Mechanics of Rigid Bodies : Objective Questions (Typical)

No of Questions: 62 **Time Allotted: 3 Hours**

All questions are compulsory

Q-01	Consider the following Two equations given here - **(A)** $\vec{R}_{cm} = \frac{1}{M}\sum_i m_i \vec{r}_i$, and **(B)** $\vec{a}_{cm} = \frac{\vec{F}}{M}$, then in a non-inertial frame - **(a)** both are correct **(b)** both are wrong **(c)** A is correct but B is wrong **(c)** B is correct but A is wrong
Q-02	Consider the following two statements - (A) Linear momentum of system remains constant (B) Center of mass of system remains constant Then – (a) A implies B, and B implies A (b) A does not imply B, B does not imply A (c) A implies B, but B does not imply A (d) B implies A but A does not imply B
Q-03	Consider the following Two statements – (A) Linear momentum of system of particles is Zero. (B) Kinetic energy of system of particles is Zero Then, (a) A implies B, and B implies A (b) A does not imply B, B does not imply A (c) A implies B, but B does not imply A (d) B implies A but A does not imply B
Q-04	Consider the following Two statements – (A) Linear momentum of system of a particle is independent of the frame of reference. (B) Kinetic energy of system of a particle is independent of frame of reference Then, (a) Both A and B are true (b) A is true but B is false (c) A is false but B is true (d) Both A and B are false
Q-05	All particles of a body are situated at a distance R from the origin. The distance of centre of mass of the body from the origin is – **(a)** $= R$ **(b)** $\leq R$ **(c)** $> R$ **(d)** $\geq R$

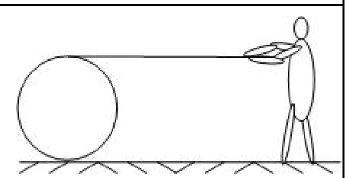
Q-06	A circular plate of diameter d is kept in a contact with a square plate of edge d as shown in the figure. The density of the material and thickness of both the plates is uniformly same. The centre of mass of the composite system will be – **(a)** Inside the circular plate **(b)** Inside the square plate **(c)** At the point of contact **(d)** Outside the system
Q-07	Consider a system of two identical particles. One of the particle is at rest and the other has an acceleration a. The centre of mass of the system has an acceleration – **(a)** Zero **(b)** $\frac{1}{2}\vec{a}$ **(c)** $\vec{a}$ **(d)** $2\vec{a}$
Q-08	Internal forces in a system can change – **(a)** Linear momentum but not the kinetic energy of the system **(b)** Kinetic energy of the system but not its linear momentum **(c)** Linear momentum as well as kinetic energy **(d)** Neither the linear momentum nor the kinetic energy
Q-09	A bullet hits a block kept at rest on a smooth horizintal surface and gets embedded into it. Which of the following does not change? **(a)** Linear momentum of the block **(b)** Kinetic energy of the block **(c)** Gravitational potential energy of the block **(d)** Temperature of the block
Q-10	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 surfce. The acceleration of the centre is – **(a)** Maximum when $h = 0$ **(b)** Maximum when $h = R$ **(c)** Maximum when $h = 2R$ **(d)** Independent of Maximum when h
Q-11	A body falling vertically downward under gravity breaks into two pieces of unequal masses. The centre of mass of the two parts taken together shift horizontally towards - **(a)** Heavier piece **(b)** Lighter piece **(c)** Does not shift horizontally **(d)** Depends on the vertical velocity at the time of breaking.
Q-12	A body at rest break into two pieces of unequal masses. The parts will move – **(a)** In the same direction **(b)** Along different lines **(c)** In opposite directions with equal speed **(d)** In opposite directions with unequal speed

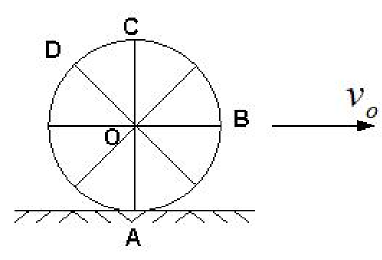
Q-13	A heavy ring of mass m is clamped on the periphery of a light circular disc. A small particle having equal mass is clamped at the centre of the disc. The system is rotated in such a way that the centre moves in a circle of radius r with a unform speed v. We can conclude that an external force – **(a)** $\frac{mv^2}{r}$ must be acting on the central particle **(b)** $\frac{2mv^2}{r}$ must be acting on the central particle **(c)** $\frac{2mv^2}{r}$ must be acting on the system **(d)** $\frac{2mv^2}{r}$ must be acting on the ring.
Q-14	A nucleus moving with veocity $\vec{v}$ emits an α-particle. Let the velocities of the α-particle and the remainibg nuleus be $\vec{v}_1$ and $\vec{v}_2$ and their masses m_1 and m_2. Then – **(a)** $\vec{v}$, $\vec{v}_1$ and $\vec{v}_2$ must be parallel to each other **(b)** None of the two of $\vec{v}$, $\vec{v}_1$ and $\vec{v}_2$ should be parallel to each other **(c)** $\vec{v}_1 + \vec{v}_2$ must be parallel to $\vec{v}$ **(d)** $m_1\vec{v}_1 + m_2\vec{v}_2$ must be parallel to $\vec{v}$
Q-15	The centre of mass of a system of particles is at the origin. It follows that – (a) The number of particles to the right of origin is equal to the number of particles to the left (b) The total mass of particles to the right of the origin is same as the total mass to the left of the origin (c) The number off paricles on X-axis should be equal to number of particesn on Y-axis (d) If there is a particle on (+)ve X-axs, there must be at least one particle on the (-)ve X-axis.
Q-16	A body has its centre of mass at the origin. The coordinates of the particles – (a) May be all positive (b) May be all negative (c) May be all non-negative (d) May be positive for some particles and negative for others
Q-17	In which of the following cases the centre of mass of a rod o a unifoem cross-section, is certainly not at its centre – (a) The density continuously increases from left to right (b) The density continuously decreases from left to right (c) The density decreases from left to centre and then increases (d) The density increases from left to centre and then decreases
Q-18	If the external forces acting on a system have a zero resultant, the centre of mass – (a) Must not move (b) Must not accelerate (c) May move (d) May accelerate

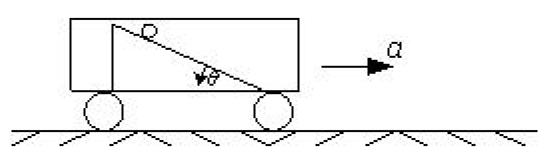
Q-19	A non-zero external force acts on a system of particles. The velocity and the acceleration of the centre of mass are found to be v_0 and a_0 at an instant t. It is possible that – (a) $v_0 = 0,\ a_0 = 0$ (b) $v_0 = 0,\ a_0 \neq 0$ (c) $v_0 \neq 0,\ a_0 = 0$ (d) $v_0 \neq 0,\ a_0 \neq 0$
Q-20	Two balls are simultaneously thrown in air. The acceleration of centre of mass of the two balls while in air – (a) Depends on the direction of motion of the balls (b) Depends on the masses of the two balls (c) Depends on the speed of the two balls (d) Is equal to g
Q-21	A block moving in air breaks in two parts separate parts. Then – (a) The total momentum must be conserved (b) The total kinetic energy must be conserved (c) Total monentum must change (d) Total kinetic energy must change
Q-22	Let $\vec{A}$ be a unit vector along the axis of rotation of a purely rotating body and $\vec{B}$ be a unit vector along the velocity of a particle P of the body away from the axis. The value of $\vec{A} \cdot \vec{B}$ is – (a) 1 (b) -1 (c) 0 (d) None of these
Q-23	A body is uniformly rotating about an axis fixed in an internal frame of reference. Let $\vec{A}$ be a unit vector along the axis of rotation and $\vec{B}$ be a unit vector along the resultant force on a particle P of the body away from the axis. The value of $\vec{A} \cdot \vec{B}$ is – (a) 1 (b) -1 (c) 0 (d) None of these
Q-24	A particle moves with a constant velocity parallel to the X-axis. Its angular momentum with respect to origin is – (a) Zero (b) Remains constant (c) Goes on increasing (d) Goes on decreasing
Q-25	A body is in pure rotation. The linear speed v of a particle, the distance r of the particle from the axis and the angular velocity ω, such that $\omega = \frac{v}{r}$. Thus – (a) $\omega \propto \frac{1}{r}$ (b) $\omega \propto r$ (c) $\omega = 0$ (d) ω is independent of r
Q-26	Figure shows a small wheel fixed coaxially on a bigger wheel of double of its radius. The system rotates about a common axis. The strings supporting masses A and B do not slip on the wheels. If x and y are distances travelled by masses A and B in the same intrval, then – (a) $x = 2y$ (b) $x = y$ (c) $y = 2x$ (d) None of these 

Q-27	A body is rotating uniformly about a vertical axis fixed in an inertial frame. The resultant force on a particle of the body not on the axis is – (a) Vertical (b) Horizontal and skew with the axis (c) Horizontal and intersecting the axis (d) None of these
Q-28	A body is rotating non-uniformly about a vertical axis in an inertial frame. The resultant force on a particle of the body not on the axis is – (a) Vertical (b) Horizontal and skew with the axis (c) Horizontal and intersecting the axis (d) None of these
Q-29	Let a force $\vec{F}$ is acting on a particle which has position vector $\vec{r}$. Let $\vec{\Gamma}$ be the torque of this force about the origin, then – (a) $\vec{r}\cdot\vec{\Gamma}=0$ and $\vec{F}\cdot\vec{\Gamma}=0$ (b) $\vec{r}\cdot\vec{\Gamma}=0$ and $\vec{F}\cdot\vec{\Gamma}\neq 0$ (c) $\vec{r}\cdot\vec{\Gamma}\neq 0$ and $\vec{F}\cdot\vec{\Gamma}=0$ (d) $\vec{r}\cdot\vec{\Gamma}\neq 0$ and $\vec{F}\cdot\vec{\Gamma}\neq 0$
Q-30	One end of a uniform rod of mass m and length l is clamped. The rod lies on a smooth horizontal surface and rotates on it about the clamped end at a uniform angular velocity ω. The force exerted by the clamp on the rod has a horizontal component – (a) $m\omega^2 l$ (b) Zero (c) mg (d) $\frac{1}{2}m\omega^2 l$
Q-31	A uniform rod is kept of length l is kept vertically on a horizotal smooth surface at a point O. It it is rotated slightly and released, it will fall down on the horizontal surface. The lower end will remain – (a) At O (b) At a distance less than $\frac{l}{2}$ from O (c) At a distance less than $\frac{l}{2}$ from O (d) At a distance larger than $\frac{l}{2}$ from O
Q-32	A circular disc P of radius r is made up of of iron plate of uniform thickness t and another circular disc Q of radius $4r$ is made up of iron plate of thickness $\frac{t}{4}$. The relation between moment of inertial I_P and I_Q is - (a) $I_P > I_Q$ (b) $I_P = I_Q$ (c) $I_P < I_Q$ (d) Depends upon actual values of t and r.
Q-33	Equal torques act on the Two circular discs A and B having radius r and uniform thickness t and another circular of radius $4r$ is made upof iron plate of thickness $\frac{t}{4}$, are made up of same material. At some instant linear speed of a point on rim of A and B are v_A and v_B, respectively. Then, (a) $v_A > v_B$ (b) $v_A = v_B$ (c) $v_A < v_B$ (d) Depends on actual magnitude of torque

Q-34	A closed cylindrical tube containing some water (not filling the entire tube) lies in a horizontal plane. If the tube is rotated about a perpendicular bisector, the moment of inertia of water about the axis – (a) Increases (b) Decreases (c) Remains constant (d) Increases if the rotation is clockwise and decreases if it is is anti-clockwise
Q-35	The moment of inertia of a uniform semicircular wire of mass M and radius r about a line perpendicular to the plane of wire through the centre is – (a) Mr^2 (b) $\frac{1}{2}Mr^2$ (c) $\frac{1}{4}Mr^2$ (d) $\frac{2}{5}Mr^2$
Q-36	If I_1 and I_2 are the moment of inertia of two bodies of identical geometry. The first is made of Aluminium and second is of iron. Then – (a) $I_1 < I_2$ (b) $I_1 = I_2$ (c) $I_1 > I_2$ (d) Relation between I_1 and I_2 depends upon actual shape of the bodies.A
Q-37	A body having its centre of mass at the origin has three of its particles at $(a,0,0)$, $(0,a,0)$ and $(0,0,a)$. The moments of inertia of the system of masses about X-axis and Y-axis are 0.20 kg. m² . Then the moment of inertia about Z-axis is – (a) 0.20 kg. m² (b) 0.40 kg. m² (c) 0.10 kg. m² (d) Cannot be deduced with the given information
Q-38	A cubical block of mass m and edge a slides down a rough inclined plane at an inclination θ with a uniform velocity. The torque of the normal force on the block about its centre has a magnitude – (a) Zero (b) mga (c) $mga\sin\theta$ (d) $\frac{1}{2}mga\cos\theta$
Q-39	A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles of mass m each are attached to to the ring at diametrically opposite point. The angular speed of the ring will become – (a) $\frac{\omega M}{M+m}$ (b) $\frac{\omega M}{M+2m}$ (c) $\frac{\omega(M-2m)}{M+2m}$ (d) $\frac{\omega(M+2m)}{M}$
Q-40	A person sitting firmly over a rotating stool has his arms stretched. If he folds his arms, his angular momentum about axis of rotation would – (a) Increase (b) Decrease (c) Remain unchanged (d) Doubles
Q-41	Centre of a wheel rolling on a plane surface move with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at speed - (a) Zero (b) v_0 (c) $\sqrt{2}v_0$ (d) $2v_0$

Q-42	A wheel of radius 20 cm is pushed to move it on a rough horizontal surface. It is found to move through a distance of 60 cm on the road during the time its completes one revolution about the centre, Assume that the linear and angular acceleration is uniform. The frictional force acting on the wheel by the surface is – (a) Along the velocity of the wheel (b) Opposite to the velocity of the wheel (c) Perpendicular to the velocity of the wheel (d) Zero
Q-43	The angular velocity of the engine (and hence of the wheel) of a scooter is proportional to the petrol input per second. The scooter is moving on a frictionless road with unform velocity. If petrol input is increased by 10%, the linear velocity of scooter is increased by – (a) 50% (b) 10% (c) 20% (d) 0%
Q-44	A solid sphere, a hollow sphere and a disc, all having same mass and radius, are placed at the top of a smooth incline and released. Least time will be taken in reaching the bottom by – (a) The sold sphere (b) The hollow sphere (c) The disc (d) All will take same time
Q-45	A solid sphere, a hollow sphere and a disc, all having same mass and radius, are placed at the top of a incline plane and released. Frictional coefficients between the objects and the incline are same and not sufficient to allow pure rolling. Least time will be taken in reaching the bottom by – (a) The sold sphere (b) The hollow sphere (c) The disc (d) All will take same time
Q-46	A solid sphere, a hollow sphere and a disc, all having same mass and radius, are placed at the top of a smooth incline and released. Frictional coefficients between the objects and the incline are same and not sufficient to allow pure rolling. Smallest kinetic energy at the bottom of the incline will be achieved by – (a) The sold sphere (b) The hollow sphere (c) The disc (d) All achience the same kinetic energy
Q-47	A string of negligible thickness is wraped several times around a cylinder kept on a rough horizontal surface. A man standing at a distance l from the cylinder holds one end of the string and pulls the cylinder towards him as shown in the figure. There is no slipping anywhere. The length of the string passed through the hand of the man while the cylinder reaches his hands is –  (a) l (b) $2l$ (c) $3l$ (d) $4l$
Q-48	Axis of rotation of a purely rotating body – (a) Must pass through the centre of mass (b) May pass through the centre of mass (c) Must pass through a particle of the body (d) May pass through a particle of the body
Q-49	Consider following two equtions : (A) $L = I\omega$ (B) $\frac{dL}{dt} = \Gamma$, then in noninertial frame – (a) Both A and B are true (b) A is true but B is false (c) B is true but A is false (d) Both A and B are false

Q-50	A particle moves on a straight line with a uniform velocity. Its angular momentum is (a) Always zero (b) Zero about a point on the straight line (c) Not zero about a point away from the straight line (d) Remains constant about any given point
Q-51	If there is no external force acting on a rigid body, which of the following quantities must remain constant ? (a) Angular momentum (b) Linear momentum (c) Kinetic energy (d) Moment of inertia
Q-52	Let I_A and I_B be moment of inertia of a body about two axes A and B respectively. The axis A passes through the centre of mass of the body but B does not. Then – (a) $I_A < I_B$ (b) If $I_A < I_B$, the axes are parallel (c) If axes are parallel, $I_A < I_B$ (d) If axes are not parallel then $I_A \geq I_B$
Q-53	A sphere is rotating about a diameter. Then- (a) The particles on the surface of the sphere do not have any linear acceleration (b) The particles on the diameter do not have any linear acceleration (c) Different particles on the surface have different angular speed (d) All particles on the surface have same linear speed.
Q-54	The density of a rod gradually decreases from one end to the other. It is pivoted at an end so that it can move about a vertical axis passing through the pivot. A horizontal force F is applied on the free end in a diretion perpendicular to the rod. The quantities that do not depend on which end of the rod is pivoted are – (a) Angular acceleration (b) Angular velocity when rod completes one revolution (c) Angular momentum when rod completes one rotation (d) Torque of the applied force
Q-55	Consider a wheel of a bicycle rolling on a level road at a linear velocity $\vec{v}_0$ as shown in the figure . Then- (a) Speed of particle A is zero (b) Speed of particles B, C and D are all equal to v_0 (c) Speed of C is $2v_0$ (d) Speed of B is greater than the speed of O 
Q-56	Two uniform solid spheres having unequal masses and unequal radii are released from rest from the same height on a rough inclined plane. If sphere rolls without slipping, then – (a) The heavier sphere reaches the bottom first (b) The bigger sphere reaches the bottom first (c) The two two sphere reach the bottom together (d) The information given is insufficient to answer which sphere will reach the bottom first.

Q-57	A hollow sphere and a solid sphere having same mass and same radii are rolled down a rough inclined plane. Then – (a) The hollow sphere reaches the bottom first (b) The solid sphere reaches the bottom with greater speed (c) The solid sphere reaches the bottom with greater kinetic energy (d) The two spheres will reach the bottom with same linear momentum
Q-58	A sphere cannot roll on a – (a) Smooth horizontal surface (b) Smooth inclined surface (c) Rough horizontal surface (d) Rough inclined surface
Q-59	In rear-wheel drive cars, the engine rotates the rear wheels and the front wheels rotate only because the car moves. If such a car accelerates on a horizontal road, the friction – (a) On the rear wheel is in forward direction (b) On the front wheel is in backward direction (c) On the rear wheel has a larger magnitude than the friction on the front wheel (d) On the car is in the backward direction
Q-60	A sphere can roll on a surface inclined at an angle θ if the frictional coefficient is more than $\frac{2}{7} g \tan\theta$. Suppose the coefficient of friction is $\frac{1}{7} g \tan\theta$. If sphere is released from rest on the incline then – (a) It will stay at rest (b) It will make pure translational motion (c) It will translate and rotate about the centre (d) The anglar moentum of the sphere aboiut its centre will remain constant
Q-61	A sphere is rolled on a rough horizontal surface. It gradually slows down and stops. The force of friction tries to – (a) Decrease the linear velocity (b) Increase the angular velocity (c) Increase the linear momentum (d) Decrease the angular momentum
Q-62	As shown in the figure, a smooth plane inclined at an angle θ is fixed in a car. The car is having an acceleration $a = g \tan\theta$ on a horizontal road. If the sphere is set in pure rolling on the incline then-  (a) It will continue pure rolling (b) It will slip down the plane (c) Its linear velocity will increase (d) Its linear velocty will slowly decrease