# ROTATION (LEVEL 1)

<u>Select the correct alternative (only one correct answer)</u>

**1.** On account of the earth rotating about its axis :-
(A) the linear velocity of objects at equator is greater than at other places
(B) the angular velocity of objects at equator is more than that of objects at poles
(C) the linear velocity of objects at all places at the earth is equal, but angular velocity is different
(D) at all places the angular velocity and linear velocity are uniform

**2.** A fly wheel originally at rest is to reach an angular velocity of 36 radian/s in 6 second. The total angle it turns through in the 6 second is
(A) 54 radian (B) 108 radian (C) 6 radian (D) 216 radian

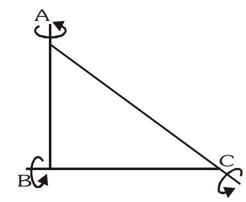
**3.** The rotating rod starts from rest and acquires a rotational speed n = 600 revolution/minute in 2 seconds with constant angular acceleration. The angular acceleration of the rod is
(A) $10\pi$ rad/s$^2$ (B) $5\pi$ rad/s$^2$ (C) $15\pi$ rad/s$^2$ (D) None of these

**4.** The number of revolutions must the 60 cm diameter wheel of a car turn as the car travels 2.5 km is
(A) 8000 revolution (B) 1000 revolution (C) 1330 revolution (D) 500 revolution

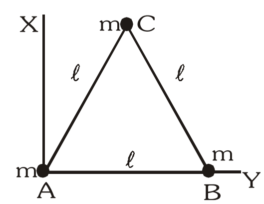
**5.** Two gear wheels which are meshed together have radii of 0.50 cm and 0.15 cm. The number of revolutions does the smaller turns when the larger turns through 3 revolution is
(A) 5 revolution (B) 20 revolution (C) 1 revolution (D) 10 revolution

**6.** The radius of a wheel of a car is 0.4m. The car is accelerated from rest by an angular acceleration of 1.5 rad/s$^2$ for 20s. The linear velocity of the wheel is
(A) 10 m/s (B) 3 m/s (C) 12 m/s (D) 2 m/s

**7.** In the adjoining figure along which axis the moment of inertia of the triangular lamina will be maximum- [Given that AB < BC < AC]
(A) AB
(B) BC
(C) CA
(D) For all axis



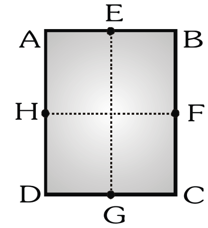

**8.** Three particles, each of mass m are situated at the vertices of an equilateral triangle ABC of side $\ell$ cm (as shown in the figure). The moment of inertia of the system about a line AX perpendicular to AB and in the plane of ABC, in gram cm$^2$ units will be :–




(A) $2\,m\ell^2$ (B) $\frac{5}{4}m\ell^2$ (C) $\frac{3}{2}m\ell^2$ (D) $\frac{3}{4}m\ell^2$

**9.** A circular disc is to be made by using iron and aluminium so that it acquired maximum moment of inertia about geometrical axis. It is possible with :–
(A) aluminium at interior and iron surrounded to it.
(B) iron at interior and aluminium surrounded to it.
(C) using iron and aluminium layers in alternate order.
(D) sheet of iron is used at both external surface and aluminium sheet as internal layer.

**10.** We have a rectangular slab of same thickness. E, F, G, H are the middle point of AB, BC, CD and AD respectively then which of the following axis the moment of inertia will be minimum :–
(A) AD (B) EG
(C) BD (D) HF




**11.** Two disc one of density 7.2 g/cm$^3$ and the other of density 8.9 g/cm$^3$ are of same mass and thickness. Their moments of inertia are in the ratio :–
(A) $\frac{8.9}{7.2}$ (B) $\frac{7.2}{8.9}$ (C) (8.9 7.2) : 1 (D) 1 : (8.9 7.2)

**12.** Off two eggs which have identical sizes, shapes and weights, one is raw and the other is half-boiled. The ratio between the moment of inertia of the raw egg and that of the half-boiled egg about a central axis is :–

(A) one (B) greater than one (C) less than one (D) incomparable

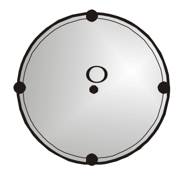
**13.** The moment of inertia of a thin uniform rod of mass M and length $\ell$ about an axis perpendicular to the rod, through its centre is I. The moment of inertia of the rod about an axis perpendicular to the rod through its end point is :–

(A) I/4 (B) I/2 (C) 2I (D) 4I

**14.** The moment of inertia of a rod about an axis through its centre and perpendicular to it is $\frac{1}{12}ML^2$ (where M is the mass and L is the length of the rod). The rod is bent in the middle so that the two half make an angle of 60 . The moment of inertia of the bent rod about the same axis would be :–

(A) $\frac{1}{48}ML^2$ (B) $\frac{1}{12}ML^2$ (C) $\frac{1}{24}ML^2$ (D) $\frac{ML^3}{8\sqrt{3}}$

**15.** Four similar point masses (each of mass m) are placed on the circumference of a disc of mass M and radius R. The M.I. of the system about the normal axis through the centre O will be:-




(A) $MR^2 + 4mR^2$ (B) $\frac{1}{2}MR^2 + 4mR^2$

(C) $MR^2 + \frac{8}{5}mR^2$ (D) None of these

**16.** Two rings of the same radius and mass are placed such that their centres are at a common point and their planes are perpendicular to each other. The moment of inertia of the system about an axis passing through the centre and perpendicular to the plane of one of the rings is (mass of the ring = m, radius = r) :–

(A) $\frac{1}{2}mr^2$ (B) $mr^2$ (C) $\frac{3}{2}mr^2$ (D) $2mr^2$

**17.** Three point masses, each of m, are placed at the corners of an equilateral triangle of side $\ell$. Then the moment of inertia of this system about an axis along one side of the triangle is :–

(A) $3\,m\ell^2$ (B) $m\ell^2$ (C) $\frac{3}{4}m\ell^2$ (D) $\frac{3}{2}m\ell^2$

**18.** Two rods each of mass m and length $\ell$ are joined at the centre to form a cross. The moment of inertia of this cross about an axis passing through the common centre of the rods and perpendicular to the plane formed by them, is :–

(A) $\frac{m\ell^2}{12}$ (B) $\frac{m\ell^2}{6}$ (C) $\frac{m\ell^2}{3}$ (D) $\frac{m\ell^2}{2}$

**19.** If the mass of hydrogen atom is 1.7 $10^{-24}$ g and interatomic distance in a molecule of hydrogen is 4 $10^{-8}$ cm, then the moment of inertia [in kg-m$^2$] of a molecule of hydrogen about the axis passing through the centre of mass and perpendicular to the line joining the atoms will be:–

(A) 6.8 $10^{-32}$ (B) 1.7 $10^{-24}$ (C) 13.6 $10^{-27}$ (D) 13.6 $10^{-47}$

**20.** If a body completes one revolution in $\pi$ sec then the moment of inertia would be:–

(A) Equal to rotational kinetic energy (B) Double of rotational kinetic energy

(C) Half of rotational kinetic energy (D) Four times of the rotational kinetic energy

**21.** For the same total mass which of the following will have the largest moment of inertia about an axis passing through its centre of mass and perpendicular to the plane of the body

(A) a disc of radius a (B) a ring of radius a

(C) a square lamina of side 2a (D) four rods forming a square of side 2a

**22.** Two rods of equal mass m and length $\ell$ lie along the x axis and y axis with their centres origin. What is the moment of inertia of both about the line x=y :

(A) $\frac{m\ell^2}{3}$ (B) $\frac{m\ell^2}{4}$ (C) $\frac{m\ell^2}{12}$ (D) $\frac{m\ell^2}{6}$

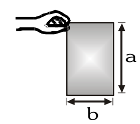
23. A rigid body can be hinged about any point on the x-axis. when it is hinged such that the hinge is at x, the moment of inertia is given by $I = x^2 - 2x + 99$. The x-coordinate of centre of mass is :–
(A) x=2 (B) x=0 (C) x=1 (D) x=3

24. The axis X and Z in the plane of a disc are mutually perpendicular and Y-axis is perpendicular to the plane of the disc. If the moment of inertia of the body about X and Y axes is respectively 30 kg $m^2$ and 40 $kgm^2$ then M.I. about Z-axis in kg $m^2$ will be:–
(A) 70 (B) 50 (C) 10 (D) Zero

25. A wheel is rotating about an axis through its centre at 720 rpm. It is acted on by a constant torque opposing its motion for 8 second to bring it to rest finally. The value of torque in Nm is :– (given $I = \frac{24}{\pi} kg - m^2$)
(A) 48 (B) 72 (C) 96 (D) 120

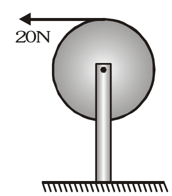
26. A rod of mass M and length L is placed in a horizontal plane with one end hinged about the vertical axis. A horizontal force of $F=\frac{Mg}{2}$ is applied at a distance $\frac{5L}{6}$ from the hinged end. The angular acceleration of the rod will be :-
(A) $\frac{4g}{5L}$ (B) $\frac{5g}{4L}$ (C) $\frac{3g}{4L}$ (D) $\frac{4g}{3L}$

27. A person supports a book between finger and thumb as shown (the point of grip is assumed to be at the corner of the book). If the book has a weight of W then the person is producing a torque on the book of



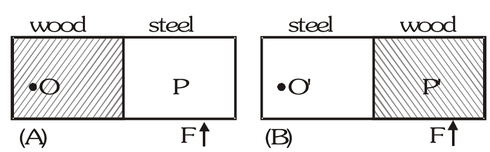

(A) $W\frac{a}{2}$ anticlockwise (B) $W\frac{b}{2}$ anticlockwise (C) Wa anticlockwise (D) Wa clockwise

28. A string is wrapped around the rim of a wheel of moment of inertia 0.20 kg-$m^2$ and radius 20 cm. The wheel is free to rotate about its axis and initially the wheel is rest. The string is now pulled by a force of 20N. The angular velocity of the string after 5 seconds will be :–



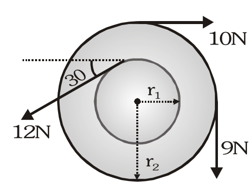

(A) 90 rad/s (B) 70 rad/s
(C) 95 rad/s (D) 100 rad/s

29. In the figure (A) half of the meter scale is made of wood while the other half of steel. The wooden part is pivoted at O. A force F is applied at the end of steel part. In figure (B) the steel part is pivoted at O' and the same force is applied at the wooden end:–



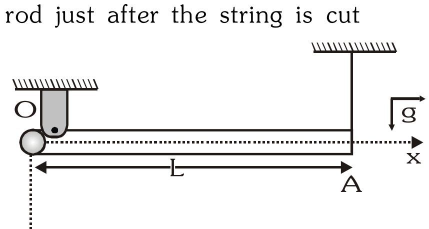

(A) More angular acceleration will be produced in (A)
(B) More angular acceleration will be produced in (B)
(C) Same angular acceleration will be produced in both conditions
(D) Information is incomplete

30. In the following figure $r_1$ and $r_2$ are 5 cm and 30 cm respectively. If the moment of inertia of the wheel is 5100 kg-$m^2$ then its angular acceleration will be :-




(A) $10^{-4}$ rad/sec$^2$ (B) $10^{-3}$ rad/sec$^2$
(C) $10^{-2}$ rad/sec$^2$ (D) $10^{-1}$ rad/sec$^2$

31. A non uniform rod OA of liner mass density $\lambda = \lambda_0 x$ $(\lambda_0 = \text{const.})$ is suspended from ceiling with hinge joint O & light string as shown in figure. Find the angular acceleration of rod just after the string is cut

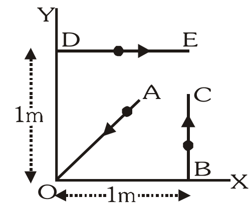



(A) $\frac{2g}{L}$ (B) $\frac{g}{L}$
(C) $\frac{4g}{3L}$ (D) None of these

**32.** If the earth is a point mass of $6 \quad 10^{24}$ kg revolving around the sun at a distance of $1.5 \quad 10^{8}$ km and in time T= $3.14 \quad 10^{7}$ second, then the angular momentum of the earth around the sun is :–

(A) $1.2 \quad 10^{18}$ kg $m^2/s$ (B) $1.8 \quad 10^{20}$ kg $m^2/s$ (C) $1.5 \quad 10^{37}$ kg $m^2/s$ (D) $2.7 \quad 10^{40}$ kg $m^2/s$

**33.** A particle of mass m moves with a constant velocity. Which of the following statements is not correct about its angular momentum :



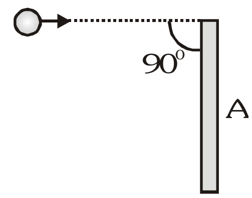

(A) it is zero when it is at A and moving along OA

(B) the same at all points along the line DE

(C) of the same magnitude but oppositely directed at B and D

(D) increases as it moves along the line BC

**34.** A thin rod of mass M and length L is struck at one end by a ball of clay of mass m, moving with speed v as shown in figure. The ball sticks to the rod. After the collision, the angular momentum of the clay-rod system about A, the midpoint of the rod, is




(A) $\left(m+\frac{M}{3}\right)\left(\frac{vL}{2}\right)$ (B) $\left(m+\frac{M}{12}\right)\left(\frac{vL}{2}\right)$

(C) $\frac{mvL}{2}$ (D) mvL

**35.** If the earth were to suddenly contract to $\frac{1}{n}$th of its present radius without any change in its mass then the duration of the new day will be nearly :–

(A) $\frac{24}{n}$ hour (B) 24n hour (C) $\frac{24}{n^2}$ hour (D) $24n^2$ hour

**36.** The angular velocity of a body changes from $\omega_1$ to $\omega_2$ without applying torque. The ratio of initial radius of gyration to the final radius of gyration is :–

(A) $\sqrt{\omega_2} : \sqrt{\omega_1}$ (B) $\sqrt{\omega_1} : \sqrt{\omega_2}$ (C) $\omega_2 : \omega_1$ (D) $\omega_1 : \omega_2$

**37.** A circular turn table has a block of ice placed at its centre. The system rotates with an angular speed $\omega$ about an axis passing through the centre of the table. If the ice melts on its own without any evaporation, the speed of rotation of the system :–

(A) becomes zero (B) remains constant at the same value of $\omega$

(C) increases to value greater than $\omega$ (D) decreases to a value less than $\omega$

**38.** A thin circular ring of mass M and radius 'r' is rotating about its axis with a constant angular velocity $\omega$. Four objects each of mass m, are kept gently to the opposite ends of two perpendicular diameters of the ring. The new angular velocity of the ring will be :–

(A) $\frac{M\omega}{4m}$ (B) $\frac{M\omega}{M+4m}$ (C) $\frac{(M+4m)\omega}{M}$ (D) $\frac{(M+4m)\omega}{M+4m}$

**39.** A person is standing on the edge of a circular platform, which is moving with constant angular speed about an axis passing through its centre and perpendicular to the plane of platform. If person is moving along any radius towards axis of rotation then the angular velocity will :–

(A) decrease (B) remain unchanged (C) increase (D) data is insufficient

**40.** An ant is sitting at the edge of a rotating disc. If the ant reaches the other end, after moving along the diameter, the angular velocity of the disc will :-

(A) remain constant (B) first decreases and then increases

(C) first increases, then decrease (D) Increase continuously

41. A boy stands over the centre of a horizontal platform which is rotating freely with a speed of 2 revolutions/s about a vertical axis through the centre of the platform and straight up through the boy. He holds 2 kg masses in each of his hands close to his body. The combined moment of inertia of the system is 1 kg-m.$^2$. The boy now stretches his arms so as to hold the masses far from his body. In this situation the moment of inertia of the system increases to 2 kg-m.$^2$. The kinetic energy of the system in the latter case as compared with that in the previous case will-

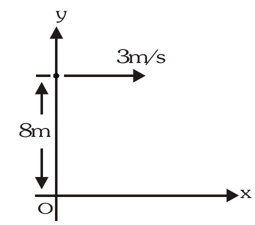
(A) Remain unchanged (B) Decrease (C) Increase (D) Remain uncertain

42. A horizontal platform is rotating with uniform angular velocity around the vertical axis passing through its centre. At some instant of time a viscous fluid of mass ''m'' is dropped at the centre and is allowed to spread out and finally fall. The angular velocity during this period :–

(A) Decreases continuously (B) Decreases initially and increases again

(C) Remains unaltered (D) Increases continuously

43. A particle starts from the point (0m, 8m) and moves with uniform velocity of $3\hat{i}$ m/s. After 5 seconds, the angular velocity of the particle about the origin will be




(A) $\frac{8}{289}$ rad/s (B) $\frac{3}{8}$ rad/s

(C) $\frac{24}{289}$ rad/s (D) $\frac{8}{17}$ rad/s

44. Two rotating bodies have same angular momentum but their moments of inertia are $I_1$ and $I_2$ respectively ($I_1>I_2$). Which body will have higher kinetic energy of rotation:–

(A) First (B) Second

(C) Both will have same kinetic energy (D) Not possible to predict

45. A thin rod of length L is suspended from one end and rotated with n rotations per second. The rotational kinetic energy of the rod will be:–

(A) $2mL^2\pi^2n^2$ (B) $\frac{1}{2}mL^2\pi^2n^2$ (C) $\frac{2}{3}mL^2\pi^2n^2$ (D) $\frac{1}{6}mL^2\pi^2n^2$

46. A rigid body of mass m rotates with angular velocity ω about an axis at a distance d from the centre of mass G. The radius of gyration about a parallel axis through G is K. The kinetic energy of rotation of the body is :–

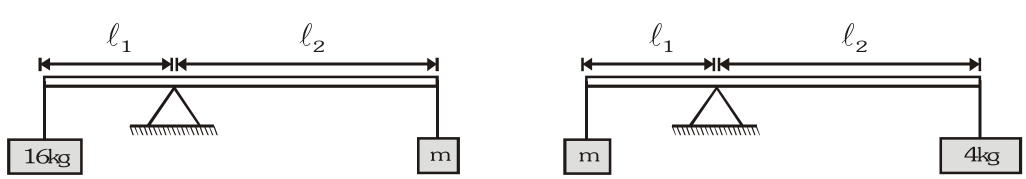
(A) $\frac{1}{2}mk^2\omega^2$ (B) $\frac{1}{2}md^2\omega^2$ (C) $\frac{1}{2}m(d^2+k^2)\omega^2$ (D) $\frac{1}{2}m(d+k)^2\omega^2$

47. A weightless rod is acted on by upward parallel forces of 2N and 4N at ends A and B respectively. The total length of the rod is AB =3 m. To keep the rod in equilibrium a force of 6N should act in the following manner:–

(A) Downwards at any point between A and B (B) Downwards at mid point of AB

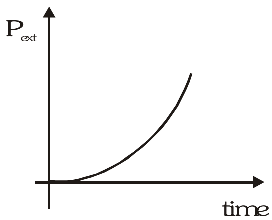
(C) Downwards at a point C such that AC =1m (D) Downwards at a point D such that BD =1m

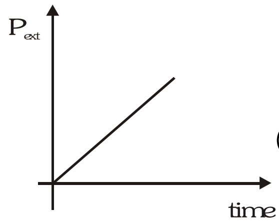
48. In an experiment with a beam balance an unknown mass m is balanced by two known masses of 16kg and 4 kg as shown in figure. The value of the unknown mass m is :–

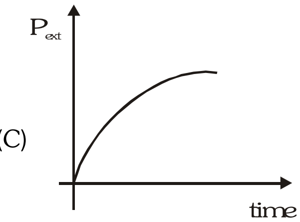


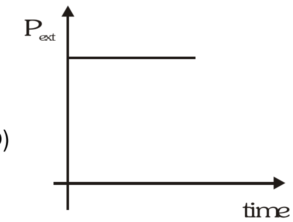

(A) 10 kg (B) 6 kg (C) 8 kg (D) 12 kg

49. A rod is hinged at its centre and rotated by applying a constant torque starting from rest. The power developed by the external torque as a function of time is :–

(A) 


(B) 


(C) 


(D) 


50. If a ring, a disc, a solid sphere and a cylinder of same radius rolls down on inclined plane, the first one to reach the bottom will be :–

(A) disc (B) ring (C) solid sphere (D) cylinder

51. A body is rolling without slipping on a horizontal surface and its rotational kinetic energy is equal to the translational kinetic energy. The body is :–

(A) disc (B) sphere (C) cylinder (D) ring

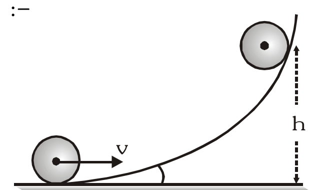
52. A solid cylinder of mass M and radius R rolls without slipping down an inclined plane of length L and height h. What is the speed of its centre of mass when the cylinder reaches its bottom :–

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

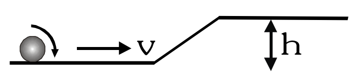
53. A disc of mass M and radius R rolls on a horizontal surface and then rolls up an inclined plane as shown in the figure. If the velocity of the disc is v, the height to which the disc will rise will be :–

(A) $\frac{3v^2}{2g}$ (B) $\frac{3v^2}{4g}$

(C) $\frac{v^2}{4g}$ (D) $\frac{v^2}{2g}$




54. A solid sphere is rolling on a frictionless surface, shown in figure with a translational velocity v m/s. If it is to climb the inclined surface then v should be:–

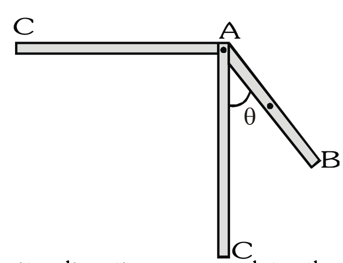



(A) $\geq \sqrt{10/7\,gh}$ (B) $> \sqrt{2gh}$ (C) 2gh (D) 10/7gh

55. A rod hinged at one end is released from the horizontal position as shown in the figure. When it becomes vertical its lower half separates without exerting any reaction at the breaking point. Then the maximum angle '$\theta$' made by the hinged upper half with the vertical is

(A) $30^0$ (B) $45^0$

(C) $60^0$ (D) $90^0$




56. There is rod of length $\ell$. The velocities of its two ends are $v_1$ and $v_2$ in opposite directions normal to the rod. The distance of the instantaneous axis of rotation from $v_1$ is :–

(A) Zero (B) $\frac{v_2}{v_1+v_2}\ell$ (C) $\frac{v_1\ell}{v_1+v_2}$ (D) $2\ell$

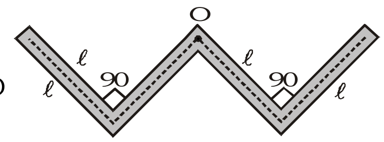
**ANSWER KEY** LEVEL -1

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | A | B | A | C | D | C | A | B | A | B | A | B | D | B | B | C | C | B | D | C |
| Que. | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| Ans. | D | C | C | C | B | B | B | D | B | B | C | D | D | C | C | A | D | B | C | C |
| Que. | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | | | | |
| Ans. | B | A | B | B | C | C | D | C | B | C | D | C | B | B | C | C | | | | |

# ROTATION (LEVEL 2)

<u>Select the correct alternatives (one or more than one correct answers)</u>

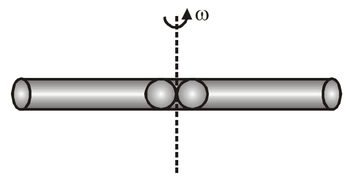
**1.** A thin rod of length $4\ell$, mass 4m is bent at the points as shown in the fig. What is the moment of inertia of the rod about the axis passing point O & perpendicular to the plane of the paper




(A) $\frac{m\ell^2}{3}$ (B) $\frac{10m\ell^2}{3}$ (C) $\frac{m\ell^2}{12}$ (D) $\frac{m\ell^2}{24}$

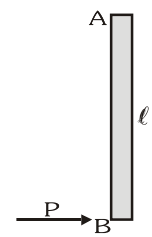
**2.** A smooth tube of certain mass is rotated in gravity free space and released.

The two balls shown in the figure move towards ends of the tube. For the whole system which of the following quantity is not conserved :-



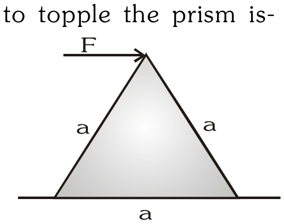

(A) Angular momentum (B) Linear momentum
(C) Kinetic energy (D) Angular speed

**3.** A uniform rod AB of mass m and length $\ell$ 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 :-



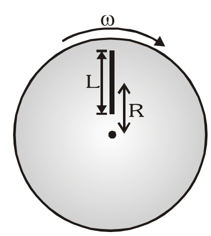

(A) $\frac{2\pi m\ell}{P}$ (B) $\frac{\pi m\ell}{3P}$
(C) $\frac{\pi m\ell}{12P}$ (D) $\frac{2\pi m\ell}{3P}$

**4.** An equilateral prism of mass m rests on a rough horizontal surface with coefficient of friction $\mu$. A horizontal force F is applied on the prism as shown in the figure. If the coefficient of friction is sufficiently high so that the prism does not slide before toppling, then the minimum force required to topple the prism is-




(A) $\frac{mg}{\sqrt{3}}$ (B) $\frac{mg}{4}$
(C) $\frac{\mu mg}{\sqrt{3}}$ (D) $\frac{\mu mg}{4}$

**5.** A uniform rod of mass M and length L lies radially on a disc rotating with angular speed $\omega$ in a horizontal plane about its axis. The rod does not slip on the disc and the centre of the rod is at a distance R from the centre of the disc. Then the kinetic energy of the rod is-




(A) $\frac{1}{2}m\omega^2\left(R^2+\frac{L^2}{12}\right)$ (B) $\frac{1}{2}m\omega^2R^2$
(C) $\frac{1}{24}m\omega^2L^2$ (D) None of these

**6.** A particle of mass m is projected with a velocity v making an angle of 45 with the horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height h is :-

(A) zero (B) $\frac{mv^3}{(4\sqrt{2}g)}$ (C) $\frac{mv^3}{\sqrt{2}g}$ (D) $m\sqrt{2gh^3}$

**7.** A tube of length L is filled completely with an incompressible liquid of mass M and closed at both the ends. The tube is then rotated in a horizontal plane about one of its ends with a uniform angular velocity $\omega$. The force exerted by the liquid at the other end is :-

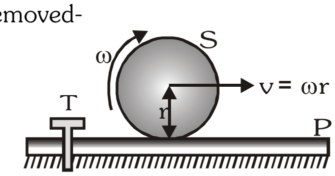
(A) $\frac{M\omega^2L}{2}$ (B) $M\omega^2L$ (C) $\frac{M\omega^2L}{4}$ (D) $\frac{M\omega^2L^2}{2}$

8. Two point masses of 0.3 kg and 0.7 kg are fixed at the ends of a rod of length 1.4 m and of negligible mass. The rod is set rotating about an axis perpendicular to its length with a uniform angular speed. The point on the rod through which the axis should pass in order that the work required for rotation of the rod is minimum, is located at a distance of :-

(A) 0.42 m from mass of 0.3 kg (B) 0.70 m from mass of 0.7 kg

(C) 0.98 m from mass of 0.3 kg (D) 0.98 m from mass of 0.7 kg

9. A sphere S rolls without slipping, moving with a constant speed on a plank P. The friction between the upper surface of P and the sphere is sufficient to prevent slipping, while the lower surface of P is smooth and rests on the ground. Initially, P is fixed to the ground by a pin T. If T is suddenly removed-



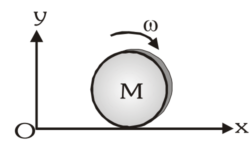

(A) S will begin to slip on P.

(B) P will begin to move backwards.

(C) the speed of S will decrease and its angular velocity will increase.

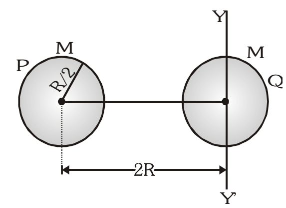
(D) there will be no change in the motion of S and P will still be at rest.

10. A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane as shown. The magnitude of angular momentum of the disc about the origin O is :–




(A) $\frac{1}{2}MR^2\omega$ (B) $MR^2\omega$ (C) $\frac{3}{2}MR^2\omega$ (D) $2MR^2\omega$

11. Two spheres each of mass M and radius R/2 are connected with a mass less rod of length 2R as shown in the-figure. What will be the moment of inertia of the system about an axis passing through the centre of one of the spheres and perpendicular to the rod

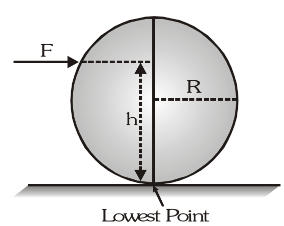



(A) $\frac{21}{5}MR^2$ (B) $\frac{2}{5}MR^2$ (C) $\frac{5}{2}MR^2$ (D) $\frac{5}{21}MR^2$

12. A cord is wound over a cylinder of radius r and moment of inertia I. A mass m is attached to the free end of the cord. The cylinder is free to rotate about its own horizontal axis. If mass m is released from rest, then the velocity of the mass after it had fallen through a distance h will be-

(A) $(2gh)^{1/2}$ (B) $\left(\frac{2mghr}{I}\right)^{1/2}$ (C) $\left(\frac{2mghr}{I+mr}\right)^{1/2}$ (D) $\left(\frac{mghr}{I+2mr}\right)^{1/2}$

13. A solid sphere of radius R is placed on smooth horizontal surface. A horizontal force 'F' is applied at height 'h' from the lowest point. For the maximum acceleration of centre of mass, which is correct-



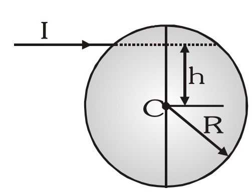

(A) h = R

(B) h = 2R

(C) h = 0

(D) No relation between h and R

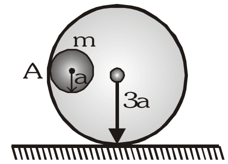
14. A solid sphere is placed on a horizontal plane. A horizontal impulse I is applied at a distance h above the central line as shown in the figure. Soon after giving the impulse the sphere starts rolling.
The ratio h/R would be-




(A) $\frac{1}{2}$ (B) $\frac{2}{5}$

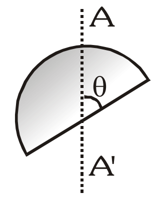
(C) $\frac{1}{4}$ (D) $\frac{1}{5}$

**15.** A ring of radius 3a is fixed rigidly on a table. A small ring whose mass is m and radius a, rolls without slipping inside it as shown in the figure. The small ring is released from position A. When it reaches at the lowest point, the speed of the centre of the ring at that time would be-




(A) $\sqrt{2ga}$ (B) $\sqrt{3ga}$ (C) $\sqrt{6ga}$ (D) $\sqrt{4ga}$

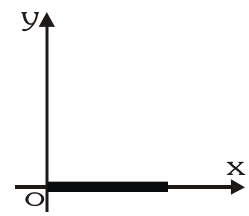
**16.** The moment of inertia of semicircular plate of radius R and mass M about axis AA' in its plane passing through its centre is




(A) $\frac{MR^2}{2}$ (B) $\frac{MR^2}{4}\cos^2\theta$

(C) $\frac{MR^2}{4}\sin^2\theta$ (D) $\frac{MR^2}{4}$

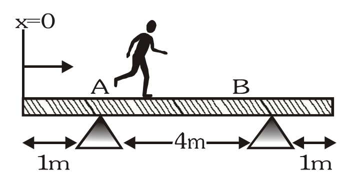
**17.** The figure shows a uniform rod lying along the x-axis. The locus of all the points lying on the xy-plane, about which the moment of inertia of the rod is same as that about O is

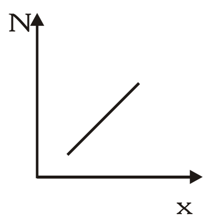


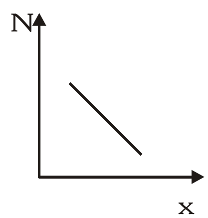

(A) an ellipse (B) a circle

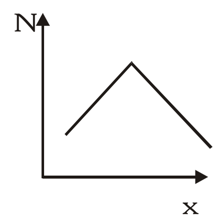
(C) a parabola (D) a straight line

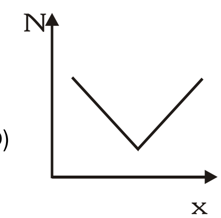
**18.** A man can move on a horizontal plank supported symmetrically as shown. The variation of normal reaction on support A with distance x of the man from the end of the plank is best represented by



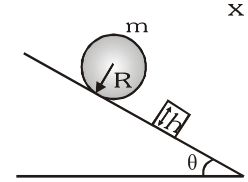

(A)



(B)



(C)



(D)


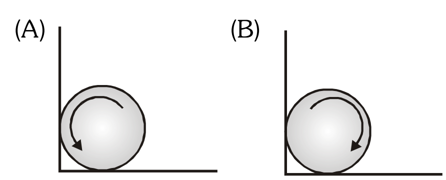

**19.** Find minimum height of obstacle so that the sphere can stay in equilibrium




(A) $\frac{R}{1+\cos\theta}$ (B) $\frac{R}{1+\sin\theta}$

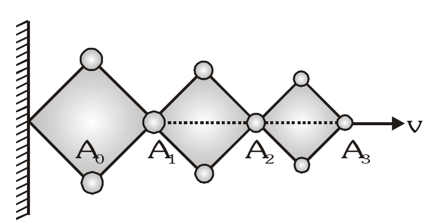
(C) $R(1-\sin\theta)$ (D) $R(1-\cos\theta)$

**20.** A sphere is placed rotating with its centre initially at rest in a corner as shown in figure (A) & (B). Coefficient of friction between all surfaces and the sphere is $\frac{1}{3}$. Find the ratio of the frictional force $\frac{f_a}{f_b}$ by ground in situations (A) & (B)




(A) 1 (B) 9/10 (C) 10/9 (D) None

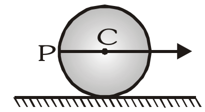
**21.** A hinged construction consists of three rhombus with the ratio of sides 5:3:2. Vertex $A_3$ moves in the horizontal direction at a velocity v. Velocity of $A_2$ is




(A) 2.5 v (B) 1.5 v

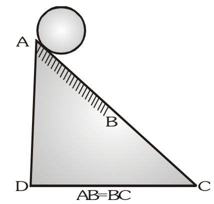
(C) $\frac{2}{3}$v (D) 0.8 v

22. A disc of radius R is rolling purely on a flat horizontal surface, with a constant angular velocity. The angle between the velocity and acceleration vectors of point P is



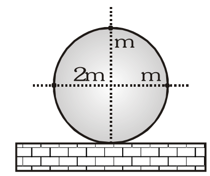

(A) Zero (B) $45^0$
(C) $135^0$ (D) $\tan^{-1}(1/2)$

23. Portion AB of the wedge shown in figure is rough and BC is smooth. A solid cylinder rolls without slipping from A to B. The ratio of translational kinetic energy to rotational kinetic energy, when the cylinder reaches point C is




(A) 3/4 (B) 5
(C) 7/5 (D) 8/3

24. A ring of mass m and radius R has three particles attached to the ring as shown in the figure. The centre of the ring has a speed $v_0$. The kinetic energy of the system is : (slipping is absent)

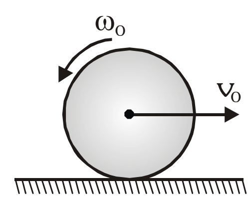



(A) $6\ mv_0^2$ (B) $12\ mv_0^2$
(C) $4\ mv_0^2$ (D) $8\ mv_0^2$

25. A slender uniform rod of length $\ell$ is balanced vertically at a point P on a horizontal surface having some friction. If the top of the rod is displaced slightly to the right, the position of its centre of mass at the time when the rod becomes horizontal
(A) lies at some point to the right of P (B) lies at some point to the left of P
(C) must be $\frac{\ell}{2}$ to the right of P (D) lies at P

26. A solid sphere with a velocity (of centre of mass) v and angular velocity $\omega$ is gently placed on a rough horizontal surface. The frictional force on the sphere
(A) must be forward (in direction of v) (B) must be backward (opposite to v)
(C) cannot be zero (D) none of the above

27. A uniform circular disc placed on a rough horizontal surface has initially velocity $v_0$ and an angular velocity $\omega_0$ as shown in the figure. The disc comes to rest after moving some distance in the direction of motion. Then $\frac{v_0}{r\omega_0}$ is

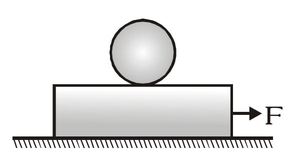



(A) 1/2 (B) 1 (C) 3/2 (D) 2

28. A body is in equilibrium under the influence of a number of forces. Each force has a different line of action. The minimum number of forces required is
(A) 2, if their lines of action pass through the centre of mass of the body
(B) 3, if their lines of action are not parallel
(C) 3, if their lines of action are parallel
(D) 4, if their lines of action are parallel and all the forces have the same magnitude

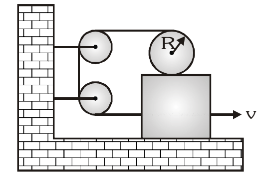
29. A particle falls freely near the surface of the earth. Consider a fixed point O (not vertically below the particle) on the ground
(A) Angular momentum of the particle about O is increasing
(B) Torque of the gravitational force on the particle about O is decreasing
(C) The moment of inertia of the particle about O is decreasing
(D) The angular velocity of the particle about O is increasing

30. A plank with a uniform sphere placed on it, rests on a smooth horizontal plane. Plank is pulled to right by a constant force F. If the sphere does not slip over the plank




(A) Acceleration of centre of sphere is less than that of the plank
(B) Acceleration of centre of sphere is greater than the plank because friction acts rightward on the sphere
(C) Acceleration of the centre of sphere may be towards left
(D) Acceleration of the centre of sphere relative to plank may be greater than that of the plank relative to floor

**31.** In the figure shown, the plank is being pulled to the right with a constant speed v. If the cylinder does not slip then



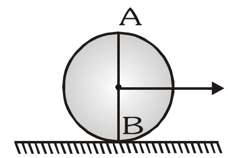

(A) the speed of the centre of mass of the cylinder is 2v

(B) the speed of the centre of mass of the cylinder is zero

(C) the angular velocity of the cylinder is v/R

(D) the angular velocity of the cylinder is zero

**32.** A uniform disc is rolling on a horizontal surface. At a certain instant B is the point of contact and A is at height 2R from ground, where R is radius of disc




(A) The magnitude of the angular momentum of the disc about B is thrice that about A

(B) The angular momentum of the disc about A is anticlockwise

(C) The angular momentum of the disc about B is clockwise

(D) The angular momentum of the disc about A is equal to that of about B

**33.** If a cylinder is rolling down the incline with sliding

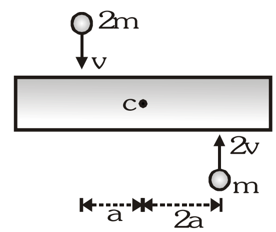
(A) after some time it may start pure rolling

(B) after some time it will start pure rolling

(C) it may be possible that it will never start pure rolling

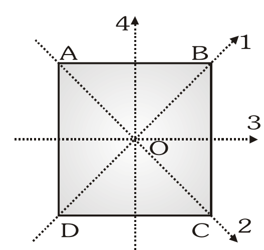
(D) None of these

**34.** A uniform bar of length 6a and mass 8m lies on a smooth horizontal table. Two point masses m and 2m moving in the same horizontal plane with speed 2v and v respectively, strike the bar (as shown in the fig.) and stick to the bar after collision. Denoting angular velocity (about the centre of mass), total energy and centre of mass velocity by $\omega$, E and $v_c$ respectively, we have after collision :




(A) $v_C = 0$ (B) $\omega = \dfrac{3v}{5a}$ (C) $\omega = \dfrac{v}{5a}$ (D) $E = 3\dfrac{mv^2}{5}$

**35.** The moment of inertia of a thin square plate ABCD, of uniform thickness about an axis passing through the centre O and perpendicular to the plane of the plate is ( where $I_1$, $I_2$, $I_3$ and $I_4$ are respectively moments of inertia about axis 1, 2, 3 and 4 which are in the plane of the plate)




(A) $I_1 + I_2$ (B) $I_3 + I_4$

(C) $I_1 + I_3$ (D) $I_1 + I_2 + I_3 + I_4$

## ANSWER KEY

LEVEL-2

| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ans. | B | D | C | A | A | B | A | C | D | C | A | C | D | B | A |
| Que. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Ans. | D | B | B | D | B | D | B | B | A | A | D | A | B,C,D | A,C,D | A |
| Que. | 31 | 32 | 33 | 34 | 35 | | | | | | | | | | |
| Ans. | B,C | A,B,C | A,C | A,C,D | A,B,C | | | | | | | | | | |