

**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 :  $g = 9.8 \text{ m/sec}^2$

Density of water =  $1 \text{ gm/cm}^3$

Periodic time of earth =  $8.64 \times 10^4 \text{ sec.}$

**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  $90^\circ$ , if modulus of rigidity of material of wire is  $2.8 \times 10^{10} \text{ N/m}^2$ . 2

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  $\gamma$ ,  $K$  and  $\eta$ . 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

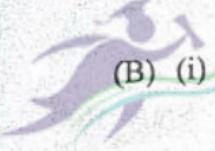
Give that, Young's Modulus of material of wire,  
 $\gamma = 2 \times 10^{11} \text{ N/m}^2$ . 2½

(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  $7.26 \times 10^3 \text{ kg/m}^3$  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,  $\sigma = 1.25 \times 10^3 \text{ kg/m}^3$ .

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

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  $45^\circ$  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

**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

Two particles each of mass 2 kg are moving with velocities  $2\hat{i} + 4\hat{j}$  m/s and  $5\hat{i} + 6\hat{j}$  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) :  $1 \times 10 = 10$

- (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<sup>2</sup>,  $\rho = 10^3$  kg/m<sup>3</sup>,  $K = 1000$ .
- (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  $1 \text{ Nm}$  is applied to a wheel of mass  $10 \text{ kg}$  and radius of gyration  $50 \text{ cm}$ . What is the resultant angular acceleration ?