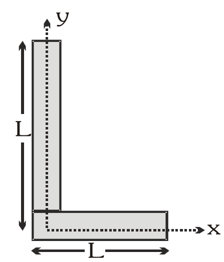
CENTRE OF MASS LEVEL 1

SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. The centre of mass of a non uniform rod of length L whose mass per unit length varies as $\rho = kx^2/L$ (where k is a constant and x is the distance measured from one end) is at the following distance from the same end.

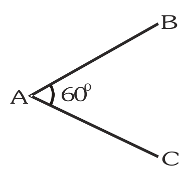
(A) 3L/4 (B) L/4 (C) 2L/3 (D) L/3

2. Centre of mass of two uniform rods of same length but made up of different materials & kept as shown, if the meeting point is the origin of co–ordinates



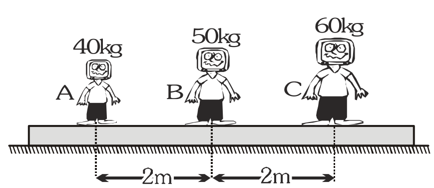
(A) (L/2,L/2) (B) (2L/3,L/2) (C) (L/3,L/3) (D) (L/3,L/6)

3. A uniform wire of length ℓ is bent into the shape of 'V' as shown. The distance of its centre of mass from the vertex A is



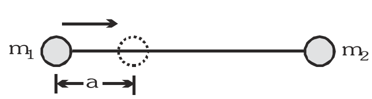
(A) $\ell/2$ (B) $\frac{\ell\sqrt{3}}{4}$ (C) $\frac{\ell\sqrt{3}}{8}$ (D) None of these

4. Three man A, B & C of mass 40 kg, 50 kg & 60 kg are standing on a plank of mass 90 kg, which is kept on a smooth horizontal plane. If A & C exchange their positions then mass B will shift



(A) 1/3 m towards left (B) 1/3m towards right
(C) will not move w.r.t. ground (D) 5/3 m towards left

5. Considering a system having two masses m_1 and m_2 in which first mass is pushed towards centre of mass by a distance a, the distance required to be moved for second mass to keep centre of mass at same position is



(A) $\frac{m_1}{m_2}a$ (B) $\frac{m_1 m_2}{a}$ (C) $\frac{m_2}{m_1}a$ (D) $\left(\frac{m_2 m_1}{m_1+m_2}\right)a$

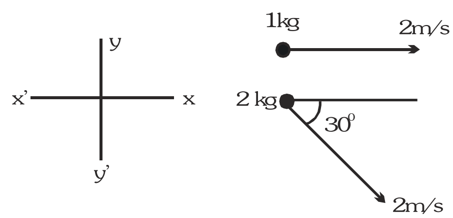
6. An isolated particle of mass m is moving in horizontal plane (x–y), along the x–axis, at a certain height above the ground. It suddenly explodes into two fragment of masses $\frac{m}{4}$ and $\frac{3m}{4}$. An instant later, the smaller fragment is at y = +15 cm. The larger fragment at this instant is at :–

(A) y = –5 cm (B) y = +20 cm (C) y = +5 cm (D) y = –20 cm

7. Two particles A and B initially at rest, move towards each other under the mutual force of attraction. At the instant when the speed of A is v and the speed of B is 2v, the speed of the centre of mass of the system is:–

(A) 3v (B) v (C) 1.5v (D) zero

8. The velocity of centre of mass of the system as shown in the figure



(A) $\left(\frac{2-2\sqrt{3}}{3}\right)\hat{i}-\frac{1}{3}\hat{j}$ (B) $\left(\frac{2+2\sqrt{3}}{3}\right)\hat{i}-\frac{2}{3}\hat{j}$

(C) $4\hat{i}$ (D) None of these

9. The figure shows the positions and velocities of two particles. If the particles move under the mutual attraction of each other, then the position of centre of mass at t =1 s is

(A) x=5m (B) x=6m (C) x=3m (D) x=2m

10. A particle of mass 2m is connected by an inextensible string of length 1.2 m to a ring of mass m which is free to slide on a horizontal smooth rod. Initially the ring and the particle are at the same level with the string taut. Both are then released simultaneously. The distance in meters moved by the ring when the string becomes vertical is

(A) 0 (B) 0.4 (C) 0.8 (D) 1.2

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

(A) 35kg m/s downwards (B) 35 kg m/s upwards

(C) 30 kg m/s downwards (D) 30kg m/s upwards

12. A particle of mass m is made to move with uniform speed v_0 along the perimeter of a regular hexagon, inscribed in a circle of radius R. The magnitude of impulse applied at each corner of the hexagon is

(A) $2mv_0\sin\pi/6$ (B) $mv_0\sin\pi/6$ (C) $mv_0\sin\pi/3$ (D) $2mv_0\sin\pi/3$

13. Two balls of same mass are dropped from the same height h, on to the floor. The first ball bounces to a height h/4 ,after the collision & the second ball to a height h/16. The impulse applied by the first & second ball on the floor are I_1 and I_2 respectively. Then

(A) $5I_1 = 6I_2$ (B) $6I_1 = 5I_2$ (C) $I_1 = 2I_2$ (D) $2I_1 = I_2$

14. An impulse $\vec{I}$ changes the velocity of a particle from $\vec{v}_1$ to $\vec{v}_2$. Kinetic energy gained by the particle is

(A) $\frac{1}{2}\vec{I}(\vec{v}_1+\vec{v}_2)$ (B) $\frac{1}{2}\vec{I}(\vec{v}_1-\vec{v}_2)$ (C) $\vec{I}(\vec{v}_1-\vec{v}_2)$ (D) $\vec{I}(\vec{v}_1+\vec{v}_2)$

15. A particle of mass 4m which is at rest explodes into masses m, m & 2m. Two of the fragments of masses m and 2m are found to move with equal speeds v each in opposite directions. The total mechanical energy released in the process of explosion is

(A) mv^2 (B) $2mv^2$ (C) $1/2\ mv^2$ (D) $4mv^2$

16. Two blocks A(3 kg) and B(2 kg) resting on a smooth horizontal surface is connected by a spring of stiffness 480N/m. Initially the spring is undeformed and a velocity of 2 m/s is imparted to A along the line of the spring away from B. The maximum extension in meters of the spring during subsequent motion is

(A) $\frac{1}{10}$ (B) $\frac{1}{2\sqrt{10}}$ (C) $\frac{1}{2\sqrt{15}}$ (D) 0.15

17. A cannon of mass 5m (including a shell of mass m) is at rest on a smooth horizontal ground, fires the shell with its barrel at an angle θ with the horizontal at a velocity u relative to cannon. Find the horizontal distance of the point where shell strikes the ground from the initial position of the cannon:

(A) $\frac{4u^2\sin 2\theta}{5g}$ (B) $\frac{u^2\sin 2\theta}{5g}$ (C) $\frac{3u^2\sin 2\theta}{5g}$ (D) $\frac{8u^2\sin 2\theta}{5g}$

18. A shell is fired from a cannon with a velocity v (m/s) at an angle θ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon and the speed (m/s) of the other piece immediately after the explosion is :–

(A) $3v\cos\theta$ (B) $2v\cos\theta$ (C) $\frac{3}{2}v\cos\theta$ (D) $\sqrt{\frac{3}{2}}v\cos\theta$

19. A ball hits the floor and rebounds after an inelastic collision. In this case :–

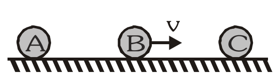
(A) the momentum of the ball just after the collision is the same as that just before the collision

(B) the mechanical energy of the ball remains the same in the collision

(C) the total momentum of the ball and the earth is conserved

(D) the total energy of the ball and the earth is conserved

20. Three balls A, B and C ($m_A = m_C = 4m_B$) are placed on a smooth horizontal surface. Ball B collides with ball C with an initial velocity v as shown in the figure. Total number of collisions between the balls will be (All collisions are elastic)



(A) One (B) Two (C) Three (D) Four

21. A body of mass 1 kg strikes elastically with another body at rest and continues to move in the same direction with one fourth of the initial velocity. The mass of the other body is –

(A) 0.6 kg (B) 2.4 kg (C) 3 kg (D) 4 kg

22. A small bucket of mass M kg is attached to a long inextensible cord of length L m . The bucket is released from rest when the cord is in a horizontal position. At its lowest position, the bucket scoops up m kg of water and swings up to a height h. The height h in meters is

(A) $\left(\frac{M}{M+m}\right)^2 L$ (B) $\left(\frac{M}{M+m}\right)L$ (C) $\left(\frac{M+m}{M}\right)^2 L$ (D) $\left(\frac{M+m}{M}\right)L$

23. A particle moving horizontally collides with a fixed plane inclined at 60° to the horizontal. If it bounces vertically, the coefficient of restitution is:

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{2}{\sqrt{3}}$ (C) $\frac{1}{3}$ (D) None of these

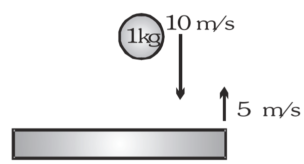
24. A ball of mass 2m impinges directly on a ball of mass m, which is at rest. If the velocity with which the larger ball impinges be equal to the velocity of the smaller mass after impact then the coefficient of restitution

(A) $\frac{1}{3}$ (B) $\frac{3}{4}$ (C) $\frac{1}{2}$ (D) $\frac{2}{5}$

25. A body of mass 2kg is projected upward from the surface of the ground at t = 0 with a velocity of 20m/s. One second later a body B, also of mass 2kg, is dropped from a height of 20m. If they collide elastically, then velocities just after collision are

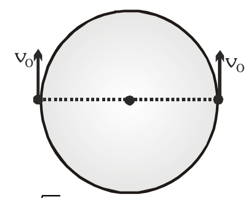
(A) v_A = 5 m/s downward, v_B = 5 m/s upward (B) v_A = 10 m/s downward, v_B= 5 m/s upward
(C) v_A = 10 m/s upward, v_B = 10 m/s downward (D) both move downward with velocity 5 m/s

26. A ball of mass 1 kg strikes a heavy platform, elastically, moving upwards with a velocity of 5m/s. The speed of the ball just before the collision is 10m/s downwards. Then the impulse imparted by the platform on the ball is



(A) 15 N–s (B) 10 N–s
(C) 20 N–s (D) 30 N–s

27. Two particles of mass m, constrained to move along the circumference of a smooth circular hoop of equal mass m, are initially located at opposite ends of a diameter and given equal velocities v_0 shown in the figure. The entire arrangement is located in gravity free space. Their velocity just before collision is



(A) $\frac{1}{\sqrt{3}}v_0$ (B) $\frac{\sqrt{3}}{2}v_0$ (C) $\frac{2}{\sqrt{3}}v_0$ (D) $\frac{\sqrt{7}}{3}v_0$

28. 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) $\frac{2v_1^2}{a}$

29. A uniform rope of linear mass density λ and length ℓ is coiled on a smooth horizontal surface. One end is pulled up with constant velocity v. Then the average power applied by the external agent in pulling the entire rope just off the ground is :

(A) $\frac{1}{2}\lambda\ell v^2 + \frac{\lambda\ell^2 g}{2}$ (B) $\lambda\ell gv$ (C) $\frac{1}{2}\lambda v^3 + \frac{\lambda\ell vg}{2}$ (D) $\lambda\ell gv + \frac{1}{2}\lambda v^3$

ANSWER KEY LEVEL –1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	A	D	C	B	A	A	D	B	B	C	B	A	A	A	B	A	A	A	C	B
Que.	21	22	23	24	25	26	27	28	29											
Ans.	A	A	C	C	A	D	D	A	C											

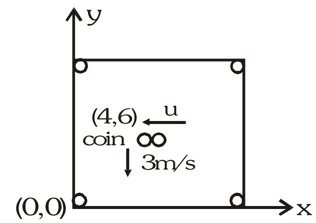
CENTRE OF MASS LEVEL 2

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

1. Two particles A and B start moving due to their mutual interaction only. If at any time 't', $\vec{a}_A$ and $\vec{a}_B$ are their respective accelerations, $\vec{v}_A$ and $\vec{v}_B$ are their respective velocities, and upto that time W_A and W_B are the work done on A and B respectively by the mutual force, m_A and m_B are their masses respectively, then which of the following is always correct.

(A) $\vec{v}_A + \vec{v}_B = 0$ (B) $m_A\vec{v}_A + m_B\vec{v}_B = 0$ (C) $W_A + W_B = 0$ (D) $\vec{a}_A + \vec{a}_B = 0$

2. On a smooth carom board, a coin moving in negative y–direction with a speed of 3 m/s is being hit at the point (4, 6) by a striker moving along negative x–axis. The line joining centres of the coin and the striker just before the collision is parallel to x–axis. After collision the coin goes into the hole located at the origin. Masses of the striker and the coin are equal. Considering the collision to be elastic, the initial and final speeds of the striker in m/s will be–

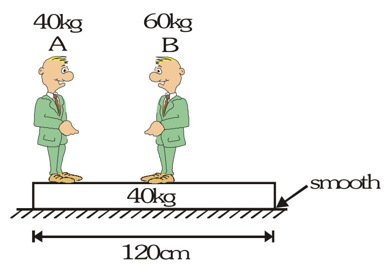


(A) (1.2, 0) (B) (2, 0) (C) (3, 0) (D) None of these

3. 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.

(A) $\ell n\ 2$ (B) $2\ell n\ 4$ (C) $2\ell n\ 2$ (D) None of these

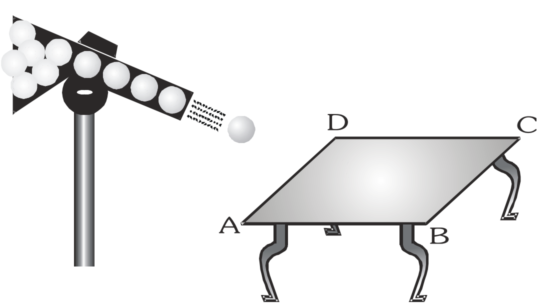
4. Two men 'A' and 'B' are standing on a plank. 'B' is at the middle of the plank and 'A' is at the left end of the plank. Surface of the plank is smooth. System is initially at rest and masses are as shown in figure. A and B starts moving such that the position of 'B' remains fixed with respect to ground then 'A' meets 'B'. Then the point where A meets B is located at–



(A) the middle of the plank (B) 30 cm from the left end of the plank

(C) the right end of the plank (D) None of these

5. A gun which fires small balls of mass 20 gm is firing 20 balls per second on the smooth horizontal table surface ABCD. If the collision is perfectly elastic and balls are striking at the centre of table with a speed 5 m/s at an angle of 60 with the vertical just before collision, then force exerted by one of the leg on ground is (assume total weight of the table is 0.2 kg and g = 10 m/s^2) :



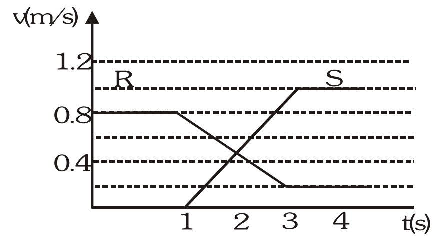
(A) 0.5 N (B) 1 N

(C) 0.25 N (D) 0.75 N

6. A ball is bouncing down a set of stairs. The coefficient of restitution is e. The height of each step is d and the ball bounces one step at each bounce. After each bounce the ball rebounds to a height h above the next lower step. Neglect width of each step in comparison to h and assume the impacts to be effectively head on. Which of the following relation is correct ?

(A) $\frac{h}{d} = 1 - e^2$ (B) $\frac{h}{d} = 1 - e$ (C) $\frac{h}{d} = \frac{1}{1-e^2}$ (D) $\frac{h}{d} = \frac{1}{1-e}$

7. The diagram shows the velocity–time graph for two masses R and S that collided elastically. Which of the following statements is true ?



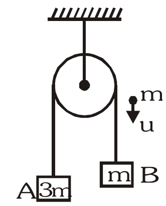
I. R and S moved in the same direction after the collision

II. The velocities of R and S were equal at the mid time of the collision.

III. The mass of R was greater than mass of S.

(A) I only (B) II only (C) I and II only (D) I, II and III

8. A system of two blocks A and B are connected by an inextensible massless strings as shown. The pulley is massless and frictionless. Initially the system is at rest when, a bullet of mass 'm' moving with a velocity 'u' as shown hits the block 'B' and gets embedded into it. The impulse imparted by tension force to the block of mass 3m is–



(A) $\frac{5mu}{4}$ (B) $\frac{4mu}{5}$ (C) $\frac{2mu}{5}$ (D) $\frac{3mu}{5}$

9. A piece of paper (shown in figure1) is in form of a square. Two corners of this square are folded to make it appear like figure.2 . Both corners are put together at centre of square 'O'. If O is taken to be (0,0), the centre of mass of new system will be at

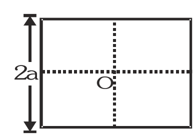


Fig.1

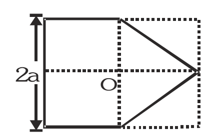
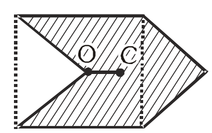


Fig.2

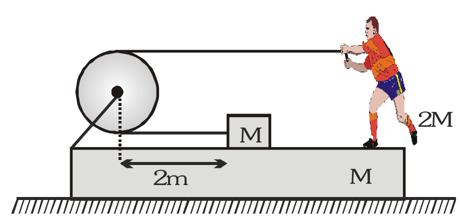
(A) $\left(-\frac{a}{8},0\right)$ (B) $\left(-\frac{a}{6},\ 0\right)$ (C) $\left(\frac{a}{12},\ 0\right)$ (D) $\left(-\frac{a}{12},\ 0\right)$

10. An arrow sign is made by cutting and rejoining a quarter part of a square plate of side 'L' as shown. The distance OC, where 'C' is the centre of mass of the arrow, is



(A) $\frac{L}{3}$ (B) $\frac{L}{4}$ (C) $\frac{3L}{8}$ (D) None of these

11. A block of mass M is tied to one end of a massless rope. The other end of the rope is in the hands of a man of mass 2M as shown in the figure. The block and the man are resting on a rough wedge of mass M as shown in the figure. The whole system is resting on a smooth horizontal surface. The man pulls the rope. Pulley is massless and frictionless. What is the displacement of the wedge when the block meets the pulley. (Man does not leave his position during the pull)



(A) 0.5m (B) 1m (C) Zero (D) 2/3 m

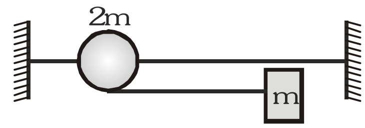
12. A continuous stream of particles of mass m and velocity v, is emitted from a source at a rate of n per second. The particles travel along a straight line, collide with a body of mass M and get embedded in the body. If the mass M was originally at rest, its velocity when it has received N particles will be

(A) $\frac{mvn}{Nm+n}$ (B) $\frac{mvN}{Nm+M}$ (C) $\frac{mv}{Nm+M}$ (D) $\frac{Nm+M}{mv}$

13. Three particles start from origin at the same time with a velocity $2ms^{-1}$ along positive x–axis, the second with a velocity $6ms^{-1}$ along negative y–axis. Find the velocity of the third particle along x=y line so that the three particles may always lie in a straight line

(A) $-3\sqrt{3}$ (B) $3\sqrt{2}$ (C) $-3\sqrt{2}$ (D) $2\sqrt{2}$

14. 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

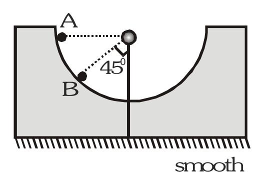


(A) $L(1-\cos\theta)$ (B) $\left(\frac{L}{2}\right)(1-\cos\theta)$ (C) $\left(\frac{L}{3}\right)(1-\cos\theta)$ (D) $\left(\frac{L}{6}\right)(1-\cos\theta)$

15. A body of mass M moves in outer space with velocity v. It is desired to break the body into two parts so that the mass of one part is one–tenth of the total mass. After the explosion, the heavier part comes to rest while the lighter part continues to move in the original direction of motion. The velocity of the small part will be

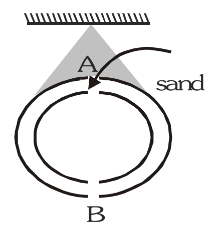
(A) v (B) $\left(\frac{v}{2}\right)$ (C) $\left(\frac{v}{10}\right)$ (D) 10 v

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



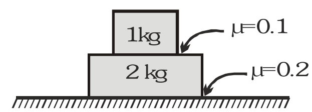
(A) $\left(\frac{gR}{3\sqrt{2}}\right)^{1/2}$ (B) $\sqrt{2gR}$ (C) $\left(\frac{5gR}{2\sqrt{3}}\right)^{1/2}$ (D) $\sqrt{\frac{3}{2}gR}$

17.. A uniform metallic spherical shell is suspended from ceiling. It has two holes A and B at top and bottom respectively. Which of the following is/are true:



(A) If B is closed and sand is poured from A, centre of mass first rises and then falls
(B) If shell is completely filled with sand and B is opened then centre of mass falls initially
(C) If shell is slightly filled with sand and B is opened, then centre of mass falls.
(D) None of these

18. If both the blocks as shown in the given arrangement are given together a horizontal velocity towards right. If a_{cm} be the subsequent acceleration of the centre of mass of the system of blocks then a_{cm} equals



(A) 0 m/s^2 (B) $\frac{5}{3}$ m/s^2 (C) $\frac{7}{3}$ m/s^2 (D) 2 m/s^2

19. A bead of mass m and diameter d is sliding back and forth with velocity v on a wire held between two rigid walls of length L. Assume that the collisions with the wall are perfectly elastic and there is no friction. The average force that the bouncing bead exerts on the one of the walls is

(A) $\frac{mv^2}{L-d}$ (B) $\frac{mv^2}{L+d}$ (C) $\frac{2mv^2}{L-d}$ (D) $\frac{2mv^2}{L+d}$

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

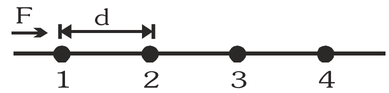
(A) The last block starts moving at $t = n\,(n-1)\frac{L}{2v}$

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

(C) The centre of mass of the system will have a final speed $\frac{v}{n}$

(D) The centre of mass of the system will have a final speed v.

21. The Fig. shows a string of equally placed beads of mass m, separated by distance d. The beads are free to slide without friction on a thin wire. A constant force F acts on the first bead initially at rest till it makes collision with the second bead. The second bead then collides with the third and so on. Suppose that all collisions are elastic,



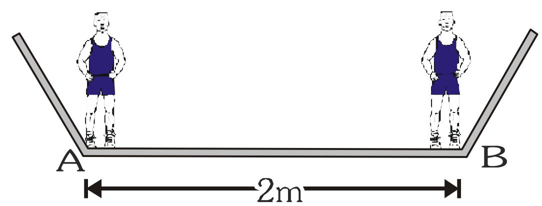
(A) Speed of the first bead immediately before and immediately after its collision with the second bead is $\sqrt{\frac{2Fd}{m}}$ and zero respectively.

(B) Speed of the first bead immediately before and immediately after its collision with the secondbead is $\sqrt{\frac{2Fd}{m}}$ and $\frac{1}{2}\sqrt{\frac{2Fd}{m}}$ respectively.

(C) Speed of the second bead immediately after its collision with third bead is zero.

(D) The average speed of the first bead is $\frac{1}{2}\sqrt{\frac{2Fd}{m}}$.

22. Two persons A and B of weight 80 kg and 50 kg respectively are standing at opposite ends of a boat of mass 70 kg and length 2m at rest. When they interchange their positions then displacement of the centre of mass of the boat will be:



(A) 60 cm towards left (B) 30 cm towards right
(C) 30 cm towards left (D) stationary

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

(A) The total momentum of the 'A plus B' system is p before and after the impact, and (p–1) during the impact.

(B) During the impact A gives impulse J to B

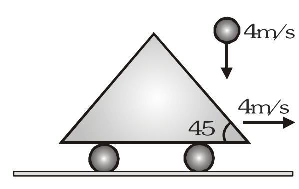
(C) The coefficient of restitution is $\frac{2J}{p}-1$

(D) The coefficient of restitution is $\frac{J}{p}+1$

24. Two balls of same mass are dropped from the same height onto the floor. The first ball bounces upwards from the floor elastically. The second ball sticks to the floor. The first applies an impulse to the floor of I_1 and the second applies an impulse I_2. The impulses obey

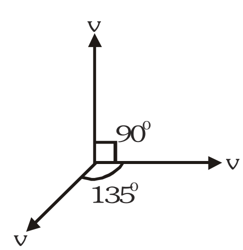
(A) $I_2 = 2I_1$ (B) $I_2 = \frac{I_1}{2}$ (C) $I_2 = 4I_1$ (D) $I_2 = \frac{I_1}{4}$

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



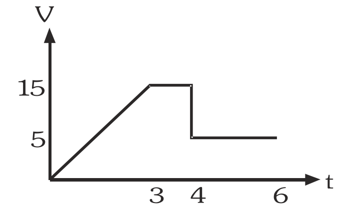
(A) $4\sqrt{2}$ m/s (B) $4\sqrt{3}$ m/s
(C) 4 m/s (D) $4\sqrt{5}$ m/s

26. A particle of mass 4m which is at rest explodes into four equal fragments. All 4 fragments scattered in the same horizontal plane. Three fragments are found to move with velocity v each as shown in the fig. The total energy released in the process of explosion is



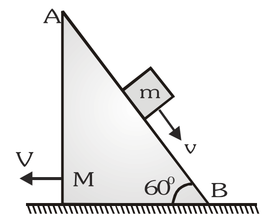
(A) $mv^2\,(3-\sqrt{2})$ (B) $mv^2\,(3-\sqrt{2})/2$
(C) $2mv^2$ (D $mv^2\,(1+\sqrt{2})/2$

27. The fig. shows the velocity as a function of the time for an object with mass 10 kg being pushed along a frictionless surface by external force. At t= 3s, the force stops pushing and the object moves freely. It then collides head on and sticks to another object of mass 25 kg.



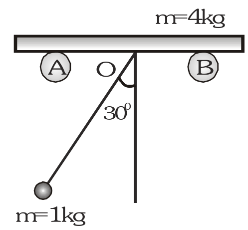
(A) External force acting on the system is 50 N
(B) Velocity of the 2^{nd} particle just before the collision is 1 m/s
(C) Before collision both bodies are moving in the same direction
(D) Before collision, bodies are moving in opposite direction with respect to each other

28. A particle of mass m = 0.1 kg is released from rest from a point A of a wedge of mass M = 2.4 kg free to slide on a frictionless horizontal plane. The particle slides down the smooth face AB of the wedge. When the velocity of the wedge is 0.2 m/s the velocity of the particle in m/s relative to the wedge is



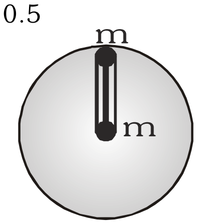
(A) 4.8 (B) 5 (C) 7.5 (D) 10

29. A ball of mass 1 kg is suspended by an inextensible string 1 m long attached to a point O of a smooth horizontal bar resting on a fixed smooth supports A and B. The ball is released from rest from the position when the string makes an angle of 30 with the vertical. The mass of the bar is 4 kg. The displacement in meters of the bar when the string makes the maximum angle on the other side of the vertical is



(A) 0 (B) 0.2 (C) 0.25 (D) 0.5

30. Find the distance between centre of gravity and centre of mass of a two particle system attached to the ends of a light rod. Each particle has same mass. Length of the rod is R, where R is the radius of earth



(A) R (B) R/2 (C) zero (D) R/4

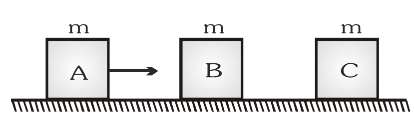
31. After scaling a wall of 3 m height a man of weight W drops himself to the ground. If his body comes to a complete stop in 0.15 s. After his feet touch the ground, calculate the average impulsive force in the vertical direction exerted by ground on his feet.

(A) 5W (B) 5.21W (C) 3W (D) 6W

32. An open water tight railway wagon of mass 5×10^3 kg coasts at an initial velocity 1.2 m/s without friction on a railway track. Rain drops fall vertically downwards into the wagon. The velocity of the wagon after it has collected 10^3 kg of water will be

(A) 0.5 m/s (B) 2m/s (C) 1 m/s (D) 1.5 m/s

33. Three blocks A, B and C each of mass m are placed on a surface as shown in the figure. Blocks B and C are initially at rest. Block A is moving to the right with speed v. It collides with block B and sticks to it. The A–B combination collides elastically with block C. Which of the following statement is (are) true about the velocity, of block B and C.



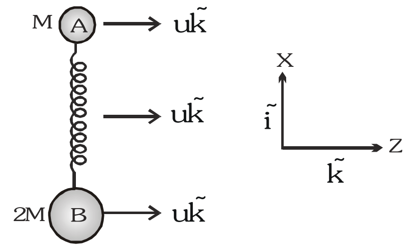
(A) Velocity of the block C after collision is 2/3 v towards right

(B) Velocity of the A–B combination after collision is $\frac{v}{3}$ towards left

(C) Velocity of the A–B combination after collision is $\frac{2}{3}$ v towards left

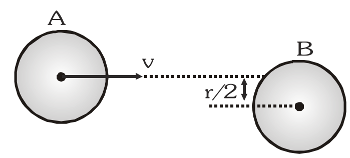
(D) Velocity of the block C after collision is $\frac{v}{3}$ towards right.

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



(A) $v_x\tilde{i}+u\tilde{k}$ (B) $-v_x\tilde{i}+u\tilde{k}$ (C) $-2v_x\tilde{i}+u\tilde{k}$ (D) $2v_x\tilde{i}+u\tilde{k}$

35. A disk A of radius r moving on perfectly smooth surface at a speed v undergoes an elastic collision with an identical stationary disk B. Find the velocity of the disk B after collision if the impact parameter is r/2 as shown in the figure



(A) $\frac{\sqrt{15}}{4}v$ (B) $\frac{v}{4}$ (C) $\frac{v}{2}$ (D) $\frac{\sqrt{3}v}{2}$

36. A spherical ball of mass 1 kg moving with a uniform speed of 1 m/s collides symmetrically with two identical spherical balls of mass 1 kg each at rest touching each other. If the two balls move with 0.5m/s in two directions at the same angle of 60 with the direction of the first ball, the loss of kinetic energy on account of the collision is :

(A) 0.125 J (B) 0.5J (C) 1.0 J (D) 0.75J

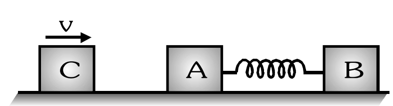
37. A smooth sphere A of mass m collides elastically with an identical sphere B at rest. The velocity of A before collision is 8 m/s in a direction making 60 with the line of centres at the time of impact.

(A) The sphere A comes to rest after collision.
(B) The sphere B will move with a speed of 8 m/s after collision.
(C) The directions of motion A and B after collision are at right angles.
(D) The speed of B after collision is 4 m/s.

38. A particle moving with kinetic energy = 3J 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 1J.
(B) the maximum elastic potential energy of the system is 2J.
(C) momentum and total energy are conserved at every instant.
(D) the ratio of kinetic energy to potential energy of the system first decreases and then increases.

39. Two blocks A and B each of mass m, are connected by a massless spring of natural length L and spring constant k. The blocks are initially resting on 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 :–



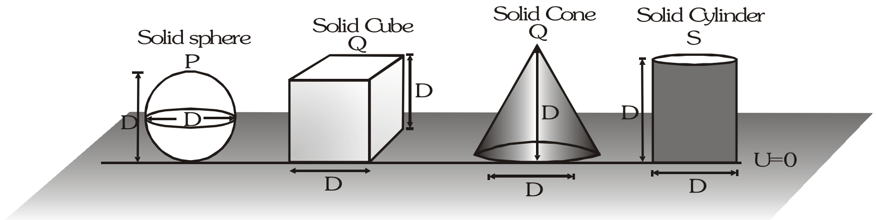
(A) the kinetic energy of the A–B system, at maximum compression of the spring, is zero

(B) the kinetic energy of the A–B system, at maximum compression of the spring, is $\frac{mv^2}{4}$

(C) the maximum compression of the spring is $v\sqrt{\left(\frac{m}{k}\right)}$

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

40. Assuming potential energy 'U' at ground level to be zero.



All objects are made up of same material.

U_P = Potential energy of solid sphere

U_Q = Potential energy of solid cube

U_R = Potential energy of solid cone

U_S = Potential energy of solid cylinder

(A) $U_S > U_P$ (B) $U_Q > U_S$ (C) $U_P > U_Q$ (D) $U_S > U_R$

41. A bag of mass M hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined system (bag + bullet) :

(A) Momentum is $mMv/(M + m)$

(B) kinetic energy is $(1/2)\ Mv^2$

(C) Momentum is mv

(D) kinetic energy is $m^2v^2/2(M + m)$

42. A ball moving with a velocity v hits a massive wall moving towards the ball with a velocity u. An elastic impact lasts for a time Δt.

(A) The average elastic force acting on the ball is $\frac{m(u+v)}{\Delta t}$

(B) The average elastic force acting on the ball is $\frac{2m(u+v)}{\Delta t}$

(C) The kinetic energy of the ball increases by $2mu(u + v)$

(D) The kinetic energy of the ball remains the same after the collision

ANSWER KEY LEVEL-2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	C	B	C	D	D	D	B	A	B	B	C	D
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	B	D	A	A,C	A,C	C	B,C	B	D	A	A,B,C	D	B	C
Que.	31	32	33	34	35	36	37	38	39	40	41	42			
Ans.	B	C	A	C	A	A	C,D	A,B,C,D	B,D	A,B,D	C,D	B,C			