

April, 2026

States of matter, and Ionic equilibrium

Full Marks : 100

Time : 3 hrs

Answer all the groups
Figures in the right hand margin indicate marks

PART-I

1. Answer all the all questions:

[10× 1=10]

- a. The number of collisions made by a gas molecule per second is known as _____.
- b. The velocity possessed by the maximum number of gas molecules is known as
 - i) Average velocity
 - ii) RMS velocity
 - iii) Most probable velocity
 - iv) Escape velocity
- c. The compressibility factor of an ideal gas is equal to _____.
- d. Surface tension of a liquid generally:
 - i) Increases with temperature
 - ii) Decreases with temperature
 - iii) Remains constant
 - iv) First increases then decreases
- e. The total number of Bravais lattices is:
 - i) 7
 - ii) 10
 - iii) 12
 - iv) 14
- f. Which defect arises due to the presence of a hole in the cationic site?
- g. Bragg's law is expressed as:
 - i) $\lambda = 2d \sin\theta$
 - ii) $n\lambda = 2d \sin\theta$
 - iii) $n\lambda = d \sin\theta$
 - iv) $\lambda = d \cos\theta$
- h. The unit of coefficient of viscosity is _____.
- i. The pOH of a Solution is 9, its pH value will be _____ ?
- j. Which substance on mixing with NH_4OH forms a buffer Solution ?

PART-II

2. Answer all the questions:

[9x2=18]

- a. What do you mean by mean free path ?
- b. Why real gases deviate from ideal behaviour ?
- c. State the Law of Equipartition of Energy.
- d. Explain the effect of temperature on the viscosity of liquids.
- e. Evaporation causes cooling- Explain.
- f. Calculate the Miller indices of crystal planes which cut through the crystal axes at (3a,b,c) of the Plane ?
- g. What do you mean by Plane of Symmetry ?
- h. Aqueous solution of Sodium acetate is alkaline in nature- Explain.
- i. Calculate the pOH of a 0.01 N HCl solution at 25°C.

PART-III

3. **Answer any Eight of the following questions :** [8x5=40]
- What is most probable velocity ? Calculate the temperature at which r.m.s. velocity of SO_2 gas will be same as that of O_2 at 27°C ?
 - Discuss the meanings of average velocity and root mean square velocity with their mathematical expressions.
 - Discuss in details Maxwell's distribution of molecular velocities. Illustrate the effect of temperature on this distribution.
 - Describe the Ostwald viscometer method for determination of viscosity of liquids.
 - Briefly describe the structure of water.
 - Define the pH of a solution. Calculate the pH of a decinormal H_2SO_4 solution at 25°C .
 - Write a note on cleansing action of detergents.
 - What are crystal defects? Differentiate stoichiometric and non-stoichiometric defects.
 - Write a note on Common ion effect.
 - Define degree of ionization ? Write the factors affecting degree of ionization.

PART-IV

4. **Answer any Four of the following questions:** [4x8=32]
- What are real gases ? Derive Vander Waals equation for 'n' moles of a real gas and explain the significance of its constants.
 - Discuss the factors on which the surface tension of the liquid depends. Describe a method to measure surface tension of a liquid.
 - State Bragg's law. Derive Bragg's equation for the determination of crystal structure.
 - What do you mean by degree of hydrolysis ? Derive mathematical expression for degree of hydrolysis, hydrolysis constant & pH of an aqueous solution of CH_3COONa .
 - Write a note on buffer solution. Derive the Henderson-Hasselbalch equation for an acidic and basic buffer.

APRIL, 2026

Chemical thermodynamics, equilibrium, and Colligative property

Full Marks : 100

Time : 3 hrs

Answer all the parts
Figures in the right-hand margin indicate marks

PART-I

1. Answer all questions or fill in blanks as required: [10×1=10]

- a. A system which can neither exchange matter nor energy with the surrounding is called as _____ System?
- b. In an isothermal process _____ of the system remains constant.
- c. What is the unit of entropy ?
- d. The efficiency of heat engine is always :
i) 0 ii) < 1 iii) > 1 iv) 1
- e. For the reaction $\text{PCl}_3 + \text{Cl}_2 \rightleftharpoons \text{PCl}_5$, increase in pressure favours _____ reaction.
- f. The entropy of a perfect crystal at absolute zero is:
i) Infinite ii) Unity iii) Zero iv) Negative
- g. The Second Law of Thermodynamics introduces the concept of:
i) Enthalpy ii) Entropy iii) Heat capacity iv) Internal energy
- h. The entropy change (ΔS) for the reaction, $\text{N}_2\text{O}_4 (\text{g}) \xrightarrow{\text{Heat}} 2\text{NO}_2 (\text{g})$ is :
i) +Ve ii) -Ve iii) Zero iv) None of these
- i. When a small amount of non-volatile solute is added to a pure solvent, the boiling point of resulting dilute solution _____ ?
i) Increases ii) decreases iii) remains the same iv) None of these
- j. Which of the following is not a colligative property?
i) Osmotic pressure ii) Elevation in boiling point
iii) Depression in freezing point iv) Surface tension

PART-II

2. Answer all the questions: [9×2=18]

- a. What are state and path functions ?
- b. State and explain 1st law of Thermodynamics.
- c. Two moles of an ideal gas expand reversibly at 300K from a volume of 10 L to 20 L. Calculate the work done.
- d. Explain the term fugacity.
- e. Between one mole of O_2 at 25°C and one mole of O_2 at 45°C, which has higher entropy and why ?
- f. What are reversible reactions? Give an example.

- g. Explain the term osmotic pressure ?
- h. What is Henry's law ? Give one of its applications.
- i. When a nonvolatile solute is added to a pure solvent, there will be depression in freezing point – why?

PART-III

3. Answer any Eight of the following questions: [8x5=40]

- a. Define enthalpy of formation and enthalpy of combustion.? Give an example from each.
- b. Explain adiabatic process and derive the expression - $PV^\gamma = \text{Constant}$
- c. Derive the relationship between heat capacities at constant pressure (C_p) and constant volume (C_v).
- d. Justify the statement- “ Entropy of the Universe is increasing”.
- e. What are spontaneous and non-spontaneous processes? Give examples.
- f. What do you mean by efficiency of a heat engine ? Calculate the efficiency of a heat engine which operates between 400 K & 300 K ?
- g. State the Third Law of Thermodynamics and explain residual entropy.
- h. What is relative lowering in vapour pressure ? Derive the relation between relative lowering of vapour pressure and mole fraction of solute.
- i. What do you mean by Chemical potential ? Derive Gibbs Duhem equation ?
- j. Discuss the effect of change of temperature and Pressure on the following system at equilibrium: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$, $\Delta H = -Ve$

PART-IV

4. Answer any Four of the following questions: [4x8=32]

- a. What is enthalpy of a reaction? Derive Kirchoff's equation showing variation of heat of reaction with temperature.
- b. Derive the expression for the efficiency of a heat engine operating between two temperatures T_1 & T_2 ($T_2 > T_1$). State and explain - Carnot's theorem?
- c. Derive the relationship between Gibb's free energy of a reaction and reaction quotient thermodynamically.
- d. What is law of chemical equilibrium ? Derive the thermodynamic relationship among the equilibrium constants K_p , K_c and K_x .
- e. What do you mean by elevation in boiling point in dilute solution and derive an expression for elevation in boiling point thermodynamically.

APRIL, 2026
Fundamental Organic Chemistry

Full Marks: 100

Time: 3 hrs

answer all the parts
Figures in the right-hand margin indicate marks

PART-I

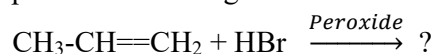
1. Answer all questions or fill in blanks as required. [10 × 1=10]

- a. Which of the following has the maximum - I effect power ?
i) F ii) Cl iii) Br iv) I
- b. The optical isomers that are not mirror images are called _____ ?
- c. Which of the following is an electrophile ?
i) NO_2^+ ii) Cl^- iii) H_2O iv) NH_3
- d. Name the electrophile in the process of Sulphonation of Benzene ?
- e. The permanent electron displacement effect is _____
i) Inductive effect ii) Electromeric effect iii) Isomerism iv) None of these
- f. The shape of Carbonium ion is _____ ?
- g. From the following which compound has chiral atom :
i) CH_2Cl_2 ii) CH_3Cl iii) $CHCl_3$ iv) $CHClBr$
- h. When ethyl iodide is heated with alcoholic KOH, we get :
i) Ethyl alcohol ii) Ethylene iii) Acetylene iv) Ethane
- i. Which of the following can not be prepared by Wurtz reaction ?
i) CH_4 ii) C_2H_6 iii) C_3H_8 iv) C_4H_{10}
- j. Which reaction introduces an acyl group into benzene?
i) Nitration ii) Sulphonation iii) Friedel–Crafts acylation iv) Halogenation

PART-II

2. Answer all the questions : [9x2=18]

- a. What are meso compounds?
- b. Why Chloro acetic acid is more acidic than acetic acid ?
- c. What happens when But-2-ene undergoes Ozonolysis ?
- d. Explain Hofmann elimination reaction with an example?
- e. Why acetylinic hydrogens are acidic in nature ?
- f. Between Chair form and Boat form of Cyclohexane, which is more stable and why ?
- g. What is Huckel's rule ?
- h. Draw Newman projection formula of ethane in staggered and eclipsed conformations.
- i. How can acetylene be prepared from calcium carbide?
- j. Complete the following reaction :



PART-III

3. **Answer any Eight of the following questions** **[8x5=40]**
- Write a note on - Inductive effect ?
 - Explain mesomeric effect in Aniline and Nitrobenzene.
 - Write a note on E₁CB reaction ?
 - Explain the Wurtz reaction and Corey-House reaction for the preparation of alkanes.
 - Explain 1,2- and 1,4-addition in conjugated dienes.
 - Discuss the sulphonation of Benzene with mechanism.
 - Explain Friedel-Crafts alkylation with mechanism.
 - Explain hydroboration-oxidation with mechanism
 - Explain why cyclohexane is more stable than cyclobutane.
 - Discuss the conformation of ethane with relative stabilities with energy profile diagram?

PART-IV

4. **Answer any four of the following questions:** **[4x8=32]**
- What are Carbonium ions? Discuss the relative stabilities of primary, secondary and tertiary Carbonium ions?
 - What is optical isomerism and what are the necessary conditions of optical isomerism?
Discuss optical isomerism by giving an example.
 - Write notes on:
 - Diels-Alder reaction
 - Saytzeff rule
 - Explain - Baeyer strain theory? Write its limitations.
 - Discuss the conformation of n-butane and explain their relative stabilities with energy profile diagram?
