Ref. No.: EX/IP/II/6/2017

BACHELOR OF SCIENCE EXAMINATION, 2017
(1st Year, 1st Semester)
Physics (Honours)
Paper: HO- 02

Time: Two Hours

Full Marks: 50
(25 marks for each group)

Use separate answer scripts for each group

GROUP A

Answer **Question No. 1** and any **three** from the rest

1.(a) The pressure exerted by a perfect gas is proportional to the absolute temperature (T). Explain physically.
(b) Write down the Maxwell's law of distribution of molecular speed in three dimension.
(c) What is the significance of the total area under the Maxwellian velocity distribution curve?
(d) A linear symmetric triatomic molecule is in thermal equilibrium with similar molecules at temperature T. Apart from translation and rotation, the end atoms can undergo longitudinal vibrations. Calculate the average energy of such a molecule. What will be the percentage change in average energy at low temperature, when vibrational modes are absent?

[2+2+2+(2+2)]

2. Define mean free path of a gas molecule. Assuming that all molecules are moving with the same average velocity $\bar{C}$, show that the mean free path can be expressed as $\lambda = \frac{3}{4\pi\sigma^2 n}$. All symbols are of usual significance.

[1+4]

3. What do you mean by self-diffusion ? Define coefficient of self –diffusion 'D'. Write down expression of 'D'. Show that $D \propto P^{-1}T^{1.5}$, where P and T are the pressure and temperature of the gas.

[1+1+1+2]

4.(a) 'Brownian motion may be considered as analogous to the heat motion of the molecules but on a much reduced scale' – Explain the significance of the statement.
(b) In an experiment with Brownian particles suspended in a liquid (coefficient of viscosity 0.01 poise) shows that the mean squared displacement per unit time is 1.5 $cm^2 s^{-1}$. The temperature of the liquid is 37^0 C. Estimate the size of the particles.

[2+3]

5.(a) What is the significance of Boyle temperature in case of real gases ?
(b) The equation of state of a real gas is given as $P(V-b) = RTe^{-\frac{a}{RTV}}$. Find the Boyle temperature.

[2+3]

6. Set up the Fourier's equation for the flow of heat in a straight linear conductor and solve it for steady state.

[3+2]

(Turn Over)

Group B

Answer **Question No.7** and any **three** from the rest.

7. a) What is gravitational self-energy of a system? What factors does it depend on?
b) Obtain the relation between the Young's modulus, Bulk modulus and the Poisson's ratio.
c) Show that the surface tension can be described as work done per unit increase in area of the liquid surface.
d) Distinguish between terminal and critical velocities.

(2+2+2+1)

8. a) For a thin spherical shell of mass 'M' and radius 'a', determine the gravitational field intensity and potential for an arbitrary point in space. Graphically represent the variation of these parameters with the distance from the center of the spherical shell.
b) A body falls from the earth's surface through a tunnel passing through its center. Calculate the time taken by the body to reach the earth's center. (Radius of earth = 6400 Km, $g = 9.8\ m/s^2$). What will be the fate of the body?

(4+2)

9. a) What are the limitations of the Jurin's law for capillary rise?
b) Obtain the expression of minimum velocity of a ripple on the surface of a liquid. Determine the minimum velocity of the ripple on the surface of water where S = 75 dynes/cm and $\lambda = 1.7$ cm.

(1+(4+1))

10. a) Explain and derive how the velocity of a fluid flowing through a capillary tube can be measured using a venturimeter. How is it different from a Pitot tube in their applications?
b) An air bubble of radius 1cm rises through a long cylindrical column of radius 5cm having a liquid of density 1.5 gm/c.c. If the air bubble travels with a steady velocity of 0.3 cm/s, find the viscosity of the liquid. (Density of air bubble can be neglected).

((3+1)+2)

11. a) Derive the torsional rigidity of a cylindrical wire having length 'l' and radius 'a' which is fixed at the upper end and a torque is applied at the bottom end.
b) Explain the reciprocal theorem for a cantilever having negligible mass.

(3+3)