3 (Sem–3/CBCS) PHY HC 2

2024

PHYSICS

(Honours)

Paper : PHY–HC–3026

(Thermal Physics)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×7=7

   (a) What is a cyclic process ?

   (b) Is coefficient of performance of a refrigerator a constant quantity ?

   (c) What is the importance of Clausius inequality in thermodynamics ?

   (d) What is the entropy value of a perfect crystalline solid at absolute zero temperature ?

(e) Name the phenomenon where transport of momentum takes place in gas.

(f) What do mean by temperature of inversion ?

(g) Define compressibility factor.

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

(a) Why is C_P greater than C_V ? Explain.

(b) What is the basic difference between reversible and irreversible processes ?

(c) What is the effect of temperature and pressure on mean free path ?

(d) How does velocity distribution curve depend on temperature ?

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

(a) Derive an expression for work done during an isothermal process.

(b) The melting point of solid tin is 232°C. The specific heat of solid tin is 0·055 *cal/gm K* and molten tin is 0·064 *cal./gm.K.* Calculate the change is entropy when one *gm* of solid tin is heated from 147°C to 310°C. (Given, $L = 15$ *cal./gm*).

(c) Calculate the average speed and the most probable speed of 1 mole of hydrogen molecule at 300 *K*. Neglect mass of electron.
K_B = Boltzmann constant = $1{\cdot}380649 \times 10^{-23}$ joule per kelvin (*K*).
2½+2½= 5

(d) For 6·75 *mol.* of N_2 gas in a volume of 1 litre at 150 *K*, calculate the pressure exerted by N_2 using *(i)* ideal gas law *(ii)* Van der Waals equation and *(iii)* Compressibility factor.
Given $a = 1{\cdot}39\ atm\,L^2/mol^2$
$b = 0{\cdot}03913\ L/mol$
$R = 0{\cdot}0821\ L\,atm/mol\,K$
1+2+2=5

(e) Show that in an isothermal expansion of a Van der Waals' gas, the heat taken in is $Q = RT\log\left(\frac{V_f - b}{V_i - b}\right)$ where V_f and V_i are the final and initial volume respectively.

4. Answer ***any three*** of the following questions : 10×3=30

(a) Explain Carnot's cycle. Calculate the work done in the cycle of operation and hence find the efficiency of a Carnot engine.

(b) Show that the change of entropy of one mole of a perfect gas is given by

$$\Delta S = C_V \log_e \frac{P_2}{P_1} + C_P \log_e \frac{V_2}{V_1}$$

(c) Deduce Clausius Clapeyron equation from Maxwell's second thermodynamic relation.

(d) Derive Maxwell's velocity distribution function.

(e) Derive an expression of coefficient of viscosity using kinetic theory.

(f) Deduce Van der Waals equation.

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