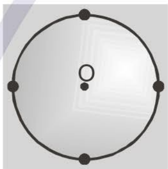
1. The moment of inertia of a solid cylinder about its own axis is the same as its moment of inertia about an axis passing through its centre of gravity and perpendicular to its length. The relation between its length L and radius R is

(1) $L = \sqrt{2}R$ (2) $L = \sqrt{3}R$

(3) L = 3R (4) L = R

2. 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:-



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

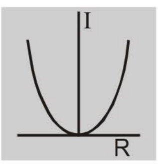
(3) $MR^2 + \frac{8}{5}mR^2$ (4) none of these

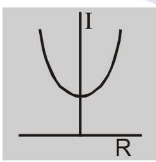
3. The axis X and Z in the plane of a disc are mutually perpendicular and Y-axis is perpendicular to the plane of the disc. If the moment of inertia of the body about X and Y axes is respectively 80 kg m² and 100 kg m² then M.I. about Z-axis in will be :-

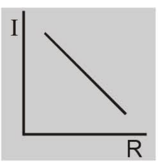
(1) 180 kg m² (2) 40 kg m²

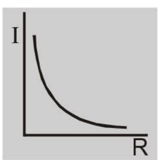
(3) 20 kg m² (4) Zero

4. The curve for the moment of inertia of a sphere of constant mass M versus its radius will be :-

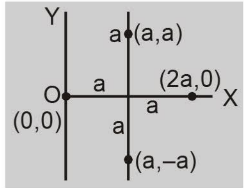
(1) 

(2) 

(3) 

(4) 

5. Four point masses (each of mass m) are arranged in the X-Y plane. The moment of inertia of this array of masses about Y-axis is



(1) ma^2

(2) $2ma^2$

(3) $4ma^2$

(4) $6ma^2$

6. If the radius of gyration of a solid disc of mass 10 kg about an axis is 0.20 m, then the moment of inertia of the disc about that axis is

(1) 0.4 kg m² (2) 0.8 kg m²

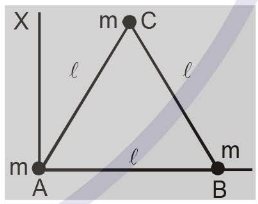
(3) 1.6 kg m² (4) 1 kg m²

7. Two rods each of mass m and length ℓ 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 :–

(1) $\frac{m\ell^2}{12}$ (2) $\frac{m\ell^2}{6}$ (3) $\frac{m\ell^2}{3}$ (4) $\frac{m\ell^2}{2}$

8. Three particles, each of mass m are situated at the vertices of an equilateral triangle ABC of side ℓ (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, will be :-



(1) $2\,m\ell^2$

(2) $\frac{5}{4}m\ell^2$

(3) $\frac{3}{2}m\ell^2$

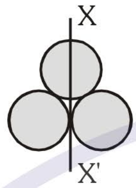
(4) $\frac{3}{4}m\ell^2$

9. Four identical thin rods each of mass M and length ℓ, form a square frame. Moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is :-

(1) $\frac{1}{3}M\ell^2$ (2) $\frac{4}{3}M\ell^2$

(3) $\frac{2}{3}M\ell^2$ (4) $\frac{13}{3}M\ell^2$

10. Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX' which is touching to two shells and passing through diameter of third shell. Moment of inertia of the system consisting of these three spherical shells about XX' axis is :-



(1) 3 mr^2

(2) $\frac{16}{5}mr^2$

(3) 4 mr^2

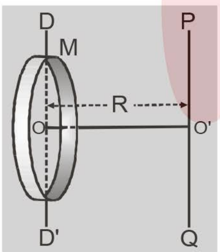
(4) $\frac{11}{5}mr^2$

11. A solid sphere and a hollow sphere of the same mass have the same M.I. about their respective diameters. The ratio of their radii will be :-

(1) 1 : 2 (2) $\sqrt{3}:\sqrt{5}$

(3) $\sqrt{5}:\sqrt{3}$ (4) 5 : 4

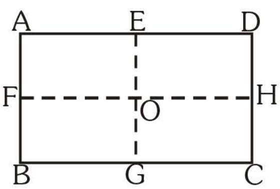
12. The moment of inertia of a ring of mass M and radius R about PQ axis will be :-



(1) MR^2 (2) $\frac{MR^2}{2}$

(3) $\frac{3}{2}$ MR^2 (4) $2MR^2$

13. In the rectangular lamina shown in the figure, AB = BC/2. The moment of inertia of the lamina is minimum along the axis passing through :-



(1) AB

(2) BC

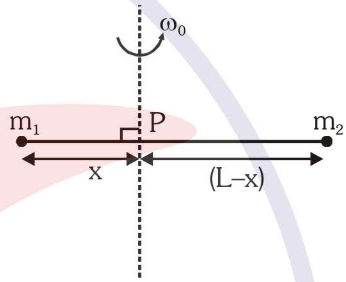
(3) EG

(4) FH

14. A particle performs uniform circular motion with an angular momentum L. If the frequency of particle's motion is doubled and its kinetic energy halved, the angular momentum becomes

(1) 2L (2) 4L (3) $\frac{L}{2}$ (4) $\frac{L}{4}$

15. Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about an axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum, is given by :-



(1) $x=\frac{m_2L}{m_1+m_2}$

(2) $x=\frac{m_1L}{m_1+m_2}$

(3) $x=\frac{m_1}{m_2}L$

(4) $x=\frac{m_2}{m_1}L$

16. If $\vec{F}$ is the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then :-

(1) $\vec{r}\cdot\vec{\tau}=0$ and $\vec{F}\cdot\vec{\tau}\neq0$

(2) $\vec{r}\cdot\vec{\tau}\neq0$ and $\vec{F}\cdot\vec{\tau}=0$

(3) $\vec{r}\cdot\vec{\tau}>0$ and $\vec{F}\cdot\vec{\tau}<0$

(4) $\vec{r}\cdot\vec{\tau}=0$ and $\vec{F}\cdot\vec{\tau}=0$

17. A force $\vec{F}=2\hat{i}-3\hat{k}$ acts on a particle at $\vec{r}=0.5\hat{j}-2\hat{k}$. The torque $\vec{\tau}$ acting on the particle relative to a point with co-ordinates (2.0 m, 0, –3.0 m) is

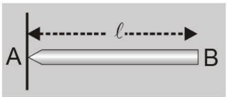
(1) $(-3.0\hat{i}-4.5\hat{j}-\hat{k})N-m$

(2) $(3\hat{i}+6\hat{j}-\hat{k})N-m$

(3) $(-20\hat{i}+4.0\hat{j}+\hat{k})N-m$

(4) $(-1.5\hat{i}-4.0\hat{j}-\hat{k})N-m$

18. A uniform rod AB of length ℓ and mass m is free to rotate about A. The rod is released from rest in the horizontal position. Given that the moment of inertia of the rod about A is $\frac{m\ell^2}{3}$, the initial angular acceleration of the rod will be :–



(1) $\frac{3g}{2\ell}$ (2) $\frac{2g}{3\ell}$ (3) $mg\frac{\ell}{2}$ (4) $\frac{3}{2}g\ell$

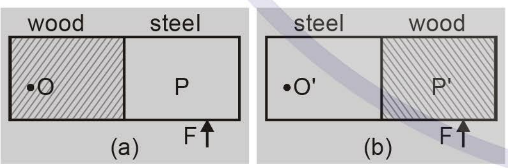
19. A solid cylinder of mass 50 kg and radius 0.5 m is free to rotate about the horizontal axis. A massless string is wound round the cylinder with one end attached to it and other hanging freely. Tension in the string required to produce an angular acceleration of 2 revolutions s^{-2} is :-

(1) 25 N (2) 50 N (3) 78.5 N (4) 157 N

20. A ladder rests against a frictionless vertical wall, with its upper end 6m above the ground and the lower end 4m away from the wall. The weight of the ladder is 500 N and its centre of gravity at (1/3)rd distance from the lower end. Wall's reaction will be, in N :-

(1) 111 N (2) 333 N (3) 222 N (4) 129 N

21. In the fig. (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 (In horizontal plane) :-



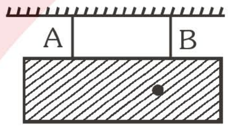
(1) more angular acceleration will be produced in (a)
(2) more angular acceleration will be produced in (b)
(3) same angular acceleration will be produced in both conditions
(4) information is incomplete

22. A constant torque acting on a uniform circular wheel changes its angular momentum from A_0 to $4A_0$ in 4 seconds. The magnitude of this torque is :–

(1) $\frac{3A_0}{4}$ (2) A_0 (3) $4A_0$ (4) $12A_0$

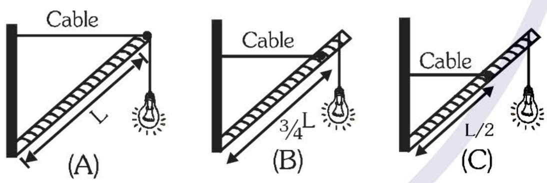
23. If a ladder is not in balance against a smooth vertical wall, then it can be made in balance by :-
(1) Decreasing the length of ladder
(2) Increasing the length of ladder
(3) Increasing the angle of inclination
(4) Decreasing the angle of inclination

24. The figure shows a horizontal block of mass M suspended by two wires A and B. The centre of mass of the block is closer to B than A. (i) Is the magnitude of the torque due to wire A is greater, less or equal to that due to B w.r.t. centre of mass ? (ii) Which wire A or B exerts more force on the block ?



(1) (i) greater (ii) B (2) (i) equal (ii) B
(3) (i) less (ii) A (4) (i) greater (ii) A

25. If a street light of mass M is suspended from the end of uniform rod of length L in the different possible patterns as shown in figure, then :-



(1) Pattern C is least sturdy
(2) Pattern B is least sturdy
(3) Pattern A is least sturdy
(4) All will have same sturdiness

26. A wheel having moment of inertia 2 kg–m² about its vertical axis, rotates at the rate of 60 rpm about the axis. The torque which can stop the wheel's rotation in one minute would be :–

(1) $\frac{\pi}{12}$ N–m (2) $\frac{\pi}{15}$ N–m

(3) $\frac{\pi}{18}$ N–m (4) $\frac{2\pi}{15}$ N–m

27. A rod of weight W is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at distance x from A. The normal reaction on A is :-

(1) $\frac{Wd}{x}$ (2) $\frac{W(d-x)}{x}$

(3) $\frac{W(d-x)}{d}$ (4) $\frac{Wx}{d}$

28. A uniform circular disc of radius 50 cm at rest is free to turn about an axis which is perpendicular to its plane and passes through its centre. It is subjected to a torque which produces a constant angular acceleration of 2.0 rad/s^2. Its net acceleration in m/s^2 at the end of 2.0 s is approximately :

(1) 8.0 (2) 7.0 (3) 6.0 (4) 3.0

29. A rope is wound around a hollow cylinder of mass 3 kg and radius 50 cm. What is the angular acceleration of the cylinder if the rope is pulled with a force of 30 N ?

(1) 0.20 rad/s^2 (2) 20 rad/s^2

(3) 4 m/s^2 (4) 20 m/s^2

30. A rotating table completes one rotation in 2 sec. and its moment of inertia is 100 kg-m^2. A person of 50 kg. mass is standing at the centre of the rotating table. If the person moves 2m. from the centre, the angular velocity of the rotating table will be:

(1) $\frac{\pi}{3}$ rad/sec (2) $\frac{\pi}{2}$ rad/sec

(3) $\frac{2\pi}{3}$ rad/sec (4) 2π rad/sec

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

(1) $\frac{M\omega}{4m}$ (2) $\frac{M\omega}{M+4m}$

(3) $\frac{(M+4m)\omega}{M}$ (4) $\frac{(M+4m)\omega}{M+4m}$

32. A small steel sphere of mass m is tied to a string of length r and is whirled in a horizontal circle with a uniform angular velocity 3ω. The string is suddenly pulled, so that radius of the circle is halved. The new angular velocity will be

(1) 3ω (2) 6ω (3) 8ω (4) 12ω

33. A circular platform is mounted on a frictionless vertical axle. Its radius R = 2m and its moment of inertia about the axle is 200 kg m^2. It is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of 1 ms^{-1} relative to the ground. Time taken by the man to complete one revolution is :-

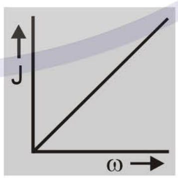
(1) 2π s (2) $\frac{\pi}{2}$ s (3) π s (4) $\frac{3\pi}{2}$ s

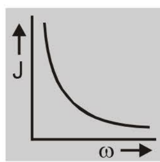
34. A particle of mass m is projected with a velocity v making an angle 45° with the horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height h, is :

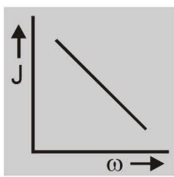
(1) zero (2) $\frac{mv^3}{4\sqrt{2}g}$

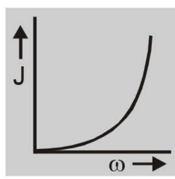
(3) $\frac{mv^3}{\sqrt{2}g}$ (4) $m^2\sqrt{2gh^3}$

35. The graph between the angular momentum J and angular velocity ω for a body will be :-

(1) 

(2) 

(3) 

(4) 

36. A particle of mass m is rotating in a plane in a circular path of radius r. Its angular momentum is L. The centripetal force acting on the particle is

(1) $\frac{L^2}{mr}$ (2) $\frac{L^2m}{r}$ (3) $\frac{L^2}{mr^2}$ (4) $\frac{L^2}{mr^3}$

37. If the earth loses its atmosphere sudeenly, then the duration of day will :-

(1) increase

(2) decrease

(3) remain unchanged

(4) nothing can be definitely said

38. 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:-

(1) remain constant

(2) first decreases and then increases

(3) first increases, then decrease

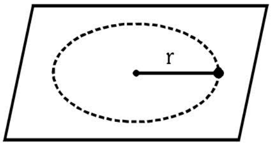
(4) Increase continuously

39. A round disc of moment of inertia I_2 about its axis perpendicular to its plane and passing through its centre is placed over another disc of moment of inertia I_1 rotating with an angular velocity ω about the same axis. The final angular velocity of the combination of discs is :–

(1) ω (2) $\frac{I_1\omega}{I_1+I_2}$

(3) $\frac{(I_1+I_2)\omega}{I_1}$ (4) $\frac{I_2\omega}{I_1+I_2}$

40. A small mass attached to a string rotates on a frictionless table top as shown. If the tension in the string is decreased by relasing the string causing the radius of the circular motion to increase by a factor of 2, the kinetic energy of the mass will :-



(1) Increase by a factor of 2

(2) Remain constant

(3) Increase by a factor of 2

(4) Decrease by a factor of 4

41. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere ?

(1) Angular velocity

(2) Moment of inertia

(3) Rotational kinetic energy

(4) Angular momentum

42. The rotational kinetic energy of a body is K_{rot} and its moment of inertia is I. The angular momentum of body is

(1) IK_{rot} (2) $2\sqrt{IK_{rot}}$

(3) $\sqrt{2IK_{rot}}$ (4) $2IK_{rot}$

43. 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 :

(1) $2mL^2\pi^2n^2$ (2) $\frac{1}{2}mL^2\pi^2n^2$

(3) $\frac{2}{3}mL^2\pi^2n^2$ (4) $\frac{1}{6}mL^2\pi^2n^2$

44. 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 kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then :-

(1) $L_B > L_A$ (2) $L_A > L_B$

(3) $L_A = \frac{L_B}{2}$ (4) $L_A = 2L_B$

45. A solid sphere of mass m and radius R is rotating about its diameter. A disc of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation (E_{sphere} / E_{disc}) will be :-

(1) 1 : 4 (2) 3 : 1

(3) 2 : 3 (4) 1 : 5

46. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2. They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is:-

(1) $\frac{1}{4}I(\omega_1-\omega_2)^2$ (2) $I(\omega_1-\omega_2)^2$

(3) $\frac{I}{8}(\omega_1-\omega_2)^2$ (4) $\frac{1}{2}I(\omega_1+\omega_2)^2$

47. Three objects, A : (a solid sphere), B : (a thin circular disk) and C = (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation :-

(1) $W_C > W_B > W_A$ (2) $W_A > W_B > W_C$

(3) $W_B > W_A > W_C$ (4) $W_A > W_C > W_B$

48. A disc is rolling on an inclined plane without slipping then what fraction of its total energy will be in form of rotational kinetic energy :–

(1) 1 : 3 (2) 1 : 2

(3) 2 : 7 (4) 2 : 5

49. A wheel is rolling along the ground with a speed of 5 ms^{-1}. The magnitude of the linear velocity of the points at the extermities of the horizontal diameter of the wheel is equal to

(1) $5\sqrt{10}\,ms^{-1}$ (2) $5\sqrt{3}\,ms^{-1}$

(3) $5\sqrt{2}\,ms^{-1}$ (4) 5 ms^{-1}

50. Calculate the ratio of the times taken by a uniform solid sphere and a disc of the same mass and the same diameter to roll down through the same distance from rest on a inclined plane.

(1) 15 : 14 (2) $\sqrt{15}:\sqrt{14}$

(3) $15^2 : 14^2$ (4) $\sqrt{14}:\sqrt{15}$

51. A body of mass m slides down an inclined plane and reaches the bottom with a velocity v. If the same mass were in the form of a ring which rolls down this incline, the velocity of the ring at the bottom would have been

(1) v (2) $v\sqrt{2}$ (3) $\frac{v}{\sqrt{2}}$ (4) $\left(\sqrt{\frac{2}{5}}\right)v$

52. A ring is rolling without slipping. Its energy of translation is E. Its total kinetic energy will be :-

(1) E (2) 2E (3) 3E (4) 4E

53. If rotational kinetic energy is 50% of total kinetic energy then the body will be :–

(1) ring (2) cylinder

(3) hollow sphere (4) solid sphere

54. A disc rolls down a plane of length L and inclined at angle θ, without slipping. Its velocity on reaching the bottom will be :-

(1) $\sqrt{\frac{4gL\sin\theta}{3}}$ (2) $\sqrt{\frac{2gL\sin\theta}{3}}$

(3) $\sqrt{\frac{10gL\sin\theta}{7}}$ (4) $\sqrt{4gL\sin\theta}$

55. A ring takes time t_1 and t_2 for sliding down and rolling down an inclined plane of length L respectively for reaching the bottom. The ratio of t_1 and t_2 is :-

(1) $\sqrt{2}$: 1 (2) 1 : $\sqrt{2}$

(3) 1 : 2 (4) 2 : 1

56. 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 :–

(1) $\sqrt{2gh}$ (2) $\sqrt{\frac{3}{4}gh}$

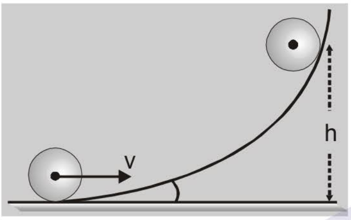
(3) $\sqrt{\frac{4}{3}gh}$ (4) $\sqrt{4gh}$

57. A sphere and a disc of same radii and mass are rolling on an inclined plane without slipping. a_s & a_d are acceleration and g is acceleration due to gravity. Then which statement is correct ?

(1) $a_s > a_d > g$ (2) $g > a_s > a_d$

(3) $a_s > g > a_d$ (4) $a_d > a_s > g$

58. 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 :-



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

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

59. A solid cylinder of mass 12 kg is rolling on a rough horizontal surface with velocity 4 ms^{-1}. It collides with a horizontal spring of force constant 200 Nm^{-1}. The maximum compression produced in the spring will be :-

(1) 0.7 m (2) 0.4 m

(3) 0.6 m (4) 1.2 m

60. A disk and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first ?

(1) Disk

(2) Sphere

(3) Both reach at the same time

(4) Depends on their masses

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**2**	**2**	**3**	**1**	**4**	**1**	**2**	**2**	**2**	**3**	**3**	**3**	**4**	**4**	**1**
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	**4**	**4**	**1**	**4**	**1**	**2**	**1**	**3**	**2**	**1**	**2**	**3**	**1**	**2**	**1**
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	**2**	**4**	**1**	**2**	**1**	**4**	**2**	**3**	**2**	**4**	**4**	**3**	**3**	**1**	**4**
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	**1**	**1**	**1**	**3**	**4**	**3**	**2**	**1**	**1**	**2**	**3**	**2**	**2**	**4**	**2**