CC-2

Mechanics

I. One mark questions.

1. If a particle moves in X-Y plane only then the angular momentum has _____ component.
2. _____ plays the same role in rotational motion as mass plays in translational motion.
3. Moment of inertia of a body about on axis is numerically equal to the _____ to produce unit angular acceleration in the body.
4. The Torque acting on a body of moment of inertia I and angular acceleration (α) are related by _____.
5. Write the SI unit of moment of inertia?
6. Under what condition the law of conservation of angular momentum hold ?
7. Torsional rigidity is the _____ per unit twist of a cylinder or wire.
8. The viscous resistance offered by the liquid flowing through a capillary tube is given by _____.
9. Poiseuille's equation holds only for liquids having _____ flow.
10. The free surface of a liquid tends to contract and minimise its area. This property is due to _____ .
11. What happens to surface tension when detergent is added to water ?
12. What do you mean by surface energy ?
13. For a particle moving in a central force field the, _____ velocity remains constant.
14. The reduced mass of two body problem is given by μ = _____. Here M_1 and M_2 are mass of two bodies.
15. If the total energy E of a particle under attractive inverse sequence low of forces is _____ then the orbit covered by the particle is elliptical.
16. Write the expression for the Gravitational potential to an internal point due to a solid sphere.
17. Does the Gravitational potential at the centre of solid sphere become maximum ? (negative). If yes, then what is its value ?
18. The intensity of Gravitational field due to a solid sphere is directly proportional to the distance of the point from the centre, for an internal point. Write yes or no.
19. Transverse Doppler effect is observed only in case of _____ and not observed in case of _____ .
20. According to special theory of relativity mass of a body _____ with its velocity given by the formula M = _____ .
21. The famous relation between mass of a body and the energy is given by _____ .
22. If acceleration of a particle in SHM is given by a = -bx where a is acceleration, x is displacement. Then find time period of oscillation.
23. What is the relation between acceleration and displacement of a particle in SHM with frequency $1/\pi$.
24. What is the direction of coriolis force?
25. What is the expression for KE of a body involving both translation and rotation ?
26. Write the SI unit of moment of inertia?

II. 1.5 mark questions.

1.What must be the relation between length l and radius R of a cylinder, if the moment of inertia of cylinder about its axis is to be the same as its moment of inertia about the equatorial axis ?

2. Two metal spheres of different densities and equal masses are made. Which sphere, either will have more moment of inertia about the diameter ?
3. The moment of inertia of a thin circular ring about an axis through its centre and perpendicular to its plane is 200 gm × cm. Calculate its moment of inertia about its any diameter.
4. A disc of mass M and radius R is cut about diameter AB and a semi-circular disc of double thickness is formed by putting one part over the other. Calculate the moment of inertia about AB axis.

5. If a solid sphere of moment of inertia I about its diameter is converted into a disc of moment of inertia I about its axis, find the ratio of their radii.
6. Two particles of mass 1 kg each are revolving about an axis at perpendicular distances of I m and 2 m; calculate the radius of gyration.
7. Two spheres of same mass and same external radius are exactly similar in appearance. One of them is hollow while the other is solid. Explain clearly how can you identify them ?
8. A solid sphere rolls down two different inclined planes of the same height but different inclines. Will it reach the bottom with the same speed in each case ? Will it take longer to roll down one incline than the other ? If so, which one and why ?
9. Show that the ratio of rotational to translational kinetic energy for a solid cylinder rolling down a plane without slipping is 1: 2.

10. A solid cylinder of mass M rolls without slipping down a plane of length I inclined at an angle Θ with the horizontal. Show that the velocity of the centre of mass of the cylinder at the bottom of the plane is $(2/\sqrt{3}) (gl \sin \Theta)^{1/2}$. If, however, the cylinder slides down the plane (without rolling) what is the final velocity?

11. A circular hoop of radius R starts rolling down a smooth inclined plane without slipping. Show thatits acceleration down the plane is ½ g sin Θ.
12. A spherical shell and a solid sphere roll down an inclined plane. Show that their acceleration will be in the ratio of 21:25.

13. A body of mass m and radius r rolling on a horizontal surface with velocityv (without slipping), rises to a maximum height h on a hill. If $h = 3v^2/4g$, determine the moment of inertia of the body.
14. Prove that $K.E. = L^2/2mr^2$, where L = Angular momentum.

15. State and explain Newton's laws of motion.

16. Give an example of (i) position dependent force; (ii) velocity dependent force.

17. When a horse pulls a cart, which force helps the horse to move forward : the ground on the horse or the horse on the ground ?

18. A book is placed on a table. What are the forces acting on the book ? How are the action andreaction forces acting ?

19. A uniform string, having mass, is suspended from ceiling with a load at the lower end. Will the tension be uniform in the string ? Explain, Where will the tension be maximum ?

20. According to Newton' s third law every force is accompanied by an equal and opposite force. How does the motion take place ?

21. What are the limitations of Newton's laws of motion ?
22. What do you understand by frame of reference ?

23. A coin is left free to fall on the ground from a moving train with constant velocity. Explain the path as seen by an observer on the ground and on the train.

24. Explain the meaning of fictitious force with reference to the non-inertial frame.

25. What are fictitious forces ? Discuss centrifugal force.
26. Differentiate between real and fictitious forces.
27. What is Coriolis force ?
28. Prove that a frame of reference fixed with the earth is non-inertial frame.
29. Discuss the effect of centrifugal and Coriolis forces due to earth's rotation.

30. What is Coriolis force ? Obtain the effect of Coriolis force over a mass freely falling from a height H.

31. What is the total energy of fluid at a point ?

32. Distinguish between streamline and turbulent motion of a liquid.

33. Can two streamlines cross in steady flow of a liquid ?

34. Explain the equation of continuity.

35. What do you mean by Reynold number ?

36. Write down the Euler's equation for, the motion of non-viscous liquid.

37. Derive Euler's equation of fluid mechanics.

38. State and prove Bernoulli's theorem.

39. Water is flowing in a horizontal tube of non-uniform cross-section in steady state. At a point A the velocity of flow of water is five times the velocity of flow at another point B. How many times will be the diameter of the tube at A relative to that at B ?
40. There is an orifice in the wall of a container filled with water and the water is emerging out. If the diameter of the orifice is increased a little, what will be the difference in (a) velocity of efflux of water and (b) volume of the water coming out per second ?

41. In order to supply the water at a distant plant, a gardener partially closes the exit hole of the pipe by putting his finger on it. Explain why this results in the water stream going to a larger distance.

42. Water is coming out slowly from a vertical pipe. We observe that as the water descends after coming out, its area of cross-section reduces. Explain this on the basis of equation of continuity.
43. Why in a river deeper water appears to be still?

44. Explain the following

(i)The front end of the wing of an aeroplane is round shaded, while the rear end is flattened.

(ii)A ping-pong ball placed on the stream of a fountain dances.

(iii)As the parachute of a soldier falling from an aeroplane Opens, his acceleration decreases andultimately becomes zero. (iv)The pressureof water is reduced when it passes from the wider tube to a narrower tube.

45. Define coefficient of viscosity. State its dimensional formula and S.l. unit. How are the S.I unit an C.G.S. unit of coefficient of viscosity related?

46. What are the conditions to apply Poiseuille's formula ?

47. Prove that velocity profile of a viscous liquid flowing through a capillary tube of uniform section is parabolic.

48. If the flow of a liquid through a capillary tube is streamline flow, then at which tube, the velocity is: (i) maximum; (ii) minimum.

III. 2.5 mark questions.

1. Differentiate between a rigid body and a deformable body.

2. Explain the meaning of centre of mass.
3. Find the centre of mass of a two-particle system.
4. What do you mean by the centre of mass frame of reference ?

5. Show that in absence of external forces, the velocity of centre of mass remains constant.

6. What is the location of the centre of mass of a uniform triangular lamina ?
8. If $\mathbf{v_c}$is the velocity of any particle of mass m relative to the centre of mass of a number of particles,then show that $\Sigma m v_c$ is zero whether any force acts on the particles or not.

9. Define angular momentum, Write the unit of angular momentum.

10. What is the law of conservation of angular momentum? What are spin and orbital angular momenta ?
11. Show that torque$\boldsymbol{\tau} = \frac{d\mathbf{J}}{dt} = \mathbf{r} \times \mathbf{F}$.

12. Prove that K.E. = $J^2/2mr^2$, where J = Angular momentum.

13. Show that the time rate of change of angular momentum of a particle about torque acting on the particle.

14. Explain steel is more elastic than rubber.

15. What are angle of twist and angle of shear ? How do you relate them for twisting of a cylinder ?

16. Differentiate between angle of twist and angle of shear.

17. Why a hollow shaft is stronger than a solid one of the same mass ?

18. Why girders for supporting roofs are formed in the shape of **'I'**?

19. A cantilever of uniform section is more likely to break near its fixed end.

20. A beam of square cross-section is stiffer than one of circular cross-section of the same material, mass and length.
21. What is cantilever ?
22. Show that torsional rigidity is greater for hollow cylinder than for a solid one of the same material,mass and length.

23. What are the theoretical limits of Poisson's ratio for an lsotropic and homogeneous body ?
24. Obtain a relation among the elastic coefficients Y, η and σ.

25. Explain the term bending moment, flexural rigidity and torsional rigidity.
26. What is Poisson's ratio ? Give its limiting values.
27. Calculate the Poisson's ratio for silver. Given Young's modulus = $\underline{7.25}$ x 10^{10} N/m^2, Bulk modulus = 11x 10^{10} N/m^2.

28. The gravitational potential energy of a body on earth's surface is -$\underline{6.4}$x 10^6 Joules, explain the meaning of this statement.

29. Why the gravitational potential energy has negative value ?

30. A body enters in the earth's gravitational field-the potential energy of the system (earth-body) will increase or decrease.

31. What are inertial and gravitational masses ? Discuss.
32. What Is the ratio of gravitational potentials at the centre and the surface of a spherical shell ?

33. Draw a graph showing the variation of gravitational potential with distance for a solid sphere.

34. What is the value of gravitational force on a mass m at the centre of a solid sphere ?

35. If a body of mass m be projected vertically upward from earth's surface (radius of earth = R) to reach a height of 10R, how much kinetic energy be given to the body ?
36. Show that the intensity of the gravitational field can be expressed as **E** = - grad V, where V is the gravitational potential ?

37. Show that the gravitational field due to a uniform solid sphere inside it is directly proportional to the distance of point from the centre of sphere.

38. Prove that the gravitational potential at the centre of a solid sphere will be 3/2 times the potential at its surface.
39. What is the ratio or gravitational potential at the surface and centre of sphere ?

40. The atmosphere on the moon's surface is rarer. Why ?

41. If R is radius of the earth and g the acceleration due to gravity, what is the expression for the mass of the earth ?

IV. 5 marks questions

1Calculate the moment of inertia of a solid sphere about it's diameter and about a tangent.

2. State and prove law of conservation of angular momentum for a system of particles.

3. Derive the expression for moment of inertia of a hollow cylinder about (I) axis of symmetry (ii) axis passing through center and perpendicular to its own axis.

4. Explain elastic and inelastic collision. Deduce the relation between (a) scattering angle (b) angle of recoil in the elastic collision between two particles as observed in Lab-frame and C-frame.

5. What is meant by angular momentum of a particle? Show that the rate of change in angular momentum of the particle is equal to the external torque acting on it. Hence derive the law of conservation of angular momentum.

6. Determine the moment of inertia of a uniform thin circular ring of mass m, radius r about an axis (I) passing through its center of gravity and perpendicular to its plane (ii) its diameter (iii)its tangent

7. Derive a relation between torque and angular momentum. Obtain an expression for the total kinetic energy of a rolling body on a plane surface as sum of translational and rational kinetic energies.

8. Derive an expression for total force and fictitious force acting on a body in a uniformly rotating non inertial frame of reference.

9. What is forced oscillation? Set the equation and solve it to find the displacement of force oscillation.

10. What is damped oscillation? Derive the expression for displacement of a damped harmonic oscillation.

11. State the postulates of special theory of relativity and deduce Lorentz transformation equations.

12. Describe Michelson-Morley experiments. Explain how the null result of the experiment was explained.

13. Derive mass-energy relations. Calculate the velocity of a particle when its rest mass energy is double to its kinetic energy.

14. Explain time dilation. Calculate the velocity of a watch when it seems to be slowed down by 1minute in 1 hour.

15. Explain length contractions. What will be the apparent length of a meter stick measured by an observer at rest, when the stick is moving along its length with a velocity equal to $\frac{\sqrt{3}}{2}$ c.

16. Derive the Poiseulles formula for a viscous flow.

17. Establish the relationship between elastic constants.

18. Discuss how two body problem in central force motion is reduced to one body problem.

19. State and prove Kepler's laws of planetary motion.

20. Derive an expression for total energy of a particle moving under central force and discuss energy diagram.

21. Derive the expression for gravitational potential and gravitational field intensity due to a solid sphere.

22. Derive the expression for gravitational potential and gravitational field intensity due to a uniform spherical shell.