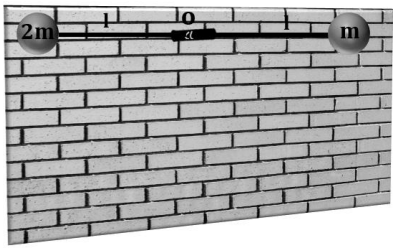
Speed

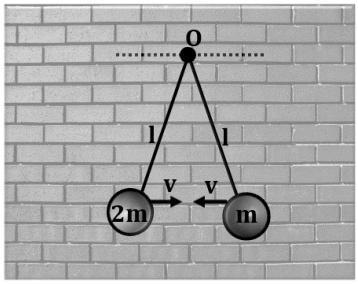
Q.1 Two balls are fastened to two light strings of same length of l and of different masses m and 2m as shown in the figure. The other end of the strings are fixed at O. The strings are kept in the same horizontal line and the system is released from rest. The collision between the balls is perfectly elastic. Find the ratio of the speeds of the balls, just after the collision.



(A) 5 : 1 **(B)** 2 : 1 **(C)** $\sqrt{2}$: 1 **(D)** $\sqrt{5}$: 1

Height

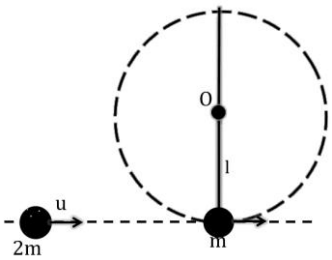
Q.2 Two balls fastened to light string of same length l and of different masses m & $2m$.The other end of the strings are fixed at O. If both the masses collide with same speed (just before collision). Find the ratio of heights raised by the balls. [Consider, collision is elastic.]



(A) 1: $\sqrt{5}$ **(B)** 1:5 **(C)** 1:2 **(D)** 1:25

Speed

Q.3 A ball of mass m is suspended by the string of length l. Another ball of mass 2m collides horizontally with ball of mass m with a speed of u so that it completes vertical circle as depicted in the below figure. Find the initial speed of the ball of mass 2m before collision. [Consider, collision is perfectly elastic, take g = 10 ms^{-2}]



(A) 5 m/s **(B)** $\sqrt{5}$m/s **(C)** 7.5m/s **(D)** $\sqrt{15}$ m/s

Line of impact

Q.4 Find the incorrect statement.

(A) Irrespective of orientation of colliding objects, line of impact (LOI) is always along common normal.

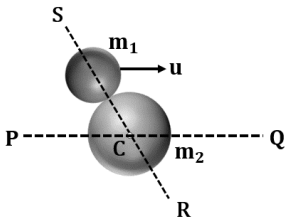
(B) Line of impact (LOI) is always along the direction of object's velocity.

(C) Maximum momentum transfer occurs along the line of impact (LOI).

(D) During collision, the common normal to the involved surface is known as the line of impact.

Conservation of momentum

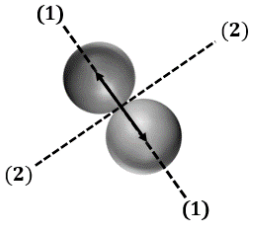
Q.5 An object of mass m_1 moving horizontally with speed u collides elastically with another object of mass m_2 at rest. Select correct statement.



(A) The momentum of the system is conserved only in direction PQ.
(B) Momentum of m_1 is conserved in direction perpendicular to SR.
(C) Momentum of m_2 will change in direction normal to CR.
(D) All of these.

Direction

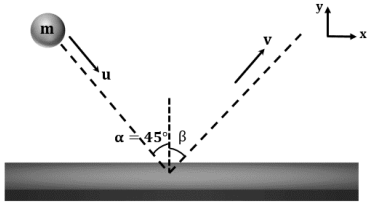
Q.6 Select the correct option.



(A) Line (1) – (1) is along common normal direction.
(B) Line (2) – (2) is along common tangent direction.
(C) Coefficient of restitution can be applied along the line (1) – (1).
(D) All of the above are correct.

Speed

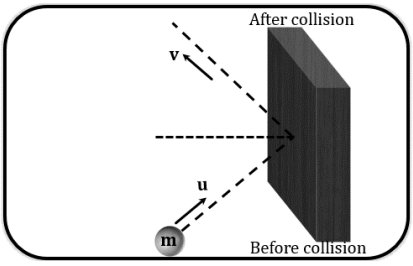
Q.7 As shown in the figure a ball of mass m hits a floor with a speed $u = 10\sqrt{2}$m/s making an angle of incidence $\alpha = 45°$ with the normal. The coefficient of restitution is $e = 0.5$. Find the speed of the reflected ball and the angle of the reflection.



(A) $10\sqrt{2}, \tan^{-1}(1)$ **(B)** $5\sqrt{5}, \tan^{-1}(2)$ **(C)** $10\sqrt{5}, \tan^{-1}(1)$ **(D)** $5\sqrt{2}, \tan^{-1}(2)$

Impulse

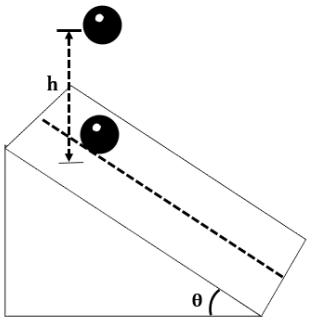
Q.8 As shown in the figure a ball is moving with a velocity $u = 6\hat{i} + \hat{j}$ and it collides with a vertical wall which is parallel to the vector $\hat{j}$. If the coefficient of restitution between the ball and the wall is 0.5 and mass of the ball is $m = 1$ kg.Find the impulse that acts on the ball.



(A) $3\hat{j}$ **(B)** $\frac{3}{2}\hat{j}$ **(C)** $-9\hat{i}$ **(D)** $-\frac{9}{2}\hat{i}$

Distance

Q.9 A ball falls on an inclined plane of inclination $\theta = 30°$ from a height $h = 10$ m above the point of impact and makes a perfectly elastic collision. Find the distance where will it hit the plane again from the initial point of impact. (Take $g = 10\ m/s^2$)



(A) 20 m **(B)** 40m **(C)** 10m **(D)** 80m

Elastic collision

Q.10 Choose the incorrect option for elastic collision.

(A) Net impulse on both the particles is zero during collision.

(B) Net momentum of both particles remains conserved before and after collision in any direction even in presence of external force.

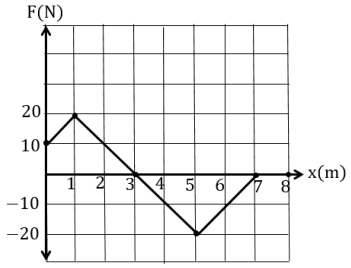
(C) No component of impulse act along common tangent direction.

(D) A pair of equal and opposite impulses act along common normal direction.

WORK SHEET

Work energy theorem

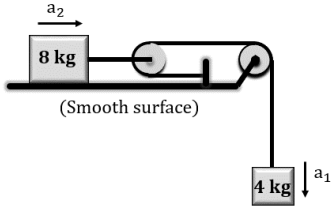
Q.1 Figure shows the variation of a force F acting on a particle along x-axis. If the particle begins at rest at $x = 0$, what is the particle's coordinate when it again has zero speed?



(A) $x = 3$ **(B)** $x = 6$ **(C)** $x = 5$ **(D)** $x = 7$

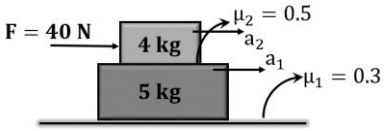
Acceleration

Q.2 If pulleys shown in the diagram are smooth and massless and a_1 & a_2 are acceleration of blocks of mass 4 kg and 8 kg respectively. Then find a_2.



(A) $g/3$ **(B)** $2g/3$ **(C)** $4g/3$ **(D)** $2g$

Q.3 Find the acceleration of the two blocks of mass 4 kg & 5 kg, if a force of 40 N is applied on 4 kg block. Friction coefficient between the respective surfaces are shown in figure. (take $g = 10\ m/s^2$)

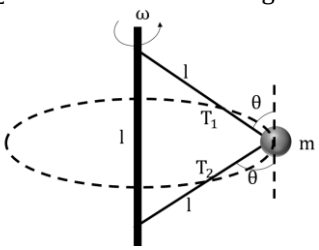


(A) $a_2 = a_1 = 5\ m/s^2$ **(B)** $a_1 = a_2 = \frac{13}{9}\ m/s^2$

(C) $a_1 = 0, a_2 = 5\ m/s^2$ **(D)** $a_2 = 0, a_1 = \frac{13}{9}\ m/s^2$

Tension

Q.4 In the figure a ball of mass m is tied with two strings of equal length as shown. If the rod is rotated with angular velocity ω and T_1, T_2 be tension in the strings as shown, then



(A) $T_1 > T_2$ **(B)** $T_2 > T_1$ **(C)** $T_1 = T_2$ **(D)** $T_1 = 2T_2$

Work done

Q.5 If two springs S_1 and S_2 of force constants k_1 and k_2 respectively, are stretched by the same force, it is found that more work is done on spring S_1 than on spring S_2.

Statement – 1: If stretched to the same extension, work done on S_1, will be more than that on S_1.

Statement – 2: $k_1 < k_2$Choose the correct option.

(A) Statement – 1 is true, Statement – 2 is true and Statement – 2 is not the correct explanation of Statement – 1.

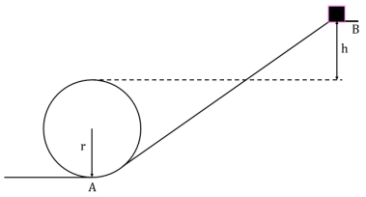
(B) Statement – 1 is false, Statement – 2 is true.

(C) Statement – 1 is true, Statement – 2 is false.

(D) Statement – 1 is true, Statement – 2 is true and Statement – 2 is the correct explanation of statement – 1.

Work energy theorem

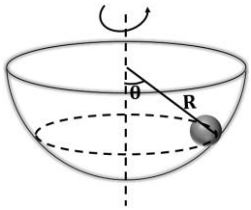
Q.6 As shown in figure, a loop-the-loop track of radius r = 10 m. A box starts sliding from a platform at a distance h above the top of the loop and goes around the loop without falling off the track. Find the minimum value of h for successful looping. (Assume friction is negligible at all surfaces.)



(A) 5 m **(B)** 10m **(C)** $\frac{5}{2}$ m **(D)** 20m

Angular speed

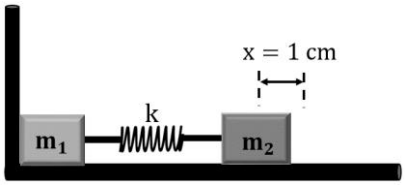
Q.7 A hemisphere ball of radius R is set rotating about its axis of symmetry which is kept vertical. A small block kept in the bowl rotates with the bowl without slipping on its surface. If the surface of the bowl is smooth is smooth and the angle made by the radius through the block with the vertical is θ, find the angular speed at which the bow is rotating.



(A) $\omega = \sqrt{\frac{g\cos\theta}{R}}$ **(B)** $\omega = \sqrt{\frac{g\sec\theta}{R}}$ **(C)** $\omega = \sqrt{\frac{2g\cos\theta}{R}}$ **(D)** $\omega = \sqrt{2gR\sec\theta}$

Velocity of COM

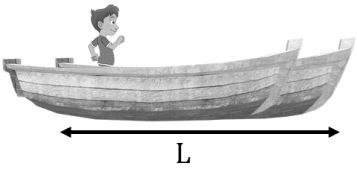
Q.8 Two blocks of mass $m_1 = 2$ kg, $m_2 = 4$ kg connected by weightless spring of stiffness k rest on a horizontal plane as shown. m_2 is shifted a small distance x = 1 cm to the left and then released. Find the velocity of COM of the system just after m_1 break off the wall. Assume k = 4 N/m.



(A) 1 m/s **(B)** $\frac{2}{3}$ m/s **(C)** 3m/s **(D)** 2m/s

Distance

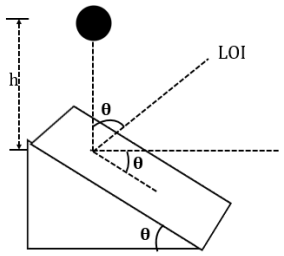
Q.9 A man of mass M = 50 kg stands at one end of the boat which is floating on still water. The man walks to the other end of the boat. Length of the boat is L = 10 m and mass $M' = 100$ kg. Then find the distance moved by the boat relative to the ground.



(A) $\frac{10}{3}$ m **(B)** $\frac{5}{3}$ m **(C)** $\frac{2}{3}$ m **(D)** 0 m

Coefficient of restitution

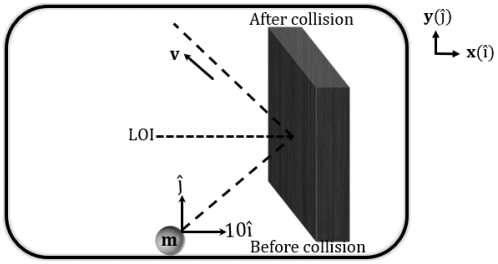
Q.10 A ball collides with smooth and fixed inclined plane of inclination θ after falling vertically through a distance h m. If it moves horizontally just after the impact, then the coefficient of restitution is.



(A) $\tan^2\theta$ **(B)** $\cot^2\theta$ **(C)** $\tan\theta$ **(D)** $\cot\theta$

Impulse

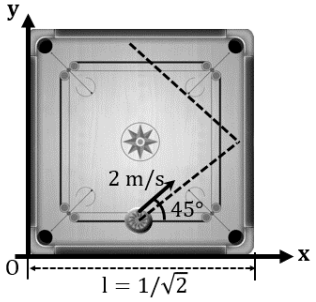
Q.11 A sphere of mass 10 kg is moving on a horizontal plane with a velocity $10\hat{i} + \hat{j}$ where it collides with a vertical wall which is parallel to $\hat{j}$. If the coefficient of restitution is 0.5, find the impulse (in SI units) acted on the sphere.



(A) $150\hat{i} - \hat{j}$ **(B)** $-15\hat{i}$ **(C)** $-150\hat{i}$ **(D)** $55\hat{i} + \hat{j}$

Elastic collision

Q.12 A striker is shot from a square carom board from a point exactly at the mid point of one of the walls with a speed 2 m/s at an angle of 45° with the x-axis as shown in the figure. The collisions of the striker with the walls of the carom are perfectly elastic. The coefficient of kinetic friction between the striker and board is 0.2. Then, [Take $g = 10\ m/s^2$]



(A) x −Coordinate of the striker when it stops (taking point O to be the origin and neglect the friction between wall and striker) is $\frac{1}{2\sqrt{2}}$.

(B) y −Coordinate of the striker when it stops (taking point O to be the origin and neglect the friction between wall and striker) is $\frac{1}{2}$.

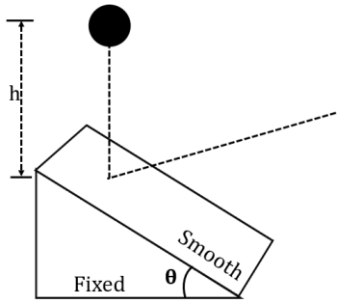
(C) x −Coordinate of the striker when it stops (taking point O to be the origin and neglect the friction between wall and striker) is $\frac{1}{\sqrt{2}}$.

(D) y −Coordinate of the striker when it stops (taking point O to be the origin and neglect the friction between wall and striker) is $\frac{1}{2\sqrt{2}}$..

Impulse

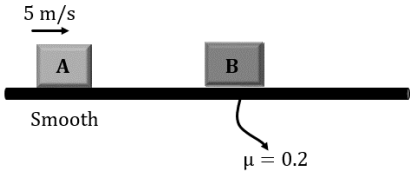
Q.13 A ball of mass m strikes the fixed inclined plane after falling through a height h. If it rebounds elastically, the impulse imparted on the ball is

(A) $2m\sqrt{2gh}\cos\theta$ **(B)** $2m\sqrt{gh}\cos\theta$ **(C)** $2m\sqrt{2gh}\sin\theta$ **(D)** $2m\sqrt{2gh}$



Elastic collision

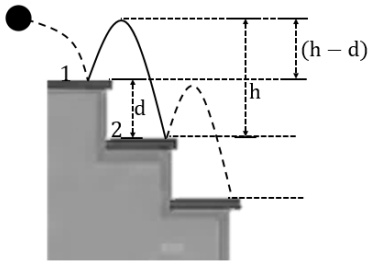
Q.14 Two blocks of equal masses are placed on a horizontal surface. The surface of A is smooth but that of B has a friction coefficient of 0.2 with the floor. Block A is given a speed 5 m/s, towards B which is kept at rest. Find the distance travelled by B, if the collision is perfectly elastic. (take $g = 10\ m/s^2$)



(A) $\frac{5}{4}$ m **(B)** $\frac{5}{5}$ m **(C)** $\frac{25}{4}$ m **(D)** $\frac{5}{2}$ m

Height

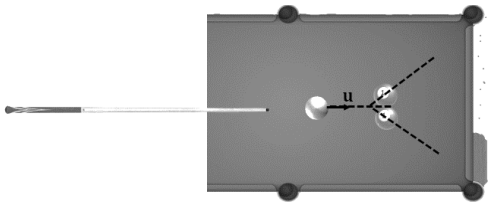
Q.15 A ball is bouncing down a set of stairs. The coefficient of restitution is e. The height of each step is d and the ball bounces one step at each bounce. After each bounce the ball rebounds to a height h above the next lower step. Neglect width of each step in comparison to h and assume the impacts to be effectively head on. Which of the following relation is correct? (given that $h > d$)



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

Coefficient of restitution

Q.16 Two identical billiard balls are in contact on a smooth table. A third identical ball strikes them symmetrically and comes to rest after impact. The coefficient of restitution is.

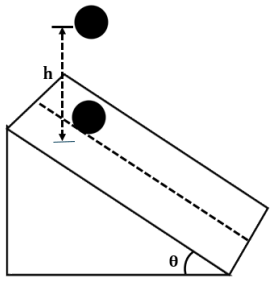


(A) $\frac{2}{3}$ **(B)** $\frac{1}{3}$ **(C)** $\frac{1}{6}$ **(D)** $\frac{\sqrt{3}}{2}$

Height

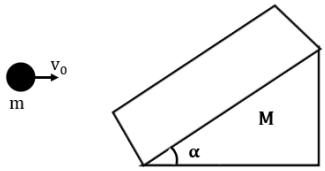
Q.17 A ball on a inclined plane of inclination $\theta = 30°$ from a height $h = 10$ m above the point of impact and makes a perfectly elastic collision. Find the maximum height attained by the ball, perpendicular to wedge surface. (take $g = 10\ m/s^2$)

(A) $5\sqrt{3}$m **(B)** 5 m **(C)** 10m **(D)** $10\sqrt{3}$ m



Speed

Q.18 A wedge of mass M has one face making an angle α with horizontal and is resting on a smooth rigid floor. A particle of mass 'm' hits the inclined face of the wedge with horizontal velocity v_0. It is observed that the particle rebounds in vertical direction after impact. Calculate the speed of particle after impact. [Neglect friction between particle and the wedge and take $M = 2m$, $v_0 = 10\ m/s$, $\tan\alpha = 2$, $g = 10\ m/s^2$]



(A) 5 m/s **(B)** 0m/s **(C)** 20 m/s **(D)** 10m/s

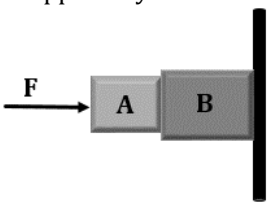
Impulse

Q.19 A small steel ball A is suspended by an inextensible thread of length $l = 1.5$ m from O as shown in the figure. Another identical ball B is thrown vertically downwards such that its surface remains just in contact with thread during downward motion and collides elastically with the suspended ball. If the suspended ball just complete vertical circle after collision, calculate the impulse on the steel ball A due to the ball B. (Take $g = 10\ m/s^2$ and mass of ball $m = 5$ kg)

(A) $50\sqrt{2}$Ns **(B)** $25\sqrt{3}$Ns **(C)** $50\sqrt{3}$Ns **(D)** 25Ns

Equilibrium

Q.20 As given in the figure two blocks A & *B* of weight 20 N and 100 N respectively are in equilibrium. These are being pressed against a wall by force F as shown. If the coefficient of friction between the two blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by wall on block B is (f_2) and the frictional force applied by block B on block A is (f_1).



(A) $f_2 = 120$ N **(B)** $f_2 = 150$ N **(C)** $f_1 = 100$ N **(D)** $f_1 = 20$ N

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(D)	(C)	(B)	(B)	(D)	(B)	(C)	(B)	(B)
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(B)	(C)	(A)	(B)	(A)	(B)	(B)	(A)	(A)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(C)	(A)	(A)	(C)	(C)	(A)	(A)	(B)	(C)	(A,D)