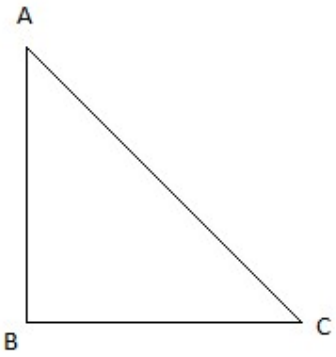
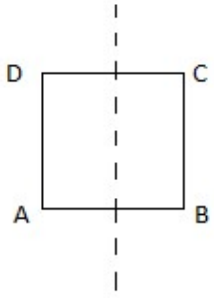
1. 

A thin uniform triangular sheet of mas m has sides AB = BC = L. What is the moment of inertia about an axis AC lying in the plane of the sheet?

a) $mL^2/12$ b) $mL^2/6$ c) $mL^2/3$ d) $2mL^2/3$

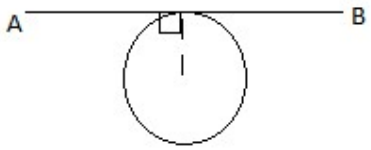
2. 

Four thin metal rods of mass m and length L each are welded to form a square ABCD as shown. What is the M.I of the composite structure about a line that bisects rods AB and CD and is in the plane of the structure?

a) $mL^2/6$ b) $mL^2/3$ c) $mL^2/2$ d) $2mL^2/3$

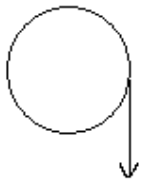
3. Three metal rods each of mass m and length L are welded to form an equilateral triangle. The M.I of the composite structure about an axis passing through the centre of mass and perpendicular to the plane of the structure is

a) $Ml^2/2$ b) $mL^2/4$ c) $mL^2/8$ d) $mL^2/12$

4. 

A thin wire of length L and uniform linear mass density ρ is bent into a circular loop as shown. The M.L of the loop about the axis AB is

a) $\rho L^3/8\pi^2$ b) $\rho L^3/16\pi^2$ c) $5\rho L^3/16\pi^2$ d) $3\rho L^3/8\pi^2$



5. A hollow cylinder of mass 3 kg and radius 40 cm is free to rotate about a fixed horizontal axis passing through its centre as shown. A rope wound round it is pulled with a force of 30 N. The angular acceleration of the cylinder (in rad/sec^2) is

   a) 10 b) 15 c) 20 d) 25

6. What is the linear acceleration (in m/s^2) of a point on the rope?

   a) 5 b) 7.5 c) 10 d) 12.5

7. A mass is whirled in a circular path with a constant angular velocity and its angular momentum is L. If the string is now halved keeping the angular velocity the same, the angular momentum is

   a) L/4 b) L/2 c) L d) 2L

8. A solid sphere A and a hollow sphere B have equal masses and equal outer radii. The densities of A and B are d_A and d_B. If their M.I about their diameters are I_A and I_B respectively, then

   a) $I_A = I_B$ b) $I_A > I_B$ c) $I_A < I_B$ d) $I_A/I_B = d_A/d_B$

9. M.I of a uniform horizontal solid cylinder of mass m about an axis passing through its edge and perpendicular to the axis of the cylinder when its length is 6 times its radius R is

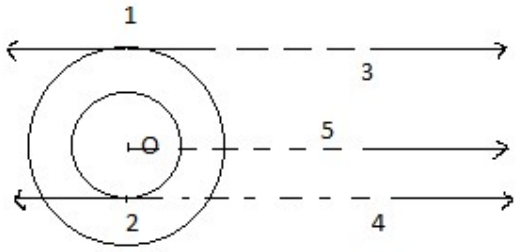
   a) $39mR^2/4$ b) $39mR/4$ c) $49mR/4$ d) $49mR^2/4$

10. Two circular loops A and B of radii r_A and r_B respectively are made of uniform wire. The ratio of their M.I about axes passing through their centres and perpendicular to their planes is $I_B/I_A = 8$. Then r_B/r_A is equal to

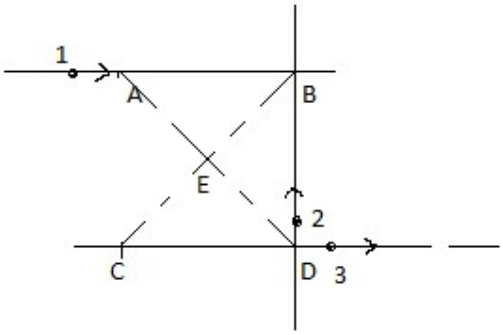
    a) 2 b) 4 c) 6 d) 8

11. At a certain time a 0.25 kg object has a position vector $\vec{r} = 2\hat{i} - 2\hat{k}$ in meters. At that instant its velocity in m/s is $\vec{v} = -5\hat{i} + 5\hat{k}$ and the force in newton acting on it is $\vec{F} = 4\hat{j}$. What is the angular momentum of the object about the origin? What torque acts on it?

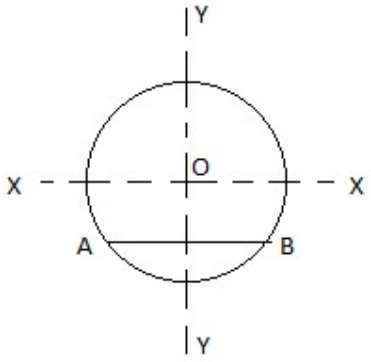
12. A 2 kg particle like object moves in a plane with velocity components v_x = 30 m/s and v_y = 60 m/s as it passes through the point with coordinates (3, -4) m. Just then what is its angular momentum relative to the origin and relative to the point (-2, -2) m?



13. Particles 1 and 2 move around the point O in circles of radii 2 m and 4 m respectively. Particles 3 and 4 travel in straight lines at perpendicular distances of 4 m and 2 m from the point O. Particle 5 moves directly away from O. All the particles have the same mass and the same constant speed. Rank the particles according to the magnitudes of their angular momentum about O, greatest first. Which particles have negative angular momentum about point O?



14. Three particles 1, 2 and 3 are of the same mass and are moving with the same speed indicated by velocity vectors. Points A, B, C and D form a square with E as the centre. Rank the points according to the magnitude of the net angular momentum of the three particle system when measured about the points. Greatest first.



A uniform rod AB of mass m and length L is attached to a uniform ring of mass 2m and radius L as shown.

15. The M.I of the system about an axis passing through the centre of the ring and perpendicular to the plane of the ring is

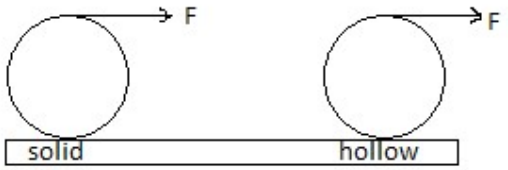
a) $34mL^2/12$ b) $25mL^2/12$ c) $22mL^2/12$ d) $13mL^2/12$

16. The M.I of the system about an axis passing through the centre of mass of the system and perpendicular to the plane of the ring is (in multiple of mL^2)

a) 33/12 b) 31/12 c) 7/3 d) 25/12

17. The M.I of the system about an axis passing through the end A of the rod and perpendicular to the plane of the ring is (in multiple of mL^2)

a) 4/3 b) 7/3 c) 11/3 d) 13/3



18. A constant horizontal force F is applied on top of a solid and hollow sphere of the same mass and radius kept on a sufficiently rough horizontal surface. Let a_1 and a_2 be their linear accelerations. Then

a) $a_1 = a_2$ b) $a_1 > a_2$ c) $a_1 < a_2$ d) can't say

19. A solid sphere of mass 2 kg and radius 5 cm rolls without slipping along a horizontal plane. The velocity of its centre of mass is 10 cm/s. The kinetic energy of the sphere is

a) 0.07 J b) 0.014 J c) 0.025 J d) 1.25 J

20. A ring is rolling on a surface without slipping. What is the ratio of its translational to rotational kinetic energies?

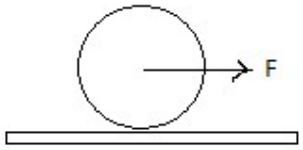
a) 5: 7 b) 2: 5 c) 2: 7 d) 1: 1

21. A body rolls down an inclined plane. If its rotational kinetic energy is 40 % of its translational kinetic energy then the body is

a) Cylinder b) ring c) disc d) solid sphere

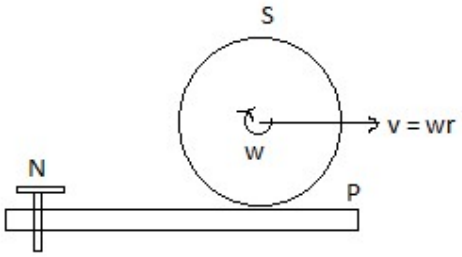
22. A loop and a disc have the same mass and roll without slipping with the same linear velocity v. If the total kinetic energy of the loop is 8 J, the kinetic energy of the disc must be

a) 6 J b) 8 J c) 12 J d) 16 J



23. A solid sphere of mass 2 kg is pulled by a constant horizontal force through its centre on a rough horizontal surface with $\mu = 0.5$. The maximum value of F so that the sphere rolls without slipping is ($g = 10\ ms^{-2}$)

a) 70 N b) 25 N c) 40 N d) 35 N



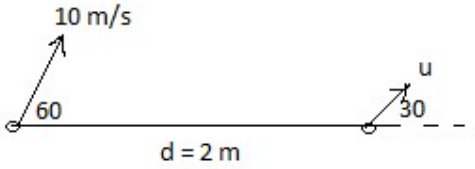
24. A sphere S rolls without slipping, moving with a constant speed on a plank P. There is sufficient friction between the sphere and the plank to prevent slipping while the lower surface of the plank in contact with the ground is smooth. Initially the plank is fixed to the ground by a pin N. If N is suddenly removed,

a) S will begin to slip on P.

b) P will begin to move backwards.

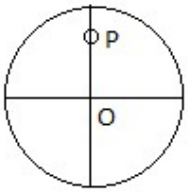
c) The speed of S will decrease and its angular velocity will increase.

d) There will be no change in the motion of S and P will still be at rest.



25. Two particles A and B are situated at a distance of 2 m. A has a velocity of 10 m/s and B has a velocity u m/s. The distance between A and B is constant. The angular velocity of B w.r.t A is

a) 5√3 m/s b) 5/√3 m/s c) 10√3 m/s d) 10/√3 m/s



26. A disc of radius R rolls on a horizontal ground with linear acceleration a to the right and angular acceleration α clockwise. It has a velocity v at the instant shown and angular velocity ω also clockwise. What is the magnitude of the acceleration of the point P, distance r from the centre?

a) $\sqrt{\left(a+\alpha r\right)^2+\left(r\omega^2\right)^2}$ b) $\frac{\alpha r}{R}$

c) $\sqrt{\alpha^2 r^2+r^2\omega^4}$ d) αr

27. A solid sphere and a hollow sphere of equal mass and radius are placed over a rough horizontal surface after rotating it about its centre of mass with the same angular velocity. Once the pure rolling starts, let v_1 and v_2 be the velocities of their centre of mass. Then

a) $v_1 = v_2$ b) $v_1 > v_2$ c) $v_1 < v_2$ d) data insufficient

28. In the above problem if t_1 and t_2 be the times after which pure rolling of solid and hollow spheres starts, then

a) $t_1 = t_2$ b) $t_1 > t_2$ c) $t_1 < t_2$ d) none

29. A homogeneous cylinder of mass m and radius r is pulled on a horizontal plane by a horizontal force F acting through its centre of mass. Assuming rolling without slipping the angular acceleration of the cylinder is

a) 3F/2mr b) 2F/3mr c) F/2mr d) 3F/4mr

30. The linear velocity of a particle moving with angular velocity $\vec{\omega} = 2\hat{k}$ having position vector $\vec{r} = 2\hat{i} + 2\hat{j}$ is

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