Bachelor of Science (B.Sc.) Semester-I (C.B.S.) Examination

PHYSICS (PROPERTIES OF MATTER AND MECHANICS)

Compulsory Paper—I

Time—Three Hours] [Maximum Marks—50

N.B. :— (1) **ALL** questions are compulsory.

(2) Draw neat diagrams wherever necessary.

Given : $g = 9.8$ m/sec^2

Density of water = 1 gm/cm^3

Periodic time of earth = 8.64×10^4 sec.

EITHER

1. (A) (i) Obtain an expression for time period of torsional pendulum. 3

(ii) A wire of length 1 m and diameter 1 mm is clamped at one end. Calculate the torque required to twist the end by 90°, if modulus of rigidity of material of wire is 2.8×10^{10} N/m^2. 2

(B) Derive an expression for the depression of the loaded end of a cantilever of circular cross section. 5

OR

(C) Assuming the relations :

$$K = \frac{\gamma}{3(1-2\sigma)} \text{ and } \eta = \frac{\gamma}{2(1+\sigma)},$$

obtain the relation between γ, K and η. 2½

(D) What do you mean by Angle of twist and angle of shear ? Obtain the relation between them. 2½

(E) Find the work done in stretching a wire of cross-sectional area 1 sq.mm. and 2 m long through 0.1 mm

Give that, Young's Modulus of material of wire, $\gamma = 2 \times 10^{11}$ N/m^2. 2½

(F) Derive an expression for restoring couple per unit twist of the cylinder. 2½

EITHER

2. (A) Derive the Poiseuille's Equation for steady flow of a liquid. State the assumptions made for deriving the equation. 5

(B) (i) Explain any two applications of Bernoulli's Theorem with suitable diagram. 3

(ii) A spherical steel ball of diameter 6 mm and density 7.26×10^3 kg/m^3 falls with a terminal velocity of 0.24 m/s through glycerin at 25°C contained in a glass vessel.

Find the coefficient of viscosity of glycerin at 25°C.

Give that, density of glycerin, $\sigma = 1.25 \times 10^3$ kg/m^3. 2

OR

(C) What do you mean by Reynold's number ? Give its physical significance. 2½

(D) Derive an expression for terminal velocity of a spherical body. 2½

(E) Calculate the mass of water flowing in 10 minutes through a tube 0.1 cm in diameter and 40 cm long under a constant pressure head of 20 cm of water. Given, coefficient of viscosity of water, $\eta = 8.2 \times 10^{-3}$ poise. 2½

(F) State the Stoke's law of viscosity and prove it by method of dimensions. 2½

EITHER

3. (A) (i) What is angle of contact ? State the characteristics of angle of contact. 3

(ii) 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. 2

(B) What is spherical polar co-ordinate system ? Obtain component of velocity and acceleration in polar co-ordinate system. 5

OR

(C) Obtain an expression for surface tension of a liquid by capillary rise method. 2½

(D) Show that, under isothermal condition, the surface energy of a liquid is equal to its surface tension. 2½

(E) A bullet of mass 500 gm is fired from a gun at an angle 45° N axis with a velocity 500 m/sec towards north. Calculate :

(i) The horizontal component of Coriolis acceleration,

(ii) The Coriolis force acting on bullet. 2½

(F) State and explain limitations of Newton's laws of motion. 2½

EITHER

4. (A) (i) Show that, the total angular momentum is constant if the resultant torque acting on the system is zero. 3

(ii) Calculate the radius of gyration of a solid sphere rotating about its diameter if its radius is 5.0 cm. 2

(B) What is elastic and inelastic collision ? Discuss the phenomenon of collision in one dimension between two particles when collision is perfectly elastic :

(i) When colliding particles have same mass.

(ii) When one of the colliding particles is initially at rest. 5

OR

(C) Obtain an expression for velocity of a single stage rocket by considering the weight of it. 2½

(D) State and prove theorem of perpendicular axis. 2½

(E) Two particles each of mass 2 kg are moving with velocities $2\bar{i} + 4\bar{j}$ m/s and $5\bar{i} + 6\bar{j}$ respectively. Calculate the kinetic energy of the system relative to the center of mass. 2½

(F) Derive the expression for moment of inertia of a solid sphere about its diameter. 2½

5. Attempt any **TEN** (1 mark each) : 1×10=10

(i) Define Poisson's ratio. State its limiting values.

(ii) What is neutral axis ?

(iii) What is bulk modulus ?

(iv) What is velocity gradient ? State its SI unit.

(v) Calculate the critical velocity of a liquid flowing through a capillary tube of radius 0.5 cm. Given : $\eta = 10^{-3}$ Ns/m^2, $\rho = 10^3$ kg/m^3, K = 1000.

(vi) State the effect of temperature on viscosity of liquids.

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

(viii) What is Coriolis force ?

(ix) Find the polar co-ordinates corresponding to Cartesian co-ordinates (1, 1).

(x) State the relation between Torque and Moment of Inertia.

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

(xii) A torque of 1 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resultant angular acceleration ?