CALCULATION OF CENTRE OF MASS

1. Three identical spheres, each of mass 1 kg are placed touching each other with their centres on a straight line. Their centre are marked P, Q and R respectively. The distance of centre of mass of the system from P is :

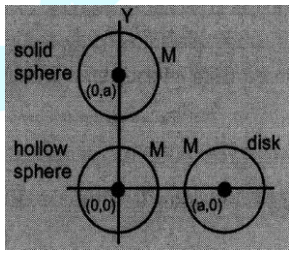
(1) $\frac{PQ+PR+QR}{3}$ (2) $\frac{PQ+PR}{3}$ (3) $\frac{PQ+QR}{3}$ (4) $\frac{PR+QR}{2}$

2. A uniform metal disc of radius R is taken and out of it a disc of diameter $\frac{R}{2}$ is cut off from the end. The centre of mass of the remaining part will be:

(1) $\frac{R}{10}$ from the centre (2) $\frac{R}{15}$ from the centre

(3) $\frac{R}{5}$ from the centre (4) $\frac{R}{20}$ from the centre

3. The Coordinate of the centre of mass of a system as shown in figure :-



(1) $\left(\frac{a}{3},0\right)$ (2) $\left(\frac{a}{2},\frac{a}{2}\right)$

(3) $\left(\frac{a}{3},\frac{a}{3}\right)$ (4) $\left(0,\frac{a}{3}\right)$

4. The centre of mass of a system of particles does not depend on :

(1) masses of the particles (2) Internal forces on the particles

(3) position of the particles (4) relative distance between the particles

5. The centre of mass of a system of two particles divides the distance between them

(1) In inverse ratio of square of masses of particles

(2) In direct ratio of square of masses of particles

(3) In inverse ratio of masses of particles

(4) 1n direct ratio of masses of particles

6. The centre of mass of a Body :-

(1) Lies always outside the body

(2) May lie within, outside of the surface of the body

(3) Lies always inside the body

(4) Lies always on the surface of the body

7. Three identical metal balls, each of radius r, are place touching each other on a horizontal surface such that an equilateral triangle is formed when the centres of the three bans are joined. The centre of mass of the system is located at :-

(1) horizontal surface (2) centre of one of the balls

(3) line joining centres of any two balls (4) point of intersection of their medians

8. A system consists of mass M and m (<< M). The centre of mass of the system is :-
(1) at the middle (2) nearer to M
(3) nearer to m (4) at the position of larger mass.

9. The centre of mass of a system of three particles of masses 1g, 2g and 3g is taken as the origin of a coordinate system. The position vector of a fourth particle of mass 4g such that the centre of mass of the four particle system lies at the point (1, 2, 3,) is $\alpha\ (\hat{i}+2\hat{j}+3\hat{k})$, where α is a constant. The value of α is :-
(1) $\frac{10}{3}$ (2) $\frac{5}{2}$ (3) $\frac{1}{2}$ (4) $\frac{2}{5}$

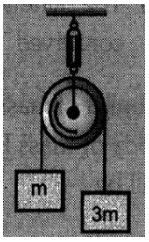
MOTION OF CENTRE OF MASS

10. The law of conservation of momentum for a system is based on Newton's :-
(1) First law of motion (2) Second law of motion
(3) Third law of motion (4) Law of gravitation

11. A person of mass m is standing on one end of a plank of mass M and length L and floating in water. The person moves from one end to another and stops. The displacement of the plank is-
(1) $\frac{Lm}{(m+M)}$ (2) Lm (M + m) (3) $\frac{(M+m)}{Lm}$ (4) $\frac{LM}{(m+M)}$

12. Bullets of mass 40 g each are fired from a machine gun with a velocity of 10^3 m/s. If the person firing the bullets experience an average force of 200 N, then the number of bullets fired per minute will be-
(1) 300 (2) 600 (3) 150 (4) 75

13. If the system is released, then the acceleration of the centre of mass of the system:
(1) $\frac{g}{4}$ (2) $\frac{g}{2}$
(3) g (4) 2g



14. Initially two stable particles x and y start moving towards each other under mutual attraction. If at one time the velocities of x and y are V and 2V respectively, what will be the velocity of centre of mass of the system ?
(1) V (2) Zero (3) $\frac{V}{3}$ (4) $\frac{V}{5}$

15. A 2 kg body and a 3 kg body are moving along the x-axis. At a particular instant the 2 kg body has a velocity of 3 m/s and the 3 kg body has the velocity of 2 m/s. The velocity of the centre of mass at that instant is :-

(1) 5 m/s (2) 1 m/s (3) 0 (4) $\frac{12}{5}$ m/s

16. Two objects of masses 200 gram and 500 gram posses velocities $10\hat{i}$ m/s and $3\hat{i}+5\hat{j}$ m/s respectively. The velocity of their centre of mass in m/s is :-

(1) $5\hat{i}-25\hat{j}$ (2) $\frac{5}{7}\hat{i}-25\hat{j}$ (3) $5\hat{i}+\frac{25}{7}\hat{j}$ (4) $25\hat{i}-\frac{5}{7}\hat{j}$

MOMENTUM CONSERVATION

17. A bomb of mass 9 kg explodes into two pieces of 3 kg and 6 kg. The velocity of 3 kg piece is 16 m/s. The kinetic energy of 6 kg piece is :-

(1) 768 J (2) 786 J (3) 192 J (4) 687 J

18. A bomb initially at rest explodes by it self into three equal mass fragments. The velocities of two fragments are $(3\hat{i}+2\hat{j})$ m/s and $(-\hat{i}-4\hat{j})$ m/s. The velocity of the third fragment is (in m/s) :-

(1) $2\hat{i}+2\hat{j}$ (2) $2\hat{i}-2\hat{j}$ (3) $-2\hat{i}+2\hat{j}$ (4) $-2\hat{i}-2\hat{j}$

19. A bomb of 50 Kg is fired from a cannon with a velocity 600 m/s. If the mass of the cannon is 10^3 kg, then its velocity will be -

(1) 30 m/s (2) –30 m/s (3) 0·30 m/s (4) –0.30 m/s

20. A metal bal does not rebound when struck on a wall, whereas a rubber ball of same mass when thrown with the same velocity on the wall rebounds. From this it is inferred that-

(1) Change in momentum is same in both
(2) Change in momentum in rubber ball is more
(3) Change in momentum in metal ball is more
(4) Initial momentum of metal ball is more than that of rubber ball

21. A bomb of mass m = 1 kg thrown vertically upwards with a speed u = 100 m/s explodes into two parts after t = 5s. A fragment of mass m_1 = 400 g moves downwards with a speed v_1 = 25 m/s, then speed v_2 and direction of another mass m_2 will be :-

(1) 40 m/s downwards (2) 40 m/s upwards
(3) 60 m/s upwards (4) 100 m/s upwards

22. A 1 kg stationary bomb is exploded in three parts having mass ratio 1 : 1 : 3. Parts having same mass move in perpendicular directions with velocity 30 m/s, then the velocity of bigger part will be:

(1) $10\sqrt{2}$ m/s (2) $\frac{10}{\sqrt{2}}$ m/s (3) $15\sqrt{2}$ m/s (4) $\frac{15}{\sqrt{2}}$ m/s

23. A heavy nucleus at rest breaks into two fragments which fly off with velocities 8 : 1. The ratio of radii of the fragments is:-

(1) 1 : 2 (2) 1 : 4 (3) 4 : 1 (4) 2 : 1

24. A stationary particle explodes into two particles of masses m1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1/E_2 is :-

(1) m_2 / m_1 (2) m_1 / m_2 (3) 1 (4) m_1v_2 / m_2v_1

25. A body of mass 4 m at rest explodes into three pieces. Two of the pieces each of mass move with a speed v each in mutually perpendicular directions. The total kinetic energy released is :-

(1) $\frac{1}{2}$ mv^2 (2) mv^2 (3) $\frac{3}{2}$ mv^2 (4) $\frac{5}{2}$ mv^2

26. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg. The smaller masses 2.0 kg and 1.0 kg. The smaller mass goes at a speed of 80 m/s. The total energy imparted to the two fragments is -

(1) 1.07 kJ (2) 2.14 kJ (3) 2.4 kJ (4) 4.8 kJ

27. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 m/s. The kinetic energy of the other mass is:-

(1) 524 J (2) 256 J (3) 486 J (4) 324 J

28. A bullet of mass m is fired from a gun of mass M. The recoiling gun compresses a spring of force constant k by a distance d. Then the velocity of the bullet is :-

(1) $kd\sqrt{M/m}$ (2) $\frac{d}{M}\sqrt{km}$ (3) $\frac{d}{m}\sqrt{kM}$ (4) $\frac{kM}{m}\sqrt{d}$

29. Identify the wrong statement.

(1) A body can have momentum without mechanical energy
(2) A body can have energy without momentum
(3) The momentum is conserved in an elastic collision only
(4) Kinetic energy is not conserved in an inelastic collision

COLLISION

30. A ball strikes the floor and after collision rebounds back. In this state -

(1) Momentum of the ball is conserved
(2) Mechanical energy of the ball is conserved
(3) Momentum of ball-earth system is conserved
(4) The kinetic energy of ball-earth system is conserved

31. A bullet of mass P is fired with velocity Q in a large body of mass R. The final velocity of the system will be:-

(1) $\frac{R}{P+R}$ (2) $\frac{PQ}{P+R}$ (3) $\frac{(P+Q)}{R}$ (4) $\frac{(P+R)}{P}Q$

32. A sphere of mass m moving with a constant velocity collides with another stationary sphere of same mass. The ratio of velocities of two spheres after collision will be, if the co-efficient of restitution is e-

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

33. Two elastic bodies P and Q having equal masses are moving along the same line with velocities of 16 m/s and l0 m/s respectively. Their velocities after the elastic collision will be in m/s :-

(1) 0 and 25 (2) 5 and 20 (3) l0 and 16 (4) 20 and 5

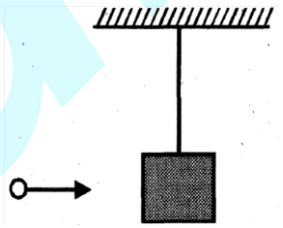
34. The unit of the coefficient of restitution is-
(1) m/s (2) s/m (3) m ×S (4) None of the above

35. Two solid balls of rubber A and B whose masses are 200 gm and 400 gm respectively, are moving in mutually opposite directions. If the velocity of ball A is 0.3 m/s and both the balls come to rest after collision, then the velocity of ball B is-
(1) 0.15 m/s (2) –0.15 m/s (3) 1.5 m/s (4) None of the above

36. A 1 Kg ball falls from a height of 25 cm and rebounds upto a height of 9 cm. The co-efficient of restitution is-
(1) 0.6 (2) 0.32 (3) 0.40 (4) 0.56

37. A 50 gm bullet moving with a velocity of 10 m/s gets embedded into a 950 gm stationary body. The loss in kinetic energy of the system will be -
(1) 5% (2) 50% (3) 100% (4) 95%

38. A bullet of mass m moving with a speed v strikes a wooden block of mass M and gets embedded into the block. The final speed is :-



(1) $\sqrt{\frac{M}{M+m}}v$ (2) $\sqrt{\frac{m}{M+m}}v$
(3) $\frac{m}{M+m}v$ (4) $\frac{v}{2}$

39. A ball is dropped from height h on the ground level. If the coefficient of restitution is e then the height upto which the ball will go after n^{th} jump will be –
(1) $\frac{h}{e^{2n}}$ (2) $\frac{e^{2n}}{h}$ (3) he^{n} (4) he^{2n}

40. Two bodies of same mass are moving with same speed V in mutually opposite directions. They collide and stick together. The resultant velocity of the system will be -
(1) Zero (2) $\frac{V}{2}$ (3) V (4) From Zero to ∞

41. The bob (mass m) of a simple pendulum of length L is held horizontal and then released. It collides elastically with a block of equal mass lying on a frictionless table. The kinetic energy of the block will be :-
(1) Zero (2) mgL (3) 2 mgL (4) $\frac{mgL}{2}$

42. Two particles each of mass m travelling with velocities u_1 and u_2 collide perfectly in elastically. The loss of kinetic energy will be –
(1) $\frac{1}{2}m(u_1-u_2)^2$ (2) $\frac{1}{4}m(u_1-u_2)^2$ (3) $m(u_1-u_2)^2$ (4) $2m(u_1-u_2)^2$

43. A ball moving with velocity of 9 m/s collides another similar stationary ball. After the collision with both the balls move in directions making an angle of 30°with the initial direction. After the collision speed will be -
(1) 2.6 m/s (2) 5.2 m/s (3) 0.52 m/s (4) 52 m/s

44. A solid sphere is moving and it makes an elastic collision with another stationary sphere of half of its own radius. After collision it comes to rest. The ratio the densities of materials of second sphere and first sphere is -
(1) 2 (2) 4 (3) 8 (4) 16

45. A 5 kg body collides with another stationary body. After the collision, the bodies move in the same direction with one-third of the velocity of the first body. The mass of the second body will be-
(1) 5 kg (2) 10 kg (3) 15 kg (4) 20 kg

46. A 10 g bullet, moving with a velocity of 500 m/s enters a stationary piece of ice of mass 10 kg and stops. If the piece of ice is lying on a frictionless plane, then its velocity will1be
(1) 5 cm/s (2) 5 m/s (3) 0.5 m/s (4) 0.5 cm/s

47. A heavy body moving with a velocity 20 m/s and another small object at rest undergo an elastic collision. The latter will move with a velocity of
(1) 20 m/s. (2) 40 m/s. (3) 60 m/s. (4) Zero ·

48. A 5 gm lump of clay, moving with a velocity of 10 cm/s towards east, collides head-on with another 2 gm lump of clay moving with 15 cm/s towards west. After collision, the two lumps stick together. The velocity of the compound lump will be -
(1) 5 cm/s towards east (2) 5 cm/s towards west
(3) 2.88 cm/s towards east (4) 2.5 cm/s towards west

49. In an inelastic collision between two bodies, the physical quantity that is conserved :-
(1) Kinetic energy (2) Momentum
(3)Potential energy (4) Kinetic energy and momentum

50. A mass of 20 kg moving with a speed of 10 m/s collides with another stationary mass of 5 kg. As a result of the collision, the two masses stick together.
The kinetic energy of the composite mass will be
(1) 600 J (2) 800 J (3) 1000 J (4) 1200 J

51. A body of mass m having an initial velocity v makes head on elastic collision with a stationary body of mass M. After the collision, the body of mass m comes to rest and only the body having mass M moves. This will happen only when :-
(1) m >> M (2) m << M (3) m = M (4) m = $\frac{M}{2}$

52. A body A experiences perfectly elastic collision with a stationary body B. If after collision the bodies fly apart in the opposite direction with equal speeds, the mass ratio of A and B is :-
(1) $\frac{1}{2}$ (2) $\frac{1}{3}$ (3) $\frac{1}{4}$ (4) $\frac{1}{5}$

53. A collision is said to be perfectly inelastic when :-

(1) Coefficient of restitution = 0 (2) Coefficient of restitution = 1
(3) Coefficient of restitution = ∞ (4) Coefficient of restitution < 1

54. A particle falls from a height 'h' upon a fixed horizontal plane and rebounds. If 'e' is the coefficient of restitution the total distance travelled before rebounding has stopped is :-

(1) $h\left(\frac{1+e^2}{1-e^2}\right)$ (2) $h\left(\frac{1-e^2}{1+e^2}\right)$ (3) $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$ (4) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

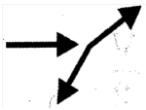
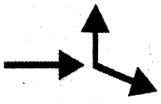
55. If two masses m_1 and m_2 collide, the ratio of the changes in their respective velocities is proportional to :-

(1) $\frac{m_1}{m_2}$ (2) $\sqrt{\frac{m_1}{m_2}}$ (3) $\frac{m_2}{m_1}$ (4) $\sqrt{\frac{m_2}{m_1}}$

56. Two particles of mass M_A and M_B and there velocities are V_A and V_B respectively collides. After collision they inter changes their velocities then ratio of $\frac{M_A}{M_B}$ is :-

(1) $\frac{V_A}{V_B}$ (2) $\frac{V_B}{V_A}$ (3) $\frac{(V_A+V_B)}{(V_B-V_A)}$ (4) 1

57. In the diagrams given below the horizontal line represents the path of a ball coming from left and hitting another ball which is initially at rest. The other two lines represents the paths of the two balls after the collision. Which of the diagram shows a physically impossible situation ?

(1)  (2)  (3)  (4) 

58. Two identical balls, one moves with 12 ,/s and second is at rest, collides elastically. After collision velocity of second and first ball will be :-

(1) 6 m/s, 6 m/s (2) 12 m/s, 12 m/s (3) 12 m/s, 0 m/s (4) 0 m/s, 12 m/s

59. A sphere P of mass m and velocity $\vec{v}_i$ undergoes an oblique and perfectly elastic collision with an identical sphere Q initially at rest. The angle θ between the velocities of the spheres after the collision shall be :-

(1) 0 (2) 45° (3) 90° (4) 180°

60. A ball is dropped from a height of 10 m. If 40% of its energy is lost on collision with the earth then after collision the ball will rebound to a height of-

(1) 10 m (2) 8 m (3) 4 m (4) 6 m

61. A rubber ball is dropped from a height of 5 m on a plane, where the acceleration due to gravity is not shown. On bouncing it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of :-

(1) $\frac{16}{25}$ (2) $\frac{2}{5}$ (3) $\frac{3}{5}$ (4) $\frac{9}{25}$

62. Which of the following is true :-

(1) Momentum is conserved in all collisions but kinetic energy is conserved only in inelastic collision
(2) Neither momentum nor kinetic energy is conserved in inelastic collisions.
(3) Momentum is conserved in all collisions but not kinetic energy
(4) Both momentum and kinetic energy are conserved in all collisions.

63. A bullet of mass m is fired into a large block of wood of mass M with velocity v. The final velocity of the system is:-

(1) $\left(\frac{m}{M-m}\right)v$ (2) $\left(\frac{m+M}{M}\right)v$ (3) $\left(\frac{M-m}{M}\right)v$ (4) $\left(\frac{m}{m+M}\right)v$

64. A big ball of mass M, moving with velocity u strikes a small, ball of mass m, which is at rest. Finally small ball attains velocity u and big ball v. What is the value of v :-

(1) $\frac{M-m}{M}u$ (2) $\frac{m}{M+m}u$ (3) $\frac{2m}{M+m}$ (4) $\frac{M}{M+m}v$

65. A particle of mass m moving with speed v towards east strikes another particle of same mass moving with same speed v towards north. After striking, the two particles fuse together. With what speed this new particle of mass 2 m will move in north-east direction?

(1) v (2) $\frac{v}{2}$ (3) $\frac{v}{\sqrt{2}}$ (4) $v\sqrt{2}$

66. Two ice skaters A and B approach each other at right angles. Skater A has a mass 30 kg and velocity 1m/s and skater B has a mass 20 kg and velocity 2 m/s. They meet and cling together. Their final velocity of the couple is

(1) 2 m/s (2) 1.5 m/s (3) l m/s (4) 2.5 m/s

ANSWER KEY

EXERCISE-I (Conceptual Questions)

1.	(2)	**2.**	(4)	**3.**	(3)	**4.**	(2)	**5.**	(3)	**6.**	(2)	**7.**	(4)
8.	(2)	**9.**	(2)	**10.**	(3)	**11.**	(1)	**12.**	(1)	**13.**	(1)	**14.**	(2)
15.	(4)	**16.**	(3)	**17.**	(3)	**18.**	(3)	**19.**	(2)	**20.**	(2)	**21.**	(4)
22.	(1)	**23.**	(1)	**24.**	(1)	**25.**	(3)	**26.**	(4)	**27.**	(3)	**28.**	(3)
29.	(3)	**30.**	(3)	**31.**	(2)	**32.**	(1)	**33.**	(3)	**34.**	(4)	**35.**	(2)
36.	(1)	**37.**	(4)	**38.**	(3)	**39.**	(4)	**40.**	(1)	**41.**	(2)	**42.**	(2)
43.	(2)	**44.**	(3)	**45.**	(2)	**46.**	(3)	**47.**	(2)	**48.**	(3)	**49.**	(2)
50.	(2)	**51.**	(3)	**52.**	(2)	**53.**	(1)	**54.**	(1)	**55.**	(3)	**56.**	(4)
57.	(3)	**58.**	(3)	**59.**	(3)	**60.**	(4)	**61.**	(2)	**62.**	(3)	**63.**	(4)
64.	(1)	**65.**	(3)	**66.**	(3)								