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

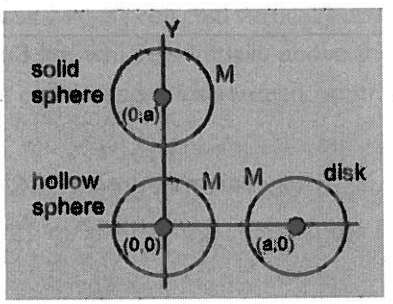
3. The coordinate of the centre of mass of a system as shown in figure :–

(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 partices

(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) In 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 placed touching each other on a horizontal surface such that an equilateral triangle is formed when the centres of the three balls are joined. The centre of mass of the system is located at :-

(1) horizontal suface

(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 –

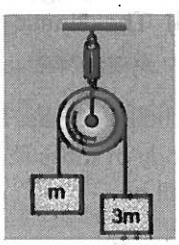
(1) $\frac{Lm}{(m+M)}$ (2) Lm(M + m)

(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 200N, 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 possess 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 3kg 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 ball 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 m_1 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 m 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 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 10 m/s respectively. Their velocities after the elastic collision will be in m/s :-

(1) 0 and 25 (2) 5 and 20

(3) 10 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

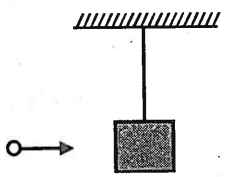
36. A 1 Kg ball falls from a height of 25 cm and rebounds upto a height of 9 cm. The co–efficient of restitution is –

(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) 2mgL (4) $\frac{mgL}{2}$

42. Two particles each of mass m travelling with velocities u_1 and u_2 collide perfectly inelastically. 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 9m/s collides with another similar stationary ball. After the collision both the balls move in directions making an angle of 30°with the initial direction. After the collision their 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 of 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 will be

(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 5gm lump of clay, moving with a velocity of 10 cm/s towards east, collides head–on with another 2gm 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 m/s and second is at rest, collides elastically. After collision velocity of second and first ball will be :

(1) 6m/s, 6m/s (2) 12m/s, 12m/s

(3) 12m/s, 0m/s (4) 0m/s, 12m/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) 45^0 (3) 90^0 (4) 180^0

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 5m 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 1 m/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) 1 m/s (4) 2.5 m/s

EXERCISE-I (Conceptual Questions) ANSWER KEY

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

EXERCISE-II (Previous Year Questions) AIPMT/NEET & AIIMS (2006-2018)

AIIMS 2006

1. For inelastic collision between two spherical rigid bodies –
(1) the total kinetic energy is conserved
(2) the total potential energy is conserved
(3) the linear momentum is not conserved
(4) the linear momentum is conserved

AIPMT 2009

2. Two bodies of mass 1 kg and 3kg have position vectors $\hat{i}+2\hat{j}+\hat{k}$ and $-3\hat{i}-2\hat{j}+\hat{k}$, respectively. The centre of mass of this system has a position vecotor :-
(1) $-\hat{i}+\hat{j}+\hat{k}$ (2) $-2\hat{i}+2\hat{k}$
(3) $-2\hat{i}-\hat{j}+\hat{k}$ (4) $2\hat{i}-\hat{j}-2\hat{k}$

3. An explosion blows a rock into three parts. Two parts go off at right angles to each other. These two are, 1 kg first part moving with a velocity of 12 m/s and 2 kg second part moving with a velocity of 8 m/s. If the third part flies off with a velocity of 4 m/s, its mass would be :- **[NEET 2013]**
(1) 3 kg (2) 5 kg
(3) 7 kg (4) 17 kg

AIPMT 2010

4. A ball moving with velocity 2 m/s collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in m/s) after collision will be :-
(1) 0, 2 (2) 0, 1
(3) 1, 1 (4) 1, 0.5

AIPMT (Pre) 2010

5. Two particles which are initially at rest, move towards each other under the action of their internal attraction. If their speeds are v and 2v at any instant, then the speed of centre of mass of the system will be :-
(1) v (2) 2v
(3) Zero (4) 1.5 v

6. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be :-
(1) 20 m (2) 9.9 m
(3) 10.1 m (4) 10 m

AIPMT (Pre) 2012

7. Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water the centre of mass of the system shifts by :
(1) zero (2) 0.75 m
(3) 3.0 m (4) 2.3 m

8. Two spheres A and B of masses m_1 and m_2 respectively collide. A is at rest initially and B is moving with velocity v along x-axis. After collision B has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass A moves after collision in the direction.
(1) $\theta = \tan^{-1}(1/2)$ to the x-axis
(2) $\theta = \tan^{-1}(-1/2)$ to the x-axis
(3) same as that of B
(4) opposite to that of B

AIPMT 2015

9. Two particles of masses m_1, m_2 move with initial velocities u_1 and u_2. On collision, one of the particles get excited to higher level, after abosrbing energy ε. If final velocities of particles be v_1 and v_2 then we must have :
(1) $\frac{1}{2}m_1u_1^2+\frac{1}{2}m_2u_2^2=\frac{1}{2}m_1v_1^2+\frac{1}{2}m_2v_2^2-\varepsilon$
(2) $\frac{1}{2}m_1u_1^2+\frac{1}{2}m_2u_2^2-\varepsilon=\frac{1}{2}m_1v_1^2+\frac{1}{2}m_2v_2^2$
(3) $\frac{1}{2}m_1^2u_1^2+\frac{1}{2}m_2^2u_2^2+\varepsilon=\frac{1}{2}m_1^2v_1^2+\frac{1}{2}m_2^2v_2^2$
(4) $m_1^2u_1+m_2^2u_2-\varepsilon=m_1^2v_1+m_2^2v_2$

10. Two spherical bodies of mass M and 5M and radii R and 2R are released in free space with initial separation between their centres equal to 12R. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is :-
(1) 4.5R (2) 7.5R
(3) 1.5R (4) 2.5R

Re-AIPMT 2015

11. A ball is thrown vertically downwards from a height of 20 m with an initial velocity v_0. It collides with the ground, loses 50% of its energy in collision and rebounds to the same height. The initial velocity v_0 is :
(Take g = 10 m/s^2)

(1) 10 m/s (2) 14 m/s

(3) 20 m/s (4) 28 m/s

12. On a frictionless surface, a block of mass. M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed $\frac{v}{3}$. The second block's speed after the collision is :-

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

AIIMS 2015

13. The variation of density of a cylindrical thick and long rod, is $\rho = \rho_0 \frac{x^2}{L^2}$, then position of its centre of mass from x = 0 end is :-

(1) 2L/3 (2) L/2 (3) L/3 (4) 3L/4

14. Find the position of centre of mass from base for a solid hemisphere of radius 16 cm,

(1) 4 cm (2) 6 cm (3) 8 cm (4) 12 cm

NEET-II 2016

15. A bullet of mass 10g moving horizontally with a velocity of 400 m/s strikes a wooden block of mass 2 kg which is suspended by a light inextensible string of length 5 m. As a result, the centre of gravity of the block is found to rise a vertical distance of 10 cm. The speed of the bullet after it emerges out horizontally from the block will be :-

(1) 120 m/s (2) 160 m/s

(3) 100 m/s (4) 80 m/s

16. Two identical balls A and B having velocities of 0.5 m/s and –0.3 m/s respectively collide elastically in one dimension. The velocities of B and A after the collision respectively will be :-

(1) –0.3 m/s and 0.5 m/s

(2) 0.3 m/s and 0.5 m/s

(3) –0.5 m/s and 0.3 m/s

(4) 0.5 m/s and –0.3 m/s

AIIMS 2016

17. A wagon of 20 metric ton moves with 10 m/s and collides perfectly inelastically with stationary wagon of 60 metric ton. Find loss of kinetic energy.

(1) 250 kJ (2) 750 kJ

(3) 500 kJ (4) 650 kJ

18. A proton of mass m_p collides with a heavy particle at rest. After collision proton bounces back with $\frac{4}{9}$ of its initial kinetic energy. Collision is perfectly elastic. Find mass of heavy particle.

(1) 5 m_p (2) 6 m_p (3) 3 m_p (4) 1.5 m_p

NEET(UG) 2018

19. A moving block having mass m, collides with another stationary block having mass 4m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of resistitution (e) will be :-

(1) 0.5 (2) 0.25

(3) 0.8 (4) 0.4

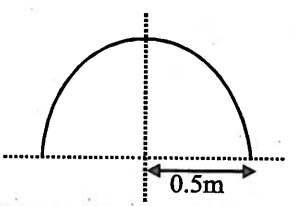
AIIMS 2018

20. The location of centre of mass of a uniform semicircular plate of radius R from its base is

(1) $\frac{4R}{3\pi}$ (2) $\frac{2R}{\pi}$

(3) $\frac{R}{2}$ (4) $\frac{3R}{8}$

21. A semicircular ring of radius 0.5m is given in diagram. The location of centre of mass on its line of symmetry above its base will be :-



(1) $\frac{2}{3\pi}$m (2) $\frac{2}{\pi}$m

(3) $\frac{1}{\pi}$m (4) $\frac{3}{2\pi}$m

22. A body of mass 10 metric ton moving with velocity 5 m/s collides head on with another body of mass 40 metric ton at rest. If they combine together just after collision then calculate loss in KE after collision.

(1) 1×10^5 J (2) 2×10^5 J

(3) 3×10^5 J (4) 4×10^5 J

23. The total mass of cart is 2 metric ton in which 1 metric ton sand is loaded. System is initially at rest. The sand leaks out of the cart (from the hole at Bottom) at the rate of 0.5 kg/s and an external horizontal force of 10N is acting on it. The final velocity of cart when the sand completely leaks out, is :-

(1) 13.86 m/s (2) 14.26 m/s

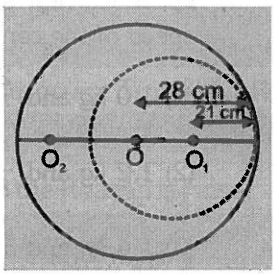
(3) 20.08 m/s (4) 16.39 m/s

EXERCISE-II (Previous Years Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	2	2	3	3	1	1 or 2	2	2	3	2	4	2	1
Que.	16	17	18	19	20	21	22	23							
Ans.	4	2	1	2	1	3	1	1							

EXERCISE-III (Analytical Questions) — Check Your Understanding

1. A circular plate of uniform thickness has a diameter 56 cm. A circular portion of diameter 42 cm is removed from one edge as shown in the figure. The centre of mass of the remaining portion from the centre of plate will be :



(1) 5 cm (2) 7 cm (3) 9 cm (4) 11 cm

2. A shell is fired from a canon with velocity V m/s at an angle θ with the horizontal direction. At the highest point in its path with same speed it explodes into two pieces of equal masses. One of the pieces retraces its path to the cannon. The speed in m/s of the other piece immediately after the explosion is :-

(1) $\left(\frac{\sqrt{3}}{2}\right)V\cos\theta$ (2) $3V\cos\theta$

(3) $2V\cos\theta$ (4) $\left(\frac{3}{2}\right)V\cos\theta$

3. After falling from a height of 5m a ball strikes the roof of a lift. If at the time of collision, lift is moving in the upward direction with a velocity of 1m/s, then the velocity with which the ball rebounds after collision will be – (e = 1)

(1) 11 m/s downwards (2) 12 m/s upwards

(3) 13 m/s upwards (4) 12 m/s downwards

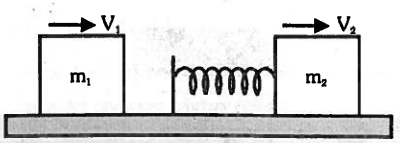
4. Two masses m_1 = 2kg and m_2 = 5kg are moving on a frictionless surface with velocities 10m/s and 3 m/s respectively. m_2 is ahead of m_1. An ideal spring of spring constant k = 1120 N/m is attached on the back side of m_2. The maximum compression of the spring will be :-

(1) 0·51 m

(2) 0·062 m

(3) 0·25 m

(4) 0·72 m



5. A frictionless steel ball of radius 2cm, moving on a horizontal plane with a velocity of 5cm/s, collides head–on with another stationary steel ball of radius 3cm. The velocities of two bodies after collision will respectively be (in cm/s) (e = 1) :–

(1) 2·7, 2·3 (2) –2·7, 2·3

(3) 2·7, –2·3 (4) –2·7, –2·3

6. A nucleus of mass number A originally at rest, emits alpha particle with speed v. The recoil speed of the daughter nucleus is :-

(1) $\frac{4v}{A-4}$ (2) $\frac{4v}{A+4}$

(3) $\frac{v}{A-4}$ (4) $\frac{v}{A+4}$

7. A sphere of diameter r is cut from a solid sphere of radius r such that the centre of mass of remaining part be at maximum distance from orginal centre, then this distance is :

(1) $\frac{r}{2}$ (2) $\frac{r}{3}$

(3) $\frac{r}{14}$ (4) none of these

8. In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 Å (1Å = 10^{-10} m). The approximate location of the centre of mass of the molecule from hydrogen atom, assuming the chlorine atom to be about 35.5 times massive as hydrogen is :

(1) 1 Å (2) 2.5 Å

(3) 1.24 Å (4) 1.5 Å

9. A man m = 80 kg is standing on a trolley of mass 320 kg on a smooth surface. If man starts walking on trolley along rails at a speed of 1 m/s, then after 4 sec, his displacement relative to ground is :-

(1) 4 m (2) 4.8 m

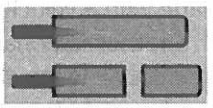
(3) 3.2 m (4) 6 m

10. A neutron makes a head on elastic collision with a stationary deuteron. The fractional energy loss of the neutron in the collision is :-

(1) 16/82 (2) 8/9

(3) 8/27 (4) 2/3

11. A cricket bat is cut at the location of its centre of mass as shown. Then :-



(1) The two pieces will have the same mass

(2) The bottom piece will have larger mass

(3) The handle piece will have larger mass

(4) Mass of handle piece is double the mass of bottom piece

12. If linear density of a rod of length 3 m varies as $\lambda = 2 + x$, then the position of the centre of gravity of the rod is :

(1) $\frac{7}{3}$ m (2) $\frac{12}{7}$ m

(3) $\frac{10}{7}$ m (4) $\frac{9}{7}$ m

13. A body of mass 2.0 kg makes an elastic collision with another body at rest and continues to move in the original direction but with one-fourth of its original speed v. What is the mass of other body and the speed of the center of mass of two bodies?

(1) 1.0 kg and $\frac{2}{3}v$

(2) 1.2 kg and $\frac{5}{8}v$

(3) 1.4 kg and $\frac{10}{17}v$

(4) 1.5 kg and $\frac{4}{7}v$

14. A uniform rod of length 1.0 metre is bent at its midpoint to make 90^0 angle. The distance of the centre of mass from the centre of the rod is :-

(1) 35.3 cm (2) 25.2 cm

(3) 17.7 cm (4) zero

EXERCISE-III (Analytical Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Ans.	3	2	2	3	2	1	3	3	3	2	2	2	2	3	

Directions for Assertion & Reason questions

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions you are required to choose any one of the following four responses.

(A) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(B) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(C) If Assertion is True but the Reason is False.

(D) If both Assertion & Reason are false.

1. ***Assertion*** **:** The centre of mass of a two particle system lies on the line joining the two particles, being closer to the heavier particle.

Reason **:** Product of mass of one particle and its distance from centre of mass is numerically equal to product of mass of other particle and its distance from centre of mass.

(1) A (2) B (3) C (4) D

2. ***Assertion*** **:** The centre of mass of a body may lie where there is no mass.

Reason **:** Centre of mass of a body is a point, where the whole mass of the body is supposed to be concentrated.

(1) A (2) B (3) C (4) D

3. ***Assertion*** **:** The centre of mass of a proton and an electron, released from their respective positions remains at rest.

Reason **:** The centre of mass remain at rest, if no external force is applied.

(1) A (2) B (3) C (4) D

4. ***Assertion*** **:** The position of centre of mass of a body does not depend upon shape and size of the body.

Reason **:** Centre of mass of a body lies always at the centre of the body.

(1) A (2) B (3) C (4) D

5. ***Assertion*** **:** Location of centre of mass is independent of the reference frame.

Reason **:** Centre of mass is same as centre of gravity.

(1) A (2) B (3) C (4) D

6. ***Assertion*** **:** The centre of mass of an electron and proton, when released moves faster towards proton.

Reason **:** Proton is heavier than electron.

(1) A (2) B (3) C (4) D

7. ***Assertion*** **:** A quick collision between two bodies is more violent than a slow collision, even when the initial and the final velocities are identical.

Reason **:** Because the rate of change of momentum which determines the force is greater in the first case.

(1) A (2) B (3) C (4) D

8. ***Assertion*** **:** Kinetic energy is conserved in both, perfectly elastic & inelastic collisions.

Reason **:** Because both the types of collisions are identical.

(1) A (2) B (3) C (4) D

9. ***Assertion*** **:** In case of bullet fired from gun, the ratio of kinetic energy of gun and bullet is equal to ratio of mass of bullet and gun.

Reason **:** In firing, momentum is conserved.

(1) A (2) B (3) C (4) D

10. ***Assertion*** **:** In an elastic collision of two billiards balls, the kinetic energy is not conserved during the short interval of time of collision between the balls.

Reason **:** Energy spent against friction does not follow the law of conservation of mechanical energy.

(1) A (2) B (3) C (4) D

11. ***Assertion*** **:** A rocket launched vertically upward explodes at the highest point it reaches. The explosion produces three fragments with non-zero initial velocity. Then the initial velocity vectors of all the three fragments are in one plane.

Reason **:** For sum of momentum of three particles to be zero, all the three momentum vectors must be coplanar.

(1) A (2) B (3) C (4) D

12. ***Assertion :-*** If ball is dropped from a higher altitude. There will be a greater value of impulse from ground during collision.

Reason :- Gravity increases momentum of a ball.

(1) A (2) B (3) C (4) D

13. ***Assertion :-*** Quick collisions are more violent than slow collisions. **[AIIMS 2018]**

Reason :- Quick collision are inelastic in nature.

(1) A (2) B (3) C (4) D

14. ***Assertion :-*** If a person jumps from a height with his legs rigid, then his ankle is more injured. **[AIIMS 2018]**

Reason :- The force will be maximum on its ankle during the collision with ground.

(1) A (2) B (3) C (4) D

EXERCISE-IV (Assertion & Reason) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ans.	1	1	1	4	3	4	1	4	1	2	1	1	3	1