

System of Particles and Rotational Motion — Assignment 1

Class 11 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
(2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
(3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Centre of Mass

MCQ Questions (choose the correct option)

- The centre of mass of a system of particles —
 - is always inside a body
 - may lie outside the body
 - always coincides with the geometric centre
 - cannot be defined for a hollow body
- The motion of the centre of mass is governed only by —
 - external forces
 - internal forces
 - both internal and external forces
 - the total kinetic energy of the system
- Two particles of masses 1 kg and 3 kg are 40 cm apart. The centre of mass is located —
 - 10 cm from the 3 kg mass
 - 10 cm from the 1 kg mass
 - 20 cm from the 3 kg mass
 - at the midpoint
- The centre of mass of a uniform rod lies —
 - at its middle point
 - at one of its ends
 - at one quarter of its length
 - outside the rod

1 Mark Questions

- Define the centre of mass of a system of particles.
- Write the expression for the position vector of the centre of mass of two particles of masses m_1 and m_2 .
- Where is the centre of mass of a uniform ring located?

2 Mark Questions

- State the rule for locating the centre of mass of two particles of unequal masses.
- Show that internal forces cannot change the motion of the centre of mass.
- Two bodies of masses 2 kg and 8 kg are placed at the ends of a light rod 1 m long. Find the position of their centre of mass from the 8 kg mass.

3 Mark Questions

- Derive the expression for the position vector of the centre of mass of a system of n particles and show it behaves like a point mass under a net external force.

2. Three particles of masses 1 kg, 2 kg and 3 kg are placed at the vertices of an equilateral triangle of side 1 m. Find the position of the centre of mass.

Torque and Translational Equilibrium

MCQ Questions (choose the correct option)

- The SI unit of torque is —
 (A) newton-metre (N m)
 (B) joule (J)
 (C) watt (W)
 (D) newton per metre
- Torque is maximum when the force makes an angle of —
 (A) 90° with the position vector
 (B) 0° with the position vector
 (C) 180° with the position vector
 (D) 45° with the position vector
- A torque is zero when the line of action of the force —
 (A) passes through the pivot
 (B) is parallel to the pivot
 (C) is very weak
 (D) is applied at the far end
- A couple consists of two equal and opposite forces. It produces —
 (A) pure rotation only
 (B) pure translation only
 (C) neither rotation nor translation
 (D) both rotation and translation

1 Mark Questions

- Define torque. Write its SI unit.
- State the conditions for translational equilibrium of a rigid body.
- What is a couple?

2 Mark Questions

- A force of 10 N acts at the end of a rod of length 0.5 m, perpendicular to it. Find the torque about the pivot at the other end.
- Explain why the effectiveness of a wrench is increased by making its handle longer.
- State the conditions for equilibrium of a rigid body under the action of several forces.

3 Mark Questions

- A uniform rod of weight 40 N and length 2 m is pivoted at one end and held horizontal by a force at the other end. Find the force needed to balance the rod.
- Derive the torque due to a force F applied at a point whose position vector is r , and show τ is perpendicular to both r and F .

Angular Momentum and Its Conservation

MCQ Questions (choose the correct option)

- Angular momentum is conserved when the net external —
 (A) torque is zero
 (B) force is zero
 (C) work done is zero
 (D) power is zero
- For a rigid body rotating about a fixed axis, angular momentum $L =$ —
 (A) $I\omega$
 (B) I/ω
 (C) $mr^2\omega/2$
 (D) mv^2/r
- When an ice skater pulls her arms in while spinning, her angular speed —
 (A) increases
 (B) decreases
 (C) remains the same
 (D) becomes zero
- The relation between torque and angular momentum is —
 (A) $\tau = dL/dt$
 (B) $\tau = I/\alpha$
 (C) $L = d\tau/dt$
 (D) $\tau = mv$

1 Mark Questions

- Define angular momentum of a particle about a point.
- Write the relation between torque and angular momentum.
- State the law of conservation of angular momentum.

2 Mark Questions

- Show that $\tau = dL/dt$ follows from Newton's second law for a particle.
- A diver curls into a tight ball during a dive then straightens out on entry. Explain the change in angular speed using angular momentum conservation.
- State the law of conservation of angular momentum and give two examples where it applies.

3 Mark Questions

- Prove that the angular momentum of a particle is conserved when the net torque on it is zero, and relate it to Kepler's second law of equal areas.
- A man stands at the centre of a rotating platform and holds weights with arms stretched out. Explain what happens when he pulls the weights in, using conservation of angular momentum.

Moment of Inertia and Theorems

MCQ Questions (choose the correct option)

- The moment of inertia of a body depends on —
 (A) the mass distribution about the axis and the axis chosen
 (B) only its mass

- (C) only its shape
(D) the applied torque
2. The moment of inertia of a uniform ring of mass M and radius R about an axis through its centre and perpendicular to its plane is —
- (A) MR^2
(B) $\frac{1}{2}MR^2$
(C) $\frac{2}{5}MR^2$
(D) $MR^2/2$
3. The parallel axes theorem is written as —
- (A) $I = I_{CM} + Md^2$
(B) $I = I_{CM} - Md^2$
(C) $I = Md^2 - I_{CM}$
(D) $I = M d^2$
4. The radius of gyration of a body is related to its moment of inertia by —
- (A) $I = Mk^2$
(B) $I = Mk$
(C) $I = M/k^2$
(D) $I = k^2/M$

1 Mark Questions

1. Define moment of inertia. Write its SI unit.
2. State the theorem of parallel axes.
3. Define the radius of gyration.

2 Mark Questions

1. State and prove the theorem of perpendicular axes for a plane lamina.
2. A ring and a disc of the same mass and radius rotate about their central axes. Compare their moments of inertia.
3. Write the moment of inertia of a thin uniform rod of length L about an axis through its centre, perpendicular to its length, and state the parallel-axes theorem.

3 Mark Questions

1. State and prove the theorem of parallel axes, using it to find the moment of inertia of a thin rod of length L and mass M about an axis through one end.
2. Find the moment of inertia of a uniform disc of mass M and radius R about a tangent in its plane, using the theorems of moment of inertia.

Rotational Kinetic Energy and Rolling

MCQ Questions (choose the correct option)

1. The rotational kinetic energy of a body rotating with angular speed ω is —
- (A) $\frac{1}{2} I\omega^2$
(B) $I\omega^2$
(C) $\frac{1}{2} I\omega$
(D) $\frac{1}{2} I^2\omega$
2. For rolling without slipping, the relation between linear speed v and angular speed ω is —
- (A) $v = r\omega$

(B) $v = \omega/r$

(C) $v = r^2\omega$

(D) $v = r\omega^2$

3. A ring, a disc and a solid sphere of the same mass and radius roll down a slope. The one that reaches the bottom first is —

(A) the solid sphere

(B) the disc

(C) the ring

(D) all reach together

4. The work done by a torque τ rotating a body through an angle θ is —

(A) $\tau\theta$

(B) τ/θ

(C) $\frac{1}{2}\tau\theta^2$

(D) $\tau^2\theta$

1 Mark Questions

1. Write the expression for the rotational kinetic energy of a rigid body.
2. State the rolling condition for a body moving without slipping.
3. Give the expression for the total kinetic energy of a rolling body.

2 Mark Questions

1. A flywheel of moment of inertia 2 kg m^2 rotates at 300 rpm. Find its rotational kinetic energy.
2. Explain why a solid sphere rolls down an incline faster than a ring of the same mass and radius.
3. Derive the total kinetic energy of a rolling body as $\frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$.

3 Mark Questions

1. A solid sphere rolls down an inclined plane of height h starting from rest. Obtain the velocity of its centre of mass at the bottom.
2. State and prove that the total kinetic energy of a rolling body equals $\frac{1}{2}Mv^2(1 + k^2/R^2)$, where k is its radius of gyration.