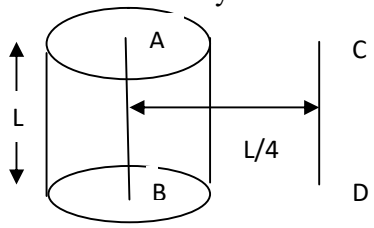
ENGINEERING PHYSICS (ASB-101)

ASSIGNMENT-UNIT 1, CLASSICAL MECHANICS

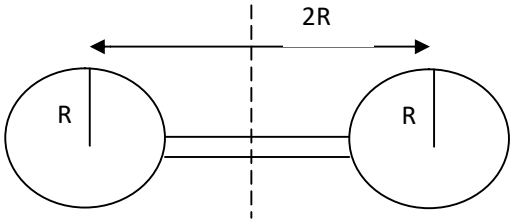
1. The ratio of moment of inertia of a disc about a tangent in its plane to the moment of inertia of sphere about its tangent is $\frac{x}{12}$. If a solid sphere of mass 15 kg and a disc of mass 14 kg have the same radius, find the value of x.
2. The solid cylinder of length $L = 80\ cm$ and mass M has a radius of 60 cm. The moment of inertia of the cylinder about an axis CD parallel to AB at a distance $L/4$ is $2.64\ kg/m^2$. Find the density of the material used for solid cylinder.



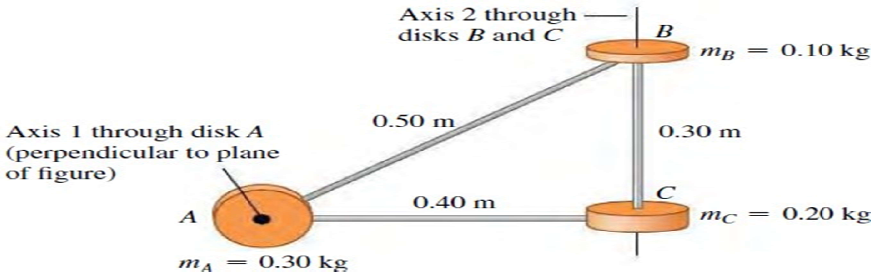
3. The moment of inertia of a uniform cylinder of length ***(l)*** and radius R about its perpendicular bisector is I. What is the ratio $\boldsymbol{l / R}$ such that the moment of inertia is minimum?
4. The linear mass density of a thin rod AB of length L varies as, $\lambda(\boldsymbol{x}) = \boldsymbol{\lambda_o}\ (\mathbf{1} + \frac{\boldsymbol{x}}{\boldsymbol{L}})$, where x is the distance from A. If M is the mass of the rod, find the moment of inertia about an axis passing through A and perpendicular to the rod.
5. A uniform thin bar of mass 12 kg and length 3.6 m is bent to make an equilateral hexagon. Calculate its moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon.
6. A circular disc of radius b has a hole of radius a at its centre. If the mass per unit area of the disc varies as, $\boldsymbol{\sigma = \sigma_o / r}$, find the radius of gyration of the disc about its axis passing through the centre.
7. Two identical spherical balls of mass M and radius R each are stuck on two ends of a rod of length 2R and mass M. Determine the moment of inertia of the system about the axis passing perpendicularly through the centre of the rod.

8. Four point masses, each of the mass m, are placed at the corners of a square ABCD of side ***l***. Determine the moment of inertia of this system about an axis passing through A and parallel to BD.

9. A lamina is made by removing a small disc of diameter 2R from a bigger disc of uniform mass density and radius 2R. The moment of inertia of this lamina about axes passing through O and P are I_o and I_P, respectively. Both axes are perpendicular to the plane of the lamina. Find the ratio I_o/ I_P.



10. A thin circular plate of mass M and radius R has its density varying as $\boldsymbol{\sigma(r) = \sigma_o r}$ with $\boldsymbol{\sigma_o}$ as a constant and r is the distance from its centre. The moment of inertia of the circular plate about an axis perpendicular to the plate and passing through its edge is $\boldsymbol{I = \alpha MR^2}$. Find the value of coefficient α.
11. A machine part consists of three disks linked by light weight struts (a) What is this body`s moment of inertia about axis 1 through the centre of disk A, perpendicular to the plane of the diagram? (b) What is its moment of inertia axis 2 through the centres of disks B and C? (c) What is the body`s kinetic energy if it rotates about axis 1 with angular speed, $\boldsymbol{\omega = 4\,rad/sec}$.



12. A simple pendulum possesses 0.05 joule energy when its length is 2 m and the amplitude of motion of the bob is 4 cm. Calculate its energy (a) when the length remains the same but the amplitude is doubled (b) the amplitude remains the same but the length is made one half.
13. A simple pendulum with length 150 cm and bob of mass 350 g is executing S.H.M. of amplitude 15 cm. Find the maximum tension in the string.
14. (a) Assuming small amplitude for a pendulum of length 2 m what would its frequency be in an elevator moves upward with an acceleration $\boldsymbol{g/2}$ (b) What would its frequency be in free fall?

15. A block of mass 0.25 kg is moving in SHM along x axis, with total energy 0.35 J and time period 1.57 sec. Assume its potential energy to be zero at the mean position. The equation of motion is known to be $x = A\sin(\omega t - a) + A\cos(\omega t - a)$. Velocity of the block is zero at t=T/4. Find the amplitude of SHM, maximum speed of the block and the values of A and a.
16. A particle is moving with S.H.M in a straight line. When the distance of the particle from the equilibrium position has the values x_1 and x_2 corresponding values of velocity are u_1 and u_2. Show that the time period is $2\pi\,[(x_2^2 - x_1^2)/(u_1^2 - u_2^2)]^{1/2}$. Find also the maximum velocity and amplitude of the particle.
17. The instantaneous displacement of a particle executing SHM is given by $\boldsymbol{y = A\sin(\omega_o t + \varphi)}$. If the displacement of the particle at t = 0 is y_o and its velocity at t = 0 is v_o, then find the values of A and $\boldsymbol{\varphi}$.
18. A uniform circular disc of radius 20 cm oscillates in a vertical plane about a horizontal axis. Find the distance of the axis of rotation from the centre for which the period is minimum. What is the value of this period?
19. A body of mass 200 gm oscillates about a horizontal axis at a distance of 20 cm from its centre of gravity. If the length of equivalent simple pendulum be 35 cm, find the moment of inertia about the axis of rotation.
20. A thin uniform bar of length 120 cm is made to oscillate about an axis through its end. Find the period of oscillation and other points about which it can oscillate with the same period.
21. A uniform thin rod of length 120 cm and width 6 cm is swinging in a vertical plane as pendulum about a point A at some distance from one end. If the time of swing is minimum, find the distance A from the end of rod.
22. A block of mass 0.32 kg is moving on x-axis, in damped harmonic motion, with a time period of 1.6 sec. Its equation of motion is $x = A\exp(-at)\cos\omega t$. Its initial position is 0.4 meter while initial velocity is 11 cm/s, to the left. Calculate the values of A, a and ω. Find mechanical energy lost by the block, in first three oscillations.
23. The amplitude of vibrations of a spring mass system decreases from 10 cm to 2.5 cm in 200 sec. Find the damping constant and relaxation time. In how much time does the amplitude falls 1/e times the initial value?

24. A damped harmonic oscillator has its first amplitude of 20 cm. It reduces to 2 cm after 100 oscillations, each of period 4.6 sec. Calculate the logarithmic decrement and damping constant. Find the number of oscillations in which the amplitude drops to 50%.
25. The amplitude of an oscillator of frequency 200 per second reduced to (1/10) of its initial value after 2000 cycles. Calculate (i) the damping constant (ii) relaxation time (iii) quality factor (iv) time in which its energy falls to 1/10 of its initial value.
26. If the quality factor of an undamped tuning fork of frequency 512 be 8×10^4, calculate the time in which its energy is reduced to (1/e) of its energy in the absence of damping. How many oscillations does the tuning fork will make in this time? Calculate the percentage reduction in the frequency of tuning fork due to damping.
27. The Q value of a spring loaded with0.3 kg is 60. It vibrates with a frequency of 2 Hz. Calculate the force constant and mechanical resistance.
28. A harmonic oscillator of a 50 gm mass attached to a massless spring has a quality factor 200. If it oscillates with amplitude of 2 cm in resonance with a periodic force of frequency 20 c.p.s, calculate (i) the average energy stored in it, (ii) the rate of dissipation of energy.
29. A damped vibrating system starting from rest reaches a first amplitude of 300 mm which reduces to 30 mm in that direction after 100 vibrations each of period 2.3 sec. Find the damping constant.
30. A massless spring, suspended from a rigid support, carries a mass of 500 gm at its lower end and the system oscillates with a frequency of 5 sec^1, with the amplitude reduced to half its undamped value in 20 sec. Calculate (i) force constant of the spring (ii) relaxation time of the system (iii) its quality factor.