# CBSE Class 12 Chemistry
## Sample paper 04 (2020-21)

**Maximum Marks: 70**
**Time Allowed: 3 hours**

**General Instructions:**

a. There are 33 questions in this question paper. All questions are compulsory.
b. Section A: Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
c. Section B: Q. No. 17 to 25 are short answer questions and carry 2 marks each.
d. Section C: Q. No. 26 to 30 are short answer questions and carry 3 marks each.
e. Section D: Q. No. 31 to 33 are long answer questions carrying 5 marks each.
f. There is no overall choice. However, internal choices have been provided.
g. Use of calculators and log tables is not permitted.

### Section A

1. **Read the passage given below and answer any four out of the following questions:**
Fluorine, chlorine, bromine, iodine and astatine are members of Group 17. These are collectively known as the halogens. The halogens are highly reactive non-metallic elements. Fluorine and chlorine are fairly abundant while bromine and iodine less so. Fluorine is present mainly as insoluble fluorides and small quantities are present in the soil, river water plants and bones and teeth of animals. All these elements have seven electrons in their outermost shell ($ns^2$ $np^5$ ). The halogens have the smallest atomic radii in their respective periods due to maximum effective nuclear charge. Halogens display smooth variations in their physical properties. Fluorine and chlorine are gases, bromine is a liquid and iodine is a solid. Their melting and boiling points steadily increase with atomic number. All halogens are coloured. $F_2$, has yellow, $Cl_2$, greenish-yellow, $Br_2$, red and $I_2$, violet colour.

**The following question are multiple choice questions. Choose the most appropriate answer.**

i. Which of the following is the correct set of increasing atomic radius
   a. F > Cl > Br > I
   b. Cl > Br > I > F
   c. Br > I > F > Cl
   d. F > I > Cl > Br

ii. _______ is the most electronegative element in the periodic table.
   a. F
   b. I
   c. Br
   d. Cl

iii. Why negative electron gain enthalpy of fluorine is less than that of chlorine?
   a. Due to the small size of fluorine atom
   b. Due to strong interelectronic repulsions in the relatively small 2p orbitals of fluorine
   c. Both (a) and (b)
   d. None of these

iv. X-X bond dissociation enthalpy show which of the following trends
   a. Cl – Cl > Br – Br > I – I
   b. I - I > Br – Br > Cl – Cl
   c. Cl – Cl > Br – Br > F – F
   d. Cl – Cl > F – F > I – I

v. Halogens have maximum negative electron gain enthalpy in the respective periods of the periodic table. Why?
   a. Due to the smallest size
   b. High effective nuclear charge
   c. They readily accept one electron to acquire noble gas electronic configuration
   d. All of these

2. **Read the following and answer any four out of the following questions:**

Some substances at low concentrations behave as normal strong electrolytes, but at higher concentrations exhibit colloidal behaviour due to the formation of aggregates this substance is called associated colloid. The aggregated particles thus formed are micelles. The formation of micelles takes place only above a particular temperature and above a particular concentration. Micelles may contain as many as 100 molecules or more. Soap is sodium or potassium salt of higher fatty acid. It consists of two parts a long hydrocarbon chain R which is hydrophobic and a polar group COO which is hydrophilic. Micelle consists of a hydrophobic hydrocarbon like central core. The cleansing action of soap is due to the fact that soap molecules form micelle around the oil droplet. Soap helps in emulsification and washing away from oils and fats.

**In these questions, a statement of assertion followed by a statement of the reason is given below. Choose the correct answer out fo the following choices**

a. Assertion and reason both are correct statements and reason is correct explanation for assertion.
b. Assertion and reason both are correct statements and reason is not correct explanation for assertion.
c. Assertion is correct but reason is wrong statement.
d. Assertion is wrong but reason is correct statement.

i. **Assertion:** On dilution associated colloids revert back to individual ions.
**Reason:** Associated colloids have both lyophobic and lyophilic parts.

ii. **Assertion:** Soap is represented as $RCOO^-Na^+$.

**Reason:** Soap when dissolved in water, do not dissociates into $RCOO^-$ and $Na^+$ ions.

iii. **Assertion:** Surface active agents such as soaps and synthetic detergents belong to associated colloids.

**Reason:** When soap dissolves in water it dissociates into $RCOO^-$ and $Na^+$ ions. The $RCOO^-$ ion present on the surface of the water with their $COO^-$ group in water and the hydrocarbon chains R staying away from it and remain at the surface water.

iv. **Assertion:** Soap molecules form micelle around the oil droplet.
**Reason:** Micelle formed in such a way that hydrophilic part of the stearate ions is in the oil droplet and hydrophobic part projects out of the grease droplet.

v. **Assertion:** Soap helps in emulsification and washing away of oils and fats.
**Reason:** The polar groups of soap interact with water, the oil droplet surrounded by stearate ions is pulled in water and removed from the dirty surface.

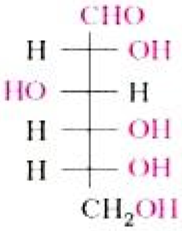
3. Quaternary ammonium salt is formed:
   a. By electrophilic substitution reaction
   b. By nucleophilic addition reaction
   c. By nucleophilic substitution of primary amines

   d. By nucleophilic substitution of tertiary amine

4. Nucleic acids are the polymers of
   a. sugars
   b. bases
   c. nucleosides
   d. nucleotides

OR

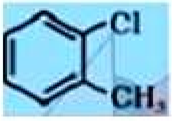
The following compound can be called as



   a. D ( - ) - glucose
   b. D(+) - glucose
   c. L(+) - glucose
   d. L ( - ) - glucose

5. Azeotrope mixture are:
   a. constant boiling mixtures
   b. those will boil at different temperature
   c. mixture of two solids
   d. those which can be fractionally distilled

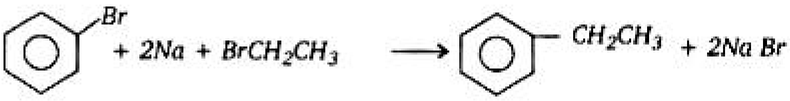
6. Give IUPAC names of the following compound:

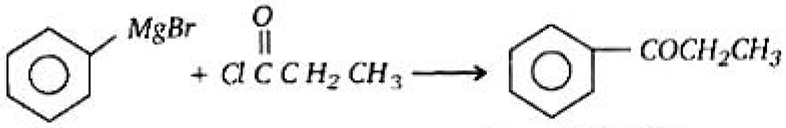


   a. Both 1-chloro-2-methylbenzene and 2-chlorotoulene
   b. 2 - Chlorotoluene
   c. O - Chlorotoluene
   d. 1 - Chloro - 2 - methylbenzene

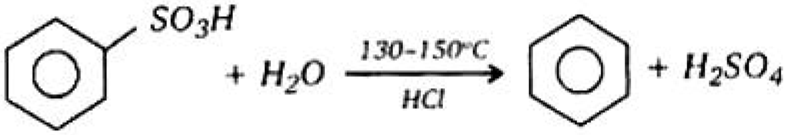
OR

Which of the following is a Wurtz-Fitting reaction?

a. 

b. 

c. 

d. 

7. Which of the following methods of preparation of amines will give same number of carbon atoms in the chain of amines as in the reactant?
   a. Treatment of amide with bromine in an aqueous solution of sodium hydroxide
   b. Heating alkylhalide with potassium salt of phthalimide followed by hydrolysis
   c. Reaction of nitrite with $LiAlH_4$
   d. Reaction of amide with $LiAlH_4$ followed by treatment with water

OR

The nitrogen atom of trimethylamine is _________ hybridized which is reflected in the CNC bond angle of _________.

   a. $sp^3$,120°
   b. $sp^2$, 120°
   c. $sp^3$, 108°
   d. $sp^2$, 108°

8. Mohr's salt is a:
   a. Basic salt
   b. Normal salt
   c. Acidic salt
   d. Double salt

OR

IUPAC name of $[Pt(NH_3)_2Cl(NO_2)]$ is:

a. Platinum diaminechloritrite
b. Diamminechlornitrite-N-platinate (II)
c. None of these
d. Chloronitrito-N-ammine platinum (II)

9. Which of the following is the most likely structure of $CrCl_3.6H_2O$ if 1/3 of total chlorine of the compound is precipitated by adding $AgNO_3$ to its aqueous solution?
a. $[Cr(H_2O)_6]Cl_3$
b. $[Cr(H_2O)_3Cl_3](H_2O)_3$
c. $[Cr(H_2O)_5Cl]Cl_2.H_2O$
d. $[Cr(H_2O)_4Cl_2]Cl.2H_2O$

10. Molecules whose mirror image is non-superimposable over them are known as chiral. Which of the following molecules is chiral in nature?
a. 2-Bromopropan-2-ol
b. 2-Bromopropane
c. 2-Bromobutane
d. 1-Bromobutane

11. Which type of solid conduct electricity in molten state but not in solid state?
a. Network
b. Metallic
c. Covalent
d. Ionic

12. **Assertion:** Toxic metal ions are removed by the chelating ligands.
**Reason:** Chelate complexes tend to be more stable.
a. Assertion and reason both are true, the reason is the correct explanation of assertion.
b. Assertion and reason both are true but reason is not the correct explanation of assertion.
c. Assertion is true, reason is false.
d. Assertion is false, reason is true.

13. **Assertion:** Deoxyribose, $C_5H_{10}O_4$ is not a carbohydrate.
**Reason:** Carbohydrates are hydrates of carbon so compounds that follow $C_x(H_2O)_y$ formula are carbohydrates.
a. Assertion and reason both are correct statements and reason explain the assertion.

b. Both assertion and reason are wrong statements.
c. The assertion is the correct statement and reason is the wrong statement.
d. The assertion is the wrong statement and reason is the correct statement.

14. **Assertion:** 1 M solution of Glauber's salt is isotonic with 1 M solution of $KNO_3$.

**Reason:** Solutions having same molar concentrations of solute may or may not have same osmotic pressure.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

OR

**Assertion:** Elevation in boiling point for two isotonic solutions may not be the same.
**Reason:** Boiling point depends upon the concentration.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Both assertion and reason are INCORRECT.

15. **Assertion:** Phenols give o - and p-nitrophenol on nitration with conc. $HNO_3$ and $H_2SO_4$ mixture.

**Reason:** -OH group in phenol is o-, p-directing.

a. Assertion and reason both are correct and the reason is correct explanation of assertion.
b. Assertion and reason both are wrong statements.
c. The assertion is a correct statement but the reason is the wrong statement.
d. The assertion is wrong statement but the reason is the correct statement.

16. **Assertion:** The boiling points of alkyl halides decrease in the order: RI > RBr > RCl > RF

**Reason:** The boiling points of alkyl chlorides, bromides, and iodides are considerably higher than that of the hydrocarbon of comparable molecular mass.

a. Assertion and reason both are correct statements but the reason is not the correct explanation of assertion.

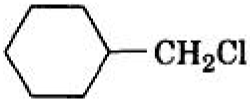
b. Assertion and reason both are correct and the reason is the correct explanation of assertion.

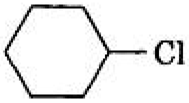
c. Assertion and reason both are wrong statements.

d. The assertion is correct but the reason is the wrong statement.

## Section B

17. Which one in the following pairs of substances undergoes $S_N2$ substitution reaction faster and why?

i. 

or 

ii. 

or 

OR

Out of o-and p-dibromobenzene which one has a higher melting point and why?

18. Calculate the osmotic pressure in pascals exerted by a solution prepared by dissolving 1.0 g of polymer of molar mass 185,000 in 450 mL of water at 37°C.

19. Arrange the following complexes in the increasing order of conductivity of their solution: $[CO(NH_3)_3Cl_3]$, $[Co(NH_3)_4Cl_2]Cl$, $[Co(NH_3)_6]Cl_3$, $[Cr(NH_3)_5Cl]Cl_2$

OR

Describe the shape and magnetic behaviour of the complex $[Ni(CN)_4]^{2-}$.

20. State the role of activated complex in a reaction and state its relation with activation energy.

21. The decomposition of A into product has value of k = $4.5 \times 10^3 s^{-1}$ at 10°C and energy of activation 60 kJ $mol^{-1}$. At what temperature would k be $1.5 \times 10^4 s^{-1}$?

22. Predict the major product of acid catalysed dehydration of
    i. 1-Methylcyclohexanol and
    ii. Butan-1-ol

23. Write some characteristics of interstitial compounds.

24. Convert methane to ethane.

25. How can you determine the atomic mass of an unknown metal if you know its density

and the dimension of its unit cell? Explain.

## Section C

26. Oxygen is a gas but sulphur is a solid. Explain.

OR

$SF_6$ is known but $SCl_6$ is not. Why?

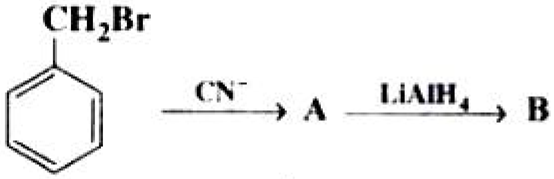
27. Write reactions for the conversion of:
    i. Aniline to benzene
    ii. Methyl amine to methyl cyanide
    iii. Propanenitrile to ethylamine.

OR

i. Stating the necessary reaction conditions, write chemical equations to obtain the following:

   Chlorobenzene from aniline

ii. Identify A and B in the following:

a. 

b. $\mathbf{R_2CO \xrightarrow{NH_3} A \xrightarrow{Ni/H_2} B}$

28. Explain how much portion of an atom located at:
    i. corner.
    ii. body centre of a cubic unit cell is part of its neighbouring unit cell.
29. How can reducing and non-reducing sugars be distinguished? Mention the structural features characterising reducing sugars.
30. How is t-butyl alcohol obtained from acetone?

## Section D

31. Explain the following observations:
    i. $Cu^+$ ion is unstable in aqueous solutions.
    ii. Although $Co^{2+}$ ion appears to be stable, it is easily oxidised to $Co^{3+}$ ion in the presence of a strong ligand.
    iii. The $E^{o}_{Mn^{2}+/Mn}$ value for the manganese is much more than expected from the trend

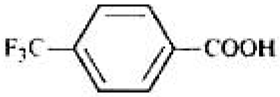
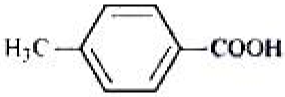
for other elements in the series.

OR

Explain giving reasons:

i. Transition metals and many of their compounds show paramagnetic behaviour.
ii. The enthalpies of atomisation of the transition metals are high.
iii. The transition metals generally form coloured compounds.
iv. Transition metals and their many compounds act as good catalyst.

32. Which acid of each pair shown here would you expect to be stronger?

i. $CH_3CO_2H$ or $CH_2FCO_2H$
ii. $CH_2FCO_2H$ or $CH_2ClCO_2H$
iii. $CH_2FCH_2CH_2CO_2H$ or $CH_3CHFCH_2CO_2H$
iv.  or 

OR

Write the chemical equation to illustrate each of the following name reactions:

i. Rosenmund reduction
ii. Hell-Volhard-Zelinsky reaction
iii. Cannizzaro reaction

33. The resistance of a conductivity cell when filled with 0.05 M solution of an electrolytes X is 100 ohms at 40°C. The same conductivity cell filled with 0.01 M solution of electrolyte Y has a resistance of 50 ohms. The conductivity of 0.05 M solution of electrolyte X is $1.0 \times 10^{-4} S cm^{-1}$ calculate.

i. Cell constant
ii. Conductivity of 0.01 MY solution
iii. Molar conductivity of 0.01 MY solution.

OR

Conductivity of 0.00241 M acetic acid is $7.896 \times 10^{-5}$ S $cm^{-1}$. Calculate its molar conductivity and if for acetic acid is 390.5 S $cm^2$ $mol^{-1}$, what is its dissociation constant?

## CBSE Class 12 Chemistry
## Sample paper 04 (2020-21)

## Solution

## Section A

1. i. (a) F>Cl>Br>I
   ii. (a) F
   iii. (c) Both (a) and (b)
   iv. (a) Cl – Cl > Br – Br > I – I
   v. (d) All of these
2. i. (b) Assertion and reason both are correct statements and reason is not correct explanation for assertion.
   ii. (c) Assertion is correct but reason is wrong statement.
   iii. (b) Assertion and reason both are correct statements and reason is not correct explanation for assertion.
   iv. (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
   v. (c) Assertion is correct but reason is wrong statement.
3. (d) By nucleophilic substitution of tertiary amine

   **Explanation:** The primary amine is obtained by nucleophilic substitution of an alkyl halide by $NH_3$.

   $NH_3 + R\text{-}X \rightarrow R\text{-}NH_2 + HX$

   This product then behaves as a nucleophile because of a lone pair of N of $RNH_2$ and further reacts with an alkyl halide to form secondary and tertiary amines, and finally quaternary ammonium salt.

   $RH_2 + RX \rightarrow R_2NH + HX$

   $R_2NH$ can further act as a nucleophile and react with RX

   $R_2NH + RX \rightarrow R_3N + HX$

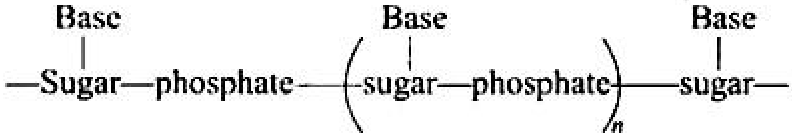
   $R_3N$ can further attack RX to give quaternary amine salts

   $R_3N + RX = R_4N^+X^-$

   The reaction cannot go any further because now the lone pair is not present on N and its valency is filled.

4. (d) nucleotides

   **Explanation:** Nucleic acids are polymers of nucleotides in which nucleic acids are linked together by a phosphodiester linkage also called a polynucleotide.



$$-\overset{\text{Base}}{\overset{|}{\text{Sugar}}}-\text{phosphate}-\left(\overset{\text{Base}}{\overset{|}{\text{sugar}}}-\text{phosphate}\right)_n-\overset{\text{Base}}{\overset{|}{\text{sugar}}}-$$

   e.g., DNA, RNA, etc.

OR

   (b) D(+) - glucose

   **Explanation:** Glucose is correctly named as D(+)-glucose. 'D' before the name of glucose represents the configuration whereas '(+)' represents dextrorotatory nature of the molecule. When the -OH group lies on right hand side in the structure it is said to have D configuration. In (+) glucose, -OH on the lowest asymmetric carbon is on the right side so (+) glucose is assigned D-configuration.

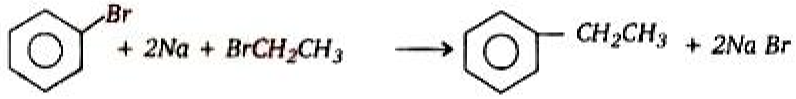
5. (a) constant boiling mixtures

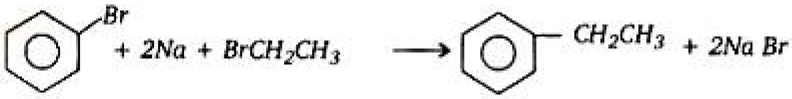
   **Explanation:** constant boiling mixtures

6. (a) Both 1-chloro-2-methylbenzene and 2-chlorotoulene

   **Explanation:** -Cl (chloro) is given priority over $-CH_3$ (methyl) group. So it is numbered as 1. So the IUPAC name is 1-chloro-2 methylbenzene. Also toluene is an IUPAC accepted name for methyl benzene. Hence the given compound can be named as 2-chlorotoluene also, in which case -Cl is numbered

OR

   (a) 

   **Explanation:** 

   A mixture of an alkyl halide and aryl halide gives an alkylarene when treated with sodium in dry ether and is called Wurtz-Fittig reaction. In above reaction ethyl bromide and bromobenzene react with sodium in dry ether to give ethyl benzene.

7. (a) Treatment of amide with bromine in an aqueous solution of sodium hydroxide

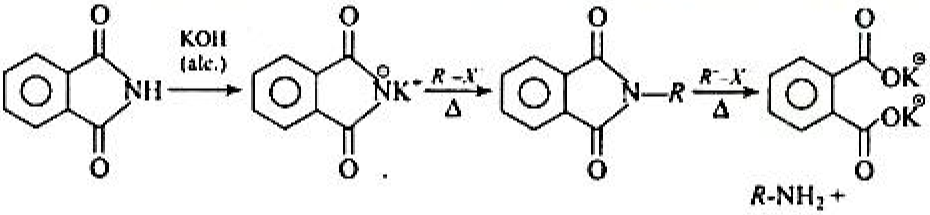
**Explanation:** Aliphatic and aryl/alkyl primary amines can be prepared by the reduction of the corresponding nitriles with lithium aluminium hydride $LiAlH_4$.

$$\underset{Alkynitrite}{R - C \equiv N}\ \underset{Arynitirite}{Ar - C \equiv N} \rightarrow LiAlH_4\ \underset{1^o a \min e}{RCH_2NH_2}$$

Heating alkyl halide with primary, secondary, and tertiary amine can be prepared by reduction of $LiAlH_4$ ether followed by treatment with water.

$$R - CONH_2 \xrightarrow[(ii)H_2O]{(i)LiAlH_4/ether} R - CH_2 - NH_2$$

Heating alkyl halide with potassium salt of phthalimide followed by hydrolysis produces primary amine. This process is known as Gabriel's phthalimide reaction. The number of carbon atoms in the chain of amines of the product is the same as a reactant.



OR

(c) $sp^3$, 108°

**Explanation:** The N atom uses its one 2s and three 2p orbitals for $sp^3$ hybridization and the bond angle is 108° less than normal tetrahedral bond angle due to lone pair- bond-pair repulsion which is more than bond pair-bond pair repulsion.

8. (d) Double salt

**Explanation:** Mohr Salt is $FeSO_4.(NH_4)_2.6H_2O$. It is obtained by a combination of two different salts which were crystallized in the same regular ionic lattice. It is formed by an equimolar mixture of ferrous sulphate and ammonium sulphate. Since two salts are involved, Mohr salt is a double salt.

OR

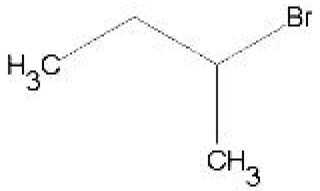
(d) Chloronitrito-N-ammine platinum (II)

**Explanation:** Chloronitrito-N-ammine platinum (II)

9. (d) $[Cr(H_2O)_4Cl_2]Cl.2H_2O$

**Explanation:** In the given molecule, there is 3 Cl present, and $(\frac{1}{3}) \times 3 = 1$ Cl is precipitated per molecule. So, 1 Cl satisfies the primary valence and is ionizable. So 1 Cl will be present outside the coordination sphere. So the correct structure is $[Cr(H_2O)_4Cl_2]Cl.2H_2O$.

10. (c) 2-Bromobutane

**Explanation:**  2-Bromobutane

It is a chiral molecule since it does not contain plane symmetry and centre of symmetry.

11. (d) Ionic

**Explanation:** In solid state the ions are not free to move about, hence they are electrical insulators. However, in molten state or when dissolved in water, the ions become free to move about and they conduct electricity.

12. (a) Assertion and reason both are true, the reason is the correct explanation of assertion.

**Explanation:** When a solution of the chelating ligand is added to a solution containing toxic metals ligands chelates the metal ions by the formation of a stable complex.

13. (b) Both assertion and reason are wrong statements.

**Explanation:** Deoxyribose is a carbohydrate and is the sugar moiety of DNA. Carbohydrates are optically active polyhydroxy aldehyde or polyhydroxy ketone or substances which give these on hydrolysis.

14. (d) Assertion is INCORRECT but, reason is CORRECT.

**Explanation:** Assertion is INCORRECT but, reason is CORRECT.

OR

(d) Both assertion and reason are INCORRECT.

**Explanation:** Both assertion and reason are INCORRECT.

15. (d) The assertion is wrong statement but the reason is the correct statement.

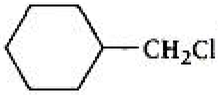
**Explanation:** Phenols give o, p-nitrophenol on nitration with dil. $HNO_3$ and with conc.$HNO_3$ + conc. $H_2SO_4$, phenol gives 2, 4, 6-trinitrophenol ( Known as Picric Acid ).

Since phenol is very reactive towards the electrophilic substitution reaction so in the nitration reaction even it can react with the dilute nitric acid.

16. (a) Assertion and reason both are correct statements but the reason is not the correct explanation of assertion.

**Explanation:** The boiling points of the alkyl halides decrease in the given order because of the size of the halogen atom. Iodide having the highest atomic number has more electrons, which means an increase in Van Der Waals forces and the higher boiling point.

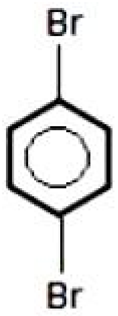
**Section B**

17. i.  It is a primary halide and therefore undergoes $S_N2$ reaction faster.

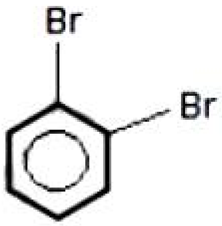
ii.  as iodide ion is a better leaving group because of its larger size therefore, it undergoes $S_N2$ reaction faster.

OR

Out of the two compounds, p-dibromobenzene has a higher melting point. This is because the symmetry of p-dibromobenzene which makes the molecule fit better in the crystal lattice better as compare to o-dibromobenzene. Due to this, it requires a higher temperature to break the bonds between the molecules and thus has a higher melting point.



p-Dibromobenzene



o-Dibromobenzene

18. It is given that:

Volume of water, $V$= 450 mL = 0.45 L

Temperature, $T$ = (37 + 273) K = 310 K

Number of moles of the polymer, $n = \frac{1}{185000} mol$

We know that:

Osmotic pressure, $\pi = \frac{n}{V} RT$

$= \frac{1}{185000} mol \times \frac{1}{0.45} \times 8.314 \times 10^3 PaLK^{-1} mol^{-1} \times 310K$

= 30.98 Pa

= 31 Pa (approximately)

19. $[CO(NH_3)_3Cl_3]$ - does not ionize

$[Co(NH_3)_4Cl_2]Cl = [Co(NH_3)_4Cl_2]^+ + Cl^-$ (ionize to give 2 ions)

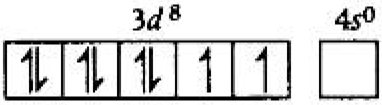
$[Co(NH_3)_6]Cl_3 = [Co(NH_3)_6]^{3+} + 3Cl^-$(ionize to give 4 ions)

$[Co(NH_3)_5Cl]Cl_2 = [Co(NH_3)_5Cl]^{2+} + 2Cl^-$ ( ionize to give 3 ions)

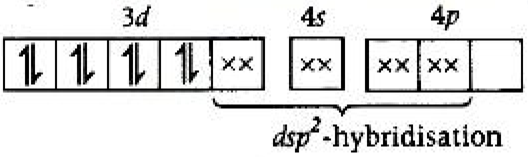
As the number of ions in solution increases, their conductivity also increases. Therefore, conductivity follows the order:
$[CO(NH_3)_3Cl_3] < [Co(NH_3)_4Cl_2]Cl < [Co(NH_3)_5Cl]Cl_2 < [Co(NH_3)_6]Cl_3$

OR

In $[Ni(CN)_4]^{2-}$, nickel is in +2 oxidation state and has the electronic configuration $3d^8\,4s^0$.

$\therefore Ni^{2+} =$ 

As $CN^-$ is a strong field ligand, the pairing of electrons takes place and resulting in $dsp^2$ hybridisation to form four hybrid orbitals. These hybrid orbitals occupied by electron pairs of four $CN^-$ ions. This is an inner orbital complex having square planar geometry.

$\therefore [Ni(CN)_4]^{2-} =$ 

**Magnetic behaviour:** It is clear from above that, there are no unpaired electrons, so the complex is diamagnetic in nature.

20. Activated complex is the higher energy unstable intermediate state formed from the reactants and get decomposed immediately to give the products. In this bonds of reactant are not fully broken while the bonds of products are not fully formed.
Energy of activated complex = Energy of reactant + Activation energy.

21. The decomposition of A into product has value of k = $4.5 \times 10^3 s^{-1}$ at 10°C and energy of activation 60 kJ $mol^{-1}$. At what temperature would k be $1.5 \times 10^4 s^{-1}$?
Give data:

$k_1 = 4.5 \times 10^3 s^{-1}$ ; $k_2 = 1.5 \times 10^4 s^{-1}$ ; $E_a$ =60 kJ $mol^{-1}$ ; $T_1$ = 10°C = 10 + 273 = 283K ;

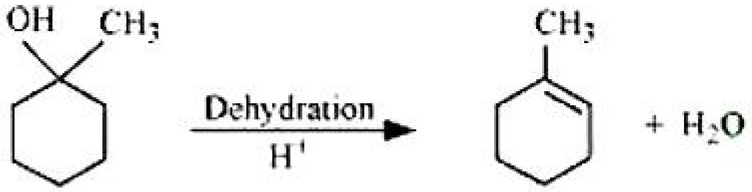
$T_2 = ?$

We know that,

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$
$$\Rightarrow \log \frac{1.5\times10^4 s^{-1}}{4.5\times10^3 s^{-1}} = \frac{60\times1000(T_2-283)}{2.303\times8.314\times283T_2}$$
$$T_2 = \frac{16980000}{57167}$$

$T_2$= 297 K = 297-273= 24°C

22. i.



1 - Methylcyclohexanol    1 - Methylcyclohexene (Major product)

ii. $CH_3CH_2CH_2CH_2OH \xrightarrow[H^+]{Dehydration} CH_3CH=CHCH_3 + H_2O$

Butan-1-ol    But-2-ene (Major product)

23. Some characteristics of interstitial compounds are as follows:
    i. They have high melting points,higher than those of pure metals.
    ii. They are very hard,some compounds approach diamond in hardness
    iii. They retain metallic conductivity.
    iv. They are chemically inert.
24. Step 1: In presence of sunlight with controlled amount of $Cl_2$, methane can be converted to methyl chloride

$$CH_4 \xrightarrow{Cl_2, UV\ Light} CH_3Cl$$

Methane

Step 2: Wurtz reaction: On reacting methyl chloride with sodium in dry ether, ethane is obtained

$$2CH_3Cl + 2Na \rightarrow \underset{Ethane}{CH_3CH_3}$$

25. By knowing the density of an unknown metal and the dimension of its unit cell, the

atomic mass of the metal can be determined.

Let edge length of a unit cell of a crystal= 'a' pm,

Density of the metal= 'd' g/cm$^3$

Mass of one atom of the metal = 'm'

Number of atoms in the unit cell = 'Z'

Now, $\text{Density of unit cell} = \frac{\text{Mass of the unit cell}}{\text{volume of the unit cell}}$ ............(1)

Volume of the unit cell= $a^3$ $(pm)^3$ = $a^3 \times 10^{-30}$ cm$^3$ ...........(2)

Mass of the unit cell = Number of atoms in the unit cell (Z) × Mass of one atom

[ Because, mass of each atom = $\frac{Atomic\ mass}{Avogadro\ number} = \frac{M}{N_\circ}$ ]

Mass of the unit cell = $\frac{Z \times M}{N_\circ}$ ...........(3)

Put values of (2) and (3) in equation (1), we get.

$$Density\ of\ unit\ cell\ (d) = \frac{Z \times M}{a^3 \times 10^{-30} \times N_\circ}\ g/cm^3$$

$$Now,\ M = \frac{d \times a^3 \times 10^{-30} \times N_\circ}{Z}\ g/mol$$

If the edge lengths are different (say a, b and c), Then the above equation becomes:

$$M = \frac{d \times (a \times b \times c) \times 10^{-30} \times N_\circ}{Z}\ g/mol$$

## Section C

26. Oxygen atoms, owing to small size, form $p\pi - p\pi$ bond between two atoms and exist as diatomic ($O_2$) molecules. As a result van der Waals' forces acting on these molecules are very less and the molecules exist in gaseous state.

On the other hand, sulphur atoms, unable to form $\pi$-bonds due to large size, form single covalent bond between atoms which results in formation of cyclic molecules comprising of 8 atoms ($S_8$).

Hence, van der Waals' forces act on these molecules to larger extent and as a result sulphur exists in solid state.

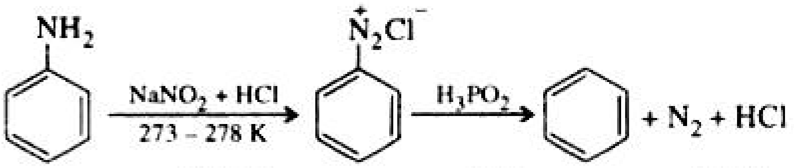
OR

Due to small size, six fluorine atoms can be accommodated around sulphur atom while chlorine atoms being larger in size are difficult to accommodate around sulphur.

The other reason is that the fluorine being highly electronegative and oxidising in nature is capable of unpairing the paired orbitals of the values shell of sulphur atom and thereby showing the highest, oxidation state of +6 while chlorine is not able to do this. therefore,

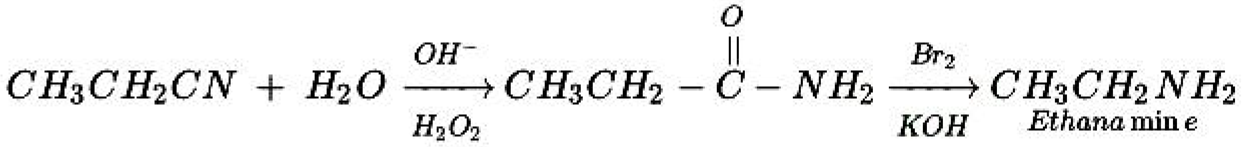
$SF_6$ is known but $SCl_6$ is not known.

27\. i.



ii. $$H_3CNH_2 \xrightarrow{HNO_2} CH_3OH \xrightarrow{PCl_5} CH_3Cl \xrightarrow{KCN} \underset{Methyl\ cyanide}{CH_3C \equiv N}$$

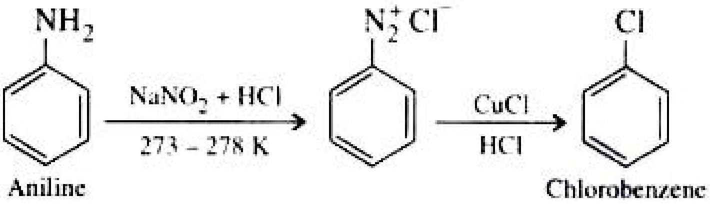
iii.



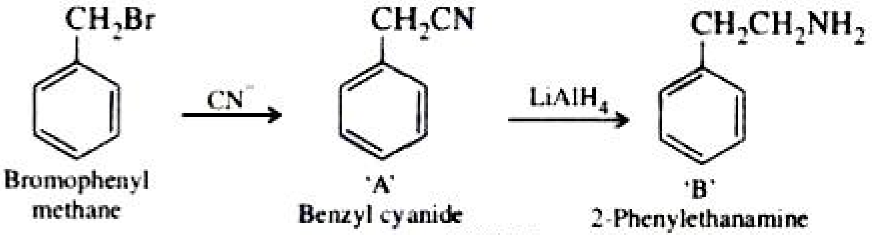
$$CH_3CH_2CN + H_2O \xrightarrow[H_2O_2]{OH^-} CH_3CH_2-\overset{\overset{O}{\|}}{C}-NH_2 \xrightarrow[KOH]{Br_2} \underset{Ethana\min e}{CH_3CH_2NH_2}$$

OR

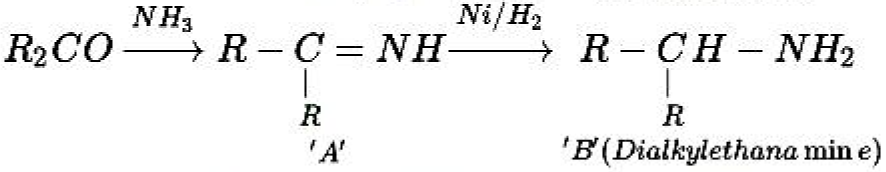
i.



ii. a.



b.



$$R_2CO \xrightarrow{NH_3} \underset{\substack{R\\ 'A'}}{R-\underset{|}{C}=NH} \xrightarrow{Ni/H_2} \underset{\substack{R\\ 'B'(Dialkylethana\min e)}}{R-\underset{|}{C}H-NH_2}$$

28\. i. In a cubic unit cell: An atom at the corner is shared by eight adjacent unit cells. Hence, portion of the atom at the corner is part of its neighbouring unit cell $= \frac{1}{8}$

ii. The atom at the body centre of a cubic unit cell is not shared by other unit cell. Hence, it belongs fully to the unit cell.

29\. **Reducing sugars:** The sugars which reduce Fehling's solution and Tollen's reagent are called reducing sugars.

Example: monosaccharides like glucose, fructose, galactose are reducing sugars.

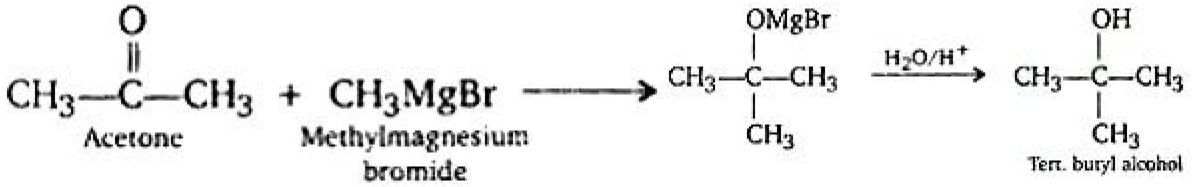
Thus, the presence of free aldehydic or ketonic group is the main feature of reducing sugars.

**Non-reducing sugars:** The sugars which do not reduce Fehling's solution or Tollen's reagent are called non-reducing sugars.

Example: maltose, lactose, sucrose are non-reducing sugars.

Thus, the absence of free aldehydic or ketonic group is the main feature of non-reducing sugars.

In non-reducing sugars, reducing groups of monosaccharides, i.e. aldehydic or ketonic groups are bonded.

30. 

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + CH_3MgBr \longrightarrow CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{OMgBr}{|}}{C}}-CH_3 \xrightarrow{H_2O/H^+} CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{OH}{|}}{C}}-CH_3$$

## Section D

31. i. Copper (I) ions are unstable in aqueous solution and undergo disproportionation.

$2Cu^+ \longrightarrow Cu^{2+} + Cu$

The stability of $Cu^{2+}$ (aq) rather than $Cu^+$ (aq) is due to the much more negative $\Delta_{hyd}$ H of $Cu^{2+}$(aq) than $Cu^+$. which compensates more for the second ionisation enthalpy of Cu.

ii. In $Co^{2+}$, electronic configuration is $3d^7$. There is one unpaired electron even after pairing occurs in the presence of a strong ligand. Hence, $Co^{2+}$ is oxidised to more stable $Co^{3+}$.

iii. In the crystal lattice, transition elements have interstitial vacant spaces into which small sized non-metal atoms such as H, B, C, or N are trapped. These compounds are known as interstitial compounds. These are neither typically ionic nor covalent, eg. TiC, $Mn_4N$, $Fe_3H$, etc.

OR

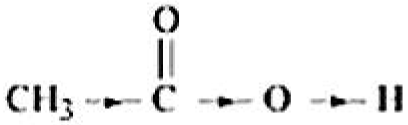
i. Transition metals show paramagnetic behaviour. Paramagnetism arises due to the presence of one or more unpaired electrons in them. For example Mn(Z=25) has configuration $3d^5\ 4s^2$ and has 5 unpaired electrons.

ii. Transition elements have high effective nuclear charge and a large number of valence electrons. They form strong metallic bonds. As the number of unpaired electrons increases strength of metallic bonding increases. When interatomic force increases, enthaply of atomization also increases.Therefore the enthalpy of atomization of transition metals is high.

iii. Most of the complexes of transition metals are coloured. This is because of the absorption of radiation from visible light region to promote an electron from lower energy d-orbitals to higher energy d orbital. In the presence of ligands, the d-orbitals split up into two sets of orbitals having different energies. Therefore, the transition of electrons can take place from lower energy set to higher energy set. The energy required for these transitions is quite small and falls in the visible region of radiation. The ions of transition metals absorb the radiation of a particular wavelength and get excited and on de excitation they emit light in visible region on spectrum, imparting colour to the solution.

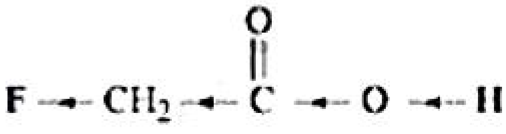
iv. The catalytic activity of the transition elements can be explained by
   a. Their ability to show variable oxidation states and to form complexes- Transition metals form unstable intermediate compounds. Thus, they provide a new path with lower activation energy for the reaction.
   b. Transition metals also provide a suitable surface for the reactions to occur.

32. i.



$CH_3 \rightarrow \overset{\overset{O}{\|}}{C} \rightarrow O \rightarrow H$

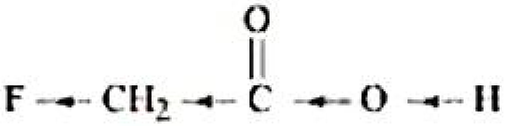
or



$F \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|}}{C} \leftarrow O \leftarrow H$

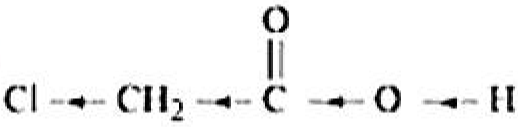
The +I effect of $-CH_3$ group increases the electron density on the O-H bond. Therefore, release of proton becomes difficult. On the other hand, the -I effect of F decreases the electron density on the O-H bond. Therefore, proton can be released easily. Hence, $CH_2FCO_2H$ is a stronger acid than $CH_3CO_2H$ .

ii.



$F \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|}}{C} \leftarrow O \leftarrow H$

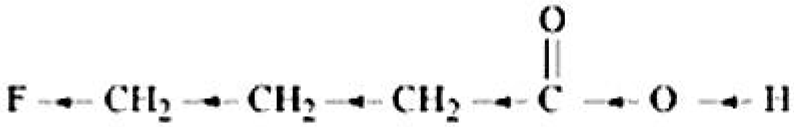
or



$Cl \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|}}{C} \leftarrow O \leftarrow H$

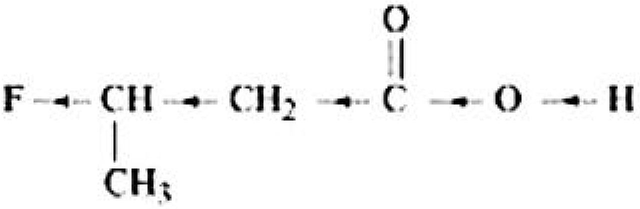
F has stronger -I effect than Cl. Therefore, $CH_2FCO_2H$ can release proton more easily than $CH_2ClCO_2H$ . Hence, $CH_2FCO_2H$ is stronger acid than $CH_2ClCO_2H$

iii.



$F \leftarrow CH_2 \leftarrow CH_2 \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|}}{C} \leftarrow O \leftarrow H$

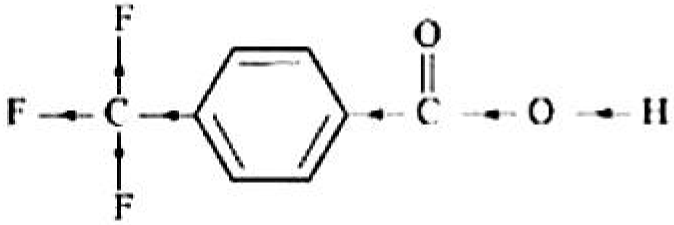
or



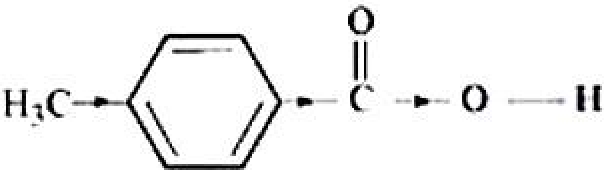
$$F \leftarrow \underset{\underset{CH_3}{|}}{CH} \leftarrow CH_2 \leftarrow \overset{\overset{O}{\|}}{C} \leftarrow O \leftarrow H$$

Inductive effect decreases with an increase in distance. Hence, the +I effect of F in $CH_3CHFCH_2CO_2H$ more than it is in $CH_2FCH_2CH_2CO_2H$. Hence, $CH_3CHFCH_2CO_2H$ is stronger acid than $CH_2FCH_2CH_2CO_2H$

iv.



or



Due to the -I effect of F, it is easier to release proton in the case of compound (A). However, in the case of compound (B), release of proton is difficult due to the +I effect of $-CH_3$ group. Hence, (A) is a stronger acid than (B).

OR

i. **Rosemund reduction**

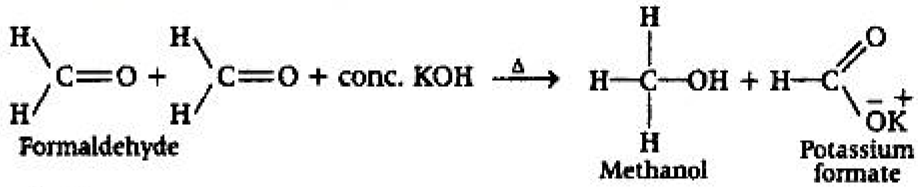
$$\underset{Ethanoyl\ chloride}{CH_3 - \underset{\underset{O}{\|}}{C} - Cl} + H_2 \xrightarrow{Pd\ BaSO_4} \underset{\text{Ethanal}}{\text{CH}_3\text{CHO}} + HCl$$

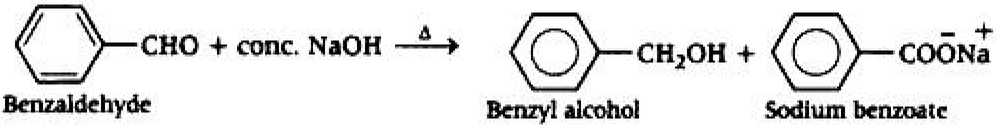
ii. Hell-Volhard-Zelinsky (HVZ)Reaction Carboxylic acids having $\alpha$-hydrogen atom are halogenated at the a-position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give $\alpha$-halocarboxylic acids. The reaction is known as Hell-Volhard Zelinsky reaction.

$$R\text{-}CH_2\text{-}COOH \xrightarrow[(ii)H_2O]{(i)X_2,\text{Re}\,d\ phosphorus} \underset{\alpha-halocarboxyhc\ acid}{R \quad -\underset{\underset{X}{|}}{CH}- \quad COOH} \text{ (X = Cl Br)}$$

iii. **Cannizzaro reaction** Aldehydes which do not have n-H atoms undergo self oxidation and reduction reaction on treatment with cone. alkali this reaction is known as

Cannizzaro reaction. In this reaction, one molecule of aldehyde is reduced to alcohol while another molecule is oxidised to the salt of carboxylic acid.





33. **For electrolyte X**

**Molarity** = 0.05 M

**Resistance** = $100\Omega$

**Conductivity** = $1.0 \times 10^{-4} S cm^{-1}$

**For electrolyte Y**

**Molarity** = 0.01 M

**Resistance** = $50\Omega$

**Conductivity** = ?

i. Cell constant = Conductivity (K) ×Resistance (R)

$$G^* = 1.0 \times 10^{-4} \times 100$$

= $10^{-2}$cm$^{-1}$

ii. Conductivity of solution Y is

$$K = \frac{G^*}{R} = \frac{10^{-2}}{50}$$
$$= 0.02 \times 10^{-2}$$
$$= 2 \times 10^{-4} S cm^{-1}$$

iii. Concentration C = 0.01 M

$$= 0.01\, mol\, L^{-1}$$

$$= 0.01 \times 1000\, mol\, ml^{-3}$$

= 10mol cm$^{-3}$

∴ Molar concentration

$$\lambda_m = \frac{K}{C} = \frac{2 \times 10^{-4}}{10}$$
$$= 0.2 \times 10^{-4} S cm^2 mol^{-1}$$

OR

Given that, $\kappa = 7.896 \times 10^{-5}$ S m$^{-1}$

$C = M = 0.00241\ \text{mol L}^{-1}$

The formula of molar conductivity,

$\Lambda_m = (k \times 1000)/M$

Plug the value we get

$$\Lambda_m = \frac{(7.896 \times 10^{-5} \times 1000)}{0.00241}$$

$= 32.76\text{S cm}^2\ \text{mol}^{-1}$

The formula of degree of dissociation

$\alpha = \Lambda m / \Lambda om$

Plug the value we get

$\alpha = 32.76\text{S}/390.5$

$= 0.084$

The formula of dissociation constant

$K = C\alpha/(1 - \alpha)$

Plug the values we get

$K = 0.00241 \times 0.084/(1- 0.084)$

$= 1.86 \times 10^{-5}\ \text{mol L}^{-1}$