[This question paper contains 3 printed pages.]

4655 *Your Roll No.* .....

B.Sc. Prog./II **AS**

MP–202 – THERMAL PHYSICS AND ELECTROMAGNETISM

(Admissions of 2008 and onwards)

Time : 3 hours *Maximum Marks : 75*

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

Attempt any **five** *questions.*
All *questions carry equal marks.*

1. (a) What is meant by a reversible process ? Give the condition of reversibility. Prove that for a given temperature of the source and the sink no engine can be more efficient than a Carnot's reversible engine. (4,7)

   (b) A Carnot's engine working between t°C and 0°C has an efficiency of 70%. Find the value of t. (4)

2. (a) Express second law of thermodynamics in terms of entropy. Explain the changes in entropy during reversible and irreversible processes. (10)

P.T.O.

(b) Derive an expression for mean free path of a molecule in a gas. If the diameter of a molecule is 3.5 A° then calculate the mean free path of molecule at 1 atmospheric pressure ($=10^5 N^{-2} m$) and temperature 27°C. Given that Boltzmann constant

$$k = 1.38 \times 10^{-23} \text{ J/K} \qquad (2,3)$$

3. Distinguish between Maxwell-Boltzmann and Bose-Einstein statistics. Obtain an expression for the distribution function corresponding to Maxwell-Boltzmann statistics. (5,10)

4. (a) Show that the number of normal modes of vibration per unit volume of an enclosure in the frequency range ν and $\nu + d\nu$ is given by

$$\frac{8\pi\nu^2 d\nu}{C^3}$$

where C is the speed of light. (7)

(b) Using the relation obtained in part(a) above, derive Planck's law for the black body radiation. Obtain the limiting cases for short and long wavelengths. (4,4)

5. (a) State and prove Gauss's law in electrostatics. Derive its differential form. (9)

(b) Derive an expression for the electric field at a point (i) inside (ii) outside a uniformly charged sphere. (6)

6. (a) State Faraday's law of electromagnetic induction and obtain its differential form. (6)

(b) Write down the general boundary conditions for the electric field and magnetic field at the interface of linear dilectric media. (9)

7. (a) Write down the Maxwell's equations for electromagnetic waves in a free space. Derive the wave equations satisfied by the electric and magnetic fields. (8)

(b) Write the plane wave solution of the wave equation and show that the electromagnetic waves are transverse in nature. (7)

8. Write short notes on any **two** of the following :

(a) Thermodynamic potentials

(b) Carnot's Heat Engine

(c) Law of equipartition of energy

(d) Fresnel's relations for reflection and refraction (7½,7½)