3/12/19 M

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7336 J

Unique Paper Code : 42224303

Name of the Paper : Thermal Physics & Statistical Mechanics

Name of the Course : **B.Sc. Prog.**

Semester : III

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Q. **1** is compulsory.
3. Attempt **five** questions in all.
4. **All** questions carry equal marks.

1. Attempt any **five**.

   (a) Using third law of thermodynamics explain why it is not possible to attain absolute zero.

   (b) Distinguish between reversible and irreversible processes.

P.T.O.

(c) Calculate mean free path of a gas molecule whose diameter is 3 Å and number of molecules /cc is 3×10^{19}.

(d) What is the wavelength at maximum intensity of radiation emitted by a body maintained at temperature 3000°C. Given Wien's constant = 2.898×10^{-3} m K.

(e) Describe all the possible microstates for a system obeying B-E statistics and having two particles and two quantum states.

(f) Establish the T-dS equation

$$T\,dS = C_v\,dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$$

(g) Using ClausiusClapeyron equation discuss the effect of pressure on boiling point of a liquid.

(5×3)

2. (a) Show that the work done in a Carnot cycle is the area enclosed by the two isotherms and two adiabatics in P-V diagram and hence derive the expression for efficiency.

(b) A Carnot engine has an efficiency of 50% when the temperature of the sink is 27°C. Calculate the temperature of the source so that the efficiency becomes 60%. (10,5)

3. (a) State first law of thermodynamics. What is its physical significance and discuss its limitations?

(b) One mole of an ideal gas ($\gamma = 1.4$) initially kept at 17°C is adiabatically compressed so that its pressure becomes 10 times its original value. Calculate

(i) its temperature after compression

(ii) work done on the gas.

(c) Calculate the change in entropy of a perfect gas in terms of temperature and pressure. (5,5,5)

4. (a) Using thermodynamic potentials derive Maxwell's four thermodynamical relations.

(b) Using appropriate Maxwell's relations prove

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

and hence show that for an ideal gas $C_p - C_v = R$.

(10,5)

5. (a) What is transport phenomenon? Derive the expression for coefficient of viscosity of a gas using Kinetic Theory.

(b) Explain the porous plug experiment and discuss its results. Prove that enthalpy remains constant in Joule-Thomson expansion. (9,6)

6. (a) Starting from the Maxwell's law of velocity distribution obtain expressions for root mean square velocity, average velocity and most probable velocity.

(b) Calculate the root mean square velocity of hydrogen molecule at 27^0c.Given mass of hydrogen molecule = 3.34×10^{-27}Kg and k = 1.38×10^{-23} J/°K.

(c) State the law of equipartition of energy and hence determine the ratio of specific heat capacities (γ) for a monoatomic and diatomic gas. (6,3,6)

7. (a) Explain the spectral distribution of radiation emitted by a black body and its variation with temperature.

(b) Derive Planck's law of black body radiation and hence derive Rayleigh-Jean's law and Wien's law. (3,12)

8. (a) Differentiate between MB, BE and FD statistics.

(b) Derive Maxwell-Boltzmann distribution law for an ideal gas having N particles and energy E. (5,10)