PHYSICS

Paper–A : Statistical Physics and Thermodynamics – II

Time Allowed : 3 Hours **Maximum Marks : 22**

Note : (1) Attempt five questions in all, selecting two from each Unit I and II. Unit III is compulsory.

(2) All questions carry marks as indicated.

(3) Non-Programmable Calculators are allowed.

(4) Logarithmic Tables can be asked.

UNIT–I

1. (a) Prove that the entropy of a Thermodynamical system :
   (*i*) Remains constant in any reversible process
   (*ii*) Increases in natural process 1,1

   (b) Making use of the Clausius inequality, show that all cycles having the same maximum temperature T_{max} and the same minimum temperature T_{min} are less efficient as compared to the Carnot cycle with same T_{max} and T_{min}. $2^1/_2$

2. (a) Prove that adiabatics are steeper than isothermals in any thermodynamical process. $1^1/_2$

   (b) Hydrogen is used in a Carnot cycle as a working substance. Find the efficiency of the cycle, if as a result of an adiabatic expansion :
   (i) The gas volume increases $n = 3.0$ times.
   (ii) The pressure of the gas increases $n = 2.0$ times. $1^1/_2$, $1^1/_2$

3. (a) Two gases having molecules N_1 and N_2 are at the same temperature and pressure. These gases are allowed to mix. Show that the change in entropy of the system is $k(N_1 + N_2) \ln 2$. $2^1/_2$

   (b) A reversible heat engine converts one sixth of heat input into work. When the temperature of the sink is reduced by 90 K, its efficiency is doubled. Find the temperature of the source and the sink. 2

UNIT–II

4. (a) Discuss the liquefaction of He gas using the principle of regenerative cooling. $2^1/_2$

   (b) Find an expression for the change in temperature of wire when stretched adiabatically. 2

5. (a) Discuss Thermodynamical potential U, F, H and G and hence derive Maxwell's thermodynamic relations. $2^1/_2$

   (b) Making use of Maxwell's Thermodynamical relation prove that heat is produced when, the substance which expands on heating is compressed. 2

6. (a) Show that the change in temperature in Joule Thomson expansion is given by $dT = V(T\alpha - 1)\, dP/C_p$ where symbols have their usual significance. $2^1/_2$

   (b) Calculate the fall in temperature produced by adiabatic demagnetization of a paramagnetic substance at an initial temperature of 6 K when the magnetic field in reduced from 10^4 gauss to zero. Given Curie constant per c.c. = 0.05 Kg^{-1} and CH = 0.1 calg $^1K^{-1}$. 2

UNIT – III (Compulsory)

7. Attempt any **eight** parts :

(a) Entropy is a measure of disorder. Explain.

(b) Give two characteristics of Carnot's reversible heat engine.

(c) Give the importance of S-T diagram.

(d) Why must the reversible process be quasistatic ? Explain.

(e) What is the concept of temperature of inversion ?

(f) What is a perfect differential ? Give one example each of perfect and imperfect differentials ?

(g) What is the wavelength at which human body radiates maximum energy ?

(h) In an adiabatic change, the pressure and temperature of a mono atomic gas are as $P \alpha T^C$. Find the value of 'C'.

(i) Show that it is impossible for two reversible adiabatics to intersect each other.

(j) Explain 'Heat Death' of the universe. 4