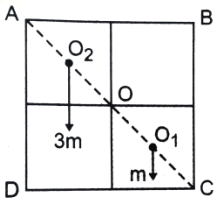
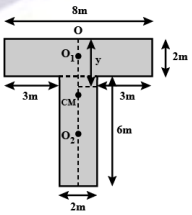
CLASS XI : ASSIGNMENT : CH-6 : ROTATIONAL MOTION : PHYSICS

CENTRE OF MASS

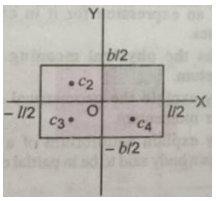
1. Is Center of mass a reality?
2. What is the advantage of concept of center of mass?
3. Does center of mass of a system of two particles lie on the line joining the particles?
4. Can center of mass of a body lie where there is absolutely no mass?
5. On what factors does the position of center of mass of a rigid body depend?
6. What is the nature of motion of center of mass of an isolated system?
7. Obtain an expression for the position vector of center of mass of a two particle system.
8. Obtain an expression for the position vector of the center of mass of a system of n particles.
9. Prove that center of mass of an isolated system moves with a uniform velocity along a straight line path.
10. Prove that the centre of mass of two particles divide the line joining the particles in the inverse ratio of their masses.
11. Where does the center of mass of a
    a) uniform triangular laminar lie?
    b) uniform cone lie?
    c) uniform rectangular laminar lie?
12. In a stationary railway compartment there are several passengers. If they start moving in the compartment, will center of mass of the compartment change? Will the center of mass of the system of compartment and passengers change?
13. An isolated particle of mass M is moving in a horizontal plane (X-Y), along the X axis at certain height above the ground. it explodes suddenly into two fragments of masses m/4 and 3m/4. an instant later, the smaller fragment is at y = + 15 cm. what is the position of larger fragment at this instant
14. Three particles of masses 0.2 Kg, 0.3 Kg and 0.4 Kg are situated at the vertices A, B and C of a right angled triangle ABC with A = 90°; AB = 2cm along X-axis and BC = 2.5cm. Find the distance of centre of mass from A.
15. Find the centre of mass of three particles at the vertices of an equilateral triangle. The masses of the particles are 100g, 150g and 200g respectively. Each side of the equilateral triangle is 0.5 m long.
16. Four particles A, B, C and D of masses m, 2m, 3m and 4m respectively are placed at the corners of a square of side x. Locate the center of mass.
17. Four particles of masses m_1 =1 Kg, m_2 = 2 Kg, m_3 = 3 Kg and m_4 = 4 kg are located at the corners of a rectangle of length a and breadth b. Locate the position of center of mass.
18. A square of side 4 cm having uniform thickness is divided into four equal squares. If one of the squares is cut off. Find the position of center of mass of the remaining portion from the center O.



19. Rectangular plate of dimensions l x b is in XY plane as shown in figure. If the portion of this plate lying in quadrant one is removed. Find the position of center of mass of remaining part of plate.
20. Find the position of center of mass of the T shaped plate from O in figure.



21. From a uniform circular disc of radius R, A circular disk of radius R/6 and having center at a distance R/2 from the center of the disk is removed. Determine the center of mass of remaining portion of the disc.



22. Circular plate of uniform thickness has a diameter of 56 cm. A circular portion of diameter 42cm is removed from one edge of the plate. Find center of mass of remaining portion of the disc.
23. Determine the coordinates of the center of mass of a right circular solid cone of base radius R and height h.

ANGULAR MOMENTUM

24. Which physical quantity is expressed by the moment of linear momentum?
25. Which physical quantity is represented by the product of the moment of inertia and the angular velocity?
26. Write the dimensional formula of angular momentum. Is it a scalar or a vector?

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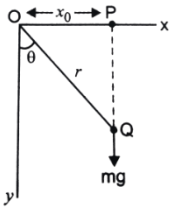
27. Name the physical quantity whose dimensions are the same as that of angular momentum.
28. Which physical quantity is conserved when a planet revolves around the sun?
29. Write the expression for angular momentum in Cartesian and polar coordinates.
30. Show that the angular momentum about any point of a single particle moving with constant velocity remains constant throughout its motion.
31. Can a body in translatory motion have angular momentum?
32. Which component of linear momentum does not contribute to angular momentum?
33. Complete the statement: angular momentum of a particle is equal to twice_____.
34. A particle moves in a circular path with decreasing speed. What happens to its angular momentum?
35. Why there are two propellers in a helicopter?
36. A planet revolves around a massive star in a highly elliptical orbit. Is its angular momentum constant over the entire orbit?
37. Briefly explain the geometrical meaning of angular momentum.
38. Show that angular momentum of a satellite of mass M_s, revolving around earth of mass M_e in an orbit of radius r is $(GM_s^2M_er)^{1/2}$.
39. An electron of mass 9 X 10^{-31} Kg revolves in a circle of radius 0.53 A^o around the nucleus of hydrogen with the velocity of 2.2 x 10^{6} m/s. Show that angular momentum of electron is h/2π where h is planck's constant.

TORQUE

40. Name the rotational analogue of force. What are its units?
41. Write an expression for torque. which rule is used for finding its direction
42. Name the physical quantity which is expressed by the moment of linear momentum
43. Torque and work are both equal to force time distance. How do they differ?
44. Why is the handle of a screw made wide?
45. Write the expression for torque in Cartesian and polar coordinates.
46. Show that movement of a couple does not depend on the point about which you take the moments.
47. Is torque a scalar or vector? if it is a vector, what rule is used to determine its direction?
48. Why do we prefer to use a wrench with a long arm?
49. Why are doors provided with handles near the outer edges, far away from the hinges?
50. It is difficult to open or close the door by pushing or pulling it at the hinges. Why?
51. To open or close a heavy door, why force is applied at right angles to the door.
52. Why is it easier to open a tab with two fingers than with one finger?
53. Find the torque of a force (5i-2 j +7K) about the origin, which acts on a particle whose position vector is (2i – J+k).
54. Find the torque of a force (5i – 2j + 3k) about the origin; which acts on a particle whose position vector is (i-j+k)
55. A particle of mass m is released from rest from point P at x = x_o on X axis from origin O, and falls vertically along Y axis as shown in figure. what is the magnitude of the torque acting on the particle at time t, when it is at the point Q w.r.t. O?



EQUATIONS OF ROTATIONAL MOTION

56. A solid sphere is made to roll down from the same height on two inclined planes, having different angles of inclination. in which case will it take less time to reach the bottom?
57. What is angular velocity of earth spinning around its own axis?
58. A body is rotating about a given axis with an angular acceleration alpha. Angle traced by the body in n_{th} second is_____.
59. A constant torque is acting on a wheel. If starting from rest, the wheel makes n rotations in t seconds. Show that the angular acceleration is given by $\alpha = 4\pi n/t^2$ rad/ s^2.
60. The speed of a motor increases from 600 rpm to 1200 rpm in 20 seconds. what is its angular acceleration and how many revolutions does it make during this time?
61. A wheel is rotating at the rate of 50 rev/min in the anticlockwise direction. What should be the magnitude and direction of the angular acceleration of the wheel so that it stops in 8s? How many revolutions will it cover

before stopping?

62. The motor of an engine is rotating about its axis with an angular velocity of 100 rpm. it comes to rest in 15 s, after being switched off. Assuming constant angular deceleration, calculate the number of revolutions made by it before coming to rest.

63. On application of a constant torque, a wheel is turned from rest through an angle of 200 radian in 8s. what is its angular acceleration, if the same torque continues to act? what will be the angular velocity of the wheel 16 s from the start?

64. A fly wheel rotating at a speed of 600 rpm about its axis is brought to rest by applying a constant torque for 10s. Find the angular deceleration and angular velocity 5 second after the application of the torque.

65. The spin dryer of a washing machine, revolving at 15 rps slows down 25 rps while making 50 revolutions. Find a) angular acceleration and b) time taken.

66. An automobile traveling at 80 Km/h has tyres of 75 cm diameter. What is the angular speed of the tyres about their axles? If the car is brought to stop uniformly in 30 complete turns of the tyres without skidding, what is the magnitude of angular acceleration of the wheels? How far does the car move during the braking?

POWER OF TORQUE

67. To maintain a rotor at a uniform angular speed of 200 s^{-1}, an engine needs to transmit a torque of 180 N-m. what is the power of the engine required?

MOMENT OF INERTIA

68. Why moment of inertia is called rotational inertia?

69. What is the advantage of a fly wheel?

70. Why spokes are provided in a bicycle wheel?

71. About which axis would the moment of inertia of a body be minimum?

72. About which axis would a uniform cube have minimum rotational inertia

73. A solid disc is recast into a thin walled cylinder of same radius. which will have larger moment of inertia?

74. For a given mass and size, moment of inertia of a solid disc is smaller than that of a ring. Why?

75. How will you distinguish between a hard boiled egg and a raw egg by spinning each on a table top?

76. The moment of inertia of a solid sphere about a tangent is 5/3 Mr^2. what would be its moment of inertia about its diameter?

77. Find radius of gyration of a rod of length L and mass M about an axis perpendicular its length through one end.

78. In our flywheel, most of the mass is concentrated at the rim. explain why?

79. Two satellites of equal masses which can be considered as particles are orbiting the earth at different heights. will their moment of inertia be same or different?

80. If earth were to shrink suddenly, what would happen to the length of the day?

81. Two discs of same mass and thickness are made of materials having different densities which one of them will have larger movement of inertia

82. If the eyes on the polar caps of the earth melts, how will it affect the duration of the day?

83. Calculate angular momentum of earth rotating about its axis. take I = 2/5 MR^2. where m = 6 X 10^{24} Kg and R = 6400 km.

84. What is the moment of inertia of a circular disc about one of its diameters.

85. What is the moment of inertia of a rod of mass M length l about an axis perpendicular to it, passing through one of its ends.

86. What is the moment of inertia of a ring about a tangent to the circle in the plane of the ring?

87. Four spheres, each of diameter 2a and mass M are placed with their centers on the four corners of a square of side b. calculate the moment of inertia of the system about one side of the square taken as the axis.

88. Find the moment of inertia of a rectangular bar magnet about an axis passing through its center and parallel to its thickness. mass of magnet is 100 g, its length is 12 cm, breadth is 3 cm and thickness is 2 cm.

89. Three balls of masses 1Kg, 2 Kg and 3Kg are arranged at the corners of an equilateral triangle of side 1m. what will be the moment of inertia of the system about an axis through the centroid and perpendicular to the plane of the triangle.

90. Calculate moment of inertia of a uniform disc of mass 700g and diameter 20cm about an

a) axis through the center of disc and perpendicular to its plane.
b) a diameter of disc. c) a tangent in the plane of the disc.
d) a tangent perpendicular to the plane of the disc.

91. What is the moment of inertia of a ring of mass 2 Kg and diameter 1m about the transverse axis passing through its center? How is moment of inertia affected if axis passes through edge of the ring parallel to given axis?

92. A uniform rod of length 1m has a mass of 500 gram. What is the moment of inertia of the rod about an axis passing through the center of the rod perpendicular to its length? How is moment of inertia changed when the same axis passes through one end of the rod?

PRINCIPLE OF CONSERVATION OF ANGULAR MOMENTUM

93. If no external torque acts on a body, will its angular velocity remain conserved?

94. A ballet dancer stretches her hands out for slowing down this is based on the principle of conservation of____ .

95. How does an ice skater, a belly dancer or an Acrobat take advantage of the principle of conservation of angular momentum?

96. Explain why the speed of a whirl wind in a tornado is alarmingly high?

97. Explain how is cat able to land on its feet after a fall taking advantage of the principle of conservation of angular momentum?

98. Where there is no external torque acting on a rotating body, which of the following quantities can change?
a) Angular acceleration b) Angular momentum c) Angular speed

99. The angular velocity of earth around the sun increases when it comes closer to the sun. Why?

100. Why spin angular velocity of a star is greatly enhanced when it collapses under gravitational pull and becomes a neutron star?

101. What will be the duration of the day if the earth suddenly shrinks 21 upon 64^{th} of its original volume mass remaining unchanged?

102. The sun rotates around itself once in 27 days if it were to expand to twice its present diameter what would be its new period of revolution?

103. A disk of mass M and radius R is rotating with an angular velocity Omega. if gently, two masses m each are placed at a distance R/2 on either side of the axis of rotation. what will be the new angular velocity?

ENERGY OF ROTATION

104. Rolling motion can be treated as a combination of .

105. Write an expression for kinetic energy of rolling body.

106. An energy of 484 J is spent in increasing the speed of a flywheel from 60 rpm to 360 rpm. Calculate moment of inertia of flywheel.

107. A thin hollow cylinder open at both ends and weighing 5 Kg a) slides with the speed of 5m/s without rotating and b) rolls with the same speed without slipping. Compare the kinetic energy of the cylinder in the two cases.

108. A wheel is rotating at a speed of 1000 RPM and its kinetic energy is 10 raised to the power six Joule what is the moment of inertia of the wheel about its axis of rotation

109. Calculate rotational kinetic energy of earth about its own axis, taking it to sphere of mass 6×10^{24}Kg and radius 6400 km.

110. A solid cylinder rolls down an inclined plane. its mass is 2 Kg and radius 0.1 m. If the height of the inclined plane is 4m, what is its rotational kinetic energy when it reaches the foot of the plane? Assume that the surfaces are smooth.

111. A 1Kg ball rolling on a smooth horizontal surface at 20m/s comes to the bottom of an inclined plane making an angle of 30° with the horizontal. Calculate kinetic energy of the ball when it is at the bottom of incline. How far up the incline will the ball roll? neglect friction

112. A very small particle rests on the top of a hemisphere of radius 20cm. Calculate the smallest horizontal velocity to be given to it if it is to leave the hemisphere without sliding down its surface. take $g = 9.8 m/s^2$.

113. Prove the result that the velocity v of translation of a rolling body (like a ring, disc, cylinder or sphere) at the bottom of an inclined plane of a height h is given by:

using dynamical consideration(i.e., by consideration of forces and torques). Note K is the radius of gyration of the body about its symmetry axis, and R is the radius of the body. The body starts from rest at the top of the plane.

114. The cylinder of mass 10 Kg and radius 15 cm is rolling perfectly on a plane of inclination 30°. The coefficient of static friction is 0.25.

a) How much is the force of friction acting on the cylinder?

b) What is the work done against friction during rolling?

c) If the inclination θ of the plane is increased, at what value of θ, does the cylinder begin to skid and not roll perfectly?