Chapter 11

Collision Exercise

Elastic collision

Q.1 When two bodies are colliding:
(A) Both should be in physical contact with each other all the time.
(B) Both should be in physical contact with each other at least once.
(C) Both may or may not be in physical contact.
(D) Both should not be in physical contact with each other.

Q.2 In an event of head-on elastic collision between two particles, which of the following statements given below is true?
(A) Transfer of energy between the particles is maximum when their mass ratiois unity.
(B) Transfer of energy between the particles is maximum when their mass ratio is less than one.
(C) Transfer of energy between the particles is maximum when their mass ratio is greater than one.
(D) Transfer of energy is maximum and is independent of masses.

Q.3 When two bodies collide elastically, then
(A) Both bodies retain their respective kinetics energies.
(B) The bodies transfer energy to each other.
(C) Only momentum is conserved.
(D) Only kinetic energy is conserved.

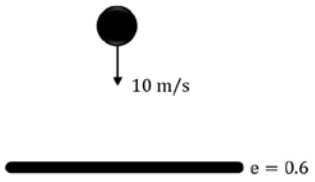
Q.4 Two objects that are moving in the xy plane on a frictionless floor collide head on. Assume that they form a closed isolated system. The following table gives the momentum components in kg m/s before and after the collision. What are the missing values (a, b) (in kg m/s)?

	Before collision		After collision	
Object	P_x	P_y	P_x	P_y
A	−4	5	3	a
B	b	−2	4	2

(A)11,1 **(B)**10,1 **(C)**5,7 **(D)**1,11

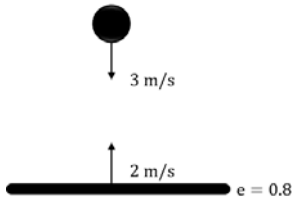
Q.5 Two balls of masses 2 kg and 4 kg are moving towards each other with speeds 6 m/s and 4 m/s respectively, on a frictionless surface. If the coefficient of restitution is 0.5, the relative velocity of separation between the two balls is
(A)1 m/s **(B)**2m/s **(C)**5m/s **(D)**−1m/s

Q.6 A metal ball is moving with velocity 10 m/s in downward direction as shown in the figure. After collision with a surface having coefficient of restitution (e) = 0.6, it rebounds back. Find the rebound velocity. (Assume the surface remains stationary)



(A)6m/s **(B)**10m/s **(C)**60m/s **(D)**0.06m/s

Q.7 A ball is moving with speed 3 m/s in downward direction and the surface is moving with a constant speed of 2 m/s upwards as shown in figure. After collision with the surface of coefficient of restitution e = 0.8, the ball rebounds back with speed v m/s. Find the value of 'v'. (Assume the surface doesn't change its velocity)



(A)3m/s **(B)**5m/s **(C)**1m/s **(D)**6m/s

Q.8 Two metal balls of masses 10 kg and 20 kg, moving in opposite directions on a frictionless floor, collide elastically. If the velocities of the balls are 3 m/s and 1 m/s respectively before collision as shown in the figure, then the velocities of the balls after collision are respectively.

(A) $\frac{5}{3}$ m/s towards right, $\frac{7}{3}$ m/s towards right **(B)** $\frac{5}{3}$ m/s towards left, $\frac{7}{3}$ m/s towards right

(C) $\frac{7}{3}$ m/s towards left, $\frac{5}{3}$ m/s towards right **(D)** $\frac{5}{3}$ m/s towards left, $\frac{7}{3}$ m/s towards left

Q.9 Two balls of masses 2 kg and 5 kg moving on a frictionless surface, collide head-on with speeds 2 m/s and 3 m/s as show in figure. If the coefficient of restitution is 0.25, then the kinetic energy lost by the balls is.

(A)0.65 J **(B)**0.35J **(C)**0J **(D)**16.74J

Q.10 Which of the following options is/are true regarding inelastic collision?

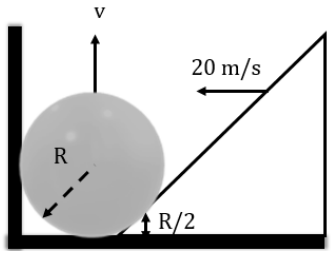
(A) Impulse of reformation is greater than impulse of deformation **(B)**$0 < e < 1$

(C) Impulse of reformation is less than impulse of deformation **(D)**$e > 1$

WORK SHEET

Wedge Constraint

Q.1 A sphere of radiuses R is in contact with a wedge. The point of contact is at a distance $\frac{R}{5}$ from the ground as show in the figure. The wedge is moving with velocity 20 m/s towards left then the velocity v of the sphere at this instant will be.



(A)20 m/s **(B)**15 m/s **(C)**16 m/s **(D)**12 m/s

Radius of Curvature

Q.2 A particle is moving in the x – y plane with uniform speed v. The equation of trajectory for the particle is represented by the parabola $y = ax^2$, where a, is a + ve constant. Find the radius of curvature of trajectory at the point $x = 0$

(A)$\frac{a}{2}$ **(B)**$\frac{1}{2a}$ **(C)**$\frac{4}{a}$ **(D)**$\frac{3}{2}a$

Work done

Q.3 A person trying to lose weight by burning fat lifts a mass of 10 kg upto a height of 1 m for 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he use up, considering work is done only when the weight is lifted up? Fat supplies 3.8 x 10^7 J/kg which is converted to mechanical energy at an efficiency at 20%. Take $g = 9.8\ ms^{-2}$. Consider weight to be lifted slowly

(A)2.45×10^{-3} kg **(B)**6.45×10^{-3} kg **(C)**9.89×10^{-3} kg **(D)**12.89×10^{-2} kg

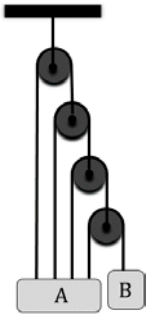
Speed

Q.4 A particle of mass 0.2 kg is moving in one dimension under a force that delivers a constant power of 0.5 W to the particle. If the initial speed (in ms^{-1}) of the particle is zero, then the speed (in ms^{-1}) of the particle after 5 s is:

(A)8 **(B)**5 **(C)**15 **(D)**25

Velocity

Q.5 The arrangement of pulley-block system is released from rest at t = 0 as shown in figure. The velocity of block B is $V_B = 45$ m/s upwards at some instant. Then, find the magnitude of velocity of block A in m/s. Consider the string to be massless and inextensible, all pulleys are light and smooth.

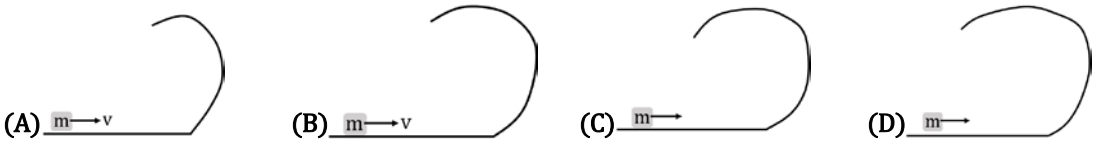


(A)9 m/s **(B)**22.5m/s **(C)**1.5m/s **(D)**3m/s

Normal reaction

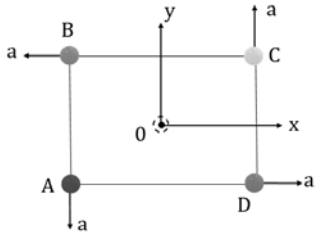
Q.6 A small block of mass m is shot into each of the four smooth tracks as shown in the given option figures. The speed v with which the block enters the track is the same in all cases and it reaches the

same height 'h' on the track in all cases. At the highest point of the track, the normal reaction is maximum in:



Acceleration of COM

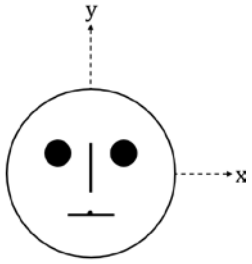
Q.7 Four particles A, B, C and D with masses $m_A = m, m_B = 2m, m_C = 3m$ *and* $m_D = 4m$ are at the corners of a square. They have accelerations of equal magnitude with direction as shown in the figure. The acceleration of centre of mass of the particles (in ms^{-2}) is:



(A) $\frac{a}{5}(\hat{i} - \hat{j})$ **(B)** $a(\hat{i} + \hat{j})$ **(C)** Zero **(D)** $\frac{a}{5}(\hat{i} + \hat{j})$

Position of COM

Q.8 Look at the drawing given in the figure, which has been drawn with ink of uniform line thickness. The mass of ink used to draw each of the two inner circles, and each of the two line segments is m. The mass of the ink used to draw the outer circle is 6m. The coordinates of centers of the different parts are: outer circle (0,0) left inner circle (-a, a), right inner circle (a, a), vertical line (0, 0), and horizontal line (0, -a). The y -ordinate of centre of mass of the ink in this drawing is:



(A) $\frac{a}{10}$ **(B)** $\frac{a}{8}$ **(C)** $\frac{a}{12}$ **(D)** $\frac{a}{3}$

Elastic collision

Q.9 In an elastic collision in the absence of external forces, which of the following is correct?

(A) The linear momentum changes in collision

(B) The final kinetic energy is less than the initial kinetic energy

(C) The linear momentum is conserved

(D) The final kinetic energy is more than the initial kinetic energy

Inelastic collision

Q.10 A ball hits the floor and rebounds after an inelastic collision. In this case,

(A) The momentum of the ball just after the collision is same as that just before the collision.

(B) The kinetic energy of the ball remains the same during the collision.

(C) The total momentum of the ball and the earth is conserved.

(D) None of the above

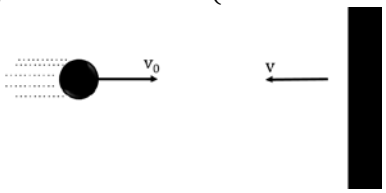
Kinetic energy

Q.11 Two perfectly elastic balls of the same mass m are moving with velocities u_1 and u_2. They collide head on elastically, n times. The kinetic energy of the system finally is

(A) $\frac{1}{2}\frac{m}{n}u_1^2$ **(B)** $\frac{1}{2}\frac{m}{n}(u_1^2+u_2^2)$ **(C)** $\frac{1}{2}m(u_1^2+u_2^2)$ **(D)** $\frac{1}{2}mn(u_1^2+u_2^2)$

Elastic collision

Q.12 A particle of mass m moves with velocity $v_o = 20$ m/s towards a large wall that is moving with velocity $v = 5$ m/s towards the particle as shown. If the particle collides with the wall elastically, then find the speed of the particle just after collision. (Assume collision with the wall is elastic)



(A) 30 m/s **(B)** 20m/s **(C)** 25m/s **(D)** 22m/s

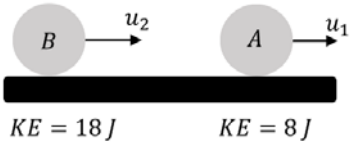
Momentum conservation

Q.13 Object A of mass m_1, is moving at a velocity v_1 to the right. It collides and sticks to object B of mass m_2 moving in the same direction as object A with velocity v_2. After collision, both the objects have the same velocity $\frac{1}{2}$(V1+V2). What is the relationship between m_1 and m_2? [v_1 and v_2 are not equal]

(A) $m_1 = m_2$ **(B)** $m_1 = 2m_2$ **(C)** $m_1 = m_2/2$ **(D)** $m_1 = 4m_2$

Elastic collision

Q.14 Two sphere are placed in a horizontal plane with kinetic energies $(KE)_A = 8J$ and $(KE)_B = 18J$ as show in figure if both the sphere collide elastically find the speed of both the sphere after collision both the sphere have the same mass m = 1 kg.



(A) $v_A = 6$ m/s $v_B = 4$ m/s **(B)** $v_A = 4$ m/s $v_B = 6$ m/s
(C) $v_A = 3$ m/s $v_B = 2$ m/s **(D)** $v_A = 2$ m/s $v_B = 3$ m/s

Q.15 There are 100 identical blocks equally spaced on a frictionless track as shown in the figure. Initially all the blocks are at rest. Block (1) is pushed with velocity v towards block 2. if each of the collisions is elastic, then the velocity of the final 100th block is

(A) $\frac{v}{99}$ **(B)** $\frac{v}{100}$ **(C)** v **(D)** zero

Q.16 Particle A makes a perfectly elastic collision with another particle B at rest. After collision, they fly apart in opposite directions with equal speeds. The ratio of masses $\frac{m_A}{m_B}$ is

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

Q.17 Two particle of masses m_1& m_2 and velocity's u_1 and $(\alpha u_1)(\alpha \neq 0)$ make in elastic head on collision. If the initial kinetic energies of the two particles are equal and m_1 comes to rest after collision, then

(A) $\frac{m_2}{m_1} = 9 + 2\sqrt{2}$ **(B)** $\frac{m_2}{m_1} = 3 - 2\sqrt{2}$ **(C)** $\frac{m_1}{m_2} = 3 - 2\sqrt{2}$ **(D)** $\frac{m_1}{m_2} = 9 + \sqrt{2}$

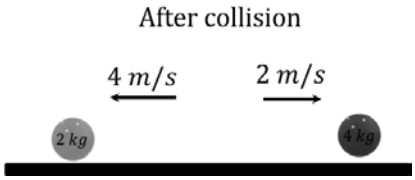
Impulse of Deformation

Q.18 Two balls of masses 2 kg and 4 kg are moved towards each other with velocities 4 m/s and 2 m/s respectively on a frictionless surface. Find the impulse of maximum deformation for the ball of 4 kg mass.

(A) $\frac{8}{3}$N − S **(B)** $\frac{4}{3}$N − S **(C)** $\frac{2}{3}$N − S **(D)** 8N − S

Impulse of Reformation

Q.19 Two balls of masses 2 kg and 4 kg after the collision are moving with speeds 4 m/s and 2 m/s as shown in figure. Find the impulse of reformation for the 4 kg ball.



(A) 4N − S **(B)** 2N − S **(C)** 8N − S **(D)** 1N − S

Frictional force

Q.20 If a man is walking on a rough horizontal ground without slipping, then identify the correct statement(s) from the options given below:

(A) Frictional force on the man will act in backward direction.

(B) Frictional force on the man will act in forward direction.

(C) Work done by frictional force on the man will be negative.

(D) Work done by frictional force on the man will be zero.

Speed of COM

Q.21 Two particles A and B initially at rest, move towards each other by mutual force of attraction. At the instant when the speed of A is v and the speed of B is 2v, identify the correct statement(s) regarding the speed of centre of mass (V_{COM}) of the system of particles:

(A) $v_{COM} = v$

(B) $v_{COM} = 1.5v$

(C) $v_{COM} = 0$

(D) Speed of centre mass of the system may change, if the vector sum of external forces acting on it is non-zero.

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(A)	(B)	(D)	(C)	(A)	(D)	(C)	(D)	(B,C)
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(B)	(D)	(B)	(D)	(A)	(D)	(A)	(C)	(C)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(C)	(A)	(A)	(A)	(C)	(B)	(C)	(D)	(C)	(B,D)
Q.	21									
Sol.	(C,D)									