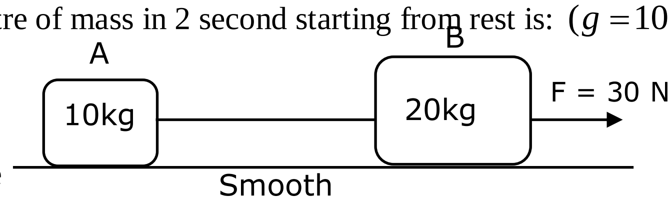
I PUC – CHAPTER-07
SYSTEM OF PARTICLES AND ROTATIONAL DYNAMICS

1. Two particles of equal mass have velocities $\vec{V}_1 = 8\hat{i}$ and $\vec{V}_2 = 8\hat{j}$. First particle has acceleration $\vec{a}_1 = (5\hat{i} + 5\hat{j})ms^{-2}$ while the acceleration of the other particle is zero. The centre of mass of the two particles moves in a path of
(a) straight line (b) parabola (c) circle (d) ellipse

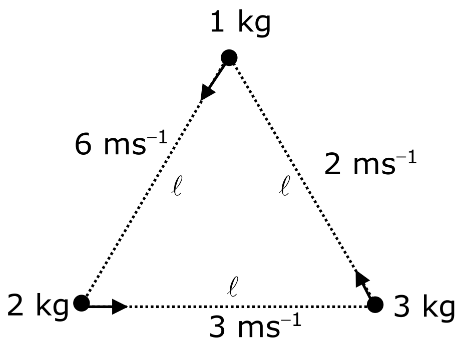
2. Two blocks A and B are connected by a massless string (shown in figure). A force of 30 N is applied on block B. The distance travelled by centre of mass in 2 second starting from rest is: $(g = 10\,ms^{-2})$



(a) 1 m (b) 2m
(c) 3 m (d) none of these

3. Two blocks of masses 10 kg and 30 kg are placed on X-axis. The first mass is moved on the axis by a distance of 2 cm right. By what distance should the second mass be moved to keep the position of centre of mass unchanged.
(a) $\frac{2}{3}$ (b) $-\frac{2}{3}$ (c) $-\frac{3}{2}$ (d) $\frac{3}{2}$

4. Three particles of masses 1kg, 2kg and 3kg are situated at the corners of an equilateral triangle move at speed $6\,ms^{-1}$, $3\,ms^{-1}$ and $2\,ms^{-1}$ respectively. Each particle maintains a direction towards the particle at the next corner symmetrically. Find velocity of CM of the system at this instant



(a) $3\,ms^{-1}$ (b) $5\,ms^{-1}$ (c) $6\,ms^{-1}$ (d) zero

5. A circular hole of radius 1 cm is cut off from a disc of radius 6 cm. The centre of hole is 3 m from the centre of the disc. The position of centre of mass of the remaining disc from the centre of disc is:
(a) $-\frac{3}{35}$cm (b) $\frac{1}{35}$cm (c) $\frac{3}{10}$cm (d) none of these

6. Three particles of masses 1 kg, 2 kg and 3 kg are situated at the corners of an equilateral triangle of side b. The coordinates of the centre of mass are
(a) $\left[0, \frac{7b}{12}, \frac{3\sqrt{3}b}{12}\right]$ (b) $\left[\frac{3\sqrt{3}b}{12}, \frac{7b}{12}, 0\right]$ (c) $\left[\frac{7b}{12}, \frac{3\sqrt{3}b}{12}, 0\right]$ (d) $\left[\frac{7b}{12}, 0, \frac{3\sqrt{3}b}{12},\right]$

7. Two particles of mass 1 kg and 3 kg have position vectors $2\hat{i}+3\hat{j}+4\hat{k}$ and $-2\hat{i}+3\hat{j}-4\hat{k}$ respectively. The centre of mass has a position vector

(a) $\hat{i}+3\hat{j}-2\hat{k}$ (b) $-\hat{i}-3\hat{j}-2\hat{k}$ (c) $-\hat{i}+3\hat{j}+2\hat{k}$ (d) $-\hat{i}+3\hat{j}-2\hat{k}$

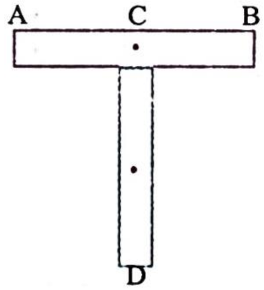
8. If two particles of masses 3kg and 6 kg which are at rest are separated by a distance of 15 m. The two particles are moving towards each other under a mutual force of attraction. Then the ratio of distances travelled by the particles before collision is

(a) 2: 1 (b) 1: 2 (c) 1: 3 (d) 3: 1

9. A man weighing 80 kg is standing at the centre of a flat boat and he is 20 m from the shore. He walks 8m on the boat towards the shore and then halts. The boat weight 200 kg. How far is he from the shore at the end of this time?

(a) 11.2 m (b) 13.8 m (c) 14.3 m (d) 15.4 m

10. Two identical thin uniform rods of length L each are joined to form T shape as shown in the figure. The distance of centre of mass from D is



(a) 0

(b) L/4

(c) 3L/4

(d) L

11. A solid sphere of mass 500g and radius 10 cm rolls down on an inclined plane without slipping. The height of the centre of mass of the sphere from the ground is 0.8 m. The translational speed of the centre of mass of the sphere on reaching the bottom of inclined will be (g = 10 ms^{-2})

(a) $\sqrt{5}$ m/s (b) $\sqrt{6}$ m/s (c) $\sqrt{10}$ m/s (d) 20 m/s

12. A horizontal rod rotates about a vertical axis through one end. A ring, which can slide along the rod without friction, is initially close to the axis and then slide to the other end of the rod. In this process, which of the following quantities will be conserved?

[L = angular momentum, K_T = total kinetic energy, K_R = rotational kinetic energy]

(a) L only (b) L and K_T only (c) L and K_R only d) K_T only

13. The ratio of radii of gyration of a circular disc and a circular ring of the same radii about a tangential axis perpendicular to plane of disc or ring is

(a) 1 : 2 (b) $\sqrt{5}:\sqrt{6}$ (c) 2 : 3 (d) $\sqrt{3}:2$

14. A body is rotating with angular velocity $\vec{\omega}=(3\hat{i}-4\hat{j}+\hat{k})$. The linear velocity of a point having position vector $\vec{r}=(5\hat{i}-6\hat{j}+6\hat{k})$ is

(a) $6\hat{i}+2\hat{j}-3\hat{k}$ (b) $18\hat{i}+3\hat{j}-2\hat{k}$ (c) $-18\hat{i}-13\hat{j}+2\hat{k}$ (d) $6\hat{i}-2\hat{j}+8\hat{k}$

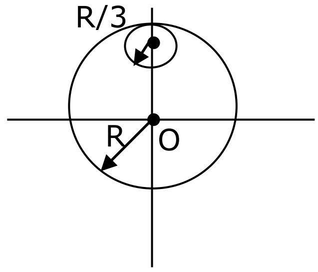
15. A circular platform is mounted on a vertical frictionless axle. Its radius is 2 m and its moment of inertia is 200 kg m^2. It is initially at rest. A 70 kg man stands on the edge of the platform and begins to walk along the edge at speed $v_0 = 1.0\ ms^{-1}$ relative to the ground. The angular velocity of the platform is

(a) 1.2 rad s^{-1} (b) 0.4 rad s^{-1} (c) 0.7 rad s^{-1} (d) 2.0 rad s^{-1}

16. A uniform solid cylinder has a radius R and length L. If the moment of inertia of this cylinder about an axis passing through its centre and normal to its circular face is equal to the moment of inertia of the same cylinder about an axis passing through its centre and perpendicular to its length, then

(a) L = R (b) $L = \sqrt{3}R$ (c) $L = \frac{R}{\sqrt{3}}$ (d) $L = \sqrt{\frac{3}{2}}R$

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



(a) $4MR^2$
(b) $\frac{40}{9}MR^2$
(c) $40MR^2$
(d) $\frac{37}{9}MR^2$

18. A thin rod of length L and mass M is bent at its midpoint into two halves so that the angle between them is 90°. The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is

(a) $\frac{ML^2}{24}$ (b) $\frac{ML^2}{12}$ (c) $\frac{ML^2}{6}$ (d) $\frac{\sqrt{2}ML^2}{24}$

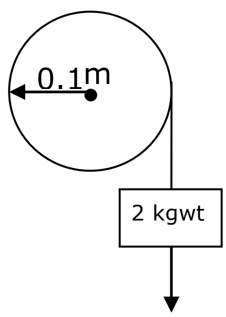
19. A solid cylinder of mass 3 kg is rolling on a horizontal surface with velocity 4m s^{-1}. It collides with a horizontal spring of force constant 200 N m^{-1}. The maximum compression produced in the spring will be

(a) 0.5 m (b) 0.6 m (c) 0.7 m (d) 0.2 m

20. 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 mass and perpendicular to the plane of hexagon is

(a) $20mL^2$ (b) $6mL^2$ (c) $\frac{12}{5}mL^2$ (d) $30mL^2$

21. The moment of inertia of a solid flywheel about its axis is 0.1 kg m^2. A tangential force of 2 kg wt. is applied round the circumference of the flywheel with the help of a string and mass arrangement as shown in the figure. If the radius of the wheel is 0.1 m, find the acceleration of the mass (g = 9.8 m/s^2)



(a) 163.3 rad s^{-2}

(b) 16.3 rad s^{-2}

(c) 81.66 rad s^{-2}

(d) 8.16 rad s^{-2}

22. A thin circular disc of mass M and radius R is rotating in a horizontal plane bout an axis passing through its centre and perpendicular to its plane with an angular velocity ω. If another disc of same dimensions but of mass M/4 is placed gently on the first disc co-axially, then the new angular velocity of the system is

(a) $\frac{5}{4}\omega$ (b) $\frac{2}{3}\omega$ (c) $\frac{4}{5}\omega$ (d) $\frac{3}{2}\omega$

23. A flywheel rotates with a uniform angular acceleration. Its angular velocity increases from 20π rad s^{-1} to 40π rad s^{-1} in 10 s. how many rotations did it make in this period?

(a) 80 (b) 100 (c) 120 (d) 150

24. An electric motor drill, rated 350 W has an efficiency of 35%. The torque produced, if it working at 3000 rpm is

(a) 0.21 N m (b) 0.6 N m (c) 0.39 N m (d) 0.9 N m

25. A rope is wound round a hollow cylinder of mass 3 kg and radius 40 cm. If the rope is pulled with a force of 30 N, angular acceleration of the cylinder will be

(a) 10 rad s^{-2} (b) 15 rad s^{-2} (c) 20 rad s^{-2} (d) 25 rad s^{-2}

26. The moment of inertia of a body about a given axis is 1.2 kg m^2. Initially, the body is at rest. In order to produce a rotational kinetic energy of 6000 joule, an angular acceleration of 25 rad s^{-2} must be applied about that axis for duration of

(a) 4 s (b) 2 s (c) 8 s (d) 10 s

27. Three point masses m_1, m_2, m_3 ate located at the vertices of an equilateral triangle of side a. The moment of inertia of system about an axis along the altitude of the triangle passing through m_1 is

(a) $(m_2 + m_3)\frac{a^2}{4}$ (b) $(m_1 + m_2 + m_3)a^2$

(c) $(m_1 + m_2)\frac{a^2}{2}$ (d) $(m_2 + m_3)a^2$

28. A solid sphere of mass M, radius R and having moment of inertia about an axis passing through the centre of mass as I, is recast into a disc of thickness t, whose moment of inertia about an axis passing through its edge and perpendicular to its plane remains I. Then, radius of the disc will be

(a) $\frac{2R}{\sqrt{15}}$ (b) $R\sqrt{\frac{2}{15}}$ (c) $\frac{4R}{\sqrt{15}}$ (d) $\frac{R}{4}$

29. Two rings of radius R and nR made up of same material have the ratio of moment of inertia about an axis passing through centre as 1 : 8. The value of n is

(a) 2 (b) $2\sqrt{2}$ (c) 4 (d) $\frac{1}{2}$

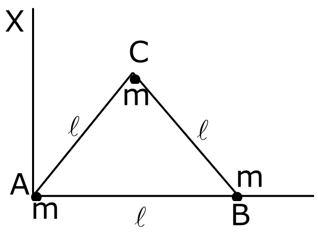
30. A wire of length ℓ and mass m is bent in the form of a rectangle ABCD with $\frac{AB}{BC} = 2$. The moment of inertia of this wire frame about the side BC is

(a) $\frac{11}{252}m\ell^2$ (b) $\frac{8}{203}m\ell^2$ (c) $\frac{5}{136}m\ell^2$ (d) $\frac{7}{162}m\ell^2$

31. Three particles, each of mass m gram, are situated at the vertices of an equilateral triangle ABC of side ℓ cm as shown in 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 will be

(a) $\frac{5}{4}ml^2$ (b) $\frac{3}{2}ml^2$

(c) $\frac{3}{4}ml^2$ (d) $2ml^2$



32. A mass M is moving with a constant velocity parallel to the x–axis. Its angular momentum w.r.t the origin
(a) is zero (b) remains constant
(c) goes on increasing (d) goes on decreasing

33. A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$. The value of α for which angular momentum about origin is conserved is
(a) 1 (b) – 1 (c) 2 (d) zero

34. A flywheel of mass 50 kg and radius of gyration about its axis of rotation of 0.5 m is acted upon by a constant torque of 12.5 Nm. Its angular velocity at t = 5 s is
(a) 2.5 rad/s (b) 5 rad/s (c) 7.5 rad/s (d) 10 rad/s

35. The moment of inertia of a disc, of mass M and radius R, about an axis which is a tangent and parallel to its diameter is
(a) $\frac{1}{2}MR^2$ (b) $\frac{3}{4}MR^2$ (c) $\frac{1}{4}MR^2$ (d) $\frac{5}{4}MR^2$

36. A ball rolls without slipping. The radius of gyration of the ball about an axis passing through its centre of mass is K. If radius of the ball be R, then the fraction of total energy associated with its rotation will be
(a) $\frac{K^2+R^2}{R^2}$ (b) $\frac{K^2}{R^2}$ (c) $\frac{K^2}{K^2+R^2}$ (d) $\frac{R^2}{K^2+R^2}$

37. 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) $\frac{2v_0h}{5r^2}$ (b) $\frac{5v_0h}{2r^2}$ (c) $\frac{2v_0r^2}{5h}$ (d) $\frac{5v_0r^2}{2h}$

38. Circular disc of mass 2 kg and radius 1 m is rotating about an axis perpendicular to its plane and passing through its centre of mass with a rotational kinetic energy of 8J. The angular momentum in (Js) is
(a) 8 (b) 4 (c) 2 (d) 1

39. Two bodies have their moments of inertia I and 2I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momenta will be in the ratio

(a) 1 : 2 (b) $\sqrt{2}:1$ (c) $1:\sqrt{2}$ (d) 2 :1

40. Angular momentum of the particle rotating with a central force is constant due to

(a) Constant torque (b) constant force

(c) Constant linear momentum (d) zero torque

41. The diameter of a flywheel is 1m. It has a mass of 20kg. It is rotating about its axis with seed of 120 rotations in one minute. Its angular momentum in kg m^2s^{-1} is

(a) 13.4 (b) 31.4 (c) 41.4 (d) 43.4

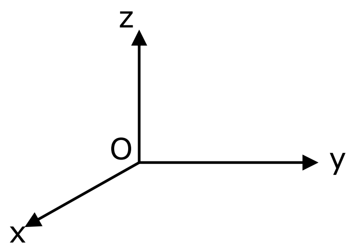
42. A carpet of mass M, made of an extensible material is rolled along its length in the form of a cylinder of radius R and kept on a rough floor. If the carpet is unrolled, without sliding to a radius R/2, the decrease in potential energy is

(a) $\frac{1}{2}MgR$ (b) $\frac{7}{8}MgR$ (c) $\frac{5}{8}MgR$ (d) $\frac{3}{4}MgR$

43. Four particles each of mass m are lying symmetrically on the rim of a disc of mass M and radius R. The moment of inertia of this system about an axis passing through one of the particle and perpendicular to plane of disc is

(a) $16mR^2$ (b) $(3M + 16m)\frac{R^2}{2}$ (c) $(3m+12M)\frac{R^2}{2}$ (d) zero

44. A force of $-F\hat{k}$ acts on O, the origin of the coordinate system. The torque about the point (1, - 1) is



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

(c) $-F(\hat{i}-\hat{j})$ (d) $F(\hat{i}-\hat{j})$

45. Three identical thin rods each of length l and mass M are joined together to form a letter H. What is the moment of inertia of the system about one of the sides of H?

(a) $\frac{Ml^2}{6}$ (b) $\frac{Ml^2}{4}$ (c) $\frac{2}{3}Ml^2$ (d) $\frac{4}{3}Ml^2$

46. The radius of gyration of a solid cylinder of mass M and radius R about its own axis is

(a) $\frac{R}{\sqrt{2}}$ (b) $\frac{R}{2}$ (c) $\frac{R}{\sqrt{3}}$ (d) $\frac{R}{3}$

47. If the radius of a solid sphere is 35 cm, calculate the radius of gyration when the axis is along a tangent:

(a) $7\sqrt{10}$ cm (b) $7\sqrt{35}$ cm (c) $\frac{7}{5}$ cm (d) $\frac{2}{5}$ cm

48. The moment of inertia of a uniform thin rod of length L and mass M about an axis passing through a point at a distance of L/3 from one of its ends and perpendicular to the rod is

(a) $\frac{7ML^2}{48}$ (b) $\frac{ML^2}{1}$ (c) $\frac{ML^2}{9}$ (d) $\frac{ML^2}{3}$

49. A uniform disc of radius R lies in XY-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 spherical ball rolls on a table without slipping. Then the fraction of its total energy associated with rotation is

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