CBSE Sample Paper 9

Class XII 2022-23

Chemistry

Time: 3 Hours **Max. Marks: 70**

General Instructions:

1. There are 35 questions in this question paper with internal choice.
2. SECTION A consists of 18 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 7 very short answer questions carrying 2 marks each.
4. SECTION C consists of 5 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. All questions are compulsory.
8. Use of log tables and calculators is not allowed.

SECTION - A

18 Marks

(The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.)

1. Henry's law constant for oxygen dissolved in water is 4.34×10^4 atm at 25°C. If the partial pressure of oxygen in air is 0.4 atm at 25°C, the concentration (in moles per liter) of the dissolved oxygen in water in equilibrium with air at 25°C is:

(a) 1.3×10^{-3} M (b) 0.13×10^{-3} M

(c) 0.28×10^{-4} M (d) 5.11×10^{-4} M 1

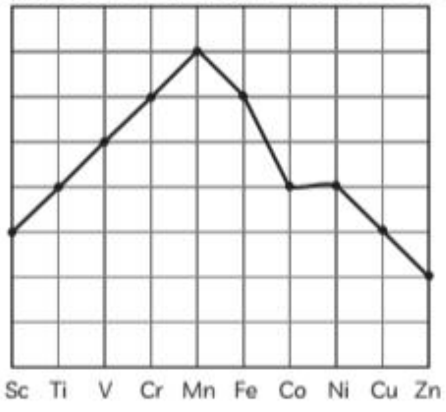
2. Which of the following option will be the limiting molar conductivity of CH_3COOH if the limiting molar conductivity of CH_3COONa is 91 Scm^2mol^{-1}? Limiting molar conductivity for individual ions are given in the following table:

S.No.	Ions	limiting molar conductivity /Scm^2mol^{-1}
1	H^+	349.6
2	Na^+	50.1
3	K^+	73.5
4	OH^-	199.1

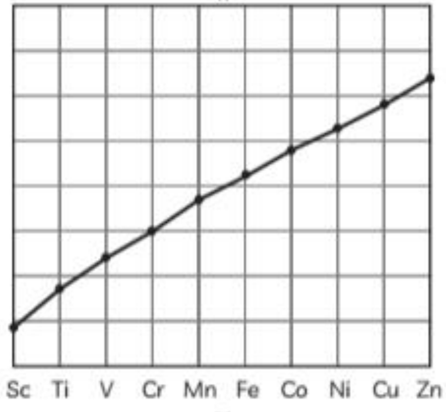
(a) 350 Scm^2mol^{-1} (b) 375.3 Scm^2mol^{-1}

(c) 390.5 Scm^2mol^{-1} (d) 340.4 Scm^2mol^{-1} 1

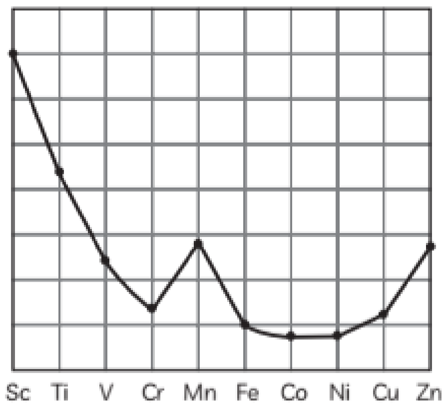
3. The three graphs below show the variation in radius, effective nuclear charge and maximum oxidation state for the transition metals of period 4. In each part below identify which property is being plotted.



(I)



(II)



(III)

Choose the correct option:

	I	II	III
(a)	Maximum oxidation state	Effective nuclear charge	Radius
(b)	Effective nuclear charge	Maximum oxidation state	Radius
(c)	Maximum oxidation state	Radius	Effective nuclear charge
(d)	Radius	Effective nuclear charge	Maximum oxidation state

1

4. The number of unpaired electrons in gaseous species of Mn^{3+}, Cr^{3+} and V^{3+} respectively are .... and the most stable species is ....:

(a) 4, 3 and 2; V^{3+} (b) 3, 3 and 2; Cr^{3+}

(c) 4, 3 and 2; Cr^{3+} (d) 3, 3 and 3; Mn^{3+} 1

5. Identify'X':

$C_6H_5COCl + (CH_3)_2NH \xrightarrow{\text{Pyridine}}$ 'X'

(a) N, N-Dimethylbenzamide
(b) N, N-Dimethylbenzene
(c) N-Methyl-N-phenylamine
(d) N, N-Diphenylmethanamine 1

6. When converting a disaccharide to monosaccharides, which bond is hydrolyzed?

(a) Disulfide bond
(b) Glycosidic bond
(c) Phosphodiester bond
(d) Hydrogen bond 1

7. Equilibrium constant K is related to E^0_{cell} and not E_{cell} because:

(a) E^0_{cell} is easier to measure than E_{cell}
(b) E_{cell} becomes zero at equilibrium point but E^0_{cell} remains constant under all conditions
(c) at a given temperature, E_{cell} changes hence value of K can't be measured
(d) any of the terms E_{cell} or E^0_{cell} can be used

1

8. Which of the following statements about $[Ni(CO)_4]$ is correct?

(a) Tetrahedral, diamagnetic
(b) Square planar, diamagnetic
(c) tetrahedral, paramagnetic
(d) Square planar, paramagnetic 1

9. The existence of two different coloured complexes with the composition $[Co(NH_3)_4Cl_2]^+$ is due to:

(a) Coordination isomerism
(b) Ionization isomerism
(c) Linkage isomerism
(d) Geometrical isomerism 1

10. Sugar that is non-reducing in nature is:

(a) maltose (b) sucrose

(c) lactose (d) glucose 1

11. The catalytic activity of transition metals and their compounds is ascribed mainly due to:

(a) their chemical behavior
(b) their chemical reactivity
(c) their ability to adopt variable oxidation states
(d) their unfilled d-orbitals 1

12. Magnetic moment is used to determine the magnetic character of a species. Which of the following has magnetic moment value of 5.9 B.M?

(a) Fe^{2+} (b) Fe^{3+}

(c) Ni^{2+} (d) Cu^{2+} 1

13. The voltage .... if the salt bridge is removed from the two half cells.

(a) drops to zero (b) increases

(c) decreases (d) remains same 1

14. Which of the following is the correct relation between conductance and resistance?

(a) $CR = 1$ (b) $C = R$

(c) $C = -R$ (d) $CR = \text{constant}$ 1

In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false
(d) (A) is false but (R) is true

15. Assertion: When a solution is separated from the pure solvent by a semi- permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side.

Reason: Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution. 1

16. Assertion: Transition metals are good catalysts.

Reason: V_2O_5 or Pt is used in the preparation of H_2SO_4 by contact process. 1

17. Assertion: In optically active halides, S_N^1 reactions proceeds through racemisation.

Reason: The nucleophile can attack from either side of the carbocation formed to give the mixture of products. 1

18. Assertion: Methoxy ethane reacts with HI to give ethanol and iodomethane

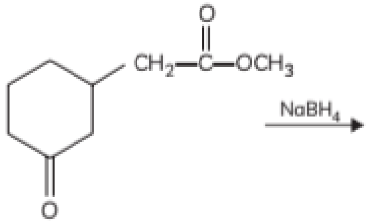
Reason: Reaction of ether with HI follows S_N^2 mechanism 1

SECTION - B

14 Marks

(The following questions are very short answer type with internal choice in two questions and carry 2 marks each.)

19. (A) Give the product for the following reaction.



(B) Which among the following will undergo cannizaro reaction?

Benzaldehyde, acetone, formaldehyde 2

20. For M^{2+}/M and M^{3+}/M^{2+} systems, the E° values for some metals are as follows:

$Cr^{2+}/Cr = -0.9$ V

$Cr^{3+}/Cr^{2+} = -0.4$ V

$Mn^{+2}/Mn = -1.2$ V

$Mn^{3+}/Mn^{2+} = +1.5$ V

$Fe^{2+}/Fe = -0.4$ V

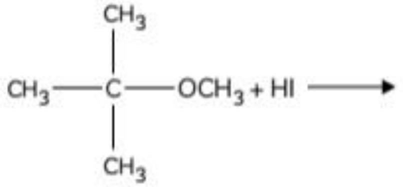
$Fe^{2+}/Fe^{2+} = +0.8$ V

Use this data to comment upon:

(A) the stability of Fe^{3+} in acid solution as compared to that of Cr^{3+} or Mn^{3+} and

(B) the ease with which iron can be oxidised as compared to a similar process for either chromium or manganese metal. 2

21. (A) Write the product for the following reaction;



$$CH_3-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-OCH_3 + HI \longrightarrow$$

(B) $C_6H_5OH \xrightarrow[\text{(ii) } CO_2.H^+]{\text{(i) aq. NaOH}}$

(C) $CH_3\text{-}CH{=}CH_2 \xrightarrow[\text{(ii) } 3H_2O_2/OH]{\text{(i) } B_2H_6}$

(D) $C_6H_5OH + CH_3COCl \xrightarrow{\text{Pyridine}}$ 2

22. (A) Of 0.1 M solution of glucose and sodium chloride respectively, which one will have a higher boiling point and why?

(B) Why is an increase in temperature observed on mixing chloroform with acetone?

OR

Calculate the molality of ethanol solution in which the mole fraction of water is 0.88. 2

23. (A) Amino acids may be acidic, alkaline or neutral, how does this happen?

(B) What are essential and non-essential amino acids? Name one of each type.

OR

Nucleosides and Nucleotides are important units of nucleic acids. State what are known as nucleosides and nucleotides. 2

24. (A) How are amines prepared from amides?

(B) Acylation of amines with acid chloride is carried out in presence of stronger base. Why?

OR

$$\begin{tikzcd}
CH_3COOH \arrow[r, "LiAlH_4"] & (A) \arrow[r, "P+I_2"] & (B) \arrow[d, "KCN"] \\
& (D) & (C) \arrow[l, "Na/Alcohol"']
\end{tikzcd}$$

Identify A, B, C and D in the above reaction. 2

25. Account for the following:

(A) Cl – CH_2COOH is a stronger acid than CH_3COOH.

(B) Carboxylic acids do not give reactions of the carbonyl group. 2

SECTION - C

15 Marks

(The following questions are short answer type with internal choice in two questions and carry 3 marks each.)

26. (A) Write the main structural difference between DNA and RNA. Of the two bases, thymine and uracil, which one is present in DNA?

(B) What are the hydrolysis products of sucrose? 3

27. Calculate the freezing point of a solution containing 8.1 g of HBr in 100 g of water, assuming the acid to be 90 % ionized. [Given: Molar mass Br = 80 g/mol, K_f water = 1.86 K kg/mol]. 3

28. Answer any three questions:

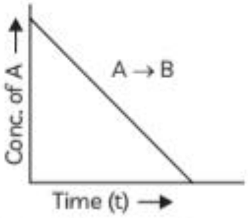
(A) State the reaction involved when sodium methoxide reacts with tert-Butylbromide.

(B) Why a weak electrolyte like carbon dioxide can be used to carry out Kolbe's reaction?

(C) State two chemicals which produce denatured alcohol.

(D) Indicate the products for the conversion of white ppt. when phenol reacts with bromine water. 3

29. The graphical representation of concentration of A Vs time is given for a general A → B,



Answer the following questions:

(A) What is the order of the reaction?

(B) What is the slope of the curve?

(C) State the units for the rate constant.

OR

The decomposition of N_2O_5 (g) is a first order reaction with rate constant of $5 \times 10^{-4}\ s^{-1}$ at 45°C. If initial concentration of N_2O_5 is 0.25 M, calculate its concentration after 2 minutes. 3

30. A colourless substance 'A' C_6H_7N is sparingly soluble in water and gives a water soluble compound 'B' on treating with mineral acid. On reacting with $CHCl_3$ and alcoholic potash 'A' produces an obnoxious smell due to the formation of compound 'C'. Reaction of 'A' with benzenesulphonyl chloride gives compound 'D' which is soluble in alkali. With $NaNO_2$ and HCl, 'A' forms compound 'E' which reacts with phenol in alkaline medium to give an orange dye 'F'. Identify compounds 'A' to 'F.' 3

SECTION - D

8 Marks

(The following questions are case-based questions. Each question has an internal choice and carries 4 (1+1+2) marks each. Read the passage carefully and answer the questions that follow.)

31. *Aldehydes and ketones are amphoteric. Thus they can react both as acids and bases. Under acidic conditions, the carbon of the protonated carbonyl group is much more electrophilic, reacting even with weak nucleophile. Carbonyl compounds give nucleophilic addition reaction. In this reaction the nucleophilic attack precedes the electrophilic attack.*

(A) Why aromatic aldehyde and formaldehyde undergo Cannizaro reaction? 1

(B) Arrange the acids given below in the decreasing order of acidity

$C_6H_5CH_2COOH$, C_6H_5COOH, CH_3COOH, CH_3CH_2COOH 1

(C) How will you convert:

(i) Toluene to Benzaldehyde.

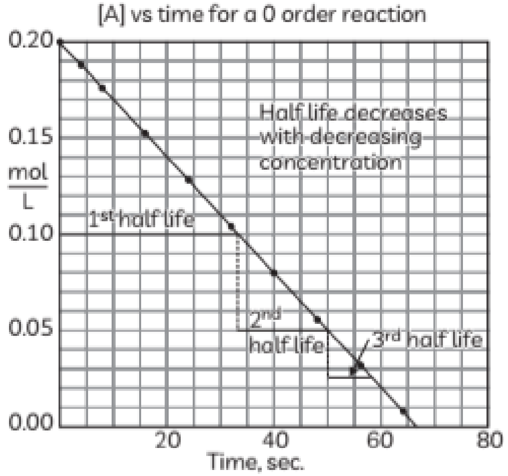
(ii) Acetone to Iodoform.

OR

Give simple chemical tests to distinguish between the following pairs of compounds:

(i) **Benzaldehyde and Acetophenone**
(ii) **Benzoic acid and phenol** 2

32. *A reaction in which rate of reaction is independent of concentration of the reactants is called zero order reaction. Photochemical combination of hydrogen and chlorine to give hydrogen chloride is an example of zero order reaction. The rate constant of a zero order reaction is equal to the rate of reaction.*



The half life period of a zero order reaction is directly proportional to initial concentration of the reactant. For a zero order reaction, k = 1/t {[A]₀–[A]}.

(A) For a reaction $\frac{1}{2}A \longrightarrow 2B$ rate of disappearance of A is 2 related to the rate of appearance of B by what expression? 1

(B) On what factors value of rate constant depends? 1

(C) (i) What does the slope determines in graph of rate vs concentration in first order reaction?

(ii) What does the slope determines in graph between $\log_{10}$[A] and time?

OR

The decomposition of nitrogen pentoxide in CCl_4 can be represented as given below:

$2N_2O_5$ (solution) $\longrightarrow$ $4NO_2$ (solution) – O_2(g)

In an experiment, the progress of the reaction was followed by measuring the volume of evolved oxygen. Following data were obtained.

Time (sec)	**0**	**300**	**600**	**900**	**∞**
Vol. of N_2 evolved (cm3)	**0**	**3.42**	**6.30**	**8.95**	**34.75**

Determine the rate law, rate constant and the order of reaction. 2

SECTION - E

15 Marks

(The following questions are long answer type and carry 5 marks each. Two questions have an internal choice.)

33. **(A) Give the IUPAC name of:**
$[PtCl(NH_2CH_3)(NH_3)_2]Cl$.

(B) Compare the magnetic behaviour of the complex entities.
$[Fe(CN)_6]^{4-}$ and $[FeF_6]^{3-}$ [Atomic number of Fe = 26]

(C) Tetrahedral complexes are always of high spin. Explain.

(D) What is the relationship between observed colour of the complex and the wavelength of the light absorbed by the complex?

OR

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

(B) What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand as well as significance of splitting energy and pairing energy.

(C) $FeSO_4$ solution mixed with $(NH_4)_2SO_4$ solution in 1:1 molar ratio gives the test of Fe^{2+} ion but $CuSO_4$ solution mixed with aqueous ammonia in 1:4 molar ratio does not give the test of Cu^{2+} ion. Explain why?

(D) What is the hybrid state and electronic configuration of coordination compound $K_3[CoF_6]$. 5

34. **(A) (i) Compound A with molecular formula C_4H_9Br is treated with *aq.* KOH solution.**

The rate of this reaction depends upon the concentration of the compound A only. When another optically active isomer B of this compound was treated with *aq.* KOH solution, the rate of reaction was found to be dependent on concentration of compound and KOH both.

Write down the structural formula of both compounds A and B.

(ii) Out of these two compounds, which

one will be converted to the product with inverted configuration? Give mechanism for the reaction

(B) Why is it necessary to avoid even traces of moisture during the use of a Grignard reagent?

(C) No effect on reactivity of haloarene is observed by the presence of electron withdrawing group at meta position. Explain why?

OR

(A) An alkyl halide, X, of formula $C_6H_{13}Cl$ on treatment with potassium tertiary butoxide gives two isomeric alkenes Y and Z (C_6H_{12}). Both alkenes on hydrogenation give 2,3-dimethylbutane. Predict the structures of X, Y and Z. Also write the reactions involved.

(B) Vinyl halides are less reactive than alkyl halides, but allyl halides are more reactive than alkyl halides. Explain.

(C) S_N^1 reaction of optically active compounds undergo racemisation whereas S_N^2 reaction led to inversion. Explain. 5

35. (A) Draw the plot of Λ_m v/s $\sqrt{c}$, for weak electrolyte. Why the limitingmolar conductivity value cannot be determined for such electrolytes?

(B) Two half-reaction of an electrochemical cell are given below:

$MnO^-_{4(aq)} + 8H^+ + 5E \rightarrow Mn^{2+}{}_{(aq)} + 4H_2O_{(l)}$; $E° = +1.51V$

$Sn^{2+}{}_{(aq)} \rightarrow Sn^{4+}{}_{(aq)} + 2e^-$, $E° = +0.15V$

Construct the redox equation from the standard potential of the cell and predict if thereaction is reactant favoured or product favoured.

(C) On the basis of E° values identify which amongst the following is the strongest oxidising agent:

$Cl_{2(g)} + 2e^- \rightarrow 2Cl^-$, $E^o = +1.36$ V,

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$, $E^o = +1.51$ V

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$, $E^o = +1.33$ V 5

SOLUTION

SECTION - A

1. *(d) 5.11×10^{-4} M*

Explanation: According to Henry's law

Given: $P = K_HX$

$K_H = 4.34 \times 10^4$ atm

$P_{O_2} = 0.4$ atm

$P_{O_2} = K_HX_{O_2}$

$$\therefore \quad X_{O_2} = \frac{P_{O_2}}{K_H}$$

$$\Rightarrow \quad X_{O_2} = \frac{0.4}{4.34 \times 10^4}$$

$$\Rightarrow \quad X_{O_2} = 9.21 \times 10^{-6}$$

Changing mole fraction into molarity

$$\text{Moles of water} = \frac{1000}{18}$$

$$\Rightarrow \quad = 55.5 \text{ mol}$$

Now, $$X_{O_2} = \frac{n_{O_2}}{n_{H_2O} + n_{O_2}}$$

$$\Rightarrow \quad n_{O_2} = X_{O_2} \times (n_{H_2O} + n_{O_2})$$

$(\because n_{O_2} << n_{H_2O})$

$$= X_{O_2} \times n_{H_2O}$$

$$= 9.21 \times 10^{-6} \times 55.5$$

$$n_{O_2} = 5.11 \times 10^{-4} \text{ mol}$$

2. *(c) 390.5 Scm^2mol^{-1}*

Explanation: The limiting molar conductivity ($\wedge^0_m$) for strong and weak electrolyte can be determined by using Kohlrausch's law which states that "the limiting molar conductivity of an electrolyte can be represented as the sum of the indivudual contributions of the anion and cation of the electrolyte."

$$\wedge^0_{CH_3COONa} = \wedge^0_{CH_3COO^-} + Na^+$$

$$91 = \wedge^0_{CH_3COO^-} + 50.1$$

$$\Rightarrow \quad \wedge_{CH_3COO^-} = 40.9$$

$$\Rightarrow \quad \wedge_{CH_3COO^-} = 40.9 Scm^2mol^{-1}$$

For acetic acid

$$\wedge^0_{CH_3COOH} = \wedge^0_{CH_3COO^-} + \wedge^0_{H^+}$$
$$= 40.9 + 349.6$$
$$= 390.5 Scm^2mol^{-1}$$

3. *(a) I: Maximum oxidation state; II: Effective nuclear charge; III: Radius*

Explanation: The atomic and ionic radii of the transition elements decrease from group 3 to group 6 due to the poor shielding offered by the small number of d-electrons. The effective nuclear charge (Z_{eff}) increases slightly along a transition series. This is because more protons are added in the nucleus, whereas the same number of electrons is added in the (n-1)d–subshell. The transition metals exhibit a variable number of oxidation states in their compounds. This is one of the notable features of the transition elements.

4. *(c) 4, 3 and 2; Cr^{3+}*

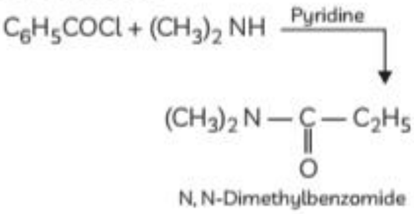
Explanation:

$Mn^{3+} = 3d^4$ = 4 unpaired electrons,
$Cr^{3+} = 3d^3$ = 3 unpaired electrons,
$V^{3+} = 3d^2$ = 2 unpaired electrons.

Cr^{3+} is most stable out of these in aqueous solution because it has half-filled t_{2g} level (*i.e.*, t^3_{2g}).

5. *(a) N, N-Dimethylbenzamide*

Explanation:



$$C_6H_5COCl + (CH_3)_2NH \xrightarrow{\text{Pyridine}} (CH_3)_2N - \underset{\underset{O}{\|}}{C} - C_2H_5$$

N, N-Dimethylbenzamide

6. *(b) Glycosidic bond*

Explanation: A disaccharide is a molecule that consists of two monosaccharides joined by a glycosidic bond. The disaccharide's glycosidic bond is hydrolyzed to release the constituent monosaccharides.

7. *(b) E_{cell} becomes zero at equilibrium point but E^0_{cell} remains constant under all conditions*

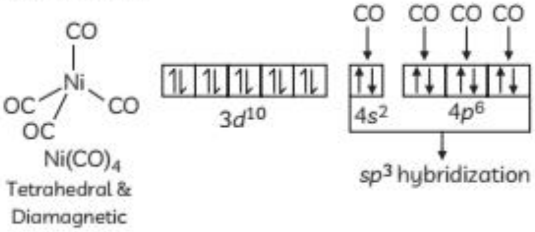
Explanation: At the equilibrium point,

E_{cell} = zero. Therefore, K is related to E^0_{cell} as,

$$\log K_c = \frac{n \times E^\circ_{cell}}{(0.0591)} V$$

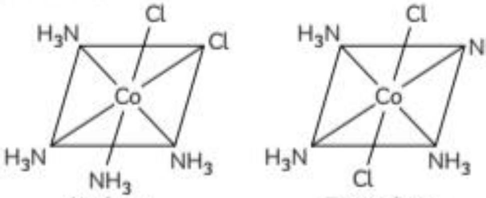
8. *(a) Tetrahedral, diamagnetic*

Explanation:



9. *(d) Geometrical isomerism*

Explanation: The complex $[Co(NH_3)_4Cl_2]^+$ is a $[MA_4B_2]$ type complex and thus, fulfills the conditions that are necessary to exhibit geometrical isomerism. Hence, it has two geometrical isomers of different colours as: The structure of the geometrical isomers are as follows:



Cis-from *Trans*-from

10. *(b) sucrose*

Explanation: Sucrose is a glucose carbon connected at the anomeric carbon to an anomeric carbon on a fructose. Since, both anomeric carbons are involved in the bond, neither one has an OH group, so it is not a reducing sugar.

11. *(c) their ability to adopt variable oxidation states*

Explanation: Transition metals show catalytic behavior mainly due to partially filled d-orbitals, ability to exhibit variable valences and tendency to form complex compounds.

12. *(b) Fe^{3+}*

Explanation: The magnetic moment 5.92 BM shows that there are five unpaired electrons present in the d-orbitals of Fe^{3+} ion. As a result, the hybridization involved is sp^3 rather than dsp^2 and shows 5.9 BM magnetic moment value.

13. *(a) drops to zero*

Explanation: Salt bridge completes the circuit, allowing current to flow. If the salt bridge is taken away, no current will flow and the voltage will fall to zero.

14. *(a) CR = 1*

Explanation: Conductance is the measure of the ease of flow of current through conductor. It is the reciprocal of the resistance of the conductor.

15. *(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).*

Explanation: Because a semipermeable membrane permits solvent molecules to pass through a solution of lower concentration to that of higher concentration. Flow of solvent molecule from solvent side to solution side through semipermeable membrane is called osmosis.

16. *(a) Both (A) and (R) are true and (R) is the correct explanation of (A).*

Explanation: V_2O_5, vanadium oxide is used in contact process as the as a catalyst as transitional metals are good catalysts.

17. *(a) Both (A) and (R) are true and (R) is the correct explanation of (A).*

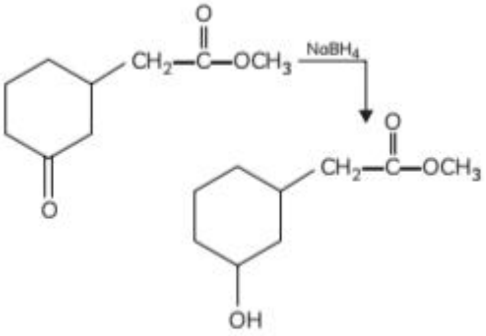
Explanation: In $S_N{}^1$ reaction carbocation intermediate formed is a planar molecule which will lead to form d - and l- products. Hence racemization occurs. And nucleophile can attack from either side of the carbocation formed to give the mixture of products.

18. *(a) Both (A) and (R) are true and (R) is the correct explanation of (A).*

Explanation: Ethers can undergo nucleophilic substitution reactions with HI. Ethers having primary alkyl group undergo S_N^2 reaction whereas tertiary alkyl ether undergo S_N^1 reaction. Protonation of ether is followed by the attack of halide ion. The halide ion preferentially attacks the less sterically hindered of the two alkyl groups which are attached etherial oxygen.

SECTION - B

19. (A) $NaBH_4$ does not reduce ester group. It is mild reducing reagent which reduces aldehyde and ketone into their respective alcohols.



(B) Benzaldehyde and formaldehyde undergo cannizaro reaction as these compounds do not contain alpha hydrogen.

20. (A) The E° value of Fe^{3+}/Fe^{2+} is higher than that for Cr^{3+}/Cr^{2+} and lower than that for Mn^{3+}/Mn^{2+}. So, the reduction of Fe^{3+} to Fe^{2+} is easier than the reduction of Mn^{3+} to Mn^{2+}, but not as easy as the reduction of Cr^{3+} to Cr^{2+}. Hence, Fe^{3+} is more stable than Mn^{3+}, but less stable than Cr^{3+}. These metal ions can be arranged in the increasing order of their stability as: $Mn^{3+} < Fe^{3+} < Cr^{3+}$

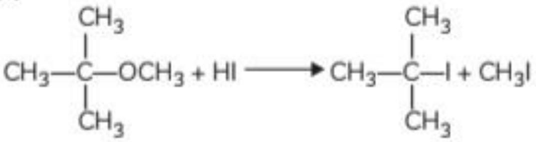
(B) The reduction potentials for the given pairs increase in the following order.

$$Mn^{2+}/Mn < Cr^{2+}/Cr < Fe^{2+}/Fe$$

So, the oxidation of Fe to Fe^{2+} is not an easy as the oxidation of Cr to Cr^{2+} and the oxidation of Mn to Mn^{2+}. Thus, these metals can be arranged in the increasing order of their ability to get oxidised as:

$$Fe < Cr < Mn.$$

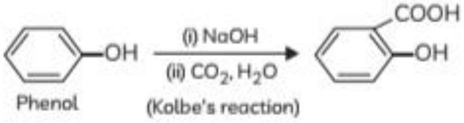
21. (A)



$$CH_3-\overset{CH_3}{\underset{CH_3}{C}}-OCH_3 + HI \longrightarrow CH_3-\overset{CH_3}{\underset{CH_3}{C}}-I + CH_3I$$

Explanation: 3^0 alkyl halide will be formed due to the formation of stable carbocation.

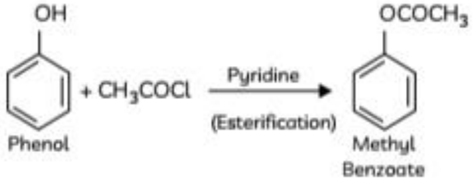
(B)



(C) $CH_3CH{=}CH_2 \xrightarrow[(ii)\ 3H_2O_2/OH^-]{(i)\ B_2H_6} 3CH_3CH_2CH_2OH$

Propene Propan-1

(D)



22. (A) 0.1 molal solution of sodium chloride will have higher ΔT_b and higher boiling point as well because it dissociates into ions. At the same time, 0.1 molal glucose solution being a molecular

23. solid will not dissociate into ions.

(B) The bonds between chloroform molecules and molecules of acetone are dipole-dipole interactions but on mixing, the chloroform and acetone molecules, they start forming hydrogens bonds which are stronger bonds resulting in the release of energy. This gives rise to an increase in temperature.

OR

Mole fraction of water = 0.88

Mole fraction of ethanol = 1 – 0.88 = 0.12

Therefore 0.12 moles of ethanol are present in 0.88 moles of water.

Mass of water = 0.88 × 18 = 15.84 g of water.

Molality = number of moles of solute (ethanol) present in 1000 g of solvent (water)

$$= 12 \times \frac{1000}{15.84}$$

$$= 7.57 \text{ m}$$

Molality of ethanol (C_2H_5OH) = 7.57 m

24. (A) Equal number of amino and carboxyl groups makes it neutral, more number of amino than carboxyl groups makes it basic and more carboxyl as compared to amino groups makes it acidic.

(i) Amino acids which contain two group and one $—NH_2$ group are called acidic amino acid, *e.g.*, aspartic acid.

(ii) Amino acids which contain two $—NH_2$ group and one group are called basic amino acids, *e.g.*, lysine.

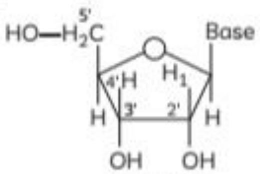
(iii) Amino acids which contain one and one $—NH_2$ group are called neutral amino acids, *e.g.*, glycine.

(B) (i) Amino acids that cannot be synthesized by the body and must be supplied in the diet are called essential amino acids, *e.g.*, lysine, valine, leucine, etc.

(ii) The amino acids which are synthesized by our body are called non-essential amino acids, *e.g.*, alanine, glycine, etc.

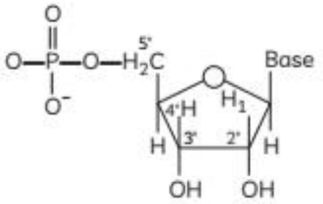
OR

Nucleosides: A nucleoside is the condensation product of purine or pyrimidine base with pentose sugar.



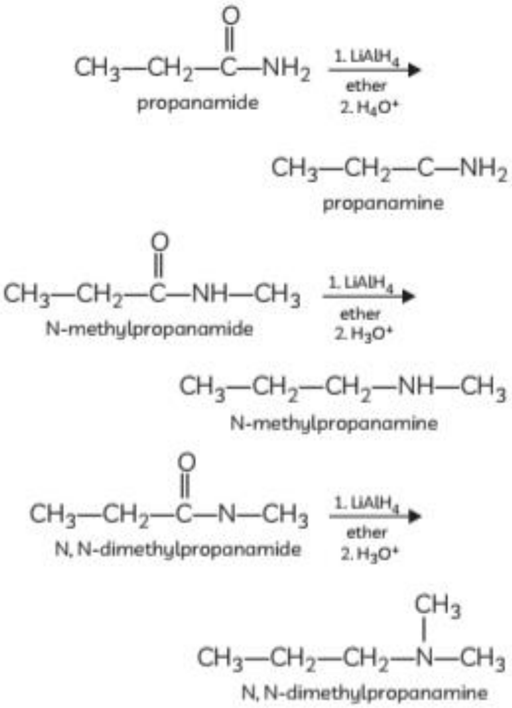
Nucleoside

Nucleotides: The monomeric unit of nucleic acid is called nucleotide. When a nucleoside is linked to phosphoric acid at 5' position of sugar moiety we get nucleotide.



Nucleotide

25. (A) Amides are reduced to their corresponding amines by lithium aluminium hydride. It is possible to synthesise secondary amines by substituting N and N, N amides.



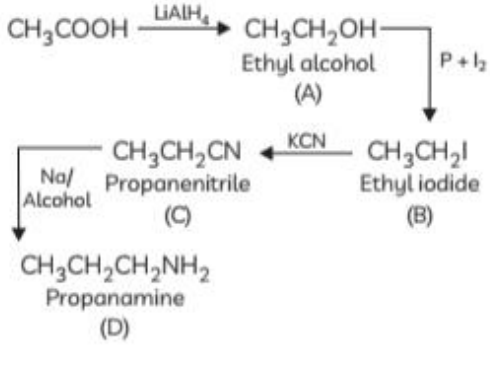
$$\underset{\text{propanamide}}{CH_3—CH_2—\overset{\overset{O}{\|}}{C}—NH_2} \xrightarrow[\text{2. } H_4O^+]{\text{1. LiAlH}_4 \text{, ether}} \underset{\text{propanamine}}{CH_3—CH_2—C—NH_2}$$

$$\underset{\text{N-methylpropanamide}}{CH_3—CH_2—\overset{\overset{O}{\|}}{C}—NH—CH_3} \xrightarrow[\text{2. } H_3O^+]{\text{1. LiAlH}_4 \text{, ether}} \underset{\text{N-methylpropanamine}}{CH_3—CH_2—CH_2—NH—CH_3}$$

$$\underset{\text{N, N-dimethylpropanamide}}{CH_3—CH_2—\overset{\overset{O}{\|}}{C}—N—CH_3} \xrightarrow[\text{2. } H_3O^+]{\text{1. LiAlH}_4 \text{, ether}} \underset{\text{N, N-dimethylpropanamine}}{CH_3—CH_2—CH_2—\overset{\overset{CH_3}{|}}{N}—CH_3}$$

(B) Pyridine is a stronger base than the amine, pyridine removes HCl formed in acylation reaction of amines and shifts the equilibrium to the right hand side.

OR



26. (A) $Cl\text{-}CH_2COOH$ has lower Pk_a value than acetic acid. Also Cl group is an electron withdrawing creating less electron density on oxygen of carboxylic acid making the release of proton easier than acetate ion. Hence, $Cl_2\text{-}CH_2COOH$ is a stronger acid than CH_3COOH.

(B) This is due to the lone pairs on oxygen atom attached to hydrogen atom in the –COOH group are involved in resonance and hence making the carbon atom less electrophilic. Hence, carboxylic acids do not give the reaction of carbonyl groups.

SECTION - C

27. (A) Difference between DNA and RNA :

S.No.	DNA	RNA
(1)	The sugar present in DNA is 2-deoxy-(-) ribose.	The sugar present in RNA is D-(-) ribose.
(2)	DNA contains cytosine and thymine as pyrimidine bases.	RNA contains cytosine and uracil as pyrimidine bases.
(3)	DNA has double standard α-helix structure.	RNA has single stranded α-helix structure.

The base which are common to both DNA and RNA are :

Adenine (A)

Guanine (G)

Cytosine (C)

Thymine is present in DNA.

(B) Sucrose on hydrolysis gives equimolar mixture of D(+)-glucose and D(-) fructose

$$C_{12}H_{22}O_{11} + H_2O \rightarrow \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$

28. Given: Weight of solute HBr (W_2) = 8.1g

Molecular weight of HBr (M_2) = 80 + 1

= 81 g mol^{-1}

Weight of solvent (W_1) = 100 g

Molecular weight of solvent (M_1) = 18 g mol^{-1}

Percentage of dissociation ($\alpha \times 100$) = 90%

$\therefore \quad \alpha = 0.90$

To find: Freezing point of solution T_f

Formula: $\Delta T_f = K_f \times m$

(*m* is molality)

$$\Delta T_f = k_f \times m$$

$$= k_f \times \frac{W_2}{M_2} \times \frac{1}{W_1} \times 1000$$

$$= 1.86 \times \frac{8.1}{81} \times \frac{1}{100} \times 1000$$

$$\Delta T_{f(\text{theor})} = 1.86 \text{ K} \qquad ...(2)$$

$$i \text{ (van't Hoff factor)} = \frac{\Delta T_f(\text{observed})}{\Delta T_f(\text{theoretical})} \qquad ...(3)$$

$$HBr \rightleftharpoons H^+ + Br^-$$

	HBr	H^+	Br^-
Initial	1	0	0
Final	$1-\alpha$	α	α

$$i = 1 - \alpha + \alpha + \alpha = 1 + \alpha = 1 + 0.90 = 1.9$$

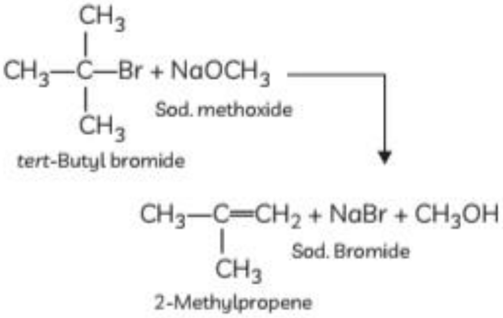
Substituting in equation (3)

$$\Delta T_{f(\text{observed})} = 1.9 \times 1.86 = 3.534$$

$$\Delta T_{f(\text{observed})} = T_0 - T_f = 0 - 3.534$$

$$= -3.53\ ^\circ C$$

29. (A)

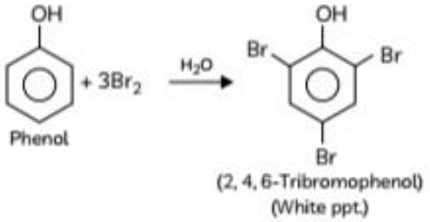


$$CH_3-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}-Br + \underset{\text{Sod. methoxide}}{NaOCH_3} \longrightarrow \underset{\text{2-Methylpropene}}{CH_3-\underset{\displaystyle CH_3}{C}=CH_2} + \underset{\text{Sod. Bromide}}{NaBr} + CH_3OH$$

(B) Phenoxide ion is more reactive than phenol towards electrophilic aromatic substitution and hence undergo electrophilic substitution with carbon dioxide which is a weak electrophile.

(C) Denatured ethanol is the ethanol with ome impurity which is called denaturing agents. Denatured alcohol is not suitable for drinking purposes and adulterated with toxic and/or bad tasting additives (e.g., methanol, benzene, pyridine, castor oil, gasoline, isopropyl alcohol, and acetone), making it unsuitable for human consumption.

(D) When phenol is treated with bromine water, white precipitate of 2, 4, 6-tribromophenol is obtained.



30. (A) Zero order reaction

(B) Slope = – k

(C) Unit of k = $\text{mol L}^{-1}\text{ s}^{-1}$

Explanation: In case of a zero-order reaction, the rate of reaction is independent of the concentration of the reactant. The concentration $[A]_t$ of the reactant at a time t is given by:

$$[A]_t = -\,kt + [A]_0 \quad (y = -\,mx + c)$$

Where, $[A]_0$ is the initial concentration of the reactant and k is a rate constant.

When the concentration of the reactant is plotted against time, a straight line with the slope equal to – k is obtained.

OR

For first order reaction:

$$k = \frac{2.303}{t}\log\frac{[R_0]}{[R]}$$

Given $k = 5 \times 10^{-4}\ s^{-1}$

$[R_0] = 0.25$ M, $t = 2$ min = 120s

After putting the value in formula

$$5 \times 10^{-4} = \frac{2.303}{120}\log\frac{[0.25]}{[R]}$$

$$\Rightarrow \log\frac{[0.25]}{[R]} = \frac{5\times120\times10^{-4}}{2.303}$$

$$\Rightarrow \log(0.25) - \log[R] = 2.6 \times 10^{-2}$$

$$\Rightarrow -0.602 - \log[R] = 0.026$$

$$\Rightarrow -\log[R] = 0.602 + 0.026$$

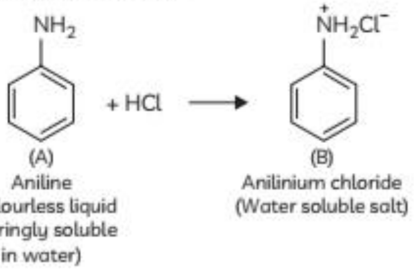
$$\Rightarrow \log[R] = 0.628$$

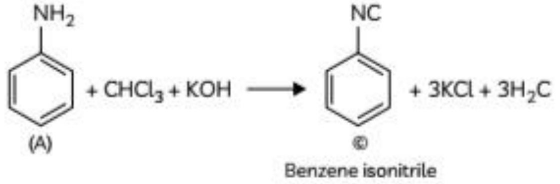
$$\Rightarrow [R] = \text{antilog}\ (-0.628)$$

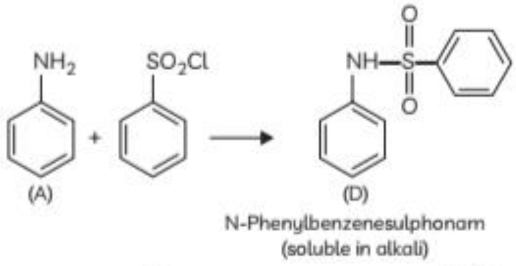
$$\Rightarrow [R] = .235\text{ M}$$

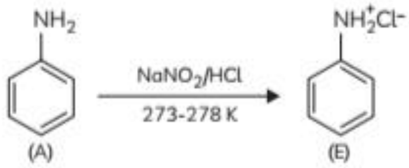
So, remaining concentration of N_2O_5 = 0.235 M.

31. Compounds are as follows:









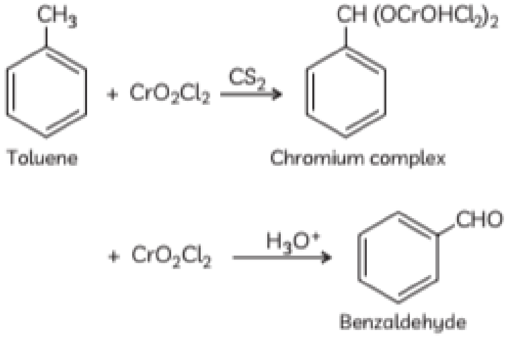
SECTION - D

32. (A) Aromatic aldehyde and formaldehyde undergo Cannizaro reaction because formaldehyde is more reactive than aromatic aldehyde

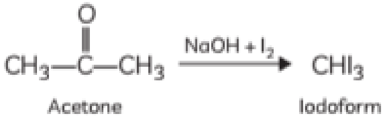
(B) The decreasing order of acidity of a few carboxylic acids is given below:

$C_6H_5COOH > C_6H_5CH_2COOH > CH_3COOH > CH_3CH_2COOH$

(C) (i)



(ii)

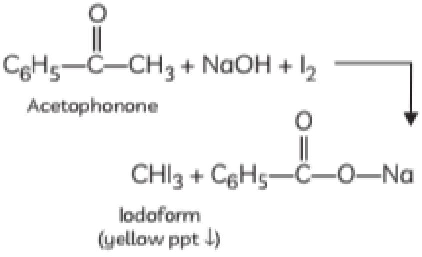


$$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{NaOH + I_2} CHI_3$$

Acetone Iodoform

OR

(i) Acetophenone is a methyl ketone. Thus it gives Iodoform test with NaOH and I_2. Benzaldehyde does not give Iodoform test.



$$C_6H_5-\overset{O}{\overset{\|}{C}}-CH_3 + NaOH + I_2 \longrightarrow CHI_3 + C_6H_5-\overset{O}{\overset{\|}{C}}-O-Na$$

Acetophonone

Iodoform (yellow ppt ↓)

(ii) (1) Phenol reacts with $FeCl_3$ solution to give a violet complex whereas benzoic acid does not gives this reaction.

(2) Phenol reacts with bromine water and it decolourises the brown colour of bromine water whereas benzoic acid does not gives this reaction.

33. (A) The reaction may be given as

$$A \longrightarrow 4B$$

$$\frac{-d[A]}{dt} = +\frac{1}{4}\frac{d[B]}{dt} = \text{Rate of reaction}$$

(B) Nature of reactant, temperature and catalyst.

(C) (i) Slope determines the 'k' i.e. rate constant.

(ii) –k/2.303

OR

Let us first assume that the given reaction is of first order. If the given reaction is of first order, it must obey the following integrated rate equation:

$$k = \frac{2.303}{t}\log_{10}\frac{a}{a-x} \quad \text{...(i)}$$

Volume of O_2 collected at t = ∞ (i.e., V_∞) ∝ Initial conc. of N_2O_5 (*i.e., a*)

Volume of O_2 collected at time *t* (*i.e.*, V_t) ∝ Amount of N_2O_5 decomposed in time (*i.e., x*)

Hence, $a \propto V_\infty$

$x \propto V_t$

$a - x \propto V_\infty - t_1$

Therefore, eq. (i) can be written as

$$k = \frac{2.303}{t}\log_{10}\frac{V_\infty}{V_\infty - V_t}$$

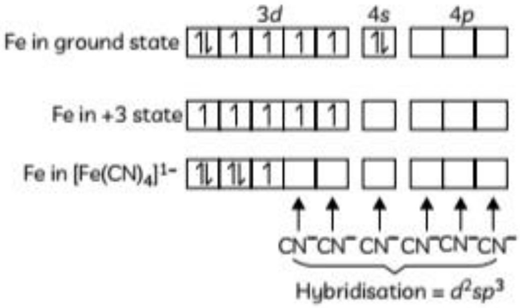
In the present case, $V_\infty = 34.75\ \text{cm}^3$.

SECTION - E

34. (A) Diamminechloro(methylamine)platinum(II) chloride

(B) In $[Fe(CN)_6]^{3-}$ complex, CN^- is a strong field ligand therefore will form low spin complex by using inner 3d-orbitals. Since, it has octahedral geometry as there are 6 ligands, so its hybridization will be d2sp3.

Fe has $4s^2 3d^6$ configuration and therefore Fe^{3+} will be $3d^5$. Upon pairing it has one unpaired electron that makes it paramagnetic complex.



F^- is a weak field ligand hence, it does not cause pairing of electrons. Due to 5 unpaired electrons, $[FeF_6]^{3-}$ is strongly paramagnetic.

(C) Crystal field stabilisation energy for tetrahedral complexes is less than pairing energy. As $\Delta_t <$ pairing energy, so electron occupies a higher energy orbital. This is because this requires less energy than occupying a lower energy orbital and pairing with another electron. Hence electron does not pair up to form low spin complexes.

(D) When white light falls on the complex, some part of it absorbed. Higher the crystal field splitting, lower will be the wavelength absorbed by the complex. The observed colour of complex is the colour generated from the wavelength left over.

OR

(A) In $[Co(NH_3)_6]^{3+}$ Co is in +3 state and has configuration $3d^6$. In the presence of NH_3, 3d electrons pair up leaving two d-orbitals empty. Hence, the hybridization is d^2sp^3 forming and inner orbital complex.

In $[Ni(NH_3)_6]^{2+}$, Ni is in +2 state and has configuration $3d^8$. In presence of NH3, the 3d electrons do not pair up. The hybridization is sp^3d^2 forming an outer orbital complex.

(B) Spectrochemical series gives the arrangement of ligands in the increasing order of crystal field splitting.

Weak field ligands cause less crystal field splitting. They form high spin complexes. Examples include chloride ions, fluoride ions *etc.*

Strong field ligands cause greater crystal field splitting. They form low spin complexes. Examples includes cyanide ion and CO.

(C) $FeSO_4$ does not form any complex with $(NH_4)_2SO_4$. Instead, it forms a double salt $FeSO_4.(NH_4)_2SO_4.6H_2O$ (Mohr's salt) which dissociates completely into ions.

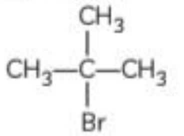
$CuSO_4$ when mixed with NH_3 forms a complex $[Cu(NH_3)_4]SO_4$ in which the complex ion $[Cu(NH_3)_4]^{2+}$ does not dissociate to give Cu^{2+} ion.

(D) The atomic number of Co is 27 and its valence shell electronic configuration is $3d^7\ 4s^2$. Co is in +3 oxidation state in the complex $[CoF_6]^{3-}$. Hence, $[CoF_6]^{3-}$ is sp^3d^2 hybridised and it is octahedral in shape.

35. (A) (i) The compound 'A', C_4H_9Br when treated with aq. KOH, proceeds with the rate of the reaction depends on the concentration of 'A' only. This means that the reaction follows first order kinetics, which is the characteristic of $S_N{}^1$ reactions. This means C_4H_9Br is a tertiary halide, because tert-halides undergo $S_N{}^1$ reactions.

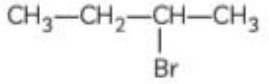
On the other hand, the optically active isomer 'B', when subjected to treatment with aq. KOH, undergoes $S_N{}^2$ reaction due to the rate of reaction depending on both the reactants. This means that the isomer is a secondary halide.

The structure of 'A' is



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

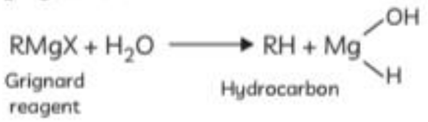
The structure of 'B' is .



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

(ii) Because of the $S_N{}^2$ reaction, compound 'B' will undergo configuration inversion and produce an inverted product.

(B) Grignard reagents are highly reactive substances. They react with any source of proton to form hydrocarbons. Even water is sufficiently acidic to convert it into the corresponding hydrocarbon. So, it is necessary to avoid even traces of moisture with the grignard reagent as they are highly reactive.



$$\underset{\text{Grignard reagent}}{RMgX} + H_2O \longrightarrow \underset{\text{Hydrocarbon}}{RH} + Mg\genfrac{}{}{0pt}{}{OH}{H}$$

(C) The presence of electron withdrawing group increases the reactivity of haloarenes. The effect is more pronounced at ortho and para position. From resonance structure of chlorobenzene we see that electron density is maximum only at o/p-position. So, it does not affect much at m-position.

The nitro group at meta position does not stabilize the negative charge and therefore no effect of nitro group on reactivity is found in case of meta nitrobenzene.

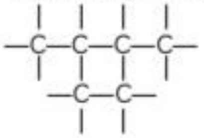
OR

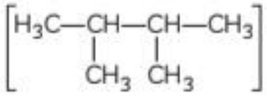
(A) Alkyl halide 'X' $\xrightarrow{t\text{-butoxide}}$ Y + Z
$(C_6H_{13}Cl)$

$\xrightarrow{(C_6H_{12})\text{Hydrogenation}}$

2, 3-dimethyl butane

Hence, in alkene four C-atoms are present in straight chain. The skeleton of C—in alkene is given as follows

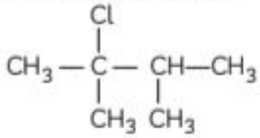




$$\left[H_3C-\underset{\displaystyle CH_3}{CH}-\underset{\displaystyle CH_3}{CH}-CH_3\right]$$

Both isomeric alkenes (C_6H_{12}) on hydrogenation give 2, 3-dimethylbutane

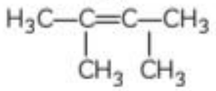
Possible alkene (Y and Z) are



$$CH_3-\overset{\displaystyle Cl}{\underset{\displaystyle CH_3}{C}}-\underset{\displaystyle CH_3}{CH}-CH_3$$

2-Chloro 2,3-dimethyl butane

(X)

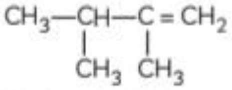


$$H_3C-\underset{\displaystyle CH_3}{C}=\underset{\displaystyle CH_3}{C}-CH_3$$

2, 3-dimethye 2-butene

(Y)

and



$$CH_3-\underset{\displaystyle CH_3}{CH}-\underset{\displaystyle CH_3}{C}=CH_2$$

2, 3-dimethyl 1-butene

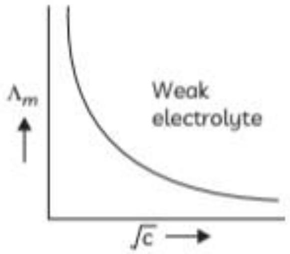
(Z)

The reactivity of alkyl halide is more than vinyl and aryl halides because the halogen atom in alkyl halide is connected to the sp3 carbon.

Whereas in vinyl or aryl the halogen atom is connected to the sp^2 carbon.

(C) Carbocations are intermediate in S^{N1} reactions. Carbocations being sp^2 hybridized are planar species, therefore, attack of nucleophile on it can occur from both front and rear (lead to form d - and l- products) with almost equal ease, giving a racemic mixture.

36. (A)



For weak electrolytes, the graph plotted between molar conductivity and $c^{1/2}$ (where c is the concentration) is not a straight line. Weak electrolytes have lower molar conductivities and lower degree of dissociation at higher concentrations which increases steeply at lower concentrations. Therefore, limiting molar conductivity, Λ_m° cannot be obtained by extrapolation of molar conductivity to zero concentration. Hence, we use Kohlrausch's law of independent migration of ions for determining to limit molar conductivity, Λ_m° of weak electrolytes.

(B) At anode : $[Sn^{2+}_{(aq)} \rightarrow Sn^{4+}_{(aq)} + 2e^-] \times 5$

At cathode :

$$[MnO_4^-{}_{(aq)} + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}] \times 2$$

Cell reaction :

$$2MnO_4^-{}_{(aq)} + 5Sn^{2+}_{(aq)} + 16H^+_{(aq)} \longrightarrow 2Mn^{2+}_{(aq)} + 5Sn^{4+}_{(aq)} + 8H_2O_{(l)}$$

$$\begin{aligned} E^\circ_{cell} &= E_{cathode} - E_{anode} \\ &= 1.51V - 0.15V \\ &= 1.36V \end{aligned}$$

As cell potential is positive, therefore the reaction is product favoured.

(C) MnO_4^- because it has highest reduction potential.