8.12.18 (M)

This question paper contains 4 printed pages.

Your Roll No.

Sl. No. of Ques. Paper: 105

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.)

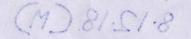
Attempt five questions in all including Question No. I which is compulsory.

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.



- (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
- (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.
 - (b) Give the necessary conditions for the reversibility of a process. Give one example each of reversible and irreversible processes.
- 3. (a) State Clausius and Kelvin statements of the second law of thermodynamics and establish their equivalence.
 - (b) Describe Carnot's cycle and deduce the efficiency of the engine. Show that 100% efficient engine is not possible.
 - (c) Calculate the efficiency of a Carnot engine working between steam point and ice point.
- 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 = 1.013×106 dynes/cm².

- (b) Derive an expression for the Joule-Thomson coefficient in terms of temperature of inversion for a van der Waals gas.
- (a) What is magneto-caloric effect? Describe with necessary theory and experimental setup the method of producing very low temperatures by adiabatic demagnetisation.
 - (b) Verify TdS equation:

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

- 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 $\frac{dP}{dT} = \frac{L}{T(v_2 v_1)}$ 3

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

- 7 (a) Derive Maxwell-Boltzmann law of distribution of speeds for an ideal gas. Show the distribution graphically for various temperatures.
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 - (b) For a gas if the number of molecules per cubic meter is $n = 3 \times 10^{25}$, average velocity is v = 426 m/sec, radius of the molecule is $r = 1.8 \times 10^{-10}$ m, compute the mean free path and the collision frequency.

- 8. (a) Describe Andrew's experiments on CO₂. Discuss the results obtained.
 - (b) Derive van der Waals equation of state. Compare the van der Waals theoretical isotherms with Andrew's experimental results.
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Given J = 4.18 Joule cal-1, R = 8.314×107 ergs K-1 mole-1