



NEET — JEE MAINS - ADVANCED

Chapter 6 : Systems of Particles and Rotational Motion (50 Important MCQs)

by - Tomar Sir

Notes

50 important MCQs from GSEB, CBSE, NEET and JEE exams · Answer key at the end

Section A — Multiple Choice Questions

Each question carries 1 mark. Choose the correct option.

Q.1 A force (5, 6, 7) N acts on a particle with position vector (2, 2, 1) m. The magnitude of the torque on the particle is ____ N m.

- (A) $\sqrt{13}$ (B) $\sqrt{149}$ (C) $\sqrt{61}$ (D) $\sqrt{23}$

Q.2 If the ice on the polar caps of the earth melts and the water collects near the equator, how will it affect the duration of a day?

- (A) Day becomes short (B) Length of day cannot change
(C) Day becomes long (D) Length of day and night becomes same

Q.3 A bus of mass 2400 kg is moving on a straight road with a speed of 30 km/h. A car of mass 1600 kg is following the bus with a speed of 40 km/h. How fast is the centre of mass of the system of two vehicles moving?

- (A) 70 km/h (B) 75 km/h (C) 34 km/h (D) 68 km/h

Q.4 The angular speed of the hour hand of a watch is ____ rad s⁻¹.

- (A) $\frac{\pi}{43200}$ (B) $\frac{\pi}{1800}$ (C) $\frac{\pi}{30}$ (D) $\frac{\pi}{21600}$

Q.5 Suppose the earth suddenly expands and its radius becomes 2R (R = radius of earth), keeping its mass the same. What will then be the length of the day, which at present is 24 hours?

- (A) 1.5 hr (B) 6 hr (C) 96 hr (D) 36 hr

Q.6 Two identical cylinders, one solid and the other hollow (thin-walled), rotate about their geometrical axes. The ratio of the radius of gyration of the hollow one to that of the solid one is

- (A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$ (C) 2 (D) $\sqrt{2}$

Q.7 A rigid body acquires an angular speed of 100 rad s⁻¹ after undergoing an angular displacement of 600 rad in 12 s (uniform angular acceleration). The initial angular speed is ____ rad s⁻¹.

- (A) 8.33 (B) 100 (C) 0 (D) 50

Q.8 A circular disc of radius r and mass m rotates about the axis passing through its centre and perpendicular to its plane with angular velocity ω . Its rotational kinetic energy is

- (A) $\frac{1}{4}mr\omega^2$ (B) $\frac{1}{2}mr\omega^2$ (C) $\frac{1}{4}mr^2\omega^2$ (D) $\frac{1}{2}mr^2\omega^2$

Q.9 The moment of inertia in terms of angular momentum (L) and kinetic energy (K) is

- (A) $\frac{L}{2K}$ (B) $\frac{L^2}{2K}$ (C) $\frac{L}{2K^2}$ (D) $\frac{L^2}{K}$

Q.10 The angular momentum of a wheel changes from $2L$ to $5L$ in 3 seconds. The magnitude of the average torque acting on it is

- (A) $\frac{L}{5}$ (B) $\frac{L}{2}$ (C) $\frac{L}{3}$ (D) L

Q.11 If the angular momentum of a body is increased by 50%, its rotational kinetic energy increases by

- (A) 125% (B) 50% (C) 100% (D) 25%

Q.12 A bird of 3 kg flies with a constant velocity of $(2\hat{i} - 4\hat{j})$ m/s and another bird of 2 kg with $(2\hat{i} + 6\hat{j})$ m/s. The velocity of the centre of mass of the two-bird system is ____ m/s.

- (A) $10\hat{i} + 10\hat{j}$ (B) $2\hat{i} + 2\hat{j}$ (C) $2\hat{i} - 2\hat{j}$ (D) $2\hat{i} + 0\hat{j}$

Q.13 In a cricket match, a bowler throws a ball of 0.5 kg with a speed of 20 m/s. The batsman hits the ball normally and it returns in the opposite direction with a speed of 30 m/s. If the time of contact of the ball with the bat is 0.1 s, the force acting on the bat is ____ N.

- (A) 50 (B) 125 (C) 250 (D) 25

Q.14 The angular momentum of a particle rotating under a centripetal (central) force is constant due to

- (A) constant linear momentum (B) constant torque
(C) zero torque (D) constant force

Q.15 The radius of gyration of a ring about a tangent perpendicular to its plane is

- (A) $\frac{R}{2}$ (B) $\sqrt{2} R$ (C) $2R$ (D) $\frac{R}{\sqrt{2}}$

Q.16 Two identical spheres, one solid and the other hollow, roll down a slope. The ratio of the moment of inertia of the solid sphere (about a diameter) to that of the hollow sphere is

- (A) $\frac{3}{5}$ (B) $\frac{2}{3}$ (C) $\frac{2}{5}$ (D) $\frac{1}{3}$

Q.17 A motor rotates at a constant angular velocity of 600 rpm. The angular displacement in 2 seconds is

- (A) 40π rad (B) 20π rad (C) 10π rad (D) $\frac{100}{3}\pi$ rad

Q.18 The moment of inertia of a solid sphere of density ρ and radius R about its diameter is (take $\pi = 22/7$)

- (A) $\frac{105}{176}R^5\rho$ (B) $\frac{105}{176}R^2\rho$ (C) $\frac{176}{105}R^5\rho$ (D) $\frac{176}{105}R^2\rho$

Q.19 A wheel with moment of inertia 2 kg m^2 about its vertical axis rotates at 60 rpm. The torque which can stop the wheel's rotation in one minute is

- (A) $\frac{\pi}{18} \text{ N m}$ (B) $\frac{2\pi}{15} \text{ N m}$ (C) $\frac{\pi}{12} \text{ N m}$ (D) $\frac{\pi}{15} \text{ N m}$

Q.20 Two bodies have moments of inertia I and $2I$ about their axes of rotation. If their rotational kinetic energies are equal, their angular momenta are in the ratio

- (A) 2 : 1 (B) 1 : 2 (C) $\sqrt{2} : 1$ (D) 1 : $\sqrt{2}$

Q.21 A thin uniform rod of mass M and length L is bent at 90° at its mid-point. The moment of inertia about an axis passing through the mid-point (the corner) and perpendicular to the plane containing both parts is

- (A) $\frac{ML^2}{24}$ (B) $\frac{ML^2}{12}$ (C) $\frac{ML^2}{6}$ (D) $\frac{\sqrt{2} ML^2}{24}$

Q.22 A thin circular ring of mass M and radius R rotates in a horizontal plane about a vertical axis through its centre with angular velocity ω . If two objects, each of mass m , are attached gently to opposite ends of a diameter, the ring will then rotate with angular velocity

- (A) $\frac{\omega M}{M+2m}$ (B) $\frac{\omega (M+2m)}{M}$ (C) $\frac{\omega M}{M+m}$ (D) $\frac{\omega (M-2m)}{M+2m}$

Q.23 A rod PQ of mass M and length L is hinged at end P. It is kept horizontal by a massless string tied to point Q. When the string is cut, the initial angular acceleration of the rod is

- (A) $\frac{2g}{3L}$ (B) $\frac{3g}{2L}$ (C) $\frac{g}{L}$ (D) $\frac{2g}{L}$

Q.24 Two spherical bodies of masses M and $5M$ and radii R and $2R$ are released in free space with an initial separation of $12R$ between their centres. If they attract each other only by gravity, the distance covered by the smaller body before collision is

- (A) $2.5R$ (B) $4.5R$ (C) $7.5R$ (D) $15R$

Q.25 A disc and a sphere of the same radius but different masses roll down two inclined planes of the same height and length. Which object reaches the bottom first?

- (A) Sphere (B) Both reach at the same time
(C) Depends on their masses (D) Disc

Q.26 A uniform circular disc of radius 50 cm at rest is free to turn about an axis perpendicular to its plane through its centre. A torque produces a constant angular acceleration of 2.0 rad s^{-2} . The net acceleration (in m s^{-2}) of a point on the rim at the end of 2.0 s is approximately

- (A) 7.0 (B) 6.0 (C) 3.0 (D) 8.0

Q.27 A particle of mass 10 g moves along a circle of radius 6.4 cm with constant tangential acceleration. What is this acceleration if the kinetic energy of the particle becomes 8×10^{-4} J by the end of the second revolution after the motion begins?

- (A) 0.15 m/s^2 (B) 0.18 m/s^2 (C) 0.2 m/s^2 (D) 0.1 m/s^2

Q.28 Two rotating bodies A and B of masses m and $2m$ with moments of inertia I_A and I_B ($I_B > I_A$) have equal rotational kinetic energy. If L_A and L_B are their angular momenta, then

- (A) $L_B > L_A$ (B) $L_A > L_B$ (C) $L_A = \frac{L_B}{2}$ (D) $L_A = 2L_B$

Q.29 A solid sphere of mass m and radius R rotates about its diameter. A solid cylinder of the same mass and radius rotates about its geometrical axis with an angular speed twice that of the sphere. The ratio of their rotational kinetic energies $E_{\text{sphere}}/E_{\text{cylinder}}$ is

- (A) $1:4$ (B) $3:1$ (C) $2:3$ (D) $1:5$

Q.30 A thin uniform rod of mass M and length L rotates with constant angular velocity ω about a perpendicular axis through its centre. Two bodies, each of mass $M/3$, are attached gently to its two ends. The new angular velocity is

- (A) $\frac{1}{3}\omega$ (B) $\frac{1}{7}\omega$ (C) $\frac{1}{6}\omega$ (D) $\frac{1}{2}\omega$

Q.31 Three objects — A: a solid sphere, B: a thin circular disc, C: a circular ring — each have the same mass M and radius R . They spin with the same angular speed ω about their own symmetry axes. The amounts of work W

required to bring them to rest satisfy

- (A) $W_A > W_C > W_B$ (B) $W_C > W_B > W_A$ (C) $W_B > W_A > W_C$ (D) $W_A > W_B > W_C$

Q.32 The moment of the force $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ acting at $(2, 0, -3)$, about the point $(2, -2, -2)$, is

- (A) $-7\hat{i} - 4\hat{j} - 8\hat{k}$ (B) $-8\hat{i} - 4\hat{j} - 7\hat{k}$ (C) $-7\hat{i} - 8\hat{j} - 4\hat{k}$ (D) $-4\hat{i} - \hat{j} - 8\hat{k}$

Q.33 A solid cylinder of mass 2 kg and radius 4 cm rotates about its axis at 3 rpm. The torque required to stop it after 2π revolutions is

- (A) 2×10^6 N m (B) 2×10^{-6} N m (C) 2×10^{-3} N m (D) 12×10^{-4} N m

Q.34 A disc of radius 2 m and mass 100 kg rolls on a horizontal floor. Its centre of mass has a speed of 20 cm/s. How much work is needed to stop it?

- (A) 1 J (B) 3 J (C) 30 kJ (D) 2 J

Q.35 Find the torque about the origin when a force of $3\hat{j}$ N acts on a particle whose position vector is $2\hat{k}$ m.

- (A) $6\hat{j}$ N m (B) $-6\hat{i}$ N m (C) $6\hat{k}$ N m (D) $6\hat{i}$ N m

Q.36 From a circular ring of mass M and radius R, an arc corresponding to a 90° sector is removed. The moment of inertia of the remaining part about an axis through the centre perpendicular to the plane of the ring is K times MR^2 . The value of K is

- (A) $\frac{1}{8}$ (B) $\frac{3}{4}$ (C) $\frac{7}{8}$ (D) $\frac{1}{4}$

Q.37 A uniform rod of length 200 cm and mass 500 g is balanced on a wedge placed at the 40 cm mark. A mass of 2 kg is suspended from the rod at 20 cm and another unknown mass m is suspended at the 160 cm mark. Find m such that the rod is in equilibrium. ($g = 10$ m/s²) [NEET 2021]

- (A) $\frac{1}{12}$ kg (B) $\frac{1}{2}$ kg (C) $\frac{1}{3}$ kg (D) $\frac{1}{6}$ kg

Q.38 The ratio of the radius of gyration of a thin uniform disc about an axis through its centre normal to its plane to that about its diameter is

- (A) 4 : 1 (B) 1 : $\sqrt{2}$ (C) 2 : 1 (D) $\sqrt{2}$: 1

Q.39 The moment of inertia of a thin rod about an axis through its mid-point perpendicular to it is 2400 g cm². The length of the 400 g rod is nearly

- (A) 20.7 cm (B) 72.0 cm (C) 8.5 cm (D) 17.5 cm

Q.40 Four holes of radius R are cut from a thin square plate of side 4R and mass M. The centres of the holes are at $(\pm R, \pm R)$, so that each hole touches two sides of the plate. The moment of inertia of the remaining portion about the Z-axis (through the centre, perpendicular to the plate) is

- (A) $\frac{\pi}{12}MR^2$ (B) $\left(\frac{4}{3} - \frac{\pi}{4}\right)MR^2$
(C) $\left(\frac{4}{3} - \frac{\pi}{6}\right)MR^2$ (D) $\left(\frac{8}{3} - \frac{10\pi}{16}\right)MR^2$

Q.41 Given $\vec{\omega} = 2\hat{k}$ and $\vec{r} = 2\hat{i} + 2\hat{j}$, the linear velocity is

- (A) $4\hat{i} + 4\hat{j}$ (B) $4\hat{i} + 4\hat{k}$ (C) $-4\hat{i} + 4\hat{j}$ (D) $-4\hat{i} - 4\hat{j}$

Q.42 A metal solid sphere rotates about an axis through its diameter. If its volume suddenly increases by 6% (mass unchanged), its moment of inertia will

- (A) decrease by 2% (B) increase by 2% (C) decrease by 4% (D) increase by 4%

Q.43 Two identical particles move towards each other with velocities 2v and v respectively. The velocity of their centre of mass is

- (A) v (B) $\frac{v}{3}$ (C) zero (D) $\frac{v}{2}$

Q.44 A child swinging on a swing in a sitting position stands up. The time period of the swing will

- (A) increase (B) decrease
(C) remain the same (D) increase if the child is tall and decrease if short

Q.45 A body A of mass M falling vertically under gravity breaks into two parts B (mass $M/3$) and C (mass $2M/3$). The centre of mass of B and C taken together, compared with that of A,

- (A) shifts towards C (B) shifts towards B
(C) depends on height of breaking (D) does not shift

Q.46 A rigid massless rod of length $3l$ has masses $5M$ and $2M$ attached at its ends. It is pivoted at point P, at distance l from the $5M$ mass (and $2l$ from the $2M$ mass), on a horizontal axis. When released from the horizontal position, its instantaneous angular acceleration is

- (A) $\frac{g}{3l}$ (B) $\frac{g}{2l}$ (C) $\frac{7g}{3l}$ (D) $\frac{g}{13l}$

Q.47 A bob of mass m is tied to a massless string whose other end is wound on a flywheel (disc) of radius R and mass m , free to rotate about a fixed horizontal axis. When released from rest, the bob falls vertically. When it has fallen a distance h , the angular speed of the wheel is (no slipping between string and wheel)

- (A) $R\sqrt{\frac{2gh}{3}}$ (B) $R\sqrt{\frac{4gh}{3}}$ (C) $\frac{1}{R}\sqrt{\frac{2gh}{3}}$ (D) $\frac{1}{R}\sqrt{\frac{4gh}{3}}$

Q.48 A uniform circular disc of radius R and mass M rotates about an axis through its centre perpendicular to its plane. A small circular part of radius $R/2$ is removed; the removed circle passes through the centre of the disc and touches its rim (its centre is at $R/2$ from the centre). The moment of inertia of the remaining part about the same axis is

- (A) $\frac{7}{32}MR^2$ (B) $\frac{17}{32}MR^2$ (C) $\frac{13}{32}MR^2$ (D) $\frac{9}{32}MR^2$

Q.49 A solid sphere is released from the top of an incline of height 7 m. Find the speed of its centre of mass at the bottom if it rolls without slipping. ($g = 10$ m/s²)

- (A) 3 m/s (B) 7 m/s (C) 10 m/s (D) 0.7 m/s

Q.50 A solid cylinder and a solid sphere of the same mass M and radius R roll down the same inclined plane from the top without slipping, starting from rest. The ratio of the velocity of the cylinder to that of the sphere at the ground is

- (A) $\sqrt{\frac{5}{3}}$ (B) $\sqrt{\frac{4}{5}}$ (C) $\sqrt{\frac{3}{5}}$ (D) $\sqrt{\frac{14}{15}}$

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	11	A	21	B	31	B	41	C
2	C	12	D	22	A	32	A	42	D
3	C	13	C	23	B	33	B	43	D
4	D	14	C	24	C	34	B	44	B
5	C	15	B	25	A	35	B	45	D
6	D	16	A	26	D	36	B	46	D
7	C	17	A	27	D	37	A	47	D
8	C	18	C	28	A	38	D	48	C
9	B	19	D	29	D	39	C	49	C
10	D	20	D	30	A	40	D	50	D

