PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

CENTER OF MASS

Check Point

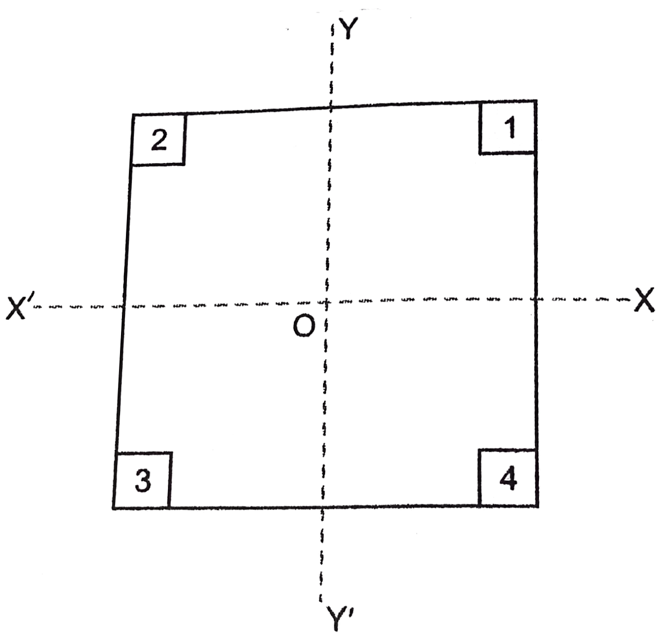
1. Fig. shown a uniform square plate from identical squares at the corners can be removed. (a) Where is the centre of mass of the plate originally ? (b)

Where is it after square 1 is removed ?

(c) where is it after squares 1 and 2 are removed ?

(d) Where is $c.m$ after squares $1, 2, 3,$ are removed ?

(f) Where is $c.m$ after all the four squares are removed ? Answer in terms of quadrants and axes.



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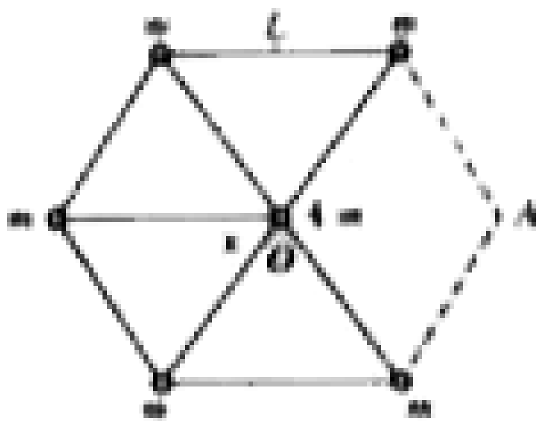
2. Find location of com of the arrangement of regular hexagon that has point masses at five vertices .



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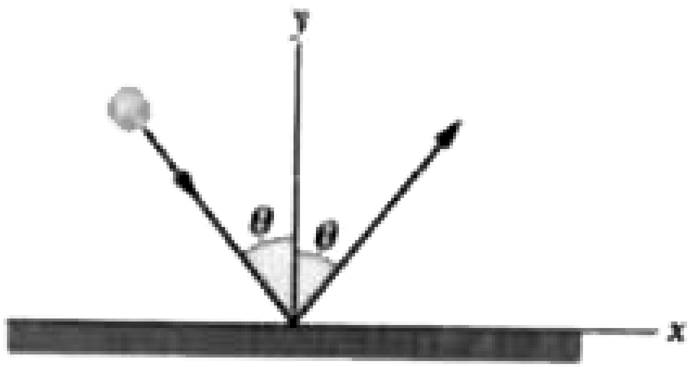
3. Two skaters on frictionless ice hold opposite ends of a pole of negligible mass. An axis runs along it, with the origin at the center of mass of the two-skater system. One skater, Fred , weighs twice as much as the other skater, Ethel. Where do the skaters meet if (a) Fred pulls hand over along the pole so as to draw himself to Ethel , (b) Ethel pulls hand over hand to draw herself to Fred, and (c) both skaters pull hand over hand ?

4. A paratrooper whose chute fails to open lands in snow, he is hurt slightly .Had he landed on bare ground , the stopping time would have been 10 times shorter and the collision lethal . Does the presence of the snow increase , decrease , or leave unchanged the values of (a) the paratrooper's change in momentum, (b) The impulse stopping the paratrooper, and (c) the force stopping the paratrooper ?

5. The figure shows an overhead view of a ball bouncing from a vertical wall without any change in its speed. Consider the change $\Delta \overrightarrow{p}$ in the ball's linear momentum . (a) Is Δp_x positive , negative , or zero ? (b) Is Δp , positive , negative , or zero ? (c) What is the direction of $\Delta \overrightarrow{p}$?



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6. An initially stationary device lying on a frictionless floor explodes into two pieces and slides across the floor one piece is moving in positive x direction then other peice is moving in

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7. Body 1 and body 2 are in a completely inelastic one-dimensional collision. What is their final momentum if their initial momenta are , respectively , (a)10 kg m/s and 0 , (b) 10 kg m/s and 4 kg m/s , (c) 10 kg m/s and -4 kg m/s ?

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Problems

1. Three particles of masses $1kg$, $2kg$ and $3kg$ are placed at the corners A, B and C respectively of an equilateral triangle ABC of edge $1m$. Find the distance of their centre of mass from A.

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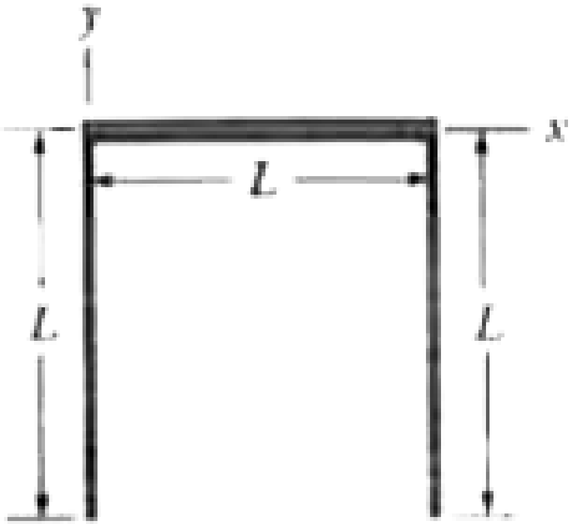
2. Three uniform thin rods, each of length L=24 cm, form an inverted U. The vertical rods each have a mass of 14 g, the horizontal rod has a mass of 42 g.

What are (a) the x coordinate and (b) the y coordinate of the system's center of mass?



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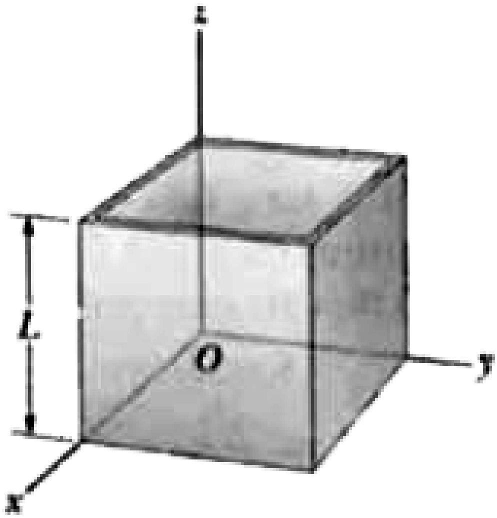
3. A cubical box that has been constructed from uniform metal plate of negligible thickness. The box is open at the top and has edge length L=50 cm.

Find (a) the x coordinate, (b) the y coordinate, and (c) the z coordinate of the center of mass of the box.



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4. A 1000 kg automobile is at rest at a traffic signal. At the instant the light turns green, the auto mobile starts to move with a constant acceleration of $3.0m/s^2$. At the same instant a 2000 kg truck, traveling at a constant speed of 8.0 m/s, overtakes and passes the automobile. (a) How far is the com of the automobile-truck system from the traffic light at t = 5.0 s? (b) What is the speed of the com then?

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5. A big olive (m=0.50 kg) lies at the origin of an xy coor dinate system, and a big Brazil nut (M = 1.5 kg) lies at the point (1.0,2.0) m. At t=0, a force $\vec{F}_o = \left(2.0\hat{i} + 3.0\hat{j}\right)N$ begins to act on the olive, and a force $\vec{F}_n = \left(-3.0\hat{i} - 2.0\hat{j}\right)N$ begins to act on the nut. In unit-vector notation, what is the displacement of the center of mass of the olive-nut system at t = 4.0 s, with respect to its position at 1= 0?

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6. Two skaters, one with mass 75 kg and the other with mass 40 kg, stand on an ice rink holding a pole of length 10 m and negligible mass. Starting from the ends of the pole. the skaters pull themselves along the pole until they meet. How far does the 40 kg skater move?

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7. Richard, of mass 80 kg, and Camelia, who is lighter, are in a 30 kg canoe on a lake. When the canoe is at rest in the placid water, they exchange seats, which are 3.0 m apart and symmetrically located with respect to the canoe's center. If the canoe moves 45 cm horizontally relative to a pier post, what is Camelia's mass?

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8. A 0.70 kg ball moving horizontally at 6.0 m/s strikes a vertical wall and rebounds with speed 3.5 m/s. What is the magnitude of the change in its linear momentum?

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9. A ball of mass 50 g moving at a speed of 2.0 m/s strikes a plane surface at an angle of incidence 45^0. The ball is reflected by the plane at an equal angle of reflection with the same speed. Calculate (a). the magnitude of the change in momentum of the ball (b). the change in the magnitude of the mometum of the ball.

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10. In February 1955, a paratrooper fell 370 m from an air plane without being able to open his chute but happened to land in snow. suffering only minor injuries. Assume that his speed at impact was 56 m/s (terminal speed), that his mass (including gear) was 85 kg, and that the magnitude of the force on him from the snow was at the survivable limit of 1.2×10^5 N. What are (a) the minimum depth of snow that would have stopped him safely and (b) the magnitude of the impulse on him from the snow?

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11. A $5.0g$ bullet moving at $100m/s$ strikes a log. Assume that the bullet undergoes uniform deceleration and stops in $6.0cm$. Find (a) the time taken for the bullet to stop, (b) the impulse on the log and (c) the average force experienced by the log.

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12. In a common but dangerous prank, a chair is pulled away as a person is moving downward to sit on it, causing the victim to land hard on the floor. Suppose the victim falls by 0.50 m, the mass that moves downward is 75 kg, and the collision on the floor lasts 0.088 s. What are the magnitudes of the (a) impulse and (b) average force acting on the victim from the floor during the collision?

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13. A $3.0kg$ block slides on a frictionless horizontal surface, first moving to the left at $50m/s$. It collides with a spring as it moves left, compresses the spring and is brought to rest momentarily. The body continues to be accelerated to the right by the force of compressed spring. Finally, the body moves to the right at $40m/s$. The block remains in contact with the spring for $0.020s$. What were the magnitude and direction of the impulse of the spring on the block? What was the spring's average force on the block?

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14. In tae-kwon-do, a hand is slammed down onto a target at a speed of 13 m/s and comes to a stop during the 5.5 ms collision. Assume that during the impact the hand is independent of the arm and has a mass of 0.70 kg. What are the magnitudes of the (a) impulse and (b) average force on the hand from the target?

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15. A ball of mass 1.00 kg is attached to a loose string fixed to a ceiling. The ball is released from rest and falls 2.00 m, where the string suddenly stops it. Find the impulse on it from the string.

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16. Jumping up before the elevator hits. After the cable snaps and the safety system fails, an elevator cab free-falls from a height of 36 m. During the collision at the bottom of the elevator shaft, a 90 kg passenger is stopped in 5.0 ms. (Assume that neither the passenger nor the cab rebounds.) What are the magnitudes of the (a) impulse and (b) average force on the passenger during the collision? If the passenger were to jump upward with a speed of 7.0 m/s relative to the cab floor just before the cab hits the bottom of the shaft, what are the magnitudes of the (c) impulse and (d) average force (assuming the same stopping time)?

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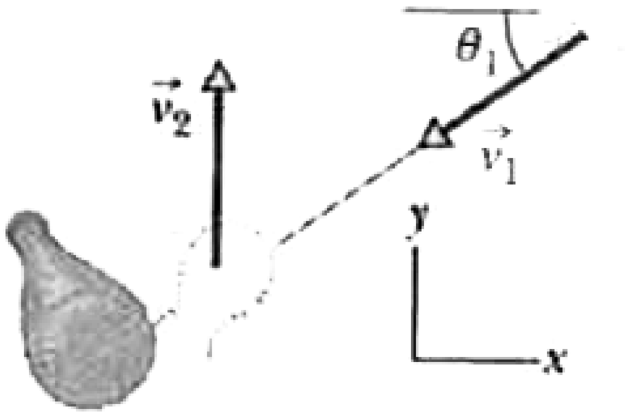
17. Figure shows a 0.300 kg baseball just before and just after it collides with a bat. Just before, the ball has velocity $\overrightarrow{v}_1$ of magnitude 12.0 m/s and angle $\theta_1 = 35.0^\circ$ Just after, it is traveling directly upward with velocity $\overrightarrow{v}_2$ of magnitude 10.0 m/s The duration of the collision is 2.00 ms. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the impulse on the ball from the bat? What are the (c) magnitude and (d) direction of the average force on the ball from the bat?



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18. A 0.25 kg puck is initially stationary on an ice surface with negligible friction. At time t = 0, a horizontal force begins to move the puck. The force is given by $\overrightarrow{F} = (12.0 - 3.00t^2)\hat{i}$, with $\overrightarrow{F}$ in newtons and t in seconds, and it acts until its magnitude is zero. (a) What is the magnitude of the impulse on the puck from the force between t= 0.750 s and t = 1.25 s? (b) What is the change in momentum of the puck between t=0 and the instant at which F=0?

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19. A particle of unknown mass is acted upon by a force $\overrightarrow{F} = \left(100e^{-2t}\hat{i}\right)N$. If at t = 0.00 s the particle is at rest, for the time interval t=0.00 s to t= 2.00 s find (a) the impulse on the particle and (b) the average force on the particle.

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20. A man of mass m_1 = 80 kg is standing on a platform of mass m_2 = 20 kg that lies on a frictionless horizontal surface. The man starts moving on the platform with a velocity v_r = 10 m/s relative to the platform. Find the recoil speed of the platform.

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21. A space vehicle is traveling at 4800 km/h relative to Earth when the exhausted rocket motor (mass

4m) is disengaged and sent backward. The relative speed between motor and command module (mass m) is then 82 km/h. What is the speed of the command module relative to Earth just after the separation ?

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22. A 15.0 kg package is moving at a speed of 10.0 m/s vertically upward along a y axis when it explodes into three fragments: a 2.00 kg fragment is shot upward with an initial speed of 20.0 m/s and a 3.00 kg fragment is shot in the positive direction of a horizontal x axis with an initial speed of 5.00

m/s. Find (a) the speed of the third fragment right after the explosion and (b) the total kinetic energy provided by the explosion.

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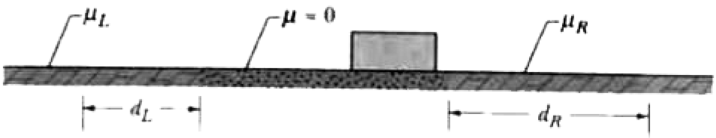
23. In Fig. a stationary block explodes into two pieces L and R that slide across a frictionless floor and then into regions with friction, where they stop. Piece L. with a mass of 2.0 kg, encounters a coefficient of kinetic friction μ_L = 0.35 and slides to a stop in distance d_L =0.15 m. Piece R encounters a coefficient of kinetic friction μ_R=0.50 and slides to a stop in distance d_R =0.30 m. What was the mass of the block?



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24. A 4.0 kg mess kit sliding on a frictionless surface explodes into two 2.0 kg parts: 3.0 m/s, due north, and 6.0 m/s, 30° north of east. What is the original speed of the mess kit ?

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25. Particle A and particle B are held together with a compressed spring between them. When they are released, the spring pushes them apart, and they then fly off in opposite directions, free of the spring. The mass of A is 2.00 times the mass of B, and the energy stored in the spring was 80 J. Assume that the spring has negligible mass and that all its stored energy is transferred to the particles. Once that transfer is complete, what are the kinetic energies of (a) particle A and (b) particle B?

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26. A bullet of mass 10 g strikes a ballistic pendulum of mass 2.0 kg. The center of mass of the pendulum rises a vertical distance of 12 cm. Assuming that the bullet remains embedded in the pendulum, calculate the bullet's initial speed.

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27. A 5.20 g bullet moving at 700 m/s strikes a 700 g wooden block at rest on a frictionless surface. The bullet emerges, traveling in the same direction with its speed reduced to 450 m/s. (a) What is the resulting speed of the block? (b) What is the speed of the bullet-block center of mass ?

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28. A completely inelastic collision occurs between two balls of wet putty that move directly toward cach other along a vertical axis. Just before the collision, one ball, of mass 3.0 kg, is moving upward at 20 m/s and the other ball, of mass 2.0 kg, is moving downward at 10 m/s. How high do the combined two balls of putty rise above the collision point? (Neglect air drag.)

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29. Block A has a mass $3kg$ and is sliding on a rough horizontal surface with a velocity $u_A = 2m/s$ when it makes a direct collision with block B, which has a mass of $2kg$ and is originally at rest. The collision is perfectly elastic. Determine the velocity of each block just after collision and the distance between the blocks when they stop sliding. The coefficient of kinetic friction between the blocks and the plane is $\mu_k = 0.3$ (Take $g = 10m/s^2$)

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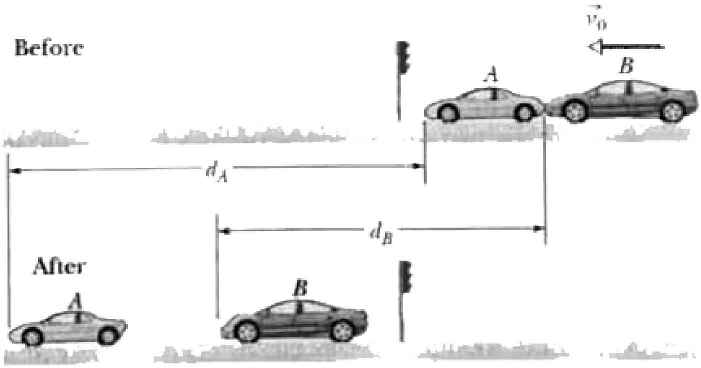
30. In the "before" part of Fig., car A (mass 1100 kg) is stopped at a traffic light when it is rear-ended by car B (mass 1400 kg). Both cars then slide with locked wheels until the frictional force from the slick road (with a low μ_k of 0.10) stops them, at distances d_A = 8.2 m and d_B = 6.1 m. What are the speeds of (a) car A and (b) car B at the start of the sliding, just after the collision? (c) Assuming that linear momentum is conserved during the collision, find the speed of car B just before the collision. (d)

Explain why this assumption may be invalid.



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31. In Fig. , a ball of mass m = 60 g is shot with speed v_i = 22 m/s into the barrel of a spring gun of mass M= 240 g initially at rest on a frictionless surface. The ball sticks in the barrel at the point of maximum compression of the spring. Assume that the increase in thermal energy due to friction between the ball and the barrel is negligible. (a) What is the speed of the spring gun after the ball stops in the barrel? (6) What fraction of the initial kinetic energy of the ball is stored in the spring?

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32. Two titanium spheres approach each other head-on with the same speed and collide elastically. After the collision, one of the spheres, whose mass is 250 g, remains at rest. (a) What is the mass of the other sphere? (b) What is the speed of the two sphere center of mass if the initial speed of each sphere is 2.00 m/s?

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33. Block 1 of mass m_1 slides along a frictionless floor and into a one-dimensional elastic collision with stationary block 2 of mass $m_2 = 3m_1$. Prior to the collision, the center of mass of the two block system had a speed of 3.00 m/s. Afterward, what are the speeds of (a) the center of mass and (b) block 2 ?

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34. Particle 1 with mass m and velocity v and particle 2 with mass 2m and velocity -2v are moving toward each other along an x axis when they undergo a one-dimensional elastic collision. After the collision, what are the velocities of (a) particle 1 and (b) particle 2? What is the velocity of the center of mass of the two-particle system (c) before and (d) after the collision?

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35. Block 1, with mass m_1 and speed 3.0 m/s, slides along an x axis on a frictionless floor and then undergoes a one dimensional elastic collision with stationary block 2, with mass $m_2 = 0.40 m_1$. The two blocks then slide into a region where the coefficient of kinetic friction is 0.50, there they stop. How far into that region do (a) block 1 and (b) block 2 slide?

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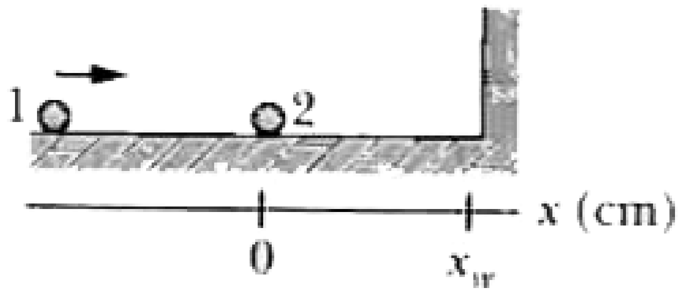
36. In Fig., particle 1 of mass m_1 = 0.30 kg slides rightward along an x axis on a frictionless floor with a speed of 2.0 m/s. When it a one-dimensional elastic collision with stationary particle 2 of mass m_2 = 0.40 kg. When particle 2 then reaches a wall at x_w = 70 cm, it bounces from the wall with no loss of speed. At what position on the x axis does particle 2 then collide with particle 1 ?



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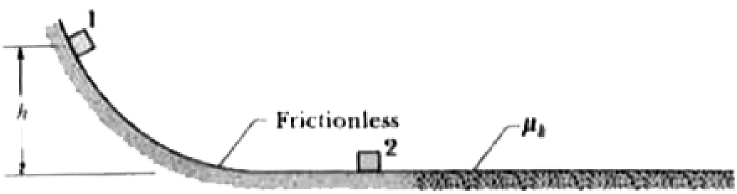
37. In Fig. , block 1 of mass m_1 slides from rest along a frictionless ramp from height h = 3.00 m and then collides with stationary block 2, which has mass $m_2 = 2.00 m_1$. After the collision, block 2 slides into a region where the coefficient of kinetic friction μ_k is 0.450 and comes to a stop in distance d within that region. What is the value of distance d if the collision is (a) elastic and (b) completely inelastic?



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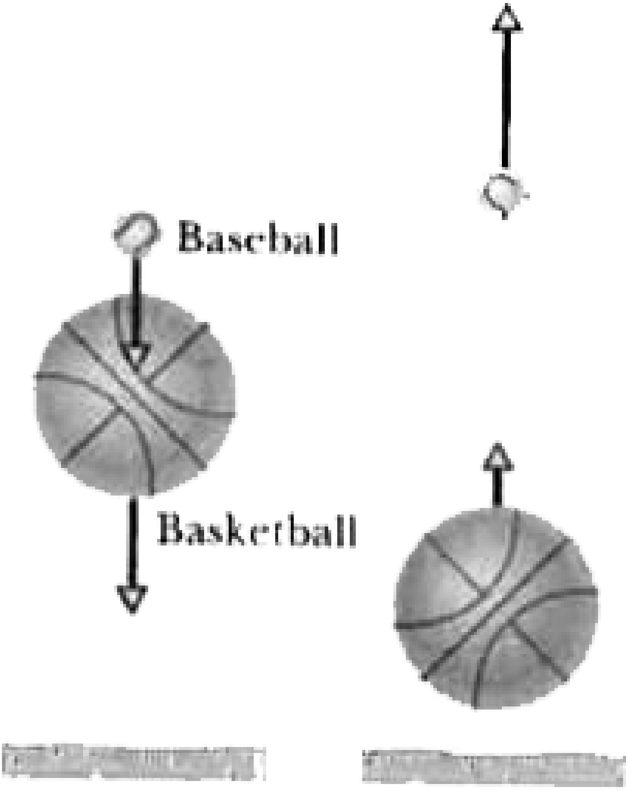
38. A small ball of mass m is aligned above a larger ball of mass M = 0.63 kg (with a slight separation, as with the baseball and basket ball of Fig.), and the two are dropped simultaneously from a height of h = 1.8 m. (Assume the radius of each ball is negligible relative to h.) (a) If the larger ball rebounds elastically from small ball rebounds elastically from the larger ball, what value of m results in the larger ball stopping when it collides with the small ball ?

(b)What height does the small ball then reach ?



(a) Before (b) After

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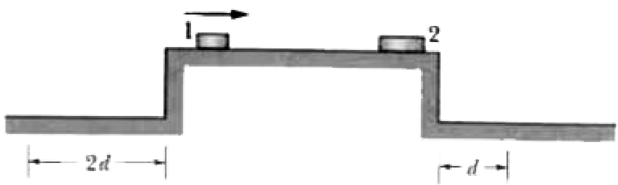
39. In Fig. puck 1 of mass m_1 = 0.25 kg is sent sliding across a frictionless lab bench, to undergo a one-dimensional elastic collision with stationary puck 2. Puck 2 then slides off the bench and lands a distance d from the base of the bench. Puck 1 rebounds from the collision and slides off the opposite edge of the bench, landing a distance 2d from the base of the bench. What is the mass of puck 2?



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40. In the two-dimensional collision in Fig., the projectile particle has mass $m_1 = m$, initial speed $v_u = 3v_0$, and final speed $v_{1f} = \sqrt{5v_0}$. The initially stationary target particle has mass m_1 = 2m and final speed $v_{2f} = v_2$. The projectile is scattered at an angle given by tan θ_1 =2.0. (a) Find angle θ_2. (b) Find v_2 in terms of v_0 .(c) Is the collision elastic?

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41. After a completely inelastic collision two objects of the same mass and same initial speed are found to move away together at half their initial speed.

Find the angle between the initial velocities of the objects.

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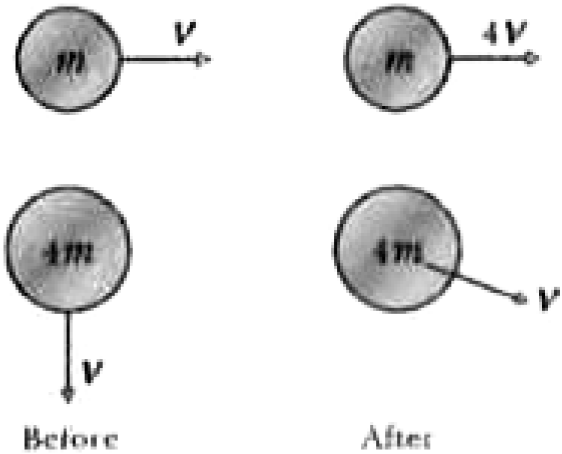
42. A force $\overrightarrow{F}$ acts on two particles of masses m and 4.0m moving at the same speed but at right angles to each other, as shown in Fig. The force acts on both the particles for a time T. Consequently, the particle of mass m moves with a velocity 4v in its original direction. (a) Find the new velocity v' of the other particle. (b) Also find the change in the kinetic energy of the system.



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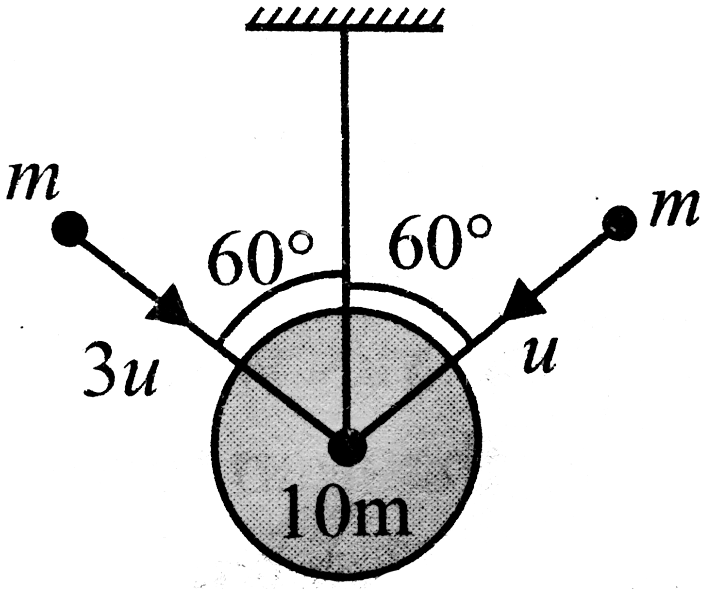
43. A bob of mass $10m$ is suspended through an inextensible string of length l. When the bob is at rest in equilibrium position, two particles, each of mass m, strike it as shown in Fig. The particles stick after collision. Choose the correct statement from the following:



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44. A 6090 kg space probe moving nose-first toward Jupiter at 120 m/s relative to the Sun fires its rocket engine, ejecting 70.0 kg of exhaust at a speed of 253 m/s relative to the space probe. What is the final velocity of the probe?

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45. Consider a rocket that is in deep space and at rest relative to an inertial reference frame. The rocket's engine is to be fired for a certain interval. What must be the rocket's mass ratio (ratio of initial to final mass) over that interval if the rocket's original speed relative to the inertial frame is to be equal to (a) the exhaust speed (speed of the exhaust products relative to the rocket) and (b) 2.0 times the exhaust speed?

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46. (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 $g = 9.8m/s^2$)

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Practice Questions Single Correct Choice

1. A ball is dropped from a height h on a floor. The coefficient of restitution for the collision between the ball and the floor is e. The total distance covered by the ball before it comes to the rest.

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

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

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

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

Answer: A

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2. Which one of the following statements concerning momentum is true?

A. Momentum is a force.

B. Momentum is a scalar quantity.

C. The SI unit of momentum is kg m^2 / s.

D. Momentum and impulse are measured in the same units.

Answer: D

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3. A 62 kg person, standing on a diving board, dives straight down into the water. Just before striking the water, her speed is 5.50 m/s. At a time of 1.65 s after she enters the water, her speed is reduced to 1.10 m/s. What is the net average force (magnitude and direction) that acts on her when she is in the water?

A. 206 N, downward

B. 248 N, upward

C. 248 N, downward

D. 165 N, upward

Answer: D

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4. A ball hits a floor and rebounds after an inelastic collision. In this case

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

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

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

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

Answer: C

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5. A 1 kg ball has a velocity of 12 m/s downward just before it strikes the ground and bounces up with a velocity of 12 m/s upward. What is the change in momentum of the ball?

A. zero kg m/s

B. 12 kg m/s, downward

C. 12 kg m/s, upward

D. 24 kg m/s, upward

Answer: D

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6. A 0.1 kg steel ball is dropped straight down onto a hard, horizontal floor and bounces straight up. The ball's speed just before and just after impact with the floor is 10 m/s. Determine the magnitude of the impulse delivered to the floor by the steel ball.

A. zero N.s

B. 1 N.s

C. 2 N.s

D. 10 N.s

Answer: C

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7. A stick is thrown in the air and lands at some distance from the thrower . The centre of mass of the stick will move along a parabolic path

A. in all cases.

B. only if the stick is uniform.

C. only if the stick does not have any rotational motion.

D. only if the center of mass of the stick lies at some point on it and not outside it.

Answer: A

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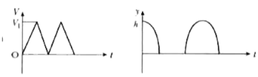
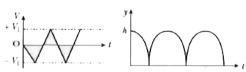
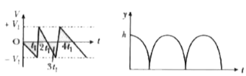
8. Consider a rubber ball freely falling from a height h = 4.9 m on a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time and the height as a function of time will be:

A. 

B. 

C. 

D. None of these

Answer: C

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9. A machine gun fires 50 g bullets at the rate of 4 bullets per second. The bullets leave the gun at a speed of 1000 m/s. What is the average recoil force experienced by the machine gun?

A. 10 N

B. 20 N

C. 100 N

D. 200 N

Answer: D

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10. A particle of mass 1.0 g moving with a velocity $\vec{v}_1 = \left(3\hat{i} - 2\hat{j}\right)$ m/s experiences a perfectly inelastic collision with another particle of mass 2.0 g and velocity $\vec{v}_2 = \left(4\hat{i} - 6\hat{j}\right)$ m/s. Find the magnitude of the velocity vector $\vec{v}$ of the coalesced particles.

A. 2.3 m/s

B. 5.93 m/s

C. 3.2 m/s

D. 6.4 m/s

Answer: B

Watch Video Solution

11. A 0.065 kg tennis ball moving to the right with a speed of 15 m/s is struck by a tennis racket, causing it to move to the left with a speed of 15 m/s. If the ball remains in contact with the racquet for 0.020 s, what is the magnitude of the average force experienced by the ball?

A. 0N

B. 98 N

C. 160 N

D. 240 N

Answer: B

Watch Video Solution

12. A space probe is traveling in outer space with a momentum that has a magnitude of 7.5×10^7 kg-m/s. A retrorocket is fired to slow down the probe. It applies a force to the probe that has a magnitude of 2.0×10^6 N and a direction opposite to the probe's motion. It fires for a period of 12 s. Determine the momentum of the probe after the retrorocket ceases to fire.

A. $+5.1 \times 10^7$ kg.m/s

B. $+2.4 \times 10^7$ kg.m/s

C. $+7.5 \times 10^7$ kg.m/s

D. $+9.9 \times 10^7$ kg.m/s

Answer: A

Watch Video Solution

13. While a car is stopped at a traffic light in a storm, rain drops strike the roof of the car. The area of the roof is 5.0 m^2. Each raindrop has a mass of 3.7×10^{-4} kg and speed of 2.5 m/s before impact and is at rest after the impact. If on average at a given time, 150 raindrops strike each square meter, what is the impulse of the rain striking the car ?

A. 0.69 N.s

B. 0.046 N.s

C. 0.14 N.s

D. 11 N.s

Answer: A

Watch Video Solution

14. A car weighing $2 \times 10^3 kg$ and moving at $20 m / s$ along a main road collides with a lorry of mass $8 \times 10^3 kg$ which emerges at $5 m / s$ from a cross road at right angles to the main road. If the two vehicles lock, what will be their velocity after the collision ?

A. $4 / \sqrt{2}$ m/s , 45° with cross-road.

B. $4 / \sqrt{2}$ m/s , 60° with cross-road.

C. $4 / \sqrt{2}$ m/s , 60° with main road

D. $4 / \sqrt{2}$ m/s , 45° with main road

Answer: D

Watch Video Solution

15. A football player kicks a 0.41 kg football initially at rest, and the ball flies through the air. If the kicker's foot was in contact with the ball for 0.051 s and the ball's initial speed after the collision is 21 m/s, what was the magnitude of the average force on the football?

A. 9.7 N

B. 46 N

C. 81 N

D. 210 N

Answer: D

Watch Video Solution

16. A man stands at one end of the open truck which can run on frictionless horizontal rails. Initially, the man and the truck are at rest. Man now walks to the other end and stops. Then which of the following is true?

A. The truck moves opposite to direction of motion of man even after the man ceases to walk.
B. The center of mass of the man and truck remains at the same point throughout the man's walk.
C. The kinetic energy of man and truck are exactly equal throughout the man's walk.
D. The truck does not move at all during the man's walk.

Answer: B

Watch Video Solution

17. A stationary bomb explodes in space breaking into a number of small fragments. At the location of the explosion, the net force due to gravity is 0 N. Which one of the following statements concerning this event is true?

A. Kinetic energy is conserved in this process

B. The fragments must have equal kinetic energies.

C. The sum of the kinetic energies of the fragments must be zero.

D. The velocity of any one fragment must be equal to the velocity of any other fragment.

Answer: D

Watch Video Solution

18. The law of conservation of momentum applies to a system of colliding objects only if

A. there is no change in kinetic energy of the system.

B. the coefficient of restitution is one.

C. the coefficient of restitution is zero

D. the net external impulse is zero.

Answer: D

View Text Solution

19. An object of mass 3m, initially at rest, explodes breaking into two fragments of mass m and 2m, respectively. Which one of the following statements concerning the fragments after the explosion is true?

A. They will fly off at right angles.

B. They will fly off in the same direction,

C. The smaller fragment will have twice the speed of the larger fragment

D. The larger fragment will have twice the speed of the smaller fragment.

Answer: C

Watch Video Solution

20. A 55-kg swimmer is standing on a stationary 210 kg boating raft. The swimmer then runs off the raft horizontally with a velocity of +4.6 m/s relative to the shore. Find the recoil velocity that the raft would have if there were no friction and resistance due to the water.

A. $+1.2$ m/s

B. -1.2 m/s

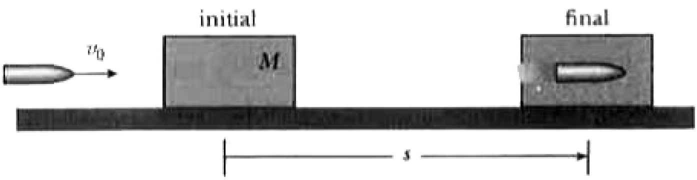
C. $+0.60$ m/s

D. -2.4 m/s

Answer: B

Watch Video Solution

21. A bullet of mass m is fired at speed v_0 into a wooden block of mass M. The bullet instantaneously comes to rest in the block. The block with the embedded bullet slides along a horizontal surface with a coefficient of kinetic friction μ.



Which one of the following expressions determines how far the block slides before it comes to rest (the magnitude of displacement s is as shown in the figure)?

A. $s = \frac{mv_0^2}{M\mu g}$

B. $s = \frac{m}{m+M}\left(\frac{v_0^2}{\mu g}\right)$

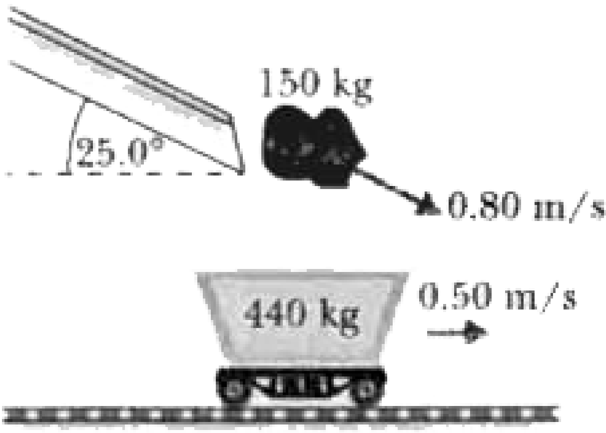
C. $s = \left(\frac{m}{m+M}\right)^2 \frac{v_0^2}{2\mu g}$

D. $s = \left(\frac{m}{m+M}\right)^2 \sqrt{\frac{v_0^2}{2\mu g}}$

Answer: C

Watch Video Solution

22. A mine car (mass = 440 kg) rolls at a speed of 0.50 m/s on a horizontal track, as the drawing shows. A 150 kg chunk of coal has a speed of 0.80 m/s when it leaves the chute. Determine the velocity of the car/coal system after the coal has come to rest in the car.



A. 0.56 m/s, to the left

B. 0.56 m/s, to the right

C. 0.28 m/s, to the left

D. 0.28 m/s, to the right

Answer: B

Watch Video Solution

23. While in Earth's orbit, an 80-kg astronaut carrying a 20-kg tool kit is initially drifting toward a stationary (to her) space shuttle at a speed of 2 m/s. If she throws the tool kit toward the shuttle with a speed of 6 m/s as seen from the shuttle, her final speed is

A. 1 m/s toward the shuttle

B. 4 m/s toward the shuttle.

C. 1 m/s away from the shuttle.

D. 6 m/s away from the shuttle.

Answer: A

Watch Video Solution

24. A person stands in a stationary canoe and throws a 5.00-kg stone with a velocity of 8.00 m/s at an angle of 30.0° above the horizontal. The person and canoe have a combined mass of 105 kg. Ignoring air resistance and effects of the water, find the horizontal recoil velocity (magnitude and direction of the canoe. Assume the hori zontal component of the velocity of the stone is in the +x direction.

A. 0.119 m/s , +x direction

B. 0.119 m/s, -x direction

C. 0.330 m/s, +x direction

D. 0.330 m/s, - direction

Answer: D

Watch Video Solution

25. On an interplanetary mission, a 58.5-kg astronaut is floating toward the front of her ship at 0.15 m/s, relative to the ship. She wishes to stop moving, relative to the ship. She decides to throw away the 2.50-kg book she's carrying. What should the speed and direction of the book be to achieve her goal?

A. 0.15 m/s, toward the front of the ship.

B. 3.5 m/s, toward the back of the ship.

C. 3.7 m/s, toward the front of the ship.

D. 0.30 m/s, toward the back of the ship.

Answer: C

Watch Video Solution

26. Two small spheres of equal mass, and heading towards each other with equal speeds, undergo a head on collision (external force acts on system of two spheres). Then which of the following statement is correct ?

A. They will exchange velocities.

B. Their velocities will be zero.

C. Their velocities will be reduced.

D. Their velocities may be zero.

Answer: D

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27. A car (mass = 1100 kg) is traveling at 32 m/s when it collides head-on with a sport utility vehicle (mass= 2500 kg) traveling in the opposite direction. In the collision, the two vehicles come to a halt. At what speed was the sport utility vehicle traveling?

A. 11 m/s

B. 14 m/s

C. 16 m/s

D. 18 m/s

Answer: B

Watch Video Solution

28. Momentum is conserved in a two-body collision only if

A. both bodies come to rest.

B. the collision is perfectly elastic.

C. the kinetic energy of the system is conserved.

D. the net external force acting on the two-body system is zero

Answer: D

Watch Video Solution

29. A completely inelastic collision occurs between two balls of wet putty that move directly toward each other along a vertical axis. Just before the collision, one ball, of mass 3.0 kg, is moving upward at 20 m/s and the other ball, of mass 2.0 kg, is moving downward at 12 m/s. How high do the combined two balls of putty rise above the collision point? (Neglect air drag.)

A. 2.3 m

B. 2.0 m

C. 2.6 m

D. 2.9 m

Answer: C

Watch Video Solution

30. A tennis ball has a velocity of 12 m/s downward just before it strikes the ground and bounces up with a velocity of 12 m/s upward. Which statement is true concerning this situation?

A. The momentum of the ball and the momentum of the earth both change.

B. Neither the momentum of the ball nor the momentum of the earth changes.

C. The momentum of the ball is changed, the momentum of the earth is not changed.

D. The momentum of the ball is unchanged, the momentum of the earth is changed.

Answer: A

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31. A railway flat car has an artillery gun installed on it. The combined system has a mass M and moves with a velocity V. The barrel of the gun makes an angle a with the horizontal. A shell of mass m leaves the barrel at a speed v relative to the barrel. The speed of the flat car so that it may stop after the firing is

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

B. $\left(\frac{Mv}{M+m}\right)\cos\alpha$

C. $\left(\frac{mv}{M+m}\right)\cos\alpha$

D. $(M+m)v\cos\alpha$

Answer: C

Watch Video Solution

32. A 3.0-kg cart moving to the right with a speed of 1.0 m/s has a head-on collision with a 5.0-kg cart that is initially moving to the left with a speed of 2.0 m/s. After the collision, the 3.0-kg cart is moving to the left with a speed of 1.0 m/s. What is the final velocity of the 5.0-kg cart?

A. zero m/s

B. 0.80 m/s to the right

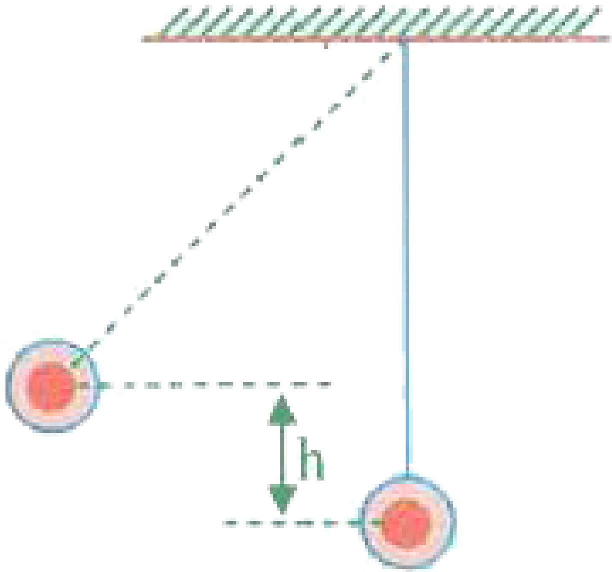
C. 0.80 m/s to the left

D. 2.0 m/s to the right

Answer: C

Watch Video Solution

33. In the figure, pendulum bob on left side is pulled a side to a height h from its initial position. After it is released it collides with the right pendulum bob at rest, which is of the same mass. After the collision the two bobs stick together and raise to a height :-



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

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

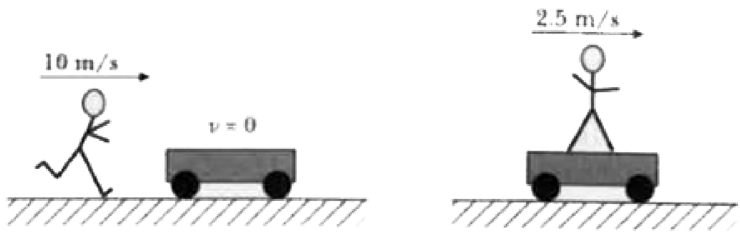
C. $\frac{3h}{3}$

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

Answer: B

Watch Video Solution

34. A 50.0-kg boy runs at a speed of 10.0 m/s and jumps onto a cart as shown in the figure. The cart is initially at rest. If the speed of the cart with the boy on it is 2.50 m/s, what is the mass of the cart?



A. 150 kg

B. 175 kg

C. 210 kg

D. 260 kg

Answer: A

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35. A student (m = 63 kg) falls freely from rest and strikes the ground. During the collision with the ground, he comes to rest in a time of 0.010 s. The average force exerted on him by the ground is +18,000 N, where the upward direction is taken to be the positive direction. From what height did the student fall ? Assume that the only force acting on him during the collision is that due to the ground.

A. 0.15 m

B. 0.21 m

C. 0.30 m

D. 0.42 m

Answer: D

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36. A 2.5-kg ball and a 5.0-kg ball have an elastic collision. Before the collision, the 2.5-kg ball was at rest and the other ball had a speed of 3.5 m/s. What is the kinetic energy of the 2.5-kg ball after the collision?

A. 1.7 J

B. 3.4 J

C. 8.1 J

D. 27 J

Answer: D

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37. A 35-kg girl is standing near and to the left of a 43-kg boy on the frictionless surface of a frozen pond. The boy throws a 0.75-kg ice ball to the girl with a horizontal speed of 6.2 m/s. What are the velocities of the boy and the girl immediately after the girl catches the ice ball?

A. Girl - 0.81 m/s, left , Boy - 0.67 m/s , right

B. Girl - 0.71 m/s , left , Boy -0.41 m/s , left

C. Girl-0.18 m/s , right , Boy - 0.13 m/s , left

D. Girl-0.13 m/s , left , Boy - 0.11 m/s , right

Answer: D

Watch Video Solution

38. A particle moving with a velocity of $(4\hat{i} - \hat{j})$ mis strikes a fixed smooth wall and finally moves with a velocity of $(3\hat{i} + 2\hat{j})$ m/s. The coefficient of restitution between the wall and the particle in the collision will be

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

B. $\frac{3}{7}$

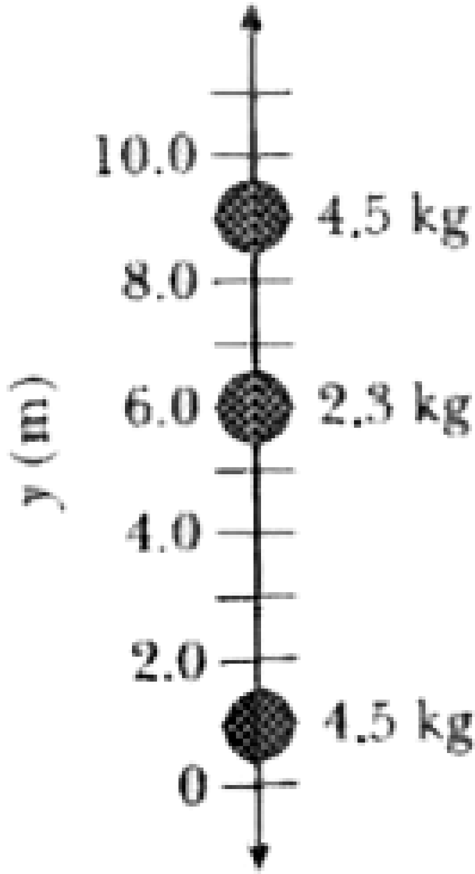
C. $\sqrt{\frac{13}{17}}$

D. $\sqrt{\frac{17}{13}}$

Answer: B

Watch Video Solution

39. The figure shows two 4.5-kg balls located on the y axis at 1.0 and 9.0 m, respectively, a third ball with a mass 2.3 kg is located at 6.0 m. What is the location of the center of mass of this system?



A. 4.8 m

B. 5.2 m

C. 5.6 m

D. 6.0 m

Answer: B

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40. During hockey practice, two pucks are sliding across the ice in the same direction. At one instant, a 0.18-kg puck is moving at 16 m/s while the other puck has a mass of 0.14 kg and a speed of 3.8 m/s. What is the velocity of the center of mass of the two pucks?

A. 5.0 m/s

B. 9.0 m/s

C. 7.0 m/s

D. 13 m/s

Answer: D

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41. A dump truck is being filled with sand. The sand falls straight downward from rest from a height of 2.00 m above the truck bed, and the mass of sand that hits the truck per second is 55.0 kg/s. The truck is parked on the platform of a weight scale. By how much does the scale reading exceed the weight of the truck and sand?

A. 626 N

B. 539 N

C. 214 N

D. 344 N

Answer: D

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42. A wagon is coasting at a speed v_A along a straight and level road. When ten percent of the wagon's mass is thrown off the wagon, parallel to the ground and in the forward direction, the wagon is brought to a halt. If the direction in which this mass is thrown is exactly reversed, but the speed of this mass relative to the wagon remains the same, the wagon accelerates to a new speed v_B. Calculate the ratio v_B / v_A.

A. 0.49

B. 1.5

C. 0.58

D. 2.0

Answer: D

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43. A projectile (mass = 0.20 kg) is fired at and embeds itself in a target (mass = 2.50 kg). The target (with the projectile in it) flies off after being struck. What percentage of the projectile's incident kinetic energy does the target (with the projectile in it) carry off after being struck?

A. 2.1 %

B. 5.0%

C. 3.8%

D. 7.4%

Answer: D

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44. A ball is dropped from rest at the top of a 6.10-m-tall building, falls straight downward, collides inelastically with the ground, and bounces back. The ball loses 10.0% of its kinetic energy every time it collides with the ground. How many bounces can the ball make and still reach a windowsill that is 2.44 m above the ground?

A. 2

B. 3

C. 4

D. 8

Answer: D

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45. A 0.10-kg cart traveling in the positive x direction at 10.0 m/s collides with a 0.30-kg cart at rest. The collision is elastic. What is the velocity of the 0.10-kg cart after the collision?

A. $+2.5$ m/s

B. $+5$ m/s

C. -2.5 m/s

D. -5 m/s

Answer: D

View Text Solution

46. The head of a hammer (m = 1.5 kg) moving at 4.5 m/s strikes a nail and bounces back with the same speed after an elastic collision lasting 0.075 s. What is the magnitude of the average force the hammer exerts on the nail?

A. 6.8 N

B. 90 N

C. 60 N

D. 180 N

Answer: D

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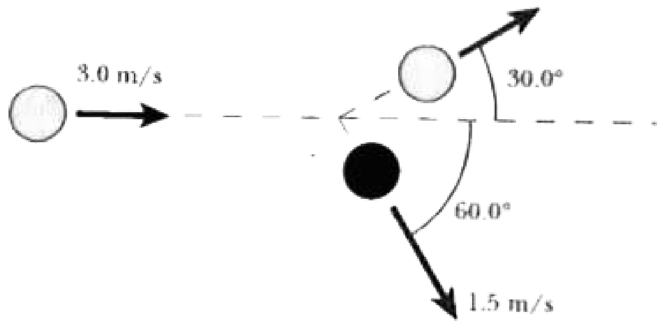
47. In the game of billiards, all the balls have approximately the same mass, about 0.17 kg. In the figure, the cue ball strikes another ball such that it follows the path shown. The other ball has a speed of 1.5 m/s immediately after the collision. What is the speed of the cue ball after the collision?



A. 1.5 m/s

B. 1.8 m/s

C. 2.6 m/s

D. 4.3 m/s

Answer: C

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Practice Questions More Than One Correct Choice

1. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 m/s. Which of the following statements are correct for the system of these two masses?

A. Total momentum of the system is 3 kg m/s.

B. Momentum of 5 kg mass after collision is 4 kg m/s.

C. Kinetic energy of the center of mass is 0.75 J.

D. Total kinetic energy of the system is 4 J.

Answer: A::C

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2. A particle strikes a horizontal smooth floor with a velocity u making an angle θ with the floor and rebounds with velocity v making an angle ϕ with the floor. The coefficient of restitution between the particle and the floor is e.

A. The impulse delivered by the floor to the body is mu (1+e) sin θ.

B. tan $\phi = e \tan \theta$.

C. $v = u\sqrt{1-(1-e^2)\sin^2\theta}$

D. The ratio of the final kinetic energy to the initial kinetic energy is $\cos^2\theta + e^2\sin^2\theta$.

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

View Text Solution

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

A. $v_0 = 0, a_0 = 0$

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

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

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

Answer: B::D

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4. The balls, having linear momenta $\overrightarrow{p}_1 = \overrightarrow{\pi}$ and $\overrightarrow{p}_2 \_ 2 = -\overrightarrow{\pi}$, undergo a collision in free space. There is no external force acting on the balls. Let $\overrightarrow{p}'_1$ and $\overrightarrow{p}'_2$ be their final momenta.The following option (s) is (are) NOT ALLOWED for any non-zero value of $p, a_1, a_2, b_1, b_2, c_1$ and c_2.

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

B. $\overrightarrow{p}_1{}' = c_1\hat{k}, \overrightarrow{p}_2{}' = c_2\hat{k}$

C.

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

D. $\overrightarrow{p}_1{}' = a_1\hat{i} + b_1\hat{j}, \overrightarrow{p}_2{}' = a_2\hat{i} + b_2\hat{j}$

Answer: A::B

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5. Choose the correct statement(s) of the following:

A. Force acting on a particle for equal time intervals can produce the same change in momentum but different change in kinetic energy.

B. Force acting on a particle for equal displacements can produce same change in kinetic energy but different change in momentum.

C. Force acting on a particle for equal time intervals can produce different change in momentum but same change in kinetic energy.

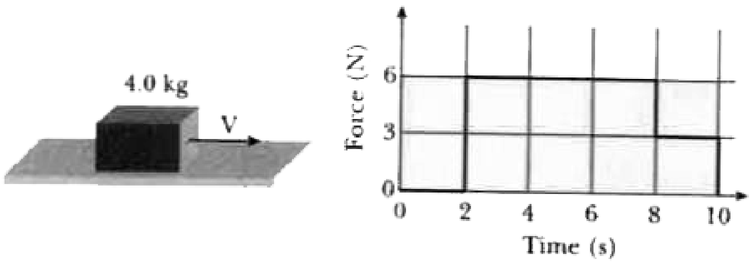
D. Force acting on a particle for equal displacements can produce different change in kinetic energy but same change in momentum.

Answer: A::B

View Text Solution

Practice Questions Linked Comprehension

1. A 4.0-kg block slides along a frictionless surface with a constant speed of 5.0 m/s as shown. Two seconds after it begins sliding, a horizontal, time-dependent force is applied to the mass. The force is removed 8 s later. The graph shows how the force on the block varies with time.



What is the approximate speed of the block at t =11 s?

A. 5.0 m/s

B. 16 m/s

C. 25 m/s

D. 65 m/s

Answer: B

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2. A comet fragment of mass 1.96×10^{13} kg is moving at 6.50×10^{4} m/s when it crashes into Callisto, a moon of Jupiter. The mass of Callisto is 1.08×10^{23} kg. The collision is completely inelastic. Assuming for this calculation that Callisto's initial momentum is zero kg m/s, what is the recoil speed of Callisto immediately after the collision?

A. 3.34×10^{-18} m/s

B. 3.58×10^{-12} m/s

C. 1.27×10^{-14} m/s

D. 1.18×10^{-5} m/s

Answer: D

Watch Video Solution

3. A comet fragment of mass 1.96×10^{13} kg is moving at 6.50×10^{4} m/s when it crashes into Callisto, a moon of Jupiter. The mass of Callisto is 1.08×10^{23} kg. The collision is completely inelastic.

How much kinetic energy was released in the collision ?

A. 8.28×10^{22} J

B. 3.51×10^{27} J

C. 7.02×10^{27} J

D. 4.14×10^{22} J

Answer: D

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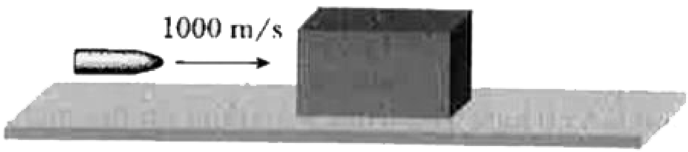
4. A 2.0-kg pistol fires a 1.0-g bullet with a muzzle speed of 1000 m/s. The bullet then strikes a 10-kg wooden block resting on a horizontal frictionless surface. The block and the embedded bullet then slide across the surface.



What is the kinetic energy of the bullet as it travels toward the block?

A. 100 J

B. 500 J

C. 1000 J

D. 5000 J

Answer: B

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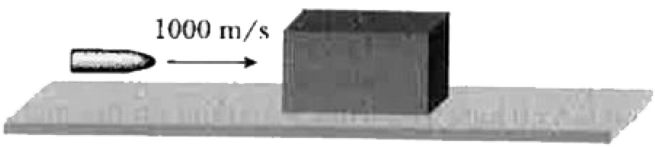
5. A 2.0-kg pistol fires a 1.0-g bullet with a muzzle speed of 1000 m/s. The bullet then strikes a 10-kg wooden block resting on a horizontal frictionless surface. The block and the embedded bullet then slide across the surface.



The explosive charge in the pistol acts for 0.001 s. What is the average force exerted on the bullet while it is being fired?

A. 0.001 N

B. 100 N

C. 1.0 N

D. 1000 N

Answer: D

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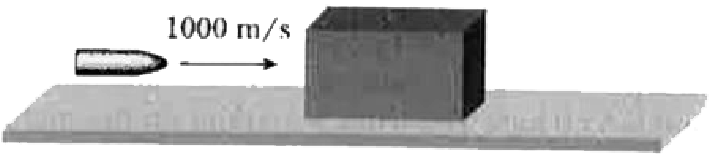
6. A 2.0-kg pistol fires a 1.0-g bullet with a muzzle speed of 1000 m/s. The bullet then strikes a 10-kg wooden block resting on a horizontal frictionless surface. The block and the embedded bullet then slide across the surface.



What is the speed of the "bullet + block" system immediately after the bullet is embedded in the block?

A. 0.1 m/s

B. 1000 m/s

C. 10 m/s

D. 10000 m/s

Answer: A

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Practice Questions Matrix Match

1. Consider a man sitting on the cart that is moving with initial and final velocities .

Column I	Column II	Column III
(I) Mass of the man = 75.2 kg	(i) Mass of the cart = 38.6 kg	(J) Initial velocity = 2.33 m/s Final velocity = 0 m/s
(II) Mass of the man = 52 kg	(ii) Mass of the cart = 22 kg	(K) Initial velocity = 2.3 m/s Final velocity = 1 m/s
(III) Mass of the man = 62 kg	(iii) Mass of the cart = 23 kg	(L) Initial velocity = 2 m/s Final velocity = 2 m/s
(IV) Mass of the man = 55 kg	(iv) Mass of the cart = 36 kg	(M) Initial velocity = 2.5 m/s Final velocity = 1.1 m/s

Which has 4.54 m/s as the resulting change in speed of the cart?

A. (I)(iii)(L)

B. (IV)(i)(M)

C. (II)(iv)(K)

D. (I)(i)(J)

Answer: D

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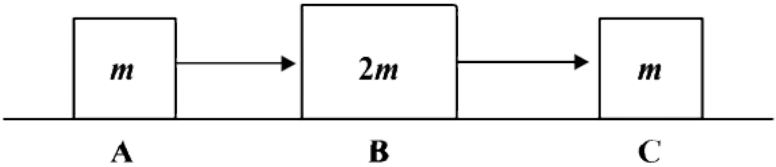
Practice Questions Integer

1. There object A, B and C are kept is a straing line a fritionlas horizental surface . These have masses have increase on $2m$ and m repectively . The object A move toward B with a speed 9 m//s and makes as electic collision with a there after B makes complately inclesis with C . All motion over on the same strangth line . Find the first speed of the object C



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2. A block of mass m_1 = 150 kg is at rest on a very long frictionless table, one end of which is terminated in a wall. Another block of mass m_2 is placed between the first block and the wall, and set in motion towards m_1 with constant speed u_2.

Assuming that all collisions are completely clas tia find the value of m_2 (in kg) for which both blocks move with the same velocity after m_2 has collided once with m_1 and once with the wall. (The wall has effectively infinite mass.)

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3. A particle of mass 1 kg is projected upwards with velocity 60 m/s. Another particle of mass 2 kg is just dropped from a certain height. If, after 2 s, when neither of the particles have collided with ground, the value of the velocity of com (in m/s) is ____

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4. A system of two objects has a total momentum of (18 kg m/s) $\hat{i}$ and its center of mass has the velocity of (3 m/s) $\hat{i}$. One of the objects has the mass 4 kg and velocity (1.5 m/s) $\hat{i}$. The mass of the other object (in kg) is ______

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