Competency Based Questions Chemistry-XII

Gajendra L Kapde TA [Chemistry]

This Booklet contains chapter wise Competency Based Questions for class XII - Chemistry 2025-26

KVS ZIET MUMBAI

NCH Colony
Kanjurmarg(West)
Mumbai-400078

022-20858264

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QUESTION BANK

COMPETENCY BASED QUESTIONS FOR

CLASS-XII:-CHEMISTRY

CONTENT

CLASS- XII : CHEMISTRY

COMPETENCY BASED QUESTIONS

CHAPTER: 1 – SOLUTION

The questions are designed in order to assess and evaluate the learning in following competencies :
Conceptual Understanding,
Application,
Problem-Solving,
Critical Thinking,
Real-World Connection,
Experimental Design,
Data Interpretation,
Synthesis.

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1. Explain the difference between molarity and molality. How does temperature affect each of these concentration terms?
2. A solution contains 5% by mass of urea (CH_4N_2O) in water. Calculate the molarity of the solution, given that the density of the solution is 1.10 g/mL.
3. If a solution shows an elevation in boiling point of 0.52 K, calculate the molar mass of the solute. The ebullioscopic constant (K_b) for water is 0.52 K kg/mol and the mass of solute used is 2 g in 100 g of water.
4. A solution is prepared by dissolving 10 grams of NaCl in 90 grams of water. Calculate the molality of the solution. (Molar mass of NaCl = 58.44 g/mol)
5. Calculate the boiling point elevation for a 0.2 m aqueous solution of NaCl. Assume complete dissociation of NaCl. The boiling point elevation constant (Kb) for water is 0.52°C/m.
6. Calculate the mole fraction of solute and solvent in a solution containing 900 g of glucose ($C_6H_{12}O_6$) and 95 moles of water.
7. Given the vapor pressure of pure water at 298 K is 23.8 mm Hg, and a solution has a vapor pressure of 22.8 mm Hg, calculate the mole fraction of solute in the solution.
8. Why do ionic compounds generally exhibit a higher boiling point elevation or freezing point depression compared to non-electrolyte solutions?
9. Why Osmotic pressure is used over other colligative properties to determine the molar mass of the proteins/macromolecules? Support your answer with the relevant facts.
10. Determine the osmotic pressure of a 0.1 M solution of glucose at 298 K. (R = 0.0821 L atm/mol/K)

11. Evaluate why non-volatile solutes decrease the vapor pressure of a solvent, and how this affects the boiling point and freezing point of the solution.
12. Critically analyze why ionic compounds produce a greater effect on colligative properties compared to non-electrolyte solutions.
13. Discuss how colligative properties are utilized in real-life scenarios, such as in antifreeze solutions or in the preservation of food.
14. Design an experiment to determine the molar mass of an unknown solute using the freezing point depression method. Outline the procedure and the calculations required.
15. Explain the term "molality" and describe how it differs from molarity. Provide an example to illustrate the difference.
16. How would you differentiate between an ideal and a non-ideal solution? Provide examples and discuss the deviations from Raoult's Law.
17. Derive the relation between relative lowering of vapour pressure and mole fraction of solute for a dilute solution.
18. Given the vapour pressure of pure water at 25°C is 23.8 mmHg, and a solution contains 1 mole of urea (a non-volatile solute) in 1000 g of water. Calculate the vapour pressure of the solution.
19. Design an experiment to determine the molar mass of an unknown solute using the elevation in boiling point method.
20. Outline the steps and necessary precautions. Devise a method to prepare a 1 L solution of 0.5 M NaOH from a 1 M stock solution.

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CHAPTER: 2 – ELECTROCHEMISTRY

The questions are designed in order to assess and evaluate the learning in following competencies :
Conceptual Understanding,
Application,
Problem-Solving,
Critical Thinking,
Real-World Connection,
Experimental Design,
Data Interpretation,
Synthesis, Case-Based Question,
HOTS Question, Assertion-Reasoning.

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1. Explain the differences between galvanic cells and electrolytic cells with suitable examples. What are the key components of each type of cell?
2. A copper rod is placed in a 1 M copper sulfate solution, and a zinc rod is placed in a 1 M zinc sulfate solution. They are connected by a salt bridge. Write the cell reaction and calculate the standard cell potential.
   (Given: $E°(Zn^{2+}/Zn) = -0.76$ V, $E°(Cu^{2+}/Cu) = +0.34$ V)
3. Calculate the equilibrium constant (K) for the following reaction at 298 K: $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$ (Given: $E°(Zn^{2+}/Zn) = -0.76$ V, $E°(Cu^{2+}/Cu) = +0.34$ V, F = 96485 C/mol)
4. Discuss why a salt bridge is used in a galvanic cell. What would happen if it is not used?
5. Interpret the following data and predict which metal will be deposited at the cathode in an electrolytic cell containing Cu^{2+} and Ag^{+} ions:

$E°(Cu^{2+}/Cu) = +0.34$ V $E°(Ag^{+}/Ag) = +0.80$ V

6. Describe an experiment to determine the molar conductivity of a strong electrolyte at different concentrations. How does molar conductivity vary with concentration for strong electrolytes?
7. Explain how the concept of electrolysis is applied in the extraction of aluminum from its ore. Include the reactions involved.
8. A galvanic cell is set up with the following half-reactions:

$Fe^{3+} + e- \rightarrow Fe^{2+}$ $E° = +0.77$ V

$I_2 + 2e- \rightarrow 2I$; $E° = +0.54$ V

Calculate the standard cell potential and predict whether the cell will operate spontaneously.

9. Given the conductivity of a 0.1 M solution of acetic acid is 4.6×10^{-5} S cm^{-1} and the molar conductivity at infinite dilution (Λ^0_m) is 390.5 S cm^2 mol^{-1}, calculate the degree of dissociation of acetic acid.
10. A car battery is an example of a lead-acid cell. After prolonged use, the battery stops functioning. Based on your understanding of electrochemistry, explain why this happens. Suggest ways to increase the lifespan of the battery.
11. A scientist is conducting an experiment with a Daniell cell, where a copper electrode is immersed in $CuSO_4$ solution, and a zinc electrode is immersed in $ZnSO_4$ solution. He observes that the voltage drops over time.

(a) Explain why the voltage decreases over time.
(b) How can the scientist restore the original voltage of the cell?
(c) Write the cell reaction and the standard cell potential for the Daniell cell.

12. Justify why fuel cells are considered more efficient and environmentally friendly compared to conventional combustion-based power generation. Include the working principle of a hydrogen-oxygen fuel cell.
13. Electrolysis of molten NaCl produces Na metal and Cl_2 gas, while electrolysis of aqueous NaCl produces H_2 gas at the cathode instead of Na metal. Explain the reason behind this difference using electrochemical principles.
14. A student performs an experiment to determine the resistance of a solution using a conductivity meter. She observes that resistance decreases with increasing temperature. Justify this observation based on the movement of ions in solution.
15. A fuel cell using hydrogen and oxygen is known for its high efficiency. Write the half-cell reactions and the overall reaction occurring in a hydrogen-oxygen fuel cell. Explain why fuel cells are considered a better alternative to conventional energy sources.
16. Calculate the standard Gibbs free energy change ($\Delta G°$) for the following redox reaction at 298 K:

$Zn(s)+Cu^{2+}(aq) \rightarrow Zn^{2+}(aq)+Cu(s)$

Given: Standard electrode potential for Zn^{2+}/Zn = **-0.76 V** and for Cu^{2+}/Cu = **+0.34 V**

($F = 96500$ C mol^{-1})

17. Assertion – Reason type question.

Assertion (A): Conductivity of a solution decreases with dilution.
Reason (R): Number of charge carriers per unit volume decreases upon dilution.

(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A is incorrect, but R is correct.

18. A researcher is studying corrosion of iron in a coastal region. He observes that iron rusts faster in humid and salty conditions compared to dry inland areas.

(a) Explain the electrochemical mechanism of rusting.
(b) How does the presence of salt accelerate the corrosion process?
(c) Suggest methods to prevent the corrosion of iron.

19. In industries, electroplating is used to coat cheaper metals with expensive metals like silver or gold. Explain the electrochemical principle behind electroplating and mention the role of the anode, cathode, and electrolyte in the process.

20. A voltaic cell is set up using two metal electrodes: Fe and Ag, with their respective salt solutions. The standard electrode potentials are:

- **Fe^{2+}/Fe = -0.44 V**
- **Ag^{+}/Ag = +0.80 V**

(a) Identify the anode and cathode in this cell.
(b) Write the overall redox reaction and calculate the standard EMF of the cell.
(c) Will this reaction be spontaneous? Justify your answer using Gibbs free energy equation.

CHAPTER: 3 – CHEMICAL KINETICS

The questions are designed in order to assess and evaluate the learning in following competencies :
Conceptual Understanding,
Application,
Problem-Solving,
Critical Thinking,
Real-World Connection,
Experimental Design,
Data Interpretation,
Synthesis,
Case-Based Question,
HOTS Question, Assertion-Reasoning.

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1. Explain the concept of reaction rate and how it can be determined experimentally.
2. Differentiate between zero-order, first-order, and second-order reactions with suitable examples and mathematical expressions.
3. Derive the integrated rate equation for a first-order reaction and explain its significance.
4. What is the half-life of a reaction? Derive the expression for the half-life of a first-order reaction.
5. Explain the effect of temperature on the rate of reaction using the Arrhenius equation. How is the activation energy determined experimentally?
6. Discuss the collision theory of chemical reactions and its importance in understanding reaction rates.
7. Enumerate and explain the factors that affect the rate of chemical reactions with examples.
8. Draw and explain the graphical representation of concentration vs. time for zero-order and first-order reactions.
9. Sketch and explain the graphical representation of concentration vs. time for zero-order, first-order, and second-order reactions. Highlight key differences in the graphs.
10. How do catalysts influence the rate of reaction? Explain with reference to the energy profile diagram.
11. Describe how the principles of chemical kinetics are applied in real-life scenarios, such as pharmaceuticals or industrial processes.
12. A reaction A → B has a rate law: Rate = k[A]^2. If the initial concentration of A is 0.5 M and the rate constant k is 0.02 L mol^{-1} s^{-1}, calculate the initial rate of the reaction.
13. Determine the order of the reaction for the following rate law: Rate = k[A]^1[B]^2. Explain how the order affects the overall reaction rate.

14. Using the Arrhenius equation, explain how an increase in temperature affects the rate of a chemical reaction. Provide an example calculation showing the effect of a 10°C increase on a reaction with an activation energy of 50 kJ/mol.
15. Derive the formula for the half-life of a first-order reaction and calculate the half-life for a reaction with a rate constant of 0.693 min^{-1}.
16. Describe the role of a catalyst in a chemical reaction. How does it alter the activation energy and reaction mechanism?
17. Derive the integrated rate law for a first-order reaction and use it to calculate the time required for the concentration of a reactant to decrease from 1.0 M to 0.25 M. The rate constant k is 0.1 s^{-1}.
18. Explain the collision theory of chemical reactions. What factors determine whether a collision between reactant molecules will result in a reaction?
19. Using the concept of temperature dependence, explain how the rate of a reaction changes with varying temperature. Provide a real-world example where this knowledge is applied.
20. Explain the concept of a pseudo first-order reaction with an example. Why certain reactions are considered pseudo first-order even though they involve more than one reactant?

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CHAPTER: 4 – d & f-BLOCK ELEMENT

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Redox reactions, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

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d-Block Elements:

1. Explain why transition metals exhibit variable oxidation states. Provide examples of two elements and their common oxidation states to illustrate your answer.
2. Transition metal compounds are often colored. Explain this phenomenon using crystal field theory. Provide examples of colored compounds and their respective colors.
3. Describe the catalytic behavior of transition metals and their compounds. Explain why they are effective catalysts with suitable examples.
4. Discuss the magnetic properties of transition metals and their compounds. How does the number of unpaired electrons affect their magnetic behavior?
5. Explain why transition metals readily form complexes. Discuss the role of ligands and the d-orbitals in complex formation with examples.
6. The d-block elements exhibit a variety of oxidation states. Explain this variability with examples from the 3d series. How does this property influence their chemical behavior?
7. Discuss the magnetic properties of d-block elements. Why do some d-block elements show paramagnetism while others exhibit diamagnetism? Provide examples.
8. Explain why many d-block elements and their compounds act as good catalysts. Provide examples of industrial processes where these catalysts are used.
9. Describe the ability of d-block elements to form complex compounds. What role do the d-orbitals play in this property? Provide examples of coordination complexes.
10. Why do d-block elements readily form alloys? Discuss the factors that contribute to this ability and provide examples of important alloys and their applications.

f-Block Elements:

11. What is the lanthanide contraction? Discuss its causes and consequences on the chemical properties of lanthanides.
12. Compare the actinides with the lanthanides in terms of their electronic configurations, oxidation states, and reactivity.

13. Describe the methods used for the separation of lanthanides. Why is their separation challenging?
14. Discuss the industrial and medical applications of f-block elements, providing specific examples for both lanthanides and actinides.
15. Explain why most actinides are radioactive. Discuss the implications of their radioactivity on their use and handling.
16. Describe the general electronic configuration of f-block elements. How does the filling of f-orbitals differ in the lanthanide and actinide series?
17. What is lanthanide contraction? Discuss its causes and consequences on the properties of elements following the lanthanide series.
18. Compare the chemical reactivity and oxidation states of actinides with lanthanides. What makes actinides more radioactive than lanthanides?
19. Explain the challenges involved in the separation of lanthanides. Discuss the methods used to achieve this separation, such as ion exchange and solvent extraction.
20. Discuss the applications of lanthanides and actinides in modern technology. Include examples from fields such as medicine, energy, and materials science.

Potassium Permanganate ($KMnO_4$):

21. Explain how potassium permanganate acts as an oxidizing agent in acidic, neutral, and basic mediums. Provide balanced chemical equations for each medium.
22. Describe the steps involved in a redox titration using potassium permanganate as the titrant. How would you determine the endpoint?
23. Discuss the use of potassium permanganate in the treatment of wastewater. What properties make it suitable for this application?
24. How can potassium permanganate be used in qualitative analysis to test for the presence of iron(II) ions? Write the reaction and explain the color change observed.
25. Write the balanced chemicalat are the products formed?

Potassium Dichromate ($K_2Cr_2O_7$):

26. Potassium dichromate is used as an oxidizing agent. Provide a balanced chemical equation where it oxidizes hydrogen sulfide (H_2S) in an acidic medium. Explain the color change.
27. Discuss the role of potassium dichromate in the tanning of leather. What chemical properties make it effective for this process?

28. Describe how potassium dichromate can be used in a voltaic cell. What is its role in the cell?

29. Potassium dichromate is toxic and poses environmental hazards. Discuss the precautions that should be taken when handling it and the methods used for its disposal.

30. Explain the chromyl chloride test for chloride ions using potassium dichromate. Write the balanced chemical equation for the reaction and describe the observations.

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CHAPTER: 5 – COORDINATION COMPOUNDS

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Redox reactions, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

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1. Explain the following terms with suitable examples:
    - Ligands
    - Coordination number
    - Chelation
2. What is the difference between a double salt and a coordination compound? Provide examples of each.

3. A coordination compound of chromium (III) chloride with ammonia has the molecular formula $[Cr(NH_3)_6]Cl_3$. Calculate the number of ions produced in solution when this compound dissociates.
4. Explain the geometrical structure and hybridization of $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ using VBT and CFT.

5. Predict the magnetic behavior (paramagnetic or diamagnetic) of the following complexes and justify your answer:
    - $[Fe(CN)_6]^{3-}$
    - $[Fe(H_2O)_6]^{2+}$
6. Given two complexes, $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$, explain which one will have a higher crystal field splitting energy and why.

7. Design a coordination complex with the formula $[M(en)_2Cl_2]$ where M is a metal ion. Write down all possible isomers and explain the type of isomerism exhibited.
8. Propose a synthesis route for $[Cu(NH_3)_4]SO_4$. Include all necessary reagents and steps involved in the synthesis.

9. Compare the stability of $[Fe(CN)_6]^{3-}$ and $[Fe(H_2O)_6]^{3+}$ in terms of the crystal field stabilization energy (CFSE). Which complex is more stable and why?
10. Critically evaluate the importance of coordination compounds in biological systems with at least two specific examples.

11. Explain the terms 'coordination entity,' 'central atom/ion,' and 'ligand' with suitable examples from coordination compounds.
12. Using VSEPR theory, predict the geometry of the complex ion $[PtCl_4]^{2-}$ and explain your reasoning.
13. Write the IUPAC name for the complex compound $[Co(NH_3)_5Cl]Cl_2$ and explain the naming process.
14. Describe Werner's theory of coordination compounds with an example. How did this theory help in understanding the structure of coordination compounds?
15. Differentiate between geometric and optical isomerism with suitable examples from coordination compounds.
16. Explain the splitting of dd-orbitals in an octahedral crystal field and how it leads to the formation of high-spin and low-spin complexes.
17. Discuss the role of coordination compounds in biological systems, providing specific examples such as hemoglobin or chlorophyll.
18. Explain how the magnetic properties of $[Fe(CN)_6]^{4-}$ and $[FeF_6]^{3-}$ differ, based on their electronic configurations and crystal field splitting.
19. What factors affect the stability of coordination compounds in aqueous solutions? Provide examples to support your answer.
20. Describe a ligand substitution reaction with a suitable example. How does the nature of ligands influence the rate of substitution?

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CHAPTER: 6 – HALOALKANES AND HALOARENES

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Redox reactions, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

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1. Describe the mechanism of nucleophilic substitution reactions in haloalkanes, providing an example for both SN1 and SN2 mechanisms.
2. Compare the physical properties of haloalkanes with their corresponding alkanes. Focus on boiling points and solubility.
3. Predict the major product when 2-bromo-2-methylpropane is treated with alcoholic KOH. Explain the mechanism involved.
4. A student is given a mixture of chloroform and benzene. Suggest a method to separate them and justify your choice.
5. Explain why iodoform (CHI_3) is used as an antiseptic, and describe the iodoform test used to identify methyl ketones.
6. Write the structural formula of p-bromoaniline. Discuss the effect of the bromine substituent on the reactivity of the benzene ring.
7. Discuss why haloalkanes are more reactive than their corresponding alkanes towards nucleophilic substitution reactions.
8. Explain the environmental impact of chlorofluorocarbons (CFCs) and describe the measures taken to reduce their usage.
9. Why is it important to avoid the use of carbon tetrachloride (CCl_4) as a cleaning agent? Discuss its health and environmental hazards.
10. Design a synthesis pathway for the preparation of 1-bromopropane from propane. Include all necessary reagents and conditions.
11. A student is provided with an organic compound and asked to identify the mechanism of nucleophilic substitution it undergoes. The compound reacts with sodium hydroxide and forms an alcohol. Based on the product and conditions, explain whether the reaction proceeds via the SN1 or SN2 mechanism. Justify your answer.
12. Chlorofluorocarbons (CFCs) are commonly used in refrigeration and air conditioning. However, they are harmful to the environment. Discuss the role of CFCs in ozone layer depletion. What alternatives have been developed, and how do they compare in terms of environmental impact?

13. A compound reacts with sodium in dry ether to form a product. Based on the reaction mechanism and product, explain the structure of the original compound. Provide an example of a similar reaction and discuss its significance.
14. Explain why alkyl iodides are more reactive than alkyl chlorides in nucleophilic substitution reactions. Provide an example to illustrate the difference in reactivity.
15. A student is asked to prepare 1-bromopropane from propane. List the reagents and conditions required for this conversion. Also, explain the type of reaction involved and any possible side reactions.
16. Discuss the electrophilic substitution reaction of chlorobenzene with bromine in the presence of $FeBr_3$. Why does chlorobenzene undergo substitution at the ortho and para positions rather than the meta position? Explain the role of the chlorine substituent in this reaction.
17. Explain the SN1 and SN2 mechanisms of nucleophilic substitution in haloalkanes with suitable examples. How do the steric hindrance and the nature of the leaving group influence the reaction mechanism?
18. Describe the preparation of chlorobenzene by the Sandmeyer reaction. What is the role of copper in this reaction? Provide an example where this reaction is used in the synthesis of an important haloarene.
19. Discuss the physical properties of haloalkanes, focusing on their solubility, boiling points, and refractive indices. How do these properties change with the type of halogen attached to the alkyl group?
20. When an alkyl halide reacts with sodium metal in dry ether, a new organic compound is formed. Explain the type of reaction occurring here and the nature of the product. Provide a general mechanism for the reaction.

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CHAPTER: 7 – ALCOHOLS, PHENOLS AND ETHERS

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Nomenclature, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Chemical distinction, conversion, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

ALCOHOLS-1

1. You are given a compound with the molecular formula $C_5H_{10}O$. Upon treatment with acidified $K_2Cr_2O_7$, it undergoes oxidation to form a compound with the molecular formula $C_5H_8O_2$. Identify the compound and explain its functional group. Write the IUPAC name of the alcohol and the product formed.
2. During the reduction of an aldehyde using lithium aluminum hydride (LiAlH4), you obtain an alcohol. Describe the mechanism involved in the reduction of an aldehyde to alcohol. Also, explain why LiAlH4 is preferred over NaBH4 in this reaction.
3. Explain the difference between primary, secondary, and tertiary alcohols in terms of their reactivity towards Lucas reagent. Illustrate the reaction with appropriate examples for each type of alcohol.
4. When an alcohol is treated with concentrated HCl in the presence of ZnCl2, it undergoes dehydration to form an alkene. Explain this reaction mechanism and how it differs for primary, secondary, and tertiary alcohols.
5. A primary alcohol reacts with alkaline KMnO4 to give a carboxylic acid. Outline the oxidation reaction mechanism and discuss why KMnO4 is used in this process. What is the role of the oxidizing agent?
6. Compare the acidic strength of phenols and alcohols. Justify your answer by discussing the factors affecting the acidity of phenols and alcohols.
7. Explain why ethanol is used as a solvent in many organic reactions. Also, discuss the polarity of ethanol and its role in solubility.
8. Describe the mechanism of dehydration of alcohols using concentrated sulfuric acid. Discuss the factors affecting the yield of the alkene in this reaction.
9. When an alcohol is heated with excess of an alkyl halide in the presence of a base, an ether is formed. Describe the reaction mechanism and identify the type of ether formed. Give an example.

10. Alcohols like isopropanol are commonly used as antiseptics. Discuss the mechanism by which alcohols exhibit their antiseptic properties and explain why they are effective in preventing microbial growth.
11. Explain how the electrophilic aromatic substitution reaction in phenols is affected by the presence of the hydroxyl group. Illustrate your answer with an example.
12. . Given the following reactions of phenol, identify the reagent involved and predict the products for each:

- Phenol reacts with bromine water.
- Phenol reacts with zinc dust.

13. How would you prepare phenol from cumene? Write the reaction and explain the steps involved.
14. Compare and contrast the acidic strength of phenol with that of alcohols. Explain why phenols are more acidic using resonance structures.
15. In the reaction of phenol with iron (III) chloride, what is the observed color change and what does this indicate about phenol's structure?
16. What happens when phenol is treated with nitric acid? Explain the type of reaction involved and the nature of the products formed.
17. If phenol is treated with zinc at high temperature, what product is formed? Explain the mechanism involved in the reduction.
18. How does the presence of the hydroxyl group in phenol affect its reactivity towards electrophilic reagents? Use specific examples of electrophilic substitution reactions.
19. A student adds sodium hydroxide to phenol and observes the formation of a soluble compound. What is the compound formed and why does it dissolve in water?
20. Discuss the effect of substituents on the reactivity of phenols in electrophilic aromatic substitution reactions. What happens when an electron-withdrawing group is present in the phenolic ring?

PHENOLS

21. Describe the method of preparation of phenol from chlorobenzene. How does the reaction mechanism differ when sodium hydroxide is used in the process?
22. Explain the acidic strength of phenols. Why does phenol exhibit stronger acidity compared to alcohols? Use the concept of resonance to support your answer.
23. How does phenol react with a mixture of zinc dust and how is it different from its reaction with sodium metal?
24. Given that phenols can undergo electrophilic substitution reactions, explain the influence of substituents like -OH and -NO_2 on the reactivity of phenols towards bromination.

25. A student adds a few drops of phenol to a solution of iron(III) chloride. What is the observed change, and what does this test indicate about phenol?
26. Discuss the effect of temperature on the reaction of phenol with chloroform and a base to form salicylaldehyde. Include the role of the base in the reaction mechanism.
27. A sample of phenol is treated with an aqueous solution of sodium hydroxide. Predict the products formed and explain the reaction involved. How does this reaction differ from the reaction of alcohol with sodium hydroxide?
28. How does the presence of substituents like -NO2 and -COOH in the aromatic ring affect the nucleophilic substitution and electrophilic aromatic substitution reactions of phenols? Provide examples.
29. A phenolic compound reacts with acetic acid in the presence of concentrated sulfuric acid. What is the product of this reaction, and what is the role of concentrated sulfuric acid in the reaction mechanism?
30. Differentiate between the properties of phenol and its derivatives such as anisole and salicylic acid. What makes the reactions of phenol distinct from those of anisole?

ETHERS-1

31. A compound ($C_6H_5OCH_3$) undergoes nucleophilic substitution when treated with HI. What is the major product formed in this reaction? Explain the mechanism involved and the role of HI in the reaction.
32. You are given a sample of ether. Describe a simple laboratory method to distinguish between an ether and an alcohol. Also, explain the principle behind the test.
33. Write the IUPAC name of the ether with the molecular formula $C_4H_{10}O$. What are the possible methods to prepare this ether in the laboratory?
34. An ether undergoes acid hydrolysis with HI to give two products. One of the products is an alcohol, and the other is an alkyl iodide. Write the reaction and identify the two products formed.
35. In a reaction involving an ether and HBr, one of the alkyl groups of the ether gets cleaved. Explain how the bond cleavage occurs and the factors that determine which bond (C–O or C–C) breaks during this reaction.
36. A certain ether reacts with HCl to give a mixture of products. Predict the products of the reaction and explain why the reaction proceeds differently with HCl as compared to HI.
37. An ether is treated with a strong acid to undergo cleavage into two parts. If the ether is asymmetric, which alkyl group will be more likely to form the carbocation and why?
38. Describe the chemical reactions and the products formed when the ether $C_6H_5OCH_3$ is treated with an excess of HBr. How would the products change if the ether were treated with HCl instead?
39. Write the mechanism for the acid-catalyzed cleavage of an ether and explain the role of the acid in facilitating the reaction. What is the effect of temperature on this process?

40. When dimethyl ether (CH_3OCH_3) is treated with concentrated HI, two products are formed. Write the reaction and explain the nature of the cleavage and the products formed. What safety precautions should be taken while handling this reaction in the laboratory?

ETHERS-2

41. Describe the Williamson synthesis of ethers. How does the choice of alkyl halide and alkoxide affect the formation of the ether? Provide an example for each type of alkyl group involved.
42. An ether undergoes cleavage with concentrated HI. Write the reaction and explain the mechanism involved. How does the structure of the ether influence its reactivity towards HI?
43. Compare the boiling points of ethers with alcohols having similar molecular weights. Explain the reasons behind the difference in boiling points.
44. You are given an unknown compound that is an ether. Explain the chemical tests you would use to identify the functional group and confirm the identity of the compound.
45. Ethers are generally less reactive than alcohols and alkyl halides. Explain why ethers are more stable than alcohols towards dehydration reactions. Include a comparison of their bond dissociation enthalpy.
46. Discuss the uses of diethyl ether as a solvent in laboratory work. How does its low boiling point make it suitable for these applications? What are the precautions one should take while handling it?
47. Ethers show limited solubility in water despite having an oxygen atom. Explain the reasons behind this and compare it with the solubility of alcohols.
48. How do ethers react with hydrogen halides (HX)? Provide an example where an ether undergoes cleavage with HI to form alkyl iodides. Explain the conditions required for this reaction.
49. Ethers do not undergo acid-catalyzed hydration easily. Justify this statement by discussing the effect of acid on ethers and the formation of possible products.
50. Ethers are often used as solvents in organic reactions. Explain why ethers are preferred over water in certain organic reactions, especially in the synthesis of Grignard reagents.

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CHAPTER: 8 – ALDEHYDES, KETONES AND CARBOXYLIC ACID

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Nomenclature, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Chemical distinction, conversion, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

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1. "Draw the structural formula of an aldehyde and a ketone, and explain how they differ in terms of their functional groups. Also, state their IUPAC names."
2. "Explain the mechanism of nucleophilic addition in aldehydes and ketones, and illustrate this with the reaction of formaldehyde with ammonia."
3. "What is the product when an aldehyde undergoes oxidation with acidified potassium dichromate? How does the reaction differ when a ketone undergoes oxidation?"
4. "Explain the reduction of an aldehyde to a primary alcohol using lithium aluminium hydride. What is the effect of this reducing agent on a ketone?"
5. "Describe the aldol condensation reaction using acetaldehyde as an example. What type of product is formed in this reaction, and how does it differ from the products of simple aldehyde reduction?"
6. "Describe Tollens' test for detecting aldehydes. What is the chemical reaction that occurs, and what are the observations that confirm the presence of an aldehyde group?"
7. "Explain why the alpha-hydrogen in aldehydes and ketones is more acidic than the hydrogens in alcohols. Support your answer with the mechanism of enolate formation."
8. "Describe the reaction of a Grignard reagent with formaldehyde. What are the products, and how does the reaction with formaldehyde differ from its reaction with a ketone?"
9. "What is the reaction of aldehydes and ketones with hydrazine? Explain the formation of hydrazone, and describe its significance in testing for carbonyl compounds."
10. "Explain how you can distinguish between an aldehyde and a ketone using chemical tests. Discuss the principle behind each test and its result."
11. Explain the mechanism of nucleophilic addition in the reaction of an aldehyde with hydrogen cyanide. How does the structure of the aldehyde influence the reaction?
12. Acetone is more reactive than formaldehyde in nucleophilic addition reactions. Justify this statement with an explanation of the electronic effects involved.
13. How would you distinguish between an aldehyde and a ketone using chemical tests? Provide the chemical reactions involved.
14. A solution of formaldehyde (HCHO) is treated with a dilute solution of sodium bisulphite. Describe the reaction and the product formed.

15. Explain the principle of the Tollens' test. What are the observations when an aldehyde is treated with Tollens' reagent? How does this test differ when a ketone is used?
16. A compound X ($C_5H_{10}O$) gives a positive test for the presence of a carbonyl group but does not undergo reduction with sodium borohydride. What is the possible structure of X and why?
17. When propan-2-one is treated with an excess of iodine in the presence of alkali, a reaction occurs. What is the product of this reaction, and what is the significance of this reaction in organic chemistry?
18. Explain how the IUPAC names of aldehydes and ketones are derived, giving examples. How does the presence of functional groups influence the naming process?
19. An unknown compound ($C_6H_{12}O$) reacts with sodium bisulphite and undergoes reduction with sodium borohydride. What type of compound is it likely to be? Explain the reasoning behind your answer.
20. Outline the steps involved in the preparation of an aldehyde from a primary alcohol and explain the reaction mechanism at each stage.

CARBOXYLIC ACID

PART-1

21. Describe the process of preparing acetic acid from ethanol and explain the role of oxidation in the reaction. How does the structure of acetic acid influence its physical properties?
22. In the reaction between a carboxylic acid and an alcohol to form an ester (Fischer esterification), explain the role of a catalyst and discuss the mechanism behind the reaction.
23. Given a sample containing an unknown carboxylic acid, outline the tests you would perform to identify it, including tests for functional groups and its reactivity with bases and alcohols.
24. How do carboxylic acids react with metals like sodium and magnesium? Provide the chemical equations and explain the observed observations during the reaction.
25. Compare the acidity of carboxylic acids to alcohols and phenols. Justify the higher acidity of carboxylic acids based on their structure and the resonance effect.
26. Write the chemical equation for the preparation of an acyl chloride from a carboxylic acid. Describe how the reaction is carried out and the conditions required for the process.
27. Explain the mechanism of decarboxylation in carboxylic acids and provide an example of a reaction in which carbon dioxide is eliminated from a carboxyl group.
28. Explain the differences between acyl chlorides, esters, and amides in terms of their reactivity and the way they are formed from carboxylic acids.

29. Discuss the industrial importance of carboxylic acids like acetic acid and their derivatives, focusing on their applications in the production of polymers and food preservatives.
30. Explain the process and conditions under which carboxylic acids can be converted into their corresponding esters and acyl chlorides. What are the key differences in these reactions?

PART-2

31. Describe the process of converting a carboxylic acid into an alcohol.
32. A sample of acetic acid is subjected to reaction with an alkali. Write the balanced chemical equation and explain the nature of the product.
33. Given the structure of a carboxylate ion, identify its functional group and describe its basic properties.
34. Explain how carboxylic acids can be reduced to aldehydes using appropriate reagents, and provide an example.
35. When propanoic acid is heated with a mixture of alcohol and concentrated sulfuric acid, what reaction takes place, and what are the products?
36. Discuss the factors that affect the acidity of carboxylic acids and explain how electron-withdrawing and electron-donating groups influence their acidity.
37. Write the mechanism for the formation of acetic anhydride from acetic acid and acetic acid chlorides.
38. How does the presence of conjugation in the structure of carboxylic acids influence their reactivity toward nucleophiles?
39. Given the reaction between a carboxylic acid and a Grignard reagent, predict the major product and explain the reaction mechanism.
40. Describe the steps involved in the preparation of benzoic acid from toluene, and explain the role of each reagent used.

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CHAPTER: 9 – AMINES

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Nomenclature, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Chemical distinction, conversion, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

PART – 1

1. Explain how the basicity of amines is influenced by the electron-donating or electron-withdrawing groups attached to the nitrogen atom. Support your answer with examples.
2. Aniline reacts with bromine water to form a white precipitate. Describe the mechanism of this reaction and explain how the nature of the substituent on the aniline molecule affects the reactivity.
3. What is the effect of the nature of alkyl groups (primary, secondary, and tertiary) on the basicity of aliphatic amines? Explain with examples.
4. A student performs a reaction of methylamine with acetic acid. Write the equation for this reaction and explain why methylamine acts as a base.
5. Compare the boiling points of primary, secondary, and tertiary amines. Provide a detailed explanation of why primary amines exhibit higher boiling points compared to secondary and tertiary amines.
6. Explain the Hofmann degradation reaction of a primary amide. What are the products of this reaction when a primary amide like acetamide undergoes Hofmann degradation?
7. A student adds nitrous acid to an amine solution and observes the formation of a diazonium salt. Explain the steps involved in the formation of the diazonium salt and its importance in the preparation of aromatic compounds.
8. How does the structure of an amine (aromatic vs aliphatic) affect its solubility in water? Provide an explanation with examples.
9. Explain the role of amines in the preparation of azo dyes. What is the significance of the amine group in this process?
10. A student is asked to distinguish between aniline and ethylamine using chemical tests. Describe the chemical tests and explain the observations that will help identify each amine.

PART – 2

11. Ammonia (NH_3) and methylamine (CH_3NH_2) both contain nitrogen, but their basic strengths are different. Explain the reason for the difference in their basicities using the concept of inductive and hyperconjugation effects.
12. Aniline is prepared from nitrobenzene via reduction using tin and hydrochloric acid. Explain the steps involved in this reduction process and discuss why tin is used as a reducing agent.
13. When ethylamine reacts with bromine in the presence of an alkali, it forms a product that is commonly used in the synthesis of dyes. Identify the product and explain its role in the synthesis process.
14. Classify the following amines as primary, secondary, or tertiary: (a) $C_6H_5NH_2$ (b) $(CH_3)_2NH$ (c) $(CH_3)_3N$. Provide reasoning for each classification.
15. A student is provided with a colorless, organic compound that smells similar to ammonia. After testing with a few reagents, it is confirmed that the compound is an amine. Suggest a possible test to distinguish between a primary and secondary amine.
16. The boiling points of amines are higher than those of alkanes of similar molecular mass. Explain why amines have higher boiling points using the concept of hydrogen bonding.
17. Aniline undergoes nucleophilic substitution when reacted with alkyl halides. Write the chemical equation for the reaction of aniline with methyl iodide and explain the mechanism behind the substitution reaction.
18. Explain why aromatic amines (such as aniline) are less basic than aliphatic amines. Discuss how the presence of the benzene ring affects the electron density on the nitrogen atom in aniline.
19. Nitro compounds can be reduced to amines using different reducing agents. Identify a suitable reducing agent for converting nitrobenzene to aniline and explain why this agent is preferred over others.
20. When phenylamine reacts with acetic anhydride, an amide is formed. Write the balanced chemical equation for this reaction and explain how this test helps in identifying amines.

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CHAPTER: 10 - BIOMOLECULES

The questions are designed in order to assess and evaluate the learning in following competencies :

Conceptual Understanding, Nomenclature, Application, Physicochemical properties, Critical Thinking, Real-World Connection, Experimental Design, Chemical distinction, conversion, Synthesis, Case-Based Question, HOTS Question, Assertion-Reasoning.

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1. Explain how the structure of an enzyme influences its activity. Describe the lock and key model with an example.
2. Classify amino acids based on the nature of their side chains. Discuss the significance of essential amino acids for the human body.
3. Describe the structure of DNA and RNA. How does the double-helix structure of DNA contribute to its function in heredity?
4. Differentiate between monosaccharides, disaccharides, and polysaccharides. How do their structures relate to their biological functions?
5. Explain the difference between saturated and unsaturated fatty acids. How do lipids contribute to energy storage and membrane structure?
6. Discuss the role of vitamins in metabolic processes. Provide examples of diseases caused by the deficiency of Vitamin C and Vitamin D.
7. Differentiate between competitive and non-competitive inhibition of enzymes. Provide examples of each and their effects on enzyme activity.
8. Describe the process of translation in protein synthesis. How do ribosomes, mRNA, and tRNA work together to form a protein?
9. Discuss the concept of structural isomerism in carbohydrates with examples. How does isomerism affect the properties of biomolecules?
10. Explain how enzyme activity is affected by varying substrate concentration, according to Michaelis-Menten kinetics. What is the significance of the Michaelis constant (Km)?
11. Explain how the concentration of enzymes affects the rate of a biochemical reaction. What is meant by the term 'activation energy', and how do enzymes influence it in biological systems?
12. Describe the four levels of protein structure. How does the change in the sequence of amino acids in a polypeptide chain affect the overall structure and function of a protein?
13. Differentiate between DNA and RNA in terms of their structure and function. How does the sequence of nitrogenous bases in a nucleic acid affect protein synthesis?
14. Explain the difference between monosaccharides, disaccharides, and polysaccharides. Provide an example of each and their respective biological roles.

15. Discuss the structural components of a phospholipid. How do phospholipids contribute to the formation of cell membranes and their selective permeability?
16. Explain the role of vitamin C in the human body. What are the consequences of its deficiency, and how does it act as a coenzyme in biochemical reactions?
17. Enzymes are highly specific to their substrates. Explain how the 'lock-and-key' model of enzyme-substrate interaction works. What are the limitations of this model?
18. Describe the role of ATP in cellular metabolism. How does ATP facilitate energy transfer in biochemical reactions?
19. Explain the role of insulin as a hormone in regulating blood glucose levels. What happens when the secretion of insulin is impaired?
20. What are hydrogen bonds, and how do they contribute to the stability of biomolecules like proteins and DNA?

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COMPETENCY BASED QUESTIONS
CHEMISTRY- XII

GAJENDRA L KAPDE

TA CHEMISTRY

KVS – ZIET Mumbai