KNT/KW/16/5043

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 : $g = 9.8$ 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 5º 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 radious 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, 2kg 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 $\frac{2 m_1 u_1}{m_1 + m_2}$. 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} Ns m^{-2} flowing through a tube of radius 0.5×10^{-2} 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