Ref. No.: EX/UG/SC/PHY/CORE-2/A/7/2019

1ST B. SC. 1ST SEMESTER, 2019
Physics (Honours)
Paper: CORE- 2

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. Find out expression for the most probable speed. The most probable speed according to one dimensional distribution is zero, but it is non zero in three dimensional distribution. Explain this apparent anomaly.

(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, when vibrational modes are absent?

[2+4+(2+2)]

2. Define mean free path of a gas molecule. Write down the expression for mean free path. Comment on its dependence on pressure. Estimate the size of a helium atom assuming its mean free path at S.T.P. to be 285 nm. Given: Density of Helium at S.T.P. is 178 $kg.m^{-3}$. The mass of a helium atom is $6X10^{-27}$ kg. [1+1+1+2]

3. Explain the origin of viscosity and thermal conduction in an ideal gas on the basis of kinetic theory. Write down the relationship between the coefficient of viscosity and the thermal conductivity. How far does this relation tally with experimental result?

[3+1+1]

4. Deduce Einstein's equation for translational Brownian motion. [5]

5. What, according to Van-der-Waals, are the reasons for the relation pV=RT not holding good for real gases? Deduce from Van-der-Waals' equation of state the law of corresponding states?

[2+3]

6. When steam is passed through a circular tube of length l having external and internal diameters a and b respectively, show by solving Fourier equation that the radial flow of heat per sec. outward is given by:

$$\dot{Q} = \frac{2\pi Kl(\theta_1 - \theta_2)}{\ln(\frac{b}{a})}$$

Where θ_1, θ_2 being the temperatures of the inner and outer surface respectively.

[5]

Group-B

Answer **Q. No. 1** and any **two** from the rest.

1. Write short note (any one): **3**
   a) Surface tension and vapour pressure.
   b) Gravitational Self-energy

2. a) State and prove Gauss's theorem in gravitation.
   b) Find an expression for the potential due to a thin uniform straight rod and comment on its equipotential surface.

5+6=11

3. a) Obtain an expression for the height h through which a liquid of surface tension S will rise in a capillary tube of radius r.

   What will happen if the length of the tube is smaller than the height of liquid ascent h?

   b) There is a minute hole (circular) at the bottom of a small hollow vessel. The vessel has to be immersed in water to a depth of 40 cm before any water penetrates inside. Find the radius of the hole if the surface tension and density of water be 73 dynes/cm and 1.00 g/cc, respectively.

7+4=11

4. a) Define co-efficient of viscosity of a fluid.
   b) Derive Poiseuille's formula for the steady flow of an incompressible viscous liquid through a horizontal capillary of uniform cross section.
   c) Show that for a homogeneous isotropic medium
   $2n(1+\sigma)=3k(1-2\sigma)$
   where n is the rigidity modulus
   k is the bulk modulus
   and σ is the poisson's ratio **1+5+5=11**