2023

(CBCS)

(5th Semester)

CHEMISTRY

SEVENTH PAPER

(Physical Chemistry—II)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(*Marks* : 10)

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

1. The average kinetic energy associated with each degree of freedom is

(a) KT ( )

(b) $2/3KT$ ( )

(c) $KT/2$ ( )

(d) $2KT$ ( )

2. The density of molecules is maximum at which speed?

(a) U_{rms} ( )

(b) U_{mp} ( )

(c) U_{av} ( )

(d) At all speeds ( )

3. Which of the following is regarded as the 'repeatable entity' of a 3D crystal structure?

(a) Bravais lattice ( )

(b) Crystal ( )

(c) Lattice ( )

(d) Unit cell ( )

4. Which of the following is correct for a tetragonal crystal system?

(a) $a = b = c$ ( )

(b) $a \neq b \neq c$ ( )

(c) $a = b \neq c$ ( )

(d) $a \neq b = c$ ( )

5. In a chemical reaction, how does the concentration of reactant change with time?

(a) Increases ( )

(b) Decreases ( )

(c) Remains unchanged ( )

(d) Increases and then decreases ( )

6. Which of the following is affected by a catalyst?

(a) ΔH ( )

(b) ΔS ( )

(c) ΔG ( )

(d) E_a ( )

7. The entropy of a perfect crystal at absolute zero is

(a) ∞ ( )

(b) 0 ( )

(c) 1 ( )

(d) undetermined ( )

In an open system, there is transfer of

(a) energy ( )

(b) entropy ( )

(c) mass ( )

(d) All of the above ( )

Upon dilution, the equivalent conductivity and molar conductivity will

(a) increase ( )

(b) decrease ( )

(c) remain unchanged ( )

(d) first increase and then decrease ( )

). The sequence of ionic mobility among the group 1 elements is

(a) $Li^+ > Na^+ > K^+ > Rb^+$ ( )

(b) $Na^+ > Li^+ > K^+ > Rb^+$ ( )

(c) $Rb^+ > K^+ > Li^+ > Na^+$ ( )

(d) $Rb^+ > K^+ > Na^+ > Li^+$ ( )

(SECTION : B—SHORT ANSWERS)

(*Marks* : 15)

3×5=15

Answer the following :

UNIT—I

1. Define root mean square velocity, average velocity and most probable velocity.

OR

2. Calculate the U_{rms} of methane molecule at 37 °C.

UNIT—II

3. Write a short note on interfacial angle.

Contd.

OR

4. Define the following :

   (a) Axis of symmetry

   (b) Plane of symmetry

   (c) Space lattice

UNIT—III

5. What is a catalyst? Write any four characteristics of catalyst.

OR

6. What do you mean by activation energy and temperature coefficient of a reaction?

UNIT—IV

7. Explain residual entropy.

OR

8. Write a short note on Nernst heat theorem.

UNIT—V

9. Define the following :

   (a) Drift velocity

   (b) Ionic mobility

   (c) Conductance

OR

10. Discuss the variation of molar conductance with dilution for weak electrolytes.

(SECTION : C—DESCRIPTIVE)

(*Marks* : 50)

nswer the following : 10×5=50

UNIT—I

1. *(a)* Discuss the Maxwell-Boltzmann distribution law of molecular velocity. 5

(b) Calculate the various degrees of freedom of the following molecules : 3

(i) HCN

(ii) H_2O

(iii) CO_2

(c) Write a short note of translational degrees of freedom. 2

OR

2. *(a)* State and explain the law of equipartition of energy. 5

(b) At what temperature will the U_{rms} of SO_2 be the same as that of O_2 at 27 °C? 3

(c) What is the average KE of a gas molecule at 77 °C? 2

UNIT—II

3. *(a)* Explain the Debye-Scherrer powder method for the determination of crystals. 5

(b) Silver (107·8 g/mol) crystallizes in a cubic lattice where its density is $10{\cdot}7\times10^3$ kg/m^3. If the edge length of the unit cell is 406 pm, determine the type of the lattice in which silver is present. 3

(c) Calculate the Miller indices of a crystal plane which cut through the crystal axes at (a, b, c) and $(2a, -3b, -3c)$. 2

OR

4. *(a)* What is unit cell? Derive Bragg's equation of X-ray crystallography. 5

(b) State and explain the law of rational indices.

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

UNIT—III

5. (a) Derive the Michaelis-Menten equation for E-S reaction.

(b) Derive the integrated form of the Arrhenius equation.

(c) What do you mean by molecularity of a reaction? Mention any one unimolecular reaction.

OR

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

(b) Write a short note on absolute reaction rate theory.

(c) What are pseudo-unimolecular reactions? Give an example of this reaction.

UNIT—IV

7. (a) Derive the expression for the variation of free energy with pressure and volume.

(b) Derive the Gibbs-Helmholtz equation for a process at constant pressure and constant volume.

OR

8. (a) Derive the expression for the variation of chemical potential with temperature and pressure.

(b) Show that the entropy of any substance at very low temperatures $(0 < T < 20K)$ is $\frac{1}{3}$rd of the molar heat capacity.

(c) Calculate the standard entropy change for the reaction $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$. Given, standard entropies for $C(s) = 5{\cdot}69\ JK^{-1}\ mol^{-1}$, $H_2O(g) = 70{\cdot}29\ JK^{-1}\ mol^{-1}$, $CO(g) = 197{\cdot}90\ JK^{-1}\ mol^{-1}$ and $H_2(g) = 328{\cdot}50\ JK^{-1}\ mol^{-1}$.

UNIT—V

(a) Derive the Ostwald dilution law. 5

(b) Write a note on Arrhenius theory of electrolytic dissociation. 3

(c) Explain electrophoretic effect. 2

OR

(a) Show that the sum of transport number of a cation and anion is unity. How would you measure transport number using Hittorf's method? 5

(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 $Ba(OH)_2$. 3

(c) State Kohlrausch's law. 2

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Student's Copy

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