CBSE EXAMINATION PAPER-2023

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 78

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **41 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 3** are case based questions

iv. **Section B** – questions number **4 to 21** are multiple choice questions

v. **Section C** – questions number **22 to 30** are very short answer

vi. **Section D** – questions number **31 to 36** are short answer

vii. **Section E** – questions number **37 to 41** are long answer

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1. Nucleophilic Substitution reaction of haloalkane can be conducted according to both SN1 and SN2 mechanisms. SN1 is a two step reaction while SN2 is a single step reaction. For any haloalkane which mechanism is followed depends on factors such as structure of haloalkane, properties of leaving group, nucleophilic reagent and solvent. Influences of solvent polarity: In SN1 reaction, the polarity of the system increases from the reactant to the transition state, because a polar solvent has a greater effect on the transition state than the reactant, thereby reducing activation energy and accelerating the reaction. In SN2 reaction, the polarity of the system generally does not change from the reactant to the transition state and only charge dispersion occurs. At this time, polar

solvent has a great stabilizing effect on Nu than the transition state, thereby increasing activation energy and slowing down the reaction rate. For example, the decomposition rate (SN1) of tertiary chlorobutane at 25 °C in water (dielectric constant 79) is 300000 times faster than in ethanol (dielectric constant 24). The reaction rate (SN2) of 2-Bromopropane and NaOH in ethanol containing 40% water is twice slower than in absolute ethanol. Hence the level of solvent polarity has influence on both SN1 and SN2 reaction, but with different results. Generally speaking, weak polar solvent is favourable for SN2 reaction, while strong polar solvent is favourable for SN1. Generally speaking, the substitution reaction of tertiary haloalkane is based on SN1 mechanism in solvents with a strong polarity (for example ethanol containing water).

Question 2.

The following questions are case – based questions. Read the passage carefully and answer the questions that follow :

Nucleophilic Substitution

Nucleophilic Substitution reaction of haloalkane can be conducted according to both SN1 and SN2 mechanisms. SN1 is a two step reaction while SN2 is a single step reaction. For any haloalkane which mechanism is followed depends on factors such as structure of haloalkane, properties of leaving group, nucleophilic reagent and solvent. Influences of solvent polarity : In SN1 reaction, the polarity of the system increases from the reactant to the transition state, because a polar solvent has a greater effect on the transition state than the reactant, thereby reducing activation energy and accelerating the reaction. In SN2 reaction, the polarity of the system generally does not change from the reactant to the transition state and only charge dispersion occurs. At this time, polar solvent has a great stabilizing effect on Nu than the transition state, thereby increasing activation energy and slow down the reaction rate. For example, the decomposition rate (SN1) of tertiary chlorobutane at 25 °C in water (dielectric constant 79) is 300000 times faster than in ethanol (dielectric constant 24). The reaction rate (SN2) of 2-Bromopropane and NaOH in ethanol containing 40% water is twice slower than in absolute ethanol. Hence the level of solvent polarity has influence on both SN1 and SN2 reaction, but with different results. Generally speaking weak polar solvent is favourable for SN2 reaction, while strong polar solvent is favourable for SN1. Generally speaking the substitution reaction of tertiary haloalkane is based on SN1 mechanism in solvents with a strong polarity (for example ethanol containing water).

(1)

Why racemisation occurs in SN1 ?

[1 Marks]

(2)

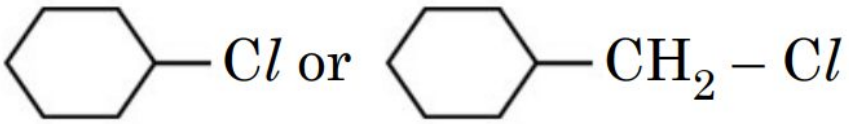
Why is ethanol less polar than water ?

[1 Marks]

(3)

Which one of the following in each pair is more reactive towards SN2 reaction ?

(i) $CH_3 - CH_2 - I$ or $CH_3CH_2 - Cl$

(ii)  or

[2 Marks]

(4)

Arrange the following in the increasing order of their reactivity towards SN1 reactions :

(i) 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane

(ii) 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 2-Bromo-3 methylbutane

[2 Marks]

Question 3.

Rahul set-up an experiment to find resistance of aqueous KCl solution for different concentrations at 298 K using a conductivity cell connected to a Wheatstone bridge. He fed the Wheatstone bridge with a.c. power in the audio frequency range 550 to 5000 cycles per second. Once the resistance was calculated from null point he also calculated the conductivity K and molar conductivity $\wedge_m$ and recorded his readings in tabular form.

S.No.	Conc.(M)	k S cm^{-1}	$\wedge_m$ S cm^2 mol^{-1}
1.	1.00	111.3×10^{-3}	111.3
2.	0.10	12.9×10^{-3}	129.0
3.	0.01	1.41×10^{-3}	141.0

(1)

Why does conductivity decrease with dilution ?

[1 Marks]

(2)

If Λ_m° of KCl is 150.0 S cm² mol⁻¹, calculate the degree of dissociation of 0.01 M KCl.

[1 Marks]

(3)

Amit, a classmate of Rahul repeated the same experiment with CH_3COOH solution instead of KCl solution. Give one point that would be similar and one that would be different in his observations as compared to Rahul.

[2 Marks]

(4)

If Rahul had used HCl instead to KCl then would you expect the Λ_m values to be more or less than those per KCl for a given concentration. Justify.

[2 Marks]

Section B

Question 4.

Which of the following molecules has a chiral centre correctly labelled with an asterisk (*)?

[1 Marks]

(A) $CH_3C^*Br_2CH_3$

(B) $CH_3C^*HClCH_2Br$

(C) $CH_3C^*HBrCH_3$

(D) $HOCH_2C^*H(OH)CH_2OH$

Question 5.

Which of the following alcohols will not undergo oxidation?

[1 Marks]

(A) 3-Methylbutan-2-ol

(B) 2-Methylbutan-2-ol

(C) Butan-2-ol

(D) Butanol

Question 6.

A voltaic cell is made by connecting two half cells represented by half equations below: $Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$ $E° = – 0.14$ V $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $E° = + 0.77$ V Which statement is correct about this voltaic cell?

[1 Marks]

(A) Fe^{2+} is oxidised and the voltage of the cell is 0.91 V

(B) Sn is oxidised and the voltage of the cell is 0.63 V

(C) Fe^{2+} is oxidised and the voltage of the cell is –0.91 V

(D) Sn is oxidised and the voltage of the cell is 0.91 V

Question 7.

Four half reactions I to IV are shown below:

I. $2Cl^- \rightarrow Cl_2 + 2e^-$

II. $4OH^- \rightarrow O_2 + 2H_2O + 2e^-$

III. $Na^+ + e^- \rightarrow Na$

IV. $2H^+ + 2e^- \rightarrow H_2$ Which two of these reactions are most likely to occur when concentrated brine is electrolysed?

[1 Marks]

(A) I and III

(B) I and IV

(C) II and III

(D) II and IV

Question 8.

Which property of transition metals enables them to behave as catalysts?

[1 Marks]

(A) Alloy formation

(B) Variable oxidation states

(C) High ionisation enthalpy

(D) High melting point

Question 9.

In the two tetrahedral structures of dichromate ion,

[1 Marks]

(A) All Cr – O bonds are equivalent in length.

(B) All Cr – O bonds are non-equivalent.

(C) 6 Cr – O bonds are equivalent in length.

(D) 4 Cr – O bonds are equivalent in length.

Question 10.

1 mole of liquid A and 2 moles of liquid B make a solution having a total vapour pressure 40 torr. The vapour pressure of pure A and pure B are 45 torr and 30 torr respectively. The above solution

[1 Marks]

(A) shows positive deviation.

(B) is a maximum boiling azeotrope.

(C) shows negative deviation.

(D) is an ideal solution.

Question 11.

Which of the following would not be a good choice for reducing nitrobenzene to aniline?

[1 Marks]

(A) H_2/Ni

(B) Sn and HCl

(C) $LiAlH_4$

(D) Fe and HCl

Question 12.

If molality of a dilute solution is doubled, the value of the molal elevation constant (Kb) will be

[1 Marks]

(A) unchanged

(B) halved

(C) doubled

(D) tripled

Question 13.

Hydrolysis of sucrose is called

[1 Marks]

(A) saponification

(B) hydration

(C) esterification

(D) inversion

Question 14.

Which one of the following has lowest pK_a value?

[1 Marks]

(A) $Cl–CH_2–COOH$

(B) $O_2N–CH_2–COOH$

(C) HCOOH

(D) $CH_3–COOH$

Question 15.

Which of the following cell was used in Apollo space programme?

[1 Marks]

(A) $H_2–O_2$ Fuel cell

(B) Daniel cell

(C) Mercury cell

(D) Dry cell

Question 16.

The following experimental rate data were obtained for a reaction carried out at 25 °C:

[1 Marks]

$A_{(g)} + B_{(g)} \rightarrow C_{(g)} + D_{(g)}$

Initial $[A_{(g)}]$/mol dm^{-3}	Initial $[B_{(g)}]$/mol dm^{-3}	Initial rate/mol $dm^{-3}s^{-1}$
3.0×10^{-2}	2.0×10^{-2}	1.89×10^{-4}
3.0×10^{-2}	4.0×10^{-2}	1.89×10^{-4}
6.0×10^{-2}	4.0×10^{-2}	7.56×10^{-4}

(A) Second, First

(B) Zero, Second

(C) First, Zero

(D) Second, Zero

Question 17.

The magnetic moment of $[NiCl_4]^{2-}$ is [Atomic number : Ni = 28]

[1 Marks]

(A) 1.82 BM

(B) 5.46 BM

(C) 4.42 BM

(D) 2.82 BM

Question 18.

Assertion (A) : Proteins are polymers of α-amino acids connected by a peptide bond.

Reason (R) : A tetrapeptide contains 4 amino acids linked by 4 peptide bonds

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(C) Assertion (A) is false, but Reason (R) is true.

(D) Assertion (A) is true, but Reason (R) is false.

Question 19.

Assertion (A) : For a zero order reaction the unit of rate constant and rate of reaction are same.

Reason (R) : Rate of reaction for zero order reaction is independent of concentration of reactant.

[1 Marks]

(A) Assertion (A) is true, but Reason (R) is false.

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

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

(D) Assertion (A) is true, but Reason (R) is false.

Question 20.

Assertion (A) : Acetic acid but not formic acid can be halogenated in presence of red P and Cl_2.

Reason (R) : Acetic acid is a weaker acid than formic acid.

(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.

Question 21.

Assertion (A) : Trans $[Cr\ Cl2(ox)_2]^{3-}$ shows optical isomerism.

Reason (R) : Optical isomerism is common in octahedral complexes involving didentate ligands.

[1 Marks]

(A) Assertion (A) is false, but Reason (R) is true.

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

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

(D) Assertion (A) is true, but Reason (R) is false.

Section C

Question 22.

(i) What should be the signs (positive/negative) for E°Cell and ΔG° for a spontaneous redox reaction occurring under standard conditions?

(ii) State Faraday's first law of electrolysis.

[2 Marks]

Question 23.

What happens to the rate constant k and activation energy E_a as the temperature of a chemical reaction is increased? Justify.

[2 Marks]

Question 24.

a) Which of the following species cannot act as a ligand? Give reason.
OH^-, NH_4^+, CH_3NH_2, H_2O

(b) The complex $[Co(NH_3)_5(NO_2)]Cl_2$ is red in colour. Give IUPAC name of its linkage isomer.

[2 Marks]

Question 25. Why is boiling point of o-dichlorobenzene higher than p-dichlorobenzene but melting point of para isomer is higher than ortho isomer?

[2 Marks]

Question 26.

For the pair phenol and cyclohexanol, answer the following:

(a) Why is phenol more acidic than cyclohexanol?

(b) Give one chemical test to distinguish between the two.

[2 Marks]

Question 27.

(i) Draw the zwitter ion structure for sulphanilic acid.

(ii) How can the activating effect of $–NH_2$ group in aniline be controlled?

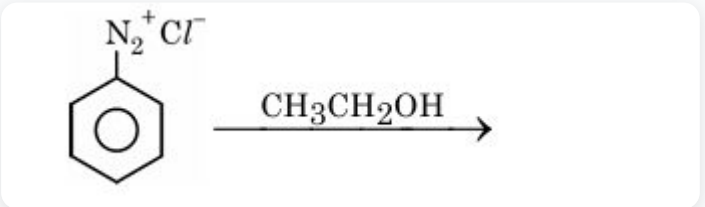
[2 Marks]

Question 28.

(i) Complete the reaction with the main product formed :

(ii) Convert Bromoethane to Propanamine.

[2 Marks]



Question 29.

Give the reaction of glucose with hydrogen cyanide. Presence of which group is confirmed by this reaction ?

[2 Marks]

Question 30.

Calculate the emf of the following cell at 298 K:

$Fe(s) \mid Fe^{2+}(0.01\ M) \parallel H^{+}(1\ M) \mid H_2(g)\ (1\ bar), Pt(s)$

Given: $E°_{cell} = 0.44\ V$

[2 Marks]

Section D

Question 31.

(a) For the reaction
$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ at 318 K,
calculate the rate of reaction if rate of disappearance of $N_2O_5(g)$ is 1.4×10^{-3} mol m^{-3} s^{-1}.

(b) For a first order reaction, derive the relationship
$t_{99}\% = 2t_{90}\%$

[3 Marks]

Question 32.

(a) On the basis of crystal field theory, write the electronic configuration for d^5 ion with a strong field ligand for which $\Delta_0 > P$.

(b) $[Ni(CO)_4]$ has tetrahedral geometry while $[Ni(CN)_4]^{2-}$ has square planar, yet both exhibit diamagnetism. Explain.

[Atomic number: Ni = 28]

[3 Marks]

Question 33.

(a) Illustrate Sandmeyer's reaction with an equation.

(b) Explain why $(CH_3)_2NH$ is more basic than $(CH_3)_3N$ in aqueous solution.

[3 Marks]

Question 34.

Give reasons for any three of the following observations:

(a) Penta-acetate of glucose does not react with hydroxylamine.

(b) Amino acids behave like salts.

(c) Water-soluble vitamins must be taken regularly in diet.

(d) The two strands in DNA are complementary to each other.

[3 Marks]

Question 35.

(i) Why is the C–O bond length in phenols less than that in methanol?

(ii) Arrange the following in order of increasing boiling point:
Ethoxyethane, Butanal, Butanol, n-butane

(iii) How can phenol be prepared from anisole? Give reaction.

[3 Marks]

Question 36.

(i) Give mechanism of the following reaction :

(ii) Illustrate hydroboration – oxidation reaction with an example.

[3 Marks]

$$CH_3CH_2OH \xrightarrow[413\ K]{H_2SO_4} CH_3CH_2 - O - CH_2CH_3 + H_2O$$

Section E

Question 37.

(i) Why is boiling point of 1 M NaCl solution more than that of 1 M glucose solution?

(ii) A non-volatile solute 'X' (molar mass = 50 g mol^{-1}) when dissolved in 78 g of benzene reduced its vapour pressure to 90%. Calculate the mass of X dissolved in the solution.

(iii) Calculate the boiling point elevation for a solution prepared by adding 10 g of $MgCl_2$ to 200 g of water assuming $MgCl_2$ is completely dissociated.
(K_β for water = 0.512 K kg mol^{-1}, Molar mass of $MgCl_2$ = 95 g mol^{-1})

[5 Marks]

Question 38.

(i) Why is the value of Van't Hoff factor for ethanoic acid in benzene close to 0.5?

(ii) Determine the osmotic pressure of a solution prepared by dissolving 2.32×10^{-2} g of K_2SO_4 in 2 L of solution at 25 °C, assuming that K_2SO_4 is completely dissociated.
(R = 0.082 L atm K^{-1} mol^{-1}, Molar mass of K_2SO_4 = 174 g mol^{-1})

(iii) When 25.6 g of sulphur was dissolved in 1000 g of benzene, the freezing point lowered by 0.512 K. Calculate the formula of sulphur (S_x).
(Kf for benzene = 5.12 K kg mol^{-1}, Atomic mass of sulphur = 32 g mol^{-1})

[5 Marks]

Question 39.

(i) Write the reaction involved in Cannizzaro's reaction.

(ii) Why are the boiling points of aldehydes and ketones lower than that of the corresponding carboxylic acids?

(iii) An organic compound 'A' with molecular formula $C_5H_8O_2$ is reduced to n-pentane with hydrazine followed by heating with NaOH and glycol. 'A' forms a dioxime with hydroxylamine and gives a positive Iodoform and Tollen's test. Identify 'A' and give its reactions for Iodoform and Tollen's test.

[5 Marks]

Question 40.

(i) Give a chemical test to distinguish between ethanal and ethanoic acid.

(ii) Why are the α-hydrogens of aldehydes and ketones acidic in nature?

(iii) An organic compound 'A' with molecular formula $C_4H_8O_2$ undergoes acid hydrolysis to form two compounds 'B' and 'C'. Oxidation of 'C' with acidified potassium permanganate also produces 'B'. Sodium salt of 'B' on heating with soda lime gives methane.

(1) Identify 'A', 'B', and 'C'.
(2) Out of 'B' and 'C', which will have higher boiling point? Give reason.

[5 Marks]

Question 41.

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

(ii) Complete the following reaction and justify that it is a disproportionation reaction :

$3MAnO4^{2-}{}_{4}- + 4H^{+} \rightarrow$_____ + _____ + 2 H2O.

(iii) The given graph shows the trends in melting points of transition metals :Explain the reason why Cr has highest melting point and manganese (Mn) a lower melting point.

Explain the reason why Cr has highest melting point and manganese

(Mn) a lower melting point.

[5 Marks]

