

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

PHYSICS (Properties of Matter and Mechanics)

Compulsory Paper—1 (101)

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 = 10^3 kg/m^3

EITHER

1. (A) Define elastic limit. State and explain Hooke's law show that for a homogeneous isotropic medium, $Y = 2\eta (1 + \sigma)$ where letters have their usual meaning. 5
- (B) (i) Describe an experiment to determine the modulus of rigidity of a material using Maxwell's Needle. 3
- (ii) A solid cylinder of length 1m and diameter 8 mm is fixed at one end and the other end is twisted through an angle 5° by an application of torque 2.5 Nm. Calculate the modulus of rigidity of the material of the cylinder. 2

OR

- (C) Derive an expression for work done in stretching a wire. 2½
- (D) Define Poisson's Ratio. Show that the Poisson's ratio lies between – 1 and 0.5 for homogeneous isotropic body. 2½
- (E) Explain external and internal bending moment. 2½
- (F) A brass bar 1 cm^2 in cross-section is supported on two knife edges one meter apart. A load of 1 kg at the centre of bar depresses that point by 2.51 mm. Calculate Young's modulus of brass. 2½

EITHER

2. (A) What is an ideal fluid ? State and prove Bernoulli's theorem. 5

(B) (i) Obtain Euler's equation of motion for non-viscous fluid. 3

(ii) Water flows through a horizontal pipe of varying cross-section. At a point where the pressure of water is 0.05 m of mercury, the velocity of flow is 0.25 m/s. Calculate the pressure at another point where velocity of flow is 0.4 m/s. 2

OR

(C) What is critical velocity ? Derive an expression for critical velocity by using method of dimensions. 2½

(D) In the Poiseuille's experiment, the following observations were made.

Volume of water collected in 5 min = 40 C.C.;

Head of water = 0.4 m,

Length of tube = 0.602 m,

Radius of Capillary tube = 0.52×10^{-3} m.

Calculate coefficient of viscosity of water. 2½

(E) What is streamline and turbulent flow of liquid ? Explain. 2½

(F) Explain the effect of temperature and pressure on the viscosity of liquid. 2½

EITHER

3. (A) What is surface tension ? State its unit and dimensions. Derive an expression for the height of liquid column in a Capillary tube of radius r. 5

(B) (i) Derive an expression for centripetal acceleration in case of rotating frame of reference. 3

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

OR

(C) On what factors does the angle of contact depend ? Explain wetting action of a solid surface by the liquid. 2½

(D) Calculate the work done in blowing a soap bubble of radius 10 cm and surface tension 30 dynes per cm. 2½

(E) State Newton's laws of motion. Derive Newton's third law from the second law. 2½

(F) What is Coriolis force ? State its applications. 2½

EITHER

4. (A) State the principle of working of a rocket and derive an expression for its instantaneous velocity. What are the advantages of multistage rockets over single stage rockets ? 5

(B) (i) State and prove the law of conservation of linear momentum. 3

(ii) The position of centre of mass of three particles of masses 1 kg, 2 kg and 3 kg is at (1, 1, 1) m. Where should a particle of mass 5 kg be kept so that the position of centre of mass of the entire system becomes (0, 0, 0) ? 2

OR

(C) State and prove the theorem of parallel axis. 2½

(D) A particle of mass m_1 moving with velocity u_1 collides head-on with a stationary particle of mass m_2 . Considering perfectly elastic collision, prove that velocity of stationary particle after collision is $\frac{2m_1u_1}{m_1 + m_2}$. 2½

(E) Calculate moment of inertia of a solid sphere of mass 50 kg and radius 10 cm about its diameter. 2½

(F) What is principal moment of inertia and principal axes of a rigid body in rotational motion ? 2½

5. Attempt any **TEN** questions :—

(i) Define Young's modulus and state its CGS unit.

(ii) What is torsional constant ?

(iii) Calculate geometric moment of inertia of a circular bar of radius 2 cm and length 1 m clamped horizontally at one end.

(iv) What is terminal velocity ?

(v) Define kinematic and dynamic viscosity.

(vi) Calculate critical velocity of a flow of liquid of density 10^3 kg/m^3 and viscosity $10^{-3} \text{ Ns m}^{-2}$ flowing through a tube of radius $0.5 \times 10^{-2} \text{ m}$. (Given : Reynold's number = 2000).

(vii) What is surface energy ?

(viii) Define inertial and non-inertial frames of reference.

(ix) Find the Cartesian co-ordinates corresponding to the polar co-ordinates $\left(-1, \frac{5\pi}{4}\right)$.

(x) Define radius of gyration.

(xi) State equation of motion of centre of mass of a system of particles.

(xii) Explain the physical significance of moment of inertia. 1×10