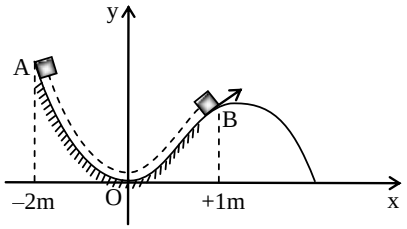
CLASS XI-PHYSICS

CONSERVATION OF MOMENTUM

ASSIGNMENT-1

NUMERICAL QUESTIONS:

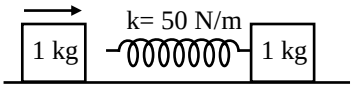
Q.1 A small body is released from point A of the smooth parabolic path $y = x^2$. Where y is vertical axis and x is horizontal axis at ground as shown. The body leaves the surface from point B. If g = 10 m/s^2 then the total horizontal distance travelled by body before it hits ground is –



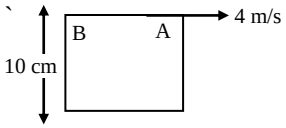
Q.2 A cubical block of mass 6 kg and side 16.1 cm is placed on frictionless horizontal surface. It is hit by a cue at the top as to impart-impulse in horizontal direction. Minimum impulse imparted to topple the block must be greater than.

Q.3 A single conservative force acts on a body of mass 1 kg that moves along the x-axis. The potential energy U(x) is given by $U(x) = 20 + (x - 2)^2$, where x is in meters. At x = 5.0 m the particle has a kinetic energy of 20 J, then the maximum kinetic energy of body in J is .

Q.4 Each of the blocks shown in figure has mass 1 kg. The rear block moves with a speed of 2m/s towards the front block kept at rest. The spring attached to the front block is light and has a spring constant 50 N/m. The maximum compression of the spring is given by $\frac{X}{10}$ m, then find X.



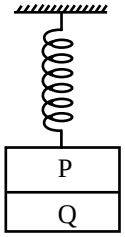
Q.5 A cube of mass 3 kg is kept on a frictionless horizontal surface. The block is given an impulse so that point 'A' acquires velocity 4 m/s in the direction shown. If speed of point B is $4\sqrt{2}$ m/s, then kinetic energy of block is –



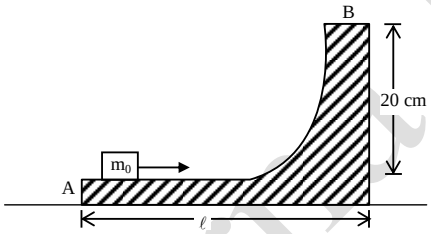
Q.6 Machine gun mounted on car is firing 30 bullets per minute onto the truck moving with speed 90 km/hr. The car is chasing truck with speed 180 km/hr. Numbers of bullet hitting the truck per min is : (Speed f bullet with respect to ground = 300 m/s)

Q.7 A body starts moving from origin at t = 0 with a velocity of $5\hat{i}$ in x-y plane under the action of force producing an acceleration of $(3\hat{i} + 2\hat{j})$ m/s^2, then y-co-ordinate in meters of body when x-co-ordinate is 84 m is.

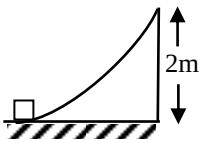
Q.8 Two blocks P and Q of masses 0.3 kg and 0.4 kg respectively are stuck to each other by some weak glue as shown in the figure. They hang together at the end of a spring with a spring constant k = 200 N/m. The block Q suddenly falls free due to failure of glue, then find maximum kinetic energy of the block P during subsequent motion in mJ.



Q.9 A wedge of mass M = 2 m_0 rests on a smooth horizontal plane. A small block of mass m_0 rests over it at left end A as shown in figure. A sharp impulse is applied on the block, due to which it starts moving to the right with velocity v_0 = 6 m/s. At highest point of its trajectory, the block collides with a particle of same mass m_0 moving vertically downwards with velocity v = 2 m/s and gets stuck with it. If the combined mass lands at the end point A of the body of mass M, calculate length ℓ in cm. Neglect friction, take g = 10 m/s^2.

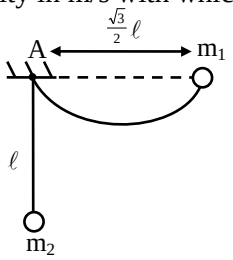


Q.10 A block is kept on a frictionless wedge. Minimum velocity given to block so that block reaches to the top of wedge is v_0. Maximum height reached by block if it is given velocity 2 v_0 at bottom is (in m) -

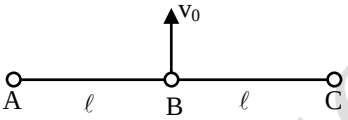


Q.11 Two balls of mass m_1 = 100 gm and m_2 = 300 gm are suspended from point A by two equal inextensible threads, each of length $\ell = \frac{32}{35}$ m. Ball of mass m_1 is drawn aside and held at the same

level as A but a distance $\frac{\sqrt{3}}{2}\ell$ from A as shown. When ball m_1 is released, it collides elastically with stationary ball m_2. Then velocity in m/s with which the ball m_1 collides with the ball m_2 is



Q.12 Three identical balls each of mass m = 0.5 kg are connected with ideal string as shown in figure and this system rests on a smooth horizontal table. At moment t = 0 ball B is imparted a velocity v_0 = 9 m/s as shown. Then the velocity of A in m/s when it collides with ball C.

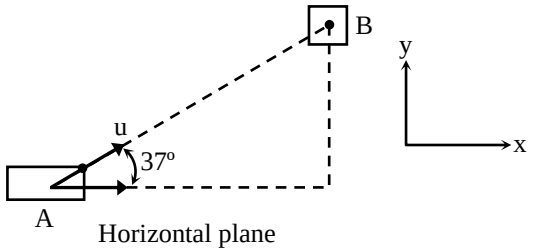


Q.13 A steel ball of radius R = 20 cm and m = 2 kg is rotating about a horizontal diameter with angular speed ω_0 = 50 rad/sec. This rotating ball is dropped on a rough horizontal floor and fall freely through a height h = 1.25 m. The coefficient of restitution is e = 1 and coefficient of friction between ball and floor is μ = 0.3. Then the distance in m between the point of first and second impact of the ball and floor is

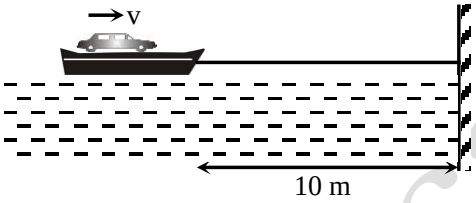
Q.14 A projectile is fixed with velocity v_0 = 2m/s at angle 60º with horizontal. At top of its trajectory it explodes into three fragment of equal mass. First fragment retraces the path, second moves vertically upward with speed $\frac{3V_0}{2}$. The speed of third fragment (in m/s) is –

Q.15 A block is hanged from spring in a cage. Elongation in spring is $x_1 = 4\sqrt{2}$ mm and $x_2 = 3\sqrt{2}$ mm when cage moves up and down respectively with same acceleration. The expansion (in mm) in spring when the cage move horizontally with same acceleration.

Q.16 A man moving on plank 'A' throws a ball of mass 'm' with horizontal component of velocity $u = 3\sqrt{34}$ m/s w.r.t. ground towards a stationary plank 'B' as shown in figure, while man of plank B catches the ball. The combined mass of plank 'A' with man as well as plank B with man is '2m'. Initially plank 'A' is moving with speed $u\hat{i}$ w.r.t. ground. There is no friction between plank and ground. The relative velocity of B (in m/s) w.r.t. A after man on 'B' catches the ball minus 10 m/s is -

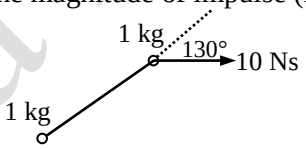


Q.17 A car of mass 200 kg initially at rest on a boat of mass 1000 kg tied to the wall of dock, through a massless inextensible string. The car accelerates from rest to velocity 10 m/s in 2 sec. At t = 2 sec car applies brake and comes to rest relative to boat in negligible time. Neglecting friction between boat and water, the time at which boat will strike the wall is -

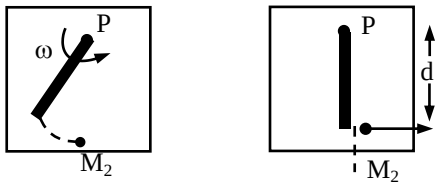


Q.18 A ball of mass m moving with K.E. 3J undergoes head on collision with another stationary ball of mass 2m. During impact maximum potential energy of system can be –

Q.19 Two balls of mass 1 kg each are connected by inextensible massless string. The system is resting on smooth horizontal surface. An impulse of $10\sqrt{3}$ Ns is applied to one of the balls at an angle 30° with the line joining two balls in horizontal direction as shown in figure. Assuming that string remains taut after the impulse, the magnitude of impulse (in Ns) minus 10 Ns is -

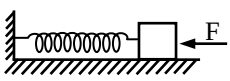


Q.20 A system contains ball of mass M_2 and uniform thin rod of mass M_1 and length 'd'. The rod is attached to frictionless horizontal table by a pivot at point 'P' and initially rotates at an angular speed ω as shown. As a result, rod stops and ball moves in the direction shown. If collision is elastic. The ratio M_1/M_2 is -

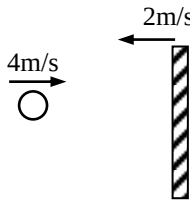


Before collision After collision

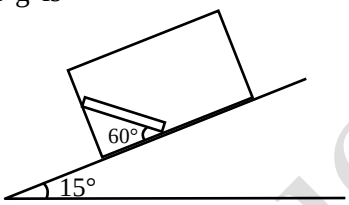
Q.21 A block is attached with spring and is kept on frictionless surface as shown. It is pushed by a force. Ratio of maximum compression and equilibrium compression in spring is -



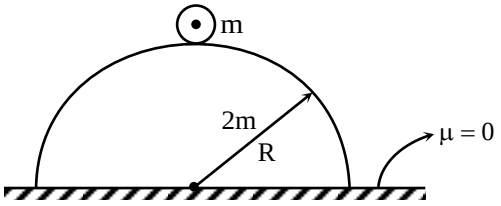
Q.22 A ball of mass 2kg moving with speed 4m/s hits a wall normally moving with speed 2 m/s in opposite direction. Coefficient of restitution between wall & ball is e = $\frac{1}{2}$. If ball remains in contact with wall till wall has moved 3m then average force (in N) on ball by wall is -



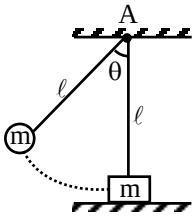
Q.23 A rod is kept inclined inside a box as shown in figure. The box is kept on a inclined plane as shown. All surfaces are frictionless. Let acceleration of box on inclined plane so that rod doesn't slip inside box be 'a'. Then ratio of 'a' and 'g' is -



Q.24 A small sphere of radius r = 2cm and mass 'm' is placed on a big sphere of mass 2m and radius R = 10 cm, which is kept on a smooth horizontal surface as shown in figure. The displacement (in cm) of hemisphere when line joining between centre of small sphere and hemisphere make angle 30º with vertical is (Assuming that small spheres does not break-off the surface of hemisphere) -

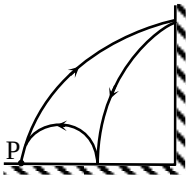


Q.25 As shown in figure ball and block have same mass 1 kg each, θ = 60º and length ℓ = 2.50 m coefficient of friction between block and floor is 0.5. When the ball is released from the position shown it collides with the block and the block stops after moving a distance 2.50 m then the coefficient of restitution for collision is (g = 10 m/s^2)



Q.26 A small sphere of mass m = 1 kg is moving with a velocity $(4\hat{i} - \hat{j})$ m/s. It hits a fixed smooth wall and rebound with velocity $(\hat{i} + 3\hat{j})$ m/s. The coefficient of restitution between the sphere and the wall is n/16. Find value of n.

Q.27 A small ball is projected from point P towards a vertical wall as shown. It hits the wall when its velocity is horizontal. Ball reaches point P after one bounce on the floor. The coefficient of restitution assuming it to be same for two collisions is n/2. All surfaces are smooth. Find the value of n.



Q.28 A cricketer hits a ball in a vertical x-y plane from the ground level with a velocity $\vec{v}_0 = (10\sqrt{3}\hat{i} + 30\hat{j})$ m/s. Find the time in which velocity vector makes an angle of 30º with horizontal x-axis. (Take g = 10 m/s^2).

Q.29 A body of mass 3 kg collides elastically with another body at rest and then continues to move in the original direction with one-half of its original speed. What is the mass of the target body in kg ?

Q.30 A single conservative force acts on a body of mass 1 kg that moves along the x-axis. The potential energy U(x) is given by U (x) = 20 + (x – 2)^2, where x is in meters. At x = 5.0 m the particle has a kinetic energy of 20 J, then the maximum kinetic energy of body in J minus 20 J is equal to.

Q.31 An artillery gun is mounted on a railway truck standing on straight horizontal rails. The total mass of the truck with gun shells and crew is M = 50 tons and the mass of each shell is m = 25 kg. The gun fires in a horizontal direction along the railway. The initial velocity of the shells is V_0 = 1000 m/s. What will the speed of truck after the second shot? Disregard friction and air resistance.

Q.32 A stationary body explodes into four identical fragments such that three of them fly off mutually perpendicular to each other, each will same K.E. E_0. The energy of explosion will be K times of E_0, then the value of K is