8.12.18 (M)

This question paper contains 4 printed pages.

Your Roll No. ....

Sl. No. of Ques. Paper : 105 I

Unique Paper Code : 32221302

Name of Paper : **Thermal Physics**

Name of Course : **B.Sc. (Hons.) Physics**

Semester : **III**

Duration : **3 hours**

Maximum Marks : **75**

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

*Attempt **five** questions in all including Question No. 1 which is compulsory. All questions carry equal marks. (Symbols have their usual meanings.)*

1. Answer any *five* of the following :

   (a) State the first law of thermodynamics in differential form. What are its limitations?

   (b) Air is compressed adiabatically to half its volume. Calculate the change in its temperature.

   (c) Explain how the internal energy of an ideal gas differs from that of a real gas.

   (d) Give any *three* basic postulates of kinetic theory of gases.

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(e) State the law of equipartition of energy and apply it to obtain the specific heats C_P and C_V of a monoatomic gas.

(f) Define Temperature of Inversion and Critical Temperature of a van der Waals gas.

(g) Why is the thermal conductivity of hydrogen gas large as compared to any other gas at a given temperature? 3×5

2. (a) Describe absolute scale of temperature explaining the meaning of zero on this scale. Show that thermodynamic scale of temperature agrees with the ideal gas scale. 10

(b) Give the necessary conditions for the reversibility of a process. Give one example each of reversible and irreversible processes. 5

3. (a) State Clausius and Kelvin statements of the second law of thermodynamics and establish their equivalence. 6

(b) Describe Carnot's cycle and deduce the efficiency of the engine. Show that 100% efficient engine is not possible. 7

(c) Calculate the efficiency of a Carnot engine working between steam point and ice point. 2

4. (a) Calculate under what pressure ice would freeze at -1°C, if the increase in specific volume, when one gram of water freezes into ice at 0°C is 0.091 c.c. Latent heat of fusion of ice, L = 79.6 cal/g, 1 atm = 1.013×10^6 dynes/cm^2. 5

(b) Derive an expression for the Joule-Thomson coefficient in terms of temperature of inversion for a van der Waals gas. 10

5. (a) What is magneto-caloric effect? Describe with necessary theory and experimental setup the method of producing very low temperatures by adiabatic demagnetisation. 10

(b) Verify TdS equation :

$$TdS = C_V\, dT + T\left(\frac{\partial P}{\partial T}\right)_V dV \qquad 5$$

6. (a) Define four thermodynamic potentials. Using these derive four Maxwell's thermodynamic relations. 8+1

(b) Using Maxwell's thermodynamic relations derive :

(i) Clausius Clapeyron equation $\dfrac{dP}{dT} = \dfrac{L}{T(v_2 - v_1)}$ 3

(ii) $\left(\dfrac{\partial C_P}{\partial P}\right) = \left(\dfrac{\partial^2 S}{\partial P\,\partial T}\right) = -T\left(\dfrac{\partial^2 V}{\partial T^2}\right)_P$ 3

7 (a) Derive Maxwell-Boltzmann law of distribution of speeds for an ideal gas. Show the distribution graphically for various temperatures. 10

(b) For a gas if the number of molecules per cubic meter is $n = 3\times10^{25}$, average velocity is $v = 426$ m/sec, radius of the molecule is $r = 1.8\times10^{-10}$ m, compute the mean free path and the collision frequency. 5

8. (a) Describe Andrew's experiments on CO_2. Discuss the results obtained. 7

(b) Derive van der Waals equation of state. Compare the van der Waals theoretical isotherms with Andrew's experimental results. 8

Given $J = 4.18$ Joule cal^{-1}, $R = 8.314 \times 10^7$ ergs K^{-1} mole^{-1}