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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 ?

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°C .
[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°C and gives out heat to sink at 127°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