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3 (Sem-3/CBCS) PHY HC 2

2025

**PHYSICS**

(Honours)

Paper : PHY-HC-3026

**(Thermal Physics)**

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) In Brownian motion, how does size of the particles affect the speed of the particles ?

(b) Name the transport phenomenon present in gases that involves energy transfer.

- (c) A box contains equal number of molecules of  $H_2$  and  $O_2$  gases. If there is a fine hole in the box, which gas will leak rapidly and why?
- (d) What does the width of Maxwell-Boltzmann velocity distribution curve characterize?
- (e) What is the change in entropy of reversible process?
- (f) What is the importance of Clausius inequality in thermodynamics?
- (g) State Zeroth law of thermodynamics.

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

- (a) The molecular diameter of argon is  $0.5 \text{ nm}$ . Calculate Maxwell's mean free path at S.T.P.
- (b) Calculate the average thermal energy of helium atom at room temperature. (Given, Boltzmann constant  $= k_B = 1.38 \times 10^{-23} \text{ m}^2 \text{ kg/s}^2 \text{ K}$ )
- (c) Using enthalpy  $H = U + PV$ , obtain Maxwell's third thermodynamical relation.

- (d) Specific heat of a gas at constant pressure is always greater than the specific heat of a gas at constant volume. Explain why.

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

- (a) Explain Stern's experiment with a diagram.  $4 + 1 = 5$
- (b) From Maxwell's velocity distribution function, deduce the expressions for root mean square velocity and average velocity.  $2\frac{1}{2} + 2\frac{1}{2} = 5$
- (c) Derive an expression for work done during an isothermal process considering 'n' moles of an ideal gas.
- (d) What are characteristics of reversible and irreversible processes? State *two* limitations of first law of thermodynamics.  $2 + 2 + 1 = 5$
- (e) A monoatomic ideal gas of volume 1 litre and pressure 6 atm undergoes adiabatic expansion until the pressure drops to 2 atm. Find the final volume and work done. (Given,  $1 \text{ atm} = 10^5 \text{ N/m}^2$ )  $2\frac{1}{2} + 2\frac{1}{2} = 5$

4. Answer **any three** questions :  $10 \times 3 = 30$

(a) Write short notes on the following :  
(any two)  $5 \times 2 = 10$

(a) Law of corresponding states

(b) Boyle's temperature

(c) Porous plug experiment

(b) What is a real gas? Deduce Van der Waals' equation of state.  $1+9=10$

(c) What is entropy? Show that the change of entropy of one mole of a perfect gas is given by

$$\Delta S = C_V \log_e \frac{P_2}{P_1} + C_P \log_e \frac{V_2}{V_1}.$$

Explain the unattainability of absolute zero temperature.  $1+6+3=10$

(d) Establish Ehrenfest equations.  $5+5=10$

(e) State Kelvin-Planck statement of second law of thermodynamics. Show that the thermodynamic scale of temperature is identical to the perfect gas scale of temperature.  $1+9=10$

(f) What is Carnot engine? Calculate the work done in each cycle of a Carnot engine and hence find the efficiency of a Carnot engine.  $1+9=10$