

Total number of printed pages-4

3 (Sem-3 /CBCS) PHY HC 2

2021

(Held in 2022)

**PHYSICS**

(Honours)

Paper : PHY-HC-3026

**(Thermal Physics-II)**

Full Marks : 60

Time : Three hours

**The figures in the margin indicate  
full marks for the questions.**

1. Answer the following questions :  $1 \times 7 = 7$

(a) What is an isobaric process ?

(b) What is the entropy of a perfect crystalline solid at absolute zero temperature ?

$$dS = dQ/T$$

Contd.

(c) Whether Maxwell-Boltzmann velocity distribution is applicable to photons.

(d) Joule-Kelvin coefficient of a perfect gas is infinite. (State True or False)

(e) At what temperature, does all molecular motion cease?

(f) Name the transport phenomenon present in a gas that involves momentum transfer.

(g) How does the diameter of a gas molecule affect mean free path?

2. Answer the following questions :  $2 \times 4 = 8$

(a) Is temperature a microscopic or macroscopic concept? Explain.

(b) Differentiate between extensive and intensive variables with examples.

(c) Calculate the average thermal energy of a helium atom at  $27^\circ\text{C}$ .

$$[\text{Given } k_B = 1.38 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ K}^{-1}]$$

(d) How do viscosity and temperature affect Brownian motion of gas molecules?

3. Answer **any three** questions :  $5 \times 3 = 15$

(a) A reversible engine takes in heat from a reservoir of heat at  $527^\circ\text{C}$  and gives out heat to sink at  $127^\circ\text{C}$ . How many calories per second must it take from the reservoir to produce useful mechanical work at the rate of 750 watts?

(b) Derive an expression for work done during an adiabatic process considering  $n$  moles of an ideal gas.

(c) Explain an experimental method to verify velocity distribution of gas molecules.

(d) The van der Waals constants of oxygen are  $a = 1.382 \text{ L}^2 \text{ bar/mol}$  and  $b = 0.03186 \text{ L/mol}$ . Calculate its Boyle's temperature and temperature of inversion.  $2\frac{1}{2} + 2\frac{1}{2} = 5$

(e) Derive Clausius-Clapeyron equation.

4. Answer the following questions :  $10 \times 3 = 30$

(a) Using Maxwell's thermodynamic relations, derive  $T_{ds}$  equations. 10

Or

What is Gibbs free energy ? Using Gibbs free energy  $G$ , show that

$$G = -T^2 \left[ \frac{\partial}{\partial T} \left( \frac{G}{T} \right) \right]_P$$

where the symbols have their usual meanings. 1+9=10

- (b) Define coefficient of diffusion. Discuss the theory of diffusion in a gas and show that coefficient of diffusion is directly proportional to square root of temperature.

1+2+7=10

Or

Derive the van der Waals equation of state and calculate the value of critical constants. 5+5=10

- (c) What do you mean by thermodynamic scale of temperature? Show that the thermodynamic scale of temperature is identical with the perfect gas scale of temperature. 3+7=10

Or

Write short notes on the following : **(any two)** 5×2=10

- (i) Carnot cycle
- (ii) Degrees of freedom
- (iii) Joule-Thomson cooling