

mol^{-1}) is a cube with edge length of 405 pm. The density of aluminium is 2.70 g cm^{-3} . What is the structure of aluminium crystal? (5)

5. (a) The variation of viscosity with temperature is given by the Arrhenius Equation as mentioned below

$$\ln \eta / \eta^\circ = \ln A + \frac{E}{RT}$$

Explain the terms involved in the equation. Draw the schematic plot of $\ln \eta / \eta^\circ$ vs $1/T$. What is its slope? (5)

- (b) Calculate mean free path (λ), Collision number (Z_1) and collision frequency (Z_{11}) for CO_2 at 300 K and 10^{-6} mmHg . (Take σ to be 460 pm). (5)
- (c) Using van der Waals equation define and calculate the critical constants with explaining continuity of state. (5)
6. (a) Rubidium Bromide (RbBr) has face centred crystal structure, however, X-ray Diffraction indicates RbBr to be simple cubic. Explain (5)
- (b) Discuss the Debye-Scherrer method (powder diffraction method). (5)
- (c) Calculate the root mean square, average and most probable speeds of oxygen molecules at 25°C . (5)

(1000)

[This question paper contains 4 printed pages.]

Your Roll No.....

आपका अनुक्रमांक.....

Sr. No. of Question Paper : 3323

I

Unique Paper Code : 2174001011

Name of the Paper : (GE) States of Matter

Name of the Course : B. Sc. (Hons)

Semester : I/III/V

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

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

1. Answer any five of the following
 - (a) Which of the two postulates of the kinetic theory of gases were found to be not applicable to real gases? (3)

P.T.O.

- (b) The addition of NaCl increases the surface tension of water, whereas, the addition of surfactants reduces the surface tension of water. Explain (3)
- (c) Gases like hydrogen and helium are difficult to liquify Why? (3)
- (d) Discuss briefly the effect of the mass of the gaseous molecule on the Maxwell Distribution curve of molecular speeds. (3)
- (e) Following are the intercepts with the three axes perpendicular to each other. Calculate the Miller indices of the faces. (3)
- (i) $2a:3b:4c$ (ii) $\frac{3}{2}a:\frac{5}{2}b:3c$ (ii) $2a:\frac{1}{2}b:\infty c$
- (f) The first order reflection of an X-ray beam from a given crystal occurs at 5.25° . At what angle will be the second order reflection? (3)
2. (a) Derive the van der Waals equation of state for n moles of real gas.
- $$\left(p + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$
- Write the units of van der Waals constants a and b . (5)
- (b) At 20°C , pure water with an absolute viscosity of $1.002 \times 10^{-3} \text{ Nm}^{-2} \text{ s}$ requires 102.2 s to flow through the capillary of an Ostwald viscometer.

- At 20°C , toluene requires 68.9 s. If the densities of water and toluene be 0.998 and 0.866 g cm^{-3} , respectively, calculate the viscosity of toluene. (5)
- (c) Discuss the crystal structure of NaCl. Why is it impossible to deduce the position of the hydrogen atom from X-ray diffraction? (5)
3. (a) (i) State the laws of crystallography. Explain how long-range order exists in crystalline materials. (5)
- (b) The first order reflection from (200) planes of NaCl using X-rays of wavelength 58 pm ($K\alpha$ line from palladium) occurs at an angle of 5.9° . Calculate (i) the edge length of the unit cell (ii) the volume of the unit cell. (5)
- (c) Derive the expression of collision frequency (Z_{11}) for bimolecular collisions in gaseous molecules. (5)
4. (a) The van der Waals constants for HCl are $a = 371.843 \text{ kPa dm}^6 \text{ mol}^{-2}$ and $b = 40.8 \text{ cm}^3 \text{ mol}^{-1}$. Find the critical constants (T_c , V_c and P_c) of this substance. (5)
- (b) (i) Define coefficient of viscosity of liquid. Arrange the coefficient of viscosity of ethanol ($\text{C}_2\text{H}_6\text{O}$), ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$) and glycerol ($\text{C}_3\text{H}_8\text{O}_3$) in increasing order. Discuss briefly the reason. (5)
- (c) The unit cell of aluminium (Molar mass = 26.98 g