GSE/M-21   **1479**

PROPERTIES OF MATTER AND KINETIC
THEORY OF GASES
Paper–I

Time : Three Hours]   [Maximum Marks : 40

Note : Attempt *five* questions in all, selecting *one* question from each unit. Q. No. l is compulsory. Each question carries equal marks. Use of scientific non-programmable calculator is allowed.

Compulsory Question

1. (a) In a fly wheel, most of the mass is concentrated at the rim. Why?   (2)

   (b) Explain why a hollow shaft of same length, mass and material as that of a solid shaft is much stronger.   (2)

   (c) When a gas is suddenly compressed its temperature increases? Explain.   (2)

   (d) Why are viscosity, thermal conductivity and diffusion called transport phenomena.   (2)

UNIT–I

2. (a) State and prove theorem of parallel axes for a laminar body.   (5)

(b) A solid sphere of mass 500 g and radius 5cm rolls with a uniform velocity of 5 cm/sec along a straight line on a horizontal table. Calculate its total energy. (3)

3. (a) A solid cylinder rolls down an inclined plane without slipping. Deduce an expression for its acceleration.

(3)

(b) Derive an expression for the moment of inertia of a hollow sphere about a diameter. (3)

(c) A sphere has a radius of 0.15 m. Calculate its moment of inertia about any diameter. Density of the material is 7.8×10^3 kg/m^3. (2)

UNIT–II

4. (a) Prove that the couple per unit twist for a hollow cylindrical rod is :

$$C = \frac{\pi \eta r^4}{2l}$$

where the symbols have their usual notations. (5)

(b) Prove that a hollow cylinder is much stronger than a solid cylinder of the same mass, length and material.

(3)

5. (a) A uniform beam is clamped horizontally at one end loaded at the other. Obtain the relation between the load and depression at the loaded end. (5)

(b) Show that a shear strain Φ is equivalent to a compression strain $\phi/2$ and an extension strain $\Phi/2$, in mutually perpendicular directions. (3)

UNIT–III

6. (a) What consideration led Van der Waal to modify the gas equation of state? Deduce Van der Waal's equation for a real gas. (4)

(b) Deduce expression for the critical constants of a gas in terms of Van der Waal's constants. (4)

7. (a) State the basic postulates of the kinetic theory of gases and prove that the pressure exerted by a perfect gas is two-thirds of the kinetic energy of translation per unit volume. (6)

(b) Calculate the temperature at which the root mean square speed of a molecule of hydrogen will be equal to 2×10^3 m/s. (2)

UNIT–IV

8. (a) Discuss Maxwell's distribution law of molecular speeds in gases and hence derive an expression for Most probable speed. (5)

(b) Define mean free path of the molecules of a gas and derive an expression for it. (3)

9. (a) On the basis of Kinetic Theory of gases, deduce an expression for coefficient of viscosity of a gas. (5)

(b) Find the diffusion coefficient of hydrogen in standard condition, if the free path of the molecule is 1.6×10^{-7} m. (3)

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