B.Sc. Semester-III Examination, 2022-23

PHYSICS [Honours]

Course ID : 32412 Course Code : SH/PHS/302/C-6

Course Title : Thermal Physics

Time : 1 Hour 15 Minutes Full Marks : 25

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

UNIT-I

1. Answer any **five** of the following questions: 1×5=5

a) Calculate the r.m.s speed of oxygen molecules $\left(m(O_2) = 5.31\times10^{-26} kg\right)$ at 300K.

b) Distinguish between reversible and irreversible processes.

c) State the Clausius theorem.

d) What is the value of the ratio C_p/C_v for the He gas?

e) How does diffusion coefficient of a gas vary with its temperature?

f) State the equipartition theorem.

g) How is thermal equilibrium related to temperature?

h) Why Gibb's function is called thermodynamic potential?

UNIT-II

2. Answer any **two** of the following questions: 5×2=10

a) Deduce an expression of thermal conductivity of a gas on the basis of kinetic theory. 5

b) 1kg of water at 273° K is brought into contact with a heat reservoir at 373° K. When the water has reached 373° K, find, (i) entropy change of water, (ii) entropy change of the heat reservoir, (iii) entropy change of the universe. 2+2+1

c) i) Prove that

$$C_p - C_v = \left\{p + \left(\frac{\partial U}{\partial V}\right)_T\right\}\left(\frac{\partial V}{\partial T}\right)_p$$

ii) Show that $C_p - C_v = VT\beta^2 / K_T$

where β is the coefficient of volume expansion and K_T is isothermal compressibility. 3+2

d) Show that for an isothermal-isochoric spontaneous change of a system Helmholtz free energy must decrease. A gas obeys an equation P(V-b)=RT (b is a constant). Show that $\left(\frac{\partial U}{\partial V}\right)_T = 0$. 3+2

UNIT-III

3. Answer any **one** of the following questions: 10×1=10

a) i) State Carnot's theorem.

ii) Distinguish between a 'heat engine' and a 'refrigerator' operated by the Carnot cycle. Derive an expression for the efficiency of a Carnot's engine using ideal gas as working substance. 2+3+5

b) Write down the expressions of four thermodynamic potentials. Why are they called potentials? Deduce the four Maxwell's relations. Show that $H = G - T\left(\frac{\partial G}{\partial T}\right)_P$, where the symbols have usual meaning. 2+1+2+5

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