2022

(November)

CHEMISTRY

(Honours)

(Chem-H-503)

(Physical Chemistry—V)

Marks : 37

Time : 2 hours

The figures in the margin indicate full marks for the questions

1. *(a)* Write Maxwell's distribution equation of molecular speed. What is the effect of temperature on distribution of speed? 4

(b) State the law of corresponding states and derive the reduced equation of state. 3

(c) Calculate the average and the root-mean-square speed of nitrogen molecule at 298 K. 2

OR

2. *(a)* Write notes on the following : 2+2=4

(i) Collision frequency

(ii) Viscosity of gases

(b) Derive the relationship among average, root-mean-square and most probable velocities. 3

(c) Calculate the Boyle temperature for CO_2 assuming that it is van der Waals' gas. 2

Given : $a = 3{\cdot}592$ atm L^2/mol^2
$b = 0{\cdot}0426$ L/mol

3. (a) Define molar refraction. Calculate the molar refraction of CCl_4 at a temperature at which its density is $1{\cdot}595\ g\ cm^{-3}$. The observed value of refraction index at this temperature is 1·4573. 1+3=4

(b) Explain the following : 1½+1½=3

(i) Dipole moment

(ii) Dielectric constant

OR

4. (a) Derive Clausius-Mosotti equation for non-polar molecules. 4

(b) At 20 °C, toluene rises 1·95 cm in a capillary tube of radius 0·3412 mm. Calculate the surface tension of toluene. Its density at 20 °C is $0{\cdot}866\ g\ cm^{-1}$. 3

5. (a) Derive Bragg's equation for X-ray diffraction by a crystal. 3

(b) What is symmetry in a crystal? Define plane and axis of symmetry in a simple cubic crystal. 1+1+1=3

OR

6. (a) Describe the Laue's method for the determination of a crystal structure. 4

(b) The second-order reflection of X-rays from (1 0 0) planes of NaCl occurs at 29·3°. If the wavelength used is 1·54 Å, calculate the distance between two successive (1 0 0) planes in NaCl. 2

7. (a) Obtain the rate expression for an opposing reaction in which the forward as well as the reverse reactions are both first-order. 4

(b) Define the following : 1+1+1=3

(i) Chain reaction

(ii) Steady-state approximation

(iii) Enzyme catalysis

OR

8. (a) Derive Michaelis-Menten equation for an enzyme-catalysed reaction. 4

(b) Write a note on consecutive reaction and obtain the rate expression for such reaction. 3

9. *(a)* Give the statement of Born-Oppenheimer approximation and mention its significance. 4

(b) The pure rotational spectrum of HCl molecule shows a series of lines seperated by $20{\cdot}8\ cm^{-1}$. Calculate the internuclear distance of HCl.

[Atomic masses of H and Cl are $1{\cdot}673\times10^{-27}$ kg and $58{\cdot}06\times10^{-27}$ kg respectively] 4

OR

10. *(a)* Derive the expression for rotational energy $E_J = BJ(J+1)\ cm^{-1}$, where the terms have their usual meanings. 4

(b) What are selection rules for rotational and vibrational spectra? 2

(c) Discuss isotopic effect in vibrational spectrum with suitable example. 2

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