TDC (CBCS) Odd Semester Exam., 2022

PHYSICS

(Honours)

(3rd Semester)

Course No. : PHSHCC–302T

(Thermal Physics)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* questions : 2×2=4

(a) State the zeroth law of thermodynamics.

(b) Why C_P is greater than C_V?

(c) What do you mean by thermodynamic scale of temperature?

2. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Show that the work done in adiabatic expansion of an ideal gas from a state (P_1, V_1) to a state (P_2, V_2) is given by $W = \frac{1}{\gamma - 1}[P_1V_1 - P_2V_2]$. 3

(b) A Carnot engine has an efficiency of 20% when the temperature of the sink is 27 °C. What must be the change in temperature of the source to make its efficiency 50%? 3

(c) State and prove Carnot's theorem. 3

(d) Discuss the equivalence of thermodynamic scale of temperature and perfect gas scale. 3

UNIT—II

3. Answer any *two* of the following questions : 2×2=4

(a) State the concept of entropy.

(b) Give the second law of thermodynamics in terms of entropy.

(c) Define Helmholtz free energy and Gibbs' free energy.

4. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Prove that for a complete reversible cycle change in the state of substance $\oint ds = 0$. 3

(b) State the significance of thermodynamic potential. 3

(c) Discuss in brief the temperature entropy diagram for Carnot's cycle. 3

(d) Show that entropy increases in irreversible process. 3

UNIT—III

5. Answer any *two* of the following questions : 2×2=4

(a) Write Four Maxwell's thermodynamic relations.

(b) What do you mean by Joule-Kelvin coefficient for a van der Waals' gas?

(c) What is first-order phase transition? Give one example.

6. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Define second-order phase transition and hence derive Ehrenfest's theorem. 3

(b) Establish the following relation : 3

$$TdS = C_V dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$$

(Here the symbols have their usual meanings)

(c) Use Maxwell's thermodynamic relations, derive the relation $C_P - C_V = R$ (here the symbols have their usual meanings). 3

(d) Establish the following relation : 3

$$TdS = C_P dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$$

(Here the symbols have their usual meanings)

UNIT—IV

7. Answer any *two* of the following questions : 2×2=4

(a) Define degrees of freedom. Write the law of equipartition of energy.

(b) Define specific heats of gases.

(c) Calculate the RMS speed of oxygen molecules at 27 °C.

8. Answer *either* [*(a)* and *(b)*] *or* [*(c)* and *(d)*] :

(a) Using Maxwell-Boltzmann distribution law of velocities, derive an expression for the most probable speed in an ideal gas. 5

(b) What is Brownian motion? 1

(c) Obtain the expression for mean free path

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

where σ is the molecular diameter and n is the number of molecules per unit volume as per the kinetic theory of gases. 4

(d) Write a short note on viscosity and diffusion. 2

UNIT—V

9. Answer any *two* of the following questions : 2×2=4

(a) What do you mean by Boyle temperature?

(b) State the limitations of van der Waals' equation.

(c) Define critical constants.

10. Answer *either (a) or (b)* : 6

(a) Discuss Andrews' experiment on CO_2 gas.

(b) What are critical constants of a real gas? Find the expressions for each of them.

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