

Sr. No. of Question Paper : 13344
Unique Paper Code : 2174001011
Name of the Paper : States of Matter
Name of the Course : B.Sc. (H)
Semester : I/III/V/VII

Duration: 2 Hours

Maximum Marks: 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt FOUR questions in all. Question No. 1 is compulsory.
3. The questions should be numbered in accordance to the number in the question paper.
4. Use of Scientific Calculator is permitted.

$$(R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}, k = 1.38 \times 10^{-23} \text{ J K}^{-1}, N_A = 6.023 \times 10^{23} \text{ mol}^{-1})$$

Q1. Answer any *five* of the following:

- (a) CO and N₂ have the same speed distribution at the same temperature.
- (b) What are the units of van der Waals constants *a* and *b*? Do these constants depend upon temperature of the gas?
- (c) What is the effect of addition of KCl on surface tension of water.
- (d) Rubidium iodide (RbI) forms a CsCl-type crystal structure with unit cell edge equals to 420pm. Find the density of RbI. (Atomic masses: Rb = 85.5, I = 127 g mol⁻¹).
- (e) How does viscosity vary with temperature in case of liquids and gases?
- (f) Find the Miller indices for the following sets of intercepts:
 - (i) *a*, $-3b$, ∞c
 - (ii) $-a/3$, ∞b , $2c$
 - (iii) $-a/2$, $b/2$, $-c/3$

(3×5)

Q2. (a) The initial slope of graph of the compressibility factor, *Z* versus the pressure, *P* at a fixed temperature is positive for some gases and negative for others. Explain this behaviour with help of diagram.

(b) What do you understand by liquid crystals? Give the classification of liquid crystals and briefly explain the difference.

(c) Calculate the temperature at which the root mean square velocity, the average velocity and the most probable velocity of oxygen gas are equal to 1500 ms⁻¹.

(5,5,5)

Q3. (a) Explain the terms mean free path (λ), collision number (Z_1), and collision frequency (Z_{11}). Discuss the effect of temperature and pressure on these terms.

(b) The critical constants for water are $T_c = 647\text{K}$, $P_c = 218\text{ atm}$ and $V_c = 0.05\text{ dm}^3\text{ mol}^{-1}$. Calculate the van der Waals constants and critical compressibility factor.

(c) Discuss the crystal structure of CsCl. How does it differ from the NaCl structure?

(5,5,5)

Q4. (a) Explain the coefficient of viscosity. Write its S.I. unit. Describe Ostwald's viscometer method for the determination of viscosity of liquid.

(b) Explain the Andrews isotherms for a real gas. Derive the relations between van der Waals constants and critical constants.

(c) A crystal has an interplanar spacing of $2.5\text{ \AA}$. At what angles will the first and second-order reflections occur for X-rays of wavelength $1.0\text{ \AA}$?

(5,5,5)

Q5. (a) If the flow time for the two liquids A and B through the same capillary is in the ratio of 5:4 and the densities in the ratio of 1:2. What is the ratio of their viscosities?

(b) What is the basic principle of Bragg's law in X-ray diffraction? How can it be used to calculate interplanar spacing in a crystal?

(c) What is the mean free path for oxygen molecules at temperature $T = 300\text{ K}$ and $P = 1.00\text{ atm}$? Assume that the molecular diameter $d = 290\text{ pm}$ and the gas is ideal.

(5,5,5)

Q6. (a) (i) Why can't X-ray diffraction distinguish between two elements that have similar atomic numbers?

(ii) Explain how the ratios of interplanar spacings can be used to distinguish between simple cubic, body-centred cubic, and face-centred cubic Bravais lattices.

(b) In the determination of surface tension of a liquid, L, by the drop number method using a Stalagmometer, liquid, L, gave 58 drops while water gave 24 drops; volume of the two liquids being the same. The densities of water and L are 0.9968 g/cm^3 and 0.8204 g/cm^3 respectively. The surface tension of water is 0.0728 N m^{-1} at 25°C . Calculate the surface tension of the liquid at temperature.

(c) Write a short note on any *two*:

i) Translational symmetry elements

ii) Glasses

iii) Point defects

(5,5,5)