

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **33 questions**. All questions are compulsory.
- (ii) Section A: Questions 1 to 16 are multiple choice questions, carrying 1 mark each.
- (iii) Section B: Questions 17 to 21 are very short answer questions, carrying 2 marks each.
- (iv) Section C: Questions 22 to 28 are short answer questions, carrying 3 marks each.
- (v) Section D: Questions 29 to 30 are case-based questions, carrying 4 marks each.
- (vi) Section E: Questions 31 to 33 are long answer questions, carrying 5 marks each.
- (vii) Attempt one alternative where an internal choice is provided. Follow the instructions within each question.
- (viii) Use of calculators is not allowed.

Section A

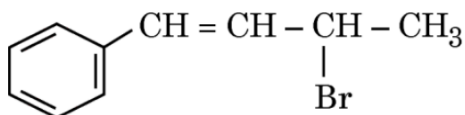
1. Which property of transition metals enables them to form alloys?

- (A) High ionization enthalpy (B) Similar atomic radii
(C) Catalytic property (D) Complex formation

2. Which of the following d-orbitals experience more repulsion in the crystal field splitting of tetrahedral complex?

- (A) $d_{x^2-y^2}$, d_{z^2} (B) $d_{x^2-y^2}$, d_{xy}
(C) d_{xy} , d_{yz} , d_{zx} (D) d_{xy} , d_{yz} , d_{z^2}

3. The position of -Br in the following compound can be classified as:



- (A) Vinylic (B) Allylic
(C) Benzylic (D) Aryl

4. Williamson synthesis is an example of:

- (A) Nucleophilic addition reaction (B) Electrophilic substitution reaction
(C) Nucleophilic substitution reaction (D) Electrophilic addition reaction

5. Number of possible stereoisomers for the complex $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ will be:

- (A) 3 (B) 4
(C) 2 (D) 1

6. The correct order of decreasing basic strength of $\text{CH}_3\text{-NH}_2$, $(\text{CH}_3)_2\text{NH}$ and $(\text{CH}_3)_3\text{N}$ in aqueous solution is:

- (A) $(\text{CH}_3)_3\text{N} > (\text{CH}_3)_2\text{NH} > \text{CH}_3\text{-NH}_2$ (B) $\text{CH}_3\text{-NH}_2 > (\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N}$
(C) $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{-NH}_2 > (\text{CH}_3)_3\text{N}$ (D) $(\text{CH}_3)_2\text{NH} > (\text{CH}_3)_3\text{N} > \text{CH}_3\text{-NH}_2$

7. When a liquid and its vapour are at equilibrium and the pressure is suddenly decreased:

- (A) vapour pressure of the solution increases (B) heating occurs
(C) cooling occurs (D) equilibrium remains unaffected

8. The boiling point of one molal NaCl solution, assuming NaCl to be completely dissociated in water is: (K_b for water = $0.52 \text{ K kg mol}^{-1}$)

- (A) 100.52°C (B) 101.04°C
(C) 100.04°C (D) 101.52°C

9. The rate of a first order reaction is $5.6 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$ when the concentration of reactant is 0.2 mol L^{-1} . The rate constant 'k' is:

- (A) $5.6 \times 10^{-3} \text{ s}^{-1}$ (B) $2.8 \times 10^{-4} \text{ s}^{-1}$
(C) $2.8 \times 10^{-5} \text{ s}^{-1}$ (D) $2.8 \times 10^{-3} \text{ s}^{-1}$

10. Consider the following cell at 298 K:



How can we increase the emf of the cell using the same substances?

- | | |
|---|--|
| (A) By decreasing only the $[\text{Mg}^{2+}]$ to 0.1 M | (B) By decreasing only the $[\text{Cu}^{2+}]$ to 0.1 M |
| (C) By increasing both $[\text{Mg}^{2+}]$ and $[\text{Cu}^{2+}]$ to 2.0 M | (D) By increasing only the $[\text{Mg}^{2+}]$ to 2.0 M |

11. Which of the following reagent is used to convert benzene diazonium chloride to benzene?

- | | |
|-------------------------------------|----------------------|
| (A) H_2O | (B) LiAlH_4 |
| (C) $\text{C}_2\text{H}_5\text{OH}$ | (D) CuCN |

12. Which of the following is a water-soluble vitamin?

- | | |
|---------------|---------------|
| (A) Vitamin K | (B) Vitamin A |
| (C) Vitamin B | (D) Vitamin D |

13. **Assertion (A):** Alcohols act as Bronsted bases as well as Bronsted acids.

Reason (R): Alcohols react as both nucleophiles and electrophiles.

- | | |
|--|---|
| (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). | (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). |
| (C) Assertion (A) is true, but Reason (R) is false. | (D) Assertion (A) is false, but Reason (R) is true. |

14. **Assertion (A):** Diazonium salts of aromatic amines are more stable than those of aliphatic amines.

Reason (R): Diazonium salts of aromatic amines undergo resonance.

- | | |
|--|---|
| (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). | (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). |
| (C) Assertion (A) is true, but Reason (R) is false. | (D) Assertion (A) is false, but Reason (R) is true. |

15. **Assertion (A):** For complex reaction, order of reaction is given by the fast step.

Reason (R): Order of reaction is determined experimentally.

- | | |
|--|---|
| (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). | (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). |
| (C) Assertion (A) is true, but Reason (R) is false. | (D) Assertion (A) is false, but Reason (R) is true. |

16. **Assertion (A):** $E^\circ_{\text{Cu}^{2+}/\text{Cu}}$ has positive value (+0.34 V).

Reason (R): It is due to its low $\Delta_{\text{hyd}}H^\circ$ and high Δ_aH° .

- | | |
|--|---|
| (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). | (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). |
| (C) Assertion (A) is true, but Reason (R) is false. | (D) Assertion (A) is false, but Reason (R) is true. |

Section B

17. (a) Explain the following with the help of Henry's law:

- (i) Bends
- (ii) Anoxia

OR

(b) How does sprinkling of salt help in clearing the snow covered roads in hilly areas? Write the name of the colligative property involved in this process.

18. Write the formulas for the following coordination compounds:

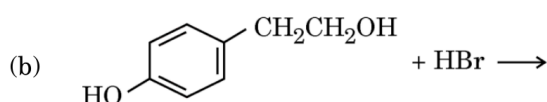
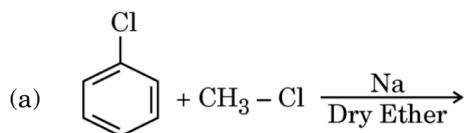
- (a) Mercury(I) tetrathiocyanato-S-cobaltate(III)
- (b) Dichloridobis(ethane-1,2-diamine) platinum(IV) nitrate

19. Name the sugar present in sugarcane. What are the hydrolysis products of this sugar? Is this sugar a reducing sugar?

20. (a) Reactions of which order will show the rate to be independent of the concentration of the reactant? Give one example of this order.

(b) State the condition under which a bimolecular reaction may be kinetically a first order reaction.

21. Draw the structures of major products in each of the following reactions:

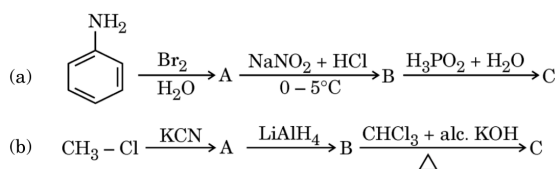


22. What happens when:

- Propanenitrile is treated with phenyl magnesium bromide followed by hydrolysis?
- p-fluorotoluene is treated with CrO_3 in the presence of acetic anhydride followed by hydrolysis with aqueous acid.
- Phthalic acid is treated with NH_3 followed by heating?

Write chemical reactions in support of your answer.

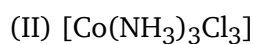
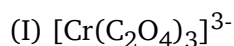
23. Give the structures of A, B and C in the following reactions:



24(a). When a coordination compound $\text{CoCl}_3 \cdot 6\text{NH}_3$ is mixed with excess of AgNO_3 solution, 3 moles of AgCl are precipitated per mole of the compound. Write the structural formula of the complex, IUPAC name, its hybridisation and magnetic behaviour on the basis of valence bond theory.

OR

24(b). (i) How many geometrical isomers are possible in each of the following complexes?



(ii) $[\text{Co}(\text{NH}_3)_6]^{3+}$ is an inner orbital complex whereas $[\text{Ni}(\text{NH}_3)_6]^{2+}$ is an outer orbital complex. Why? [Atomic number: Co = 27, Ni = 28]

(iii) Write the formula of Wilkinson catalyst and its use.

25. Answer the following questions:

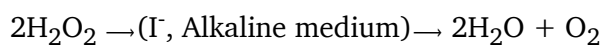
- Why is direct current (DC) not used to measure the resistance of an ionic solution?
- Why are the products of electrolysis different for the electrolysis of aqueous solution of AgNO_3 with silver electrodes and electrolysis of aqueous solution of AgNO_3 with platinum electrodes?
- Why are magnesium blocks fixed to the iron pipelines carrying water?

26. Answer the following:

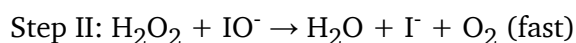
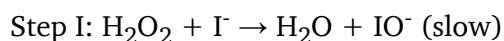
- Which isomer of $\text{C}_4\text{H}_9\text{Br}$ is most reactive towards $\text{S}_{\text{N}}1$ reaction?
- Predict the alkene that would be formed by dehydrohalogenation of 1-Bromo-1-methylcyclohexane.
- Although chlorine shows strong -I effect, yet it is ortho- and para-directing in electrophilic aromatic substitution reactions. Why?

27. Calculate the vapour pressure of a solution containing 61 g of benzoic acid (molar mass = 122 g mol^{-1}) dissolved in 500 g of benzene when the vapour pressure of pure benzene at this temperature of experiment is 66 torr. Assume complete dimerization of benzoic acid in benzene.

28. Consider the decomposition of hydrogen peroxide (H_2O_2) as per the equation given below:



The mechanism for this reaction was found to be:



- Write the rate law expression.
- Determine the order of reaction with respect to H_2O_2 , I^- and overall order of reaction.
- What is the molecularity of the reaction in Step II?

29(a). Case Study (Alcohols and Phenols):

Alcohols and Phenols are acidic in nature. Electron withdrawing groups in phenol increase its acidic strength and electron releasing groups decrease it. Alcohols undergo nucleophilic substitution with hydrogen halides to yield alkyl halides. Dehydration of alcohols gives alkenes. On oxidation, primary alcohols yield aldehydes with mild oxidising agents and carboxylic acids with strong oxidising agents, while secondary alcohols yield ketones. Tertiary alcohols are resistant to oxidation. The presence of -OH group in phenols activates the aromatic ring towards electrophilic substitution and directs the incoming group to ortho and para positions due to resonance effect.

(a) Write the mechanism of acid dehydration of ethanol to yield ethene.

29(b)(i). (b) (i) Why are tertiary alcohols resistant to oxidation?

OR

(b) (ii) Write the structure of the major product expected from the dinitration of 3-methylphenol.

29(c). (c) Why is ortho-nitrophenol more acidic than ortho-methoxyphenol?

30(a). Case Study (Carbohydrates):

Carbohydrates are optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis. They have been broadly classified into three groups - monosaccharides, oligosaccharides and polysaccharides. The carbohydrates may also be classified as either reducing or non-reducing sugars. An important monosaccharide glucose is an aldohexose and is correctly named as D(+)-glucose. It was assigned the open structure on the basis of its reactions with HI, NH_2OH , Br_2 water, $(\text{CH}_3\text{CO})_2\text{O}$ and nitric acid. Despite having the -CHO group, glucose does not give Schiff's test and hydrogen sulphite addition product with NaHSO_3 . It was found that glucose forms a six-membered ring in which one of the -OH groups add to the -CHO group and form a cyclic hemiacetal structure.

(a) How do you explain the following?

(i) Presence of a carbonyl group in glucose

(ii) Presence of five -OH groups in glucose which are attached to different carbon atoms.

30(b). (b) What type of carbohydrates are called reducing sugars?

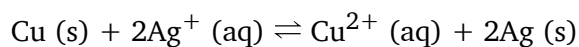
30(c)(i). (c) (i) In D(+)-glucose, what do the letter 'D' and sign '(+)' represent?

OR

(c) (ii) Draw the six-membered ring structure of α -D(+)-glucose.

Section E

31(a). (i) Calculate E_{cell} for the following reaction which is at equilibrium:



Equilibrium constant (K_c) for the cell is 10^{15} .

[Given: $\log 10 = 1$]

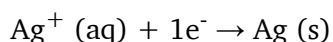
(ii) Write anode, cathode and overall reaction of lead storage battery when it is in use.

(iii) How much electricity is required in coulombs for the oxidation of 1 mol of FeO to Fe_2O_3 ?

OR

31(b). (i) Conductivity of 0.0024 M acetic acid is $7.2 \times 10^{-5} \text{ S cm}^{-1}$. If Λ_m° for acetic acid is $390.5 \text{ S cm}^2 \text{ mol}^{-1}$, then calculate the degree of dissociation (α) of acetic acid.

(ii) Calculate the cell potential for the following half cell reaction at 25°C :



Given that: $[\text{Ag}^+] = 0.01 \text{ M}$ and $E^\circ_{\text{Ag}^+/\text{Ag}} = +0.80 \text{ V}$ [$\log 10 = 1$]

(iii) Write the name of the electrolyte used in:

(I) Dry cell

(II) Fuel cell ($\text{H}_2\text{-O}_2$)

32(a). (i) Account for the following:

(I) MnO is basic while Mn_2O_7 is acidic.

(II) Iron has higher enthalpy of atomization than that of copper.

(III) Mn^{3+} is a stronger oxidising agent than Cr^{3+} .

(ii) How do you prepare potassium dichromate from sodium chromate? Write balanced chemical equation for each step.

OR

32(b). Answer the following questions:

(i) Why is chemistry of actinoids more complicated as compared to lanthanoids?

(ii) $E^\circ_{\text{M}^{2+}/\text{M}}$ values are not regular for first row transition elements (3d series). Why?

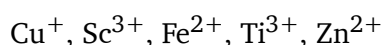
(iii) Identify the following:

(I) Oxoanion of chromium which is stable in acidic medium.

(II) The lanthanoid element that exhibits +4 oxidation state.

(iv) Write the products obtained on heating KMnO_4 .

(v) Predict which of the following ions will be coloured in aqueous solution:



33(a). (i) How will you bring about the following conversions:

(I) Bromobenzene to 1-phenylethanol

(II) Benzene to m-nitroacetophenone

(ii) An organic compound with the molecular formula C_8H_8O forms 2,4-DNP derivative, reduces Tollens' reagent and undergoes Cannizzaro reaction. On vigorous oxidation with acidic or alkaline $KMnO_4$ it gives Benzene-1,2-dicarboxylic acid. Identify the compound and write the products when it undergoes Cannizzaro reaction.

(iii) Arrange the following compounds in increasing order of their acid strength:

C_6H_5COOH , O_2N-CH_2-COOH , CF_3-COOH , $HCOOH$

OR

33(b). (i) Write the products formed when benzaldehyde reacts with the following reagents:

(I) 2,4-Dinitrophenylhydrazine

(II) Acetophenone in the presence of dilute $NaOH$ followed by heating

(ii) Give reasons for the following:

(I) Benzoic acid does not undergo Friedel-Crafts reaction.

(II) Carboxylic acids have higher boiling point than alcohols of comparable molecular mass.

(iii) Write simple chemical test to distinguish between propanal and propanone.

- End of Question Paper -