

- 1) The velocity vectors of three particles of masses 5 kg, 10 kg and 15 kg are respectively $(5, 3, 0)$, $(1, 1, 2)$ and $(1, 2, 4)$. Find the velocity of the centre of mass. The velocity-vector components are in m/s. [March, 1999, March, 1998]
[Ans: $(5/3, 11/6, 8/3)$]

- 2) A system is made up of three particles. The respective linear momenta of particles are $10 \hat{i}$; $20 \hat{j} + 10 \hat{k}$ and $10 \hat{k}$. If the centre of mass of the system is moving with velocity $30 \hat{i} + 60 \hat{j} + 90 \hat{k}$, calculate the total mass of the system. [Oct., 1997, similar in Oct., 1989]
(Ans: There is a printing error in the problem. The linear momentum of the third particle should be corrected as $20 \hat{k}$. Then the answer will be mass = 1/3 unit.)

- 3) Find out the centre of mass of a system of two bodies 20 cm apart. The masses of the bodies are 2 kg and 8 kg. [October, 1996]
(Ans: At 4 cm from the 8 kg mass on a line joining the masses.)

- 4) The forces of 1 N, 2 N, 3 N and 4 N are acting on the particles of a system of four particles, in the direction of west, east, south and north respectively. Find the force and the direction of the force acting on the centre of mass of the system. [March, 1996]
(Ans: $\sqrt{2}$ N in the north-east direction)

- 5) Three particles of mass $m_1 = 1.0$ kg, $m_2 = 2.0$ kg and $m_3 = 3.0$ kg are placed at the vertices of an equilateral triangle of side 1 m. Find the coordinates of the centre of mass of the system with reference to the particle of mass m_1 [March, 1994]
(Ans: $(2/3, \sqrt{3}/6)$ with m_1 at origin, m_3 on +ve x-axis and m_2 in the first quadrant.)

- 6) Two bodies of masses 10 kg and 2 kg moving with velocities $2 \hat{i} + 7 \hat{j} + 3 \hat{k}$ and $10 \hat{i} + 35 \hat{j} + 3 \hat{k}$ m/s respectively. Find the velocity of the centre of mass. [October, 1993]
(Ans: $2 \hat{k}$ m/s)

- 7) The coordinates of particles of mass 2 gm, 3 gm and 5 gm are $(3, 3, 0)$, $(3, 3, 5)$ and $(5, 3, 1)$ respectively. Find the coordinates of its centre of mass. [March, 1988]
[Ans: $(4, 3, 2)$]

- 8) A chemical bomb of 80 kg mass at rest suddenly explodes without any external force on it. It splits into two parts of 60 kg and 20 kg. The velocity of the bigger part is 1.5 m/s. Find the velocity of the smaller part. What is the velocity of the centre of mass of the bomb after the explosion? [March, 1991]
(Ans: -4.5 m/s, zero)

- 9) A light and a heavy body have equal kinetic energies of translation. Which one has the larger momentum ?
(Ans: Heavy body)
- 10) A dog of mass 10 kg is standing on board floating frictionless in water. Initially, the dog and the board are stationary and the dog is 20 m away from the bank. Now the dog travels a distance of 8 m on the board towards the bank. If the mass of the boat is 40 kg, find the distance of the dog at the end of this motion.
(Ans: 13.6 m)
- 11) Two bodies of masses 100 gm and 400 gm are moving towards each other with speeds 100 cm/s and 10 cm/s respectively. They suffer a head on collision and stick together.
(i) In which direction will the combined mass move after the collision ? and (ii) What will be the distance traveled by the combined mass after 10 s ?
(Ans: (i) in the direction of motion of 100 gm mass, (ii) 120 cm)
- 12) A sphere moving with velocity $9\sqrt{2}$ m/s collides with another identical sphere at rest. After collision both the spheres are moving in a direction making angle of 45° with the velocity of the first sphere. Find the velocities of the spheres after collision.
(Ans: 9 m/s)
- 13) A 15 gm bullet fired from a gun has a velocity of 10 m/s when it enters a stationary wooden block of mass 985 gm. If the bullet comes to rest in the block, find the velocity of the block and the percentage loss of kinetic energy of the system of bullet and the block.
(Ans: 0.15 m/s, 98.5 %)
- 14) A bomb is dropped from a height of 1000 m from the surface of the earth. After 10 seconds, it explodes into two pieces of equal masses. One piece moves towards the earth with a speed of 300 m/s. To what maximum height from the surface of the earth will the other piece reach ?
(Ans: 1000 m)

