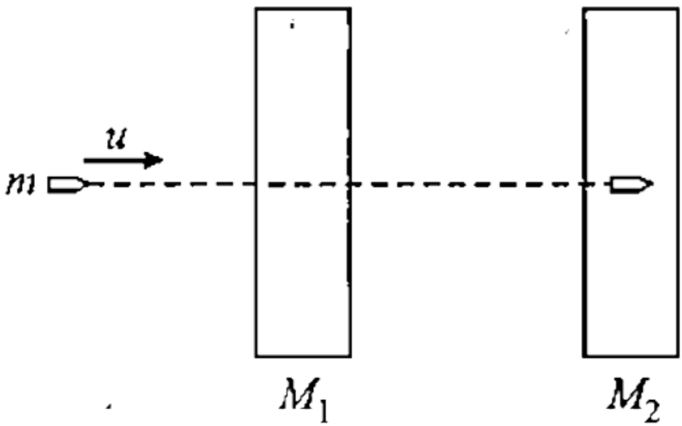
7. A m=20gm bullet pierces through a plate of mass $M_1 = 1kg$ and then comes to rest inside a second plate of mass$M_2 = 2.98kg$ as shown in figure. It is found that the two plates, initially at rest, now move with equal velocities. Find the percentage loss in the initial velocity of the bullet when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



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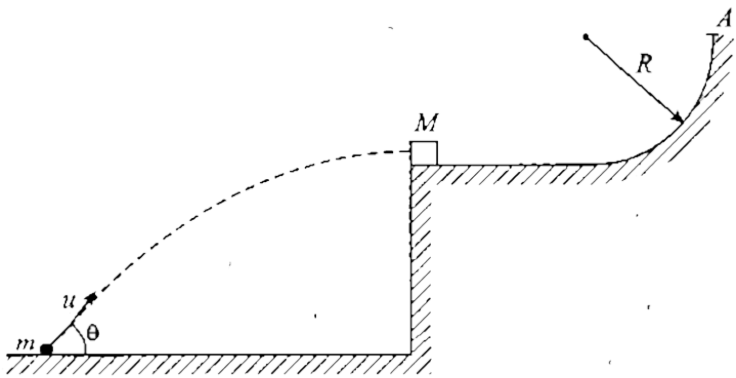
8. A ball of mass m is shot with a velocity u at an angle 0 with the horizontal which strikes the box of mass M resting at the edge of a smooth table as shown in figure . After striking the box ball falls down vertically. Find the value of u such that the box is raised to the point A shown in figure. Also find the horizontal distance l from which shot was fired.



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9. A locomotive of mass m starts moving so that its velocity varies according to the law $v = a\sqrt{s}$, where a is a constant, and s is the distance covered. Find the total work performed by all the forces which are acting on the locomotive during the first t seconds after the beginning of motion.

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10. A ball moving translationally collides elastically with another, stationary, ball of the

same mass. At the moment of impact the angle between the straight line passing through the centres of the balls and the direction of the initial motion of the striking ball is equal to $\alpha = 45^\circ$. Assuming the balls to be smooth, find the fraction η of the kinetic energy of the striking ball that turned into potential energy at the moment of the maximum deformation.

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11. A rod of length 1m and mass $0.5kg$ is fixed at one end is initially hanging vertical. The other end is now raised until it makes an angle 60° with the vertical. How much work is required ?

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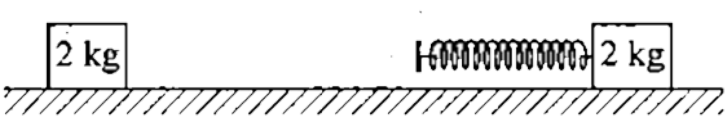
12. A block of mass 2 kg is moving on a frictionless horizontal surface with a velocity of $1m/s$ towards another block of equal mass kept at rest. The spring constant of the spring fixed at one end is $100N/m.$ Find the rnaximum compression of the spring



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13. A particle 1 moving with velocity $v = 10m/s$ experienced a head on collision with a stationary particle 2 of the same mass. As a result of collision, the kinetic energy of the system decreased by 50%. Find the magnitude and direction of the velocity of the particle 1 after collision.

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14. $A 3kg$ melon is balanced on a bald man's head. His friend shoots a $50gm$ arrow at it with speed $25m/s$. The arrow passes through the melon and emerges at $10m/s$. Find the speed of the melon as it flies off the man's head.

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15. $A 42kg$ girl walks along a stationary uniform beam of mass $21kg$. She walks with a speed of $0.75m/s$. What is the speed of the center of mass of the system of girl plus beam ?

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16. Two perfectly smooth elastic discs A and B, one k times as massive as the other, rest on a smooth horizontal table. The disc A is made to move towards B with velocity u and make a head on collision. Calculate the fraction of the kinetic energy transferred to B from A. Also show that the value of this fraction is the same whether B is k times as massive as A or vice versa.

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

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18. Two vehicles A and B are traveling west and south,respectively, towards the same intersection where they collide and lock together. Before the collision A (9001 b) is moving with a speed of 40 mph, and B(12001 b) has a speed of 60 mph. Find the' magnitude and direction of the velocity of the interlocked vehicles immediately after collision.

View Text Solution

19. An object of mass 5 kg is projecte with a velocity of $20ms^{-1}$ at an angle of 60° to the horizontal. At the highest point of its path , the projectile explodes and breaks up into two fragments of masses 1kg and 4 kg. The fragments separate horizontally after the explosion, which releases internal energy such that $K.E.$ of the system at the highest point is doubled. Calculate the separation betweent the two fragments when they reach the ground.

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20. $A 120 gm$ ball moving at $18 m/s$ strikes a wall perpendicularly and rebounds straight back at $12 m/s$. After the initial contact, the center of the ball moves 0.27 cm closer to the wall. Assuming uniform deceleration, show that the time of contact is 0.00075 seconds. How large an average force does the ball exert on the wall ?

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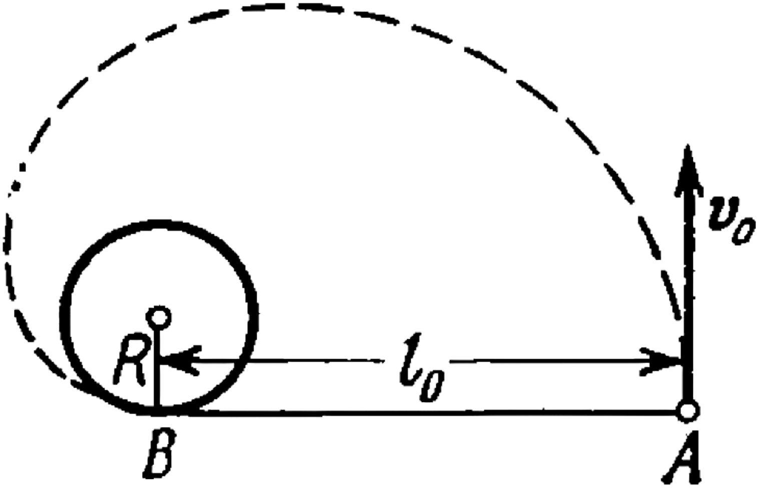
21. A horizontal plane supports a stationary vertical cylinder of radius R and a disc A attached to the cylinder by a horizontal thread AB of length l_0 (figure, to view). An initial velocity v_0



is imparted to the disc as shown in the figure. How long will it move along the plane until it strikes against the cylinder? The friction is assumed to be absent.

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22. Two carts,initially at rest,are free to move on a horizontal plane. Cart A has mass 4.52 kg and cart B has a mass 2.37kg. They aretied together, compressing a light spring in between them. When the string holding them together is burned, the cart A moves off with a speed of 2.11 m/s.(a) With what speed does cart B leave ? (b) How much energy was stored in the spring before the string was burned ?

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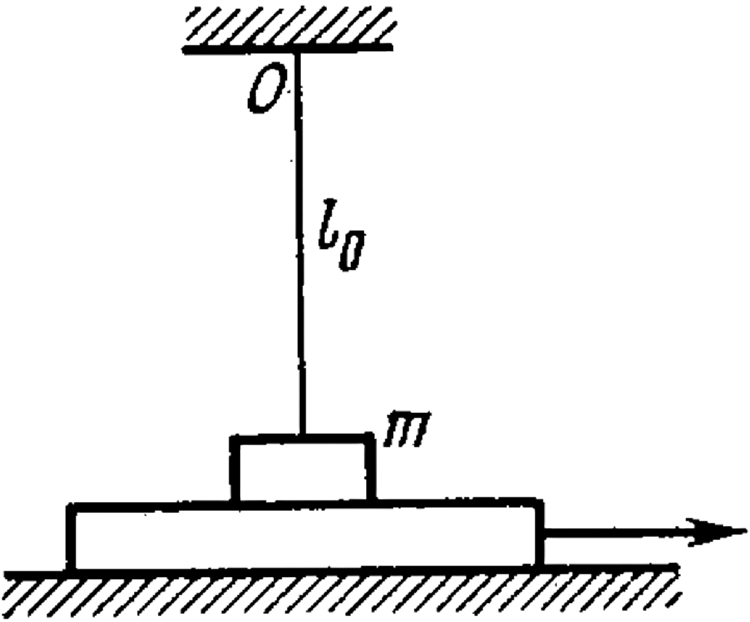
23. A horizontal plane supports a plank with a bar of mass $m = 1.0kg$ placed on it and attached by a light elastic non-deformed cord of length $l_0 = 40cm$ to a point O(figure). The coefficient of friction between the bar and the plank equals $k = 0.20$. The plank is slowly shifted to the right until the bar starts sliding over it. It occurs at the moment when the cord deviates from the vertical by an angle $\theta = 30^\circ$. Find the work that has been performed by that moment by the friction force acting on the bar in the reference frame fixed to the plane.



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24. N identical balls are placed on a smooth horizontal surface. An another ball of same mass

collides elastically with velocity u with first ball of N balls. A process of collision is thus started in which first ball collides with second ball and the with the third ball and so on. The coefficient of restitution for each collision is e. Find the speed of Nth ball.

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25. A steel ball of mass w=50gm falls from height h=1 m on the horizontal surface of a massive slab. Find the cumulative momentum imparted to the slab by the ball after numerous bounces, if the coefficient of restitution between the ball and the slab is e = 0.8.

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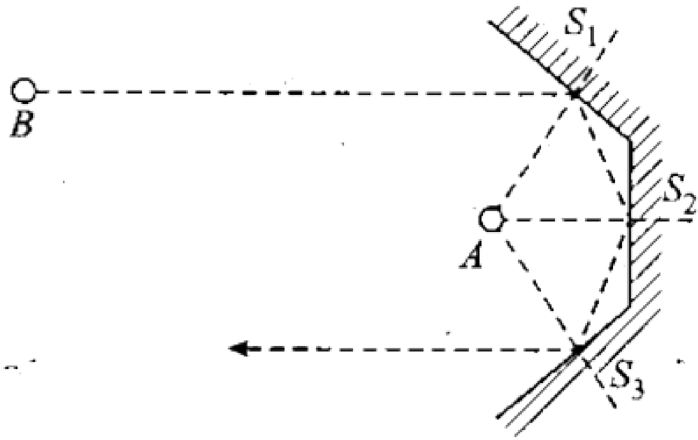
26. In the figure-4.133 shown A is a ball of mass 2kg fixed at its position and S_1, S_2 are the walls facing A. Another ball B of mass 4 kg incident on the wall at an angle of incidence 60° and then successively it collides elastically with wall and as shown in figure-4.132. Trace the locus of centre of mass of the two balls during the motion of the ball B



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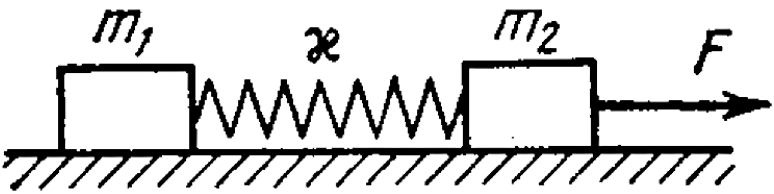
27. Two bars connected by a weightless spring of stiffness $\varkappa$ and length (in the non-deformed state) l_0 rest on a horizontal plane. A constant horizontal force F starts acting on one of the bars as shown in figure. Find the maximum and minimum distances between the bars during the subsequent motion of the system, if the masses of the bars are:

(a) equal:

(b) equal to m_1 and m_2, and the force F is applied to the bar of mass m_2.



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28. A raft of mass M with a man of mass m aboard stays motionless on the surface of a lake. The man moves a distance l' relative to the raft with velocity $v'(t)$ and then stops. Assuming the water resitance to be negligible, find:

(a) the displacement of the raft 1 relative to the shore,

(b) the horizontal component of the force with which the man acted on the raft during the motion.

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29. A shell flying with velocity v= 500 m/s bursts into three identical fragments so that kinetic energy of the system increases 1.5 times. What maximum velocity can one ofthe fragments obtain ?

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30. 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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31. A 2 kg block rests over a small hole in a table. A woman beneath the table shoots a 15 gm bullet through the hole into the block, where it lodges. How fast was the bullet going if the block rises 75 cm above the table ?

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32. A 1 kg block slides down an inclined plane of mass 3.2kg having inclination 45°. If the inclined plane is fixed and the 1kg block slides without friction, find the acceleration of the centre of mass of the system of the block and inclined plane.

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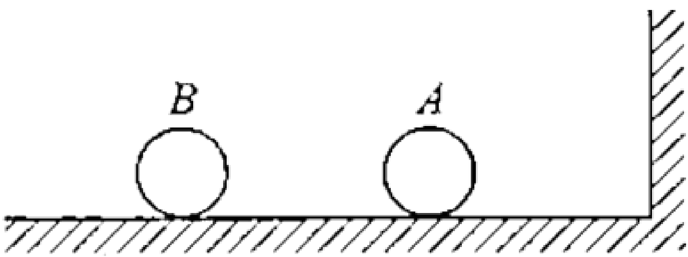
33. A ball A of mass 10kg and a ball B of unknown mass are placed on a horizontal frictionless table which rest against a rigid wall as shown in figure-4.135. The hail A moves towards the ball B with a velocity v.What should be the mass of B such that both A and B move with the same speed after A has undergone a collision with ball B and the wall ? All collisions are assumed to the elastic.



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34. A plastic ball is dropped from a height of one meter and rebounds several times from the floor. If 1.3 seconds elapse from the moment it is dropped to the second impact with the floor, what is the coefficient of restitution.

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35. A uniform chain is held on a frictionless table with one- fifth of its length hanging over the edge. If the chain has a length l and a mass m, how much work is required to pull the hanging part back on the table ?

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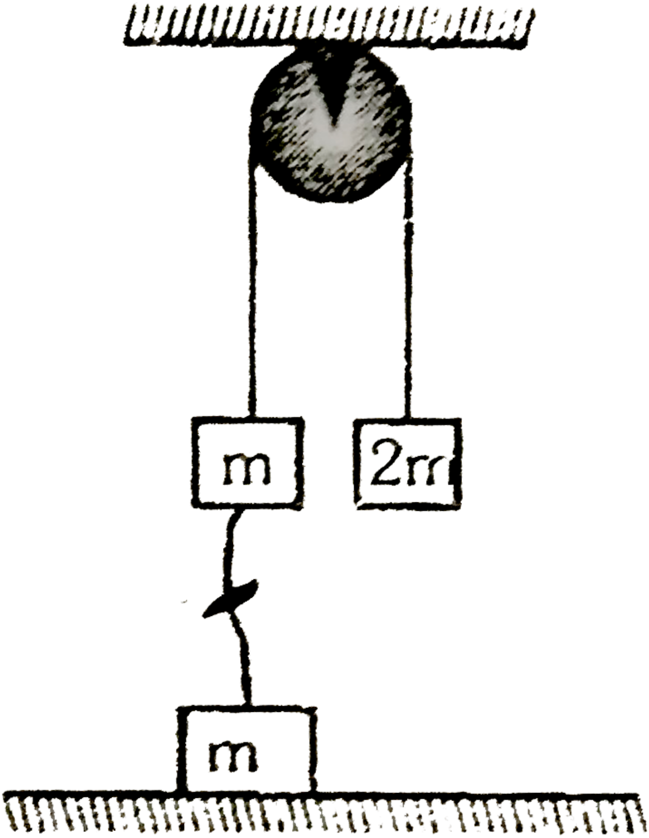
36. The Atwood machine in figure has a third mass attached to it by a limp string. After being released, the $2m$ mass falls a distance x before the limp string becomes laut. Thereafter both the mass on the left rise at the same speed. What is the final speed ? Assume that pulley is ideal.



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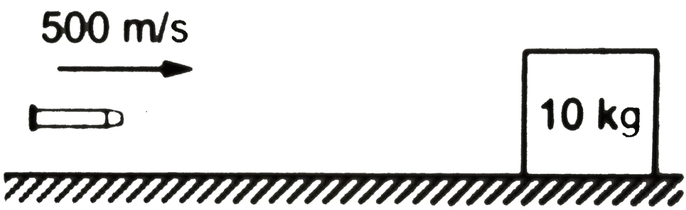
37. A bullet of mass 20 g travelling horizontally with a speed of 500 m/s passes through a wooden block of mass 10.0 kg initially at rest on a level surface. The bulet emerges with speed of 100 m/s and the block slides 20 cm on the surface before coming to rest. Find the friction cioefficient between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



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38. A particle A of mass m moving on a smooth horizontal surface collides with a stationary particle B of mass 2m directly, situated at a distance d from a wall. The coefficient of restitution between A and B and between B and the wall is e = 1/4. Calculate the distance from the wall where they collide again. Assume that the entire motion takes place along a straight line perpendicular to the wall.

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39. An 80 kg caveman, standing on a branch of a tree 5 m high, swings on a vine and catches a 60 kg cavegirl at the bottom of the swing. How high will both of them rise ?

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40. What is the thrust of a rocket that bums fuel at a rate of $1.3X10^4$ kg/sec if the exhaust gases have a velocity $2.5x10^3$m/s with respect to the rocket.

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41. A cannon is mounted on a railway wagon which stands on a straight section of the track. The mass of the wagon with the cannon,projectiles and man is 2000 kg and mass of each projectile is 25 kg. The cannon is fired in a horizontal direction along the track, the projectiles having an initial velocity of 1000m/s with respect to the cannon (i) what should be the speed of the cannon after the first shot ? (ii) what should be the speed after the third shot?

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42. A wagon of mass M can move without friction along horizontal rails. A simple pendulum consisting of a sphere of mass m is suspended from the ceiling of the wagon by a string of length l. At the initial moment the wagon and the pendulum are at rest and the string is deflected through an angle α from the vertical. Find the velocity of the wagon when the pendulum passes through its mean position.

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43. A ball of mass 2m moving due east with a speed of 8u collides directly with a ball B of mass m and the velocity of B after collision is 5 u due east. If the coefficient of restitution is 1/11, find the fraction of the total kinetic energy lost?

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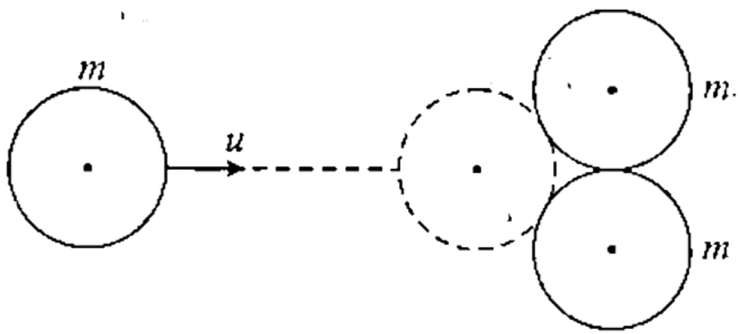
44. A ball with initial speed of10m/s collides elastically with two other identical balls at rest as shown in figure, whose centres are on a line perpendicular to the initial velocity and which are initially in contact with each other.All the three balls are lying on a smooth horizontal table. The first ball is aimed directly at the contact point of the other two balls.All the balls are smooth. Find the velocities of the three balls after the collision.



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45. A rocket with initial mass 8000 kg is fired vertically. Its exhaust gases have a relative velocity of 2500 m/s and are ejected at a rate of 40kg/s. (a) What is the initial acceleration of therocket? (b) What is its acceleration after 20 s have elapsed.

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46. A ball of mass m is moving with speed u to the left along the positive x-axis, toward the origin. It strikes another ball of mass m/4 at rest at the origin. After collision the incoming ball is reflected back to the right an angle of 37° to the positive x-axis with a speed of m/5. Find the speed,and direction of motion of the other ball.

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47. A shell of mass 3m is moving horizontally through air with velocity u when an internal explosion causes it to separates into two parts of masses m and 2m, which continue to move horizontally in the same vertical plane. If the explosion generates additional energy, of amount

$12\mu^2$ prove that the two fragments separate with relative speed 6u.

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48. A closed system consists of two particles of masses m_1 and m_2 which move at right angles to each other with velocities v_1 and v_2. Find:

(a) the momentum of each particle and

(b) the total kinetic energy of the two particles in the reference frame fixed to their centre of inertia.

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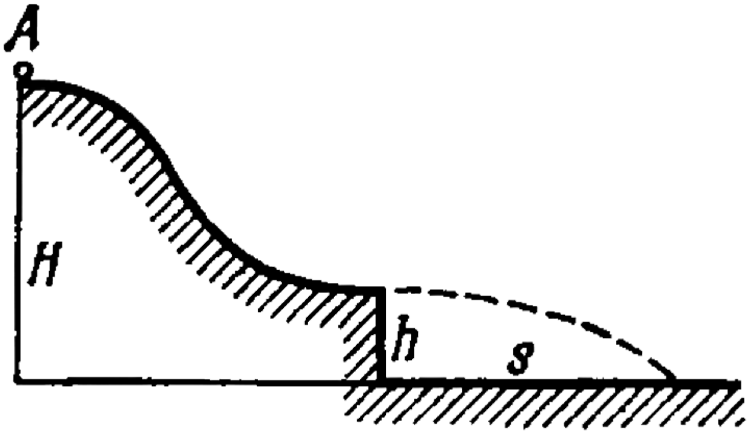
49. A small disc A slides down with initial velocity equal to zero from the top of a smooth hill of height H having a horizontal portion. What must be the height of the horizontal portion h to ensure the maximum distance s covered by the disc? What is it equal to?



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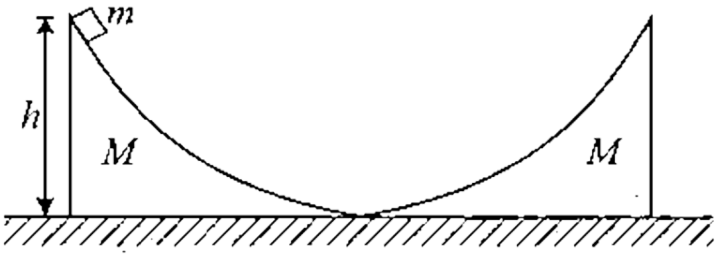
50. The inclined surfaces of two movable wedges of the same mass M are smoothly conjugated with the horizontal plane as shown in figure. A.small block of mass m slides down the left wedge from a height h. To what maximum, height will the block rises on the right wedge.



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51. A particle of mass m having collides with a stationary particle of mass M deviated by an angle $\pi/2$ whereas the particle M recoiled at an angle $\theta = 30^\circ$ to the direction of theinitial motion of the particle m. How much in percent and in what way has the kinetic energy of this system changed after the collision, if $\frac{M}{m} = 5$.

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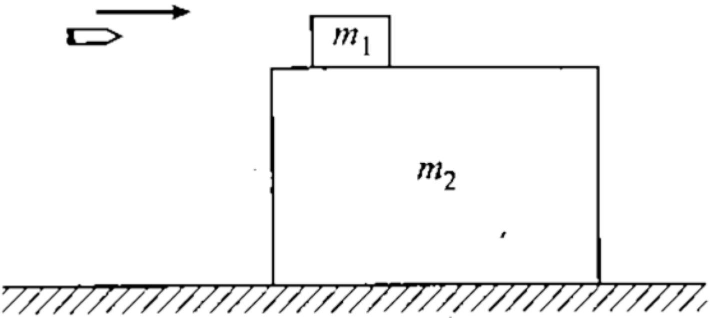
52. A bullet of mass 0.25 kg is fired with velocity 302m/s into a block of wood of mass 37.5kg.It gets embedded into it. The block m_1 is resting on a long block and the horizontal surface on which it is placed. The coefficient of friction between m_1 and m_2 is 0.5. Find the displacement of on and the common velocity of m_1 and m_2. Mass m^2= 12.5kg.



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53. A simple pendulum of length l and consisting of a ball of mass m is released from a position making an angle $\theta = \cos^{-1}$ (0.8) with the vertical and strikes at its lowest position a block of mass

M resting on a rough horizontal plane. If the coefficient of kinetic friction between the plane and the block is 0.2 find

(a) How long the block will move along the plane, if the ball of the pendulum rebounds to an angle $\beta = \cos^{-1}(0.9)$A

(b) The coefficient of restitution, use $\frac{M}{m} = 10$ and 1= 1 m

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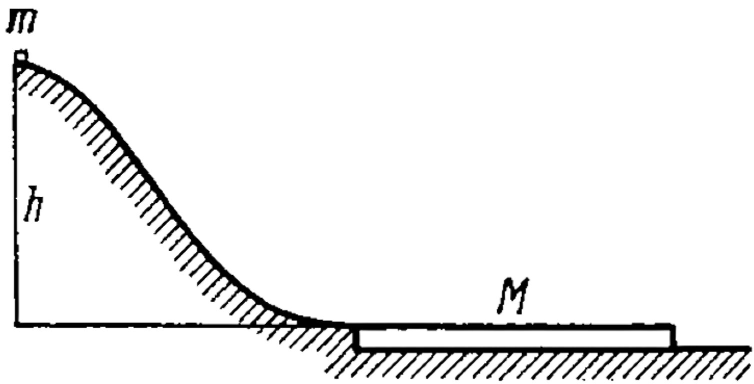
54. A small disc of mass m slides down a smooth hill of height h without initial velocity and gets onto a plank of mass M lying on the horizontal plane at the base of the hill. (figure). Due to friction between the disc and the plank the disc slows down and, beginning with a certain moment, moves in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

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

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

frame?



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55. A steel ball of mass $m = 50g$ falls from the height $h = 1.0m$ on the horizontal surface of a massive slab. Find the cumulative momentum that the ball imparts to the slab after numerous bounces, if every impact decreases the velocity of the ball $\eta = 1.25$ times.

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56. A ball is projected from a given point with velocity u at some angle with the horizontal and after hitting a vertical wall returns to the same point. Show that the distance of the point from the wall must be less than $\frac{eu^2}{(1+e)g}$, where e is the coefficient of restitution.

57. A body of mass m moving with velocity V in the X-direction collides with another body of mass M moving in Y-direction with velocity v. They coalesce into one body during collision. Calculate :

(i) the direction and magnitude of the momentum of the final body.

(ii) the fraction of initial kinetic energy transformed into heat during the collision in terms of the two masses.

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58. A 10 kg hummer sstrikes a nail at a velocity of 12.5 m/s and comes to rest in a tuime interval of 0.044 sec. Find the impules imparted to the nail and the average force imparted to the nail

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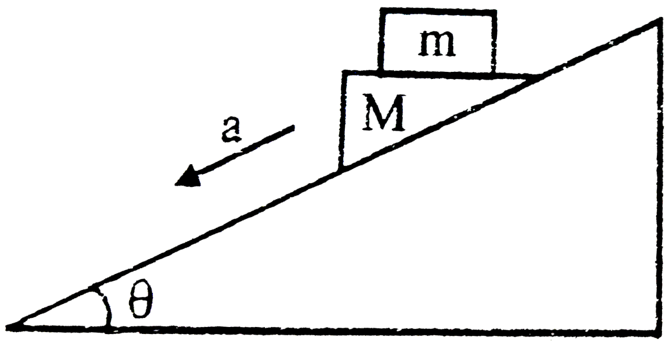
59. As shown in the figure, a wedge of mass M is placed on a smooth inclined ramp that makes an angle θ to the horizontal. An object of mass m rests on top of the wedge. The sliding down the ramp at acceleration a. determine the apparent weight of the objects as it slides down. noth that there is friction between the object and the wedge so that the object remains relatively at rest on the wedge.



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60. A mass of 2.9 kg, is suspended from a string of length 50 cm, and is at rest. Another body of mass 100 gm moving horizontally with a velocity of 150 m/sec, strikes and sticks to it. What is the tension in the string when it makes an angle of 60 with the vertical

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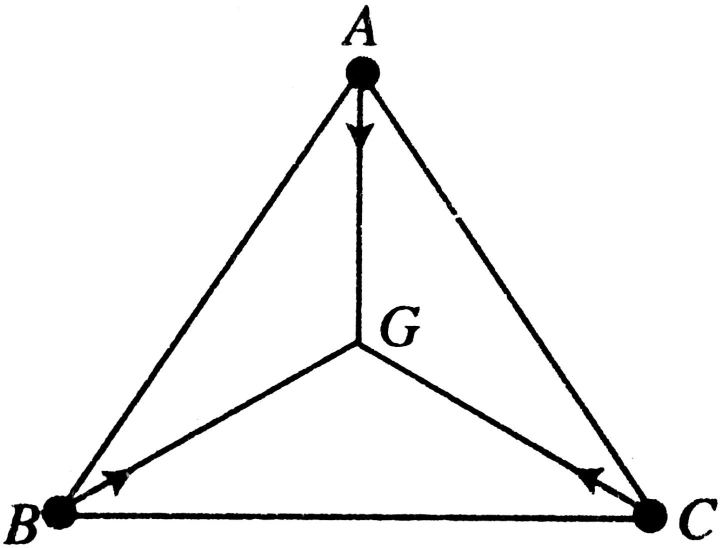
61. Three particles A, B and C of equal mass move with equal speed $V = 5ms^{-1}$ along the medians of an equilateral triangle as shown in the figure. They collide at the centroid G of the triangle. After the collision, A comes to rest, B retraces its path with the speed $V = 5ms^{-1}$. What is the speed of C?



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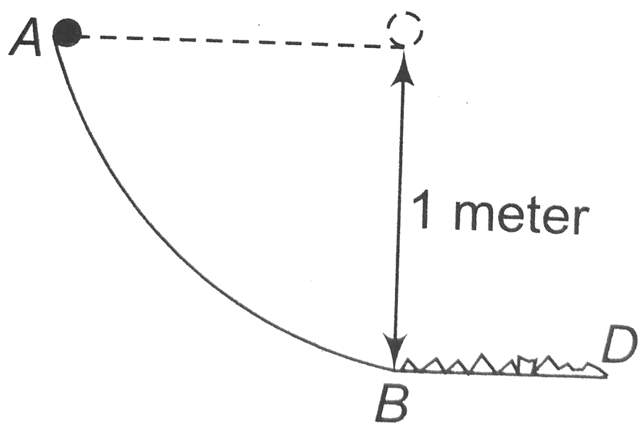
62. In the track shown in figure section AB is a quadrant of a circle of 1 meter radius. A block is released at A and slides without friction until it reaches B. After B it moves on a rough horizontal floor and comes to rest at distance 3 meters from B. What is the coefficient of friction between floor and body?



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63. A cylindrical solid of mass $10^{-2} kg$ and cross-sectional area $10^{-4} m^2$ is moving parallel to its axis (the x-axis) with a uniform speed of $10^3 m / s$ in the positive direction. At $t = 0$, its front face passes the plane $x = 0$. The region to the right of htis plane is filled with the dust particle of uniform density $10^{-3} k \frac{g}{m^3}$. When a dust particles collides with the face of the cylinder, it stricks to its surface. Assuming that the dimensions of the cylinder remain parctically unchanged adn that the dust sticks only to the front face of the cylinder find the x-coordinate of the front of th ecylinder at $t = 150s$.

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64. Two small discs of masses m_1 and m_2 interconnected by a weightless spring rest on a smooth horizontal plane. The discs are set in motion with initial velocities v_1 and v_2 whose directions are mutually perpendicular and lie in a horizontal plane. Find the total energy $\widetilde{E}$ of this system in the frame of the centre of inertia.

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65. A cart loaded with sand moves along a horizontal floor due to a constant force F coinciding in direction with cart's velocity vector. In the process, the sand spills through a hole in the bottom with a constant rate $\mu kg / s$. Find the acceleration and velocity of the cart at the moment t, if at the initial moment $t = 0$ the cart with loaded sand had mass m_0 and its velocity was equal to zero. Friction is to be neglected.

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66. A ball falls undal gravity from a height of 10m with an initial downward velocity u. It collides with ground, loses halft its energy and then rises back to the same height. Find the initial velocity u.

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67. Two balls A and B. are of the sme size but the mass of A is double that of B. they move along the sme line in opposite direction. A with velocity 2μ and B with velocity 3μ If their total kinetoc energy after collision is half their total kinetic energy before collision find the coefficient of restitution. Find also their velocities after collision.

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68. Find the mass of the rocket as a function of time, if it moves with a constant acceleration a, in absence of external forces. The gas escapes with a constant velocity u relative to the rocket and its mass initially was m_0.

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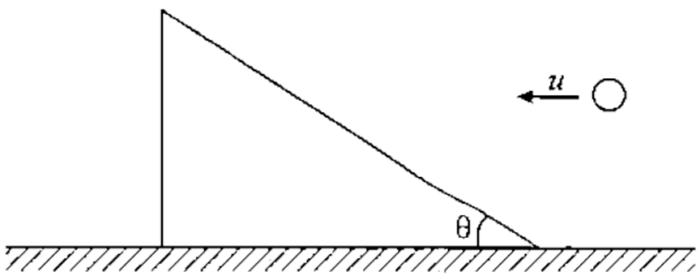
69. A ball moves towards a smooth wedge with a velocity μ as shown in figure -4.145. After colllision the ball rebounds verically upwards. The coefficient of restitution is e. Find the velocity of the wedgt block and bell after collision. Do you need some other parameters to solve the given problems.



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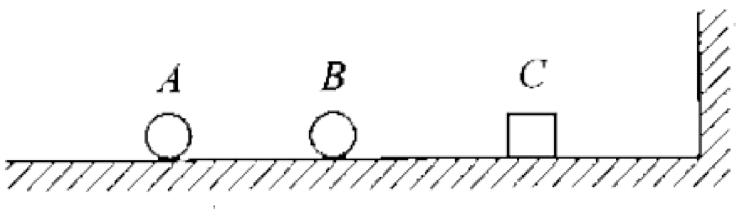
70. Masses of the bodies A,B and C are 1 kg, 2 kg and 3 kg respectively. There is no friction between the ground and the bodies. Initially ball A is moving with a avelocity 20 m/s collieds inelhastically $(e = 0.5)$ with the ball B,which was initially at rest. The ball B further colides elasticaly to the block C (at rest), and then C collides elastically to the will in front. Find the velocities of the three blocks after all collisions occurred.



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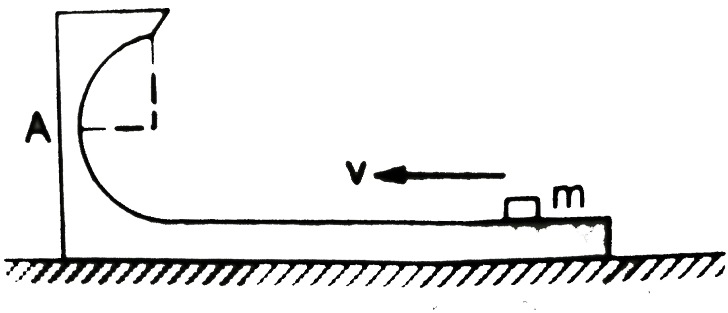
71. Figure shows a small block of mass m which is started with a speed v on the horizontal part of the bigger block of mas m placed on a horizontal floor. The curved part of the surface shown is semicircular. All the surfaces are frictionless. Find the speed of the bigger block when the smaller block reaches the point A of the surface.



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72. Form a uniform circular disc a circular hole is cut out touching the rim of the disc at the poing A. prove that the ecenter of gravity G of the remainder is on the circumference of the hole if $AG^2 = AB \times GB$ where B is the other and of the diameter through A of the disc

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73. A block of mass 2.0 kg moving at 2.0 m/s collides head on with another block of equal

mass kept at rest. (a). Find the maximum possible loss in kinetic energy due to the collision. (b).If the actual loss in kinetic energy is half of this maximum, find the coefficient of restitution.

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74. A ball moving with a speed of $9m/s$ strikes an identical ball at rest, such that after the collision, the direction of each ball makes an angle of 30° with the original line of motion. Find the speeds of the two balls after collision.

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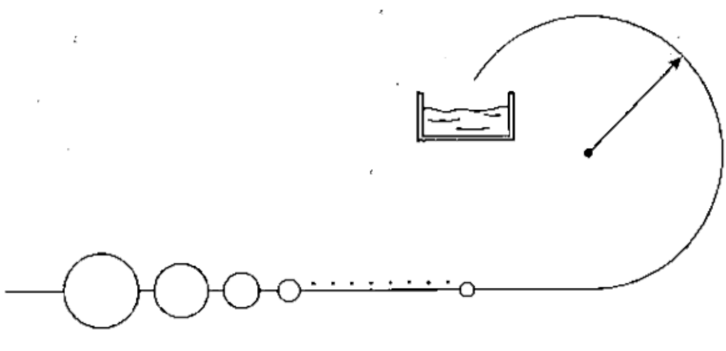
75. N beads are restiog on a smooth horizontal wire which is circular at the end with radius r as shown in figure the masses of the beads are m, $m/2, m/2\ldots.., m/2^{n-1}$ respectively. Find the minimum velocity which should be iparted to the first bead of mass m such that the n^{th} bead wil fall in the tank shown in figure -40148.



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76. While moving in a wagon $(5kg)$along a smoth road at 0.5 m/s, a 15 kg boy throws a 3 kg bag of send in front of him with a speed 4 m/s relative to his original motion. How fast is he moving after he throws the bag of send. What is his final direction of motion ?

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77. Two men, each of mass m, stand on the edge of a stationary buggy of mass M. Assuming the

friction to be negligible, find the velocity of the buggy after both men jump off with the same horizontal velocity u relative to the buggy: (1) simultaneously, (2) one after the other. In what case will the velocity of the buggy be greater and how many times?

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78. Accordingto a FIR in police station, car A wassittingat rest waiting for a red light at a crossing when it was hit by an identical car B from rear side. Bothcars had their hand brakes on, and from their skid marks it is surmised that they skidded together about 6m in the oriinal directionof travel before coming to reat. Assuming a stopping force of about 0.7 times the combined weights of the cars (that is, $\mu = 0.7$) what must have been the approximate speed of car B just before the collision ?

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79. A particle of mass M is at rest when it suddenly explodes into there picces of equal massses. One piece flies out along the positive x-axis with a speed of 30m/s while anotheer goes in the negative y direction with a speed of 20m/s Find the componenrts of the cvelocity of the third piece.

Repeat if the third piecre has a mass $M/2$ and the other two each have mass $M/4$

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80. Avertical, uniform chain of total mass M and length L is being lowered onto atable at aconstant speed V. At time $t=0$ the lower end of the chain toucjhes the table. Find the exerted by the chain on the table as a function of time, as the chain is deposited on the table.

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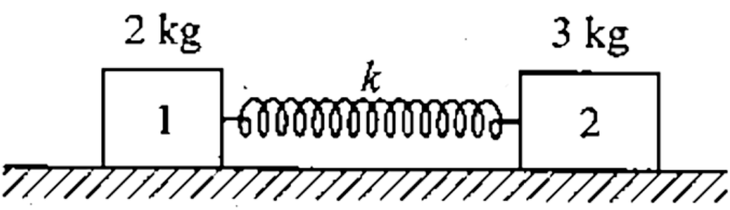
81. A spring of free length 15 cm is connected to the two masses as shown in the figure -4.149 and compressed 5 cm. The system is released on a smooth horizonal surface. Find the speed of each block when the spring is again at its free length. The force constant for spring is $2100Nm^1$



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82. A 441 gm bullet strikes an d becomes embedded in a 1.54 kg block of wood placed on a horizonatal surface just in front of the gun. If the coefcient of kinetic friction between the block and the surface is 0.28, and the impact drives the block a distance of 18 m before it comes to rest, what was the muzzle speed of the bullet ?

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83. A 4200 kg rocket is traveling in outer space with a velocity of 150 m/s toward the sun. It wishes to alter its course by 30°, and can do this by shooting its rockets briefly in a direction perpendicular to its original motion. If the rocket gases are expelled at a speed of 2700 m/s, what mass of gas must be explled ?

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84. The tennis ball may leave the racket of a top player on the serve with a speed of 65 m/s If mass of the ball is 0.06 kg and is in bontact with the racket for 0.03 sec, what the average force n the ball ?

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85. A block of miss 2kg slides down a 30° incline which is 3.6m high At the bottom, it strikes a block or mass 6 kg which is at rest on a horizontall surface. If the colision is elastic, and friction can be ignored, determing (a) the speeds of the two blocks after the collision and (b) how far back up the incline the smaller mass will go.

86. A rocket ejects a steady jet whose velocity is equal to u relative to the rocket. The gas discharge rate equals $\mu kg/s$. Demonstrate that the rocket motion equation in this case takes the form

$$mw = F - \mu u,$$

where m is the mass of the rocket at a given moment, w is its acceleration, and F is the external force.

87. Two billiard balls of equal mass move at tight angles and meet at the origin of a coordinate system. First is moving up along the y-axis with speed 4.8 m/s. After the elestic collision, the second ball is moving along the positive y-axis. What is the final direction of the first ball, and what are their two speed. ?

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88. A cannon of mass M starts sliding freely down a smooth inclined plane at an angle α to the horizontal. After the cannon covered the distance l, a shot was fired, the shell leaving the cannon in the horizontal direction with a momentum p. As a consequence, the cannon stopped. Assuming the mass of the shell to be negligible, as compared to that of cannon, determine the duration of the shot.

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89. A ball moving translationally collides elastically with another, stationary, ball of the same mass. At the moment of impact the angle between the straight line passing through the centres of the balls and the direction of the initial motion of the striking ball is equal to $\alpha = 45^{\circ}$. Assuming the balls to be smooth, find the fraction η of the kinetic energy of the striking ball that turned into potential energy at the moment of the maximum deformation.

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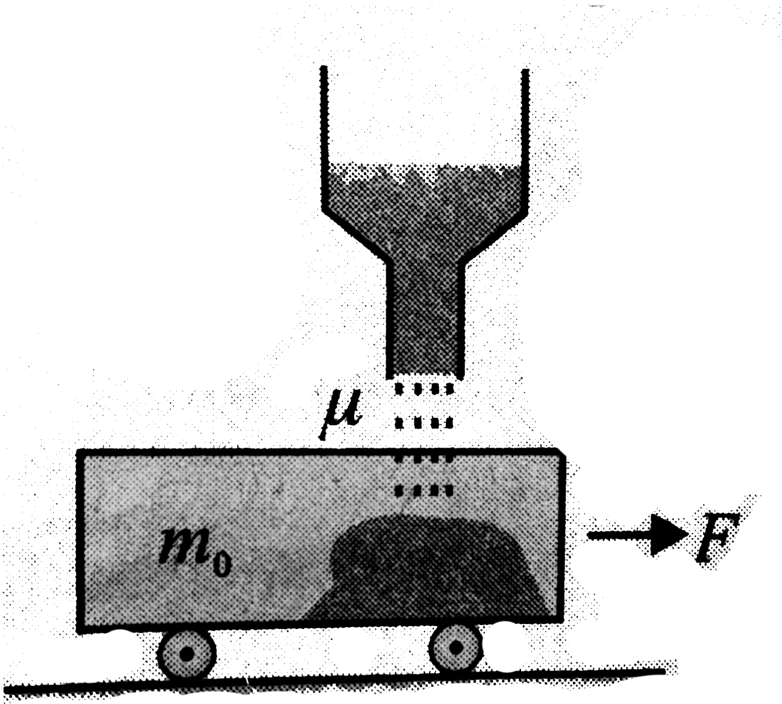
90. A flat car of mass m_0 starts moving to the right due to a constant horizontal force F. S and spills on the flat car from a stationary hopper.

The rate of loading is constant and equal to $\mu kg/s$. Find the time dependence of the velocity and the acceleration of the flat car in the process of loading. the friction is negligibly small.



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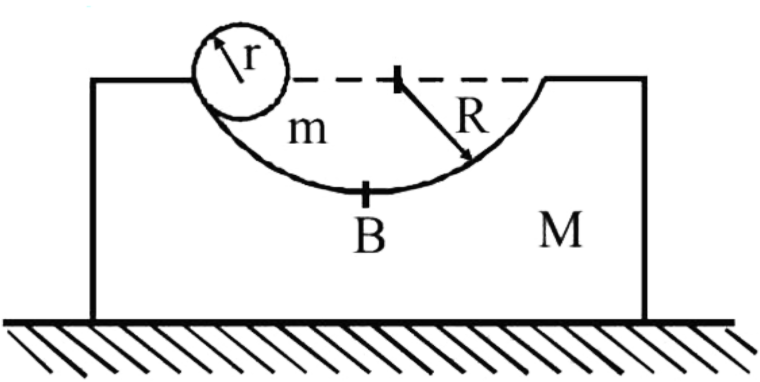
91. A block of mass M with a semicircualr of radius R, rests on a horizontal frictionless surface. A uniform cylinder of radius r and mass m is released from rest the top point A The cylinder slips on the semicircular frictionless track. How far has the block moved when the cylinder reaches the bottom (point B) of the track ? How fast is the block moving when the cylinder reaches the bottom of the track?



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92. Two balls having masses m and 2m are fastened to two light strings of same length shown in the figure. The other ends of the strings are fixed at O. The strings are kept in the same horizontal line and the system is released from rest. The collision between the balls is elastic. (a). Find velocities of the balls just after their collision. (b). How high will the balls rise after the collision.

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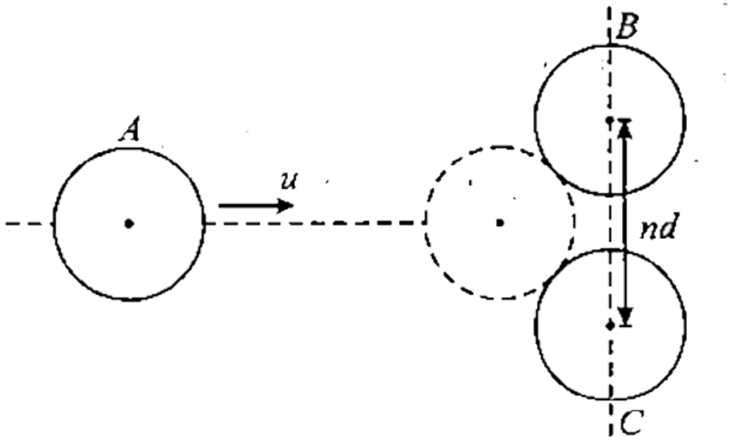
93. Three identical discs A,B and C rest on a smooth horizonal plane as shown in figure -40151. The disc A is set in motion with velocity b along the perpendicular bisector of the line BC joining the centres of the stationary discs. The distance BC joining the cnetes of the stationary disck B and C is n times the diameter of each disc. At what value of n will the disc A recoil, Stop, and move on after elastic collision. ?



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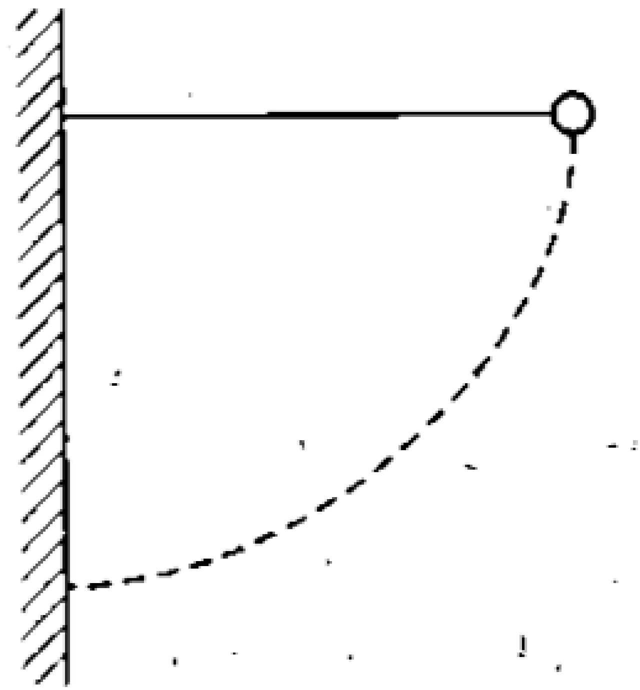
94. A simple pendulum is supended from a peg on a verticl wall. The pendulum is pulled away from the wall to a horizontal position and releases as shown in figure -4.152. The ball hits the wall, the coefficient of restitution being $2/\sqrt{2}$. What is the minimum number of collisions after which the amplitude of oscillation becomes less than 60°



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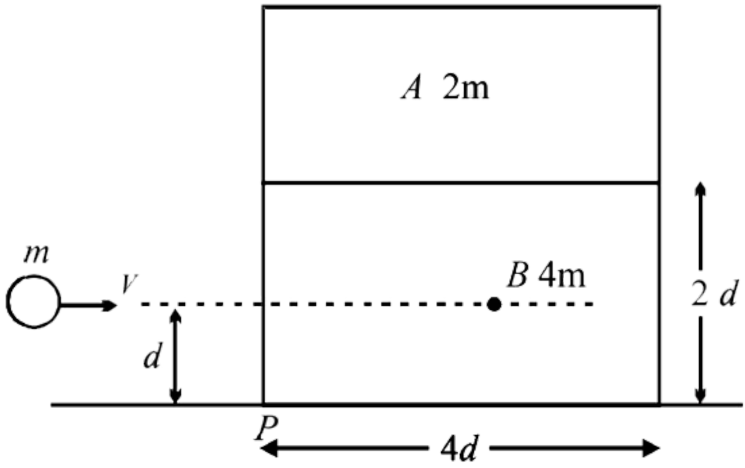
95. A block 'A' of mass 2m is placed on another block 'B' of mass 4m which in turn is placed on a fixed table. The two blocks have a same length 4d and they are placed as shown in fig The coefficient of friction (both static and kinetic) between the block 'B' and table is μ. There is no friction between the two blocks. A small object of mass m moving horizontally along a line passing through the centre of mass (cm.) of the block B and perpendicular to its face with a speed v collides elastically with the block B at a height d above the table.



(a) What is the minimum value of v(call it v_0) required to make the block A topple?

(b) If $v = 2v_0$,find the distance (from the point P in the figure) at which the mass m falls on the table after collision. (Ignore the role of friction during the collision).

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96. A hainmer of mass Mkg falls from a height h meter upon the top of an inelastic pile of mass m kg and drive it into the groung a sistance x meter. Find the resistance of the ground ehen it is assumed to be constant. Find also the time during which the lile is in motion and the kinetic energy lost at the impact.

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97. Two identical blocks A and B each of mass 2 kg hanging stationsary by a light inextensible flexible string passing over a light and frictionless pulley. A shot C, of mass 1 kg moving vertically with velocity 9 m/s collides with block B and get stuck to it. Calculate :

Time after which block B starts moving downward

Maximum height reached by B

Loss of mechanical energy upto that instant

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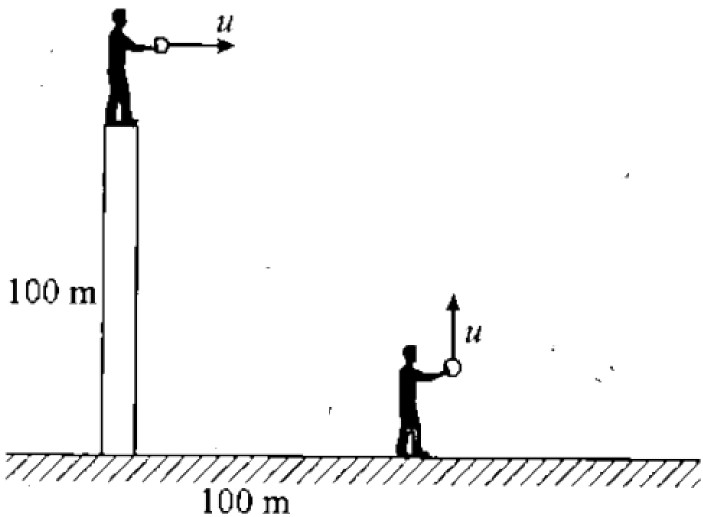
98. A shot of mass m is fired horizontally from the top of a tower of height 100m, with a velocity $\mu = 50$ m/s as shown in figure -4.154 At a distance 100m from the foot the tower a child throws a ball or same m in vertial direction with the same velocity $\mu = 50$ m/s. He throws the ball such that the ball will colides with the shot in its path and merged with it makeing an object of mass 2m. Find the distance form the child, where this object lands on ground.



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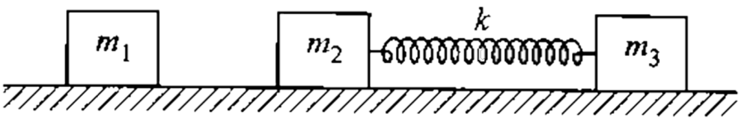
99. Mass m_1 hits m_2 with inelastic impact (e=0) while slliding horizontally with velocity v along the common line of centres of three equal mass as shoun in fugure $-4.155.$ Initially, masses m_2 and m_3 are stationary and the spring is unstressed. Find:



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100. A spaceship of mass m_0 moves in the absence of external forces with a constant velocity v_0. To change the motion direction, a jet engine is switched on. It starts ejecting a gas jet with velocity u which is constant relative to the spaceship and directed at right angles to the spaceship motion. The engine is shut down when the mass of the spaceship decreases to m. Through what angle α did the motion direction of the spaceship deviate due to the jet engine operation?

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101. A cannon of mass M located at the base of an inclined plane, shoots a shell of mass m in a horizontal direction with velocity v. To what vertial, heigh does the cannon ascend the inclined plane as a result of recoil, if the angle of inclination of the plane if α and the coefficient of friction between the cannon and the plane is μ.

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102. A projectile is fired with a speed u at an angle θ above the horizontal field. The coefficient of restitution between the projectile and field is e. Find the position from the starting point when the projectile will land at its second collision

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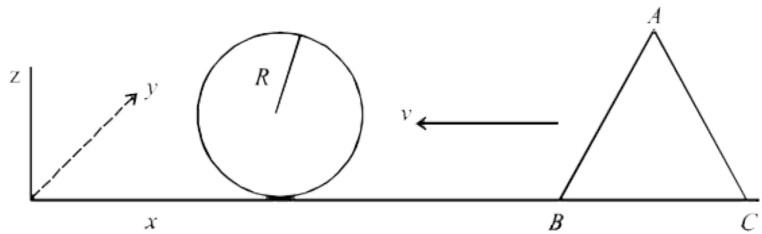
103. A wedge of mass m and triangular cross-section (AB = BC = CA = 2R) is moving with a constant velocity $-v\hat{I}$ towards a sphere of radius R fixed on a smooth horizontal table as shown in figure. The wadge makes an elastic collision with the fixed sphere and returns along the same path without any rotaion. Neglect all friction and suppose that the wedge remains in contact with the sphere for a very shot time. Δt, during which the sphere exerts a constant force F on the wedge.



(a) Find the force F and also the normal force N exerted by the table on the wedge during the time Δt.

(b) Ler h denote the perpendicular distance between the centre of mass of the wedge and the line of action of F. Find the magnitude of the torque due to the normal force N about the centre of the wedge, during the interval Δt.

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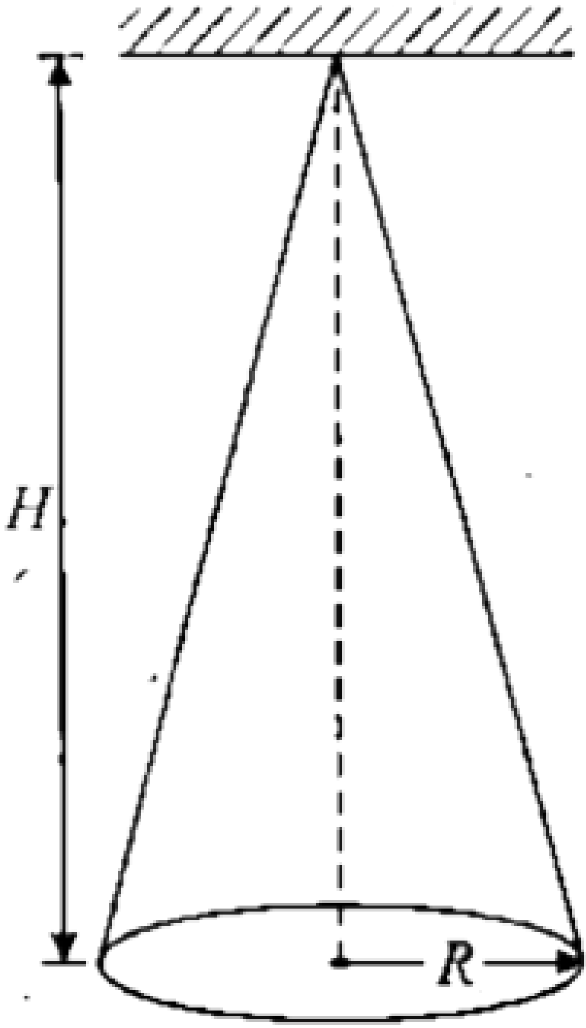
104. A cone of mass M, radius R and height H is hanging from its apex from the ceiling Its height is verticl in this position. Now two small beads of masses m each are noe stuck on the laterl surface of the cone. One at the rim of its base and other at the surface at its mid height on its opposite projector. In this situation find the angle made by the axis of the cone with the vertical.



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105. A chain of mass m and length l rests on a roung surfced table so that one of its ends hangs over the edge. The chain starts sliding off the table all by itself provided the overhanging part equals $1/3$of the chain length. What will be the total work performed by the fricition forces acting on the chain by the moment is slides completely off the table ? Friction cofficient is μ

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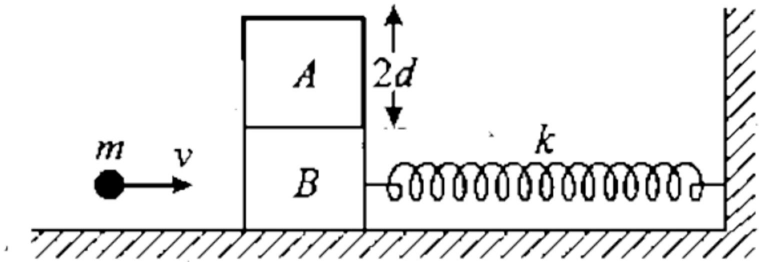
106. A and B are two identical blocks of same mass 2 m and same physical dimensions as shown in figure -4.158 A is placed over the block B which is attached to one end of the spring of natural length l and spring contant k. The other end of the speing is attached to a wall. The system is resting on a smooth horizontal surface with the spring in the relaxed state. A small object of mass m moving horizontally with speed v at a height d above the horizontal surface hits the block B along the line of therir cntre of mass in a perfectly elastic collision. There is no friction between A and B.

Find the minimum value of v $(\text{say} v_o)$ such that the block A will topple over block B.

What is the energy stored in the spring when the blocks A and B returns to their initial position as before collision



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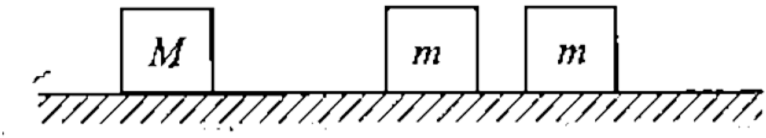
107. The two masses on the right are slightly spearated and initially at rest, the left mass in incident with speed v_oAssuming head on elestic collisions, (a)if $M < m$, show that there are exactly two collisions and find all final velocities, if $M > m$ show that there are three collisions and find all final velocities.



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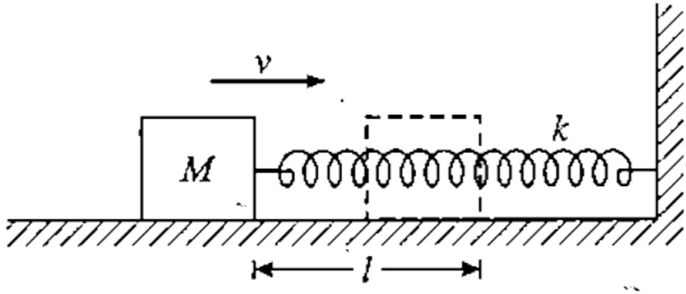
108. The block of mass M in figure -4.160, initially has a velocity v_o to the right and its positionis much that the spring exerts no froce on it, i.e, the spring is not stretched or comkpressed. The block moves to the right a distance l before sttoping in the dotted position shown. The speing constant is k and the coefficeent of kinetic friction between block and table is μ. as the block moves the distance l, what is the work done on it by the friction force ? (b) What is the work done on it by the spring force ? (c) are there other forces actionon the block, and if so what work do they do ? (d) what is the total work done on the block? (e) find the value of l.



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109. A ball of maas m moving with a velocity v along X-axis, strikes another ball of mass 2m kept at rest. The first ball comes to rest after collision and the other breaks into two equal pieces. One of the pieces starts moving along Y-axis with a speed v_1. what will be the velocity of the other piece?

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110. Two spheres of masses 2m and 3m move towards each other with speed μ and v respectively. The centres of the sphere move in the same sraight line. The coeffcient of restitutionis $1/2$ Find

The condition for which motionof each sphere will be reversedon impect

The condition for which each sphere will lose knetic energy on impect.

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Exercise 1 3

1. An isolated particle of mass m is moving in horizontal planexy along the x-axis, at a certain height above the ground. It suddenly explodes into two fragment of masses $m/4$ and $3m/4$. An instant later, the smaller fragment is at

$y = +15$ cm. The larger fragment at this instant is at

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2. A shell at rest at origin explodes into three fragments of masses 1 kg, 2 kg and m kg. The fragments of masses 1 kg and 2 kg fly off with speeds $12 m/s$ along x-axis and $8 m/s$ along y-axis. If the m kg piece flies off with speed of $40 m/s$ then find the total mass of the shell.

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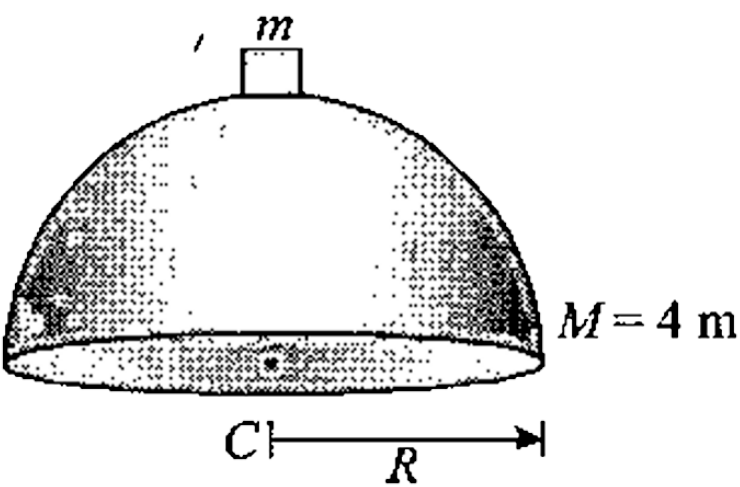
3. A small block of mass m starts sliding down from rest along the smooth surface of a fixed hollow hemisphere of same mass m. Find the distance of centre of mass of block and hemishere from centre of hemisphere C when block m separates from the surface of hemisphere.



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