2014

PHYSICS

(Major)

Paper : 2.2

Full Marks : 60

Time : 2½ hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option : 1×7=7

(a) The average velocity of the molecules in a gas in equilibrium is

(i) proportional to $\sqrt{T}$

(ii) proportional to T

(iii) proportional to T^2

(iv) equal to zero

(b) The number of degrees of freedom of each molecule of a monoatomic gas is

(i) 1

(ii) 3

(iii) 5

(iv) 6

(c) The average translational kinetic energy per molecule of any gas is

(i) $\frac{1}{2}kT$ (ii) kT

(iii) $\frac{3}{2}kT$ (iv) $\frac{5}{2}kT$

(d) In which process, network done is zero?

(i) Cyclic

(ii) Free expansion

(iii) Isothermal

(iv) Adiabatic

(e) A gas is compressed adiabatically till its temperature is doubled. The ratio of its final volume to initial volume will be

(i) 1/2

(ii) more than 1/2

(iii) less than 1/2

(iv) between 1 and 2

(f) Entropy change in a Carnot cycle is

(i) $\frac{Q_1}{T_1}$

(ii) $\frac{Q_2}{T_2}$

(iii) $\frac{Q_1 - Q_2}{T}$

(iv) zero

(g) Distribution of energy in the spectrum of a blackbody can be correctly represented by

(i) Wien's law

(ii) Stefan's law

(iii) Planck's law

(iv) Kirchhoff's law

2. Answer the following questions : 2×4=8

(a) "Critical temperature enables us to get an estimate of the strength of intermolecular force field." Explain.

(b) What are transport phenomena? Indicate in each case the physical quantity that is transported when—

(i) mechanical equilibrium is disturbed;

(ii) thermal equilibrium is disturbed;

(iii) chemical equilibrium is disturbed.

(c) What is meant by 'quasi static process'? What conditions are to be fulfilled for a process to be quasi static?

(d) Write down the Maxwell's four famous thermodynamical relations.

3. Answer any *three* of the following : 5×3=15

(a) Calculate the change in entropy of an ideal gas when it undergoes a reversible isothermal expansion.

(b) What is Gibbs phase rule?

(c) State and explain Kirchhoff's law of radiation.

(d) Derive the relation

$$\left(\frac{\delta P}{\delta T}\right) = \frac{L}{T(V_2 - V_1)}$$

where the symbols have their usual meanings.

(e) The entropy S of a gas is given by $S = CV^{1/4}U^{3/4}$, where C is a constant, U the energy and V the volume. Determine the temperature and pressure of the gas. Show that its chemical potential μ defined by

$$\mu = -T\left(\frac{\delta S}{\delta N}\right)_{U,\,V}$$

where N is the number of particles, is zero.

(f) Derive van der Waals equation of state

$$\left[P + \frac{a}{V^2}\right](V - b) = RT$$

4. *(a)* What is meant by free path? Establish that

$$\bar{\lambda} = \frac{1}{\sqrt{2}\,\pi\sigma^2 n}$$

on the basis of kinetic theory of gas. 2+8=10

Or

Find an expression for pressure exerted by a confined gas on the basis of kinetic theory of gas using spherical polar coordinates. 10

(b) Develop Fourier's theory for one-dimensional heat flow. What will be the modification for a perfectly 'lagged bar'? 9+1=10

Or

What is absolute scale of temperature? Derive Kelvin's expression for absolute thermodynamic scale of temperature. Show that the ideal gas scale and the thermodynamic scale are identical. Is negative temperature possible in this scale? 1+6+2+1=10

(c) What is Joule-Thomson effect? Show that enthalpy remains constant in the Joule-Thomson effect. 3+7=10

Or

Write short notes on the following : 5×2=10

(i) Wien's displacement law

(ii) Second law of thermodynamics

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