Date: 28/02/2026

Question Paper Code

56/4/1

Set-1

Corporate Office: Aakash Educational Services Limited,
3rd Floor, Incuspaze Campus-2, Plot No. 13, Sector-18, Udyog Vihar, Gurugram, Haryana - 122015

Time: 3 hrs.

Max. Marks: 70

Class-XII

CHEMISTRY (Theory)

(CBSE 2026)

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

(i) This question paper contains **33** questions. **All** questions are compulsory.

(ii) Question paper is divided into **FIVE** sections – Sections **A**, **B**, **C**, **D** and **E**.

(iii) **In Section – A :** Question Nos. **1** to **16** are Multiple Choice (MCQ) type questions, carrying **1** mark each.

(iv) **In Section – B :** Question Nos. **17** to **21** are Very Short Answer (VSA) type questions, carrying **2** marks each.

(v) **In Section – C :** Question Nos. **22** to **28** are Short Answer (SA) type questions, carrying **3** marks each.

(vi) **In Section – D :** Question Nos. **29** and **30** are Case-Based questions, carrying **4** marks each.

(vii) **In Section – E :** Question Nos. **31** to **33** are Long Answer (LA) type questions, carrying **5** marks each.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except Section A. You have to attempt only one of the choices in such questions.

(ix) Use of calculator is **NOT** allowed.

SECTION-A

*Questions No. **1** to **16** are Multiple Choice type questions, carrying **1** mark each.* **16 × 1 = 16**

1. Oxidation of chloroform by air in the presence of sunlight produces a poisonous gas known as:

(A) Mustard gas (B) Tear gas
(C) Chlorine gas (D) Phosgene gas

Answer (D)

Sol. Oxidation of chloroform by air in the presence of sunlight produces a poisonous gas known as phosgene gas

$$2CHCl_3 + O_2 \xrightarrow{\text{light}} \underset{\text{Phosgene}}{2COCl_2} + 2HCl$$

2. Lucas reagent produces cloudiness immediately with:

(A) 2-methyl-1-propanol (B) Butan-2-ol

(C) 2-methyl-2-propanol (D) Butan-1-ol

Answer (C)

Sol. Conc. HCl and $ZnCl_2$ is known as Lucas reagent.

Tertiary alcohols produces cloudiness immediately with Lucas reagent

(A) 2-methyl-1-propanol – Primary alcohol

(B) Butan-2-ol – Secondary alcohol

(C) 2-methyl-2-propanol – Tertiary alcohol

(D) Butan-1-ol – Primary alcohol

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

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

(C) $d_{xy}, d_{x^2-y^2}$ (D) d_{xz}, d_{z^2}

Answer (B)

Sol. The $d_{x^2-y^2}$ and d_{z^2} orbitals which point towards the axes along the direction of the ligand will experience more repulsion

4. The chelating ligand used for the treatment of lead poisoning is:

(A) Ethane-1, 2-diamine (B) Oxalate ion

(C) Dimethylglyoxime (D) EDTA

Answer (D)

Sol. EDTA is used in the treatment of lead poisoning.

5. Manganate ion is paramagnetic due to the presence of:

(A) One unpaired electron (B) Two unpaired electrons

(C) Three unpaired electrons (D) Fully paired electrons

Answer (A)

Sol. Manganate ion is MnO_4^{2-} where Mn is present in +6 oxidation state.

Mn^{+6} $3d^1$ $\boxed{\uparrow}\boxed{}\boxed{}\boxed{}\boxed{}$

Since, 3d subshell contains one unpaired electron, so, manganate ion is paramagnetic.

6. The correct order of decreasing basicities of $C_2H_5NH_2, (C_2H_5)_2NH$ and $(C_2H_5)_3N$ in aqueous solution is:

(A) $(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2$ (B) $(C_2H_5)_2NH > C_2H_5NH_2 > (C_2H_5)_3N$

(C) $C_2H_5NH_2 > (C_2H_5)_2NH > (C_2H_5)_3N$ (D) $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2$

Answer (D)

Sol. The basic strength is inversely related to pK_b.

Base	pK_b
$(C_2H_5)NH_2$	3.29
$(C_2H_5)_2NH$	3.00
$(C_2H_5)_3N$	3.25

The correct decreasing order of basic strength is

$(C_2H_5)_2NH > (C_2H_5)_3N > (C_2H_5)NH_2$

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

(A) 100·52°C (B) 101·04°C

(C) 100·04°C (D) 101·52°C

Answer (B)

Sol. Elevation of boiling point

$\Delta T_b = i\,K_b m$

$T_b - T_b^{\circ} = i\,K_b m$

van't Hoff factor for 100% dissociation of NaCl,

$NaCl \rightleftharpoons Na^+ + Cl^-$

$i = 2$

$T_b - 373.15 = 2 \times 0.52 \text{ K kg mol}^{-1} \times 1 \text{ molal}$

$T_b = 1.04 + 373.15$

$= 374.19 \text{ K}$

$T_b = 374.19 - 273.15$

$= 101.04°C$

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

(A) Vapour pressure of the solution increases

(B) Heating occurs

(C) Cooling occurs

(D) Equilibrium remains unaffected

Answer (C)

Sol. Liquid $\rightleftharpoons$ vapour

Upon decreasing the pressure, the equilibrium gets disturbed.

Hence to re-establish the equilibrium, more evaporation will take place.

Since evaporation is an endothermic process, cooling occurs.

9. Consider the following cell at 298 K :

$Mg(s) \mid Mg^{2+} (1.0 \text{ M}) \parallel Cu^{2+} (1.0 \text{ M}) \mid Cu(s)$

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

(A) By decreasing only the $[Mg^{2+}]$ to 0.1 M

(B) By decreasing only the $[Cu^{2+}]$ to 0.1 M

(C) By increasing both $[Mg^{2+}]$ and $[Cu^{2+}]$ to 2.0 M

(D) By increasing only the $[Mg^{2+}]$ to 2.0 M

Answer (A)

Sol. The cell reaction is

$Mg(s) + Cu^{2+}\ (1.0\ M) \rightarrow Mg^{2+}\ (1.0\ M) + Cu(s)$

$$E_{cell} = E^{\circ} - \frac{RT}{nF} \ln \frac{[Mg^{2+}]}{[Cu^{2+}]}$$

$$E_{cell} > E^{\circ}_{cell} \ \text{ if } \ \frac{[Mg^{2+}]}{[Cu^{2+}]} < 1$$

If only $[Mg^{2+}]$ is decreased to 0.1 M

$$\frac{[Mg^{2+}]}{[Cu^{2+}]} = \frac{0.1}{1} = \frac{1}{10} = 0.1$$

So (A) is correct.

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

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

(C) $2.8 \times 10^{-5}\ s^{-1}$ (D) $2.8 \times 10^{-3}\ s^{-1}$

Answer (D)

Sol. For first order reaction

$r = k\,[A]$

Given $r = 5.6 \times 10^{-4}$ mol L^{-1} s^{-1}

$[A] = 0.2$ mol L^{-1}

$$\therefore\ k = \frac{r}{[A]}$$

$$= \frac{5.6 \times 10^{-4}\ \text{mol}\ L^{-1}\ s^{-1}}{0.2\ \text{mol}\ L^{-1}}$$

$= 2.8 \times 10^{-3}\ s^{-1}$

11. Nucleic acids are polymers of :

(A) amino acids (B) nucleosides

(C) nucleotides (D) pentose sugar

Answer (C)

Sol. Nucleic acids are polymers of nucleotides, so they are called polynucleotides.

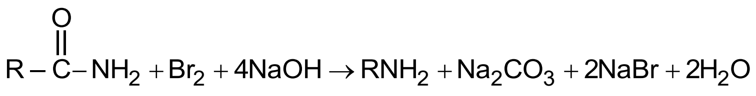
12. In the reaction of NaOBr with amide, the carbonyl carbon is lost as :

(A) HCO_3^{-} (B) CO_3^{2-}

(C) CO_2 (D) CO

Answer (B)

Sol. In Hoffmann bromamide degradation, NaOBr reacts with amide to form primary amine and the carbonyl carbon is lost as carbonate $\left(CO_3^{2-}\right)$ ion.



$$R-\overset{O}{\overset{\|}{C}}-NH_2 + Br_2 + 4NaOH \rightarrow RNH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

*For Questions number **13** to **16**, two statements are given — one labelled as **Assertion (A)** and the other labelled as **Reason (R)**. Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.*

(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.

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

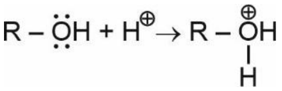
Reason (R) : It is due to the presence of unshared electron pairs on oxygen atom and presence of polar O – H bond.

Answer (A)

Sol. Bronsted acid nature :

$$R-OH \rightarrow RO^{\ominus} + H^{\oplus}$$

Bronsted base nature :



$$R-\ddot{\underset{\cdot\cdot}{O}}H + H^{\oplus} \rightarrow R-\overset{\oplus}{\underset{\displaystyle H}{\underset{|}{O}}}H$$

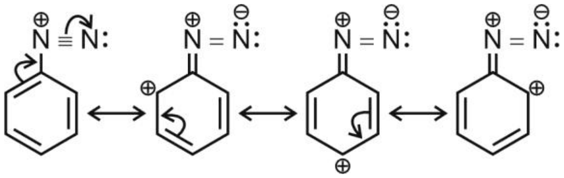
Hence, alcohols act as Bronsted acid and bases as well. It is due to the presence of unshared electron pairs on oxygen, which makes them proton acceptors and presence of acidic hydrogen bonded with O.

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

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

Answer (C)

Sol. Diazonium salts of aromatic primary amine are more stable than that of those aliphatic amine due to following resonance.



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

Reason (R) : Order of a reaction is an experimental quantity.

Answer (B)

Sol.
- Order of a reaction is an experimental quantity.
- For complex reaction, order is given by the slowest step.

16. **Assertion (A) :** $E^{o}_{Sc^{3+}/Sc^{2+}}$ has low value.

Reason (R) : Because of the stability of Sc^{3+} ion which has a noble gas configuration.

Answer (A)

Sol. Sc^{3+} has stable noble gas configuration hence it is difficult to reduce. This is the reason for the low value of $E^{o}_{Sc^{3+}/Sc^{2+}}$ redox couple.

SECTION-B

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

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

[1 + 1 = 2]

Sol. (a) For zero order reactions, the rate of reaction is independent on the concentration of the reactant(s).

eg: Decomposition of gaseous ammonia at high pressure on a hot platinum surface is a zero order reaction

$$2NH_3(g) \xrightarrow[\text{Pt Catalyst}]{1130\text{ K}} N_2(g) + 3H_2(g)$$

Rate = $k[NH_3]^0 = k$

(b) In a biomolecular reaction if concentration of one reactant taken is in large excess, therefore concentration of excess reactant is not altered much and the reaction behaves as first order. Such reactions are called pseudo first order reactions.

18. (a) Explain the following with the help of Henry's law: **[1 + 1 = 2]**

(i) Bends (ii) Anoxia

OR

(b) How does sprinkling of salt help in clearing the snow covered roads in hilly areas? Write the name of the colligative property involved in this process. **[2]**

Sol. (a) (i) When the Scuba divers come towards surface of the sea, the pressure gradually decreases. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends.

(ii) Anoxia is a medical condition in which persons or climbers become weak and unable to think clearly due to low solubility of oxygen in blood at high altitude.

OR

(b)
- When salt (like NaCl) is sprinkled on snow, it dissolves in the thin layer of water present on the surface of ice and form a salt solution. This salt solution has a lower freezing point than pure water, so the ice melts even below 0°C. As more ice melts, the solution forms and the snow gradually clear.
- Depression in freezing point involved in this process.

19. Write IUPAC names of the following compounds: **[1 + 1 = 2]**

(a) $[Cr(NH_3)_4(ONO)Cl]NO_3$

(b) $Na[Ag(CN)_2]$

Sol. (a) The correct IUPAC name of $[Cr(NH_3)_4(ONO)Cl]NO_3$ is Tetraamminechloridonitrito-O-chromium(III) nitrate

(b) The correct IUPAC name of $Na[Ag(CN)_2]$ is Sodium dicyanidoargentate(I)

20. What are the hydrolysis products of the following? **[1 + 1 = 2]**

(a) Lactose

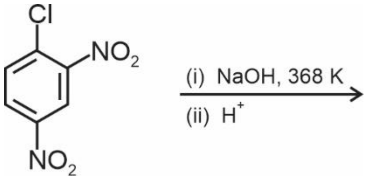
(b) DNA containing Thymine

Sol. (a) Lactose is a disaccharide which upon hydrolysis gives β-D-galactose and β-D-glucose.

(b) Complete hydrolysis of DNA yields a pentose sugar, phosphoric acid, adenine, guanine, cytosine and thymine.

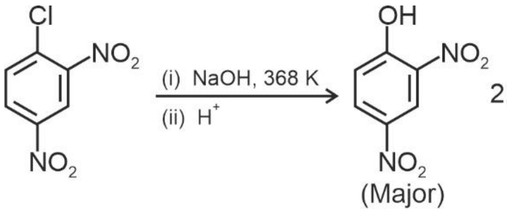
21. Draw the structures of major product(s) in each of the following reactions: **[2 × 1 = 2]**

(a)



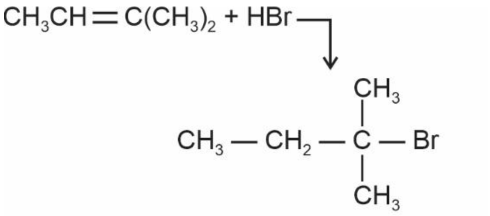
(b) $CH_3CH = C(CH_3)_2 + HBr \longrightarrow$

Sol. (a)



2,4-Dinitrophenol

(b)

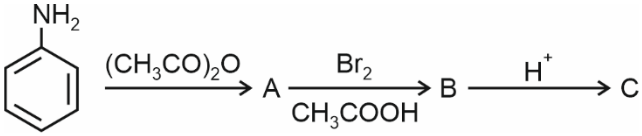


2-Bromo-2-methylbutane

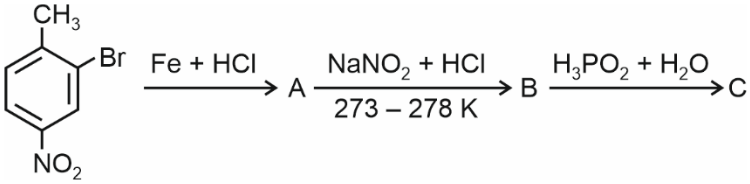
SECTION-C

22. Write the structures of A, B and C in the following reactions : **$[\,2\times1\frac{1}{2}=3\,]$**

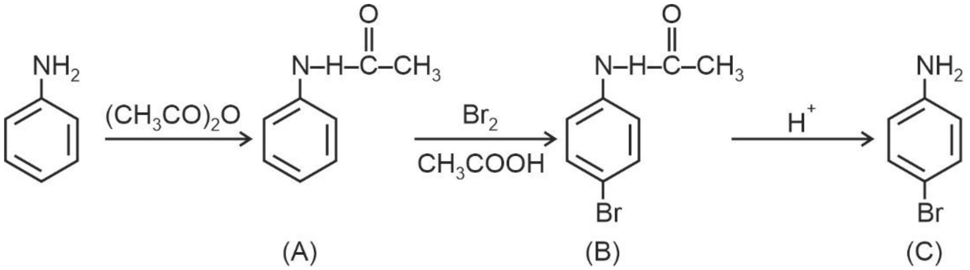
(a)



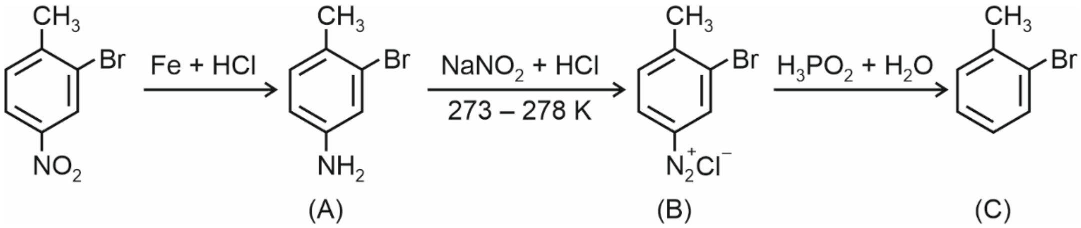
(b)



Sol. (a)



(b)



23. What happens when :

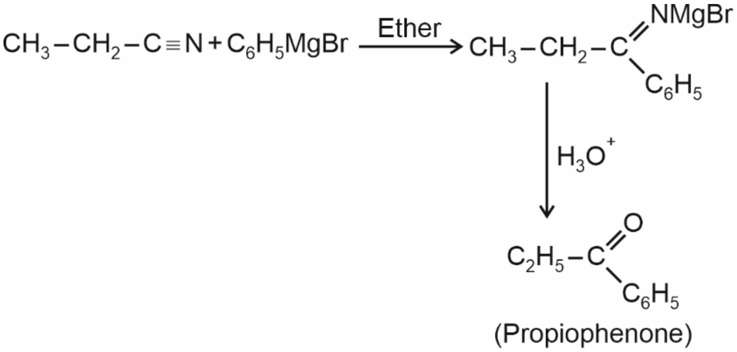
(a) Propanenitrile is treated with phenyl magnesium bromide followed by hydrolysis?

(b) p-fluorotoluene is treated with CrO_3 in the presence of acetic anhydride followed by hydrolysis with aqueous acid.

(c) Phthalic acid is treated with NH_3 followed by heating?

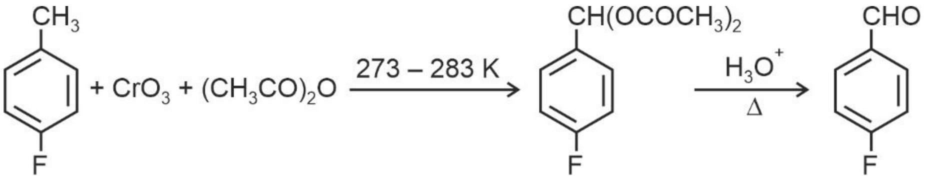
Write chemical reactions in support of your answer. **[3 × 1 = 3]**

Sol. (a) Treating propanenitrile with phenyl magnesium bromide (Grignard reagent) followed by hydrolysis gives propiophenone(1-phenylpropanone)

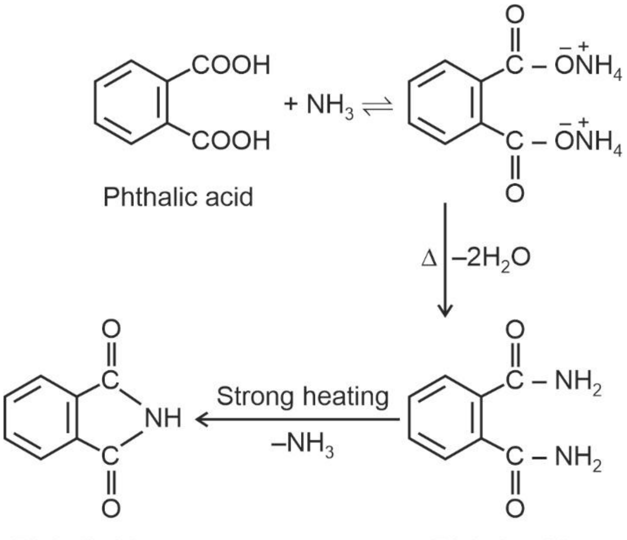


(Propiophenone)

(b) Substituted toluene (p-fluorotoluene) is converted to benzylidene diacetate on treating with chromic oxide in acetic anhydride which on hydrolysis gives p-fluorobenzaldehyde



(c) Phthalic acid react with ammonia to give ammonium salt which on further strong heating gives phthalimide



Phthalic acid

Phthalimide

Phthalamide

24. Answer the following questions : **[3 × 1 = 3]**

(a) Why is direct current (DC) not used to measure the resistance of an ionic solution?

(b) Why are the products of electrolysis different for the electrolysis of aqueous solution of $AgNO_3$ with silver electrodes and electrolysis of aqueous solution of $AgNO_3$ with platinum electrodes?

(c) Why are magnesium blocks fixed to the iron pipelines carrying water?

Sol. (a) Direct current (DC) is not used to measure resistance as passage of direct current through ionic solution over a prolonged period can lead to change in its composition due to electrochemical reactions.

(b) During electrolysis of aq $AgNO_3$ using Ag electrode at anode oxidation of Ag takes place that turns to $Ag^+(aq)$ while if Pt electrodes are used then oxidation of H_2O will take place resulting formation of O_2, Hence different products are obtained.

(c) As Mg is high reactive metal than Fe, it gets oxidised before Fe which can prevent corrosion of iron pipes carrying water.

25. (a) When a coordination compound $CoCl_3 \cdot 6NH_3$ is mixed with excess of $AgNO_3$ solution, 3 moles of AgCl are precipitated per mole of the compound. Write the structural formula of the complex, IUPAC name, its hybridisation and magnetic behaviour on the basis of valence bond theory. **[3]**

OR

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

(I) $\left[Cr(C_2O_4)_3\right]^{3-}$

(II) $\left[Co(NH_3)_3 Cl_3\right]$

(ii) $\left[Co(NH_3)_6\right]^{3+}$ is an inner orbital complex whereas $\left[Ni(NH_3)_6\right]^{2+}$ is an outer orbital complex. Why?

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

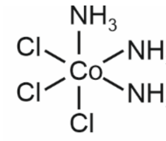
(iii) Write the formula of Wilkinson catalyst and its use. **[3 × 1 = 3]**

Sol. (a)
- Since three moles of AgCl is obtained from one mole of the coordination compound, three chloride ions are present outside the coordination sphere. So structure of the complex is $[Co(NH_3)_6]Cl_3$.
- IUPAC name of $[Co(NH_3)_6]Cl_3$ is Hexaamminecobalt(III) chloride.
- The given complex is diamagnetic in nature hence the pairing of *d* electrons will take place. Hybridisation of the complex will be d^2sp^3.

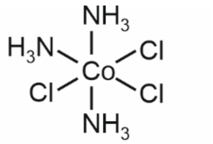
OR

(b) (i) (I) $\left[Cr(C_2O_4)_3\right]^{3-}$ will not show geometrical isomers. It will have one isomer.

(II) $\left[Co(NH_3)_3 Cl_3\right]$ will give rise to the formation of two geometrical isomers



Facial isomer



Meridional isomer

(ii)
- In $[Co(NH_3)_6]^{3+}$ complex, cobalt is present in +3 oxidation state which will result in an increased value of Δ_0. The pairing of electrons take place in t_{2g} level leading to the formation of inner orbital complex having hybridisation d^2sp^3.
- In $[Ni(NH_3)_6]^{2+}$ complex, nickel is present in +2 oxidation state because of which Δ_0 value will be lesser. The pairing of electrons in the *d* orbitals is not possible hence the formation of outer orbital complex having hybridisation sp^3d^2 will be achieved.

(iii) Formula of Wilkinson catalyst is : $[(Ph_3P)_3RhCl]$. It is used for the hydrogenation of alkene.

26. Calculate the vapour pressure of a solution containing 61 g of benzoic acid (molar mass = 122 g mol^{-1}) dissolved in 500 g of benzene when the vapour pressure of pure benzene at this temperature of experiment is 66 torr. Assume complete dimerization of benzoic acid in benzene. **[3]**

Sol.
- van't Hoff factor (i) for association

$$i = 1 + \left(\frac{1}{n} - 1\right)\alpha$$

$$i = 1 + \left(\frac{1}{2} - 1\right) \times 1 \quad [\because \text{ For dimerization, n = 2, for complete dimerization, } \alpha = 1]$$

$$i = 1 + \left(-\frac{1}{2}\right) = 0.5$$

- $\text{RLVP} = \frac{P^0 - P_s}{P^0} = \frac{in}{in + N}$ [n = Mole of solute, N = Mole of solvent, P^0 : Vapour pressure of solvent, P_s : Vapour pressure of solution]

$$\begin{bmatrix} n = \frac{61}{122} = \frac{1}{2} = 0.5 \\ N = \frac{500}{78} = 6.41 \\ \text{and } P^0 = 66 \text{ torr} \end{bmatrix}$$

So $\frac{66 - P_s}{66} = \frac{0.5 \times 0.5}{0.5 \times 0.5 + 6.41}$

$\Rightarrow$ P_s = 63.52 torr

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

$$2H_2O_2 \xrightarrow[\text{Alkaline medium}]{I^-} 2H_2O + O_2$$

The mechanism for this reaction was found to be :

Step I : $H_2O_2 + I^- \longrightarrow H_2O + IO^-$ (slow)

Step II : $H_2O_2 + IO^- \longrightarrow H_2O + I^- + O_2$ (fast)

(a) Write the rate law expression.

(b) Determine the order of reaction with respect to H_2O_2, I^- and overall order of reaction.

(c) What is the molecularity of the reaction in Step II? **[3]**

Sol. (a) From the given reaction mechanism 1st step is slow step i.e rate determining step. So for elementary reaction rate = k $[H_2O_2]$ $[I^-]$

(b) Order with respect to H_2O_2 = 1

Order with respect to I^- = 1

Overall order of reaction = 1 + 1 = 2

(c) In reaction mechanism all steps involve are elementary reaction. So molecularity of step II is 2.

Both the steps are bimolecular elementary reactions.

28. Answer the following: **[3 × 1 = 3]**

(a) Which isomer of C_4H_9Br is most reactive towards S_N1 reaction?

(b) Predict the alkene that would be formed by dehydrohalogenation of 1-Bromo-1-methylcyclohexane.

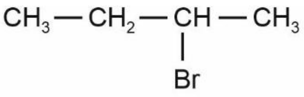
(c) Although chlorine shows strong-I effect, yet it is ortho- and para-directing in electrophilic aromatic substitution reactions. Why?

Sol. C_4H_9Br has four structural isomers

(a) $CH_3-CH_2-CH_2-CH_2-Br$

(i)

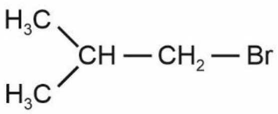
1-Bromobutane



$CH_3-CH_2-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$

(ii)

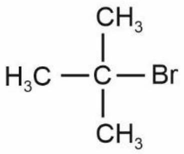
2-Bromobutane



$(H_3C)_2CH-CH_2-Br$

(iii)

1-Bromo-2-methylpropane



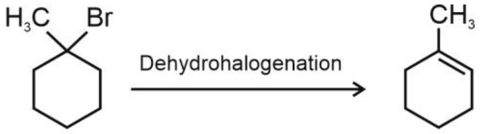
$H_3C-\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}-Br$

(iv)

2-Bromo-2-methylpropane

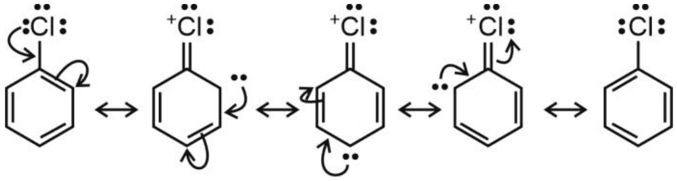
2-Bromo-2-methylpropane is most reactive towards S_N1 reaction.

(b)



1-Bromo-1-methylcyclohexane (Major)

(c) In chlorobenzene, due to resonance the electron density on o- and p-positions is greater than that at the m-position. So, it is ortho- and para directing in electrophilic aromatic substitution reactions



SECTION-D

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

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

Answer the following questions:

(a) Write the mechanism of acid dehydration of ethanol to yield ethene. **[2]**

(b) (i) Why are tertiary alcohols resistant to oxidation? **[1]**

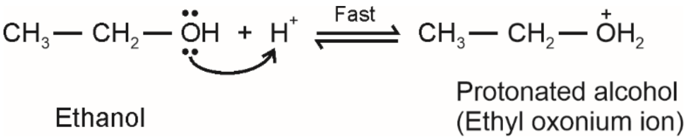
OR

(b) (ii) Write the structure of the major product expected from the dinitration of 3-methylphenol. **[1]**

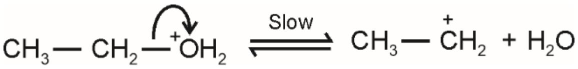
(c) Why is ortho-nitrophenol more acidic than ortho-methoxyphenol? **[1]**

Sol. (a) Mechanism of dehydration of ethanol to ethene is as follows.

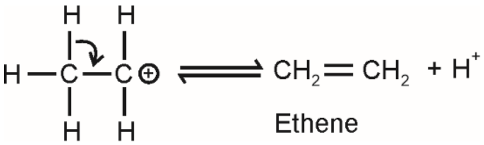
Step-1: Formation of protonated alcohol.



Step-2: Formation of carbocation



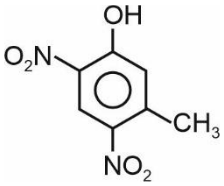
Step-3: Elimination of a proton



(b) (i) Tertiary alcohols do not contain any α-hydrogen connected to the carbon containing –OH group, so they are resistant to oxidation.

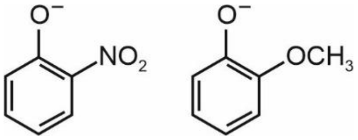
OR

(ii)



–OH group is strongly activating towards electrophilic substitution reaction and is ortho and para directing. Dinitration of 3-Methylphenol would direct electrophile at 4th and 6th position. Nitration would not occur at 2nd position because of steric hindrance.

(c) ortho-nitrophenol is more acidic than ortho-methoxyphenol. Because –NO_2 is strongly electron withdrawing group which increase the acidic strength of phenol derivatives. –OCH_3 is a strong electron donating group which would decrease the acidic strength of phenol derivatives.



–NO_2 stabilises the conjugate base whereas –OCH_3 destabilises the conjugate base shown above.

30. Carbohydrates are optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis. They have been broadly classified into three groups - monosaccharides, oligosaccharides and polysaccharides. The carbohydrates may also be classified as either reducing or non-reducing sugars. An important monosaccharide glucose is an aldohexose and is correctly named as D(+)-glucose. It was assigned the open structure on the basis of its reactions with HI, NH_2OH, Br_2 water, $(CH_3CO)_2O$ and nitric acid.

Despite having the –CHO group, glucose does not give Schiff's test and hydrogen sulphite addition product with $NaHSO_3$. It was found that glucose forms a six-membered ring in which one of the –OH groups add to the –CHO group and form a cyclic hemiacetal structure.

Answer the following questions:

(a) How do you explain the following? **[2 × 1 = 2]**

(i) Presence of a carbonyl group in glucose

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

(b) What type of carbohydrates are called reducing sugars? **[1]**

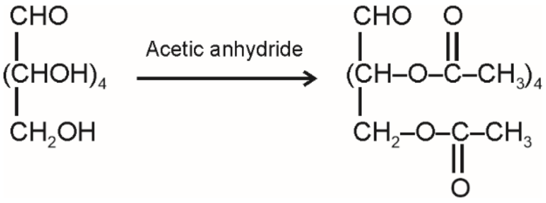
(c) (i) In D(+)–glucose, what do the letter ‘D’ and sign ‘(+)’ represent? **[1]**

OR

(c) (ii) Draw the six-membered ring structure of α–D(+)–glucose. **[1]**

Sol. (a) (i) **Presence of a carbonyl group in glucose:** Glucose reacts with hydroxylamine to form an oxime and adds a molecule of hydrogen cyanide to give cyanohydrin. These reactions confirm the presence of a carbonyl group in glucose.

(ii) Acetylation of glucose with acetic anhydride gives glucose pentaacetate which confirms the presence of five –OH groups.



$$\underset{CH_2OH}{\overset{CHO}{(CHOH)_4}} \xrightarrow{\text{Acetic anhydride}} \underset{CH_2-O-\overset{O}{\overset{\|}{C}}-CH_3}{\overset{CHO}{(CH-O-\overset{O}{\overset{\|}{C}}-CH_3)_4}}$$

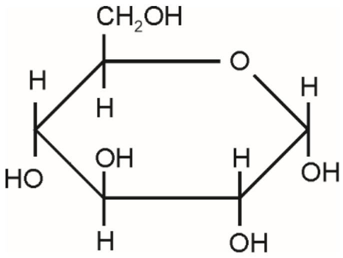
(b) All those carbohydrates which reduce Fehling's solution and Tollens’ reagent are referred to as reducing sugars. All monosaccharides are reducing sugars.

(c) (i) The letters ‘D’ or ‘L’ before the name of any compound indicate the relative configuration of a particular stereoisomer of a compound with respect to configuration of some other compound; configuration of which is known. Letter D in the D(+)-glucose represents that it is chemically correlated with D(+) isomer of glyceraldehyde.

The sign (+) represents dextrorotatory nature of the molecule.

OR

(ii) α-D(+)-Glucopyranose



SECTION-E

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

(I) MnO is basic while Mn_2O_7 is acidic.

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

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

(ii) How do you prepare potassium dichromate from sodium chromate ? Write balanced chemical equation for each step. **[3 + 2 = 5]**

OR

(b) Answer the following questions: **[5 × 1 = 5]**

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

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

(iii) Identify the following:

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

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

(iv) Write the products obtained on heating $KMnO_4$.

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

Cu^{+}, Sc^{3+}, Fe^{2+}, Ti^{3+}, Zn^{2+}

Sol. (a) (i) (I) Oxides in lower oxidation states of metals are basic and in higher oxidation states are acidic. The oxidation number of Mn in MnO is +2 while that in Mn_2O_7 is +7. So MnO is basic while Mn_2O_7 is acidic.

(II) Fe has four unpaired electron in 3*d* subshell whereas Cu has one unpaired electron. More number of unpaired electrons in Fe leads to stronger interatomic interaction resulting in higher enthalpy of atomisation.

(III) Cr^{3+} has half filled t_{2g} configuration while Mn^{3+} gains an electron to get stable half filled d^5 configuration. So, $E^{o}_{Mn^{3+}/Mn^{2+}}$ is high. Therefore, Mn^{3+} is stronger oxidising agent than Cr^{3+}.

(ii) Sodium chromate is obtained from fusion of $FeCr_2O_4$ in free access of air

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \longrightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

The yellow solution of sodium chromate is filtered and acidified with H_2SO_4 to give a solution from which orange sodium dichromate, $Na_2Cr_2O_7{\cdot}2H_2O$ is crystallised

$$2Na_2CrO_4 + 2H^{+} \longrightarrow Na_2Cr_2O_7 + 2Na^{+} + H_2O$$

Sodium dichromate is now treated with KCl

$$Na_2Cr_2O_7 + 2KCl \longrightarrow \underset{\text{(crystallised out)}}{K_2Cr_2O_7} + 2NaCl$$

OR

(b) (i) Chemistry of actinoids is more complicated as compared to lanthanoids because of partly owing to the occurrence of wide range of oxidation states and partly because of its radioactivity which creates special problems in its study.

(ii) $E^{o}_{M^{2+}/M}$ values are not regular for the first row transition elements (3d series) due to irregular trends in the sum of first and second ionization enthalpies ($\Delta_iH_1 + \Delta_iH_2$) and sublimation enthalpies.

(iii) (I) The oxoanion of chromium which is stable in acidic medium is dichromate ion $(Cr_2O_7^{2-})$

(II) Lanthanoid that exhibits +4 oxidation state is Cerium (Ce)

(iv) $KMnO_4$ when heated at 513 K, it decomposes

$$2KMnO_4 \xrightarrow[513\,K]{\Delta} K_2MnO_4 + MnO_2 + O_2$$

(v) The ions having partially filled d-orbitals will undergo d-d transition and will be coloured.

Species	**E.C.**	**Colour**
Cu^{+}	$[Ar]\ 3d^{10}$	Colourless
Sc^{3+}	$[Ar]\ 3d^{0}$	Colourless
Fe^{2+}	$[Ar]\ 3d^{6}$	Green colour
Ti^{3+}	$[Ar]\ 3d^{1}$	Purple colour
Zn^{2+}	$[Ar]\ 3d^{10}$	Colourless

Only Fe^{2+} and Ti^{3+} will be coloured.

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

(I) Bromobenzene to 1-phenylethanol

(II) Benzene to m-nitroacetophenone

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

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

$C_6H_5COOH, O_2N-CH_2-COOH, CF_3-COOH, HCOOH$ **[2 + 2 + 1 = 5]**

OR

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

(I) 2,4-Dinitrophenylhydrazine

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

(ii) Give reasons for the following :

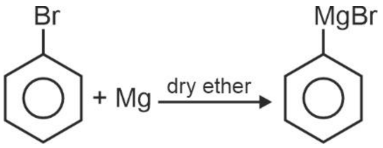
(I) Benzoic acid does not undergo Friedel-Crafts reaction.

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

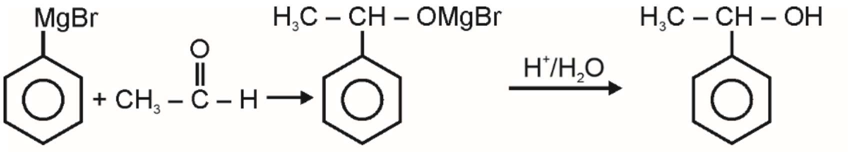
(iii) Write simple chemical test to distinguish between propanal and propanone. **[2 + 2 + 1 = 5]**

Sol. (a) (i) (I) Bromobenzene to 1-phenyl ethanol

Step-I : Conversion of bromobenzene to phenyl magnesium bromide



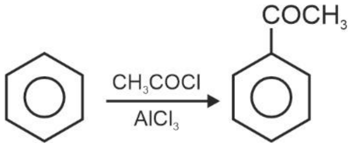
Step-II : Reaction of phenyl magnesium bromide with ethanol followed by H^{+}/H_2O



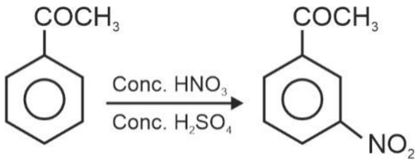
1-Phenyl ethanol

(II) Benzene to m-nitroacetophenon

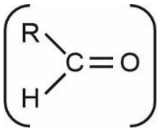
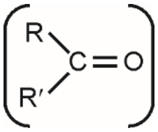
Step-I : Friedel Craft acetylation of benzene to obtain acetophenone



Step-II: Nitration of acetophenone



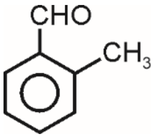
(ii) Observation (I) C_8H_8O forms 2, 4-DNP derivatives hence it is a carbonyl compound that is aldehyde

 or Ketone 

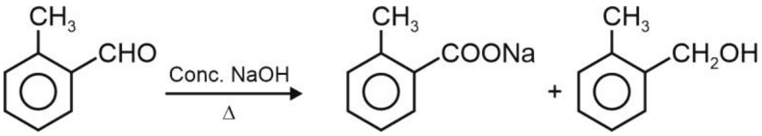
Observation (II) : Since C_8H_8O reduces Tollens' reagent and undergoes Cannizzaro reaction, it is an aldehyde with no α-hydrogen atom.

Observation (III) Since on vigorous oxidation with $KMnO_4$ it gives benzene-1,2-dicarboxylic acid, hence it is an aromatic aldehyde with alkyl substitution at ortho position.

Hence structure of C_8H_8O



The reaction products obtained are



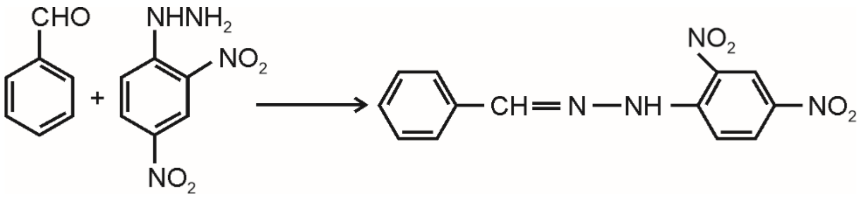
(iii) Presence of electron withdrawing groups increases acidic strength of carboxylic acid, hence $NO_2 - CH_2 - COOH$ and $CF_3 - COOH$ are more acidic than other two.

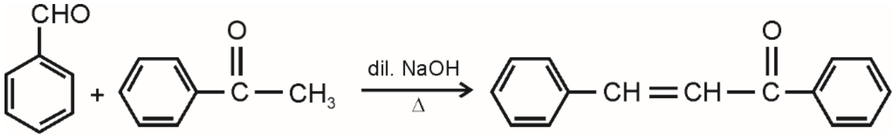
- CF_3COOH is most acidic due to maximum '-I' effect.
- HCOOH is more acidic than C_6H_5COOH due to more effective similar resonating structures.

Hence correct increasing order of acidic strength will be as following:

$CF_3 - COOH > NO_2 - CH_2 - COOH > HCOOH > C_6H_5COOH$

OR

(b) (i) (I) 

(II) 

(ii) (I) Benzoic acid does not undergo Friedel-Crafts reaction because the carboxyl group is deactivating and the catalyst $AlCl_3$ gets bonded to the carboxyl group.

(II) Carboxylic acids are extensively associated through hydrogen bonding as compared to the alcohols of comparable molecular mass hence their boiling points are higher than alcohols.

(iii) Propanal and propanone can be chemically distinguished by Tollens' test. Propanal will give positive Tollens' test while propanone will not respond to the test as Tollens' test is given by aldehydes not by ketones.

$$CH_3CH_2CHO + 2[Ag(NH_3)_2]^+ + 3OH^- \rightarrow CH_3CH_2COO^- + 2Ag + 2H_2O + 4NH_3$$

33. (a) (i) Calculate E^0_{cell} for the following reaction which is at equilibrium :

$$Cu(s) + 2Ag^+(aq) \rightleftharpoons Cu^{2+}(aq) + 2Ag(s)$$

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

[Given : log10 = 1]

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

(iii) How much electricity is required in coulombs for the oxidation of 1 mol of FeO to Fe_2O_3? **[2 + 2 + 1 = 5]**

OR

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

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

$$Ag^+(aq) + 1e^- \longrightarrow Ag(s)$$

Given that : $\left[Ag^+\right] = 0.01M$ and

$$E^0_{Ag^+/Ag} = +0.80\,V$$

$[\log 10 = 1]$

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

(I) Dry cell

(II) Fuel cell ($H_2 - O_2$) **[2 + 2 + 1 = 5]**

Sol. (a) (i) Relation between E°_{cell} and K_{eq} is

$$-nFE^\circ_{cell} = -2.303RT\log K_{eq} \qquad \ldots(1)$$

(where n: No. of Electron(s) involved in Cathode or in anode of Balance cell Reaction)

Given $K_{eq} = 10^{15}$, so using equation (1)

$$-2 \times 96500 \times E^\circ_{cell} = -2.303 \times 8.314 \times 298 \log 10^{15}$$

$$\text{or} \quad E^\circ_{cell} = \frac{2.303 \times 8.314 \times 298}{2 \times 96500} \times 15$$

$$= 0.44 \text{ volt}$$

(ii) During use or during discharging of lead storage battery

Anode: lead(Pb)

Cathode: A Grid of lead packed with lead Oxide (PbO_2)

Electrolyte: 38% solution of sulphuric Acid

Overall Reaction

$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

(iii) 1 Faraday (i.e., 96500 C) charge involved during exchange of 1 mol electron while electrolysis.

$$\overset{+2}{Fe}O \longrightarrow \overset{+3}{Fe_2}O_3 \quad \text{or} \quad (\overset{+2}{Fe} \longrightarrow \overset{+3}{Fe} + e^-)$$

Hence 1 mol electron release for 1 mol FeO so to convert 1 mol FeO into Fe_2O_3, 1 F or 96500 C charge is required

OR

(b) (i) $\Lambda_m = \dfrac{K \times 1000}{C}$

$$= \frac{7.2 \times 10^{-5} \times 1000}{2.4 \times 10^{-3}}$$

$$= 3 \times 10$$

$$= 30 \text{ S cm}^2 \text{ mol}^{-1}$$

Degree of dissociation $(\alpha) = \dfrac{\Lambda_m}{\Lambda_m^o} = \dfrac{30}{390.5} = 0.0768$

(ii) Given half cell reaction

$Ag^+(aq) + 1e^- \rightarrow Ag(s)$

$E^o_{Ag^+/Ag} = 0.80 \text{ V}$

By applying Nernst equation

$$E_{Ag^+/Ag} = E^o_{Ag^+/Ag} - \frac{0.059}{1}\log\frac{1}{10^{-2}}$$

$$= 0.80 - 0.059 \log 10^2$$

$$= 0.80 - 0.059 \times 2 \times \log 10$$

$$= 0.80 - 0.118$$

$$= 0.682 \text{ V}$$

(iii) (I) Electrolyte used in dry cell is moist paste of ammonium chloride (NH_4Cl) and zinc chloride ($ZnCl_2$)

(II) Electrolyte used in fuel cell ($H_2 - O_2$) is concentrated aqueous sodium hydroxide solution.

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