

2022

(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. For a given gas, which of the following relationships is correct at a given temperature?

(a) $U_{\text{rms}} \quad U_{\text{avg}} \quad U_{\text{mp}} \quad (\quad)$

(b) $U_{\text{rms}} \quad U_{\text{avg}} \quad U_{\text{mp}} \quad (\quad)$

(c) $U_{\text{rms}} \quad U_{\text{avg}} \quad U_{\text{mp}} \quad (\quad)$

(d) $U_{\text{rms}} \quad U_{\text{avg}} \quad U_{\text{mp}} \quad (\quad)$

2. The numbers of translational, rotational and vibrational degrees of freedom respectively for H₂O molecules are

(a) 3, 3, 3 ()

(b) 3, 2, 1 ()

(c) 1, 2, 3 ()

(d) 2, 2, 2 ()

3. Bragg's equation for diffraction of X-rays is

- (a) $n \lambda = 2d \sin \theta$ ()
- (b) $n \lambda = 2d \sin^2 \theta$ ()
- (c) $\sin^2 \theta = n \lambda$ ()
- (d) $n \lambda = 2d \sin^2 \theta$ ()

4. Which of the following is true for hexagonal crystal system?

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

5. If the activation energy of reaction decreases, then the rate of reaction

- (a) becomes zero ()
- (b) decreases ()
- (c) increases ()
- (d) remains constant ()

6. The order of reaction is

- (a) never zero ()
- (b) never fractional ()
- (c) always equal to stoichiometric number of reactants ()
- (d) an experimentally determined quantity ()

7. Nernst heat theorem is applicable to

- (a) pure solids only ()
- (b) solids and liquids ()
- (c) solids, liquids and gases ()
- (d) pure gases only ()

8. The property of chemical potential is

- (a) intensive ()
- (b) extensive ()
- (c) exothermic ()
- (d) endothermic ()

9. The sum of the transport number of Na⁺ cation and Cl⁻ anion in NaCl solution is equal to
- (a) 0 ()
 - (b) 1 ()
 - (c) 0.5 ()
 - (d) 2 ()
10. Ostwald dilution law is valid only for
- (a) strong electrolytes ()
 - (b) weak electrolytes ()
 - (c) both strong and weak electrolytes ()
 - (d) None of the above ()

(SECTION : B—SHORT ANSWER)

(Marks : 15)

(Use of simple calculator is allowed)

Answer the following :

3×5=15

UNIT—I

1. Calculate the temperature at which the most probable velocity, the root-mean-square velocity and the average velocity of O₂ gas molecules are all equal to 1500 ms⁻¹.

OR

2. Calculate root-mean-square velocity, average velocity and most probable velocity of H₂ gas molecule at 0 °C.

UNIT—II

3. Define the following terms used in crystallography :

- (a) Face
- (b) Form
- (c) Crystal habit

OR

4. What is radius ratio? How does coordination number vary with the radius ratio?

UNIT—III

5. Write the difference between order and molecularity of a reaction.

OR

6. What is meant by rate of the reaction? Write rate law and define rate constant.

UNIT—IV

7. What do you understand by partial molar quantities?

OR

8. Define third law of thermodynamics and discuss its application in determination of entropy change.

UNIT—V

9. What is the effect of dilution on specific conductance?

OR

10. Write a note on asymmetry effect.

(SECTION : C—DESCRIPTIVE)

(Marks : 50)

Answer the following :

10×5=50

UNIT—I

1. (a) Give an account on Maxwell's distribution of molecular velocities. Explain how velocities change with temperature. 5
- (b) Define most probable velocity, average velocity and root-mean-square velocity. 3
- (c) The temperature of an ideal gas is raised from 27 °C to 927 °C. Calculate the ratio of final U_{rms} to the initial U_{rms} . 2

OR

2. (a) Derive the relationships among (i) most probable velocity, (ii) average velocity and (iii) root-mean-square velocity. 3
- (b) What is meant by degree of freedom of a molecule? How is this classified into different types? 1+4=5

- (c) Using the principle of equipartition of energy, estimate the energy of H₂O and CO₂ at room temperature, assuming that all the degrees of freedom are excited and contribute towards the energy of the molecules. 2

UNIT—II

3. (a) Explain the following terms : 3
(i) Plane of symmetry
(ii) Axis of symmetry
(iii) Centre of symmetry
(b) Explain the law of constancy of interfacial angles. 3
(c) Iron crystallizes in a b.c.c. system with $a = 2861 \text{ \AA}$. Molar mass of iron = 55.85 g mol⁻¹. Calculate the density of iron. 4

OR

4. (a) Describe the different types of unit cells (crystal systems). Calculate the number of atoms per unit cell in each of them. 6
(b) What are meant by space lattice and unit cell? 2
(c) Calculate the angle at which (i) first-order reflection and (ii) second-order reflection will occur in an X-ray spectrometer when X-rays of wavelength 1.54 Å are diffracted by the atoms of a crystal. Given that the interplanar distance is 4.04 Å. 2

UNIT—III

5. (a) Differentiate between homogeneous and heterogeneous catalyses. Give examples to illustrate your answer. 3
(b) Discuss the effect of temperature on the rate of reaction. 4
(c) Show that for a first-order reaction, the time required for 99% of the reaction to take place is about 10 times required for 50% completion. 3

OR

6. (a) Describe the Lindemann's theory of unimolecular reactions. 3
(b) What is enzyme catalysis? Explain the mechanism of enzyme reactions giving Michaelis-Menten equation. 1+4=5
(c) Write the units of the rate constants for the following : 2
(i) Zero-order reaction
(ii) Half-order reaction

UNIT—IV

7. (a) Describe Nernst heat theorem. What is residual entropy? 3+1=4
(b) Derive Gibbs-Helmholtz equation. 3
(c) What is meant by chemical potential? Derive an expression for the variation of chemical potential with temperature. 1+2=3

OR

8. (a) Define third law of thermodynamics. Show that the entropy of any substance at very low temperature, when Debye's relation for heat capacities of crystals is valid, is one-third of the molar heat capacity. 1+3=4
(b) How does work function vary with temperature and volume? 3
(c) Derive Gibbs-Duhem equation. 3

UNIT—V

9. (a) What are meant by specific, equivalent and molar conductances? 3
(b) What is meant by the term 'transport number'? Describe the determination of transport number by moving boundary method. 1+3=4
(c) During the electrolysis of a solution of potassium chloride between platinum electrodes, 0.0137 g of the chloride was lost from the anodic compartment and 0.0857 g of silver was deposited in a silver coulometer connected in series with the cell. Determine the transport number of K⁺ and Cl⁻ ions. (Equivalent weight of Cl = 35.5 and that of Ag = 108) 3

OR

10. (a) Discuss the variation of conductivity with concentration of strong electrolytes. 4
(b) State and explain Kohlrausch's law of independent migration of ions. Describe its one application. 2+1=3
(c) 0.5 normal solution of a salt placed between two electrodes 3 cm apart and area of cross-section 6 sq cm has a resistance of 25 ohms. Calculate the equivalent conductivity of the solution. 3
