[This question paper contains 4 printed pages.]

1003 *Your Roll No.* .....

B.Sc. (Hons.) / I **C**

ELECTRONIC SCIENCE – Paper 1.3 (III)

(Thermal Physics)

Time : 3 Hours *Maximum Marks : 38*

(Write your Roll No. on the top immediately on receipt of this question paper.)

Answer **five** *questions in all, including Q. No.* **1** *which is compulsory.*

1. (a) An air conditioner removes 1.5 Kcal/sec from a large room. The power required to run it is 2 KW. If the typical value of $\frac{Q_2}{W} = \frac{1}{10}$ that of Carnot refrigerator and temperature outside is 40°C, what is the temperature inside ?

   (b) Show that for an ideal gas undergoing an adiabatic process : PV^{γ} = Constant.

   (c) Define Fermi energy for free electrons in a metal at absolute zero.

P.T.O.

(d) Calculate the average speed and r.m.s speed of oxygen molecule at 300^0 K.

Given, Mass of oxygen molecule = 5.31×10^{-26} Kg,

Boltzmann constant, $K_b = 1.38 \times 10^{-23}$ J/K.

(e) What do you understand by degree of freedom of a system ? Show that for a perfect gas having 'n' degrees of freedom

$$\gamma = \frac{C_P}{C_V} = 1 + \frac{2}{n} \qquad (2\times5=10)$$

2. (a) Express second law of thermodynamics in terms of entropy. Discuss the changes in entropy during reversible and irreversible processes. (3)

(b) State and prove Carnot theorem. (2)

(c) Using Maxwell relations, prove that

$$C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P \qquad (2)$$

3. (a) Give the physical significance of F-Helmholtz function. (3)

(b) Derive Claussius-Clapayron latent heat equation using P-V diagram. Show that how does pressure varies with melting and boiling point of a substance. (2,2)

4. (a) Derive Planck's law of black body radiation. Explain how it leads to Rayleigh Jean's law. (4,1)

(b) Using Maxwell Boltzmann distribution law, show that the number of molecules having kinetic energy in the range ε and $\varepsilon + d\varepsilon$ is

$$dN_\varepsilon = \frac{2N}{\sqrt{\pi}} \frac{1}{(K_B T)^{3/2}} e^{-\frac{\varepsilon}{K_B T}} \sqrt{\varepsilon}\, d\varepsilon \qquad (2)$$

5. (a) If the root mean square speed of hydrogen molecule at N.T.P is 1.84 Km/sec. Calculate root mean square speed of oxygen molecules at N.T.P. Given, Molecular weight of hydrogen and oxygen are 2 and 32 respectively. Given, $N_A = 6 \times 10^{26}$/ Kmol. (2)

(b) Derive law of equipartition of energy. (2)

(c) Derive Einstein's equation of translational Brownian motion. (3)

6. (a) Explain Debye's T^3 law for specific heat of solids at low temperature. (3)

(b) Define Bose -Einstein condensation. (2)

P.T.O.

(c) Calculate the Fermi energy in eV for silver.

Given, Number density = 5.86×10^{28} es^{-}/m^3,

Mass of electron = 9.11×10^{-31} Kg,

Planck's constant, $h = 6.62 \times 10^{-34}$ Jsec.

(2)

7. Write note on any **two** of the following :

(a) Concept of negative temperature

(b) Thermodynamical scale of temperature

(c) Joule-Thomson effect (7)