

Date: 27/02/2024

Question Paper Code

56/5/2

Time: 3 hrs.

CHEMISTRY (Theory)

Max. Marks: 70

Class-XII

(CBSE 2023-24)

Answers & Solutions

GENERAL INSTRUCTIONS

Read the following instructions carefully and follow them:

- (i) This question paper contains **33** questions. **All** questions are compulsory.
- (ii) Question paper is divided into **FIVE** sections – Section **A, B, C, D** and **E**.
- (iii) **Section – A** : Question Number **1** to **16** are Multiple Choice type questions (MCQs) carrying **1** mark each.
- (iv) **Section – B** : Question Number **17** to **21** are Very Short Answer (VSA) type questions carrying **2** marks each.
- (v) **Section – C** : Question Number **22** to **28** are Short Answer (SA) type questions carrying **3** marks each.
- (vi) **Section – D** : Question Number **29** and **30** are case-based questions carrying **4** marks each.
- (vii) **Section – E** : Question Number **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**.
- (ix) Use of calculator is **NOT** allowed.
- (x) Candidates must write the Q.P. Code on the title page of the answer-book.

SECTION-A

Question No. 1 to 16 are Multiple Choice type Questions, carrying 1 mark each.

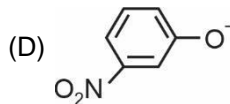
[16 × 1 = 16]

1. Which of the following species can act as the strongest base?

(A) OH⁻

(B) C₆H₅O⁻

(C) RO⁻



Answer (C)

Sol. An alkoxide ion is a better proton acceptor than hydroxide ion. Hence, alkoxides are stronger bases.

2. Auto-oxidation of chloroform in air and light produces a poisonous gas known as

(A) Phosphine

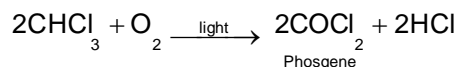
(B) Mustard gas

(C) Phosgene

(D) Tear gas

Answer (C)

Sol. Chloroform is slowly oxidised by air in the presence of light to an extremely poisonous gas, carbonyl chloride, also known as phosgene



3. Isotonic solutions have the same

(A) Density

(B) Refractive index

(C) Osmotic pressure

(D) Volume

Answer (C)

Sol. Isotonic solutions have same osmotic pressure at a given temperature.

4. The specific sequence in which amino acids are arranged in a protein is called its

(A) Primary structure

(B) Secondary structure

(C) Tertiary structure

(D) Quaternary structure

Answer (A)

Sol. Each polypeptide in a protein has amino acids linked with each other in a specific sequence of amino acids, called primary structure of protein.

5. Transition metals are known to make interstitial compounds. Formation of interstitial compounds makes the transition metal

(A) More hard

(B) More soft

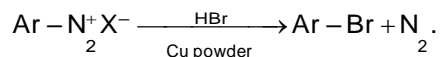
(C) More ductile

(D) More metallic

Answer (A)

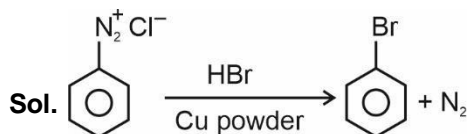
Sol. Interstitial compounds are very hard, some borides approach diamond in hardness.

6. The correct name of the given reaction is



- (A) Hoffmann Bromamide degradation reaction (B) Gabriel Phthalimide synthesis
(C) Carbyl amine reaction (D) Gatterman reaction

Answer (D)

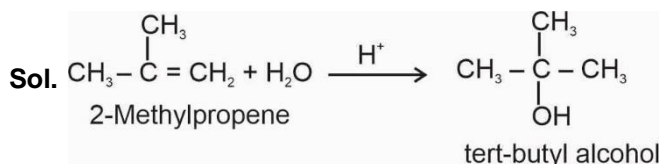


Gatterman reaction is used for obtaining chlorobenzene or bromobenzene from benzene diazonium chloride by treating it with Cu/HCl or Cu/HBr respectively.

7. Visha took 4 test-tubes namely A, B, C & D containing $\text{CH}_3\text{CH}=\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$, $\text{CH}_3\text{CH}=\text{CH}-\text{CH}_3$ and $(\text{CH}_3)_2\text{C}=\text{CH}_2$ respectively and tried to convert them into tert-butyl alcohol. She carried out acid catalysed hydration reaction on every alkene. Out of the four test-tubes, the one which will give desired result is

- (A) A (B) B
(C) C (D) D

Answer (D)



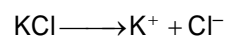
In the presence of few drops of conc. H_2SO_4 , alkenes react with water to form alcohol in accordance with the Markovnikov rule.

8. Van't Hoff factor for KCl solution assuming the complete dissociation is

- (A) 1 (B) 2
(C) 0.5 (D) 1.5

Answer (B)

Sol. Upon complete dissociation,



van't Hoff factor = 'n' for strong electrolytes

$$\therefore \boxed{n = 2}$$

9. Dilution affects both molar conductivity as well as conductivity. Effect of dilution on both is

- (A) Molar conductivity decreases whereas conductivity increases on dilution
(B) Molar conductivity increases whereas conductivity decreases on dilution
(C) Both decrease with dilution
(D) Both increase with dilutions

Answer (B)

Sol. Upon dilution, conductivity decreases, due to decrease in concentration of ions.

Upon dilution, due to increase in total number of ions in weak electrolytes and in strong electrolytes mobility increases. Hence, molar conductivity increases.

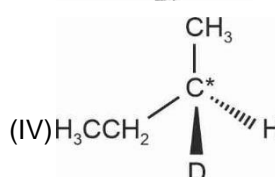
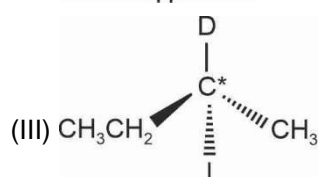
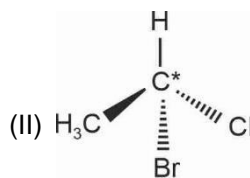
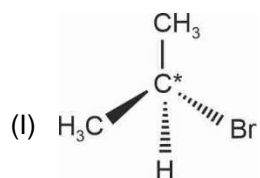
10. Which of the following cell is used in inverter?

- (A) Fuel cell
- (B) Mercury cell
- (C) Lead storage cell
- (D) Dry cell

Answer (C)

Sol. Lead storage cell is used in inverter.

11. In which of the following molecules, C atom marked with asterisk is chiral?

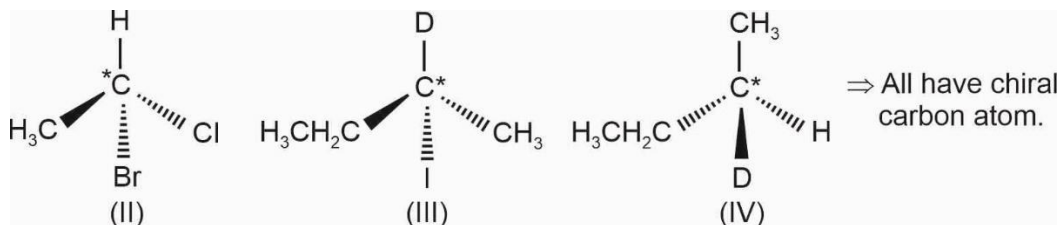
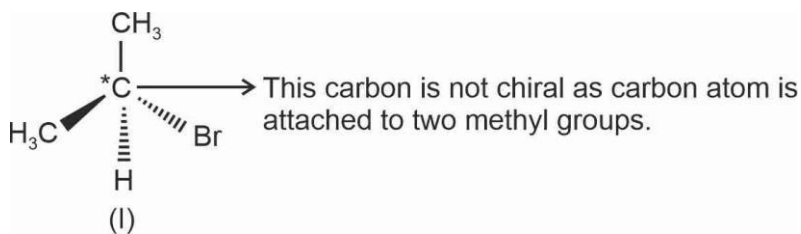


- (A) I, II, III
- (B) II, III, IV
- (C) I, II, III, IV
- (D) I, III, IV

Answer (B)

Sol. The correct answer is (B)

The chiral carbon atom is the one which is bonded to four different atoms/groups.

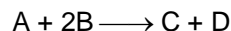


12. For the reaction $A + 2B \longrightarrow C + D$. The order of the reaction is

- (A) 1 with respect to A
- (B) 2 with respect to B
- (C) Can't be predicted as order is determined experimentally
- (D) 3

Answer (C)

Sol. Order of a reaction is an experimental quantity, which cannot be determined theoretically.



The order of the above reaction can't be predicted as order is determined experimentally.

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 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) : p-methoxyphenol is a stronger acid than p-nitrophenol.

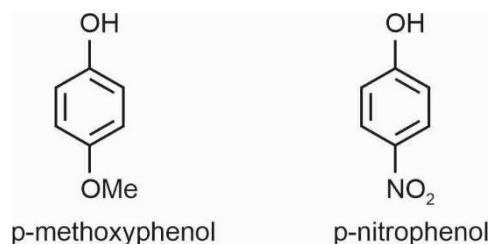
Reason (R) : Methoxy group shows +I effect whereas nitro group shows –I effect.

Answer (*)

Sol. None of the option is correct

p-methoxyphenol is weaker acid as compared to p-nitrophenol due to the reason that the conjugate base formed in p-nitrophenol is stabilised by the –M effect of nitro group.

Also, methoxy group shows –I and +M effect which makes both Assertion (A) and Reason (R) are false.



14. Assertion (A) : Inversion of configuration is observed in S_N2 reaction.

Reason (R) : The reaction proceeds with the formation of carbocation.

Answer (C)

Sol. Assertion saying inversion of configuration is observed in S_N2 reaction is correct. As attack of nucleophile takes place from backside.

S_N2 reaction proceeds with the formation of transition state, no intermediate is formed in the reaction, making the reason a false statement. (A) is true and (R) is false.

15. Assertion (A) : The units of rate constant of a zero order reaction and rate of reaction are the same.

Reason (R) : In zero order reaction, the rate of reaction is independent of the concentration of reactants.

Answer (A)

Sol. A \longrightarrow Products

$$\text{Rate} \propto [A]^n$$

$$\text{Rate} = k[A]^n, \quad n = \text{order of reaction}$$

For zero order, $n = 0$

$$\text{Rate} = k$$

So, units of rate is same as that of rate constant for zero order reaction i.e., $\text{mol L}^{-1}\text{s}^{-1}$

and this is due to rate of reaction is independent of concentration of reactants.

(A) is true and (R) is true and (R) is correct explanation of (A)

16. Assertion (A): Zr and Hf are of almost similar atomic radii.

Reason (R): This is due to Lanthanoid contraction.

Answer (A)

Sol. [Zr(160 pm); Hf (159 pm)]

Zr and Hf are of almost similar atomic radii despite of having a difference in principal quantum number.

This is due to the lanthanoid contraction which compensates this increasing size.

SECTION-B

17. Define the following terms:

[2]

(a) Faraday's second law of electrolysis

(b) Corrosion

Sol. (a) Faraday's second law of electrolysis :

The amount of different substances liberated by the same quantity of electricity passing through the electrolytic solution are proportional to their chemical equivalent weights.

(b) Corrosion : The coating of surfaces of metallic objects with oxides or other salts of the metal is called corrosion.

Some examples of corrosion are rusting of iron, tarnishing of silver and development of green coating on copper and bronze.

18. Resistance of a conductivity cell filled with 0.2 mol L^{-1} KCl solution is 200Ω . If the resistance of the same cell when filled with 0.05 mol L^{-1} KCl solution is 620Ω , calculate the conductivity and molar conductivity of 0.05 mol L^{-1} KCl solution. The conductivity of 0.2 mol L^{-1} KCl solution is 0.0248 S cm^{-1} . **[2]**

Sol. As cell is same, then cell constant is same i.e. $\frac{l}{A}$ of both the solution is same.

$$\kappa_1 \times R_1 = \frac{l}{A} = \kappa_2 \times R_2$$

$$\kappa_1 = \text{Conductivity of } 0.2 \text{ mol L}^{-1} \text{ KCl solution} = 0.0248 \text{ S cm}^{-1}$$

$$R_1 = \text{Resistance of } 0.2 \text{ mol L}^{-1} \text{ KCl solution} = 200 \Omega$$

$$\kappa_2 = \text{Conductivity of } 0.05 \text{ mol L}^{-1} \text{ KCl solution (We have to calculate)}$$

$$R_2 = \text{Resistance of } 0.05 \text{ mol L}^{-1} \text{ KCl solution} = 620 \Omega$$

$$0.0248 \text{ S cm}^{-1} \times 200 \Omega = \kappa_2 \times 620 \Omega$$

$$\kappa_2 = \frac{0.0248 \times 200}{620} \text{ S cm}^{-1}$$

$$\kappa_2 = 0.008 \text{ S cm}^{-1}$$

$$\text{For molar conductivity, } \wedge_m = \frac{\kappa}{C}$$

$$\wedge_m = \frac{0.008 \text{ S cm}^{-1}}{0.05 \text{ mol L}^{-1}}$$

$$\wedge_m = 0.16 \text{ S cm}^{-1} \text{ dm}^3 \text{ mol}^{-1}$$

$$\wedge_m = 0.16 \times 10^3 \text{ S cm}^2 \text{ mol}^{-1} \text{ (1 dm = 10 cm)}$$

$$\wedge_m = 160 \text{ S cm}^2 \text{ mol}^{-1}$$

19. Show that in case of a first order reaction, the time taken for completion of 99% reaction is twice the time required for 90% completion of the reaction. ($\log 10 = 1$) [2]

Sol. Time required for the completion of 99% reaction

$$t_{99\%} = \frac{2.303}{k} \log \frac{[R_0]}{[R]}$$

$$\text{At } t_{99\%}, \text{ if } [R_0] = 100$$

$$[R] = 1$$

$$t_{99\%} = \frac{2.303}{k} \log 100 = \frac{2 \times 2.303}{k} \quad \dots \text{(i)}$$

Similar

$$t_{90\%} = \frac{2.303}{k} \log \frac{[R_0]}{[R]}$$

$$t_{90\%} = \frac{2.303}{k} \log \frac{100}{10} = \frac{2.303}{k} \quad \dots \text{(ii)}$$

Divide (i) by (ii)

$$\frac{t_{99\%}}{t_{90\%}} = \frac{2 \times 2.303 / k}{2.303 / k} = 2$$

$$\text{Hence } t_{99\%} = 2 \times t_{90\%}$$

20. (a) Carry out the following conversions :

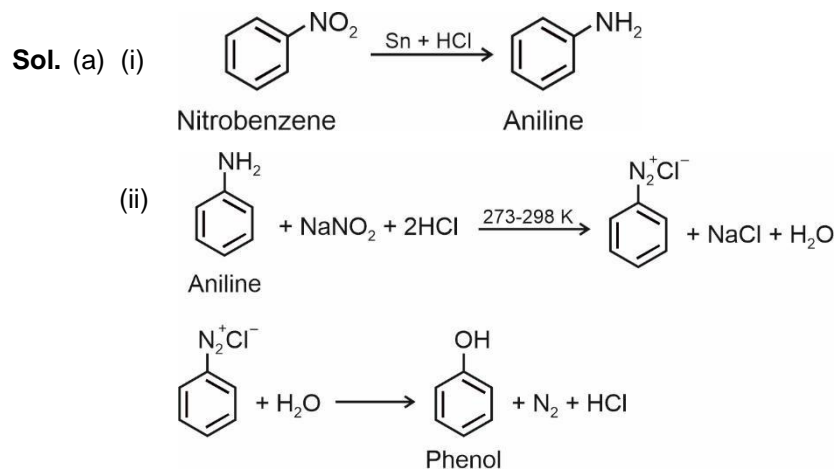
(i) Nitrobenzene to Aniline [1]

(ii) Aniline to Phenol [1]

OR

(b) (i) Write a chemical test to distinguish between Dimethyl amine and Ethanamine. [1]

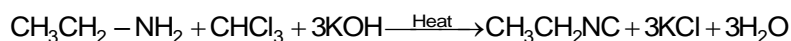
(ii) Write the product formed when benzene diazonium chloride is treated with KI. [1]



OR

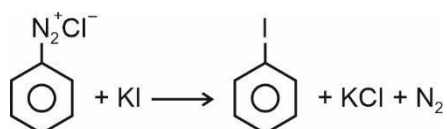
(b) (i) Carbylamine reaction can distinguish between Dimethyl amine and Ethanamine.

Ethanamine reacts with CHCl₃ and ethanolic KOH to form isocyanides which is foul smelling substance.



Dimethyl amine is secondary amine and do not show this reaction.

(ii) Iodobenzene is formed along with KCl and N₂.



21. Classify the following sugars into monosaccharides and disaccharides :

[2]

Fructose, Lactose, Glucose, Maltose

Sol. • Monosaccharides are Glucose and Fructose.

• Disaccharides are Lactose and Maltose.

SECTION-C

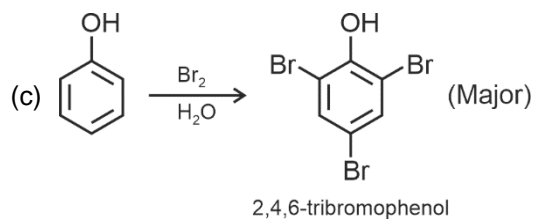
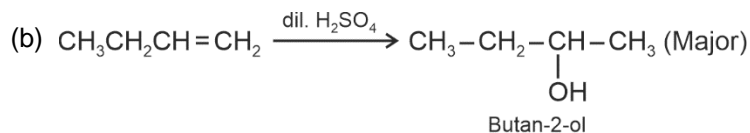
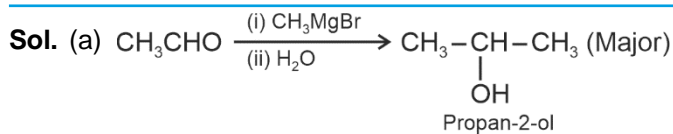
22. Give the structure of the major product expected from the following reactions:

[1 × 3]

(a) Reaction of Ethanal with methyl-magnesium bromide followed by hydrolysis.

(b) Hydration of But-1-ene in the presence of dilute sulphuric acid.

(c) Reaction of phenol with bromine water.

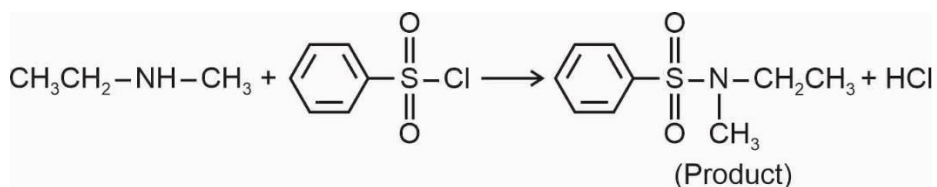


23. A compound 'X' with molecular formula $\text{C}_3\text{H}_9\text{N}$ reacts with $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ to give a solid, insoluble in alkali. Identify 'X' and give the IUPAC name of the product. Write the reaction involved. [3]

Sol. Compound 'X' = $\text{CH}_3\text{CH}_2-\text{NH}-\text{CH}_3$ (secondary amine)

IUPAC name : N-Ethyl-N-methylbenzene sulphonamide (Product)

Reaction with aryl sulphonyl chloride



24. The rate constant of a reaction quadruples when the temperature changes from 300 K to 320 K. Calculate the activation energy for this reaction.

$[\log 2 = 0.30, \log 4 = 0.60, 2.303R = 19.15 \text{ J K}^{-1} \text{ mol}^{-1}]$

[3]

Sol. $\log \frac{k'}{k} = \frac{E_a}{2.303R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$

$\log \left(\frac{4k}{k} \right) = \frac{E_a}{2.303R} \left[\frac{1}{300} - \frac{1}{320} \right]$

$\log 4 = \frac{E_a}{2.303R} \left[\frac{320 - 300}{96000} \right]$

$0.60 = \frac{E_a}{19.15} \left[\frac{20}{96000} \right]$

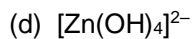
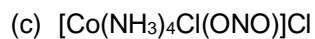
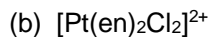
$\frac{0.6 \times 19.15 \times 9600}{2} = E_a$

$E_a = 55152 \text{ J/mol}$

$E_a = 55.152 \text{ kJ/mol}$

25. Write IUPAC names of the following coordination compounds : (any three)

[1 × 3]



Sol. IUPAC names of the given compounds are

(a) Potassium hexacyanidoferrate (III)

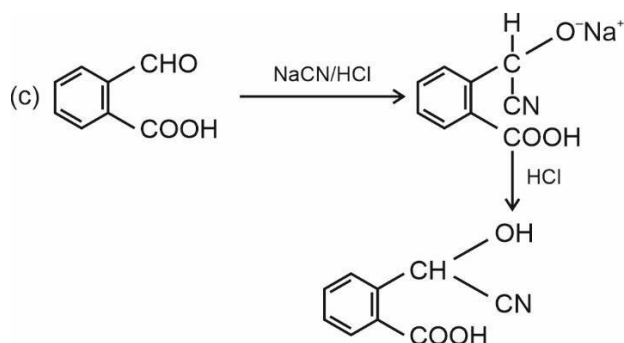
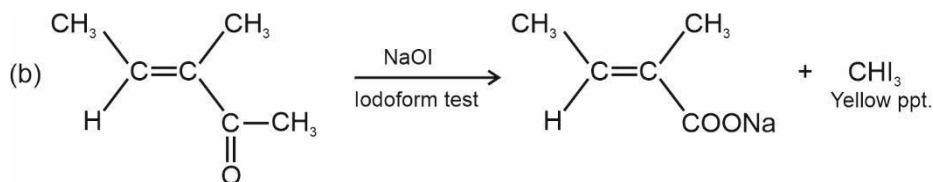
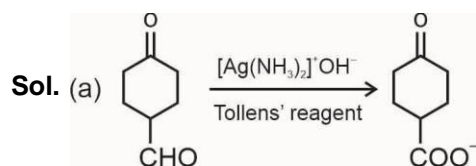
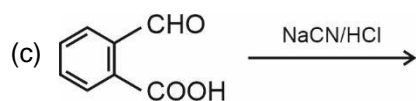
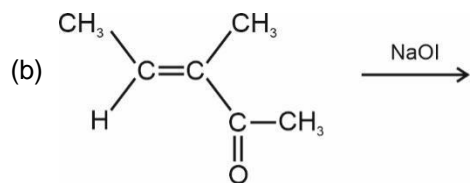
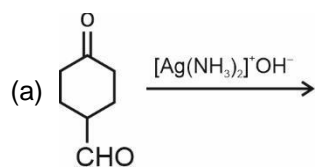
(b) Dichloridobis (ethane-1,2-diamine) platinum (IV)

(c) Tetraamminechloridonitrito-O-cobalt (III) chloride

(d) Tetrahydroxidozincate (II)

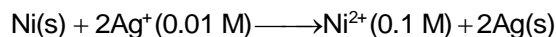
26. Draw the structures of major product(s) in each of the following reactions :

[1 × 3]



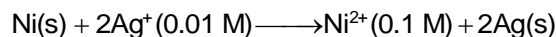
27. Calculate the emf of the following cell :

[3]



Given that $E_{\text{cell}}^{\circ} = 1.05 \text{ V}$, $\log 10 = 1$

Sol. For the given cell



$$\begin{aligned} E_{\text{cell}} &= E_{\text{cell}}^{\circ} - \frac{0.059}{2} \log \frac{[\text{Ni}^{2+}]}{[\text{Ag}^+]^2} \\ &= 1.05 - \frac{0.059}{2} \log \frac{10^{-1}}{10^{-2}} \\ &= 1.05 - \frac{0.059}{2} \log 10^3 \\ &= 1.05 - \frac{0.059 \times 3}{2} \\ &= 1.05 - 0.09 \\ &= 0.96 \text{ volt} \end{aligned}$$

28. Account for the following :

[1 × 3]

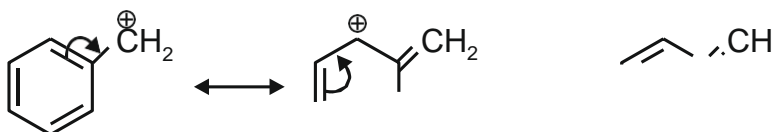
- Haloalkanes react with NaCN to form both cyanides and isocyanides.
- Haloarenes do not undergo nucleophilic substitution reaction easily.
- Benzyl chloride gives $\text{S}_{\text{N}}1$ reaction.

Sol. (a) Haloalkane react with NaCN to form cyanides (major product) and isocyanides (minor product) because

CN^- is an ambidentate ligand and it can attack either by C centre or N centre.

(b) C – Cl bond acquires a partial double bond character due to resonance, so haloarenes do not undergo nucleophilic substitution reaction easily.

(c) Benzyl chloride gives $\text{S}_{\text{N}}1$ reaction because the carbocation formed gets stabilised through resonance.



SECTION-D

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

29. Certain organic compounds are required in small amounts in our diet but their deficiency causes specific disease. These compounds are called vitamins. Most of the vitamins cannot be synthesized in our body but plants can synthesize almost all of them. So they are considered as essential food factors. However, the bacteria of the gut can produce some of the vitamins required by us. All the vitamins are generally available in our diet. The term 'vitamin' was coined from the words vital + amine, since the earlier identified compounds had amino group. Vitamins are classified into two groups depending upon their solubility in water or fat namely-fat soluble vitamins and water soluble vitamins.

Answer the following questions :

- (a) What is the other name of vitamin B₆? [1]
 (b) Name the vitamin whose deficiency causes increased blood clotting time. [1]
 (c) Xerophthalmia is caused by the deficiency of which vitamin? Give two sources of this vitamin. [2]

OR

- (c) Why can't vitamin C be stored in our body? Name the disease caused by the deficiency of this vitamin. [2]

Sol. (a) Pyridoxine is the other name of vitamin B₆.

- (b) Deficiency of vitamin K causes increased blood clotting time.
 (c) Xerophthalmia is caused by the deficiency of vitamin A.

Two sources of vitamin A are:

- (1) Fish liver oil
 (2) Carrots

OR

- (c) Vitamin C is water soluble vitamin so it is readily excreted in urine and cannot be stored in our body.

Scurvy disease is caused by the deficiency of vitamin C.

- 30.** The oxidation number of the central atom in a complex is defined as the charge it would carry if all the ligands are removed along with the electron pairs that are shared with the central atom. Similarly the charge on the complex is the sum of the charges of the constituent parts i.e. the sum of the charges on the central metal ion and its surrounding ligands. Based on this, the complex is called neutral if the sum of the charges of the constituents is equal to zero. However, for an anion or cationic complex, the sum of the charges of the constituents is equal to the charge on the coordination sphere.

Based on the above information, answer the following questions :

- (a) Define ambidentate ligand with an example. [1]
 (b) What type of isomerism is shown by $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$? [1]
 (c) Define Chelate effect. How it affects the stability of complex? [2]

OR

- (c) Find the coordination number and oxidation state of chromium in $\text{Na}_3[\text{Cr}(\text{C}_2\text{O}_4)_3]$. [2]

Sol. (a) Ligand which has two different donor atoms and either of the two ligetes in the complex is called ambidentate ligand.

Example : NO_2^- and SCN^- ion

NO_2^- ion can coordinate either through nitrogen or through oxygen to a central metal atom/ion.

- (b) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$ show ionisation isomerism.
 (c) When bidentate or polydentate ligand coordinate with the central metal ion by ring formation, this effect is known as chelate effect.

When a ligand attaches to the metal ion in a manner which leads to the formation of 5- or 6- membered ring. Then the metal-ligand association is found to be more stable.

OR

(c) Coordination number of chromium in $\text{Na}_3[\text{Cr}(\text{C}_2\text{O}_4)_3]$ is 6 because $\text{C}_2\text{O}_4^{2-}$ ligand is bidentate ligand.

Oxidation number of chromium in $\text{Na}_3[\text{Cr}(\text{C}_2\text{O}_4)_3]$ is

$$\Rightarrow +3 + x + 3(-2) = 0$$

$$x = +3$$

SECTION-E

31. (a) An organic compound (A) with the molecular formula $\text{C}_9\text{H}_{10}\text{O}$ forms 2, 4-DNP derivative, reduces Fehling solution and undergoes Cannizzaro reaction. On vigorous oxidation, it gives 1, 2-benzene dicarboxylic acid.

(i) Identify the compound (A) and write its IUPAC name.

(ii) Write the reaction of compound (A) with

(1) 2, 4-Dinitrophenyl hydrazine and

(2) Fehling solution

(iii) Write the equation of compound (A) when it undergoes Cannizzaro reaction.

[2 + 2 + 1]

OR

(b) (i) Account for the following :

[1 × 2]

(1) The alpha (α)-hydrogens of aldehydes and ketones are acidic in nature.

(2) Oxidation of aldehydes is easier than ketones.

(ii) Arrange the following in :

[1 × 2]

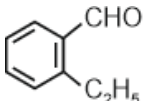
(1) Decreasing reactivity towards nucleophilic addition reaction propanal, acetone, benzaldehyde.

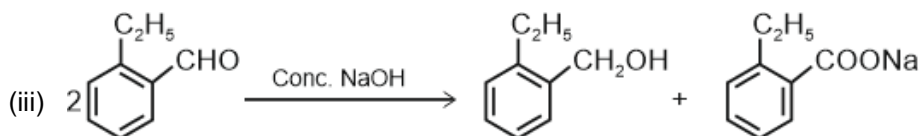
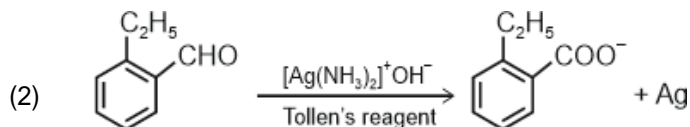
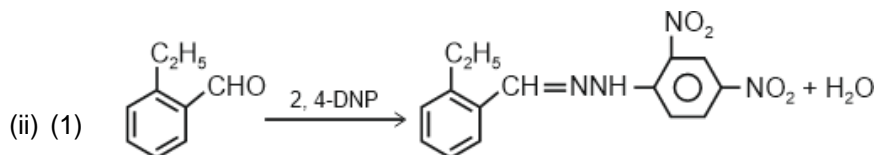
(2) Increasing order of boiling point :

Propane, Ethanol, Dimethylether, Propanal

(iii) Give simple chemical test to distinguish between Benzoic acid and Benzaldehyde.

[1]

Sol. (a) (i)  2-ethylbenzaldehyde



OR

(b) (i) (1) The acidity of α -hydrogen atoms of carbonyl compounds is due to strong electron withdrawing effect of the carbonyl group and resonance stabilization of the conjugate base.

(2) Aldehydes have H attached to carbonyl C, so aldehydes can be oxidised by mild oxidising agent.

Oxidation of ketones involves C – C bond cleavage.

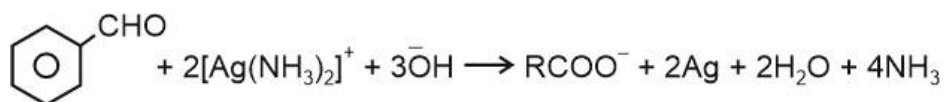
(ii) (1) Propanal > Benzaldehyde > Acetone

Aldehydes are generally more reactive towards nucleophilic addition reaction.

(2) Propane < Dimethylether < Propanal < Ethanol

(iii) Tollen's test

Benzaldehyde gives Tollen's test



Benzoic acid does not give Tollens' test.

32. Attempt any **five** of the following :

[1 × 5]

(a) Ce(III) is easily oxidised to Ce(IV). Comment.

(b) $E^\circ(\text{Mn}^{2+}/\text{Mn})$ is -1.18 V. Why is this value highly negative in comparison to neighbouring d block elements?

(c) Which element of 3d series has lowest enthalpy of atomisation and why?

(d) What happens when sodium chromate is acidified?

(e) Zn, Cd and Hg are soft metals. Why?

(f) Why is permanganate titration not carried out in the presence of HCl?

(g) The lower oxides of transition metals are basic whereas the highest are amphoteric/acidic. Give reason.

Sol. (a) Ce(III) is easily oxidised to Ce(IV) because formation of Ce(IV) is favoured by its noble gas configuration, *i.e.*, $[\text{Xe}]4f^0$.

Hence, Ce(III) changes its E.C. $[\text{Xe}]4f^1$ to Ce(IV) $[\text{Xe}]4f^0$.

(b) $E^\circ_{\text{Mn}^{2+}/\text{Mn}}$ is highly negative in comparison to neighbouring d-block elements, *i.e.*, (Cr and Fe).

$$E^\circ_{\text{Mn}^{2+}/\text{Mn}} = -1.18 \text{ V}, E^\circ_{\text{Cr}^{2+}/\text{Cr}} = -0.91, E^\circ_{\text{Fe}^{2+}/\text{Fe}} = -0.44 \text{ V}$$

The highly negative $E^\circ_{\text{Mn}^{2+}/\text{Mn}}$ is determined on the basis of summation of $\Delta_a H^\circ$, $\Delta_i H^\circ$, $\Delta_i H^\circ$ and $\Delta_{\text{hyd}} H^\circ$ of particular metal

(c) Zinc has lowest enthalpy of atomisation in 3d series. The $\Delta_a H^\circ$ (kJ mol^{-1}) of Zn is 126.

Zn has lowest enthalpy of atomisation due to absence of number of unpaired electrons.

Zn has weaker interatomic interaction and hence weak bonding exist between zinc atoms resulting in lowest enthalpy of atomisation.

(d) When sodium chromate is acidified with sulphuric acid, then orange coloured sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$) is formed.



- (e) Zn, Cd and Hg are soft metals because they have completely filled d-orbitals.

Due to absence of unpaired electrons, weak metallic bonding takes place.

Outer E.C. of Zn = $3d^{10}4s^2$

Outer E.C. of Cd = $4d^{10}5s^2$

Outer E.C. of Hg = $5d^{10}6s^2$

- (f) MnO_4^- (permanganate) titration is not carried out in the presence of HCl.

MnO_4^- is a strong oxidising agent which will convert Cl^- and Cl_2 . Some of the MnO_4^- is used for the conversion of Cl^- to Cl_2 which will not give exact result of titration.

Hence, we cannot use HCl with MnO_4^- for quantitative estimation.

- (g) In lower oxidation state of transition metals, some of the valence electrons of the metal atom are not involved in bonding.

Hence, in lower oxides, metal can donate electrons and behave as base.

While in higher oxides of transition metals, valence electrons are involved in bonding and are not available for donation of electrons. In higher oxides, effective nuclear charge of metal is also high, which allow the metal ion to accept the electrons and behave as acid.

33. (a) (i) Ishan's automobile radiator is filled with 1.0 kg of water. How many grams of ethylene glycol (Molar mass = 62 g mol^{-1}) must Ishan add to get the freezing point of the solution lowered to $-2.8 \text{ }^\circ\text{C}$. K_f for water is $1.86 \text{ K kg mol}^{-1}$. [3]
- (ii) What type of deviation from Raoult's law is shown by ethanol and acetone mixture? Give reason. [2]

OR

- (b) (i) Boiling point of water at 750 mm Hg pressure is $99.68 \text{ }^\circ\text{C}$. How much sucrose (Molar mass = 342 g mol^{-1}) is to be added to 500 g of water such that it boils at $100 \text{ }^\circ\text{C}$? (K_b for water = $0.52 \text{ K kg mol}^{-1}$).
- (ii) State Henry's law and write its any one application. [3 + 2]

- Sol. (a) (i) $\Delta T_f = K_f m$ [1]

Let x g of ethylene glycol is added to radiator

$$\Rightarrow \Delta T_f = K_f \frac{x}{62 \times 1} \quad [1/2]$$

$$x = \frac{62 \Delta T_f}{K_f} = \frac{62 \times 2.8}{1.86} \quad [1/2]$$

$$\Rightarrow x = 93.33 \quad [1]$$

- (ii) • Mixture of ethanol and acetone shows positive deviation from Raoult's law. [1]
- In pure ethanol, molecules are hydrogen bonded. On adding acetone, its molecules get in between the host molecules and break some of the hydrogen bonds between them. Due to weakening of interactions, the solution shows positive deviation from Raoult's Law. [1]

OR

- (b) (i) $\Delta T_b = 100^\circ - 99.68^\circ = 0.32 \text{ }^\circ\text{C}$ [1/2]

$$\Delta T_b = K_b m \quad [1/2]$$

Let x g of sucrose is added

[½]

$$\Delta T_b = K_b \times \frac{x \times 1000}{342 \times 500}$$

$$\text{or, } x = \frac{\Delta T_b \times 342 \times 500}{K_b \times 1000}$$

$$x = \frac{0.32 \times 342 \times 500}{0.52 \times 1000} = 105.2 \text{ g}$$

[1]

Mass of sucrose added = 105.2 g

[½]

- (ii) • Henry's law states that, the partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution. [1]

$$p = K_H \times x \text{ [} K_H \text{ is Henry's law constant]}$$

- Application of Henry's law: To increase the solubility of CO₂ in soft drinks and soda water, the bottle is sealed under high pressure. [1]

□ □ □