CBSE EXAMINATION PAPER-2023

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 79

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. The polarity of C–X bond of alkyl halides is responsible for their nucleophilic substitution, elimination and their reaction with metal atoms to form organometallic compounds. Alkyl halides are prepared by the free radical halogenation of alkanes, addition of halogen acids to alkenes, replacement of OH group of alcohols with halogens using phosphorus halides, thionyl chloride or halogen acids. Aryl halides are prepared by electrophilic substitution of arenes. Nucleophilic substitution reactions are categorised into SN1 and SN2 on the basis of their kinetic properties. Chirality has a profound role in understanding the SN1 and SN2 mechanism.

Question 2.

The following questions are case-based questions. Read the case carefully and answer the questions that follow

The polarity of C- X bond of alkyl halides is responsible for their nucleophilic substitution, elimination and their reaction with metal atoms to form organometallic compounds. Alkyl halides are prepared by the free radical halogenation of alkanes, addition of halogen acids to alkenes, replacement of - OH group of alcohols with halogens using phosphorus halides, thionyl chloride or halogen acids. Aryl halides are prepared by electrophilic substitution of arenes. Nucleophilic substitution reactions are categorised into SN1 and SN2 on the basis of their kinetic properties. Chirality has a profound role in understanding the SN1 and SN2 mechanism.

(1)

What happens when bromobenzene is treated with Mg in the presence of dry ether ?

[1 Marks]

(2)

Write the equations for the preparation of 1-iodobutane from

(1) 1-chlorobutane

(2) but-1-ene.

[2 Marks]

(3)

Which compound in each of the following pairs will react faster in SN1 reaction with OH- ?

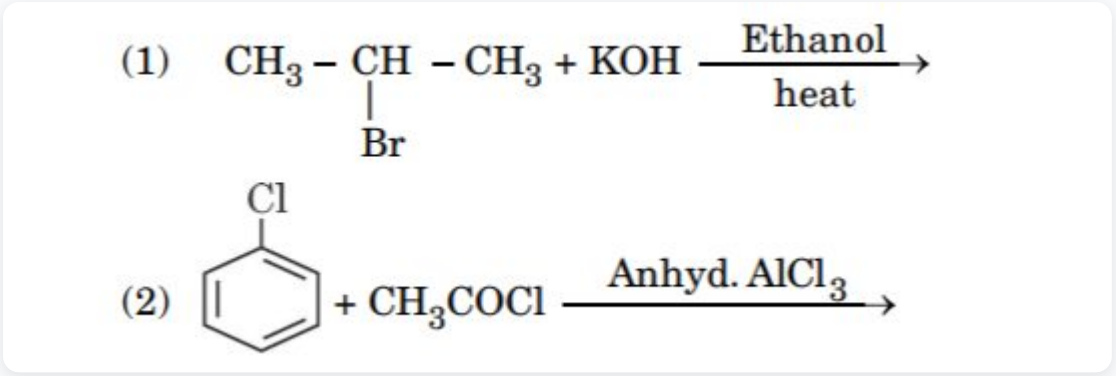
(1) CH_2 = CH- CH_2- Cl or CH_3- CH_2- CH_2- Cl

(2) $(CH_3)_3$C- Cl or CH_3Cl

[1 Marks]

(4)

Write the structure of the major products in each of the following reactions :



[2 Marks]

Question 3.

Coordination compounds are widely present in the minerals, plant and animal worlds and are known to play many important functions in the area of analytical chemistry, metallurgy, biological systems and medicine. Alfred Werner's theory postulated the use of two types of linkages (primary and secondary), by a metal atom/ion in a coordination compound. He predicted the geometrical shapes of a large number of coordination entities using the property of isomerism. The Valence Bond Theory (VBT) explains the formation, magnetic behaviour and geometrical shapes of coordination compounds. It, however, fails to describe the optical properties of these compounds. The Crystal Field Theory (CFT) explains the effect of different crystal fields (provided by the ligands taken as point charges) on the degeneracy of d-orbital energies of the central metal atom/ion.

(1)

When a coordination compound $NiCl_2 . 6H_2O$ is mixed with $AgNO_3$ solution, 2 moles of AgCl are precipitated per mole of the compound. Write the structural formula of the complex and secondary valency for Nickel ion.

[1 Marks]

(2)

Write the IUPAC name of the ionisation isomer of $[Co(NH_3)_5(SO_4)]Cl$.

(3)

Using Valence Bond Theory, predict the geometry and magnetic nature of :

(1) $[Ni(CO)_4]$

(2) $[Fe(CN)_6]^{3-}$

[Atomic number : Ni = 28, Fe = 26]

[2 Marks]

(4)

Give reasons :

(1) Low spin tetrahedral complexes are not formed.

(2) $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{2+}$ is an outer orbital complex.

[Atomic number : Co = 27, Ni = 28]

[2 Marks]

Section B

Question 4.

Which of the following is not true about enantiomers?

[1 Marks]

(A) They have the same specific rotation.

(B) They have the same chemical reactivity.

(C) They have the same density.

(D) They have the same melting or boiling point.

Question 5.

Aspirin is obtained by the acetylation of which of the following compounds?

[1 Marks]

(A) Salicylic acid

(B) Phenol

(C) Acetyl salicylic acid

(D) Salicylaldehyde

Question 6.

The reactivities of the carbonyl compounds HCHO (I), CH_3CHO (II) and CH_3COCH_3 (III) towards nucleophilic addition reaction decreases in the order:

[1 Marks]

(A) II > III > I

(B) I > III > II

(C) III > II > I

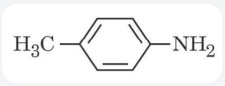
(D) I > II > III

Question 7.

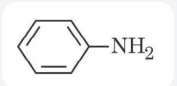
Among the following, which is the strongest base?

[1 Marks]

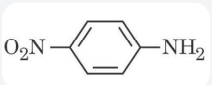
(A)



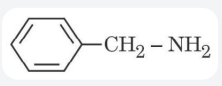
(B)



(C)



(D)



Question 8.

On hydrolysis, which of the following carbohydrates gives only glucose?

[1 Marks]

(A) Lactose

(B) Sucrose

(C) Starch

(D) Fructose

Question 9.

Which of the following vitamins is water soluble?

[1 Marks]

(A) Vitamin E

(B) Vitamin A

(C) Vitamin D

(D) Vitamin C

Question 10.

The unit of the rate of reaction is the same as that of the rate constant for a:

[1 Marks]

(A) first order reaction

(B) it cannot be same

(C) zero order reaction

(D) second order reaction

Question 11.

Kohlrausch gave the following relation for strong electrolyte:

$\Lambda = \Lambda_0 - A\sqrt{C}$ Which of the following equality holds true?

[1 Marks]

(A) $\Lambda = \Lambda_0$ as C → 1

(B) $\Lambda = \Lambda_0$ as C → 0

(C) $\Lambda = \Lambda_0$ as C → ∞

(D) $\Lambda = \Lambda_0$ as C → √A

Question 12.

An azeotropic mixture of two liquids has a boiling point higher than either of the two liquids when it:

[1 Marks]

(A) obeys Raoult's law.

(B) shows large positive deviation from Raoult's law.

(C) shows no deviation from Raoult's law.

(D) shows large negative deviation from Raoult's law.

Question 13.

Which of the following colligative property is used to find the molar mass of proteins?

[1 Marks]

(A) Depression in freezing point

(B) Relative lowering of vapour pressure

(C) Elevation in boiling point

(D) Osmotic pressure

Question 14.

Among the following outermost configurations of transition metals which one shows the highest oxidation state?

[1 Marks]

(A) $3d^5 4s^2$

(B) $3d^3 4s^2$

(C) $3d^5 4s^1$

(D) $3d^6 4s^2$

Question 15.

How many ions are produced in the solution from the complex $[Ni(NH_3)_6]Cl_2$?

[1 Marks]

(A) 5

(B) 3

(C) 2

(D) 4

Question 16.

Which of the following species is not expected to be a ligand?

[1 Marks]

(A) NH_3

(B) NH_4^+

(C) CO

(D) H_2O

Question 17.

Which of the following is the most stable complex species?

[1 Marks]

(A) $[Fe(C_2O_4)_3]^{3-}$

(B) $[Fe(CO)_5]$

(C) $[Fe(CN)_6]^{3-}$

(D) $[Fe(H_2O)_6]^{3+}$

Question 18.

Assertion (A) : Order and molecularity of a reaction are always same.

Reason (R) : Complex reactions involve a sequence of elementary reactions and the slowest step is rate determining.

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

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

Question 19.

Assertion (A) : Electrolysis of aqueous solution of NaCl gives chlorine gas at anode instead of oxygen gas.

Reason (R) : Formation of oxygen gas at anode requires overpotential.

[1 Marks]

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

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

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

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

Question 20.

Assertion (A) : Nucleophilic substitution of iodoethane is easier than chloroethane.

Reason (R): Bond energy of C Cl bond is less than C I bond.

[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 true, but Reason (R) is false.

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

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

Question 21.

Assertion (A): Zinc is not regarded as a transition element.

Reason (R): In zinc, 3d orbitals are completely filled in its ground state as well as in its oxidised state.

[1 Marks]

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

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

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

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

Section C

Question 22.

Write the structures and IUPAC names of the products expected from the following reactions:

(a) Reaction of methanal with $(CH_3)_2CHMgBr$ followed by hydrolysis.

(b) Reaction of phenol with conc. HNO_3 .

[2 Marks]

Question 23.

A chemical reaction $2N_2O_5\ (g) \longrightarrow 4NO_2\ (g) + O_2\ (g)$ in gas phase was carried out in a closed vessel. The concentration of NO2 was found to increase by 5* 10^{-3} mol L^{-1} in 10 seconds. Calculate :

(a) the rate of formation of NO_2.

(b) the rate of consumption of N_2O_5 .

[2 Marks]

Question 24.

Define fuel cell and write its two advantages.

[2 Marks]

Question 25.

(i) How are carbohydrates stored in animal body ? Mention any one organ where they are present.

(ii) What is the basic structural difference between starch and cellulose ?

[2 Marks]

Question 26.

Differentiate between :

(i) Peptide linkage and Glycosidic linkage

(ii) Nucleoside and Nucleotide

[2 Marks]

Question 27.

Give reasons for the following :

(a) Carboxylic carbon is less electrophilic than Carbonyl carbon of aldehydes and ketones.

(b) Propanal is more reactive than Propanone towards addition of HCN.

[2 Marks]

Question 28.

Write the chemical equation involved in the following reactions :

(a) Carbylamine reaction

(b) Gabriel phthalimide synthesis

[2 Marks]

Question 29.

Give reasons for the following :

(a) Aquatic animals are more comfortable in cold water in comparison to warm water.

(b) Sprinkling of salt helps in clearing the snow-covered roads in hilly areas.

[2 Marks]

Question 30.

Using E° values of X and Y given below, predict which is better for coating the surface of Iron to prevent corrosion and why ?

Given : E° X^{2+}/X = -2.36V

E° Y^{2+}/Y = -0.14V

E° Fe^{2+}/Fe = -0.44V

[2 Marks]

Section D

Question 31.

(a) Write the mechanism of the following reaction :

(b) Write the equation of the reaction for the preparation of phenol from cumene.

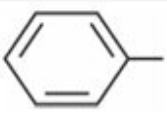
[3 Marks]

$$CH_3 - CH_2 - OH \xrightarrow[443\ K]{H^+} CH_2 = CH_2 + H_2O$$

Question 32.

Write the structures of A, B and C in the following reactions :

[3 Marks]

(i)  $\xrightarrow[\Delta]{NH_3}$ A $\xrightarrow{Br_2 + NaOH}$ B $\xrightarrow[0°C]{NaNO_2 + HCl}$ C

(ii) $CH_3CH_2Br \xrightarrow{KCN}$ A $\xrightarrow{LiAlH_4}$ B $\xrightarrow[0°C]{HNO_2}$ C

Question 33.

0.3 g of acetic acid (M = 60 g mol^{-1}) dissolved in 30 g of benzene shows a depression in freezing point equal to 0.45 °C. Calculate the percentage association of acid if it forms a dimer in the solution.

(Given : Kf for benzene = 5.12 K kg mol^{-1})

[3 Marks]

Question 34.

The rate of a reaction doubles when temperature changes from 27 °C to 37 °C. Calculate energy of activation for the reaction.

(R = 8 .314 J K^{-1} mol^{-1})

(Given : log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021)

[3 Marks]

Question 35.

Write the structure of product when D-Glucose reacts with the following : (any three)

(a) HI

(b) Conc. HNO_3

(c) Br_2 water

(d) HCN

[3 Marks]

Question 36.

How will you convert the following :

(i) Aniline to p-bromoaniline

(ii) Ethanoic acid to methanamine

(iii) Butanenitrile to 1-aminobutane

[3 Marks]

Section E

Question 37.

(i) Account for the following:

(1) Transition metals form complex compounds;

(2) The $E°Mn^{2+}/Mn$ value for manganese is highly negative whereas $E°Mn^{2+}/Mn$ is highly positive.

(3) Cu^{2+} ion is unstable in aqueous solution.

(ii) Write the equations involved in the preparation of $KMnO_4$ from Pyrolusite ore (MnO_2).

[5 Marks]

Question 38.

(i) Identify the following :

(1) Transition metal of 3d series that exhibits only one oxidation state.

(2) Transition metal of 3d series that acts as a strong reducing agent in +2 oxidation state in aqueous solution.

(ii) Complete and balance the following equations :

(1) $Cr_2O^{2-}_7 + 14H^+ + 6Fe^{2+} \longrightarrow$

(2) $KMnO_4$ (heat) $\longrightarrow$

(iii) What is Misch metal ? Write its one use.

[5 Marks]

Question 39.

(i) An organic compound (X) having molecular formula $C_5H_{10}O$ can show various properties depending on its structures. Draw each of the structures if it

(1) gives positive iodoform test.

(2) shows Cannizzaro's reaction

(3) reduces Tollens' reagent and has a chiral carbon.

(ii) Write the reaction involved in the following :

(1) Wolff-Kishner reduction

(2) Hell-Volhard-Zelinsky reaction

[5 Marks]

Question 40.

(i) How can you convert each of the following compounds to Benzoic acid ?

(1) Acetophenone

(2) Ethylbenzene

(3) Bromobenzene

(ii) Arrange the following compounds in increasing order of their property as indicated :

(1) O_2N -CH_2 -COOH, F -CH_2- COOH, CN- CH_2COOH (Acidic character)

(2) Ethanal, Propanal, Butanone, Propanone (Reactivity in nucleophilic addition reactions)

[5 Marks]

Question 41.

(a) Calculate the emf of the following cell at 25° C :

Zn (s) | Zn^{2+} (0.1M) || H^+ (0.01M) | H (g) (1 bar), Pt (s)

[Given: E° Zn^{2+}/Zn = -0.76V, E° H^+/H = 0.00V, log 10 = 1]

(b) State Kohlrausch law of independent migration of ions. Why does the conductivity of a solution decrease with dilution ?

[5 Marks]