This question paper contains 2 printed pages. *Your Roll No. .....*

Sl. No. of Ques. Paper : **8403 C**

Unique Paper Code : **222304**

Name of Paper : **PHHT-309 : Thermal Physics**

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

Semester : **III**

Duration : 3 hours *Maximum Marks* : 75

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

1. Answer any ***five*** of the following: $3\times5=15$

   (a) Apply zeroth law of thermodynamics to show that at equilibrium the systems are at the same temperature.

   (b) Show that an adiabatic is γ times steeper than an isothermal.

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

   (d) A domestic refrigerator is regarded as a reversible engine working between temperature of melting ice and that of atmosphere at 17°C. Calculate the energy required to freeze 1 kg of water at 0°C.

   (e) Derive Energy equation

   $$(\partial U/\partial V)_T=T(\partial P/\partial T)_V-P$$

   And show that for a van der Waals' gas

   $$(\partial U/\partial V)_T=a/V^2$$

   (f) Calculate the molecular diameter of a gas whose mean free path of STP is $2\cdot85\times10^{-7}$ m. $5\times3=15$

2. (a) State Kelvin-Planck and Clausius statements of second law of thermodynamics and prove that both the statements are equivalent.
   (b) State and prove Carnot's Theorem. 8,7

3. (a) State and prove the Clausius inequality.

   (b) Draw T-S diagram for a Carnot's cycle and discuss its physical significance.

   (c) m gm of water at temperature T_1 is isobarically and adiabatically mixed with an equal mass of water at temperature T_2. Show that change in entropy is

P. T. O.

$$2m\,C_p \ln (T_{av} / \sqrt{T_1 T_2})$$

where $T_{av}=(T_1+T_2)/2$. 6,3,6

4. (a) Define thermodynamic potentials (U, F, G and H) and give their physical significance. Using them, derive corresponding Maxwell's thermodynamic relations.

   (b) Prove the relation

$$\beta_s / \beta_v = \gamma/(\gamma-1)$$

   where β is pressure coefficient of expansion. 8,7

5. (a) What are transport phenomena? Obtain an expression for diffusion coefficient of a gas on the basis of Kinetic theory of gases.

   (b) Discuss Doppler's broadening of spectral lines as a consequence of the Maxwell's law of distribution of velocities. 10,5

6. (a) State the law of equipartition of energy and apply it to study the specific heat of monoatomic, diatomic and triatomic gases.

   (b) Starting from the Maxwell's law of distribution of velocities obtain expressions for root mean square velocity (C_{rms}), average ($\bar{C}$) and most probable (C_{mp}) velocity. Hence show that $C_{rms}>\bar{C}>C_{mp}$.

   (c) Obtain an expression for adiabatic lapse rate. 7,4,4

7. (a) Calculate critical constants for a van der Waals' gas. Show that value of critical coefficient is 2·67.

   (b) Discuss the variation of force of surface tension with temperature with the help of Maxwell's relations.

   (c) What do you understand by 1st and 2nd order phase transitions? Discuss with examples. 7,4.4

8. (a) Explain Joule-Thomson effect. Show that Enthalpy remains constant in adiabatic throttling process.

   (b) Derive expression of Joule-Thomson coefficient for :

      (i) Perfect gas

      (ii) van der Waals' gas. 6,9