SAMPLE PAPER 9

CHEMISTRY PAPER 1

(THEORY)

Maximum Marks: 70

Time Allowed: Three Hours

*(Candidates are allowed **additional 15 minutes** for **only** reading the paper.*

*They must **NOT** start writing during this time.)*

This paper is divided into four sections – A, B, C and D.
*Answer **all** questions.*
***Section – A** consists of **one** question **having sub-parts** of **one** mark each.*
***Section – B** consists of **ten** questions of **two** marks each.*
***Section – C** consists of **seven** questions of **three** marks each, and*
***Section – D** consists of **three** questions of **five** marks each.*
Internal choices have been provided in one question each in Section B, Section C and Section D.
All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
The intended marks for questions or parts of questions are given in brackets [ ].
Balanced equations must be given wherever possible and diagrams where they are helpful.
When solving numerical problems, all essential working must be shown.
In working out problems, use the following data:
Gas constant R = 1.987 cal deg^{-1} mol^{-1} = 8.314 JK^{-1} mol^{-1} = 0.0821 dm^3 atm $K^{-1}mol^{-1}$
1 L atm = 1 dm^3 atm = 101.3 J, 1 Faraday = 96500 coulombs, Avogadro's number = 6.023 x 10^{23}

SECTION A – 14 MARKS

Question 1

(A)

Ans.: L mol^{-1} s^{-1}, s^{-1}

(ii)
Ans.: Octahedral, square planar

(iii)
Ans.: alkyl nitrites, nitroalkanes
(iv)
Ans.: Conc. HCl, anhydrous $ZnCl_2$

(B)

(i)

Ans.: (c) Velocity of both K^+ and NO_3^- are nearly same

(ii)

Ans.: (a) Triamminebromochloronitroplatinum(IV) chloride

(iii)

Ans.: (b) Decreases

(iv)

Ans.: (a) $CH_3CH_2CH_2N_2Cl$

(v)

Ans.: (d) Equal to that of sucrose solution

(vi)

Ans.: (d) Assertion is false but Reason is true.

(vii)

Ans.: (c) Assertion is true but Reason is false.

(C)

Ans.: (i) Elevation of boiling point is a colligative property. Since sodium chloride dissociates in the solution we get abnormal molecular mass.

(ii) $\Delta T_b = iK_bm$
$= 3 \times 0.52 \times 0.1$
$= 1.56$ K

(iii) $\Delta T_f = iK_fm$

For NaCl, I = 1+1 =2

$\therefore -2 = 2K_fm$

$\Rightarrow K_f m = -1$

For $BaCl_2$, I = 1+2 =3

$\therefore \Delta T_f = K_f m \times i$
$= -1 \times 3$
$= -3\ ^oC$

SECTION B – 20 MARKS

Question 2

Ans.:

(i) $C_2H_5Cl < C_2H_5NH_2 < C_2H_5OH$

(ii) $CH_3COOH > C_2H_5OH > CH_3NH_2 > CH_3OCH_3$

Question 3

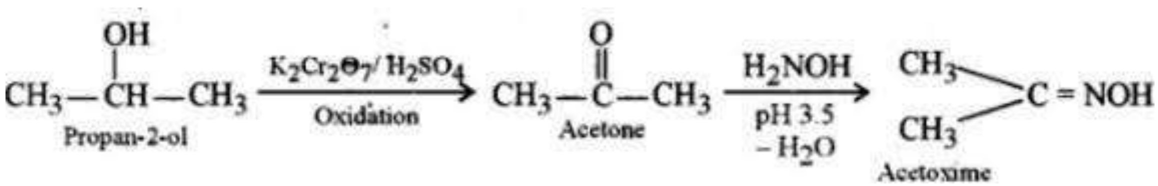
Ans.:

(i) A transition metal exhibits higher oxidation states in oxides and fluorides because oxygen and fluorine are highly electronegative elements, small in size and strongest oxidising agents.

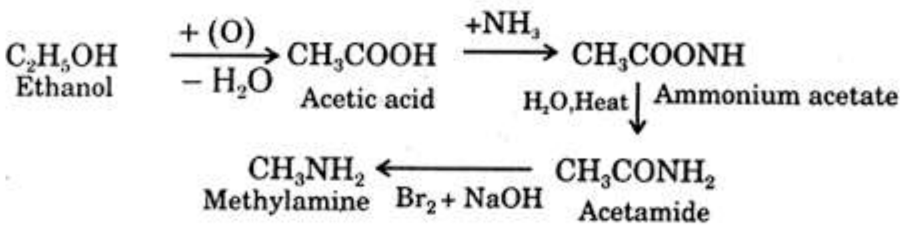
(ii) In the given ions, the oxidation states of V, Cr and Mn are +5, +6 and +7 respectively. As the oxidation state increases, the ease with which the ions accept electrons increases. After reduction V, Cr and Mn form more stable species where Mn is in +2 oxidation state, is relatively more stable (d^5) than Cr^{2+} (d^3) and V^{3+} (d^0).

Question 4

Ans.: **(i)**



(ii)



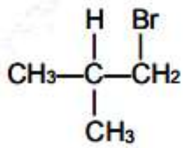
Question 5

Ans.: **(i)** As Cu^{2+} contains one unpaired electron hence, it's salts show paramagnetic behaviour whereas contains no unpaired electron and therefore it shows diamagentic behavior.

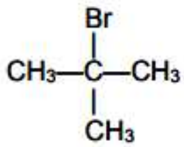
(ii) Due to presence of more unpaired electrons and use of all 4s and 3d electrons in the middle of series.

Question 6

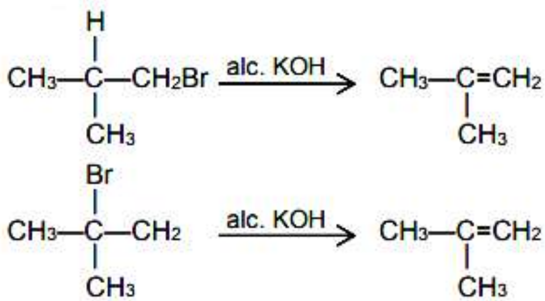
Ans.: **(i)**



1-bromo-2-methyl propane



2-bromo-2-methyl propane



(ii) Racemic mixture contains two enantiomers (*d* and *l* forms) in equal proportions and thus, the rotation due to one isomer is cancelled by the rotation due to another. Therefore, it has zero optical rotation and hence, it is optically inactive. For example, (±)2-Butanol is optically inactive.

Question 7

Ans.: Chlorine is placed below iodine in electrochemical series having higher E^{o}_{Red} and thus undergoes reduction whereas I^- undergoes oxidation.

$$2I^- \rightarrow I_2 + 2e^-$$

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

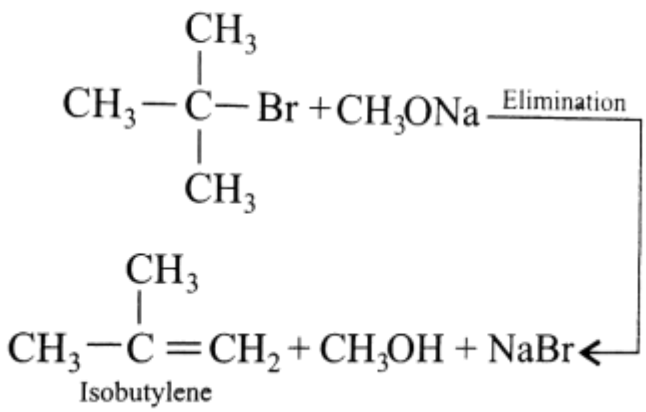
$$Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$$

I_2 so formed gets absorbed in starch to give blue colour.

Question 8

Ans.: **(a)**

(b)



Question 9

Ans.:

Given:

$w = 9{\cdot}25$ g, V = 450 mL $= \frac{450}{1000} = 0{\cdot}45$ litre

$R = 0{\cdot}0821$ L atm K^{-1} mol^{-1}

T = 273 + 27 = 300 K , $\pi = \frac{350}{760} = 0 \cdot 46\ atm$

$$\pi V = \frac{w}{m}RT$$

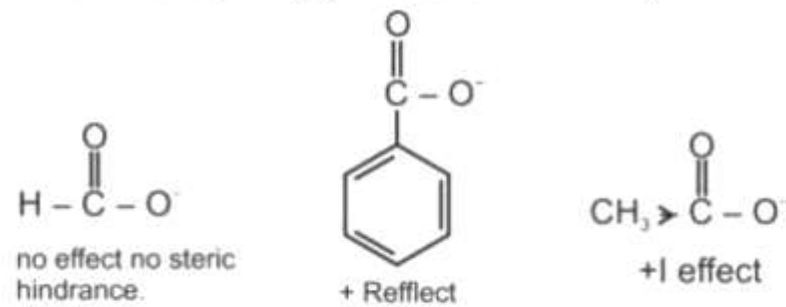
$$\frac{350}{760} \times \frac{450}{1000} = \frac{9{\cdot}25 \times 0{\cdot}0821 \times 300}{m}$$

$$m = \frac{9{\cdot}25 \times 0{\cdot}0821 \times 300}{\frac{350}{760} \times \frac{450}{1000}} = 1099{\cdot}36 \text{ g mol}^{-1}$$

Question 10

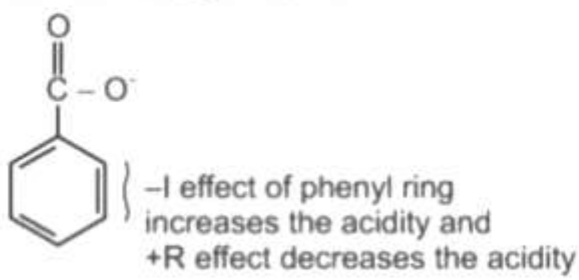
Ans.: **(i)**

More is the stability of conjugate base, more is the acidity.



Equivalent resonating structure provide extra stability and also no steric hindrance.

So most acidic among given options:



So order of acidity $HCOOH > C_6H_5COOH > CH_3COOH$

(ii) Aldehydes and ketones are polar molecules due to the electronegativity difference in C-O bond (O is more electronegative than C). So there is intermolecular interactions in aldehydes and ketones due to the dipole-dipole interactions while hydrocarbons are non-polar so, such interactions are absent.

Question 11

Ans.:

(i) Copper readily loses one electron from its 4s orbital, to form stable 3d electronic configuration.

(ii) The structural variability in actinoids is obtained due to irregularities in metallic radii which are far greater than in lanthanoids.

SECTION C – 21 MARKS

Question 12

Ans.:

(a) Rate expression for 1st experiment

$$4.2 \times 10^{-2} = K\,[A]^{\alpha}[B]^{\beta}$$

$$4.2 \times 10^{-2} = K[0.2]^{\alpha}[0.3]^{\beta} \quad \ldots\ldots\ldots\ldots (1)$$

Rate expression for 3rd experiment

$$1.68 \times 10^{-1} = K[0.4]^{\alpha}\,[0.3]^{\beta} \quad \ldots\ldots\ldots\ldots (2)$$

Dividing eq. (2) by eq. (1)

$$\frac{1.68 \times 10^{-1}}{4.2 \times 10^{-2}} = \frac{K\left[0.4\right]^{\alpha}[0.3]^{\beta}}{K[0.2]^{\alpha}\left[0.3\right]^{\beta}}$$

$$4 = [2]^{\alpha}$$

$$2^2 = 2^{\alpha}$$

$$\alpha = 2$$

Rate expression for 2nd experiment

$$6.0 \times 10^{-3} = K[0.1]^2\,[0.1]^{\beta} \quad \ldots\ldots\ldots\ldots (3)$$

Rate expression for 4th experiment

$$2.40 \times 10^{-2} = K[0.1]^2\,[0.4]^{\beta} \quad \ldots\ldots\ldots\ldots (4)$$

Dividing equation 4 by equation 3

$$\frac{2.40 \times 10^{-2}}{6.0 \times 10^{-3}} = \frac{K\left[0.1\right]^2\left[0.4\right]^{\beta}}{K\left[0.1\right]^2\left[0.1\right]^{\beta}}$$

$$4 = \left[\frac{0.4}{0.1}\right]^{\beta}$$

$$4 = 4^{\beta}$$

$$\beta = 1$$

Order of reaction in respect of A is 2

Order of reaction in respect of B is 1

(b) Rate law for the given reaction is

$$\text{rate} = K[A]^2\left[B\right]^1$$

Thus Order of reaction $n = 2 + 1 = 3$

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$$\text{rate} = K[A]^2[B]^1$$

Thus Order of reaction $n = 2 + 1 = 3$

(c) Rate constant K is calculated by the equation (1)

$$4.2 \times 10^{-2} = K\,[0.2]^2\,[0.3]^1$$

$$K = \frac{4.2\times 10^{-2}}{[0.2]^2[0.3]^1}$$

$$K = \frac{4.2\times 10^{-2}}{.04\times .3}$$

$$K = 3.5\ M^{-3}\ min^{-1}$$

Question 13

Ans.: **(i)** Increasing order of basic strength:

$(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > C_6H_5NH_2$

(ii) Decreasing order of their basic strength in gas phase:

$(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2 > C_6H_5NH_2$

Question 14

Ans.: **(i)** The hydrolysis of sucrose generates an equimolar mixture of fructose and glucose, commercially known as invert sugar.

(ii) Vitamins B and C are two of the most important. Not only do they support a strong immune system and help your body to ward off illness, but they can also help your body to function optimally and give you energy.

(iii) An egg white is rich in protein. When cooked, it becomes firm and opaque. This is because the heat of cooking denatures the protein, causing it to unfold. As the proteins unfold, their hydrophobic sections become exposed and the proteins begin to form a white, solid meshwork.

Question 15

Ans.:

(a) Addition of glucose to water is an endothermic reaction. According to Le Chatelier's principle, on increase in temperature, solubility will increase.

(b) Q is ocean water; due to the presence of salts it freezes at lower temperature (depression in freezing point)

(c)

$K_3[Fe(CN)_6]$ gives 4 ions in aqueous solution

$$i = 1 + (n-1)\alpha$$

$$i = 1 + (4-1)\times 0.0.852$$

$$i = 3.556$$

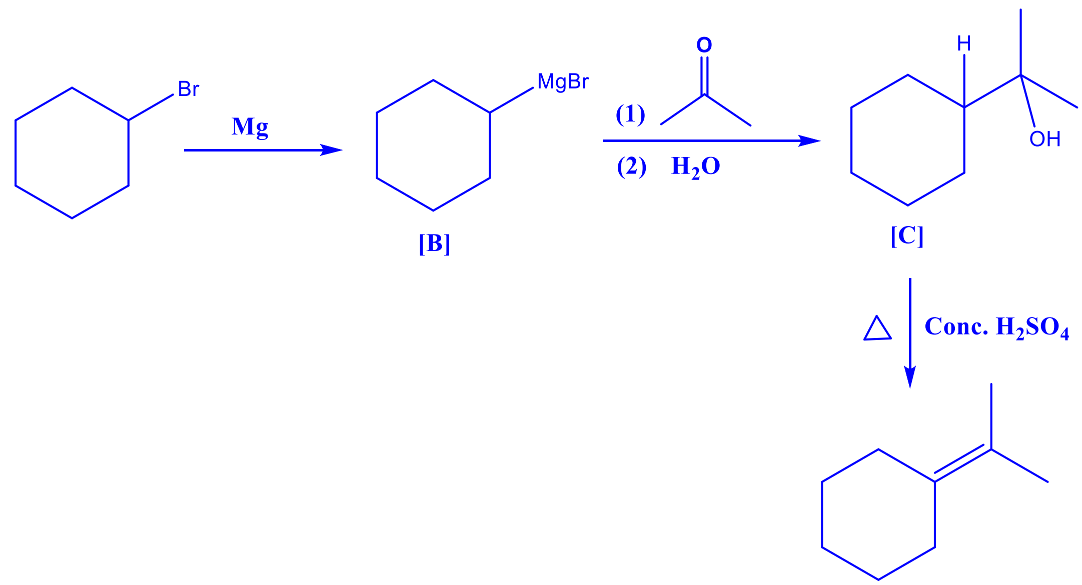
$$\Delta Tb = iKb\ m = 3.556 \times 0.52 \times 1 = 1.85$$

$$Tb = 101.85^{\circ}C$$

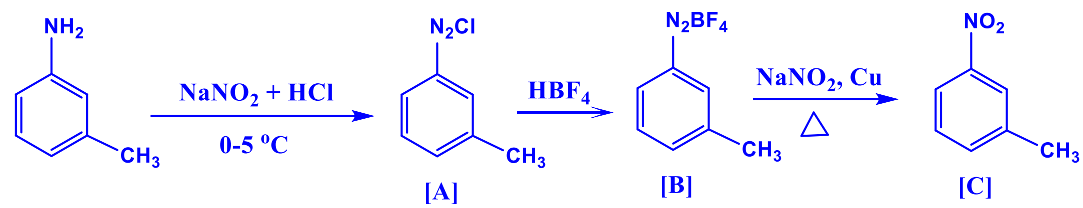
Question 16

Ans.:

(i)



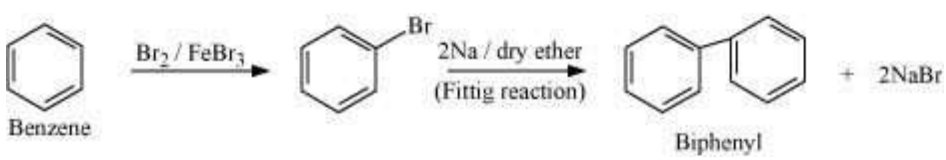
(ii)



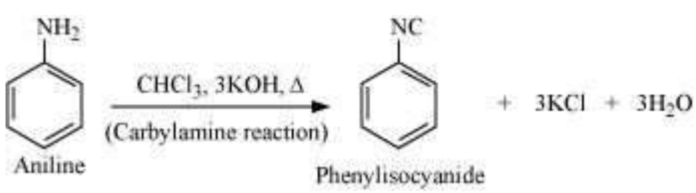
Question 17

Ans.:

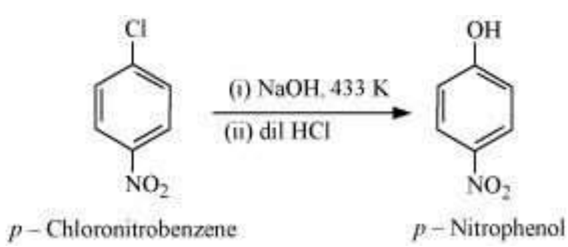
(a)



(b)



(c)



Question 18

Ans.: **(i)**

Radioactive decay follows first order kinetics,

Decay constant (k) = $\frac{0.693}{t_{1/2}} = \frac{0.693}{5730} yr^{-1}$

According to question, living tree has 80% ^{14}C hence,

$$k = \frac{2.303}{t} \log \frac{[A]_0}{[A]}$$

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]}$$

$$t = \frac{2.303 \times 5730}{0.693} \log \frac{100}{80}$$

$$t = \frac{2.303 \times 5730 \times 0.0969}{0.693}$$

t = 1845 years

Hence the age of sample is = 1845 years

(ii)

$$E_a = ?\, k_2 = 2k_1, T_1 = 298K, T_2 = 308K$$

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{T_2 - T_1}{T_1 T_2}\right)$$

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303 \times 8.314}\left(\frac{10}{298 \times 308}\right)$$

$$0.3010 = \frac{E_a}{2.303 \times 8.314} \times \frac{10}{298 \times 308}$$

$$E_a = \frac{0.3010 \times 2.303 \times 8.314 \times 298 \times 308}{10}$$

$$= 52897.7 mol^{-1}.$$

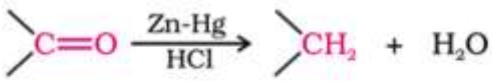
$$E_a = 52.8977 kJmol^{-1}.$$

SECTION D – 15 MARKS

Question 19

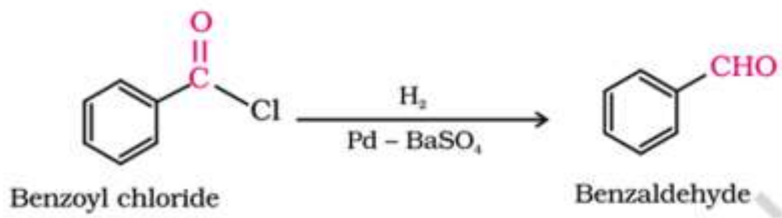
Ans.: **(a)**

Clemmensen reduction



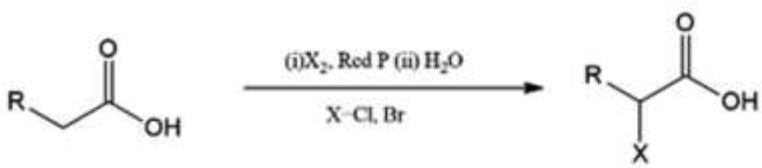
(b)

(Rosenmund's reduction)



(c)

Hell-Volhard Zelinsky Reaction



(ii)

Ans.: A, B and C contain carbonyl group as they give positive 2,4 DNP test

A and B are aldehydes as aldehydes reduce Tollen's reagent
C is a ketone, as it contains carbonyl group but does not give positive Tollen's test.
C is a methyl ketone as it gives positive iodoform test
B is an aldehyde that gives positive iodoform test.
D is a carboxylic acid
Since the number of carbons in the compounds A, B, C and D is three or two
B is CH_3CHO as this is only aldehyde which gives a positive iodoform test.
The remaining compounds A, C and D have three carbons
A is CH_3CH_2CHO, C is CH_3COCH_3 and D is CH_3CH_2COOH

Question 20

Ans.: **(a)** Ammonia acts as a very good ligand but ammonium ion does not form complexes because NH^+_4 ion does not have any lone pair of electrons.

(b) Stability of a coordination compound in a solution is the degree/level of association among the species involved in a state of equilibrium.

Stability can also be written quantitatively in terms of formation constant or stability constant.

$M + 3L \rightarrow ML_3$

Stability constant, $\beta = [ML_3]/[M][L]^3$

Greater the value of β, stronger is the metal –ligand bond.

Factors responsible for the stability of a complex:

1. Charge on the central metal ion – bigger the charge, more stable is the complex.
2. Nature of ligand – chelating ligand produces a more stable complex.
3. The basic strength of ligand- more basic a ligand, more stable its complex.

(c) Crystal-field splitting energy is the difference in the energy between the two levels (i.e., t_{2g} and e_g) that have split from a degenerated d orbital because of the presence of a ligand. It is symbolised as Δo.

Once the orbitals split up, electrons start filling the vacant spaces. An electron each goes into the three t_{2g} orbitals, the fourth electron, however, can enter either of the two orbitals:

- It can go to the e_g orbital (producing $t_{2g}^3 e_g^1$ like electronic configuration), or
- it can go to the t_{2g} orbitals (producing $t_{2g}^4 e_g^0$ like electronic configuration).

This filling of the fourth electron is based on the energy level of Δo. If a ligand has a Δo value smaller than the pairing energy, then the fourth electron enters the e_g orbital. However, if the value of Δo is greater than the value of pairing energy, the electron enters t_{2g} orbital.

Question 21

Ans.: (i)

(a) The ions moving towards the cathode are Na^+. The electrolyte is molten sodium chloride, so only one cation (Na^+) is present in the reaction medium.

(b) The product expected at the anode is chlorine.

The anode reaction is:

$Cl^- \rightarrow \frac{1}{2} Cl_2 (g) + e^-$

(c) The net reaction for the process is:

$2NaCl \rightarrow 2Na + Cl_2 (g)$

OR

(ii) (a)

Ans.: (ii) (a) In molar conductivity vs $\sqrt{C}$ graph,

1. a weak electrolyte gives a curved decreasing graph
2. strong electrolytes give straight-line decreasing graphs, in which the graph of stronger electrolyte will always be above the graph of the comparatively weaker electrolyte.

Graph 3 is curved and corresponds to Na_2SO_4, which is a weak electrolyte. Graph 2 & 1 respectively represent NH_4OH and H_2SO_4 ($\because H_2SO_4$ is a stronger electrolyte than NH_4OH).

(b)

$C = 0.025 \text{ mol L}^{-1}$

$$\Lambda_m = 46.1 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\lambda^0(H^+) = 349.6 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\lambda^0(HCOO^-) = 54.6 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\begin{aligned}\Lambda_m^0(HCOOH) &= \lambda^0(H^+) + \lambda^0(HCOO^-)\\ &= 349.6 + 54.6\\ &= 404.2 \text{ S cm}^2 \text{ mol}^{-1}\end{aligned}$$

Now, degree of dissociation:

$$\begin{aligned}\alpha &= \frac{\Lambda_m(HCOOH)}{\Lambda_m^0(HCOOH)}\\ &= \frac{46.1}{404.2}\\ &= 0.114 (\text{approximately})\end{aligned}$$

Thus, dissociation constant:

$$\begin{aligned}K &= \frac{c \propto^2}{(1-\propto)}\\ &= \frac{(0.025 \text{ mol L}^{-1})(0.114)^2}{(1-0.114)}\\ &= 3.67 \times 10^{-4} \text{ mol L}^{-1}\end{aligned}$$

****************************** The End ******************************