NKT/KS/17/5043

Bachelor of Science (B.Sc.) Semester—I (C.B.S.) Examination
PHYSICS (Properties of Matter and Mechanics)
Compulsory Paper—1

Time : Three Hours]   [Maximum Marks : 50

Note :— (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) What is angle of twist and angle of shear ? Obtain an expression for torque required to twist a cylinder at its free end.   5

(B) (i) For homogeneous isotropic medium, show that $Y = 3K(1 – 2\sigma)$ where symbols have their usual meaning.   3

(ii) What force is required to stretch a steel wire of cross-section of 0.5 cm^2 to double its length ? (Given : $Y = 2\times10^{11}$ N/m^2)   2

OR

(C) Describe how the modulus of rigidity of the material of a wire can be determined by using torsional pendulum.   2½

(D) What is external bending moment ? Obtain an expression for external bending moment of a beam fixed at one end and loaded at the other.   2½

(E) A steel rod of length 50 cm, width 1cm and thickness 0.5 cm is bent in the form of an arc of radius of curvature 2.0 m. Calculate the internal bending moment if Young's modulus of the material of the rod is 2×10^{11} N/m^2.   2½

(F) Define elasticity. Explain graphically, the behaviour of a wire under increasing load.   2½

EITHER

2. (A) What is terminal velocity ? Explain. State and prove Stoke's law of viscosity. How can it be used to determine the terminal velocity of a body in a viscous fluid ?   5

(B) (i) What is Newton's law of viscous force ? Obtain an expression for coefficient of viscosity. State its units and dimensions.   3

(ii) Water flows through a horizontal capillary tube of 1 mm internal diameter of length 70 cm under pressure of a column of water 30 cm in height. Find the rate of flow of water through capillary tube. (Given : $\eta = 10^{-3}$ Ns/m^2)   2

OR

(C) Deduce an expression for the velocity of a liquid flowing through a uniform capillary tube of circular cross-section. 2½

(D) State Bernoulli's theorem. Explain the lifting of an aeroplane. 2½

(E) Eight drops of water of the same size are falling through air with terminal velocity of 10 m/sec. If the eight drops combine to form a single drop, what will be the new terminal velocity ? 2½

(F) What is viscosity of liquid ? How critical velocity of liquid makes a difference of streamline and turbulent flow ? 2½

EITHER

3. (A) Obtain equations for components of velocity and acceleration in spherical coordinate system. 5

(B) (i) What is surface energy ? Show that the surface tension of a liquid is equal to its surface energy per unit area. 3

(ii) Calculate the height to which a liquid will rise in a capillary tube of radius 0.2 mm when surface tension of liquid is 20×10^{-3} N/m and density 800 kg/m³. (Given : Angle of contact = 0) 2

OR

(C) Explain the Quincke's method for determination of surface tension of a liquid. 2½

(D) Obtain an expressions for the radial and transverse components of velocity and acceleration of a particle moving along a curve in a plane. 2½

(E) What are inertial and non-inertial frames of reference ? Give its examples. 2½

(F) A point is moving in a plane has co-ordinates x = 3, y = 4 and has components of speed $\dot{x}$ = 5m/sec, $\dot{y}$ = 8 m/sec at some instant of time. Find the components of speed in polar co-ordinates r, $\dot{\theta}$ along directions $\hat{r}$ and $\hat{\theta}$. 2½

EITHER

4. (A) Define centre of mass. Obtain the equation of motion of centre of mass. Show that when no external force acts on a body the acceleration of centre of mass is zero and its velocity is constant. 5

(B) (i) Derive an expression for moment of inertia of solid cylinder about an axis passing through its centre and perpendicular to its axis. 3

(ii) Calculate radius of gyration of solid cylinder at mass 20 kg and radius 40 cm about an axis passing through its centre along its length. 2

OR

(C) Distinguish between elastic collision and inelastic collision. 2½

(D) A rocket of mass 6000 kg is projected vertically. If the exhaust gases escape out with velocity 500 m/sec, find the rate of consumption of fuel to overcome the weight of the rocket. 2½

(E) What is moment of inertia ? State its unit. Explain the physical significance of moment of inertia. 2½

(F) State and prove the law of conservation of energy. 2½

5. Attempt any **TEN** questions :—

(i) State Hooke's law.

(ii) Draw a labelled diagram of Maxwell's needle.

(iii) Calculate the Poisson's ratio of a material having Young's Modulus 7.25×10^{10} N/m^2 and bulk modulus 11×10^{10} N/m^2.

(iv) State the limitations of Poiseuille's equation.

(v) State the equation of continuity.

(vi) Calculate the Reynold's number from the given data :

Radius of capillary tube = 0.5×10^{-2} m.

Coefficient of viscosity of water = 10^{-3} Ns/m^2.

Density of water = 10^3 kg/m^3.

Critical velocity = 20×10^{-2} m/sec.

(vii) State the characteristics of angle of contact.

(viii) What is the difference of pressure between the inside and outside of a spherical drop of water of radius 1 mm ? (Given : Surface tension of water = 73×10^{-3} N/m)

(ix) What are the limitations of Newton's laws of motion ?

(x) State the laws of parallel and perpendicular axes.

(xi) Define principal moments.

(xii) Define linear momentum of a particle. $1 \times 10 = 10$