1. A body is thrown vertically upwards with a velocity of 100 m/s at a 60° latitude. Calculate the displacement from the vertical in 10 s
   (a) 24.5 cm on the west
   (b) 24.5 cm on the east
   (c) 24.5 cm on the north
   (d) 24.5 cm on the south

2. A quadrilateral ABCD has masses 1, 2, 3 and 4 units located at its vertices A(-1, -2, 2), B(3, 2, -1), C(1, -2, 4) and D(3, 1, 2). Find the center of mass
   (a) (2, 0, 2)
   (b) (2, 0, -2)
   (c) (-2, 0, 2)
   (d) (-2, 0, -2)

3. Three particles of masses 2, 1, 3 respectively have position vectors
   \( \mathbf{r}_1 = 5t \mathbf{i} - 2t^2 \mathbf{j} + (3t - 2) \mathbf{k} \),
   \( \mathbf{r}_2 = (2t - 3) \mathbf{i} + (12 - 5t^2) \mathbf{j} + (4 + 6t - 3t^3) \mathbf{k} \),
   \( \mathbf{r}_3 = (2t - 1) \mathbf{i} + (t^2 + 2) \mathbf{j} - t^3 \mathbf{k} \) where \( t \) is the time. Find the velocity of center of mass at \( t = 1 \text{ sec} \)
   (a) \( \mathbf{i} - \mathbf{j} - \mathbf{k} \)
   (b) \( 3\mathbf{i} - 2\mathbf{j} + \mathbf{k} \)
   (c) \( 3\mathbf{i} + 2\mathbf{j} - \mathbf{k} \)
   (d) \( 3\mathbf{i} - 2\mathbf{j} - \mathbf{k} \)

4. Calculate the center of mass of a uniform semi-circular wire of radius \( a \)
   (a) \( \frac{a}{2\pi} \mathbf{y} \)
   (b) \( \frac{3a}{2\pi} \mathbf{y} \)
   (c) \( \frac{a}{\pi} \mathbf{y} \)
   (d) \( \frac{2a}{\pi} \mathbf{y} \)

5. Two particles having masses \( m_1 \) and \( m_2 \) move so that their relative velocity is \( v \) and the velocity of their center of mass is \( \bar{v} \). If \( M = m_1 + m_2 \) is the total mass and \( \mu = \frac{m_1 m_2}{m_1 + m_2} \) is the reduced mass of the system, the total kinetic energy is
   (a) \( \frac{1}{2}Mv^2 + \frac{1}{2}\mu \bar{v}^2 \)
   (b) \( \frac{1}{2}M\bar{v}^2 + \frac{1}{2}\mu v^2 \)
   (c) \( \frac{1}{2}M\bar{v}^2 - \frac{1}{2}\mu v^2 \)
   (d) \( \frac{1}{2}(M + \mu)\bar{v}^2 \)

6. Degrees of freedom of a linear tri-atomic molecule is
   (a) 3
7. A tri-atomic molecule is moving in a space such that distance between any two of them is always constant. Degrees of freedom of the system is
   (a) 3
   (b) 5
   (c) 6
   (d) 7

8. Find the center of mass of a semi-circular plate of radius \(a\)
   (a) \(\frac{4a}{3}\hat{y}\)
   (b) \(\frac{2a}{3}\hat{y}\)
   (c) \(\frac{4a}{3}\hat{y}\)
   (d) \(\frac{2a}{3}\hat{y}\)

9. Calculate the moment of inertia of a right circular cone of height \(h\) and radius \(a\) about its axis
   (a) \(\frac{2}{5}Ma^2\)
   (b) \(\frac{3}{10}Ma^2\)
   (c) \(\frac{1}{10}Ma^2\)
   (d) \(\frac{7}{10}Ma^2\)

10. Two particles of masses \(m_1\) and \(m_2\) are connected by a rigid massless rod of length \(a\) and move freely in a plane. The moment of inertia of the system about an axis perpendicular to the plane and passing through center of mass is
    (a) \(\frac{1}{2}\mu a^2\)
    (b) \(\frac{2}{3}\mu a^2\)
    (c) \(\frac{2}{5}\mu a^2\)
    (d) \(\mu a^2\)