ST.JOSEPH'S UNIVERSITY, BENGALURU -27
B.Sc.(Physics) – I SEMESTER
SEMESTER EXAMINATION: OCTOBER 2023
(Examination conducted in November /December 2023)
PH 121: MECHANICS AND PROPERTIES OF MATTER

(For current batch students only)

Time: 2 Hours   **Max Marks: 60**
This paper contains 2 printed pages and 3 parts

PART - A
Answer any four of the following: **(4 x 8 = 32)**

1. (a) The velocity of a particle is given by the expression $\vec{v} = \dot{r}\hat{r} + r\dot{\theta}\hat{\theta}$.
      Obtain an expression for radial and transverse acceleration.
   (b) Deduce the equation of motion of the centre of mass.   (4+4)

2. Define proper length. Obtain an expression for the Lorentz contraction of a moving rod.
   Show that the maximum length of a rod is equal to its proper length.   (8)

3. (a) Derive an expression for moment of inertia of circular disc about an axis passing
       through the centre and perpendicular to its plane.
   (b) Distinguish between rotational motion and translational motion.   (5+3)

4. Define modulus of elasticity. Obtain an expression for the depression at the free
   end of a thin beam clamped at one end and loaded at the other.   (8)

5. What is gravitational potential? Deduce an expression for the gravitational potential
   at any point outside the spherical shell.   (8)

6. (a) Define surface tension and angle of contact.
   (b) Obtain an expression for the pressure difference between the two sides of a curved
       liquid surface.   (2+6)

PART – B

Solve any four of the following: **(4 x 5= 20)**

7.The distance between Carbon and Oxygen atom in CO molecule is 1.12Å.
   Find the centre of mass of CO molecule with respect to C atom. Atomic mass
   of oxygen is 16 and of carbon is 12.

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8. Find the angle between the two vectors $(2\hat{i}+2\hat{j} + 2\hat{k})$ and $(6\hat{i} - 3\hat{j} + 2\hat{k})$.

9. A steel ball of radius 2mm falls in a vertical column of castor oil. The coefficient of viscosity of castor oil is 0.7 Nsm^{-2} and its density is 0.98x10^3 kgm^{-3}. The density of steel is 7.8x10^3 kgm^{-3}, find the terminal velocity of the ball.

10. A satellite revolves round a planet in an orbit just above the planet's surface. Find the time period of the satellite, considering the mean density of the planet to be 8000 kg m^{-3}. Given: G = 6.67 x 10^{-11} Nm^{2}kg^{-2}

11. A body executes torsional oscillations, about a wire of length1.2m long, 0.6mm radius and with a period of 1.25 seconds. If the rigidity modulus of the material of the wire is 8x10^{10} Nm^{-2}, calculate the moment of inertia of the body about the axis of rotation.

12. A uniform rectangular lamina weighs 2kg. Its length and breadth are 30cm and 10 cm respectively. Calculate its moment of inertia about an axis perpendicular to its plane and passing through its centre. Find the associated radius of gyration.

PART – C

Answer any four of the following: (4 x 2 = 8)

13. Can a particle be in equilibrium position in a non-inertial frame of reference? Explain.

14. A geostationary satellite does not fall towards the earth. Why?

15. A big soap bubble is connected to a small soap bubble using a drinking straw. The big bubble becomes larger. Justify.

16. Why do machines with moving parts get jammed in winter?

17. Can a vector have zero component along a line and still have nonzero magnitude. Explain.

18. Glass is more elastic than rubber. Why?

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