Exercise-1

ONLY ONE OPTION CORRECT TYPE

SECTION (A): CALCULATION OF CENTRE OF MASS

1. The centre of mass of a body:
(1) Lies always at the geometrical centre
(2) Lies always inside the body
(3) Lies always outside the body
(4) Lies within or outside the body

2. A body has its centre of mass at the origin. The x-coordinates of the particles
(1) may be all positive
(2) may be all negative
(3) must be all non-negative
(4) may be positive for some particles and negative in other particles

3. All the particles of a body are situated at a distance R from the origin. The distance of the centre of mass of the body from the origin is
(1) = R (2) ≤ R (3) > R (4) ≥ R

4. Where will be the centre of mass on combining two masses m and M (M > m):
(1) towards m (2) towards M (3) at middle of m and M(4) anywhere

5. Two homogenous spheres A and B of masses m and 2m having radii 2a and a respectively are placed in touch. The distance of centre of mass from first sphere is :
(1) a (2) 2a (3) 3a (4) none of these

6. In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 Å (1 Å = 10^{-10} m). The approximate location of the centre of mass of the molecule, distance from hydrogen atom assuming the chlorine atom to be about 35.5 times massive as hydrogen is **[Kerala PET 2002]**
(1) 1Å (2) 2.5 Å (3) 1.24 Å (4) 1.5 Å

7. The distance between the carbon atom and the oxygen atom in a carbon monoxide molecule is 1.1 Å. Given, mass of carbon atom is 12 a.m.u. and mass of oxygen atom is 16 a.m.u., calculate the position of the centre of mass of the carbon monoxide molecule **[CBSE PMT 1997; Kerala (Engg.) 2001]**
(1) 6.3 Å from the carbon atom
(2) 1 Å from the oxygen atom
(3) 0.63 Å from the carbon atom
(4) 0.12 Å from the oxygen atom

8. 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 centres of three balls are joined. The centre of the mass of system is located at **[CBSE PMT 1999]**
(1) Horizontal surface
(2) Centre of one of the balls
(3) Line joining centres of any two balls
(4) Point of intersection of the medians

9. Centre of mass is a point **[CPMT 1997]**
(1) Which is geometric centre of a body
(2) From which distance of particles are same
(3) Where the whole mass of the body is supposed to concentrated
(4) Which is the origin of reference frame

10. Choose the correct statement about the centre of mass (CM) of a system of two particles **[AMU 1995]**
(1) The CM lies on the line joining the two particles midway between them
(2) The CM lies on the line joining them at a point whose distance form each particle is inversely proportional to the mass of that particle
(3) The CM lies on the line joining them at a point whose distance from each particle is proportional to the square of the mass of that particle
(4) The CM is on the line joining them at a point whose distance from each particle is proportional to the mass of that particle

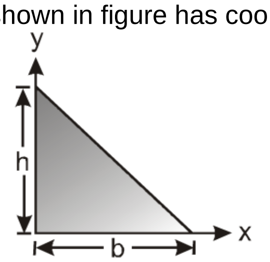
11. The centre of mass of a system of two particles divides the distance between them **[MH CET 2004]**
(1) In inverse ratio of square of masses of particles

(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

12. A cricket bat is cut at the location of its centre of mass as shown. Them **[Kerala PMT 2005]**

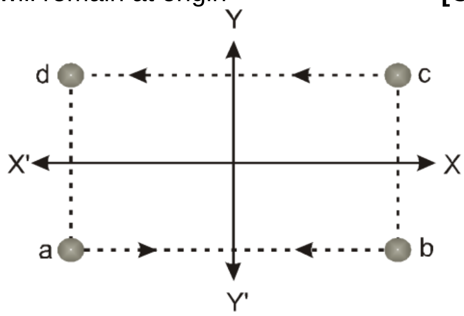
(1) The two pieces will have the same mass
(2) The bottom piece will have larger mass
(3) The handle piece will have larger mass
(4) Mass of handle piece is double the mass of bottom piece

13. The centre of mass of triangle shown in figure has coordinates **[SCRA 1994]**



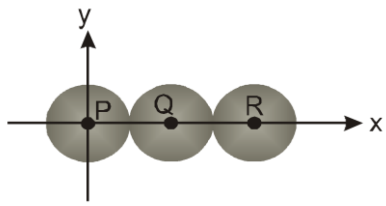
(1) $x = \frac{h}{2}, y = \frac{b}{2}$ (2) $x = \frac{b}{2}, y = \frac{h}{2}$ (3) $x = \frac{b}{3}, y = \frac{h}{3}$ (4) $x = \frac{h}{3}, y = \frac{b}{3}$

14. Four bodies of equal mass start moving with same speed as shown in the figure. In which of the following combination the centre of mass will remain at origin **[Orissa JEE 2005]**



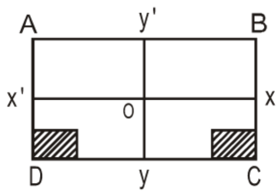
(1) c and b (2) a and d (3) a and c (4) b and c

15. Three identical spheres, each of mass 1 kg are kept as shown in figure, touching each other, with their centres on a straight line. If their centres are marked P, Q, R respectively, the distance of centre of mass of the system from P (origin) is **[Kerala PET 2005]**



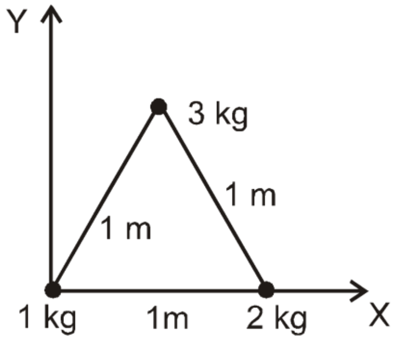
(1) $\frac{PQ + PR + QR}{3}$ (2) $\frac{PQ + PR}{3}$ (3) $\frac{PQ + QR}{3}$ (4) PR + QR

16. A uniform square plate ABCD has a mass of 10 kg. If two point masses of 3 kg each are placed at the corners C and D as shown in the adjoining figure, then the centre of mass shifts to the point which is lie on -



(1) OC (2) OD (3) OY (4) OX

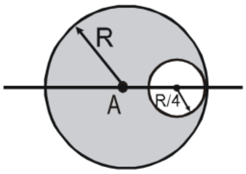
17. Three particles of masses 1 kg, 2 kg and 3 kg are placed at the corners of an equilateral triangle of side 1.0 m as shown in the fig. The coordinates of the centre of masses of the system are **[RPMT- 2014]**



(1) $\left(\frac{7}{12}m, \frac{\sqrt{3}}{4}m\right)$ (2) $\left(\frac{1}{2}m, \frac{\sqrt{3}}{4}m\right)$ (3) $\left(\frac{3}{12}m, \frac{1}{4}m\right)$ (4) $\left(\frac{3}{12}m, \frac{\sqrt{3}}{4}m\right)$

18. A non–uniform thin rod of length L is placed along x-axis as such its one of ends at the origin. The linear mass density of rod is $\lambda = \lambda_0 x$. The distance of centre of mass of rod from the origin is :
(1) L/2 (2) 2L/3 (3) L/4 (4) L/5

19. The centre of mass of the shaded portion of the disc is : (The mass is uniformly distributed in the shaded portion) :



(1) $\frac{R}{20}$ to the left of A (2) $\frac{R}{12}$ to the left of A (3) $\frac{R}{20}$ to the right of A (4) $\frac{R}{12}$ to the right of A

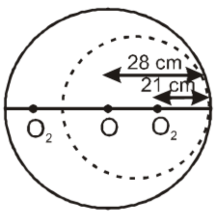
20. Four particle of masses m, 2m, 3m and 4m are arranged at the corners of a parallelogram with each side equal to a and one of the angle between two adjacent sides is 60º. The parallelogram lies in the x-y plane with mass m at the origin and 4m on the x-axis. The centre of mass of the arrangement will be located at **[AMU (Med.) 1999]**

(1) $\left(\frac{\sqrt{3}}{2}a, 0.95a\right)$ (2) $\left(0.95a, \frac{\sqrt{3}}{4}a,\right)$ (3) $\left(\frac{3a}{4}, \frac{a}{2}\right)$ (4) $\left(\frac{a}{2}, \frac{3a}{4}\right)$

21. Masses 8, 2, 4, 2 kg are placed at the corners A,B, C, D respectively of a square ABCD of diagonal 80 cm. The distance of centre of mass from A will be **[MP PMT 1999]**
(1) 20 cm (2) 30 cm (3) 40 cm (4) 60 cm

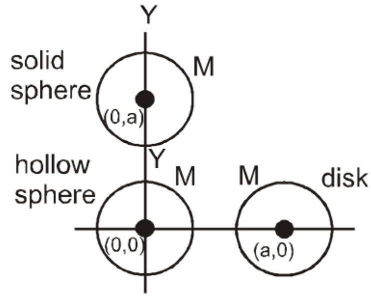
22. If linear density of a rod of length 3m varies as $\lambda = 2 + x$, then the position of the centre of gravity of the rod is **[BCECE 2005]**
(1) $\frac{7}{3}$ m (2) $\frac{12}{7}$ m (3) $\frac{10}{7}$ m (4) $\frac{9}{7}$ m

23. 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:



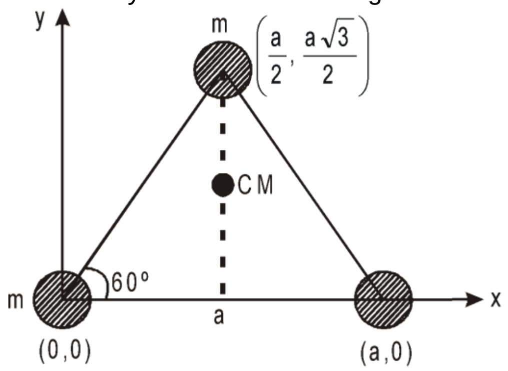
(1) 5 cm (2) 7 cm (3) 9 cm (4) 11 cm

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

25. The coordinate of the centre of mass of a system as shown in figure: -



(1) $\frac{a\sqrt{3}}{2}, \frac{a}{2}$ (2) $\frac{a}{2}, \frac{a}{6}\sqrt{3}$ (3) $\frac{a}{4}, \frac{a}{4}\sqrt{3}$ (4) $\frac{a}{2}, \frac{a}{\sqrt{3}}$

26. The centre of masses of three particles of mass $m_1 = m_2 = 1$ kg at the corners of an equilateral triangle of side 1 m will be -
(1) 0.50m, 0.43m (2) 0.43m, 0.50m (3) 0.25m, 0.25m (4) 0.22m, 0.22m

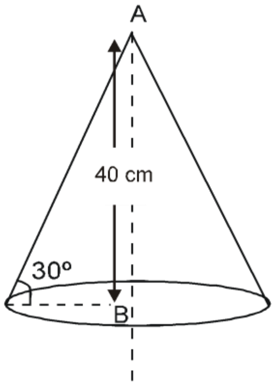
27. Two bodies of mass 1 kg and 3 kg have position vector $\hat{i}+2\hat{j}+\hat{k}$ and $-3\hat{i}-2\hat{j}+\hat{k}$ respectively. The centre of mass of this system has a position vector. **[AIPMT- Mains-2009]**
(1) $-2\hat{i}+2\hat{k}$ (2) $-2\hat{i}-\hat{j}+\hat{k}$ (3) $2\hat{i}-\hat{j}-2\hat{k}$ (4) $-\hat{i}+\hat{j}+\hat{k}$

28. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the discs coincide. The centre of mass of the new disc is αR from the centre of the bigger disc. The value of α is: **[AIEEE 2007, 3/120]**
(1) 1/3 (2) 1/2 (3) 1/6 (4) 1/4

29. Two semicircular rings of linear mass densities λ and 2 λ and of radius 'R' each are joined to form a complete ring. The distance of the center of the mass of complete ring from its geometrical centre is:
(1) $\frac{3R}{8\pi}$ (2) $\frac{2R}{3\pi}$ (3) $\frac{3R}{4\pi}$ (4) none of these

30. A uniform metal disc of radius R is taken and out of it a disc of diameter R is cut off from the end. The centre of mass of the remaining part will be:
(1) $\frac{R}{4}$ from the centre (2) $\frac{R}{3}$ from the centre (3) $\frac{R}{5}$ from the centre (4) $\frac{R}{6}$ from the centre

31. A uniform solid cone of height 40 cm is shown in figure. The distance of centre of mass of the cone from point B (centre of the base) is:



(1) 20 cm (2) 10/3 cm (3) 20/3 cm (4) 10 cm

SECTION (B) : MOTION OF CENTRE OF MASS

1. A bomb travelling in a parabolic path under the effect of gravity, explodes in mid air. The centre of mass of fragments will:
(1) Move vertically upwards and then downwards
(2) Move vertically downwards
(3) Move in irregular path
(4) Move in the parabolic path which the unexploded bomb would have travelled.

2. If a ball is thrown upwards from the surface of earth and during upward motion :
(1) The earth remains stationary while the ball moves upwards
(2) The ball remains stationary while the earth moves downwards
(3) The ball and earth both moves towards each other
(4) The ball and earth both move away from each other

3. Internal forces can change :
(1) the linear momentum but not the kinetic energy of the system.
(2) the kinetic energy but not the linear momentum of the system.
(3) linear momentum as well as kinetic energy of the system.
(4) neither the linear momentum nor the kinetic energy of the system.

4. If the external forces acting on a system have zero resultant, the centre of mass
(1) must not move (2) must accelerate (3) may move (4) may accelerate

5. Two balls are thrown in air. The acceleration of the centre of mass of the two balls while in air (neglect air resistance)
(1) depends on the direction of the motion of the balls
(2) depends on the masses of the two balls
(3) depends on the speeds of the two balls
(4) is equal to g

6. Two particles of mass 1 kg and 0.5 kg are moving in the same direction with speed of 2m/s and 6m/s respectively on a smooth horizontal surface. The speed of centre of mass of the system is :
(1) $\frac{10}{3}$ m/s (2) $\frac{10}{7}$ m/s (3) $\frac{11}{2}$ m/s (4) $\frac{12}{3}$ m/s

7. The motion of the centre of mass of a system of two particles is unaffected by their internal forces :
(1) irrespective of the actual directions of the internal forces
(2) only if they are along the line joining the particles
(3) only if they are at right angles to the line joining the particles
(4) only if they are obliquely inclined to the line joining the particles.

8. Two objects of masses 200 gm and 500 gm 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 : **[EAMCET 2003]**

(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) $25\hat{i}-\frac{5}{7}\hat{j}$

9. 2 bodies of different masses of 2kg and 4kg are moving with velocities 20m/s and 10m/s towards each other due to mutual gravitational attraction. What is the velocity of their centre of mass? **[BHU 1998]**
(1) 5 m/s (2) 6 m/s (3) 8 m/s (4) zero

10. Two spheres of masses 2M and M are initially at rest at a distance R apart. Due to mutual force of attraction, they approach each other. When they are at separation R/2, the acceleration of the centre of mass of spheres would be **[CPMT 1993]**
(1) $0\ m/s^2$ (2) $g\ m/s^2$ (3) $3g\ m/s^2$ (4) $12g\ m/s^2$

11. Two bodies A and B have masses M and m respectively, where M > m and they are at a distance d apart. Equal force is applied to them so that they approach each other. The position where they hit each other is **[NTSE 1995]**
(1) Nearer to B (2) Nearer to A
(3) At equal distance from A and B (4) Cannot be decided

12. Two particles whose masses are 10 kg and 30 kg and their position vectors are $\hat{i}+\hat{j}+\hat{k}$ and $-\hat{i}-\hat{j}-\hat{k}$ respectively would have the centre of mass at -
(1) $-\frac{(\hat{i}+\hat{j}+\hat{k})}{2}$ (2) $\frac{(\hat{i}+\hat{j}+\hat{k})}{2}$ (3) $-\frac{(\hat{i}+\hat{j}+\hat{k})}{4}$ (4) $\frac{(\hat{i}+\hat{j}+\hat{k})}{4}$

13. Two balls A and B of masses 100 gm and 250 gm respectively are connected by a stretched spring of negligible mass and placed on a smooth table. When the balls are released simultaneously the initial acceleration of B is 10 cm/sec^2 west ward. What is the magnitude and direction of initial acceleration of the ball A -
(1) 25 cm/sec^2 East ward (2) 25 cm/sec^2 North ward
(3) 25 cm/sec^2 West ward (4) 25 cm/sec^2 South ward

14. A shell of mass m moving with velocity u suddenly breaks into 2 pieces. The part having mass m/4 remains stationary. The velocity of the other shell will be : **[CPMT 1993]**
(1) u (2) 2u (3) $\frac{3}{4}u$ (4) $\frac{4}{3}u$

15. A stone is projected with an initial velocity at some angle to the horizontal. A small piece separates from the stone before the stone reaches its maximum height. Then the piece will :
(1) fall to the ground
(2) fly horizontally initially and will then describe a parabolic path
(3) fly side by side with the parent stone along a parabolic path
(4) lag behind the parent stone increasing the distance from it.

16. Three particles with masses 10, 20 and 40gm are moving with velocities $10\hat{i}, 10\hat{j}$ and $10\hat{k}$ m/sec respectively. If due to some internal force, the first particle comes to rest and the velocity of second becomes $(3\hat{i}+4\hat{j})$ m/sec. then the velocity of third particle after the interaction is-
(1) $\hat{i}+\hat{j}+5\hat{k}$ (2) $\hat{j}+10\hat{k}$ (3) $\hat{i}+\hat{j}+10\hat{k}$ (4) $\hat{i}+3\hat{j}+10\hat{k}$

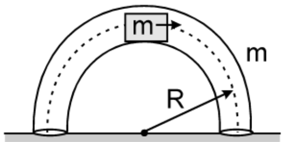
17. Two particles having mass ratio n : 1 are interconnected by a light inextensible string that passes over a smooth pulley. If the system is released, then the acceleration of the centre of mass of the system is :
(1) $(n-1)^2 g$ (2) $\left(\frac{n+1}{n-1}\right)^2 g$ (3) $\left(\frac{n-1}{n+1}\right)^2 g$ (4) $\left(\frac{n+1}{n-1}\right) g$

18. A uniform thin rod of mass M and Length L is standing vertically along the y-axis on a smooth horizontal surface, with its lower end at the origin (0,0). A slight disturbance at t = 0 causes the lower end to slip on the smooth surface along the positive x-axis, and the rod starts falling. The acceleration vector of centre of mass of the rod during its fall is : **[JEE - 1993]**

[$\vec{R}$ is reaction from surface]

(1) $\vec{a}_{CM} = \frac{M\vec{g}+\vec{R}}{M}$ (2) $\vec{a}_{CM} = \frac{M\vec{g}-\vec{R}}{M}$ (3) $\vec{a}_{CM} = M\vec{g}-\vec{R}$ (4) None of these

19. In a vertical plane inside a smooth hollow thin tube a block of same mass as that of tube is released as shown in figure. When it is slightly disturbed it moves towards right. By the time the block reaches the right end of the tube then the displacement of the tube will be (where 'R' is mean radius of tube). Assume that the tube remains in vertical plane.



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

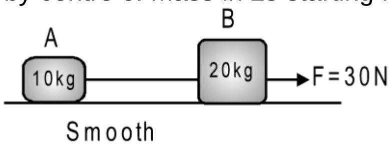
20. A ball kept in a closed box moves in the box making collisions with the walls. The box is kept on a smooth surface. The centre of mass :

(1) of the box remains constant
(2) of the box plus the ball system remains constant
(3) of the ball remains constant
(4) of the ball relative to the box remains constant

21. A man of mass M stands at one end of a plank of length L which lies at rest on a frictionless surface. The man walks to the other end of the plank. If the mass of plank is M/3, the distance that the plank moves relative to the ground is :

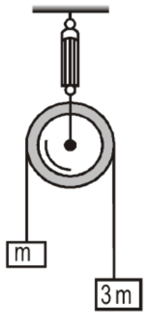
(1) 3L/4 (2) L/4 (3) 4L/5 (4) L/3

22. Two blocks A and B are connected by a massless string (shown in figure) A force of 30 N is applied on block B. The distance travelled by centre of mass in 2s starting from rest is :



(1) 1m (2) 2m (3) 3m (4) none of these

23. If the system is released, then the acceleration of the centre of mass of the system : **[UPSEAT 2002]**



(1) $\frac{g}{4}$ (2) $\frac{g}{2}$ (3) g (4) 2g

24. Three particles of masses 1 kg, 2 kg and 3 kg are subjected to forces $(3\hat{i}-2\hat{j}+2\hat{k})$N, $(-\hat{i}+2\hat{j}-\hat{k})$N, and $(\hat{i}+\hat{j}+\hat{k})$N respectively. The magnitude of the acceleration of the CM of the system is :

(1) $\frac{\sqrt{11}}{6}ms^{-2}$ (2) $\frac{\sqrt{14}}{6}ms^{-2}$ (3) $\frac{11}{6}ms^{-2}$ (4) $\frac{22}{6}ms^{-2}$

25. Two bodies of mass 10 kg and 2 kg are moving with velocity $2\hat{i}-7\hat{j}+3\hat{k}$ m/s and $-10\hat{i}+35\hat{j}-3\hat{k}$ m/s respectively. The velocity of their centre of mass is :

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

26. Consider a system of two particles having masses m_1 and m_2. If the particle of mass m_1 is pushed towards the mass centre of particles through a distance d, by what distance would the particle of mass m_2 move so as to keep the mass centre of particles at the original position ? **[AIPMT-2004]**

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

27. Two identical particles move towards each other with velocity 2v and v respectively. This velocity of centre of mass is – **[AIEEE 2002, 4/300]**

(1) v (2) v/3 (3) v/2 (4) zero

28. Two blocks of masses 10kg and 4kg are connected by a spring of negligible mass and are placed on a frictionless horizontal surface. An impulse gives a speed of 14 ms^{-1} to the heavier block in the direction of the lighter block. Then, the velocity of the centre of mass is **[JEE 2002 Scr., 2/105]**

(1) 30 ms^{-1} (2) 20 ms^{-1} (3) 10 ms^{-1} (4) 5 ms^{-1}

29. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table? **[AIEEE 2004, 4/300]**

(1) 7.2 J (2) 3.6 J (3) 120 J (4) 1200 J

30. A body A of mass M while falling vertically downwards under gravity breaks into two parts; a body B of mass $\frac{1}{3}$ M and, a body C of mass $\frac{2}{3}$M. The centre of mass of bodies B and C taken together shifts compared to that of body A towards: **[AIEEE 2005, 4/300]**

(1) depends on height of breaking (2) does not shift
(3) shift towards body C (4) shift towards body B

31. Consider a two particle system with particles having masses m_1 and m_2. If the first particle is pushed towards the centre of mass through a distance d, by what distance should the second particle be moved, so as to keep the centre of mass at the same position ? **[AIEEE 2006, 3/180]**

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

32. A uniform sphere is placed on a smooth horizontal surface and a horizontal force F is applied on it at a distance h above the surface. The acceleration of the centre

(1) is maximum when h = 0 (2) is maximum when h = R
(3) is maximum when h = 2R (4) is independent of h

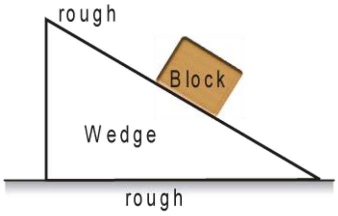
33. A can of height h is filled with liquid of uniform density ρ. If the liquid is coming out from the bottom then centre of mass of the **" can + water in the can "**

(1) first ascends and then descends (2) first descends and then ascends
(3) always decreases (4) none of these

34. A man of mass M stands at one end of a plank of length L which lies at rest on a frictionless horizontal surface . The man walks to the other end of the plank. If the mass of the plank is M/3, the distance that the man moves relative to the ground is

(1) 3 L/4 (2) 4 L/5 (3) L/4 (4) none of these

35. When a block is placed on a wedge as shown in figure, the block starts sliding down and the wedge also start sliding on ground. All surfaces are rough. The centre of mass of (wedge + block) system will move



(1) leftward and downward. (2) right ward and downward.
(3) leftward and upwards. (4) only downward.

36. 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 ms^{-1} and the 3 kg body has the velocity of 2 ms^{-1}. The velocity of the centre of mass at that instant is **[AMU (Med.) 2002]**

(1) 5 ms^{-1} (2) 1 ms^{-1} (3) zero (4) None of these

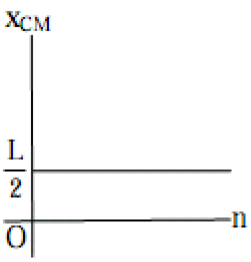
37. Two bodies of masses 2 kg and 4 kg are moving with velocities 2 m/s and 10m/s respectively along same direction. Then the velocity of their centre of mass will be **[MH CET (Med.) 2000]**
(1) 8.1 m/s (2) 7.3 m/s (3) 6.4 m/s (4) 5.3 m/s

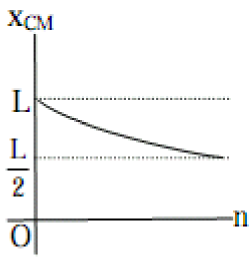
38. Two particle of masses m_1 and m_2 initially at rest start moving towards each other under their mutual force of attraction. The speed of the centre of mass at any time t, when they are at a distance r apart, is **[Harayna CEE 1996]**
(1) Zero (2) $\left(G\frac{m_1m_2}{r^2}.\frac{1}{m_1}\right)t$ (3) $\left(G\frac{m_1m_2}{r^2}.\frac{1}{m_2}\right)t$ (4) $\left(G\frac{m_1m_2}{r^2}.\frac{1}{m_1+m_2}\right)t$

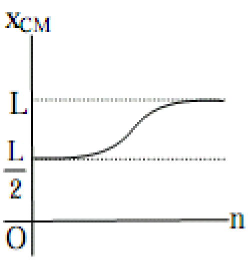
39. A body of mass 20 kg is moving with a velocity of 2v and another body of mass 10 kg is moving with velocity V along same direction. The velocity of their centre of mass is **[Pb. PET 2000]**
(1) 5v/3 (2) 2v/3 (3) v (4) Zero

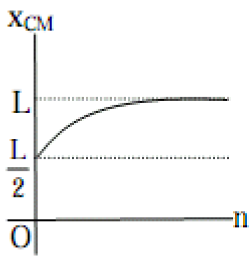
40. The two particles X and Y, initially at rest, start moving towards each other under mutual attraction. If at any instant the velocity of X is V and that of Y is 2V, the velocity of their centre of mass will be **[RPET 2002]**
(1) Zero (2) V (3) 2V (4) V/2

41. A thin rod of length 'L' is lying along the x-axis with its ends at x = 0 and x = L. Its linear density (mass/length) varies with x as $k\left(\frac{x}{L}\right)^n$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best approximates the dependence of x_{CM} on n ? **[AIEEE 2008, 3/105]**

(1)


(2)


(3)


(4)


SECTION (C) : CONSERVATION OF LINEAR MOMENTUM

1. Two particles A and B initially at rest move towards each other under a mutual force of attraction. The speed of centre of mass at the instant when the speed of A is v and the speed of B is 2v is : **[JEE - 89]**
(1) v (2) Zero (3) 2 v (4) 3 v /2

2. If the KE of a body becomes four times its initial value, then the new momentum will be more than its initial momentum by;
(1) 50% (2) 100% (3) 125% (4) 150%

3. A particle of mass 4m which is at rest explodes into three fragments. Two of the fragments, each of mass m are found to move with speed v each, in mutually perpendicular directions. The total energy released in the process of explosion is- **[IIT-1987]**
(1) $3mv^2/2$ (2) mv^2 (3) $4mv^2$ (4) $2mv^2$

4. A bullet of mass m is being fired from a stationary gun of mass M. If the velocity of the bullet is v, the velocity of the gun is- **[MPPET-88]**

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

5. A bomb explodes in air in two equal fragments. If one of the fragments is moving vertically upwards with velocity v_0, then the other fragment is moving- **[RPET-88]**

(1) Vertically up with velocity v_0 (2) Vertically downwards with velocity v_0
(3) In any arbitrary direction (4) None of these

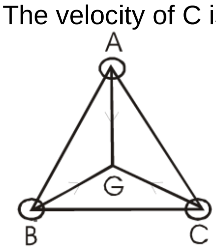
6. Two particles with equal kinetic energies are having masses in the ratio of 1 : 2. Then linear momenta will be in the ratio- **[RAJ PET-91]**

(1) 1 (2) 4 (3) 0.707 (4) 2

7. If a shell fired from a canon is exploded in air then- **[CPMT-91]**

(1) Momentum decreases (2) Momentum increases
(3) Kinetic energy increases (4) K.E. decreases

8. Three particles A, B and C of equal mass move with equal speeds v along the medians of an equilateral triangle as shown in the figure. They collide at the centroid G of the triangle. After collision A comes to rest, B retraces its path with speed v. The velocity of C is- **[RPET-92]**



(1) $\vec{v}$, direction $\vec{GA}$ (2) $2\vec{v}$ & direction $\vec{GA}$ (3) 2v, direction $\vec{GB}$ (4) $\vec{v}$, & direction $\vec{BG}$

9. Under the effect of mutual internal attractions- **[RPMT-93]**

(1) The linear momentum of a system increases
(2) The linear momentum of a system decrease
(3) The linear momentum of the system is conserved
(4) The angular momentum increases

10. A ball of mass 3 kg collides with a wall with velocity 10 m/sec at an angle of 30° and after collision reflects at the same angle with the same speed. The change in momentum of ball in MKS unit is- **[RAJ PET-94]**

(1) 20 (2) 30 (3) 15 (4) 45

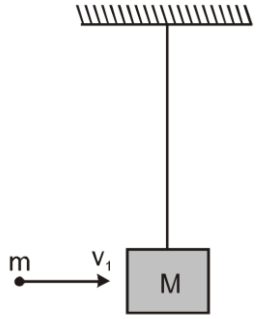
11. A particle is moving in X–Y plane under the action of a force $\vec{F}$ such that at some instant 't' the components of its linear momentum $\vec{p}$ are $p_x = 2\cos t$ and $p_y = 2\sin t$. At this instant the angle between and $\vec{F}$ and $\vec{p}$ is- **[MP PMT-96]**

(1) 90° (2) 0° (3) 180° (4) 30°

12. The kinetic energies of a lighter body and a heavier body are same. Then the value of momentum is- **[MP PMT-97]**

(1) Higher for lighter body
(2) Higher for heavier body
(3) Same for both
(4) Additional information is needed for replying this question

13. A bullet of mass m moving with a velocity v_1 strikes a suspended wooden block of mass M as shown in the figure and sticks to it. If the block rises to a height h the initial velocity of the bullet is- **[MP PMT-97]**



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

14. If the mass and kinetic energy of a particle are m and E respectively, then the value of its momentum is- **[AFMC-97]**

(1) $\sqrt{mE}$ (2) $\sqrt{2mE}$ (3) $\sqrt{2E/m}$ (4) $\sqrt{2m/E}$

15. If a lighter body (mass M_1 and velocity V_1) and a heavier body (mass M_2 and velocity V_2) have the same kinetic energy, then- **[MP PMT-97]**

(1) $M_2V_2 < M_1V_1$ (2) $M_2V_2 = M_1V_1$ (3) $M_2V_1 = M_1V_2$ (4) $M_2V_2 > M_1V_1$

16. A bomb of mass 12kg at rest explodes into two fragments of masses in the ratio 1: 3. The K.E. of the smaller fragment is 216 J. The momentum of heavier fragment is (in kg-m/sec) - **[RAJ-97]**

(1) 36 (2) 72 (3) 108 (4) Insufficient data

17. A bomb is projected with 200m/s at an angle 60° with horizontal. At the highest point, it explodes into three particles of equal masses. One goes vertically upward with velocity 100m/sec, second particle goes vertically downward with the same velocity as the first. Then what is the velocity of the third one- **[AFMC-97]**

(1) 120 m/sec with 60° angle (2) 200 m/sec with 30° angle
(3) 50 m/sec, in horizontal direction (4) 300 m/sec, in horizontal direction

18. The law of conservation of energy implies that the- **[RAJ PMT-98]**

(1) Total mechanical energy is conserved (2) Total kinetic energy is conserved
(3) Total potential energy is conserved (4) Sum of all kinds of energies is conserved

19. If the kinetic energy of a body becomes four times of its initial value, then new momentum will- **[AFMC-98]**

(1) Become twice its initial value (2) Become three times, its initial value
(3) Become four times, its initial value (4) Remains constant

20. A space craft of mass M is travelling in space with velocity v. It then breaks up into two parts such that the smaller part m comes to the rest, then the velocity of the remaining part is- **[JIPMER-2000]**

(1) $\frac{Mv}{M-m}$ (2) $\frac{Mv}{M+m}$ (3) $\frac{mv}{M-m}$ (4) $\frac{Mv}{m}$

21. A bomb at rest has mass 60 kg. It explodes and a fragment of 40 kg has kinetic energy 96 joule. Then kinetic energy of other fragment is- **[CPET-2002]**

(1) 180 J (2) 190 J (3) 182 J (4) 192 J

22. Consider the following two statements- **[CPET-2003]**

(A) Linear momentum of a system of particle is zero
(B) kinetic energy of a system of particles is zero. Then
(1) A does not imply B but B implies A (2) A implies B and B implies A
(3) A does not imply B & B does not imply A (4) A implies B but B does not imply A

23. When a U_{238} nucleus originally at rest, decays emitting an alpha particle having a speed 'u', the recoil speed of the residual nucleus is- **[CPMT-2003]**

(1) $\frac{4u}{234}$ (2) $-\frac{4u}{238}$ (3) $\frac{4u}{238}$ (4) $-\frac{4u}{234}$

24. A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60 feet tall building. After a fall of 30 feet each towards earth, their respective kinetic energies will be in the ratio of- **[CPMT Scr.-2004]**

(1) $\sqrt{2} : 1$ (2) 1 : 4 (3) 1 : 2 (4) $1 : \sqrt{2}$

25. A moving body of mass m and velocity 3 km/hr collides with a body at rest and of mass 2m and then sticks to it. Now the combined mass starts to move, then the combined velocity will be : **[RPMT-2005]**

(1) 4 km/hr (2) 3 km/hr (3) 2 km/hr (4) 1 km/hr

26. A 50 g bullet moving with velocity 10 m/s strikes a block of mass 950 g at rest and gets embedded into it. The loss in kinetic energy will be **[RPMT 2009]**

(1) 100 % (2) 95 % (3) 5 % (4) 50 %

27. A body at rest splits into three parts of mass m, m and 4m respectively. The two equal masses fly off perpendicular to each other and each with speed of V. The speed of 4m will be **[RPMT-2010]**

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

28. A stationary body explodes into two fragments of masses m_1 and m_2. If momentum of one fragment is p, the minimum energy of explosion is

(1) $\frac{p^2}{2(m_1+m_2)}$ (2) $\frac{p^2}{2\sqrt{m_1m_2}}$ (3) $\frac{p^2(m_1+m_2)}{2m_1m_2}$ (4) $\frac{p^2}{2(m_1-m_2)}$

29. A train of mass M is moving on a circular track of radius ' R ' with constant speed V. The length of the train is half of the perimeter of the track. The linear momentum of the train will be

(1) 0 (2) $\frac{2MV}{\pi}$ (3) MVR (4) MV

30. Two bodies of masses m and 4m are moving with equal linear momentum. The ratio of their kinetic energies is :

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

31. If the momentum of a body increases by 20%, the percentage increase in its kinetic energy is equal to :

(1) 44 (2) 88 (3) 66 (4) 20

32. A man is in a moving train, then wrt train :

(1) his momentum must not be zero (2) his kinetic energy is zero
(3) his kinetic energy is not zero (4) his kinetic energy may be zero

33. A bomb dropped from an aeroplane explodes in air. Its total :

(1) momentum decreases (2) momentum increases
(3) kinetic energy increases (4) kinetic energy decreases

34. Two blocks of masses m_1 and m_2 are connected by a massless spring and placed on smooth surface. The spring initially stretched and released. Then :

(a) the momentum of each particle remains constant separately
(b) the momentums of each body are equal
(c) the magnitude of momentums of each body are equal to each other
(d) the mechanical energy of system remains constant

(1) a and b are correct (2) a, b and c are correct
(3) c and d are correct (4) only c is correct

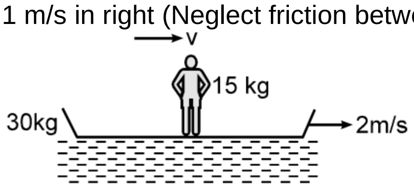
35. A bag of mass M hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined system (bag + bullet) :

(1) Momentum is mMv/(M + m) (2) KE is (1/2) Mv^2
(3) Momentum is mv (4) KE is $m^2v^2/(M + m)$

36. A man of mass 'm' climbs on a rope of length L suspended below a balloon of mass M. The balloon is stationary with respect to ground. If the man begins to climb up the rope at a speed v_{rel} (relative to rope). In what direction and with what speed (relative to ground) will the balloon move?

(1) downwards, $\frac{mv_{rel}}{m+M}$ (2) upwards, $\frac{Mv_{rel}}{m+M}$
(3) downwards, $\frac{mv_{rel}}{M}$ (4) downwards, $\frac{(M+m)v_{rel}}{M}$

37. In the figure shown the initial velocity of **boat (30 kg) + person** (15 kg) is 2 m/s. Find velocity of person w.r.t. boat so that velocity of boat will be 1 m/s in right (Neglect friction between boat and water)



(1) 3 m/s towards right (2) 3 m/s towards left
(3) 4 m/s towards right (4) 4 m/s towards left

38. 1 kg body explodes into three fragments. The ratio of their masses is 1 : 1 : 3. The fragments of same mass move perpendicular to each other with speeds 30 m/s, while the heavier part remains in the initial direction. The speed of heavier part is : **[AIPMT-2001]**

(1) $\frac{10}{\sqrt{2}}$ m/s (2) $10\sqrt{2}$ m/s (3) $20\sqrt{2}$ m/s (4) $30\sqrt{2}$ m/s

39. 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 :- **[AIPMT-2003]**

(1) m_2/m_1 (2) m_1/m_2 (3) 1 (4) $m_1 v_2/m_2 v_1$

40. A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2. Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$ then : **[AIPMT-2004]**

(1) $E_1 < E_2$ (2) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$ (3) $E_1 > E_2$ (4) $E_1 = E_2$

41. 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 ms^{-1}. The kinetic energy of the other mass is : **[AIPMT-2005]**

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

42. A shell of mass 200 g is ejected from a gun of mass 4 kg by an explosion that generates 1.05 kJ of energy. The initial velocity of the shell is **[AIPMT-2008]**

(1) 100 ms^{-1} (2) 80 ms^{-1} (3) 40 ms^{-1} (4) 120 ms^{-1}

43. 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 : **[AIIMS-2004]**

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

44. Consider the following two statements : **[AIEEE 2003, 4/300]**

A. Linear momentum of a system of particles is zero
B. Kinetic energy of a system of particles is zero,
Then,

(1) A does not imply B and B does not imply A (2) A implies B but B does not imply A
(3) A does not imply B but B implies A (4) A implies B and B implies A

45. A bomb of mass 16 kg at rest explodes into two pieces of masses of 4 kg and 12 kg. The velocity of the 12 kg mass is 4 ms^{-1} . The kinetic energy of the other mass is : **[AIEEE 2006, 1.5/180]**

(1) 96 J (2) 144 J (3) 288 J (4) 192 J

46. A block of mass 0.50 kg is moving with a speed of 2.00 ms^{-1} on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is : **[AIEEE 2008, 3/105]**

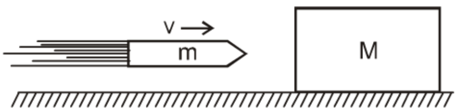
(1) 1.00 J (2) 0.67 J (3) 0.34 J (4) 0.16 J

47. Which of the following is incorrect ?
(1) If centre of mass of three particles is at rest, and it is known that two of them are moving along different non parallel lines then the third particle must also be moving.
(2) If centre of mass remains at rest, then net work done by the forces acting on the system must be zero.
(3) If centre of mass remains at rest then net external force must be zero
(4) None of these statement is incorrect

48. A bomb at rest explodes in three segments of unequal masses. The most general description of the final state is that:
(1) the fragments fly off in any arbitrary direction.
(2) the fragments fly off in such a way that there directions lie in the same plane.
(3) two of the three must go opposite to each other.
(4) two of the three must fly off at right angles to each other.

49. Two particles A and B start moving due to their mutual interaction only. If at any time 't', $\vec{a}_A$ & $\vec{a}_B$ are their respective accelerations, $\vec{v}_A$ and $\vec{v}_B$ are their respective velocities, and upto that time w_A and w_B are the work done on A & B respectively by the mutual force, m_A and m_B are their masses respectively, then which of the following is always correct.
(1) $\vec{v}_A + \vec{v}_B = 0$ (2) $m_A\vec{v}_A + \vec{v}_B m_B = 0$ (3) $w_A + w_B = 0$ (4) $\vec{a}_A + \vec{a}_B = 0$

50. In the diagram shown, a block of mass M initially at rest on a frictionless horizontal surface is struck by a bullet of mass m moving with horizontal velocity v. What is the velocity of the bullet-block system after the bullet embeds itself in the block ?



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

51. A continuous stream of particles of mass *m* and velocity *v*, is emitted from a source at a rate of *n* per second. The particles travel along a straight line, collide with a body of mass M and are buried in this body. If the mass M was originally at rest, its velocity when it has received N particles will be:
(1) $\frac{mvn}{Nm+n}$ (2) $\frac{mvN}{Nm+M}$ (3) $\frac{mv}{Nm+M}$ (4) $\frac{Nm+M}{mv}$

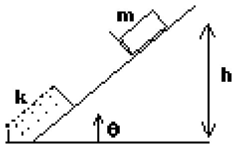
52. On doubling the speed of an object its- **[RPET-2002]**
(1) K.E. is doubled (2) P.E. is doubled
(3) Momentum is doubled (4) Acceleration is doubled

53. A block moving in air explodes in two parts then just after explosion
(1) the total momentum must be conserved
(2) the total kinetic energy of two parts must be same as that of block before explosion.
(3) the total momentum must change
(4) the total kinetic energy must not be increased

54. A particle of mass m moving with velocity v rebounds with the same speed after making impact with a wall. The change in its momentum shall be- **[CPMT-2002]**
(1) –2mv (2) mv (3) –mv (4) Zero

SECTION (D) : SPRING - MASS SYSTEM

1. A block of mass m slips down an inclined plane as shown in the figure and it presses a spring lying at the bottom. If the length of the spring h >> ℓ and spring constant is K the compression in the spring will be-



(1) $\sqrt{\frac{mgh}{k}}$ (2) $\sqrt{\frac{2mgh}{k}}$ (3) $\sqrt{\frac{gh}{mk}}$ (4) $\sqrt{\frac{2gh}{mk}}$

2. One end of a vertical ideal spring is attached to a rigid support and to other end a weight of 200 gm is suspended. If this weight is doubled then the value of the spring constant is :
(1) halved (2) unchanged (3) doubled (4) zero

3. A mass M is hanging from a spring. If on hanging an additional mass 'm' the string further get stretched by x meters, then the spring constant is :
(1) mg/x (2) (m + M)g/x (3) Mg/x (4) Mx/m

4. After falling from a height h a mass m compresses a spring of force constant k. The compression produced in the spring is :
(1) $(mgh/k)^{1/2}$ (2) $(2mgh/k)^{1/2}$ (3) $(k/mgh)^{1/2}$ (4) $(2k/mgh)^{1/2}$

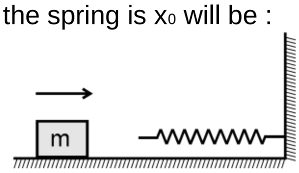
5. With how much velocity a block of mass 2 kg should move on a frictionless surface so as to compress a spring with force constant 2 newton/meter by 4 meter :
(1) 4 m/s (2) 16 m/s (3) 2 m/s (4) 8 m/s

6. A body of mass 8kg moving with a velocity of 2 m/sec comes to the rest, after compressing a spring placed on a frictionless table. If the spring constant is 5000N/m then compression produced in the spring shall be :
(1) 4 cm (2) 8 cm (3) 16 cm (4) 32 cm

7. A mass of 2 kg falls from a height 0.4 m on a spring of force constant k = 1960 N/m. The maximum distance upto which the string can be compressed is :
(1) 9 cm (2) 4.5 cm (3) 12.6 cm (4) 6.3 cm

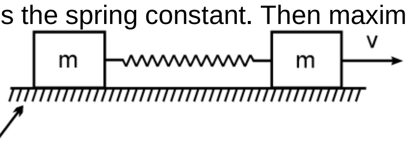
8. An object is attached to a vertical spring and slowly lowered to its equilibrium position. This stretches the spring by 10 cm. If the same object is attached to the same vertical spring but permitted to fall instead, the maximum distance upto which the spring can be stretched is :
(1) 5 cm (2) 10 cm (3) 20 cm (4) 40 cm

9. In the figure shown the magnitude of change in momentum of the block when it comes to its initial position if the maximum compression of the spring is x_0 will be :



(1) $2\sqrt{km}\,x_0$ (2) $\sqrt{km}\,x_0$ (3) zero (4) none of these

10. Two masses are connected by a spring as shown in the figure. One of the masses was given velocity v = 2 k, as shown in figure where 'k' is the spring constant. Then maximum extension in the spring will be



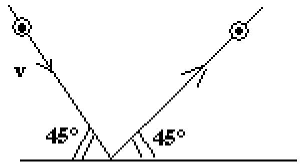
(1) 2 m (2) m (3) $\sqrt{2mk}$ (4) $\sqrt{3mk}$

SECTION (E) : IMPULSE

1. A force of 50 dynes is acted on a body of mass 5gm which is at rest for an interval of 3 sec, then impulse is- **[AFMC-98]**

(1) 0.16×10^{-3} N-S (2) 0.98×10^{-3} N-S (3) 1.5×10^{-3} N-S (4) 2.5×10^{-3} N-S

2. A body of mass M moving with a speed V collides on a surface at an angle 45 degree without changing its speed the change in momentum of the body will be-



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

3. The area of F-t curve is A, where 'F' is the force on one mass due to the other. If one of the colliding bodies of mass M is at rest initially, its speed just after the collision is :

(1) A/M (2) M/A (3) AM (4) $\sqrt{\frac{2A}{M}}$

4. A body of mass 0.5 kg is projected under gravity with a speed of 98 m/s at an angle of 60° with the vertical. The change in momentum [in magnitude] of the body when it returns on ground is **[MP PET-97]**

(1) 24.5 N-s (2) 49.0 N-s (3) 98.0 N-s (4) 49 $\sqrt{3}$ N-s

5. A body of mass 'M' collides against a wall with a velocity υ and retraces its path the same speed. The change in momentum is (take initial direction of velocity as positive) : **[EAMCET 1982]**

(1) zero (2) 2Mυ (3) Mυ (4) –2Mυ

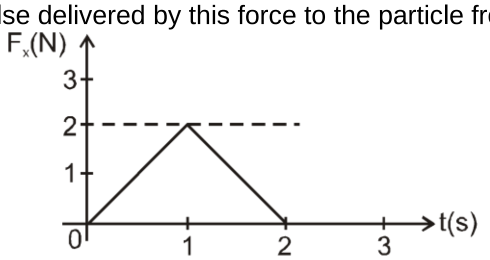
6. If two balls, each of mass 0.06 kg, moving in opposite directions with speed of 4m/s, collide and rebound with the same speed, then the impulse imparted to each ball due to other (in kg-m/s) is : **[AFMC 1998]**

(1) 0.48 (2) 0.53 (3) 0.81 (4) 0.92

7. A ball of mass 50 gm is dropped from a height h = 10 m. It rebounds losing 75 percent of its kinetic energy. If it remains in contact with the ground for Δt = 0.01 sec., the impulse of the impact force is :

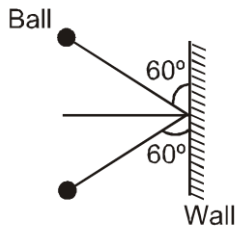
(1) 1.3 N–s (2) 1.05 N-s (3) 1300 N–s (4) 105 N–s

8. The given figure shows a plot of the time dependent force F_x acting on a particle in motion along the x-axis. What is the total impulse delivered by this force to the particle from time t = 0 to t = 2second?



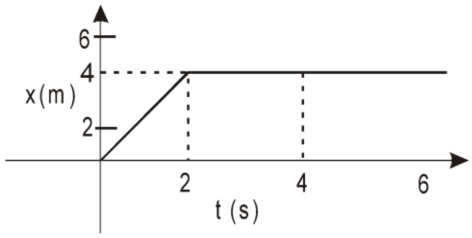
(1) 0 (2) 1 kg-m/s (3) 2 kg-m/s (4) 3 kg-m/s

9. A ball of mass 3 kg moving with a speed of 100 m/s, strikes a wall at an angle 60º (as shown in figure). The ball rebounds at the same speed and remains in contact with the ball for 0.2 s, the force exerted by the ball on the wall is : **[AIPMT-2000]**



(1) 1500 $\sqrt{3}$ N (2) 1500 N (3) 300 $\sqrt{3}$ N (4) 300 N

10. In the figure given the position-time graph of a particle of mass 0.1 kg is shown. The impulse at t = 2 s is: **[AIIMS-2005]**

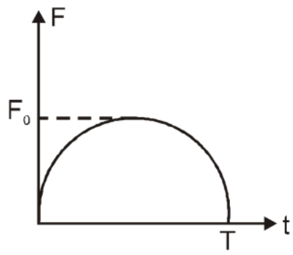


(1) 0.2 kg m s^{-1} (2) – 0.2 kg m s^{-1} (3) 0.1 kg m s^{-1} (4) – 0.4 kg m s^{-1}

11. Two balls of the same mass are dropped from the same height onto the floor. The first ball bounces upwards from the floor elastically. The second ball sticks to the floor. The first applies an impulse to the floor of I_1 the second applies an impulse I_2 (for the duration of collision). Then the relation between both the impulses is,

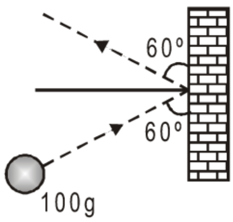
(1) $I_2 = 2I_1$ (2) $I_2 = \frac{I_1}{2}$ (3) $I_2 = 4I_1$ (4) $I_2 = \frac{I_1}{4}$

12. A particle of mass m initially at rest, is acted upon by a variable force F for a brief interval of time T. It attains a velocity u after the force stops acting. F is shown in the graph as a function of time. The curve is a semicircle, find u.



(1) $\frac{\pi F_0^2}{2m}$ (2) $\frac{\pi T^2}{8m}$ (3) $\frac{\pi F_0 T}{4m}$ (4) $\frac{F_0 T}{2m}$

13. A mass of 100g strikes the wall with speed 5m/s at an angle as shown in figure and it rebounds with the same speed. If the contact time is 2×10^{-3} sec., what is the force applied on the mass by the wall : **[Orissa JEE 2005]**



(1) $250\sqrt{3}$ to right (2) 250 N to right (3) $250\sqrt{3}$ N to left (4) 250 N to left

14. Two particles of masses m_1 and m_2 in projectile motion have velocities $\vec{u}_1$ and $\vec{u}_2$ respectively at time t = 0. They collide at time t_0. Their velocities become $\vec{v}_1$ and $\vec{v}_2$ at time $2t_0$ while still moving in air. The value of $[(m_1\vec{v}_1 + m_2\vec{v}_2) - (m_1\vec{u}_1 + m_2\vec{u}_2)]$ is **[JEE (Scr) - 2001, 3/100]**

(1) Zero (2) $(m_1 + m_2)gt_0$ (3) $2(m_1 + m_2)gt_0$ (4) $\frac{1}{2}(m_1 + m_2)gt_0$

SECTION (F) : COLLISION

1. A body is moving towards a finite body which is initially at rest collides with it. In the absence of any external impulsive force, it is not possible that
(1) both the bodies come to rest
(2) both the bodies move after collision

(3) the moving body comes to rest and the stationary body starts moving
(4) the stationary body remains stationary, the moving body is not changed its velocity.

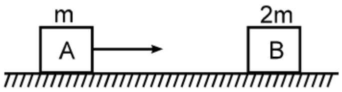
2. In head on elastic collision of two bodies of equal masses, it is not possible :
(1) the velocities are interchanged
(2) the speeds are interchanged
(3) the momenta are interchanged
(4) the faster body speeds up and the slower body slows down

3. A massive ball moving with speed v collides head-on with a tiny ball at rest having a mass very less than the mass of the first ball. If the collision is elastic, then immediately after the impact, the second ball will move with a speed approximately equal to:
(1) v (2) 2v (3) v/2 (4) ∞.

4. A ball of mass 'm', moving with uniform speed, collides elastically with another stationary ball. The incident ball will lose maximum kinetic energy when the mass of the stationary ball is **[REE - 1996]**
(1) m (2) 2m (3) 4m (4) infinity

5. In a collision between two solid spheres, velocity of separation along the line of impact (assume no external forces act on the system of two spheres during impact) :
(1) cannot be greater than velocity of approach (2) cannot be less than velocity of approach
(3) cannot be equal to velocity of approach (4) none of these

6. In the figure shown the block A collides head on with another block B at rest. Mass of B is twice the mass of A. The block A stops after collision. The co-efficient of restitution is :



(1) 0.5 (2) 1 (3) 0.25 (4) it is not possible

7. A sphere of mass m moving with a constant velocity hits another stationary sphere of the same mass. If e is the coefficient of restitution, then ratio of speed of the first sphere to the speed of the second sphere after collision will be :
(1) $\left(\frac{1-e}{1+e}\right)$ (2) $\left(\frac{1+e}{1-e}\right)$ (3) $\left(\frac{e+1}{e-1}\right)$ (4) $\left(\frac{e-1}{e+1}\right)$

8. A ball rebounds after colliding with the floor, then in case of inelastic collision- **[IIT-1986]**
(1) The momentum of the ball before and after collision is same
(2) The mechanical energy of the ball is conserved
(3) The total momentum of the earth-ball system is conserved
(4) The total kinetic energy of earth and ball is conserved

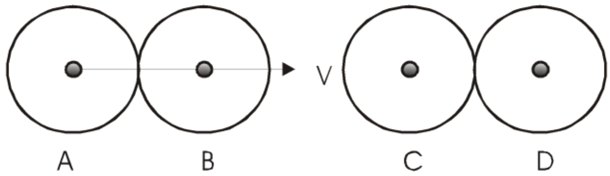
9. A ball is allowed to fall from a height of 8cm, if the ball is perfectly elastic, how much it rise after rebound- **[MP PET-86]**
(1) 8 cm (2) 1 cm (3) 0.5 cm (4) 0

10. A particle of mass m_1 moving with a velocity of 5m/s collides head on with a stationary particle of mass m_2. After collision both the particle move with a common velocity of 4m/s, then the value of m_1/m_2 is- **[CPMT-88]**
(1) 4 : 1 (2) 2 : 1 (3) 1 : 8 (4) 1 : 1

11. A body of mass m_1 collides head on elastically with a stationary body of mass m_2. If velocities of m_1 before and after the collision are v and –v/3 respectively then the value of m_1/m_2 is- **[RAJ PET-91]**
(1) 1 (2) 2 (3) 0.5 (4) 4

12. A sphere of mass 0.1 kg is attached to a cord of 1m length. Starting from the height of its point of suspension this sphere hits a block of same mass at rest on a frictionless table. If the impact is elastic, then the kinetic energy of the block after the collision is- **[RPET-91]**
(1) 1 J (2) 10 J (3) 0.1 J (4) 0.5 J

13. Two identical smooth spheres A and B are moving with same velocity and collides with similar spheres C and D, then after elastics collision- (Consider one dimensional collision) **[RPET-93]**



(1) D will move with greater speed
(2) C and D will move with same velocity v
(3) C will stop and D will move with velocity v
(4) All spheres A, B, C & D will move with velocity v/2

14. A ball is allowed of fall from a height 1.0 m. If the value of the coefficient of restitution is 0.6, then after the impact ball will go up to- **[UP PMT-93]**
(1) 0.16 m (2) 0.36 m (3) 0.40 m (4) 0.60 m

15. A ball of mass m moving with velocity v collides elastically with another ball of identical mass coming from the opposite direction with velocity 2v. Their velocities after collisions are- **[MPPMT-94]**
(1) – v, 2v (2) – 2v, v (3) v, – 2v (4) 2v, – v

16. A sphere of mass M moving with velocity u collides head on elastically with a sphere of mass m at rest. After collision their respective velocities are V and v. The value of v is- **[MPPET-95]**
(1) $2u\frac{M}{m}$ (2) $2u\frac{m}{M}$ (3) $\frac{2u}{1+m/M}$ (4) $\frac{2u}{1+M/m}$

17. A scooter of 40 kg mass moving with velocity 4 m/s collides with another scooter of 60 kg mass and moving with velocity 2 m/s. After collision the two scooters stick to each other the loss in kinetic energy- **[UP PMT-96]**
(1) 392 J (2) 440 J (3) 48 J (4) 110 J

18. Two spheres approaching each other collides elastically. Before collision the speed of A is 5m/s and that of B is 10m/s. Their masses are 1kg and 0.5kg. After collision velocities of A and B are respectively- **[Bihar PMT-96]**
(1) 5 m/s –10 m/s (2) 10 m/s, –5 m/s (3) –10 m/s, –5 m/s (4) –5 m/s, 10 m/s

19. After falling from a height h and striking the ground twice, a ball rise up to the height [e = coefficient of restitution] **[R-PMT-96]**
(1) he (2) he_2 (3) he_3 (4) he_4

20. A metal ball of mass 2.0kg moving at 36km/hr collides with a stationary ball of mass 3.0kg. If after the collision both balls move together, the loss in kinetic energy will be- **[CPMT-97]**
(1) 40 J (2) 60 J (3) 100 J (4) 140 J

21. A rubber ball is dropped from a height of 5m on a plane. On bouncing it rises to 1.8m. The ball loses its velocity on bouncing by a factor of- **[CBSE PMT-98]**
(1) 16/25 (2) 2/5 (3) 3/5 (4) 9/25

22. One sphere collides with another sphere of same mass at rest inelastically. If the value of coefficient of restitution is 1/2, the ratio of their speeds after collision shall be- **[RPMT-98]**
(1) 1 : 2 (2) 2 : 1 (3) 1 : 3 (4) 3 : 1

23. A steel ball of radius 2cm is initially at rest on a horizontal frictionless surface. It is struck head on by another steel ball of 4 cm radius travelling with a velocity of 81 cm/s. The velocities of two balls after collision are- **[RPET-99]**
(1) 72 cm/s and 56 cm/s
(2) 144 cm/s and 56 cm/s
(3) 144 cm/s and 63 cm/s
(4) 63 cm/s and 72 cm/s

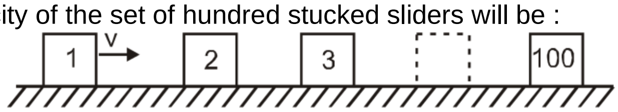
24. Which of the following statements is true for collisions- **[UP CPMT-2000]**
(1) Momentum is conserved in elastic collisions but not in inelastic collisions
(2) Total kinetic energy is conserved in elastic collisions but momentum is not conserved
(3) Total kinetic energy is not conserved in inelastic collisions but momentum is conserved
(4) Total kinetic energy and momentum both are conserved in all types of collisions

25. For a two particle collision, the following quantities are conserved in general- **[ICS-2000]**
(1) Kinetic energy
(2) Momentum
(3) Both kinetic energy and momentum
(4) Neither kinetic energy nor momentum

26. A completely inelastic collision is one in which the two colliding particles-
(1) Are separated after the collision. (2) Remain together after the collision.
(3) Split into small fragments flying in all directions. (4) None of the above.

27. A bullet of mass m = 50 gm strikes a sand bag of mass M = 5 kg hanging from a fixed point, with a horizontal velocity $\vec{v}_p$. If bullet sticks to the sand bag then the ratio of final & initial kinetic energy of the bullet is (approximately) :
(1) 10^{-2} (2) 10^{-3} (3) 10^{-6} (4) 10^{-4}

28. There are hundred identical sliders equally spaced on a frictionless track as shown in the figure. Initially all the sliders are at rest. Slider 1 is pushed with velocity v towards slider 2. In a collision the sliders stick together. The final velocity of the set of hundred stucked sliders will be :



(1) $\frac{v}{99}$ (2) $\frac{v}{100}$ (3) zero (4) v

29. The co-efficient of restitution depends upon-
(1) The masses of the colliding bodies (2) The direction of motion of the colliding bodies
(3) The inclination between the colliding bodies (4) The materials of the colliding bodies

30. In an elastic collision of two particles the following is conserved : **[MP PET 1994; DPMT 2001]**
(1) Momentum of each particle (2) Speed of each particle
(3) Kinetic energy of each particle (4) Total kinetic energy of both the particles

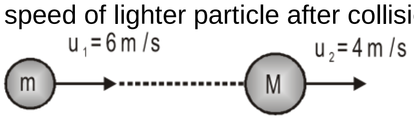
31. A body of mass M_1 collides elastically with another mass M_2 at rest. There is maximum transfer of energy when : **[Orissa JEE 2002 ; DCE 2001,02]**
(1) $M_1 > M_2$ (2) $M_1 < M_2$
(3) $M_1 = M_2$ (4) Same for all values of M_1 and M_2

32. Two putty balls of equal mass moving with equal velocity in mutually perpendicular directions, stick together after collision. If the balls were initially moving with a velocity of $45\sqrt{2}$ ms^{-1} each, the velocity of their combined mass after collision is : **[Haryana CEE 1996 ; BVP 2003]**
(1) $45\sqrt{2}$ ms^{-1} (2) 45 ms^{-1} (3) 90 ms^{-1} (4) $22.5\sqrt{2}$ ms^{-1}

33. The coefficient of restitution e for a perfectly elastic collision is : **[CBSE PMT 1988]**
(1) 1 (2) 0 (3) ∞ (4) –1

34. Two perfectly elastic particles P and Q of equal mass travelling along the joining them with velocities 15m/sec. and 10 m/sec. After collision, their velocities respectively (in m/sec.) will be :
[CPMT 1983 ; MP PMT 1994]
(1) 0,25 (2) 5,20 (3) 10, 15 (4) 20, 5

35. A particle of mass m moving with horizontal speed 6 m/sec. as shown in figure. If m << M then for one dimensional elastic collision, the speed of lighter particle after collision will be : **[MP PMT 2003]**



(1) 2 m/sec in original direction (2) 2 m/sec opposite to the original direction
(3) 4 m/sec opposite to the original direction (4) 4 m/sec in original direction

36. A particle of mass m moving towards East with a velocity v collides with another particle of same mass moving towards North with the same speed and adheres to it. The velocity of the combined particle is-
[UP CPMT-97]
(1) $v/\sqrt{2}$ along North-East (2) $v/\sqrt{2}$ along North-West
(3) $\sqrt{2}v$ along North-East (4) $\sqrt{2}v$ along North-West

37. A particle of mass 'm' and velocity '$\vec{v}$' collides oblique elastically with a stationary particle of mass 'm'. The angle between the velocity vectors of the two particles after the collision is : **[REE - 97]**
(1) 45° (2) 30° (3) 90° (4) None of these

38. An iron ball of mass 100gm moving at a speed of 10m/sec strikes a wall at angle of 30° and reflects at the same angle. If ball and wall remain in contact for 0.1 sec, the force exerted on the wall will be- **[UP CPMT-97]**
(1) 10 N (2) 100 N (3) 1.0 N (4) 0.1 N

39. If a ball of mass 10 gm strikes perpendicular on a hard floor with speed 5 m/sec. and rebounces with the same speed and remains in contact with floor for 1 sec, then the force applied on the ball by the floor is-
(1) 100 N (2) 10 N (3) 1.0 N (4) 0.1 N

40. For inelastic collision between two spherical rigid bodies : **[RPMT-2007]**
(1) The total kinetic energy is conserved
(2) The linear momentum is not conserved
(3) The total mechanical energy is not conserved
(4) The linear momentum is conserved

41. 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 both masses stick together. The kinetic energy of the composite mass will be : **[RPMT-2009]**
(1) 600 J (2) 800 J (3) 1000 J (4) 1200 J

42. When two bodies collide elastically, then : **[RPMT-2009]**
(1) Kinetic energy of the system alone is conserved
(2) Only momentum is conserved
(3) Both energy and momentum are conserved
(4) Neither energy nor momentum is conserved

43. A ball of mass 'm' moving with the velocity v collides head on with another ball of mass m at rest, If the coefficient of restitution is e, then the ratio of the velocities of the first and second ball after the collision is **[RPMT_COM_2014]**
(1) $\frac{1-e}{1+e}$ (2) $\frac{1+e}{1-e}$ (3) $\frac{1+e}{2}$ (4) $\frac{1-e}{2}$

44. When two bodies collide elastically, the force of interaction between them is :
(1) conservative (2) non–conservative
(3) either conservative or non–conservative (4) zero

45. In an elastic collision in absence of external force, which of the following is/are correct : **[REE - 95]**
(1) The linear momentum is not conserved
(2) The potential energy is conserved in collision
(3) The final kinetic energy is less than the initial kinetic energy
(4) The final kinetic energy is equal to the initial kinetic energy

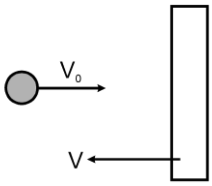
46. A shell explodes in a region of negligible gravitational field, giving out n fragments of equal mass m. Then its total **[REE - 97]**
(1) Kinetic energy is smaller than that before the explosion
(2) Kinetic energy is equal to the before the explosion
(3) Momentum and kinetic energy depend on n
(4) Momentum is equal to that before the explosion.

47. During the head on collision of two masses 1 kg and 2 kg the maximum energy of deformation is $\frac{100}{3}$ J. If before collision the masses are moving in the opposite direction, then their velocity of approach before the collision is :
(1) 10 m/sec. (2) 5 m/sec. (3) 20 m/sec. (4) $10\sqrt{2}$ m/sec.

48. A block A of mass m moving with a velocity 'v' along a frictionless horizontal track and a blocks of mass m/2 moving with $2v$ collides with plank elastically. Final speed of the block A is :

(1) $\frac{5v}{3}$ (2) v (3) $\frac{2v}{3}$ (4) none of these

49. A particle of mass m moves with velocity v_0 = 20 m/sec towards a wall that is moving with velocity v = 5 m/sec. If the particle collides with the wall elastically, the speed of the particle just after the collision is :



(1) 30 m/s (2) 20 m/s (3) 25 m/s (4) 22 m/s

50. A super-ball is to bounce elastically back and forth between two rigid walls at a distance d from each other. Neglecting gravity and assuming the velocity of super-ball to be v_0 horizontally, the average force being exerted by the super-ball on one wall is :

(1) $\frac{1}{2}\frac{mv_0^2}{d}$ (2) $\frac{mv_0^2}{d}$ (3) $\frac{2mv_0^2}{d}$ (4) $\frac{4mv_0^2}{d}$

51. Which of the following relation(s) is/are always correct. [p = linear momentum]

(1) thrust = $u_{rel}\frac{dm}{dt}$ (2) F = $m\frac{dp}{dt}$ (3) F = $m\frac{dv}{dt}$ (4) F = $m\frac{dv}{dt} + v\frac{dm}{dt}$

52. **STATEMENT-1 :** In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.
because
STATEMENT-2 : In an elastic collision, the linear momentum of the system is conserved
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True,Statement-2 is True;Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True. **[JEE-2007, 3/162]**

53. A ball hits a floor and rebounds after an inelastic collision. In this case
(1) the momentum of the ball just after the collision is same as that just before the collision
(2) the mechanical energy of the ball remains the same during the collision
(3) the total momentum of the ball and the earth is conserved
(4) the total energy of the ball and the earth remains the same

54. Two balls having mass 2 kg and 3 kg are approaching each other with velocities 3 m/s and 2 m/s respectively on the horizontal frictionless surface. They undergo a head on elastic collision. Find out the maximum potential energy of deformation.
(1) zero (2) 12.5 J (3) 15 J (4) none of these

55. A particle 'A' of mass m collides head on with another stationary particle 'B' of the same mass 'm'.The kinetic energy lost by the colliding particle 'A' will be maximum if the coefficient of the restitution is
(1) 1 (2) 0 (3) 0.5 (4) none

56. Two particles A and B of masses 10 kg and 38 kg respectively are moving along the same straight line with velocities 15 m/s & 3 m/s respectively in the same direction. After elastic collision the velocities of A and B are v_A and v_B in the direction of initial motion. Then :

(1) v_A = 20, v_B = 8 (2) v_A = – 4, v_B = 8 (3) v_A = 16, v_B = 28 (4) v_A = – 5, v_B = 10

57. Two small spheres of equal mass, and heading towards each other with equal speeds, undergo a head-on collision (no external force acts on system of two spheres). Then which of the following statement is correct?
(1) Their final velocities must be zero.
(2) Their final velocities may be zero.
(3) Each must have a final velocity equal to the other's initial velocity.
(4) Their velocities must be reduced in magnitude

58. In a perfectly inelastic direct collision maximum transfer of energy takes place if-
(1) $m_1 >> m_2$ (2) $m_1 << m_2$ (3) $m_1 = m_2$ (4) $m_2 = 0$

59. Which of the following statement is true for collisions-
(1) Momentum is conserved in elastic collisions but not in inelastic collisions.
(2) Total K.E. is conserved in elastic collisions but momentum is not conserved.
(3) Total K.E. is not conserved in inelastic collisions but momentum is conserved.
(4) Total K.E. and momentum both are conserved in all types of collisions.

60. A body falls on a surface of coefficient of restitution 0.6 from a height of 1m. Then the body rebounds to a height of : **[CPMT 1993; Pb.PET 2001]**
(1) 0.6 m (2) 0.4 m (3) 1m (4) 0.36 m

SECTION (G) : VARIABLE MASS

1. If the force on a rocket which is ejecting gases with a relative velocity of 300 m/s, is 210 N. Then the rate of combustion of the fuel will be :
:
(1) 10.7 kg/sec (2) 0.07 kg/sec (3) 1.4 kg/sec (4) 0.7 kg/sec

2. A belt is moving horizontally with a speed of 2m/s and sand is falling on it at the rate of 150 gm/sec. The additional force require to keep constant the speed of belt, is- **[RPET-1999]**
(1) 0.015 N (2) 0.30 N (3) 3N (4) 300 N

3. A rocket with a lift-off mass 3.5×10^4 kg is blasted upwards with an initial acceleration of 10 m/s^2. The initial thrust of the blast is- **[CPET-2003]**
(1) 14.0×10^5 N (2) 1.76×10^5 N (3) 3.5×10^5 N (4) 7.0×10^5 N

4. Fuel is consumed at the rate of 100 kg/sec. in a rocket. The exhaust gases are ejected as a speed of 4.5×10^4 m/s. What is the thrust experience by the rocket-
(1) 3×10^6 N (2) 4.5×10^6 N (3) 6×10^6 N (4) 9×10^6 N

5. A rocket of initial mass 6000 kg. ejects mass at a constant rate of 16 kg/sec. with constant relative speed of 11 km/sec. What is acceleration of the rocket, a minute after the blast-(Consider acceleration due to gravity g = 10$msec^{-2}$)
(1) 28.3 m/sec^2 (2) 42 m/sec^2 (3) 34.9 m/sec^2 (4) 24.92 m/sec^2

6. A 6000 kg rocket is set for vertical firing. If the exhaust speed is 1000 m/sec. How much gas must be ejected each second to supply the thrust needed to give the rocket an initial upward acceleration of 20 m/sec^2- (consider g = 9.8 $msec^{-2}$ acceleration due to gravity)
(1) 92.4 kg/sec (2) 178.8 kg/sec (3) 143.2 kg/sec (4) 47.2 kg/sec

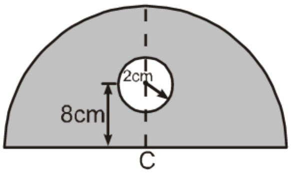
7. The rocket works on the principle of conservation of- **[NDA-2000]**
(1) Energy (2) Angular momentum (3) Momentum (4) Mass

8. A rocket with a lift-off mass 3.5×10^4 kg is blasted upwards with an initial acceleration of 10 m/s^2. Then the initial thrust of the blast is : **[AIEEE 2003, 4/300]**
(1) 3.5×10^5 N (2) 7.0×10^5 N (3) 14.0×10^5 N (4) 1.75×10^5 N

9. A balloon having mass 'm' is filled with gas and is held in hands of a boy. Then suddenly it get released and gas starts coming out of it with a constant rate. The velocities of the ejected gases is also constant 2 m/s with respect to the balloon. Find out the velocity of the balloon when the mass of gas is reduced to half. (1) ℓn 2 (2) 2 ℓn 4 (3) 2 ℓn 2 (4) none of these

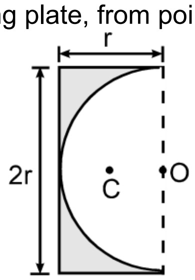
Exercise-2

1. In the figure shown a hole of radius 2 cm is made in a semicircular disc of radius 6 π cm at a distance 8 cm from the centre C of the disc. The distance of the centre of mass of this system from point C is:



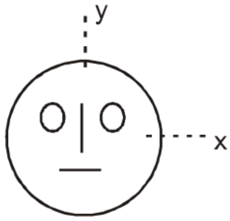
(1) 4 cm (2) 8 cm (3) 6 cm (4) 12 cm

2. A semicircular portion of radius 'r' is cut from a uniform rectangular plate as shown in figure. The distance of centre of mass 'C' of remaining plate, from point 'O' is :



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

3. 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 the centres 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-coordinate of the centre of mass of the ink in this drawing is **[JEE-2009, 3/160, –1]**



(1) $\frac{a}{10}$ (2) $\frac{a}{8}$ (3) $\frac{a}{12}$ (4) $\frac{a}{3}$

4. Two spherical bodies of mass M and 5M and radii R and 2R respectively 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 just before collision is : **[RPMT-2008]**

(1) 2.5R (2) 4.5 R (3) 7.5R (4) 1.5 R

5. A radioactive nucleus initially at rest decays by emitting an electron and neutrino at right angles to one another. The momentum of the electron is 3.2×10^{-23} kg-m/sec. and that of the neutrino is 6.4×10^{-23} kg-m/sec. The direction of the recoiling nucleus with that of the electron motion is-

(1) $\tan^{-1}(0.5)$ (2) $\tan^{-1}(2)$ (3) $\pi - \tan^{-1}(2)$ (4) $\frac{\pi}{2} + \tan^{-1}(2)$

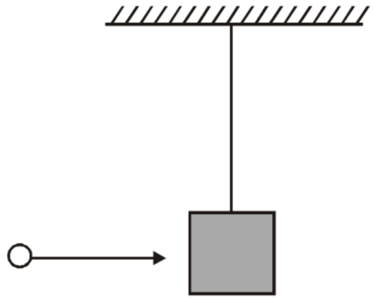
6. A particle of mass 1 kg is thrown vertically upwards with speed 100 m/s. After 5s it explodes into two parts. One part of mass 400g comes back with speed 25 m/s, what is the speed of other part just after explosion? **[AIPMT-2000]**

(1) 100 m/s upwards (2) 600 m/s upwards (3) 100 m/s downward (4) 300 m/s upward

7. A mass 'm' moves with a velocity 'v' and collides inelastically with another identical mass at rest. After collision the 1st mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision : **[AIEEE 2005, 4/300]**

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

8. A mass of 10 gm, moving horizontally with a velocity of 100 cm/sec, strikes the bob of a pendulum and sticks to it. The mass of the bob is also 10 gm. The maximum height to which the system can be raised is (g = 10 m/sec^2) **[CPMT-99]**



(1) Zero (2) 5 cm (3) 2.5 cm (4) 1.25 cm

9. A solid iron ball A of radius r collides head on with another stationary solid iron ball B of radius 2r. The ratio of their speeds just after the collision (e = 0.5) is :
(1) 3 (2) 4 (3) 2 (4) 1

10.* Two balls, having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$, undergo a collision in free space. There is no external force acting on the balls. Let $\vec{p'}_1$ and $\vec{p'}_2$ be their final momenta. The following option(s) is(are) **NOT ALLOWED** for any non-zero value of p, a_1, a_2, b_1, b_2, c_1 and c_2. **[JEE-2008, 3/163]**

(1) $\vec{p'}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$, $\vec{p'}_2 = a_2\hat{i} + b_2\hat{j}$
(2) $\vec{p'}_1 = c_1\hat{k}$, $\vec{p'}_2 = c_2\hat{k}$
(3) $\vec{p'}_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$, $\vec{p'}_2 = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$
(4) $\vec{p'}_1 = a_1\hat{i} + b_1\hat{j}$, $\vec{p'}_2 = c_2\hat{k}$

Exercise-3

PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. An explosion blows a rock into three parts. Two parts go off at right angles of each other. These two are 1 kg first part moving with a velocity of 12 ms^{-1} and 2 kg second part moving with a velocity of 8 ms^{-1}. If the third part files off with a velocity of 4 ms^{-1}, its mass would be : **[AIPMT-2009]**
(1) 5 kg (2) 7 kg (3) 17 kg (4) 3 kg

2. 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 **[AIPMT-2010]**
(1) 0, 1 (2) 1, 1 (3) 1, 0.5 (4) 0, 2

3. 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 **[AIPMT-2010]**
(1) 2v (2) zero (3) 1.5 v (4) v

4. A mass m moving horizontally (along the x-axis) with velocity v collides and sticks to mass of 3m moving vertically upward (along the y-axis) with velocity 2v. The final velocity of the combination is : **[AIPMT (MAINS) 2011]**
(1) $\frac{1}{4}v\hat{i} + \frac{3}{2}v\hat{j}$ (2) $\frac{1}{3}v\hat{i} + \frac{2}{3}v\hat{j}$ (3) $\frac{2}{3}v\hat{i} + \frac{1}{3}v\hat{j}$ (4) $\frac{3}{2}v\hat{i} + \frac{1}{4}v\hat{j}$

5. 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 : **[AIPMT_Pre_2012]**

(1) 3.0 m (2) 2.3 m (3) zero (4) 0.75 m

6. 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. **[AIPMT_Pre_2012]**
(1) same as that of B (2) Opposite to that of B
(3) $\theta = \tan^{-1}(1/2)$ to the x-axis (4) $\theta = \tan^{-1}(-1/2)$ to the x-axis

7. Three masses are placed on the x-axis : 300 g at origin, 500g at x = 40 cm and 400g at x = 70 cm. The distance of the centre of mass from the origin is : **[AIPMT 2012 (Mains)]**
(1) 40 cm (2) 45 cm (3) 50 cm (4) 30 cm

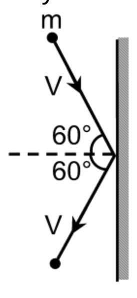
8. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1kg moves with a speed of 12 ms^{-1} and the second part of mass 2 kg moves with 8 ms^{-1} speed. If the third part flies off with 4 ms^{-1} speed, then its mass is : **[NEET_2013]**
(1) 5 kg (2) 7 kg (3) 17 kg (4) 3 kg

9. A body of mass (4m) is lying in x-y plane at rest. It suddenly explodes into three pieces. Two pieces, each of mass (m) move perpendicular to each other with equal speeds (υ). The total kinetic energy generated due to explosion is : **[AIPMT-2014]**
(1) $m\upsilon^2$ (2) $\frac{3}{2}m\upsilon^2$ (3) $2m\upsilon^2$ (4) $4m\upsilon^2$

10. 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 absorbing energy ε If final velocities of particles be v_1 and v_2 then we must have: **[AIPMT-2015]**
(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) $m_1^2u_1 + m_2^2u_2 - \varepsilon = m_1^2v_1 + m_2^2v_2$

11. Two spherical bodies of mass M and 5 M and radii R and 2R released in free space with initial separation between their centres equal to 12 R. If they attract each other due to gravitational force only, then the distance covered by the smaller body before collision is: **[AIPMT-2015]**
(1) 4.5 R (2) 7.5 R (3) 1.5 R (4) 2.5 R

12. A rigid ball of mass m strikes a rigid wall at 60º and gets reflected without loss of speed as shown in the figure below. The value of impulse imparted by the wall in the ball will be **[NEET-2016]**



(1) $\frac{mV}{3}$ (2) mV (3) 2mV (4) $\frac{mV}{2}$

13. A bullet of mass 10 g moving horizontally with a velocity of 400 ms^{-1} strikes of 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 **[NEET 2016]**
(1) 160 ms^{-1} (2) 100 ms^{-1} (3) 80 ms^{-1} (4) 120 ms^{-1}

14. 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 **[NEET-2016]**

(1) 0.3 m/s and 0.5 m/s (2) – 0.5 m/s and 0.3 m/s(3) 0.5 m/s and – 0.3 m/s(4) – 0.3 m/s and 0.5 m/s

15. 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 restitution (e) will be **[NEET-2018]**

(1) 0.5 (2) 0.4 (3) 0.8 (4) 0.25

16. Body A of mass 4 m moving with speed u collides with another body B of mass 2 m at rest the collision is head on and elastic in nature. After the collision the fraction of energy lost by colliding body A is : **[NEET_2019-I]**

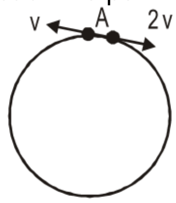
(1) $\frac{5}{9}$ (2) $\frac{1}{9}$ (3) $\frac{8}{9}$ (4) $\frac{4}{9}$

17. A particle of mass 5 m at rest suddenly breaks on its own into three fragments. Two fragments of mass m each move along mutually perpendicular direction with speed v each. The energy released during the process is **[NEET_2019-II]**

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

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

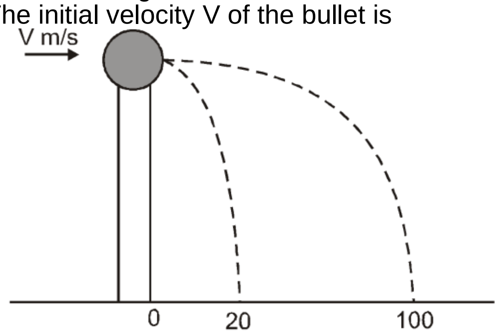
1. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and 2v, respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particles will again reach the point A? **[JEE-2009, 3/160, –1]**



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

2. **STATEMENT-1 :** Two particles moving in the same direction do not lose all their energy in a completely inelastic collision.
STATEMENT-2 : Principle of conservation of momentum holds true for all kinds of collisions.
[AIEEE 2010, 4/144]
(1) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1.
(2) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1
(3) Statement-1 is false, Statement-2 is true.
(4) Statement-1 is true, Statement-2 is false.

3. A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg, traveling with a velocity V m/s in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The initial velocity V of the bullet is **[JEE-2011, 3/160. –1]**



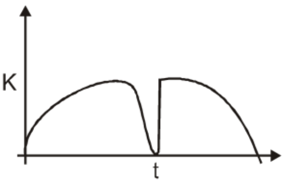
(1) 250 m/s (2) 250 $\sqrt{2}$ m/s (3) 400 m/s (4) 500 m/s

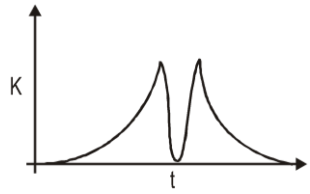
4. This question has statement I and Statement II. Of the four choices given after the Statements, choose the one that best describes the two Statements.
Statement - I : A point particle of mass m moving with speed υ collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\frac{1}{2}m\upsilon^2\right)$ then $f = \left(\frac{m}{M+m}\right)$.
[JEE (Main) 2013, 4/120]
Statement - II : Maximum energy loss occurs when the particles get stuck together as a result of the collision.
(1) Statement -I is true, Statement -II is true, Statement -II is the correct explanation of Statement -I.
(2) Statement -I is true, Statement - II is true, Statment-II is not the correct explanation of Statement - I.
(3) Statement -I is true, Statement - II is false.
(4) Statement -I is false, Statement - II is true.

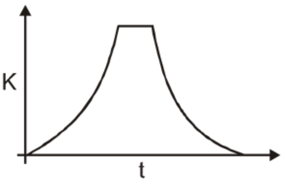
5. A particle of mass m is projected from the ground with an initial speed u_0 at an angle α with the horizontal. At the highest point of its trajectory, it makes a completely inelastic collision with another identical particle, which was thrown vertically upward from the ground with the same initial speed u_0. The angle that the composite system makes with the horizontal immediately after the collision is :
[JEE-Advanced-2013]

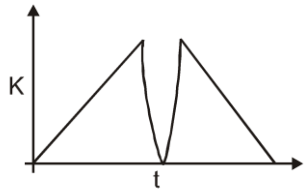
(1) $\frac{\pi}{4}$ (2) $\frac{\pi}{4}+a$ (3) $\frac{\pi}{4}-a$ (4) $\frac{\pi}{4}$

6. A tennis ball is dropped on a horizontal smooth surface. It bounces back to its original position after hitting the surface. The force on the ball during the collision is proportional to the length of compression of the ball. Which one of the following sketches describes the variation of its kinetic energy K with time t most appropriately?The figures are only illustrative and not to the scale.**[JEE(Advanced)-2014,3/60,–1]**

(1) 

(2) 

(3) 

(4) 

7. A particle of mass m moving in the x direction with speed 2v is hit by another particle of mass 2m moving in the y direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to : **[JEE(Main)-2015; 4/120, –1]**

(1) 44% (2) 50% (3) 56% (4) 62%

8. Distance of the centre of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is R and its height is h then z_0 is equal to **[JEE(Main)-2015; 4/120, –1]**

(1) $\frac{h^2}{4R}$ (2) $\frac{3h}{4}$ (3) $\frac{5h}{8}$ (4) $\frac{3h^2}{8R}$

9. It is found that if a neutron suffers an elastic collinear collision with deuterium at rest, fractional loss of its energy is p_d, while for its similar collision with carbon nucleus at rest, fractional loss of energy is p_c. The values of p_d and p_c are respectively : **[JEE-Main-2018]**

(1) (0, 0) (2) (0, 1) (3) (.89, .28) (4) (.28, .89)

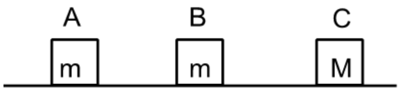
10. The mass of a hydrogen molecule is 3.32×10^{-27} kg. If 10^{23} hydrogen molecules strike, per second, a fixed wall of area $2cm^2$ at an angle of 45° to the normal, and rebound elastically with a speed of 10^3 m/s, then the pressure on the wall is nearly : **[JEE-Main-2018]**

(1) 2.35×10^2 N/m^2 (2) 4.70×10^2 N/m^2 (3) 2.35×10^3 N/m^2 (4) 4.70×10^3 N/m^2

11. In a collinear collision, a particle with an initial speed v_0 strikes a stationary particle of the same mass. If the final total kinetic energy is 50% greater than the original kinetic energy, the magnitude of the relative velocity between the two particles, after collision, is : **[JEE-Main-2018]**

(1) $\frac{v_0}{2}$ (2) $\frac{v_0}{\sqrt{2}}$ (3) $\frac{v_0}{4}$ (4) $\sqrt{2}v_0$

12. Three blocks A, B and C are lying on a smooth horizontal surface, as shown in the figure. A and B have equal masses, m which C has mass M. Block A is given an initial speed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically $\frac{5}{6}$th of the initial kinetic energy is lost in whole process. What is value of M/m ? **[JEE-Main-2019]**



(1) 2 (2) 4 (3) 5 (4) 3

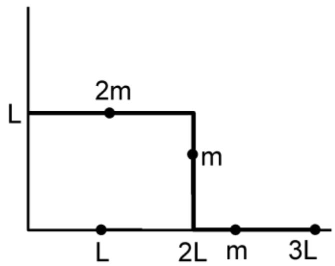
13. A piece of wood of mass 0.03 kg is dropped from the top of a 100 m height building. At the same time a bullet of mass 0.02 kg is fired vertically upwards, with a velocity 100 ms^{-1} from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the building before falling below is : (g = 10 m/s^{-2}) **[JEE-Main-2019]**

(1) 10 m (2) 20 m (3) 30 m (4) 40 m

14. A simple pendulum, made of a string of length ℓ and a bob of mass m, is released from a small angle θ_0. It strikes a block of mass M, kept on a horizontal surface at its lowest point of oscillations, elastically. It bounces back and goes up to an angle θ_1. Then M is given by : **[JEE-Main-2019]**

(1) $m\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$ (2) $\frac{m}{2}\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$ (3) $\frac{m}{2}\left(\frac{\theta_0+\theta_1}{\theta_0-\theta_1}\right)$ (4) $m\left(\frac{\theta_0-\theta_1}{\theta_0+\theta_1}\right)$

15. The position vector of the centre of mass $\vec{r}$cm of an asymmetric uniform bar of negligible area of cross-section as shown in figure is: **[JEE-Main-2019]**



(1) $\vec{r}_{cm}=\frac{3}{8}L\hat{x}+\frac{11}{8}L\hat{y}$ (2) $\vec{r}_{cm}=\frac{11}{8}L\hat{x}+\frac{3}{8}L\hat{y}$ (3) $\vec{r}_{cm}=\frac{13}{8}L\hat{x}+\frac{5}{8}L\hat{y}$ (4) $\vec{r}_{cm}=\frac{5}{8}L\hat{x}+\frac{13}{8}L\hat{y}$

Answers

EXERCISE # 1

SECTION (A) :

1.	(4)	**2.**	(4)	**3.**	(2)	**4.**	(2)	**5.**	(2)	**6.**	(3)	**7.**	(3)
8.	(4)	**9.**	(3)	**10.**	(2)	**11.**	(3)	**12.**	(2)	**13.**	(3)	**14.**	(3)
15.	(2)	**16.**	(3)	**17.**	(1)	**18.**	(2)	**19.**	(1)	**20.**	(2)	**21.**	(2)
22.	(2)	**23.**	(3)	**24.**	(3)	**25.**	(2)	**26.**	(1)	**27.**	(2)	**28.**	(1)
29.	(2)	**30.**	(4)	**31.**	(4)								

SECTION (B) :

1.	(4)	**2.**	(4)	**3.**	(2)	**4.**	(3)	**5.**	(4)	**6.**	(1)	**7.**	(1)
8.	(3)	**9.**	(4)	**10.**	(1)	**11.**	(2)	**12.**	(1)	**13.**	(1)	**14.**	(4)
15.	(3)	**16.**	(4)	**17.**	(3)	**18.**	(1)	**19.**	(3)	**20.**	(2)	**21.**	(1)
22.	(2)	**23.**	(1)	**24.**	(2)	**25.**	(2)	**26.**	(2)	**27.**	(3)	**28.**	(3)
29.	(2)	**30.**	(2)	**31.**	(4)	**32.**	(4)	**33.**	(2)	**34.**	(3)	**35.**	(2)
36.	(4)	**37.**	(2)	**38.**	(1)	**39.**	(1)	**40.**	(1)	**41.**	(4)		

SECTION (C) :

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

SECTION (D) :

1.	(2)	**2.**	(2)	**3.**	(1)	**4.**	(2)	**5.**	(1)	**6.**	(2)	**7.**	(1)
8.	(3)	**9.**	(1)	**10.**	(3)								

SECTION (E) :

1.	(3)	**2.**	(4)	**3.**	(1)	**4.**	(2)	**5.**	(4)	**6.**	(1)	**7.**	(2)
8.	(3)	**9.**	(1)	**10.**	(2)	**11.**	(2)	**12.**	(3)	**13.**	(3)	**14.**	(3)

SECTION (F) :

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

SECTION (G) :

1.	(4)	**2.**	(2)	**3.**	(4)	**4.**	(2)	**5.**	(4)	**6.**	(2)	**7.**	(3)
8.	(2)	**9.**	(3)										

EXERCISE # 2

1.	(2)	**2.**	(4)	**3.**	(1)	**4.**	(3)	**5.**	(3)	**6.**	(1)	**7.**	(3)
8.	(4)	**9.**	(3)	**10.***	(1,4)								

EXERCISE # 3

PART- I

1.	(1)	**2.**	(1)	**3.**	(2)	**4.**	(1)	**5.**	(3)	**6.**	(4)	**7.**	(1)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(2)	**12.**	(2)	**13.**	(4)	**14.**	(3)
15.	(4)	**16.**	(3)	**17.**	(4)								

PART- II

1.	(3)	**2.**	(1)	**3.**	(4)	**4.**	(4)	**5.**	(1)	**6.**	(2)	**7.**	(3)
8.	(2)	**9.**	(3)	**10.**	(3)	**11.**	(4)	**12.**	(2)	**13.**	(4)	**14.**	(4)
15.	(3)												