

2023

Time - 3 hours

Full Marks - 60

Answer all groups as per instructions.

Figures in the right hand margin indicate marks.

*Candidates are required to answer
in their own words as far as practicable.*

GROUP – A

1. Fill in the blanks. (all) [1 × 8]
- (a) Methylamine is _____ basic than ammonia.
- (b) Aliphatic carbocations are stabilised by _____.
- (c) Between different Newman conformations of n-butane, _____ is most stable conformation.
- (d) _____ are stereoisomers which are not mirror images of each other.
- (e) Alkyl halides is which both hydrogen and halogen are removed together to give an alkene is _____ mechanism.
- (f) Diels-Alder reaction is _____ addition reaction.
- (g) Meso structures contain _____ element of symmetry.

[2]

- (h) Between benzoic acid and o-hydroxy benzoic acid, _____ is more acidic.

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8]

- (a) Why propene is more stable than ethene ?
- (b) Between fumaric acid and maleic acid, which has higher dipole moment and why ?
- (c) Explain why phenol is acidic ?
- (d) Between OH^- and OCH_3^- , which is stronger nucleophile and why ?
- (e) What is racemic mixture ? Give example.
- (f) Differentiate between relative and absolute configuration.
- (g) Give an example of Hofmann elimination.
- (h) What happens when acetylene is hydrolysed in presence of HgSO_4 ?
- (i) Between chair, boat and twist boat forms of cyclohexane, which is more stable and why ?

- (j) Give an example of 1,4-addition reactions in conjugated dienes.

GROUP – C

3. Answer any eight of the following questions within 75 words each.

[2 × 8

- (a) Between benzyl carbocation and propyl carbocation, which is more stable and why ?
- (b) What is the difference between Inductive Effect and Electromeric Effect ?
- (c) Draw the possible hyper conjugative structures of n-propyl and iso-propyl carbocation and state which is more stable.
- (d) Find out the differences between (i) 'd' and 'D' and (ii) 'l' and 'L'.
- (e) Draw different Newmann conformations of n-butane.
- (f) Differentiate between meso isomer and racemic mixture.
- (g) How can you synthesise propanol from propene ?
- (h) What is oxymercuration-demercuration reaction giving an example.
- (i) Draw the different forms of cyclohexane.
- (j) How can you prepare acetaldehyde starting from but-2-ene ?

[4]

GROUP – D

4. Answer any four of the following questions.

(a) Write notes on :

[3 × 2

(i) Huckel's rule

(ii) Reactive intermediates

(b) Describe Wurtz reaction, its mechanism, applications and disadvantages

[2 + 2 + 2

(c) Write notes on :

[3 × 2

(i) Optical isomerism

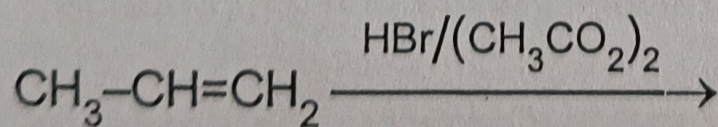
(ii) Electrophilic Aromatic Substitution reaction

(d) (i) Draw and explain the M.O. Structure of Pyrrole [3

(ii) Write a note on cis-trans isomerism. [3

(e) (i) Give the differences between E₁ and E₂ reactions. [3

(ii) Complete the reaction, giving a possible mechanism for it :



[3

(f) Write notes on :

[3 × 2

(i) Stability of cycloalkanes

(ii) Friedel-Craft's reaction

[5]

- (g) (i) Discuss the acidity of ethylene and acetylene hydrogen. [2]
- (ii) What happens when propyl amine is treated with excess methyl iodide and moist silver oxide. [2]
- (iii) How can you prepare toluene starting from benzene. [2]

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GROUP - A

1. Fill in the blanks. (all)

[1 × 8

- (a) For a reaction to take place, $\Delta G =$ _____.
- (b) A system which exchanges energy but not matter with surroundings is called _____.
- (c) In a spontaneous process, entropy of the process _____.
- (d) Entropy of H_2 is finite at absolute zero temperature. It is an example of _____ entropy.
- (e) The phenomenon in which in a binary solution the chemical potential of one component affects the value of other component is called _____.

[2]

- (f) The ratio of molar concentrations of the product to reactant species at any stage of a reaction is called _____.
- (g) The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid is called _____.
- (h) Boiling point elevation of a liquid is _____ proportional to the number of moles of solute dissolved in the liquid.

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8

- (a) Define extensive property.
- (b) What is an adiabatic process ?
- (c) Give one limitation of second law of thermodynamics.
- (d) Define irreversible process in thermodynamic system.
- (e) What is inversion temperature ?
- (f) Give the integrated form of Van't Hoff equation and explain the terms involved.
- (g) State chemical potential in a mixture of ideal gases.
- (h) What do you understand by colligative properties of dilute solutions ?

[3]

- (i) What are the necessary conditions for the solution to be ideal ?
- (j) Give the thermodynamic derivation of Raoult's law.

GROUP – C

3. Answer any eight of the following questions within 75 words each.

[2 × 8

- (a) State what are state of systems and state variables. Give examples of each.
- (b) Differentiate between Reversible and Irreversible processes.
- (c) Describe 'Efficiency of a heat engine'.
- (d) Calculate the entropy change (ΔS) in the melting point of 1gm of ice at 0°C , latent heat of fusion of ice is $1440\text{ Cal. mol}^{-1}$.
- (e) Describe the industrial applications of Le-Chatelier's principle.
- (f) Give the significance of entropy.
- (g) The freezing point of pure benzene is 5.4°C and that of solution containing 2.0 gm of solute per 100 gm of benzene is 4.4°C . Calculate the molecular mass of the solute ($K_f = 50$).
- (h) What do you mean by exo-osmosis, endo-osmosis and reverse osmosis ?
- (i) Show that elevation of boiling point is a colligative property.

P.T.O.

- (j) Distinguish between Gibb's free energy and Helmholtz free energy.

GROUP – D

4. Answer any four of the following questions within 500 words each.

- (a) Define Bond energy. Calculate the bond energy of H–Br bond in Hydrogen bromide at 25⁰ C. Heat of formation of HBr, hydrogen atom and bromine atom is –8.66 kCal, 52.1 kCal and 26.7 kCal respectively. [1 + 5]
- (b) Derive adiabatic equation of state $PV^\gamma = \text{constant}$. [6]
- (c) State the limitations of first law of thermodynamics and how it was overcome by second law of thermodynamics. [3 + 3]
- (d) State and explain Carnot's cycle and derive an expression for the efficiency of a reversible heat engine using it. [2 + 4]
- (e) Describe the characteristics of Equilibrium constant. Derive a relation between K_p and K_c for the reaction :

$$aA + bB \rightleftharpoons cC + dD.$$
 [2 + 4]
- (f) Derive Van't Hoff equation and give its significance. [6]
- (g) Define Raoult's law. 2.5 gm of a substance with molecular mass 200 have been dissolved in 50 gm of the solvent (molecular mass = 60 and vapour pressure = 40 cm). Find the vapour pressure of the solution. [2 + 4]

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GROUP – A

1. Answer all questions and fill in blanks as required. [1 × 8]

(a) The expression for uncertainty principle is given by _____.

(b) Electromagnetic radiation with highest wavelength is _____.

(c) The presence of three unpaired electrons in the nitrogen atom can be explained by _____ principle.

(d) Which of the following is least ionic ?

AgCl, KCl, BaCl₂ and COCl₂

(e) Which rule determines the extent of polarisation of an anion by a cation ?

- (f) Which is more acidic – Ethanoic acid or Propanoic acid ?
- (g) Between cis and trans 1,2-dichloro ethene, which has a higher dipole moment ?
- (h) In elimination reaction of alkyl halides, according to which rule the double bond goes to highly substituted carbon atoms ?

GROUP – B

2. Answer any eight of the following questions within two to three sentences each. [1½ × 8

- (a) Give any two limitations of Bohr's theory.
- (b) Determine the 'n', 'm' and 'l' values of an electron present in outer most shell of sodium atom.
- (c) Write the electronic configuration of Cr^{2+} ion.
- (d) In terms of lattice energy and hydration energy, what is the condition for an ionic compound to be soluble in water ?
- (e) What is Fajan's rule ?
- (f) What is the bond order of nitrogen molecule ?
- (g) Define nucleophile. Give an example.
- (h) Arrange the different types of carbocations in order of stability.

[3]

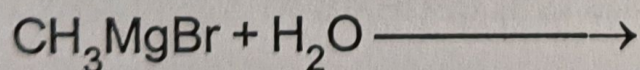
- (i) Draw the Newman, Sawhorse and Fischer projections of n-butane.
- (j) How can you prepare propyne from ethyne ?

GROUP – C

3. Answer any eight of the following questions within 75 words each.

[2 × 8

- (a) Write Schrodinger wave equation and explain the meaning of the terms used in the equation.
- (b) Explain the physical significance of ψ and ψ^2 .
- (c) Define lattice energy of a solid ? Give an example.
- (d) State two rules for LCAO method.
- (e) Between ammonia and aniline, which is more basic and why ?
- (f) Meso tartaric acid has chiral carbon atoms but it does not rotate the plane of plane polarised light. Explain.
- (g) Complete the reaction giving a mechanism

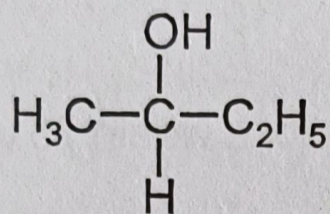


- (h) What happens when ethene is passed through Bayer's reagent ?

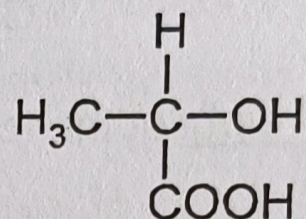
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[4]

- (i) How can you distinguish between but-1-ene and but-2-ene by a chemical reaction ?
- (j) Assign R, S notations to the following :



(I)



(II)

GROUP – D

4. Answer any four of the following questions.

- (a) (i) Describe the shapes of 1s and 2s orbitals. What is the basic difference between their shapes ? [3]
- (ii) What do you understand by Hund's rule of maximum multiplicity ? Discuss this rule by taking examples. [3]
- (b) (i) Explain how Born-Haber cycle is used to calculate the lattice energy of NaCl. [3]
- (ii) Explain why the melting point of NaCl is higher than that of AlCl_3 . [3]
- (c) (i) Bring out the differences between the valence bond and molecular orbital theories. [3]

[5]

- (ii) With the help of MO diagram, explain that the bond length of CO^+ is larger than that of CO . [3]
- (d) (i) State and explain Huckel's rule for aromaticity. [3]
- (ii) Explain why benzene undergoes electrophilic substitution reaction whereas, alkenes undergo addition reactions. [3]
- (e) Write notes on any two of the followings : [3 × 2]
- (i) Resonance
- (ii) Inductive Effect
- (iii) Hyperconjugation
- (f) (i) Write a note on carbocations and their stability. [3]
- (ii) What are electrophiles and nucleophiles ? Give examples of each. [3]
- (g) Write notes on any two of the followings : [3 × 2]
- (i) Acidity of acetylene hydrogen
- (ii) Ozonolysis of alkenes and alkynes
- (iii) Electrophilic and free radical addition reactions of unsaturated hydrocarbons