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(CBCS)

(5th Semester)

CHEMISTRY

SEVENTH PAPER

(Physical Chemistry—II)

Full Marks : 75

Time : 3 hours

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. The average translational kinetic energy of a gas depends upon

(a) pressure ( )

(b) volume ( )

(c) temperature ( )

(d) number of molecules ( )

2. For a non-linear polyatomic HCHO molecule, the number of vibrational degrees of freedom is given by

(a) 1 ( )

(b) 4 ( )

(c) 5 ( )

(d) 6 ( )

3. The crystal plane for which the interplanar spacing d_{hkl} $a / \sqrt{12}$, is

(a) 111 ( )

(b) 122 ( )

(c) 211 ( )

(d) 222 ( )

4. For a cubic crystal, d_{100} / a is equal to

(a) 1/1 ( )

(b) 1/2 ( )

(c) 1/4 ( )

(d) 1/8 ( )

5. If activation energy (E_a) of a reaction is 0, then k is equal to

(a) 0 ( )

(b) ( )

(c) A ( )

(d) A^{1} ( )

6. The reaction $A \quad B \quad C$ Products, obeys the rate law, $r \quad d[A]/dt \quad k[A]^2[B]^{3/2}[C]^{1/2}$, the overall order of reaction is

(a) 3 ( )

(b) 1/2 ( )

(c) 3/2 ( )

(d) 5/2 ( )

7. Relation between entropy and thermodynamic probability is given by

(a) $k \quad S\ln W$ ( )

(b) $W \quad S\ln k$ ( )

(c) $W \quad k\ln S$ ( )

(d) $S \quad k\ln W$ ( )

8. As per the third law of thermodynamics, as $T \quad 0$

(a) $G \quad 0$ ( )

(b) $S \quad 0$ ( )

(c) $U \quad 0$ ( )

(d) $H \quad 0$ ( )

9. The unit of molar conductance is given by

(a) $S\,m^{-1}\,mol^{-1}$ ( )

(b) $S\,m^{-2}\,mol^{-1}$ ( )

(c) $S\,m^{2}\,mol^{-1}$ ( )

(d) $S\,m^{-2}\,mol^{-2}$ ( )

10. Upon dilution, specific conductance of a solution

(a) decreases ( )

(b) increases ( )

(c) remains unchanged ( )

(d) increases then decreases ( )

SECTION—B

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Calculate the average speed of H_2 gas molecules at 0 °C.

OR

2. Calculate the kinetic energy of 1 mole of a $N_2(g)$ at 27 °C.

3. What are elements of symmetry in a crystal? Give an example each of *(a)* elements of symmetry, *(b)* plane of symmetry and *(c)* centre of symmetry.

OR

4. Differentiate between isotropy and anisotropy. Give two examples each for isotropy and anisotropy.

5. Derive the integrated form of Arrhenius equation.

OR

6. Define *(a)* molecularity of a reaction, *(b)* threshold energy and *(c)* turnover number.

7. Write the expression for the standard entropy of a gas above its boiling point.

OR

8. Write a note on the Nernst heat theorem.

9. Define transport number of an ion. Show that the sum of transport numbers of cation and anion is unity.

OR

10. Define *(a)* equivalent conductivity and *(b)* molar conductivity. What is the unit of equivalent conductivity?

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* Derive Maxwell-Boltzmann distribution law of molecular velocities. 5½

(b) Give the expression for mean free path of a gaseous molecule. 1

(c) Calculate the root meat square velocity of O_2(g) molecule having density $1{\cdot}429\ kg\ m^{-3}$ at STP. 3½

OR

2. *(a)* Derive root mean square from Maxwell's relation. 3½

(b) State and explain the law of equipartition of energy. 3½

(c) Calculate the various degrees of freedom in case of *(i)* CO_2, *(ii)* H_2O and *(iii)* C_6H_6 gaseous molecules. 3

3. *(a)* Calculate the number of atoms present in—

(i) simple cubic unit cell;

(ii) face-centred cubic unit cell;

(iii) body-centred cubic unit cell. 3

(b) Define centre of symmetry. Find the total number of symmetry elements of various types in a cubic crystal. 1+2½=3½

(c) The parameters of an orthorhombic unit cell are a 50 pm, b 100 pm and c 150 pm. Determine the spacing between (123) planes. 3½

OR

4. (a) Derive Bragg's equation. 3½

(b) What are meant by crystal habit, interfacial angle and plane of symmetry? 3

(c) Calculate the longest wavelength of the X-ray that may be used to determine a lattice spacing of 1 Å by the Bragg reflection method. 3½

5. (a) Discuss in detail the collision theory of bimolecular reactions. 5

(b) Write the reaction involved in the hydrolysis of ethyl acetate. What are the order and molecularity of this reaction? 2

(c) The rate constants of second-order reaction are $5{\cdot}70\times10^{5}$ dm^3 mol^{1} s^{1} and $1{\cdot}64\times10^{4}$ dm^3 mol^{1} s^{1} at 25 °C and 40 °C respectively. Calculate the activation energy of the reaction. 3

OR

6. (a) What are the types and characteristics of catalysis? 3

(b) Write the reaction and type of catalyst involved in the inversion of cane sugar. 2

(c) Derive Michaelis-Menten equation in case of enzyme catalysis. 5

7. (a) Show that the entropy of any substance at very low temperatures (0 T 20K) is 1/3rd of the molar heat capacity. 3

(b) Derive Gibbs-Helmholtz equation. 3½

(c) Calculate the standard entropy change for the reaction N_2 (g) O_2 (g) 2 NO (g). Given standard entropies for N_2 (g) 191·62 JK^{1} mol^{1}, O_2 (g) 205·01 JK^{1} mol^{1} and NO (g) 210·45 JK^{1} mol^{1}. 3½

OR

8. *(a)* Define chemical potential. 1

(b) Derive Gibbs-Duhem equation. 3½

(c) How does chemical potential vary with pressure as well as temperature? 5½

9. *(a)* Derive Ostwald dilution law. 3½

(b) Derive the expression for drift speed. 3

(c) A potential of 12 volt was applied across the two electrodes placed 20 cm apart. A dilute solution of NaCl was placed between the electrodes when Na ion was found to move a distance of 1·60 cm in 1 hour. Calculate the mobility of Na ion. 3½

OR

10. *(a)* On the basis of asymmetry and electrophoretic effects, discuss in detail the Debye-Hückel-Onsager theory of strong electrolytes. 6½

(b) For strong electrolytes NaOH, NaCl and $BaCl_2$, the molar ionic conductances at infinite dilution are $248{\cdot}1\times10^{-4}\ Sm^2\ mol^{-1}$, $126{\cdot}5\times10^{-4}\ Sm^2\ mol^{-1}$ and $280{\cdot}0\times10^{-4}\ Sm^2\ mol^{-1}$ respectively. Calculate molar conductivity at infinite dilution for $Ba(OH)_2$. 3½

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