Q1. Displacement of a particle of mass 2 kg moving in a straight line varies with time as

$s = (2t^3 + 2)$ m

Impulse of the force acting on the particle over a time interval between t = 1 s is:

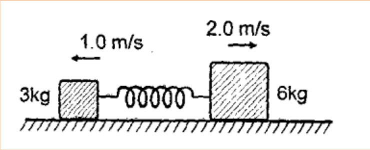
(a) 10 N-s (b) 12 N-s (c) 8 N-s (d) 6 N-s

Q2. A particle of mass 1 kg is projected at an angle of 30^o with horizontal with velocity $v = 40$ m / s.

The change in linear momentum of the particle after time $t = 1$ s will be : ($g = 10$ m/s^2)

(a) 7.5 kg-m/s (b) 15 kg-m/s

(c) 10 kg-m/s (d) 20 kg-m/s



Q3. Two blocks of mass 3 kg and 6 kg respectively are placed on a smooth horizontal surface. They are connected by a light spring of force constant $k = 200$ N/m. initially the spring is unstretched. The indicated velocities are imparted to the blocks. The maximum extension of the spring will be:

(a) 30 cm (b) 25 cm (c) 20 cm (d) 15 cm

Q4. The centre of mass of a non-uniform rod of length L whose mass per unit length $\lambda = \frac{kx^2}{L}$, where k is a constant and x is the distance from one end is :

(a) $\frac{3L}{4}$ (b) $\frac{L}{8}$ (c) $\frac{K}{L}$ (d) $\frac{3K}{L}$

Q5. A particle of mass m is made to move with uniform speed v along the perimeter of a regular polygon of 2 n sides. The magnitude of impulse applied at each corner of the polygon is :

(a) $2\,mv \sin\frac{\pi}{2n}$ (b) $mv\,\sin\frac{\pi}{2n}$ (c) $mv\,\cos\frac{\pi}{2n}$ (d) $2\,mv\,\cos\frac{\pi}{2n}$

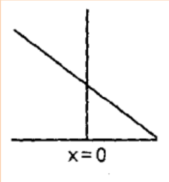
Q6. From a circular disc of radius R a square is cut out with a radius as its diagonal. The distance of the centre of mass of the remainder from the centre of the disc is :

(a) $\frac{R}{\pi-2}$ (b) $\frac{R}{\pi}$ (c) $\frac{R}{2\ 2\pi-1}$ (d) $\frac{R}{2}$

Q7. A force $\vec{F} = 2\hat{i} + \hat{j} + 3\hat{k}$ N acts on a particle of mass 1 kg for 2s. if initial velocity of particle is $\vec{u} = 2\hat{i} + \hat{j}$ m/s. Speed of particle at the end of 2s will be :

(a) 12 m/s (b) 6 m/s (c) 9 m/s (d)4 m/s

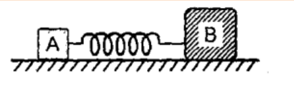
Q8. A uniform rod of length I is kept vertically on a rough horizontal surface at x 0. It is rotated slightly and released. When the rod finally falls on the horizontal surface, the lower end will remain at:



(a) x = l/2 (b) x > l/2

(c) x < l/2 (d) x = 0

Q9. Two blocks A and B of mass m and 2 m are connected by a massless spring of force constant *k*. They are placed on a smooth horizontal plane. Spring is stretched by an amount x and then released. The relative velocity of the blocks when the spring comes to its natural length is:



(a) $\left(\sqrt{\frac{3k}{2m}}\right)x$ (b) $\left(\sqrt{\frac{2k}{3m}}\right)x$ (c) $\sqrt{\frac{2kx}{m}}$ (d) $\sqrt{\frac{3km}{2x}}$

Q10. A ball of mass *m* approaches wall of mass *M* (>> *m*) with speed 4 m/s along the normal to the wall. The speed of wall is 1 m/s towards the ball. The speed of the ball after an elastic collision with the wall is :

(a) 5 m/s away from the wall

(b) 9 m/s away from the wall

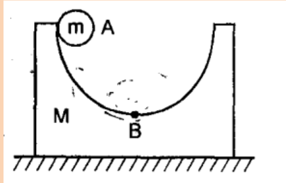
(c) 3 m/s away from the wall

(d) 6 m/s away from the wall

Q11. After perfectly inelastic collision between two identical particles moving with same speed in different directions, the speed of the particles become half the initial speed. The angle between the velocities of the two before collision is :

(a) 60^{o} (b) 45^{o}

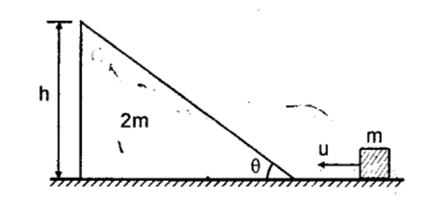
(c) 120^{o} (d) 30^{o}



Q12. A block of -mass M =2 kg with a semicircular track of radius R = 1.1 m rests on a horizontal frictionless surface. A unifonn cylinder of radius r=10 cm and mass m = 1.0 kg is released from rest from the top point A. The cylinder slips on the semicircular frictionless track. The speed of the block when the cylinder reaches the bottom of the track at B is : (g =10 m/s2)

(a) $\sqrt{\frac{10}{3}}$ m/s (b) $\sqrt{\frac{4}{3}}$ m/s (c) $\sqrt{\frac{5}{2}}$ m/s (d) $\sqrt{10}$ m/s

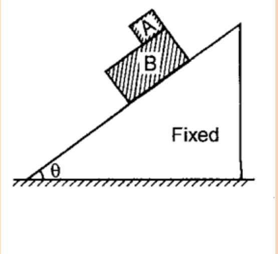
Q13. A block of mass m is pushed towards a movable wedge of mass 2m and height h with a velocity u. All surfaces are smooth. The minimum value of u for which the block will reach the top of the wedge is :



(a) $2\sqrt{gh}$ (b) $\sqrt{3gh}$

(c) $\sqrt{6gh}$ (d) $\sqrt{\frac{3}{2}gh}$

Q14. A block A slides over an another block B which is placed over a smooth inclined plane as shown in figure. The coefficient of friction between the two blocks A and B is μ. Mass of block B is two times the mass of block A. the acceleration of the centre of mass of two blocks is :



(a) $g \sin \theta$ (b) $\frac{g \sin \theta - \mu g \cos \theta}{3}$

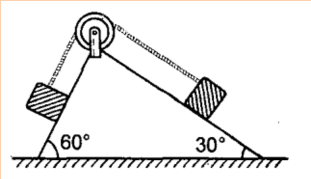
(c) $\frac{g \sin \theta}{3}$ (d) $\frac{2g \sin \theta - \mu g \cos \theta}{3}$

Q15. A man of mass m moves with a constant speed on a plank of mass M and length L kept initially at rest on a frictionless horizontal surface, from one end to the other in time t. The speed of the plank relative to ground while man is moving, is:

(a) $\frac{L}{t}\left(\frac{M}{m}\right)$ (b) $\frac{L}{t}\left(\frac{m}{M+m}\right)$

(c) $\frac{L}{t}\left(\frac{m}{M-m}\right)$ (d) none of these

Q16. Two blocks of equal mass are tied with a light string, which passes over a massless pulley as shown in figure. The magnitude of acceleration of centre of mass of both the blocks is : (neglect friction everywhere)



(a) $\left(\frac{\sqrt{3}-1}{4\sqrt{2}}g\right)$ (b) $\sqrt{3}-1\ g$

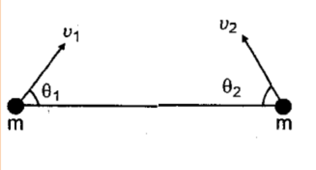
(c) $\frac{g}{2}$ (d) $\left(\frac{\sqrt{3}-1}{\sqrt{2}}\right)g$

Q17. A rope thrown over a pulley has a ladder with a man of mass m on one of its ends and a counterbalancing mass M on its other end. The man climbs with a velocity V. relative to ladder. Ignoring the masses of the pulley and the rope as well as the friction on the pulley axis, the velocity of the centre of mass of this system is :

(a) $\frac{m}{M}v_r$ (b) $\frac{m}{2M}v_r$

(c) $\frac{M}{m}v_r$ (d) $\frac{2M}{m}v_r$

Q18. Two particles of equal mass m are projected from the ground with speeds v1 and v2 at angles-01 and 02 as shown in figure. The centre of mass of the two particles:



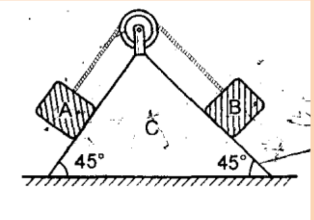
(a) will move in a parabolic path for any values of v_1, v_2, θ_1 and θ_2

(b) can move in a vertical line

(c) can move in a horizontal line

(d) will move in a straight line for any values of v_1, v_2, θ_1 and θ_2

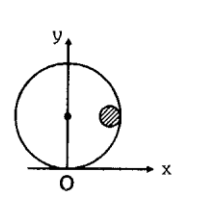
Q19. A system of two blocks A and B and a wedge C is released from rest as shown in figure. Masses of the blocks and the wedge are m, 2 m and 2 m respectively. The displacement of wedge C when block B slides down the plane a distance 10 cm is :r (neglect friction)



(a) $5\sqrt{2}$ cm (b) $3\sqrt{2}$ cm

(c) 4 cm (d) $\frac{5}{\sqrt{2}}$ cm

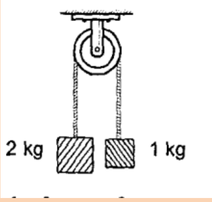
Q20. A small sphere of radius R held against the inner surface of a smooth spherical shell of radius 6R as shown in figure. The masses of the shell and small spheres are 4M and M respectively. This arrangement is placed on a smooth horizontal table. The small sphere is now released. The x-coordinate of the centre of the shell when the smaller sphere reaches the other extreme position is:



(a) R (b) 2R

(c) 3R (d) 4R

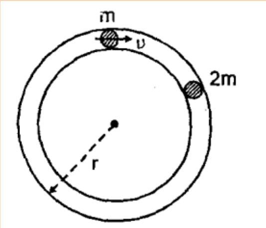
Q21. Two blocks of masses 2 kg and 1 kg respectively are tied to the ends of a string which passes over a light frictionless pulley. The masses are held at rest at the same horizontal level and then released. The distance traversed by centre of mass in 2 s is :



(g =10 m/s^2)

(a)	1.42 m	(b)	2.22 m
(c)	3.12 m	(d)	3.33 m

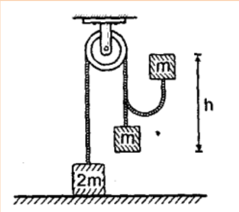
Q22. A particle of mass m moving with a speed v hits elastically another stationary particle of mass 2 m on a smooth horizontal circular tube of radius r. The time in which the next collision will take place is equal to:



(a) $\frac{2\pi r}{v}$ (b) $\frac{4\pi r}{v}$

(c) $\frac{3\pi r}{2v}$ (d) $\frac{\pi r}{v}$

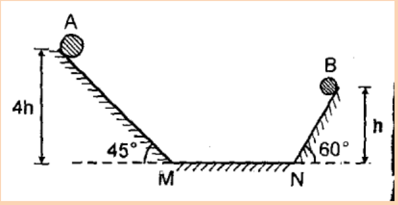
Q23. A mass 2 m rests on a horizontal table. It is attached to a light inextensible string which passes over a smooth pulley and carries a mass m at the other end. If the mass m is raised vertically through a distance h and is then dropped, then the speed with which the mass 2 m begins to rise is:



(a) $\sqrt{2gh}$ (b) $\frac{\sqrt{2gh}}{3}$

(c) $\frac{\sqrt{gh}}{2}$ (d) $\sqrt{gh}$

Q24. Two identical balls A and B are released from the positions shown in figure. They collide elastically on horizontal portion MN. The ratio of heights attained by A and B after collision will be: (neglect friction)



(a) 1: 4 (b) 2 : 1

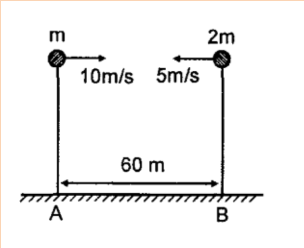
(c) 4: 13 (d) 2 : 5

Q25. 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 an impulse J to A. Then coefficient of restitution between the two is :

(a) $\frac{2J}{P} - 1$ (b) $\frac{2J}{P} + 1$

(c) $\frac{J}{P}+1$ (d) $\frac{J}{P}-1$

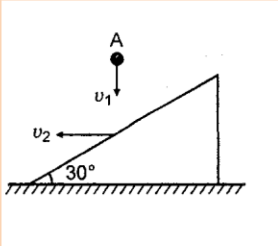
Q26. Two particles one of mass m and the other of mass 2m are projected horizontally towards each other from the same level above the ground with velocities 10 m/s and 5 m/s respectively. They collide in air and stick to each other. The distance from A, where the combined mass finally land is:



(a) 40m (b) 20m

(c) 30m (d) 45m

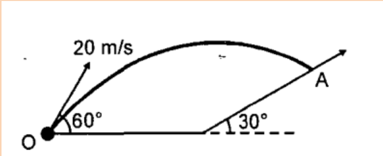
Q27. A ball A falling vertically downwards with velocity v1. It strikes elastically with a wedge moving horizontally with velocity v2 as shown in figure. What must be the ratio $\frac{v_1}{v_2}$ so that the ball bounces back in vertically upward direction relative to the wedge:



(a) $\sqrt{3}$ (b) $\frac{1}{\sqrt{3}}$

(c) 2 (d) $\frac{1}{2}$

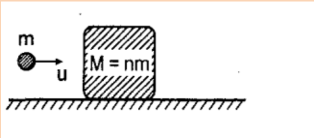
Q28. A ball is projected from the point 0 with velocity 20 m/s at an angle of 60° with horizontal as shown in figure. At highest point of its trajectory it strikes a smooth plane of inclination 30° at a point A. The collision is perfectly inelastic. The maximum height from the ground attained by the ball is: ($g = 10\ m/s^2$)



(a) 18.75 m (b) 15 m

(c) 22.5 m (d) 20.25 m

Q29. A bullet of mass m moving with velocity u passes through a wooden

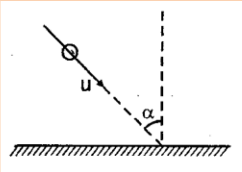


block of mass M = nm. The block is resting on a smooth horizontal floor. After passing through the block the velocity of bullet is v. Its velocity relative to block is:

(a) $\frac{(1+n)v-u}{n}$ (b) $\frac{nv-u}{n+1}$

(c) $\frac{nu-v}{n+1}$ (d) $\frac{(n+1)u+v}{2n+1}$

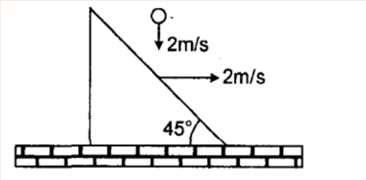
Q30. A ball of mass m collides with the ground at an angle α with the vertical. If the collision lasts for time t, the average force exerted by the ground on the ball is (e = coefficient of restitution between the ball and the ground)



(a) $\frac{e\,mu\cos\alpha}{t}$ (b) $\frac{2(1+e)\,mu\cos\alpha}{t}$

(c) $\frac{(1+e)\,mu\cos\alpha}{t}$ (d) $\frac{e\,mu}{t}$

Q31. A small ball falling vertically downward with constant velocity 2 m/s strikes elastically an inclined plane moving with velocity 2 m/s as shown in figure. The velocity of rebound of the ball with respect to ground is:



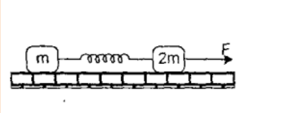
(a) 4 m/s

(b) $2\sqrt{5}$ m/s

(c) $2\sqrt{2}$ m/s

(d) 2 m/s

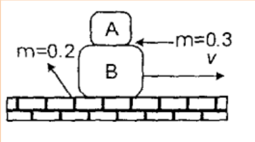
Q32. Two blocks of masses m and 2m are kept on a smooth horizontal surface. They are connected by an ideal spring of force constant k. Initially the spring is unstretched. A constant force is applied to the heavier block in the direction shown in figure. Suppose at time t displacement of smaller block is x, then displacement of the heavier block at this moment would be:



(a) $\frac{x}{2}$ (b) $\frac{\text{Ft}^2}{6\text{m}} + \frac{x}{3}$

(c) $\frac{x}{3}$ (d) $\frac{\text{Ft}^2}{4\text{m}} - \frac{x}{2}$

Q33. 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



$m_A = 2m_B$

(a) 0 m/s^2 (b) 5/3 m/s^2

(c) 7/3 m/s^2 (d) 2 m/s^2

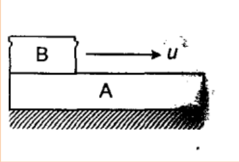
Q34. A particle of mass 3m is projected from the ground at some angle with horizontal. Its horizontal range is R. At the highest point of its path it breaks into two pieces of masses m and 2m respectively. The smaller mass comes to rest. The larger mass finally falls at a distance x from the point of projection where x is equal to

(a) $\frac{3}{4}$R (b) $\frac{3}{2}$R

(c) $\frac{5}{4}$R (d) 3R

More than one Option

Q35. A horizontal 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 other end with some velocity u.



The coefficient of friction between blocks is u Then:

(a) the blocks will reach a final common velocity u/3

(b) the work done against friction is two-third of the initial kinetic energy of B

(c) before the blocks reach a common velocity, the acceleration of A relative to B is (2/3) ug

(d) before the blocks reach a common velocity, the acceleration of A relative to B is (3/2) ug

Q36. In a one-dimensional collision between two particles B is stationary and A has momentum p before impact. During impact, A gives impulse J to B. Then:

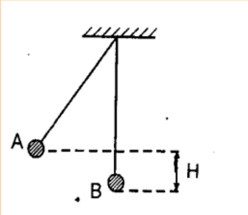
(a) the total momentum of A plus B system is p before and after the impact and (p-J) during the impact

(b) during the impact B gives impulse J to A

(c) the coefficient of restitution is (2J/p) — 1

(d) the coefficient of restitution is (2J/p) + 1

Q37. Two small balls A and B of mass M and 3M hang from the ceiling by strings of equal length. The ball A is drawn a side so that it is raised to a height H. It is then released and collides with ball B.



Select the correct answer(s).

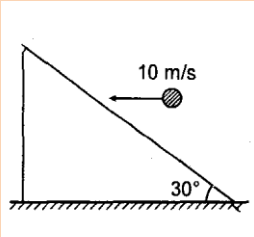
(a) If collision is perfectly elastic, ball B will rise to a height H/4

(b) If the collision is perfectly elastic ball A will rise upto a height R/4

(c) If the collision is perfectly inelastic, the combined mass will rise to a height H/16

(d) If the collision is perfectly inelastic, the combined mass will rise to a height H/4

Q38. A ball of mass 1 kg strikes a wedge of mass 4 kg horizontally with a velocity of 10 m/s. Just after collision velocity of wedge becomes 4 m/s. Friction is absent everywhere and collision is elastic. Select the correct alternative(s) :



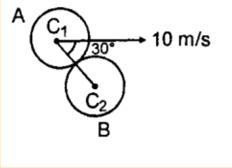
(a) Speed of ball after collision is 6 m/s

(b) Speed of ball after collision is 8 m/s

(c) Impulse between ball and wedge during collision is 16 N-s

(d) Impulse between ball and wedge during collision is 32 N-s

Q39. A ball A collides elastically with an another identical ball B with velocity 10 m/s at an angle of 30° from the line joining their centres C_1 and C_2. Select the correct alternative(s)



(a) Velocity of ball A after collision is 5 m/s

(b) Velocity of ball B after collision is $5\sqrt{3}$ m/s

(c) Both the balls move at right angles after collision

(d) Kinetic energy will not be conserved here, because collision is not head on

Q40. A projectile is fired on a horizontal ground. Coefficient of restitution between the projectile and the ground is e. Let a, b and c be the ratio of time of flight $\left(\frac{T_1}{T_2}\right)$ maximum height $\left(\frac{H_1}{H_2}\right)$ and horizontal range $\left(\frac{R_1}{R_2}\right)$ in first two collisions with the ground. Then:

(a) $a = \frac{1}{e}$ (b) $b = \frac{1}{e^2}$

(c) $c = \frac{1}{e^2}$ (d) all of these

Q41. A man of mass m is stationary on a stationary flat car. The car can move without friction along horizontal rails. The man starts walking with velocity v relative to the car. Work done by him:

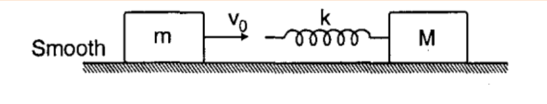
(a) is less than $\frac{1}{2}mv^2$, if he walks along the rails

(b) is equal to $\frac{1}{2}mv^2$, if he walks normal to rails

(c) can never be less than $\frac{1}{2}mv^2$

(d) is greater than $\frac{1}{2}mv^2$, if he walks along the rails

Q42. A block of mass m moving with a velocity v_0 collides with a stationary block of mass M at the back of which a spring of spring constant k is attached, as shown in the figure. Select the correct alternative(s) :



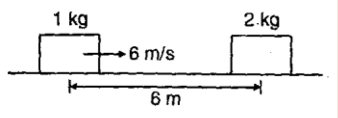
(a) The velocity of centre of mass is $\frac{m}{m+M}v_0$

(b) The initial kinetic energy of the system in the centre of mass frame is $\frac{1}{4}\left(\frac{mM}{M+m}\right)v_0^2$

(c) The maximum compression in the spring is $v_0\sqrt{\frac{mM}{m+M}\frac{1}{k}}$

(d) When the spring is in the state of maxim compression the kinetic energy in the centre of mass frame is zero

Q43. A block of mass 1 kg is pushed towards another block of mass 2 kg from 6 m distance as shown in figure. Just after collision velocity of 2 kg block becomes 4 m/s.



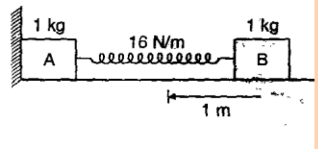
(a) coefficient of restitution between two blocks is 1

(b) coefficient of restitution between two blocks is 1/2

(c) velocity of centre of mass after 2 s is 2 m/s

(d) velocity of centre of mass after 2 s is 1 m/s

Q44. In the system shown in figure block A is not attached with wall. Block B is compressed 1m and then released at time t = 0. Then:



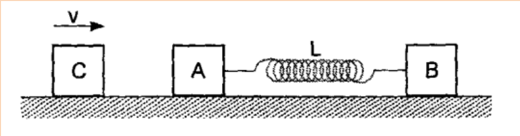
(a) net force on the system is non zero for t < $\frac{\pi}{2}$ second

(b) net force on the system is non zero all the time

(c) final velocity of centre of mass is 4 m/s

(d) final velocity of centre of mass is 2 m/s

Q45. 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 figure. 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 $mv^2/4$

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

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