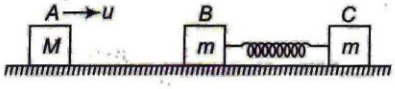
1. A block A of mass M moving with speed u collides elastically with block B of mass m which is connected to block C of mass m with a spring.



When the compression in spring is maximum the velocity of block C with respect to block A is (Neglect the friction everywhere)

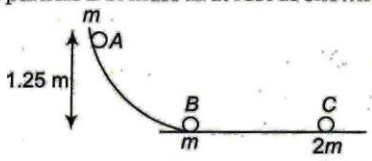
(a) zero

(b) $\left(\frac{M}{M+m}\right)u$

(c) $\left(\frac{m}{M+m}\right)u$

(d) $\left(\frac{m}{M}\right)u$

2. A particle A of mass m initially at rest slides down a height of 1.25 m on a frictionless ramp, collides with and sticks to an identical particle B of mass m at rest as shown in the figure.



Then, particles A and B together collide elastically with particle C of mass 2 m at rest. The speed of particle C after the collision with combined body $(A + B)$ would be $(g = 10\ \text{m/s}^2)$

(a) 2.0 m/s

(b) 1.25 m/s

(c) 2.5 m/s

(d) 5 m/s

ROUGH-

3. A bullet is fired from a gun. The force on the bullet is given by $F = 600 - 2 \times 10^5 t$

where F is in newton and t in second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

(a) 8 Ns (b) Zero
(c) 0.9 Ns (d) 1.8 Ns

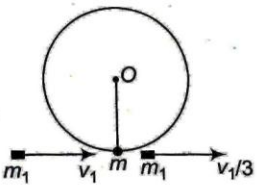
4. At high altitude, a body explodes at rest into two equal fragments with one fragment receiving horizontal velocity of 20 m/s. Time taken by the velocity vectors of the fragments to make 90° is ($g = 10$ m/s^2)

(a) 0.5 s (b) 4 s (c) 2 s (d) 1 s

5. A train of mass M is moving on a circular track of radius R with constant speed v. The length of the train is half of the perimeter of the track. The linear momentum of the train will be

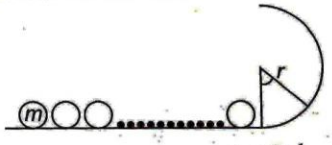
(a) πMv (b) $\frac{2Mv}{\pi}$
(c) $\frac{\pi Mv}{2}$ (d) Mv

6. A pendulum consists of a wooden bob of mass m and length l. A bullet of mass m_1 is fired towards the pendulum with a speed v_1 and it emerges from the bob with speed $\frac{v_1}{3}$. The bob just completes motion along a vertical circle. Then, v_1 is



(a) $\frac{m}{m_1}\sqrt{5gl}$ (b) $\frac{3m}{2m_1}\sqrt{5gl}$
(c) $\frac{2}{3}\left(\frac{m}{m_1}\right)\sqrt{5gl}$ (d) $\left(\frac{m_1}{m}\right)\sqrt{gl}$

7. n elastic balls are placed at rest on a smooth horizontal plane which is circular at the ends with radius r as shown in the figure. The masses of the balls are m, $\frac{m}{2}$, $\frac{m}{2^2}$, ... $\frac{m}{2^{n-1}}$ respectively. What is the minimum velocity which should be imparted to the first ball of mass m such that this nth ball will complete the vertical circle?

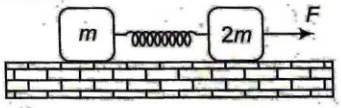


(a) $\left(\frac{3}{4}\right)^{n-1}\sqrt{5gr}$ (b) $\left(\frac{4}{3}\right)^{n-1}\sqrt{5gr}$
(c) $\left(\frac{3}{2}\right)^{n-1}\sqrt{5gr}$ (d) $\left(\frac{2}{3}\right)^{n-1}\sqrt{5gr}$

8. A particle of mass m moving with speed v hits elastically another stationary particle of mass 2 m inside a smooth horizontal circular tube of radius r. The time after which the second collision will take place is

(a) $\frac{2\pi r}{v}$ (b) $\frac{4\pi r}{v}$
(c) $\frac{3\pi r}{2v}$ (d) $\frac{\pi r}{v}$

9. Two blocks of mass 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) $\frac{Ft^2}{6m} + \frac{x}{3}$
(c) $\frac{x}{3}$ (d) $\frac{Ft^2}{4m} - \frac{x}{2}$

10. A bullet of mass 20 g and moving with 600 m/s collides with a block of mass 4 kg hanging with the string of length 0.4 m. What is velocity of bullet when it comes out of block, if block rises to height 0.2 m after collision?

(a) 200 m/s (b) 150 m/s
(c) 400 m/s (d) 300 m/s

11. A particle of mass 1 kg is thrown vertically upward with speed 100 m/s. After 5 s, it explodes into two parts. One part of mass 400 g comes back with speed 25 m/s, what is the velocity of other part just after explosion?

(a) 100 m/s upward (b) 600 m/s upward
(c) 100 m/s downward (d) 300 m/s upward

12. A ball falling freely from a height of 4.9 m/s, hits a horizontal surface. If $e = \frac{3}{4}$, then the ball will hit the surface, second time after

(a) 1.0 s (b) 1.5 s (c) 2.0 s (d) 3.0 s

13. A disc of mass 10 g is kept floating horizontally by throwing 10 marbles per second against it from below. If the mass of each marble is 5 g. What will be velocity with which the marble are striking the disc? Assume that the marble strikes the disc normally and rebound downwards with the same speed

(a) 2.98 m/s (b) 0.98 m/s
(c) 0.49 m/s (d) 1.96 m/s

14. If a man of mass M jumps to the ground from a height h and it moves a small distance x inside the ground, the average force acting on him from ground is

(a) $\frac{Mgh}{x}$ (b) $\frac{Mgx}{h}$
(c) $Mg\left(\frac{h}{x}\right)^2$ (d) None of these

15. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it, can exert a maximum force of 144 N on the gun. How many bullets can be fired per second at the most?

(a) One (b) Four
(c) Two (d) Three

16. A straight rod of length L has one of its ends at the origin and the other at $x = L$. If the mass per unit length of the rod is given by Ax, where A is constant, where is its mass centre?

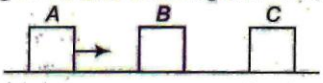
(a) $\frac{L}{3}$ (b) $\frac{L}{2}$ (c) $\frac{2L}{3}$ (d) $\frac{3L}{4}$

17. In a one dimensional collision between two identical particle 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) $\frac{J}{p} - 1$

18. Three identical blocks A, B and C are placed on horizontal frictionless surface. The blocks B and C are at rest. But A is approaching towards B with a speed 10 m/s.



The coefficient of restitution for all collision is 0.5. The speed of the block C just after collision is approximately

(a) 5.6 m/s (b) 6.4 m/s (c) 3.2 m/s (d) 4.6 m/s

19. A particle of mass m moving with a velocity $(3\hat{i} + 2\hat{j})$ m/s collides with a stationary body of mass M and finally moves with a velocity $(-2\hat{i} + \hat{j})$ m/s. If $\frac{m}{M} = \frac{1}{13}$, then

(a) the impulse is $\pm m(5\hat{i} + \hat{j})$

(b) the velocity of the M is $\frac{1}{13}(5\hat{i} + \hat{j})$

(c) Both (a) and (b) are wrong

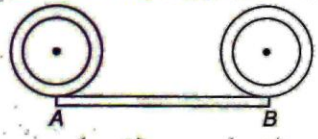
(d) Both (a) and (b) are correct

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

(a) 1 (b) $\frac{3}{4}$

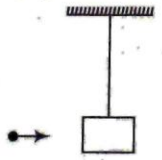
(c) $\frac{1}{2}$ (d) $\frac{1}{4}$

21. You are supplied with three identical rods of same length and mass. If the length of each rod is 2π. Two of them are converted into rings and then placed over the third rod as shown in figure. If point A is considered as origin of the coordinate system the coordinate of the centre of mass will be (you may assume AB as x-axis of the coordinate system)



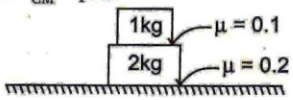
(a) $\left(\frac{\pi}{2}, \frac{1}{3}\right)$ (b) $\left(\frac{\pi}{2}, \frac{2}{3}\right)$ (c) $\left(\pi, \frac{1}{3}\right)$ (d) $\left(\pi, \frac{2}{3}\right)$

22. A mass of 10 g moving horizontally with a velocity of 100 cm/s strikes a pendulum bob of mass 10 g. Length of string is 50 cm. The two masses stick together. The maximum height reached by the system now is ($g = 10$ m/s^2)



(a) 7.5 cm (b) 5 cm (c) 2.5 cm (d) 1.25 cm

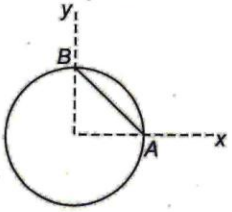
23. Both the blocks as shown in the given arrangement are given together a horizontal velocity towards right. If a_{CM} be the subsequent acceleration of the centre of mass of the system of blocks then a_{CM} equals



(a) Zero (b) $\frac{5}{3}$ m/s^2

(c) $\frac{7}{3}$ m/s^2 (d) 2 m/s^2

24. An object comprises of a uniform ring of radius R and its uniform chord AB (not necessarily made of the same material) as shown. Which of the following can not be the centre of mass of the object?



(a) $\left(\frac{R}{3}, \frac{R}{3}\right)$ (b) $\left(\frac{R}{\sqrt{2}}, \frac{R}{\sqrt{2}}\right)$

(c) $\left(\frac{R}{4}, \frac{R}{4}\right)$ (d) None of these

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

(a) $v^2 - gd$ (b) $\frac{gd}{v^2 - gd}$

(c) $\frac{gd}{v^2}$ (d) $\frac{v^2}{gd}$