2018

CBCS

3rd Semester

PHYSICS

PAPER—C6T

(Honours)

Full Marks : 40

Time : 2 Hours

The figures in the right-hand margin indicate full marks.

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

Illustrate the answers wherever necessary.

Thermal Physics

1. Answer any *five* quesitons : 5×2

(a) Calculate the efficiency of Carnot-engine using T-S diagram. 2

(b) Calculate the temperature of inversion and Boyle temperature for H_2 if the critical temperature is 22k. 2

(Turn Over)

(c) The number of degrees of freedom per molecule of a gas is 6. The gas performs 50 J of work when it expands at constant pressure. Find the heat absorbed by the gas. 2

(d) At any temperature, will the mean translation kinetic energy per molecule be the same for a monoatomic and that for a diatomic gas ? Give reasons for your answer. 2

(e) Show that $C_V = -T\left(\frac{\partial^2 F}{\partial T^2}\right)_V$ (notations bear their usual meanings). 2

(f) An ideal gas is expanded free, double to its original volume. Obtain the change in entropy. 2

(g) Distinguish between cooling produced by J-T expansion and adiabatic expansion. 2

(h) Calculate the r.m.s velocity of O_2 at N.T.P. 2

2. Answer any *four* questions : 4×5

(a) Show that $C_P - C_V = \left\{P + \left(\frac{\partial u}{\partial v}\right)_T\right\} \left(\frac{\partial V}{\partial T}\right)_p$. Derive $(C_p - C_v)$ for n mole of ideal gas. 5

(b) Deduce expressions for the work done in a quasistatic isothermal and adiabatic expansion or compression of an ideal gas. 5

(c) Establish the differential equation for the flow of heat through a metal bar of uniform cross-section heated at one end. 5

(d) State Nernst's heat theorem. Establish the equivalence of the third law of thermodynamics and Nernst's heat theorem. Show that the specific heats (C_P and C_V) of thermodynamic system approaches to zero as $T \to 0$. 1+3+1

(e) Write Maxwells distribution law of molecular speeds explaining each term. Using the Maxwell distribution equation find the values of average speed and root mean square speed of the molecule of an ideal gas at temperature T. 1½+2+1½

(f) (i) Show that the ratio of two specific heats is the ratio of the adiabatic to isothermal elasticity. 2

(ii) State Clausius theorem and discuss briefly the concept of entropy. Show that the entropy of n mole of an ideal gas of constant heat capacity C_v at a temperature T and volume V is given by

$$S = C_v \ln T + nR \ln V + k,$$ where k is a constant. 3

3. Answer any *one* question : 1×10

(a) (i) What do you understand by 'mean free path' of the molecules of a gas ? Obtain an expression for the law of distribution of free paths. Consider a gas composed of N_0 molecules having a mean free path λ; What fraction of them will have freepaths between λ and 2λ. 1+4+1

(ii) Derive the relation $R = \frac{8}{3} \frac{V_C P_C}{T_C}$ for a Vander Waal's gas where R is the universal gas constant, P_c, V_c and T_c represents critical pressure, critical volume and critical temperature. 4

(b) (i) Derive an expression for the Joule-Thomson coefficient and discuss its significance. Explain why the J-T coefficient is zero for an ideal gas and non-zero for a real gas. 8

(ii) 50 gms of hydrogen gas at 10° C are compressed isothermally to 1/4 of the original volume. Find the amount of workdone. 2

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