PHYSICS

1. There are some passengers inside a stationary railway compartment. The track is friction less. The centre of mass of the compartment itself (without the passengers) is C_1, while the centre of mass of the 'compartment plus passengers' system is C_2. If the passengers move about inside the compartment along the track.

1) Both C_1 and C_2 will move with respect to the ground

2) Neither C_1 *nor* C_2 will move with respect to the ground

3) C_1 *will move but* C_2 will be stationary with respect to the ground

4) C_2 *will move but* C_1 will be stationary with respect to the ground

2. Two billiard balls undergo a head – on collision. Ball 1 is twice as heavy as ball 2. Initially, ball 1 moves with a speed v towards ball 2 which is at rest. Immediately after the collision, ball 1 travels at a speed of v/3 in the same direction. What type of collision has occurred?

1) Inelastic 2) Elastic

3) Completely inelastic

4) cannot be determined from the information given

3. A system of N particles is free from any external forces. Which of the following must be true for the sum of the magnitudes of the momentum of the individual particles in the system?

1) It must be zero

2) It could be non-zero, but it must be constant

3) It could be non-zero, and it might not be constant

4) It could be zero, even if the magnitude of the total momentum is not zero

4. In a one dimensional collision, a particle of mass 2m collides with a particle of mass m at rest. If the particles stick together after the collision, what fraction of the initial kinetic energy is lost in the collision?

1) $\frac{1}{4}$ 2) $\frac{1}{3}$

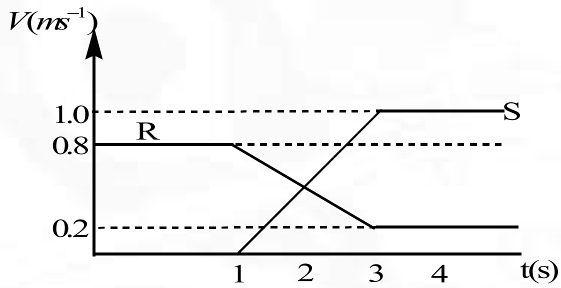
3) $\frac{1}{2}$ 4) $\frac{3}{4}$

5. 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.



1) I only 2) II only 3) I and II only 4) I, II and III

6. A body of mass 5kg moves along the x-axis with a velocity 2m/s . A second body of mass 10kg moves along the y-axis with a velocity $\sqrt{3}\, m/s$. If collision is perfectly inelastic, the maximum possible amount of heat liberated in the collision is

1) $\frac{35}{3}J$ 2) $\frac{30}{7}J$ 3) $\frac{36}{7}J$ 4) $\frac{40}{3}J$

7. The velocity of the CM of a system changes from $\overrightarrow{v_1} = 4\hat{i}\ m/s$ to $\overrightarrow{v_2} = 3\hat{j}\ m/s$ during time $\triangle t = 2s$. If the mass of the system is m=10 kg, the constant force acting on the system
is :

1) 25 N 2) 20 N 3) 50 N 4) 5 N

8. A particle moving with kinetic energy 3 joule makes an elastic head on collision with a stationary particle which has twice it mass during the impact. Choose wrong one

1) The minimum kinetic energy of the system is 1 joule.

2) The maximum elastic potential energy of the system is 2 joule

3) Momentum and total kinetic energy of the system are conserved at every instant.

4) The ratio of kinetic energy to elastic potential energy of the system first decreases and then increases.

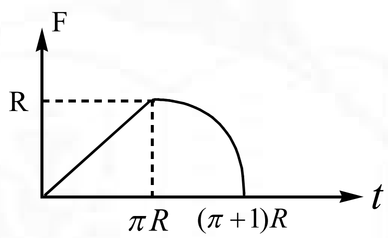
9. A ball strikes a smooth horizontal ground at an angle of $45°$ with the vertical. What cannot be the possible angle of its velocity with the vertical after the collision. (Assume $e \le 1$).

1) 45^0 2) 30^0 3) 53^0 4) 60^0

10. A uniform thin rod of mass M and Length L is standing vertically along the y-axis on a smooth horizontal surface, with its lower end at the origin (0,0). A slight disturbance at t = 0 causes the lower end to slip on the smooth surface along the positive x-axis, and the rod starts falling. The acceleration vector of centre of mass of the rod during its fall in vertical direction is : $\left[\vec{R}\, is\, reaction\, from\, surface\right]$

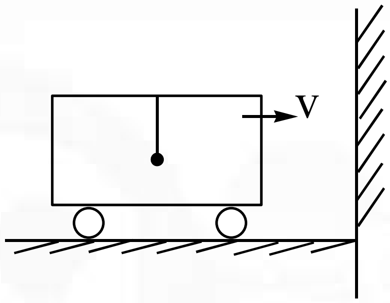
1) $\vec{a}_{CM} = \dfrac{M\vec{g}+\vec{R}}{M}$ 2) $\vec{a}_{CM} = \dfrac{M\vec{g}-\vec{R}}{M}$ 3) $\vec{a}_{CM} = \vec{g}$ 4) $\vec{a} = \vec{o}$

11. A uniform ball colloids with a smooth surface and rebounds. During collision impulsive force 'F' acting on ball varies with time as shown in figure. Coefficient of restitution is (In period of restitution graph is circular)



1) 1 2) 0.5 3) 0.2 4) information is insufficient

12. A car is approaching to a vertical wall with constant speed v, initially pendulum is at rest relative to car. Collision of car with wall is elastic. Just after collision tension in string will be? Mass of car and bob are '2m' and 'm' respectively. [ignore gravity]



1) zero 2) $\frac{mv^2}{l}$ 3) $\frac{2mv^2}{l}$ 4) $\frac{4mv^2}{l}$

13. Internal forces can change

1) The linear momentum but not K.E 2) The K.E. but not linear momentum

3) Linear momentum as well as K.E 4) Neither linear momentum nor K.E

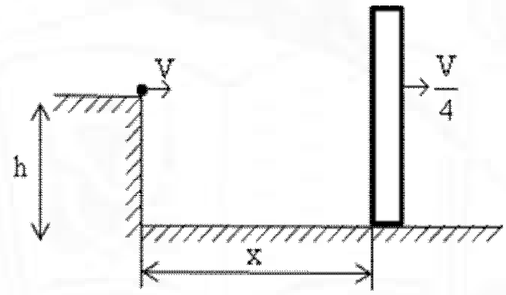
14. An impulse $\vec{I}$ changes the velocity of a particle from $\vec{v}_1$ to $\vec{v}_2$. Kinetic energy gained by the particle is:

1) $\vec{I}.(\vec{v}_2 - \vec{v}_1)$ 2) $\vec{I}_1.(\vec{v}_1 + \vec{v}_2)$ 3) $\frac{1}{2}\vec{I}.(\vec{v}_1 - \vec{v}_2)$ 4) $\frac{1}{2}\vec{I}.(\vec{v}_1 + \vec{v}_2)$

15. Two identical balls undergo elastic collision. Speed of both the balls before collision is u. The maximum possible speed of any ball after collision will be

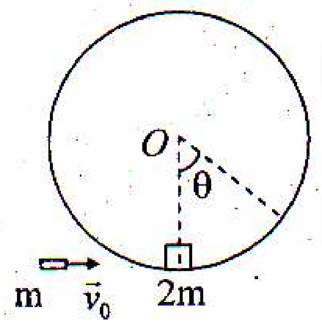
1) u 2) $2u$ 3) $\sqrt{3}u$ 4) $\sqrt{2}$ u

16. A particle is thrown horizontally from a height 'h' towards a smooth vertical massive wall moving away as shown in figure. Velocity of projection of the particle is V and velocity of the wall is $\frac{V}{4}$ (constant). The particle returns to the point of projection, after suffering two elastic collisions, first with the wall and then with frictionless ground, in time T. Let x be the initial separation between the particle and the wall (at the time of projection). Then (Acceleration due to gravity is g)



1) $T = 2\sqrt{\frac{2h}{g}}$ 2) $x = V\sqrt{\frac{h}{4g}}$ 3) $T = 2\sqrt{\frac{h}{2g}}$ 4) $x = V\sqrt{\frac{2h}{g}}$

17. A small block of mass 2m initially rests at the bottom of a fixed vertical circular track of radius 1m. A bullet of mass m strikes the block horizontally with initial speed $v_0 = \sqrt{990}\, m/s$ and remains embedded in the block. Assume no friction between block and circular track. The ratio of tangential and centripetal acceleration for $\theta = 60^0$ is (g = 10m/s^2)



1) $5\sqrt{3}:1$ 2) $10:\sqrt{3}$ 3) $\sqrt{3}:20$ 4) $1:2\sqrt{3}$

18. A stationary body explodes into four identical fragments such that three of them fly off mutually perpendicular to each other, each with same K.E., E_0 . The energy released in the explosion is

1) $6E_0$ 2) $\frac{4E_0}{3}$ 3) $4E_0$ 4) $8E_0$

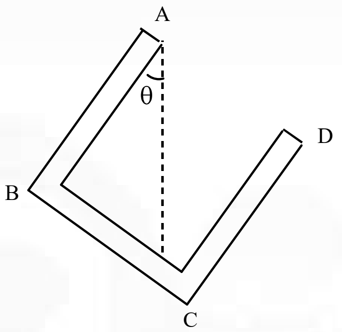
19. Two identical balls are lying on a smooth table. A third ball of equal mass and radius moving at speed u along their common tangent, and strikes them simultaneously. If e is coefficient of restitution, the speed of each of first two balls after collision is

1) $\frac{u}{5}(2-3e)$
2) $\frac{u}{5}(1+e)$
3) $\frac{u}{5}$
4) $\frac{u\sqrt{3}}{5}(1+e)$

20. W.r.t a frame fixed to the centre of mass of a two particle system, some statements are given in following options. Select the correct statement if the particles don't have same velocity w.r.t. an inertial frame.

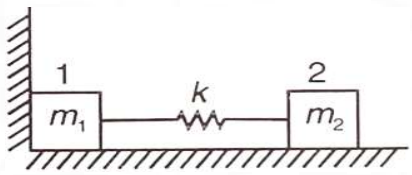
1) The two particles may move in same direction
2) The two particles must move in opposite directions
3) The two particles may have perpendicular velocities
4) The two particles should have same momentum

21. Three identical thin uniform rods of AB, BC and CD are joined to form the three sides of a square and suspended about a horizontal axis through point A. The inclination θ of the rod AB with the vertical in equilibrium is



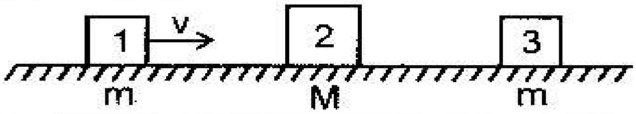
1) $\tan^{-1}\left(\frac{3}{4}\right)$ 2) $\tan^{-1}\left(\frac{4}{3}\right)$ 3) $\tan^{-1}(2)$ 4) 45^{o}

22. Two bars connected by a weightless spring of stiffness k, rest on a smooth horizontal plane as shown in figure. Bar 2 is shifted a small distance x to the left and then released. The velocity of the centre of inertia of the system after bar 1 breaks off the wall is



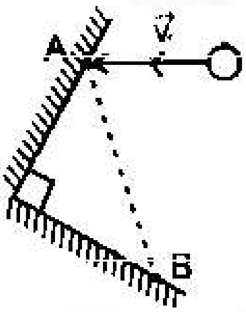
1) $\frac{x\sqrt{m_2 k}}{m_1+m_2}$ 2) $\frac{kx}{m_1+m_2}$ 3) Zero 4) $\frac{\sqrt{m_1 k}x}{m_1+m_2}$

23. Three blocks are placed on smooth horizontal surface and lie on same horizontal straight line. Block 1 and block 3 have mass m each and block 2 has mass M (M > m). Block 2 and block 3 are initially stationary, while block 1 is initially moving towards block 2 with speed v as shown. Assume that all collisions are head-on and perfectly elastic. What value of $\frac{M}{m}$ ensures that block 1 and block 3 have the same final speed (non zero)?



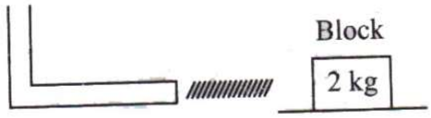
1) $5+\sqrt{2}$ 2) $5-\sqrt{2}$ 3) $2+\sqrt{5}$ 4) $3+\sqrt{5}$

24. AB is an L shaped obstacle fixed on a horizontal smooth table. A ball strikes it at A, gets deflected and re-strikes it at B. If the velocity vector before collision is v and coefficient of restitution of each collision is 'e', then the velocity of ball after its second collision at B is:



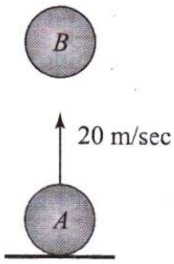
1) e^2 2) $-e^2\vec{v}$ 3) $-e\vec{v}$ 4) Data insufficient

25. A block of metal weighing 2 kg is resting on a frictionless plane. It is struck by a jet releasing water at a rate of 1 kg/s and at a speed of 5m/s. the initial acceleration of the block is



1) $\frac{5}{3} m/s^2$ 2) $\frac{25}{4} m/s^2$ 3) $\frac{25}{6} m/s^2$ 4) $\frac{5}{2} m/s^2$

26. A sphere A is thrown up with velocity 20 m/sec from the ground sphere B of same mass is dropped from a height of 80 m, simultaneously, at time $t = 0$ so that both collide in air and stick together. Find the time (in second) after which the combined mass will fall on the ground (calculate from $t = 0$) ($g = 10\, m/\sec^2$)

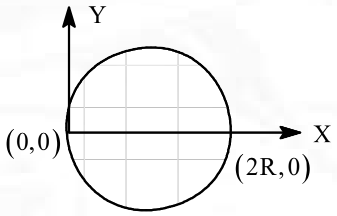


1) 2 2) 4 3) 6 4) 8

27. Sand falls vertically at rate of 5 kg/s on a conveyor belt moving horizontal with velocity of 0.6m/s. Find the extra force(in Newton) required to keep the belt moving uniformly.

1) 3 2) 6 3) 9 4) 12

28. At time t = 0, a particle P of mass 'm' moving in a circular path of radius R with a constant speed V_2 is at a point $(2R,0)$ while another particle Q of same mass moving along positive y – axis constant velocity V_1 is at origin (0, 0). Find linear momentum of particle P relative to Q when their velocities are mutually perpendicular for first time : (t is the time when their velocities become perpendicular)



1) $m\left[\left(V_2 \sin\frac{V_2}{R}t\right)\hat{i} + V_1\hat{j}\right]$ 2) $m\left[\left(V_2 \cos\frac{V_2}{R}t\right)\hat{i} + V_1\hat{j}\right]$

3) $m\left[\left(V_1 \sin\frac{V_1}{R}t\right)\hat{i} + V_2\hat{j}\right]$ 4) $-m\left[\left(V_2 \sin\frac{V_2}{R}t\right)\hat{i} + V_1\hat{j}\right]$

29. The ball B is at rest. A moving ball A collides elastically with it in one dimension. The masses of balls are equal. For ball B, which of the following will be greatest (numerically), if final velocity of A is greater than 2m/sec?

1) Kinetic energy
2) Momentum
3) Potential energy
4) None of these

30. 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 fragments of masses $(m/4)$ and $(3m/4)$. At an instant later, the smaller fragment is at $y = +15\text{ cm}$. The larger fragment at this instant is at :

1) $y = -5\text{ cm}$
2) $y = +20\text{ cm}$
3) $y = +5\text{ cm}$
4) $y = -20\text{ cm}$