OBJECTIVE UNSOLVED LEVEL - I

1. A body having its centre of mass at the origin has three of its particles (a, 0, 0), (0, a, 0), (0, 0, a). The moments of inertia of the body about the X and Y axes are 0.2 kg-m^2 each. The moment of inertia about the Z-axis
   (a) is 0.20 kg-m^2 (b) is 0.40 kg-m^2
   (c) is $0.20\sqrt{2}$ kg-m^2 (d) cannot be deduced with this information.

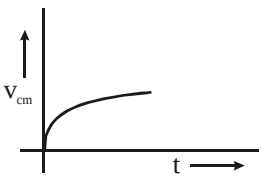
2. The ratio of the radii of gyration of a circular disc and a circular ring of the same masses and radii about a tangential axis parallel to the their planes is
   (a) $\sqrt{6}:\sqrt{5}$ (b) $1:\sqrt{2}$
   (c) $\sqrt{5}:\sqrt{6}$ (d) none of these.

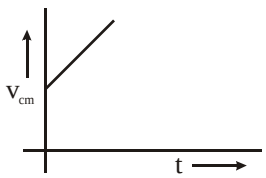
3. Let $\vec{F}$ be a force acting on a particle having position vector $\vec{r}$. Let $\vec{\Gamma}$ be the torque of this force about the origin, then
   (a) $\vec{r}.\vec{\Gamma}=0$ and $\vec{F}.\vec{\Gamma}=0$ (b) $\vec{r}.\vec{\Gamma}=0$ but $\vec{F}.\vec{\Gamma}\neq 0$
   (c) $\vec{r}.\vec{\Gamma}\neq 0$ but $\vec{F}.\vec{\Gamma}\neq 0$ (c) $\vec{r}.\vec{\Gamma}\neq 0$ and $\vec{F}.\vec{\Gamma}\neq 0$

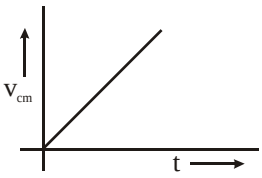
4. A body is in pure rotation. The linear speed v of a particle, the distance r of the particle from the axis and the angular ω of the body are related as $\omega = v/r$. Thus
   (a) $\omega\alpha\dfrac{1}{r}$ (b) $\omega\alpha r$
   (c) $\omega=0$ (d) ω is independent of r.

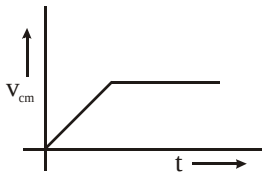
5. A mass m is moving with a constant velocity parallel to the x-axis. Its angular momentum w.r.t. the origin
   (a) 0 (b) remains constant
   (c) goes on increasing (d) goes on decreasing.

6. A unifrom disc of radius r is rotated in clockwise sense with angular speeds ω and kept vertical on a rough surface. Which of the graph of V_{cm} - t is correct.

(a) 

(b) 

(c) 

(d) 

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7. A unifrom sphere of mass m and radius r rolls without slipping down a inclined plane, inclined at an angle 45^0 to the horizontal. Find the magnitude of frictional coefficient at which slipping is absent.

(a) $\frac{1}{3}$ (b) $\frac{2}{7}$

(c) $\frac{1}{5}$ (d) $\frac{1}{7}$.

8. A hollow sphere and a solid sphere having same mass and same radii are rolled down on a rough inclined plane
(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 .

9. 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 solid sphere (b) the hollow sphere
(c) the disc (d) all will take same time.

10. A hoop of radius r, mass m kg. It rolls along a horizontal floor so that its centre of mass has a speed v m/s. How much work has to be done to stop it ?

(a) $\frac{1}{2}mv^2$ (b) mv^2

(c) $2mv^2$ (d) $\frac{1}{3}mv^2$.

11. In rear-wheel drive cars, the engine rotates the rear wheels and the front wheels rotate only because the cars moves. If such a car accelerates on a horizontal road, the friction (Indicate the **FALSE** statement)
(a) on the rear wheels is in the forward direction
(b) on the front wheels is in the backward direction
(c) on the rear wheels has larger magnitude than the friction on the front wheels
(d) on the car is in the backward direcition.

12. The centre of a wheel rolling on plane surface moves 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) $2v_{0.}$

13. A thin circular ring of mass M and radius R is rotating about its axis with a constant angular velocity ω. Two objects, each of mass m are attached gently to the opposite ends of the diameter of the ring. The wheel now rotates with an angular velocity.

(a) $\frac{\omega M}{(M+m)}$ (b) $\left(\frac{(M-2m)}{(M+2m)}\right)\omega$

(c) $\left(\frac{M}{(M+2m)}\right)\omega$ (d) $\left(\frac{(M+2m)}{M}\right)\omega$.

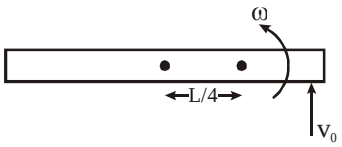
14. A uniform rod of length $2l$ is placed with one end in contact with the horizontal table and is then inclined at an angle α to the horizontal and allowed to fall. When it becomes horizontal, its angular velocity will be

(a) $\omega = \sqrt{\left(\frac{3g\sin\alpha}{2l}\right)}$ (b) $\omega = \sqrt{\left(\frac{2l}{3g\sin\alpha}\right)}$

(b) $\omega = \sqrt{\left(\frac{g\sin\alpha}{l}\right)}$ (d) $\omega = \sqrt{\left(\frac{l}{g\sin\alpha}\right)}$.

OBJECTIVE UNSOLVED LEVEL - II

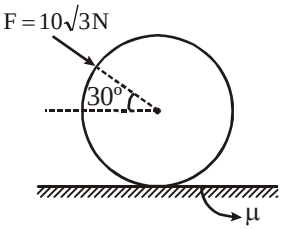
1. A stick of length l and mass m lies on a frictionless horizontal surface on which it is free to move in any direction. A ball of same mass m moving with speed v_0 perpendicularly to this length collides at the end of stick. Find the angular velocity when the ball sticks to the end of the stick.



(a) $\frac{12}{7}\frac{v_0}{l}$ (b) $\frac{6v_0}{5l}$

(c) $\frac{24v_0}{5l}$ (d) $\frac{3v_0}{7l}$.

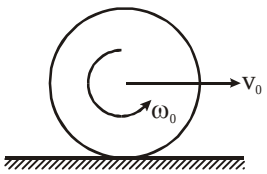
2. A hollow sphere of mass 2kg is kept on a rough horizontal surface. A force of $10\sqrt{3}$N is applied as shown in the figure. Find the minimum value of 'μ' so that the sphere starts pure rolling. (Take g = 10 m/s²)



(a) 0.3 (b) 0.2

(c) 0.1 (d) for no value of μ it will start pure rolling.

3. A uniform circular disc of radius r is placed on a rough horizontal surface and given a linear velocity v_0 and angular velocity ω_0 as shown. The disc comes to rest after moving some distance to the right. It follows that



(a) $3v_0 = 2\omega_0 r$ (b) $2v_0 = \omega_0 r$

(c) $v_0 = \omega_0 r$ (d) $2v_0 = 3\omega_0 r$.

4. A hollow sphere of outer radius R is allowed to roll down on an incline without slipping and it reaches with a speed v_0 at the bottom of the incline. The incline is then made smooth by waxing and the sphere is allowed to slide without rolling and now the speed attained is $\frac{5}{4}v_0$. What is the radius of gyration of the sphere about an axis passing its centre ?

(a) $\sqrt{\frac{2}{5}}R$ (b) $\frac{3R}{4}$

(c) $\frac{4R}{5}$ (d) $\sqrt{\frac{2}{3}}R$.

5. A hollow straight tube of length $2l$ and mass m can turn freely about its centre on a smooth horizontal table. Another smooth uniform rod of same length and mass is fitted into the tube so that their centres coincide. The system is set in motion with an initial angular velocity ω_0. Find the angular velocity of the tube at the instant when the rod slips out of the tube.

(a) $\frac{\omega_0}{4}$ (b) $\frac{\omega_0}{5}$

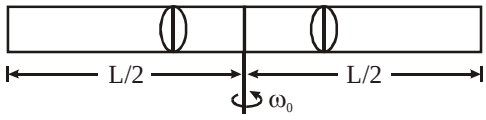
(c) $\frac{\omega_0}{7}$ (d) $\frac{\omega_0}{2}$.

6. A pendulum consists of a wooden bob of mass m and length *l*. A bullet of mass m_1 is fired towards the pendulum with a speed v_1. The bullet emerges out with a velocity $\frac{v_1}{3}$ and the bob just completes the motion along a vertical circle. Then v_1 is

(a) $\frac{3}{2}\left(\frac{m}{m_1}\right)\sqrt{5gl}$ (b) $\left(\frac{m}{m_1}\right)\sqrt{5gl}$

(c) $\frac{3}{2}\left(\frac{m}{m_1}\right)\sqrt{gl}$ (d) $\left(\frac{m}{m_1}\right)\sqrt{5gl}$.

7. A smooth uniform rod of length, L and mass M has two identical beads of negligible size, each of mass m, which can slide freely along the rod. Initially, the two beads are at the centre of the rod and the system is rotating with an angular velocity ω_0 about an axis perpendicular to the rod and passing through the midpoint of the rod.



There is no external force when the beads reach at the ends of the rod. The angular velocity of the system at that instant is

(a) $\omega_0\sqrt{\frac{M}{M+6m}}$ (b) $\frac{M\omega_0}{M+6m}$

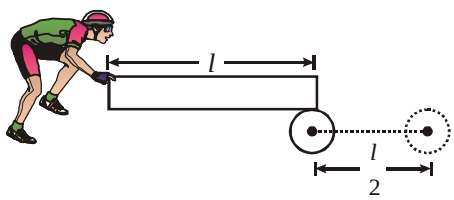
(c) ω_0 (d) zero.

8. A fly wheel rotates about an axis. Due to friction at the axis, it experiences angular retardation proportional to its angular velocity. If its angular velocity falls to half the value while it makes n revolutions, how many more revolutions will it make before coming to rest ?

(a) 2n (b) n

(c) n/2 (d) n/3.

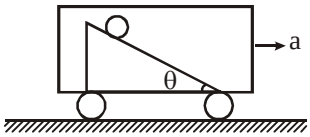
9. A man pushes a cylindrical drum through a board of length *l* as shown in figure. The drum rolls forward on the ground a distance of *l*/2. There is no slipping at any instant. During the process of pushing the board the distance moved by the man on the ground is



(a) *l*/2 (b) 3 *l*/4

(c) *l* (d) 3*l*/8.

10. Figure shows a smooth inclined plane fixed in a car accelerating on a horizontal road. The angle of incline θ is related to the acceleration a of the car as $a = g \tan\theta$. If the sphere is set in pure rolling on the incline



(a) It will continue pure rolling
(b) it will slip down the plane
(c) its linear velocity will increase
(d) its linear velocity will decrease.

11. A sphere is rotating about a diameter.
(a) The particles on the surface of the sphere do not have any linear acceleration.
(b) The particles on the diameter mentioned above do not have any linear acceleration.
(c) Different particles on the surface have different angular speeds.
(d) All the particles on the surface have same linear speed.

12. A cubical block of mass M and edge *a* slides down a rough inclined plane of 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) $Mg(a/2)\sin\theta$
(d) $Mga\cos\theta$.

13 A rod of length L is hinged from one end. It is brought to a horizontal position and then released. The angular velocity of the rod when it is in vertical position is

(a) $\sqrt{\frac{2g}{L}}$
(b) $\sqrt{\frac{3g}{L}}$
(c) $\sqrt{\frac{g}{2L}}$
(d) $\sqrt{\frac{g}{L}}$.

14. A uniform rod AB of mass m and length *l* at rest on a smooth horizontal surface. An impulse P is applied to the end B. The time taken by the rod to turn through a right angle is
(a) $\pi ml/12P$
(b) $\pi ml/6P$
(c) $ml/6P$
(d) none of these.

15. Two uniform solid spheres having unequal masses and unequal radii are released from rest from the same height on a rough incline. If the spheres roll without slipping.
(a) the heavier sphere reaches the bottom first
(b) the bigger sphere reaches the bottom first
(c) the two spheres reach the bottom together
(d) the information given is not sufficient to tell which sphere will reach the bottom first.