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

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

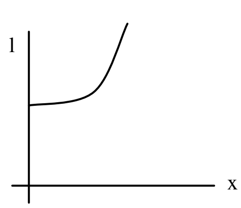
(c) $\frac{3}{2}mr^2$ (d) $2mr^2$

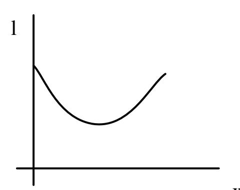
2. A uniform thin bar of mass 6m and length 12L is bent to make a regular hexagon. Its moment of inertia about an axis passing through the centre of the mass and perpendicular to the plane of hexagon is

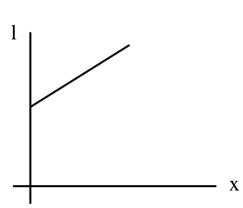
(a) $20\ mL^2$ (b) $6\ mL^2$

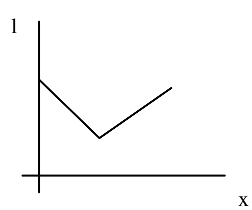
(c) $\frac{12}{5}\ mL^2$ (d) $30\ mL^2$

3. Moment of inertia I of a solid sphere about an axis parallel to a diameter and at a distance x from its centre of mass varies as

(a) 

(b) 

(c) 

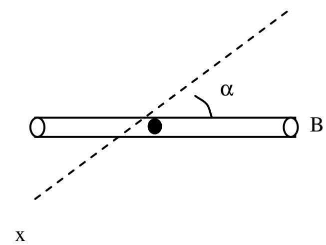
(d) 

4. Locus of all the points in a plane on which the moment of inertia of a rigid body is same throughout is

(a) a straight line (b) a circle

(c) a parabola (d) an ellipse

5. The moment of inertia of a uniform rod of length 2l and mass m about an axis xx passing through its centre and inclined at an angle α is



(a) $\frac{ml^2}{3}\sin^2\alpha$ (b) $\frac{ml^2}{12}\sin^2\alpha$

(c) $\frac{ml^2}{6}\cos^2\alpha$ (d) $\frac{ml^2}{2}\cos^2\alpha$

6. A wire of length l and mass m is bent in the form of a rectangle ABCD with $\frac{AB}{BC} = 2$. The moment of inertia of this wire frame about the side BC is

(a) $\frac{11}{252}ml^2$ (b) $\frac{8}{203}ml^2$

(c) $\frac{5}{136}ml^2$ (d) $\frac{7}{162}ml^2$

7. A particle moves in a circle with constant angular velocity ω about a point P on its circumference. The angular velocity of the particle about the centre C of the circle is

(a) 2ω

(b) $\frac{\omega}{2}$

(c) ω

(d) Not constant

8. Two equal and opposite forces act on a rigid body at a certain distance. Then

(a) the body is in equilibrium

(b) the body will rotate about its centre of mass

(c) the body may rotate about any point other than its centre of mass

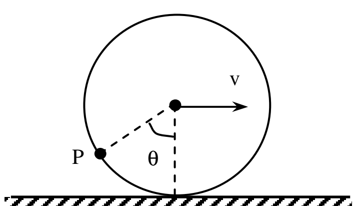
(d) the body cannot rotate about its centre of mass

9. A uniform stick of length l and mass m lies on a smooth table. It rotates with angular velocity ω about an axis perpendicular to the table and through one end of the stick. The angular momentum of the stick about the end is

(a) $ml^2\omega$ (b) $\frac{ml^2\omega}{3}$

(c) $\frac{ml^2\omega}{12}$ (d) $\frac{ml^2\omega}{6}$

10. A hoop rolls on a horizontal ground without slipping with linear speed ν. Speed of a particle P on the circumference of the hoop at angle θ is



(a) $2v \sin\left(\frac{\theta}{2}\right)$ (b) $\nu \sin\theta$

(c) $2\nu \cos\left(\frac{\theta}{2}\right)$ (d) $\nu \cos\theta$

11. A disc is rotating with an angular velocity ω_0. A constant retarding torque is applied on it to stop the disc. The angular velocity becomes $\frac{\omega_0}{2}$ after n rotations. How many more rotations will it make before coming to rest?

(a) n (b) 2n

(c) $\frac{n}{2}$ (d) $\frac{n}{3}$

12. A uniform cube of side a and mass m rests on a rough horizontal surface. A horizontal force F is applied normal to none face at a point that is directly above the centre of the face at a height $\frac{a}{4}$ above the centre. The minimum value of F for which the cube begins to topple above an edge without sliding is

(a) $\frac{1}{4}$ mg (b) 2 mg

(c) $\frac{1}{2}$ mg (d) $\frac{2}{3}$ mg

13. A particle of mass 1 kg is moving along the line y = x + 2 (here, x and y are in metres) with speed 2m/s. The magnitude of angular momentum of particle about origin is

(a) 4kg - m^2/s (b) $2\sqrt{2}$ kg - m^2/s

(c) $4\sqrt{2}$ kg – m^2/s (d) 2 kg – m^2/s

14. A rigid spherical body is spinning around an axis without any external torque. Due to temperature its volume increase by 3%. Then percentage change in its angular speed is

(a) –2% (b) –1%

(c) –3% (d) 1%

15. A solid sphere and a hollow sphere of equal mass and radius are placed over a rough horizontal surface after rotating it about its mass centre with same angular velocity ω_0. Once the pure rolling starts leg ν_1 and ν_2 be the linear speeds of their centres of mass. Then

(a) $\nu_1 = \nu_2$

(b) $\nu_1 > \nu_2$

(c) $\nu_1 < \nu_2$

(d) data is insufficient

16. In the above problem if coefficient of friction for both the spheres is same and let t_1 and t_2 be the times when pure rolling of solid sphere and the hollow sphere is started. Then

(a) $t_1 = t_2$ (b) $t_1 < t_2$

(c) $t_1 > t_2$ (d) none of these

17. A circular platform is mounted on a vertical frictionless axle. Its radius is r = 2 m and its moment of inertia is I = 200 kg-m². It is initially at rest. A 70 kg man stands on the edge of the platform and begins to walk along the edge at speed v_0 = 1.0 m/s relative to the ground. The angular velocity of the platform is

(a) 1.2 rad/s (b) 0.4 rad/s

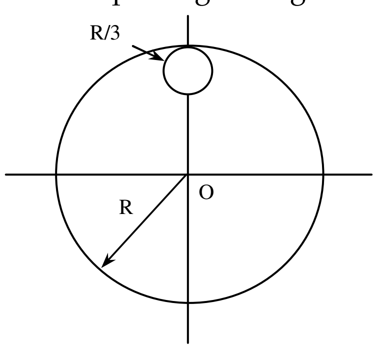
(c) 2.0 rad/s (d) 0.7 rad/s

18. In the above problem when the man has walked once around the platform, so that he is at his original position on it, what is his angular displacement relative to ground?

(a) $\frac{6}{5}\pi$ (b) $\frac{5}{6}\pi$

(c) $\frac{4}{5}\pi$ (d) $\frac{5}{4}\pi$

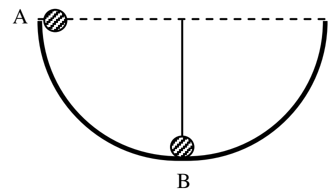
19. From a circular disc of radius R and mass 9M, a small disc of radius $\frac{R}{3}$ is removed from the disc. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is



(a) 4 MR² (b) $\frac{40}{9}$ MR²

(c) 10 MR² (d) $\frac{37}{9}$ MR²

20. A ball of radius r rolls inside a hemispherical shell of radius R. It is released from the rest from point A as shown in figure. The angular velocity of centre of the ball in position B about the centre of the shell is



(a) $2\sqrt{\frac{g}{5(R-r)}}$ (b) $\sqrt{\frac{10g}{7(R-r)}}$

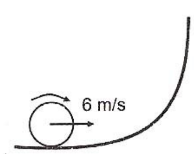
(c) $\sqrt{\frac{2g}{5(R-r)}}$ (d) $\sqrt{\frac{5g}{2(R-r)}}$

21. In the above problem the normal force between the ball and the shell in position B is (m = mass of ball)

(a) $\frac{12}{7}$ mg (b) $\frac{7}{9}$ mg

(c) $\frac{17}{7}$ mg (d) $\frac{10}{7}$ mg

22. A disc of radius 0.1 m rolls without sliding on a horizontal surface with a velocity of 6 m/s. It then ascends a smooth continuous track as shown in figure. The height upto which it will ascend is (g = 10 m/s²)



(a) 2.4 m

(b) 0.9 m

(c) 2.7 m

(d) 1.8 m

23. A solid sphere rolls down two different inclined planes of same height but of different inclinations. In both cases

(a) the speed but time of descend will be same

(b) the speed will be same but time of descend will be different

(c) the speed will be different but time of descend will be same

(d) speed and time of descend both are different

24. An inclined plane makes an angle of 60^o with horizontal. A disc rolling down this inclined plane without slipping has a linear acceleration equal to

(a) $\frac{g}{3}$ (b) $\frac{3}{4}g$

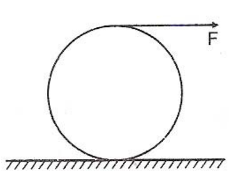
(c) $\frac{g}{\sqrt{3}}$ (d) $\frac{g}{2}$

25. A homogenous cylinder of mass M and radius R is pulled on a horizontal plane by a horizontal force F acting through its mass centre. Assuming rolling without slipping the angular acceleration of the cylinder is

(a) $\frac{2F}{2MR}$ (b) $\frac{2F}{2MR}$

(c) $\frac{F}{2MR}$ (d) $\frac{3R}{4MR}$

26. A force F is applied at the top of a ring of mass M and radius R placed on a rough horizontal surface as shown in figure. Friction is sufficient to prevent slipping. The friction force acting on the ring is



(a) $\frac{F}{2}$ towards right (b) $\frac{F}{3}$ towards left

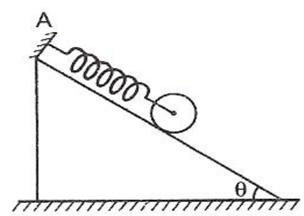
(c) $\frac{2F}{3}$ towards right (d) zero

27. A body of radius R and mass m is rolling horizontally without slipping with speed v. It then rolls up a hill to a maximum height h = $\frac{3v^2}{4g}$. The body might be a

(a) solid sphere (b) hollow sphere

(c) disc (d) ring

28. A uniform cylinder of mass M and radius R rolls without slipping down a slope of angle θ with horizontal. The cylinder is connected to a spring of force constant k at the centre, the other side of which is connected to a fixed support at A. The cylinder is released when the spring is unstretched. The force of friction (f) is



(a) always upwards

(b) always downwards

(c) initially upwards and then becomes downwards

(d) initially upwards and then becomes zero

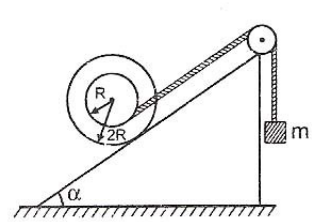
29. A spool of mass M and radius 2F lies on an inclined plane as shown in figure. A light thread is wound around the connecting tube of the spool and is free end carries a weight of mass m. The value of m so that system is in equilibrium is

(a) $2M \sin \alpha$

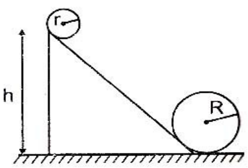
(b) $M \sin \alpha$

(c) $2M \tan \alpha$

(d) $M \cos \alpha$



30. A solid sphere rolls without slipping along the track shown in figure. The sphere starts from rest from a height h above the bottom of a loop of radius R which is much larger than the radius of the sphere r. The minimum value of h for the sphere to complete the loop is



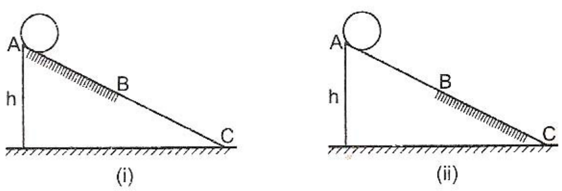
(a) 2.1 R

(b) 2.3 R

(c) 2.7 R

(d) 2.5 R

31. In both the figures all other factors are same, except that in figure (i) AB is rough and BC is smooth while in figure (ii) AB is smooth and BC is rough. Kinetic energy of the ball on reaching the bottom



(a) is same in the both the cases

(b) is greater in case (i)

(c) is greater in case (ii)

(d) information insufficient

32. A ring of radius R is first rotated with an angular velocity ω_0 and then carefully placed on a rough horizontally surface. The coefficient of friction between the surface and the ring is μ. Time after which its angular speed reduced to half is

(a) $\frac{\omega_0 \mu R}{2g}$ (b) $\frac{\omega_0 g}{2\mu R}$

(c) $\frac{2\omega_0 R}{\mu g}$ (d) $\frac{\omega_0 R}{2\mu g}$

33. A uniform rod of mass m and length l is suspended by means of two light inextensible strings as shown in figure. Tension in one string immediately after the other string is cut is

(a) $\frac{mg}{2}$ (b) 2 mg

(c) $\frac{mg}{4}$ (d) mg

34. A billiard ball is hit by a cue at a height h above the centre. It acquires a linear velocity v_0. Mass of the ball is m and radius is r. The angular velocity ω_0 acquired by the ball is

(a) $\frac{2v_0 h}{5r^2}$ (b) $\frac{5v_0 h}{2r^2}$

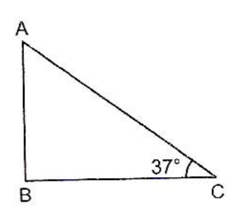
(c) $\frac{2v_0 r^2}{5h}$ (d) $\frac{5v_0 r^2}{2h}$

35. The liner velocity perpendicular to radius vector of a particle moving with angular velocity $\vec{\omega} = 2\hat{k}$ at position vector $\vec{r} = 2\hat{i} + 2\hat{j}$ is

(a) $4(\hat{i} - \hat{j})$ (b) $4(\hat{j} - \hat{i})$

(c) $4\hat{i}$ (d) $-4\hat{i}$

36. ABC is a right angled triangular plate of uniform thickness. I_1, I_2 and I_3 are moments of inertia about AB, BC and AC respectively. Then which of the following relation is correct?



(a) $I_1 = I_2 = I_3$

(b) $I_2 > I_1 > I_3$

(c) $I_3 < I_2 < I_1$

(d) $I_3 > I_1 > I_2$

37. A solid sphere, a ring and a disc all having same mass and radius are placed at the top of an incline and released. The friction coefficient between the objects and the inclined are same but not sufficient to allow pure rolling. Least time will be taken in reaching the bottom by

(a) the solid sphere

(b) the ring

(c) the disc

(d) all will take the same time

38. In the above problem, the smallest kinetic energy at the bottom of the incline will be achieved by

(a) the solid sphere

(b) the ring

(c) the disc

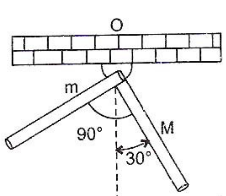
(d) all will achieve the same kinetic energy

39. A wheel of radius R rolls on the ground with a uniform velocity v. The relative acceleration of topmost point of the wheel respect to the bottom most point is

(a) $\frac{v^2}{R}$ (b) $\frac{2v^2}{R}$

(c) $\frac{v^2}{2R}$ (d) $\frac{4v^2}{R}$

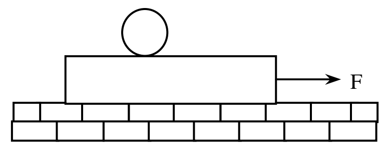
40. The uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shown. If in equilibrium the body is in the shown configuration, ratio M/m will be



(a) 2 (b) 3

(c) $\sqrt{2}$ (d) $\sqrt{3}$

41. A plank with a uniform sphere placed on it is resting on a smooth horizontal plane. Plank is pulled to the right by a constant force F. If sphere does not slip over the plank. Which of the following is incorrect?



(a) Acceleration of the centre of sphere is less than the of the plank

(b) Work done by friction acting on the sphere is equal to its total kinetic energy

(c) Total kinetic energy of the system is equal to work done by the force F

(d) None by the above

42. A rod of length l is given two velocities v_1 and v_2 in opposite direction at its two ends at right angle to the length. The distance of the instantaneous axis of rotation from v_1 is

(a) zero (b) $\frac{v_1}{v_1 + v_2}$ I

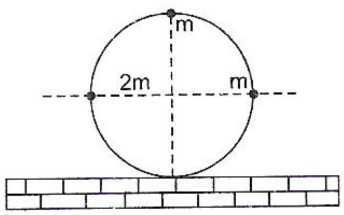
(c) $\frac{v_2 I}{v_1 + v_2}$ (d) l/2

43. Two particle of equal mass m at A and B are connected by a right light rod AB, lying on a smooth horizontal table. An impulse J is applied at A in the plane of the table and perpendicular at AB. Then the velocity of particle at A is

(a) $\frac{J}{2m}$ (b) $\frac{J}{m}$

(c) $\frac{2J}{m}$ (d) zero

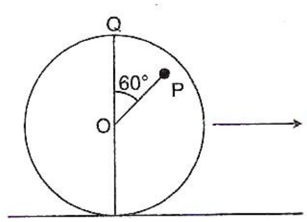
44. A ring of mass m and radius R has three particles attached to the figure. The centre of the ring has a speed v_0. The kinetic energy of the system is (Slipping is absent)



(a) $6\ mv_0^2$ (b) $12\ mv_0^2$

(c) $4\ mv_0^2$ (d) $8\ mv_0^2$

45. A disc of radius r rolls without slipping on a horizontal floor. If velocity of its centre of mass is v_0, then velocity of point P, as shown in the figure (OP = r/2 and $\angle QOP = 60^o$), is



(a) v_0 (b) $\frac{v_0}{2}$

(c) $\frac{v_0}{2}\sqrt{7}$ (d) $\frac{v_0}{2}\sqrt{3}$

46. A solid uniform sphere among about its axis with kinetic energy E_1 is gently placed on a rough horizontal plane at time t = 0, Assume that at time $t = t_1$, it starts pure rolling and at that instant total KE of the sphere is E_2. After sometime at time $t = t_2$ KE of the sphere is E_3. Then

(a) $E_1 = E_2 = E_3$ (b) $E_1 > E_2 = E_3$

(c) $E_1 > E_2 > E_3$ (d) $E_1 < E_2 = E_3$

47. A solid sphere and a solid cylinder of same mass are rolled down on two inclined planes of height h_1 and h_2 respectively. If at the bottom of the plane the two objects have same linear velocities, then the ratio of $h_1 : h_2$ is

(a) 2 : 3 (b) 7 : 5

(c) 14 : 15 (d) 15 : 14

48. A wire of mass m and length l is bent in the form of a quarter circle. The moment of inertia of this wire about an axis passing through the centre of the quarter circle and perpendicular to the plane of the quarter circle is approximately

(a) $0.6\ ml^2$ (b) ml^2

(c) $0.2\ ml^2$ (d) $0.4\ ml^2$

49. A uniform disc of radius R lies in x-y plane with its centre at origin. Its moment of inertia about the axis x = 2R and y = 0 is equal to the moment of inertia about the axis y = d and z = 0. Where d is equal to

(a) $\frac{4}{3}R$ (b) $\frac{\sqrt{17}}{2}R$

(c) $\sqrt{13}R$ (d) $\frac{\sqrt{15}}{2}R$

50. A wire of length l and mass m is first bent in a circle, then in a square and then in an equilateral triangle. The moment of inertia in these three cases about an axis perpendicular to their planes and passing through their centres of mass are I_1, I_2 and I_3 respectively. Then maximum of them is

(a) I_1 (b) I_2

(c) I_3 (d) Data insufficient

ANSWERS KEY

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