Total number of printed pages–4

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 : 1×7=7

   (a) What is an isobaric process ?

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

(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 ? Zero

(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 :   2×4=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 $k_B = 1\cdot38 \times 10^{-23} \, m^2 \, kg \, s^{-2} \, K^{-1}$]

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

3. Answer **any three** questions : 5×3=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 $a = 1.382$ $L^2 bar/mol$ and $b = 0.03186$ L/mol. Calculate its Boyle's temperature and temperature of inversion. 2½+2½=5

(e) Derive Clausius-Clapeyron equation.

4. Answer the following questions : 10×3=30

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

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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