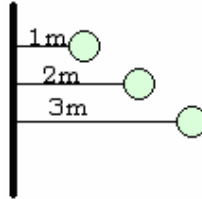
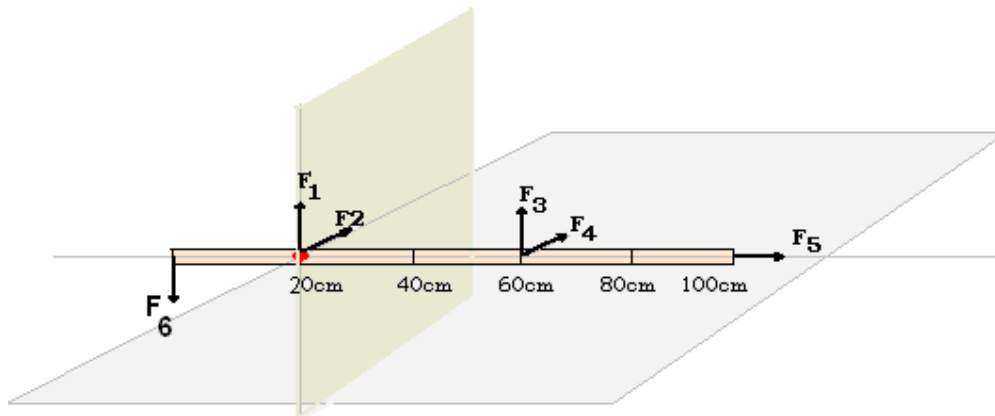


7. ROTATIONAL MOTION

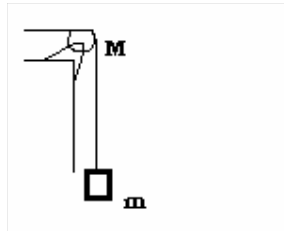
1. rpm is about _____ rad/s.
2. A wheel rotates with constant angular acceleration of $\pi \text{ rad/s}^2$. During the time interval from t_1 to t_2 , its angular displacement is $\pi \text{ rad}$. At time t_2 its angular velocity is $2\pi \text{ rad/s}$. What is its angular velocity at time t_1 ?
3. If the angular velocity of a spinning body points out of the page, then describe how is the body spinning?
4. The angular velocity vector of a spinning body points out of the page. If the angular acceleration vector points into the page then describe the motion of the body.
5. For wheel spinning on an axis through its centre
 - (i) the ratio of the tangential acceleration of a point on the rim to the tangential acceleration of a point halfway between the centre and the rim is _____.
 - (ii) ratio of the radial acceleration is _____.
6. Three identical balls are tied by light strings to the same rod and rotate around it, as shown below. Rank the balls according to their rotational inertia, least to greatest.



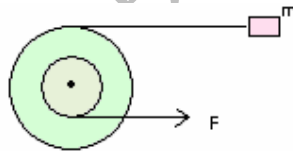
7. The rotational inertia of a wheel about its axle does not depend upon its:
 - A. diameter
 - B. mass
 - C. speed of rotation
 - D. material composition
8. The meter stick shown below rotates about an axis through the point marked •, 20cm from one end. Magnitudes of all forces are same. Rank the forces according to the magnitude of torque they produce about the pivot point, least to greatest.



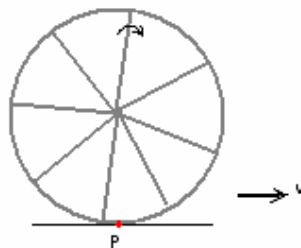
9. A cylinder is 0.10 m in radius and 0.20 m in length. If rotational inertia, about the cylinder axis on which it is mounted is $0.020 \text{ kg}\cdot\text{m}^2$. A string is wound around the cylinder and pulled with a force of 1.0 N. Find the angular acceleration of the cylinder.
10. A certain wheel has a rotational inertia of $12 \text{ kg}\cdot\text{m}^2$. As it turns through 5.0 revolutions, its angular velocity increases from 5.0 rad/s to 6.0 rad/s. What is the net torque that acts on it?
11. A uniform disk, with mass $M = 2.5 \text{ kg}$ and radius $R = 20 \text{ m}$, is mounted on a fixed horizontal axle. A block with mass $m = 1.2 \text{ kg}$ hangs from a mass-less cord, that is wrapped around the rim of the disk. Find the acceleration of the falling block, angular acceleration of the disk and tension in the cord. The cord does not slip and there is no friction at the axle.



12. A small disk of radius R_1 , is mounted coaxially with a larger disk of radius R_2 . The disks are accurately fastened to each other and the combination is free to rotate on a fixed axle that is perpendicular to a horizontal frictionless table top. The rotational inertia of the combination is I . A string is wrapped around the large disk and attached to a block of mass m , on the table. Another string is wrapped around smaller disk and is pulled with a force F as shown. The acceleration of the block is:



13. A grinding wheel, used to sharpen tools is powered by a motor. A knife against the wheel exerts a torque of $0.80 \text{ N}\cdot\text{m}$. If the wheel rotates with an angular velocity of 20 rad/s , the work done by the wheel on the motor in 1.0 minute is _____.
14. A wheel rolls without slipping along a horizontal reel. The velocity of the centre of the wheel is represented by the \rightarrow . Point P is a point on the rim of the wheel. What is the instantaneous velocity of point P ?



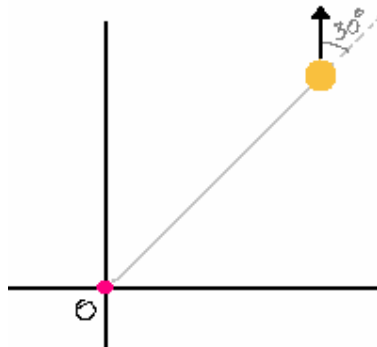
15. A thin walled hollow tube rolls without slipping along the floor. The ratio of its translational kinetic energy to its rotational kinetic energy (about an axis through its

centre of mass) is _____
 A. 1 B. 2 C. 3 D. 1/2 E. 1/3

16. The unit $\frac{kgm^2}{s}$ can be used for:

A. angular momentum B. work C. power D. Linear momentum E. moment of inertia

17. A 6 kg particle moves about point O. It has a velocity of 4m/s. What is its angular momentum about point O?



18. A 2.0 kg block starts from rest on the positive x axis 3.0 m from the origin and there after has an acceleration given by $a = 4.0\hat{i} - 3.0\hat{j}$ in m/s^2 . What is its angular momentum about the origin at the end of 2.0 s.

19. A uniform sphere of radius R rotates about a diameter with angular momentum L. Under the action of internal forces the sphere collapses to a uniform sphere of radius R/2. What is the new angular momentum?

20. Two disks are mounted on low friction bearings on a common shaft. The two disks are slowly forced toward each other along the shaft until they couple and have a final common angular velocity. Find the common velocity at which they will rotate.

21. A diver dives off a board with arms straight up and legs straight down, giving him a of inertia about his rotation axis of $2.0 kg.m^2$. He then tucks into a small ball decreasing his moment of inertia to $3.6 kg.m^2$. While tucked he makes 2 complete revolutions in 1.2 s. If he hadn't tucked at all, how many revolutions would he have made in the 1.5 s from board to water. (hint: use conservation of angular momentum to find the initial angular velocity. Then use this angular velocity to find angular displacement in 1.5s)

22. Write an expression for the coordinates of the centre of mass of a two particle system. Does the centre of mass of a body necessarily lie within the body?

23. What is the cause of rotational motion?

24. What is the torque due to the gravitational force of Sun on Earth?

25. Define angular momentum. Is it a vector or scalar quantity?

26. What is the magnitude of the angular velocity of the second's hand of a clock?
27. Why does a cyclist bend inwards while negotiating a bend?
28. Explain why does cream get separated, when milk is churned?
29. A ring, a disc and a sphere, all of the same radius and mass roll down an inclined plane from the same height, h . Which of the three reaches the bottom (i) earliest (ii) latest?
30. A child stands at the centre of a turn table with his two arms stretched. The turntable is set rotating with an angular speed of 40 revolutions/min. How much is the angular speed of the child if he folds his hands back and thereby reduces his moment of inertia to $2/5$ times, the initial value?
31. A solid cylinder of mass 230 kg rotates about its axis with an angular speed 1000 rad/s. The radius of the cylinder is 0.1 m. Calculate its kinetic energy and its angular momentum about its axis.
32. If a wheel turns with constant angular speed then:
A. Each point on its rim moves with constant velocity.
B. Each point on its rim moves with constant acceleration
C. The wheel turns through equal angles in equal time
D. The angle through which the wheel turns in each second as time goes on
33. The angular velocity of a wheel increases by 2 revs every minute. What is the angular acceleration of the wheel in rad/s^2 ?
34. A child riding on a large merry-go-round travels a distance of 3,000 m in a circle of diameter 40 m. What is the total angle in radians through which she revolves?
35. A string is wrapped around the periphery of a cylinder, 5.0 cm in radius. It is free to rotate on its axis. If the string is pulled out at a constant rate of 10 cm/s and does not slip on the cylinder, what is the angular velocity of the cylinder is ?
36. Two wheels are identical but wheel B is spinning with twice the angular velocity of wheel A. The ratio of the radial acceleration of a point on the rim of B to the radial acceleration of a point on the rim A is _____?
37. Show that if a force \mathbf{F} is applied to an object, at a distance \mathbf{r} from the axis of rotation, rotating in the xy plane, then the torque produced by the force is $\mathbf{r} \times \mathbf{F}$.
38. Consider four objects, each having the same mass and same radius:
1. a solid sphere
2. a hollow sphere
3. a flat disk in the XY plane
4. a hoop in the XY plane
Write the rotational inertia of these objects about an axis through the centre of mass and parallel to the Z -axis.
39. Define angular momentum. Show that if an object is rotating then the angular momentum of a point on the object can be measured in terms of its areal velocity.
40. A disk with a rotational inertia of $5.0 \text{ kg}\cdot\text{m}^2$ and radius 0.25 m rotates on a fixed axis perpendicular to the disk and through its centre. A force of 2.0 N is applied tangentially to the rim. As the disk turns through half a rotation, how much work is

done by the force?

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