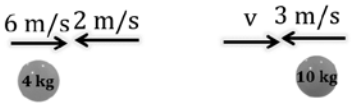
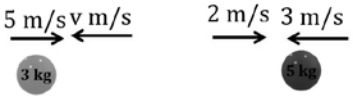
Conservation of momentum

Q.1 Balls of masses 4 kg and 10 kg are moving towards each other with speeds 6 m/s and 3 m/s respectively on a frictionless surface. After collision, the 4 kg ball is observed to return back (towards left) with speed 2 m/s. Find the velocity of 10 kg ball after collision



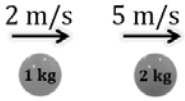
(A) 2 m/s **(B)** 0.2 m/s **(C)** 9 m/s **(D)** 1 m/s

Q.2 Two balls of masses 3 kg and 5 kg are moving towards each other with speeds 5 m/s and 3 m/s respectively on a frictionless surface as shown in figure. After collision, the 5 kg ball retraces its path with speed 2 m/s. Find the coefficient of restitution.



(A) 1 **(B)** $\frac{1}{3}$ **(C)** $\frac{2}{3}$ **(D)** $\frac{8}{3}$

Q.3 Two balls of masses 1 kg and 2 kg are moving with speeds 2 m/s and 5 m/s as shown in figure. Find the impulse of deformation of 2 kg mass.



(A) 2 Ns **(B)** –2 Ns **(C)** 0 Ns **(D)** 10 Ns

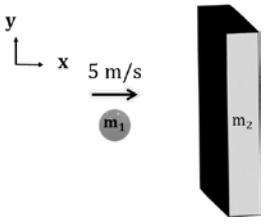
Q.4 In the figure shown below, two particles have masses 2 kg each and they are moving with velocities 4 m/s and 2 m/s respectively towards each other. Assume the collision between the particles is perfectly elastic. Find their respective magnitudes of velocities after the collision.

(A) $v_1 = 3\ m/s\,; v_2 = 3\ m/s$ **(B)** $v_1 = 2\ m/s\,; v_2 = 3\ m/s$
(C) $v_1 = 2\ m/s\,; v_2 = 4\ m/s$ **(D)** $v_1 = 4\ m/s\,; v_2 = 4\ m/s$

Q.5 A particle of mass $'m'$ is moving with speed 8 m/s on a frictionless surface as shown in figure. If m<<M, then for one dimensional elastic collision, the speed of the lighter particle after collision will be

(A) 4 m/sIn original direction. **(B)** 4 m/sOpposite to the original direction.
(C) 6 m/s In original direction. **(D)** 6 m/sOpposite to the original direction.

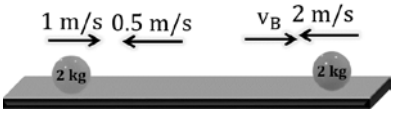
Q.6 A ball is moving with velocity 5 m/s towards a heavy wall which is at rest as shown in figure. Assuming collision to be perfectly elastic, find the velocity of the ball immediately after the collision.



(A) 5 m/s Towards left **(B)** 0 m/s towards left

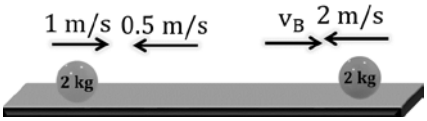
(C) 5 m/s Towards right **(D)** $\frac{5}{2}$ m/s towards left

Q.7 Two balls A and B of masses 2 kg each are moving with speeds 1 m/s and 2 m/s on a frictionless surface. After colliding, the ball A returns back with speed 0.5 m / s, then the impulse of reformation of ball B is



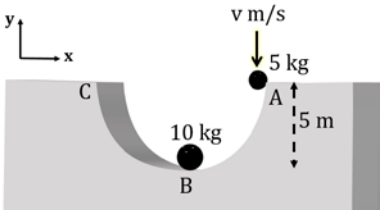
(A) –2 Ns **(B)** 0 Ns **(C)** 4 Ns **(D)** –4 Ns

Q.8 Two balls A and B of masses 2 kg each are moving with speeds 1 m/s and 2 m/s on a frictionless surface. After colliding, the ball A returns back with speed 0.5 m / s, then the maximum potential energy of deformation is



(A) 45 J **(B)** 24 J **(C)** 4.5 J **(D)** 2.4 J

Q.9 Two balls of masses 5 kg and 10 kg are at the positions shown in figure. The track on which the balls move is frictionless. Initially, the 10 kg ball is kept at rest and the 5 kg ball is dropped with speed v from height 5 m. Assuming the collision between the balls is perfectly elastic, find the value of v such that the 10 kg ball reaches point *C*.



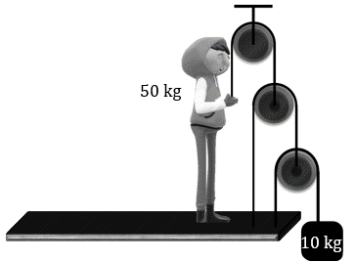
(A) 10 m/s **(B)** 0 m/s **(C)** 22.4 m/s **(D)** 11.2 m/s

Q.10 Two identical balls of masses 5 kg each are kept on a frictionless surface as shown in the figure below. One of the balls moving at 4 m/s makes a head-on collision with the other at rest initially. It is observed that final kinetic energy of the balls is half of the initial kinetic energy. Find the coefficient of restitution.

WORK SHEET

Equilibrium

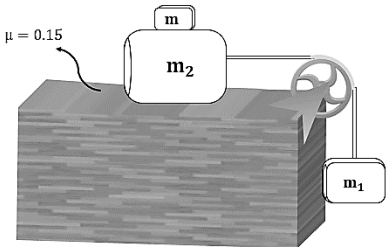
Q.1 As shown in figure, a man of mass M is standing on a platform and holding an inextensible massless string which passes over a system of ideal pulleys. Another body of mass m is hanging as shown in figure. Find the force exerted by the platform on man if $M = 50$ kg, $m = 10$ kg, Take $g = 10\ m/s^2$



(A) 10 N **(B)** 100 N **(C)** 25 N **(D)** 50 N

Static Friction

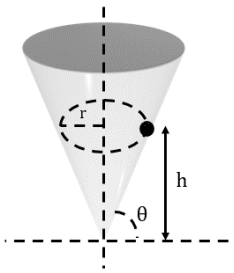
Q.2 Two masses $m_1 = 5$ kg, $m_2 = 10$ kg connected by an inextensible massless sting over a frictionless pulley, are released from rest as shown in the figure. The coefficient of static friction between the horizontal surface and block m_2 is 0.15. The minimum mass m in kg that should be put on top of m_2 to stop the motion is



(A) 23.33 kg **(B)** 43.3 kg **(C)** 10.3 kg **(D)** 18.3 kg

Uniform circular motion

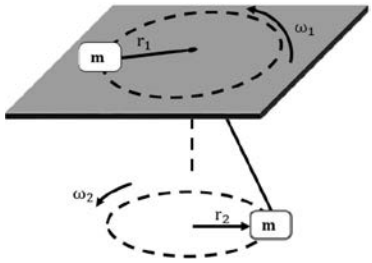
Q.3 A particle describes a horizontal circle of radius r at a uniform speed, on the inside of the smooth surface of an inverted cone as shown in figure. The height of the plane of the circle above the vertex is h, then the speed of particle should be:



(A) $\sqrt{rg}$ **(B)** $\sqrt{2rg}$ **(C)** $\sqrt{gh}$ **(D)** $\sqrt{2gh}$

Conical pendulum

Q.4 A particle of mass m is attached to one end of a weightless and inextensible sting of length L. The particle is on a smooth horizontal table. The string passes through a hole in the table and to its other end is attached a small particle of equal mass m. The system is set in motion with the first particle describing a circle on the table with constant angular velocity ω_1 and the second particle moving in the horizontal circle as a conical pendulum with constant angular velocity ω_2. Then $\omega_2^2 : \omega_1^2 =$ [Take $r_1 = 1$ m, L = 3 m]



(A) $1:2$ **(B)** $1:4$ **(C)** $1:\sqrt{2}$ **(D)** $2:3$

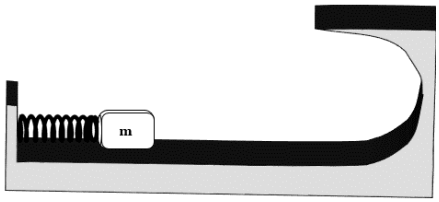
Potential energy

Q.5 A particle is moving in a circular path of radius a with constant speed under the action of an attractive conservative force. Potential energy of the particle is given by the relation $U = -\frac{K}{2r^2}$, where r is the radial distance of the particle from the center of the circular path. Its total energy will be:

(A) $\frac{K}{2a^2}$ **(B)** Zero **(C)** $-\frac{3}{2}Ka^2$ **(D)** $-\frac{K}{4a^2}$

Work power energy

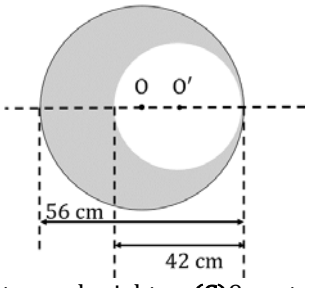
Q.6 Figure shows a smooth track, a part of which is a circle of radius r. A block of mass m is pushed against a spring of spring constant k fixed at the left end and is then released. Find the initial compression of the spring so that the block presses the track with a force mg when it reaches the point P, where the radius of the track is horizontal.



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

Centre of mass

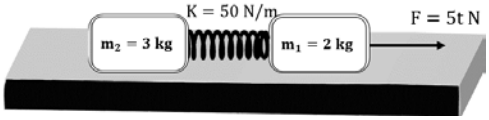
Q.7 A circular plate of uniform density has a diameter of 56 cm. A circular portion of diameter 42 cm is removed from the original circular plate as shown in figure. Find the position of the COM of the remaining portion from the center of the original plate.



(A) 7 cm towards left **(B)** 7 cm towards right **(C)** 9 cm towards left **(D)** 9 cm towards right

Centre of mass

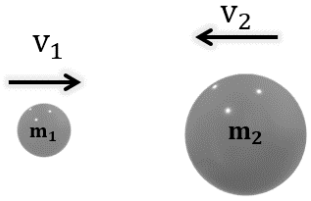
Q.8 For a spring block system as shown in figure, a time varying force $F = 5t$ N is applied on mass 2 kg. After 10 seconds, velocity of 3 kg mass is 30 m/s. Find the velocity of 2 kg mass at this instant.



(A) 40 m/s **(B)** 80 m/s **(C)** $\frac{80}{3}$ m/s **(D)** 20 m/s

Collision

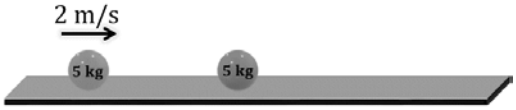
Q.9 Two balls of masses m_1 *and* m_2 such that ($m_2 \gg m_1$) are moving with initial velocities v_1 *and* v_2 respectively towards each other. The final velocity of m_2 after collision will be [Assume collision to be perfectly elastic]



(A) $v_1 + v_2$ **(B)** v_1 **(C)** v_2 **(D)** Data insufficient

Collision

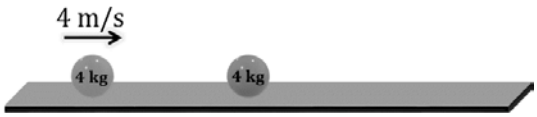
Q.10 A ball of mass 5 kg moving at speed 2 m/s makes a head on collision with an identical ball at rest. The velocities of the balls after the perfectly elastic collision between them are respectively



(A) 1 m/s, 1 m/s **(B)** 0 m/s, 2 m/s **(C)** 1.2 m/s, 0.5 m/s **(D)** 1.5 m/s, 0.2 m/s

Coefficient of restitution

Q.11 A ball of mass 4 kg moving with velocity 4 m/s collides with another identical ball at rest. The kinetic energy of the balls after collision is 7/8 times of the original. Find the coefficient of restitution (e).



(A) 1 **(B)** 0.866 **(C)** 0.732 **(D)** 0.239

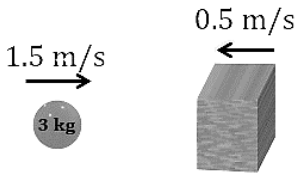
Conservation of momentum

Q.12 A rifle man, who together with his rifle has a mass of 100 kg, stands on a smooth surface and fires 10 shots horizontally. Each bullet has a mass of 10 g and a muzzle velocity of 800 m/s. What velocity does the rifle man acquire at the end of 10 shots?

(A) 0.8 m/s **(B)** 0.5 m/s **(C)** 0.3 m/s **(D)** 1.2 m/s

Elastic Collision

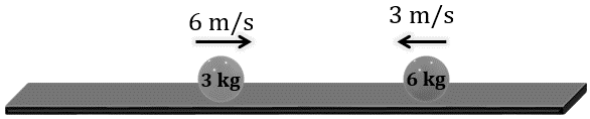
Q.13 A ball of mass 3 kg is moving with velocity 1.5 m/s towards a heavy block which is moving towards the ball with velocity 0.5 m/s as shown in the figure. Assuming the collision to be elastic, the velocity of the ball immediately after the collision is



(A)1.2 m/s **(B)**2.5 m/s **(C)**2 m/s **(D)**3 m/s

Coefficient of restitution

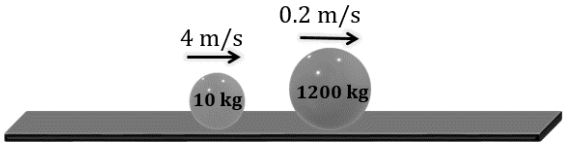
Q.14 Two balls of mass 3 kg and 6 kg are moving towards each other with velocities 6 m/s and 3 m/s respectively on a frictionless surface. After colliding, the 3 kg ball returns with velocity 3 m/s. Velocity of 6 kg ball (after collision) and coefficient of restitution are respectively



(A)1.5 m/s, 0.5 **(B)**2 m/s, 0.20 **(C)**3 m/s, 1 **(D)**2.2 m/s, 0.3

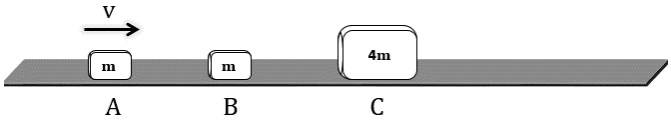
Elastic Collision

Q.15 A small ball of mass 10 kg moving with initial velocity of 4 m/s collides with a heavy iron ball initially moving with velocity 0.2 m/s as shown in the figure below. The velocity of 10 kg mass after collision will be approximately (Assume collision to be perfectly elastic)



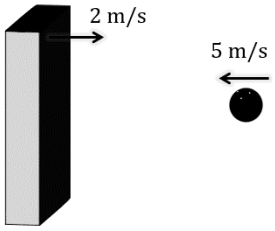
(A)4.4 m/s **(B)**3.6 m/s **(C)**3 m/s **(D)**2.8 m/s

Q.16 Three blocks are initially placed as shown in the figure. Block A has mass m and initial velocity v to the right. Block B with mass m and block C with mass 4m are both initially at rest. Neglect friction. All collisions are elastic. The final velocity of block A is



(A)0.6v to the left **(B)**0.4 v to the left **(C)**zero **(D)**0.4 v to the right

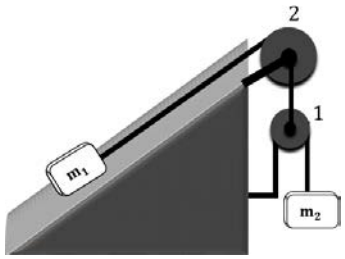
Q.17 A ball is moving with a speed of 5 m/s towards a heavy wall which is moving towards the ball with speed 2 m/s as shown in figure. Assuming the collision to be perfectly elastic, find the speed of the ball and speed of the wall immediately after the collision



(A)9 m/s, 3 m/s **(B)**7 m/s, 3 m/s **(C)**9 m/s, 2 m/s **(D)**7 m/s, 2 m/s

String Constraints

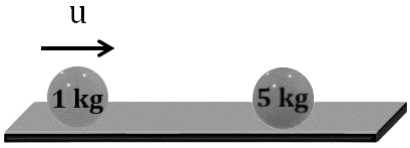
Q.18 Find the acceleration of mass m_1 and m_2 in the arrangement shown in figure, if mass m_2 is twice that the mass m_1, and the angle that the inclined plane forms with the horizontal is equal to 30°. Mass of the pulley and string are negligible and friction is absent everywhere



(A) $(a)_{m_2} = \frac{2g}{18}$ **(B)** $(a)_{m_2} = \frac{7g}{9}$ **(C)** $(a)_{m_1} = \frac{7g}{18}$ **(D)** $(a)_{m_1} = \frac{7g}{9}$

Elastic Collision

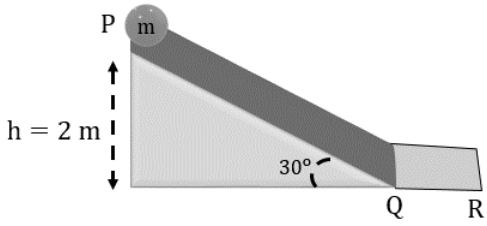
Q.19 A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 m/s. Which of the following statements is (are) correct for the system of two masses?



(A) Total momentum of the system is 7 kg – ms^{-1}
(B) Momentum of 5 kg mass after collision is 5 kg -ms^{-1}
(C) Velocity of 5 kg after collision is 1 m /s
(D) Velocity of 1 kg before collision is 2 m/s

Energy Conservation

Q.20 A particle of mass m moves along the uniformly rough track PQR as shown in the figure. The coefficient of friction ($\mu_g = \mu_k = \mu$) between the particle and the rough track is equal throughout the track. The particle is released from rest, from the point *P* and it comes to rest again at point R. The energy lost by the particle, over the parts PQ and QR of the track are equal and no energy is lost when the particle changes direction from PQ to QR. Then, values of the distance x = QR and coefficient of friction μ are respectively close to:



(A) $x = \sqrt{3}m$ **(B)** $\mu = 1/\sqrt{3}$ **(C)** $x = 2\sqrt{3}m$ **(D)** $\mu = \frac{1}{2\sqrt{3}}$

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(D)	(C)	(C)	(C)	(B)	(A)	(B)	(C)	(D)	(0)
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(A)	(C)	(A)	(B)	(C)	(C)	(B)	(C)	(B)
Q.	11	12	13	14	15	16	17	18	19	20

Sol.	(B)	(A)	(B)	(A)	(B)	(A)	(C)	(B,C)	(B,C)	(C,D)