End Semester Examination, 2022

Semester - III

Physics

PAPER - CC-6T

Full Marks : 40

Time : 2 Hours

The Figures in the right hand margin indicate marks. Candidates are required to give their answers in their own words as far as practicable.

Group - A

1. *Answer any <u>five</u> questions :* ***5x2=10***

a) What, according to van der waals, are the reasons for the relation PV = RT not holding good for real gases ?

b) Calculate the mean free path and Collision state of hydrogen atom, given $\eta = 85\times10^{-6}$ dyne/sq.cm per unit velocity gradient, $\bar{c} = 16\times10^{4}$ cm/s and $\rho = 0.000089$ g/c.c.

c) What is 'inversion temperature'? What is its relation with Boyle and critical temperatures ?

d) Calculate efficiency of Carnot' engine with from T–$\mathcal{S}$ diagram.

e) Derive $\left(\frac{\partial c_v}{\partial V}\right)_T = T\left(\frac{\partial^2 P}{\partial T^2}\right)_V$.

f) If the equation of state for a gas with internal energy u is $PV = \frac{1}{3}U$, then derive the equation in acliabatic process.

g) Given PV = RT + bP. Derive expressions for heat & work in a reversible isothermal expansion of gas.

h) What is the importance of thermodynamic functions ?

Group - B

Answer any <u>four</u> questions : **4x5=20**

2. Show that work done (dw) of ideal gas is inexact differential. How can you remove this discrepancy ? What is the name of new exact differential ? 2+2+1

3. a) The distribution function of a gas of n particles is given by

$$dN_V = KV \quad for\ 0 < V < V_0$$
$$0 \quad for\ V > V_0$$

Find the value of K and hence compare the average speed of the particles.

b) Calculate the van der Waals' constant for dry air, given that T_c = 132K, P_c = 37.2 atoms, R per mole = 82.07 cm^3 atmos K^{-1}. 3+2

4. a) Obtain the following Tds equation :

$$Td\$ = C_V dT + T\beta E_T dV$$

Where, β = volume co-efficient of expansion =

$\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ and E_T = Isothernial elasticity = $-V\left(\frac{\partial P}{\partial V}\right)_T$.

b) Show that entropy increases in natural processes. 3+2

5. Derive expressions of Jule-Thomson coefficient for Van der Waals gas. Modify this equation with inversion temperature.

6. a) Show that the entropy and pressure of a fixed T and a fixed V system are

$$S = -\left(\frac{\partial F}{\partial T}\right)_V,\ P = -\left(\frac{\partial F}{\partial T}\right)_T$$

b) Show that cyclic rule is applicable for Van der Waals' gas. 2+3

7. Derive Maxwell's Thermodynamic relations.

Group - C

Answer any <u>one</u> of the following : **1x10=10**

8. a) When two gases at the same temperature and pressure diffuse into each other, show that there is an increase in en-tropy in the process.

b) Show that $\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$.

For a gas obeying $P = \frac{RT}{V-b}\exp\left(-\frac{a}{RTV}\right)$

Show that $\left(\frac{\partial U}{\partial V}\right)_T = \frac{ap}{RTV}$

c) Calculate the change in melting point of ice at 0^0c when pressure is increased by 2 atoms. How much pressure is required to lower the melting point by 1^0c ?

Given : latent heat of fusion 80 cal/gm and the specific volumes of water and ice are respectively 1.0001 c.c. and 1.0908 c.c. 4+3+3

9. a) Show that the probability of gas molocule traversing a distance x without suffering a collision is exp $\left(-x/\lambda\right)$, where λ is mean free path of gas.

b) The quantity $(c-\bar{c})^2 = c^2 - 2c\bar{c} + \bar{c}^2$ is the square of the derviation of the speed of mole cule from the average or mean speed. Find the average value of this quantity using Maxwell's distribution law and then take the square root of the result to obtain the r.m.s. deviation of the distribution.

c) What are the critical constants of a gas ? Obtain their values in terms of the constants of Van der Waals equation. 3+3+(1+3)