Bachelor of Science (B.Sc.) Semester—I Examination

101 : PHYSICS

(Properties of Matter and Mechanics)

Paper—I

Time—Three Hours] [Maximum Marks—50

N.B. :— (1) All questions are compulsory.

(2) Draw neat diagram wherever necessary.

(3) Symbols have their usual meaning unless otherwise stated.

EITHER

1. (A) Define stress, strain and modulus of elasticity. Also mention their dimensions. State Hook's law and give mathematical equation for the same. 5

(B) (i) Derive the relation between Y, K and σ for an elastic unit cube. 3

(ii) What force is required to stretch a metal wire to double its length, if its Young's modulus is 2×10^{11} N/m^2 and area of cross section is 1 cm^2. 2

OR

(C) Derive an expression for depression in cantilever with rectangular cross-section clamped horizontally at one end and loaded at the free end. 2½

(D) Describe a method to determine coefficient of rigidity of modulus of thin wire using torsional pendulum. 2½

(E) What is torsional pendulum ? Obtain an expression for the time period of vibration. 2½

(F) The cantilever depresses 10 mm under a certain load at the end. Calculate the depression under same load for another cantilever of same material, 2 times its length, 2 times its width and 3 times in thickness. 2½

EITHER

2. (A) What are the assumptions of Poiseuille's flow equation and hence derive an expression for the coefficient of viscosity of a liquid. 5

(B) (i) Derive equation for the steady flow of an incompressible and non-viscous liquid. State the principle on which equation of continuity is derived. 3

(ii) For water at 20°C flowing through a tube of circular cross-section of diameter 1 cm. find the maximum average velocity of flow upto which the flow would be streamline.

(Given : The coefficient of viscosity of water at 20°C is 10^{-3} NS/m^2 and density of water is 10^3 kg/m^3 and Reynolds number is 1000). 2

OR

(C) State and give a mathematical equation of Bernoulli's theorem for fluid motion. Also explain static pressure and dynamic pressure. 2½

(D) Check the dimensional consistency of the mathematical formula :

$$Q = \frac{\pi r^4 (p_1 - p_2)}{8 \eta \ell}$$

where

Q – Volume of liquid flowing per second

r – Radius of the tube

ℓ – Length of the tube

$(p_1 - p_2)$ – Pressure difference

η = Coefficient of viscosity. 2½

(E) State Stoke's law and derive an expression for terminal velocity attained by the spherical body falling through a viscous medium. 2½

(F) The capillary tubes of length ℓ, 2ℓ and $\ell/2$ are connected in series. The radii being r, r/2 and r/3 respectively. If streamline flow is maintained and the pressure across first capillary is P_1. Deduce pressure across the second and third capillaries. 2½

EITHER

3. (A) What is centripetal acceleration ? Derive an expression for the centripetal acceleration in terms of its components. 5

(B) (i) Derive an expression for Coriolis force. 3

(ii) The position vector of a point is given by $\bar{r} = (4t^2 - 2t)i + t^2 j$. Find the velocity and acceleration of a point at t = 3 sec. in S.I. Units. 2

OR

(C) What is capillarity ? Describe a method to determine surface tension of water by capillary rise method. 2½

(D) Derive a relation between motion of centre of mass and linear momentum for system of N particles. 2½

(E) State Newton's second law of motion and deduce $\bar{F} = m\bar{a}$ for a body of mass m moving along a straight line with velocity V. 2½

(F) The height of water column in a clean capillary tube of glass of diameter 1 mm is 2.9 cm. Calculate the surface tension of water.

Given : Angle of contact for water and glass = 0° and density of water = 1 gm/cm^3. 2½

EITHER

4. (A) Derive an expression for the velocity of the particle in perfectly elastic collision in one dimension. Discuss its special cases. 5

(B) (i) Show that the mechanical energy of a system of a particles under the conservative forces remains conserved. 3

(ii) Two particles each of mass 2 kg are moving with velocities $(2\bar{i} + 4\bar{j})$ m/s and $(5\bar{i} + 6\bar{j})$ m/s respectively. Find the kinetic energy of the system relative to centre of mass. 2

OR

(C) Write a note on multistage rocket with necessary diagram. 2½

(D) State and prove the law of conservation of angular momentum. 2½

(E) Show that the moment of inertia of a solid sphere about a diameter of $I = \frac{2}{5} MR^2$ where the symbols have their usual meaning. 2½

(F) A flywheel of mass 500 kg and radius 1 meter makes 500 revolutions per minute. Assuming the mass to be concentrated along the rim, calculate the kinetic energy of the flywheel. 2½

5. Attempt any **TEN** questions :

(i) What is Maxwell's needle ?

(ii) "Glass is more elastic than rubber." Justify your answer.

(iii) One end of a wire of 4×10^{-3} m radius and 100 cm in length is twisted through 60°. Calculate the style of shear on its surface.

(iv) Define the term viscosity.

(v) What is the effect of temperature and pressure on viscosity ?

(vi) Draw a figure of method to determine the viscosity of a liquid by Poiseuille's flow method.

(vii) State any two applications of surface tension phenomenon.

(viii) What is the effect of temperature on surface tension of a liquid ?

(ix) A bubble of diameter 8 mm is formed in the air, the surface tension of soap solution is 30 dyne/cm. Calculate the excess pressure inside the bubble.

(x) Define system of particles.

(xi) State the law of conservation of linear momentum.

(xii) What will be the moment of inertia of a body of mass 2000 gm having radius of gyration 10 cm.

1 mark each