Class XII Session 2026-27
Subject - Chemistry
Sample Question Paper - 1

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

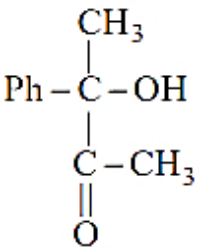
General Instructions:

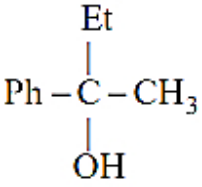
Read the following instructions carefully.

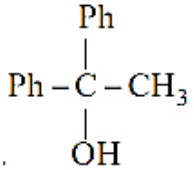
1. There are **33** questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
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.**

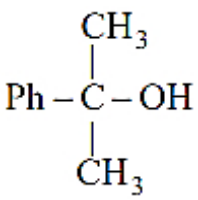
Section A

1. Acetophenone $\xrightarrow[(ii)H_2O]{(i)CH_3MgBr}$ **[1]**

a) 

b) 

c) 

d) 

2. Fat soluble vitamins are stored in **[1]**

a) Adipose and liver

b) Eyes

c) Pancreas

d) Stomach

3. Which one of the following compounds has the highest pK_a value? **[1]**

a) 2, 4, 6-Trinitrophenol

b) m-Nitrophenol

c) p-Cresol

d) p-Nitrophenol

4. The fragrance of the aldehyde and ketone are used for perfume and similar uses depend on: **[1]**

a) moisture of the air.

b) on its reactivity with other functional groups.

c) only solubility of aldehydes and ketones.

d) size and solubility of the aldehyde and ketone molecule.

5. The half life of a substance in a first order reaction is 15 min. The rate constant is **[1]**

a) $4.62 \times 10^{-2}\ min^{-1}$

b) $2.46 \times 10^{2}\ min^{-1}$

c) $7.18 \times 10^{2}\ min^{-1}$

d) $6.74 \times 10^{-2}\ min^{-1}$

6. Match the items given in column I with that in column II. **[1]**

Column I	Column II
(a) Molarity	(i) $\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$
(b) Molality	(ii) Number of gram moles of a solute per litre of solution
(c) Normality	(iii) Number of gram moles of a solute per kg of solvent
(d) ppm	(iv) Number of gram equivalent of a solute per litre of solution

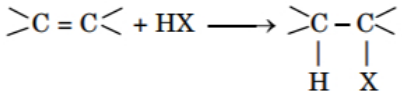
a) (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

b) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

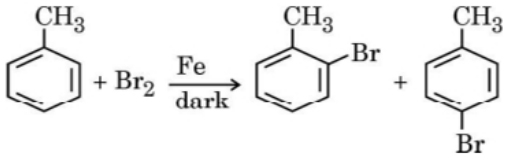
c) (a) - (i), (b) - (ii), (c) - (iii), (d) - (iv)

d) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

7. Which of the following reactions is a halogenated exchange reaction: **[1]**

a) 

b) $R - X + NaI \xrightarrow{Dry\ acetone} R - I + NaX$

c) 

d) $R - OH + HCl \xrightarrow{ZnCl_2} R - Cl + H_2O$

8. The product of the oxidation of I^- with MnO_4^- in alkaline medium is: **[1]**

a) IO_4^-

b) I_2

c) IO_3^-

d) IO^-

9. The half-life of a reaction is doubled when the initial concentration is doubled. The order of the reaction is: **[1]**

a) 1 b) 0

c) 2 d) 4

10. Oximes are formed by the reaction of aldehydes and ketones with: **[1]**

a) NH_2OH b) $NH_2NHC_6H_5$

c) NH_3 d) NH_2NH_2

11. Ethyl chloride is converted into diethyl ether by **[1]**

a) Williamson's synthesis b) Wurtz synthesis

c) Perkin's reaction d) Kucherov's reaction

12. If amines are arranged in increasing order of their basic strength in gaseous phase, then the correct order will be: **[1]**

a) $(CH_3)_3\ N < (CH_3)_2NH < CH_3NH_2 < NH_3$

b) $NH_3 < (CH_3)_2NH < (CH_3)_3\ N < CH_3NH_2$

c) $NH_3 < CH_3NH_2 < (CH_3)_2NH < (CH_3)_3\ N$

d) $NH_3 < CH_3NH_2 < (CH_3)_3\ N < (CH_3)_2NH$

13. **Assertion (A):** Vitamin D cannot be stored in our body. **[1]**
Reason (R): Vitamin D is fat soluble vitamin and is not excreted from the body in urine.

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.

14. **Assertion (A):** Carbonyl compounds undergo nucleophilic addition. **[1]**
Reason (R): Addition of KCN solution to carbonyl compounds decreases the pH of solution.

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 (A):** Boiling point of alkyl halides increases with an increase in molecular weight. **[1]**
Reason (R): Boiling point of alkyl halides is in the order RI > RB > RCl > RF.

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.

16. **Assertion (A):** Boiling point of butan-1-ol is higher than that of butan-1-amine. **[1]**
Reason (R): Being more polar, butan-1-ol forms stronger intermolecular hydrogen bonds as compared to butan-1-amine

a) Both A and R are true and R is the

b) Both A and R are true but R is not

correct explanation of A. the correct explanation of A.

c) A is true but R is false. d) A is false but R is true.

Section B

17. 200 cm^3 of an aqueous solution of a protein contains 1.26 g of the protein. The osmotic pressure of such a solution at 300 K is found to be 2.57×10^{-3} bar. Calculate the molar mass of the protein. **[2]**

OR

Give reasons:

a. Cooking is faster in pressure cooker than in an open pan.

b. On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution? What change in temperature would you observe after mixing liquids X and Y?

18. Using the valence bond approach, deduce the shape and magnetic character of $[Co(NH_3)_6]^{3+}$.[Atomic number of Co = 27] **[2]**

19. Complete and balance the following reaction : **[2]**

$8MnO_4^- + 3S_2O_8^{2-} + H_2O \rightarrow$

20. **Answer the following:** **[2]**

i. Identify the reaction order if the unit of rate constant is sec^{-1}. **[1]**

ii. Can order of reaction be zero? Give example. **[1]**

21. Name the electrophile produced in the reaction of benzene with benzoyl chloride in the presence of anhydrous $AlCl_3$. Name the reaction also. **[2]**

Section C

22. Write mathematical expression for Kohlrausch's law. **[3]**

23. Following reaction takes place in on step. **[3]**

$2No(g) + O_2(g) \rightleftharpoons 2No_2(g)$

How will the rate of the above reaction change if the volume of the reaction vessel is diminished to one third of its original volume? Will there be any change in the order of the reaction with the reduced volume?

24. Give reason for the higher boiling point of ethanol in comparison to methoxymethane. **[3]**

25. An organic compound A ($C_7H_6Cl_2$)on treatment with NaOH solution gives another compound B(C_7H_6O). B on oxidation gives an acid C (C_7H_6O2) which on treatment with a mixture of cone. HNO_3 and H_2SO_4 gives a compound D ($C_7H_5NO_4$). B on treatment with cone. NaOH gives a compound E (C_7H_8O) and C_6H_5COONa. Deduce the structures of A, B, C, D and E. **[3]**

26. Give reasons for the following: **[3]**

a. The pH of aqueous NaCl increases when it is electrolysed.

b. Unlike dry cell, mercury cell has a constant cell potential through its lifetime.

c. Conductivity of solution decreases with dilution.

27. Which compound in each of the following pairs will react faster in S_N2 reaction with **[3]**

OH^-?

i. CH_3Br or CH_3I

ii. $(CH_3)_3CCl$ or CH_3Cl

28. What is the difference between Galvanic cell (Electrochemical cell) and Electrolytic cell. **[3]**

Section D

29. **Read the following text carefully and answer the questions that follow:** **[4]**

The transition metals when exposed to oxygen at low and intermediate temperatures form thin, protective oxide films of up to some thousands of Angstroms in thickness. Transition metal oxides lie between the extremes of ionic and covalent binary compounds formed by elements from the left or right side of the periodic table. They range from metallic to semiconducting and deviate by both large and small degrees from stoichiometry. Since d-electron bonding levels are involved, the cations-exist in various valence states and hence give rise to a large number of oxides. The crystal structures are often classified by considering a cubic or hexagonal close-packed lattice of one set of ions with the other set of ions filling the octahedral or tetrahedral interstices. The actual oxide structures, however, generally show departures from such regular arrays due in part to distortions caused by packing of ions of different size and to ligand field effects. These distortions depend not only on the number of d-electrons but also on the valence and the position of the transition metal in a period or group.

i. Why does copper, which is in first series of transition metal exhibits +1 oxidation state most frequently? (1)

ii. The lowest oxide of transition metal is basic. Why? (1)

iii. The variability in oxidation states of d-block different from that of the p-block elements. Explain. (2)

OR

Crystal structure of oxides of transition metals often show defects. Given reason. (2)

30. **Read the following text carefully and answer the questions that follow:** **[4]**

The boiling point elevation and the freezing point depression of solutions have a number of practical applications. Ethylene glycol ($CH_2OH{\cdot}CH_2OH$) is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has a low vapour pressure. We can also use glycerol as an antifreeze. In order for boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol (CH_3OH), a fairly volatile liquid that boils only at 65^oC is sometimes used as antifreeze in automobile radiators.

i. Out of the CH_3OH and $C_6H_{12}O_6$, which is a better reagent for depression in freezing point but not for elevation in boiling point? (1)

ii. Will the depression in freezing point be same or different, if 0.1 moles of sugar or 0.1 moles of glucose is dissolved in 1 L of water? (1)

iii. 124 g each of the two reagents glycerol and glycol are added in 5 kg water of the radiators in the two cars. Which one is better for a car? Justify your answer. (2)

OR

If the cost of glycerol, glycol and methanol are the same, then what would be the sequence of the economy to use these compounds as antifreeze? (2)

Section E

31. **Attempt either A or B** **[5]**

i. **Answer the following questions:** **[1]**

i. What is the basic structural difference between starch and cellulose ?

ii. What are Purines and Pyrimidines? Name the purines and Pyrimidines present in DNA and RNA nucleic Acids.

iii. What are biocatalysts? Give an example.

iv. Write the reactions showing the presence of following in the open structure of glucose:

i. a carbonyl group

ii. chain with six carbon atoms

v. Account for the following:

a. There are 5 -OH groups in glucose.

b. Glucose is a reducing sugar

ii. **Answer the following questions:** **[1]**

i. What is anomeric carbon?

ii. Differentiate between

a. Nucleotide and Nucleoside

b. Amylose and Amylopectin

iii. Define the following terms:

i. Glycosidic linkage

ii. Native protein

iv. How do you explain the presence of all six carbon atoms in glucose in a straight chain?

v. What are the three components of nucleic acids?

32. **Attempt either A or B** **[5]**

i. **Answer the following questions:** **[1]**

i. A coordination compound with molecular formula $CrCl_3.\ 4H_2O$ precipitates one mole of AgCl with $AgNO_3$ solution. Its molar

conductivity is found to be equivalent to two ions. What is the structural formula and name of the compound?

ii. What is the difference between a complex and a double salt?

iii. Draw one of the geometrical isomers of the complex $[Co(en)_2CI_2]^+$ which is optically active.

iv. Write the hybridization and magnetic character of following complexes:

i. $[Fe(H_2O)_6]^{2+}$

ii. $[Fe(CO)_5]$

(Atomic no. of Fe = 26)

v. Write the hybridization and magnetic character of the complex $[Ni(CO)_4]$ on the basis of valence bond theory.

[Atomic No.: Ni = 28]

ii. **Answer the following questions:** **[1]**

i. Name the compound used for measuring the hardness of water i.e. for estimation of $Ca^{2+}$and Mg^{2+}ions.

ii. Why is geometrical isomerism not possible in tetrahedral complexes having two different types of unidentate ligands coordinated with the central metal ion?

iii. What are complex compounds?

iv. Write the IUPAC name of the complex:

$[Co(H_2O)(CN)(en)_2]^{2+}$

v. Why are low spin tetrahedral complexes not formed?

33. i. Write the structure of main products when aniline reacts with the following reagents : **[5]**

a. Br_2 water

b. HCl

c. $(CH_3CO)_2O$/pyridine

ii. Arrange the following in the increasing order of their boiling point: $C_2H_5NH_2$, C_2H_5OH, $(CH_3)_3N$

iii. Give a simple chemical test to distinguish between the following pair of compounds : $(CH_3)_2NH$ and $(CH_3)_3N$.

OR

a. Write the reactions involved in the following:

i. Hoffmann bromamide degradation reaction

ii. Diazotisation

iii. Gabriel phthalimide synthesis

b. Give reasons:

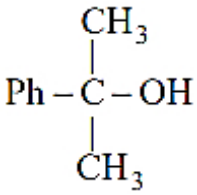
i. $(CH_3)_2NH$ is more basic than $(CH_3)_3N$ in an aqueous solution.

ii. Aromatic diazonium salts are more stable than aliphatic diazonium salt.

Solution

Section A

1.

(d) 

Explanation:
The solution is correct because the images provided correspond to the expected reaction products of acetophenone under the specified conditions. The selected option accurately represents the structure that results from the reaction, confirming it aligns with the chemical transformations that occur with acetophenone.

2. **(a)** Adipose and liver
Explanation:
Vitamins which are soluble in fat and oils but insoluble in water are fat soluble vitamins. These are vitamins A, D, E and K. They are stored in liver and adipose (fat storing) tissues.

3.
(c) p-Cresol
Explanation:
p-Cresol

4.
(d) size and solubility of the aldehyde and ketone molecule.
Explanation:
Size and solubility of aldehyde and ketone determine fragrance. For example, aldehyde C-10 is used in floral blends like rose, jasmine, etc. While aldehyde C-11 has a strong citrus smell and aldehyde C-16 has a strong strawberry smell.

5. **(a)** $4.62 \times 10^{-2}\,\text{min}^{-1}$
Explanation:
for first order reaction
$t_{1/2} = \frac{0.693}{k}$

6. **(a)** (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)
Explanation:
(a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

7.
(b) $R - X + NaI \xrightarrow{Dry\ acetone} R - I + NaX$
Explanation:

$$R-X\ +\ NaI\ \xrightarrow{Dry\ acetone}\ R-I\ +\ NaX$$

8.

(c) IO_3^-
Explanation:
IO_3^-

9.

(b) 0
Explanation:
If $t_{1/2}$ is doubled, [A] is also doubled then the reaction is of **zero order.**

10. **(a)** NH_2OH
Explanation:
Aldehydes and ketones react with NH_2OH (hydroxylamine) to form oximes as shown in the given reaction.
RCOR' + $NH_2OH \rightarrow$ RR'C=NOH (oxime)

11. **(a)** Williamson's synthesis
Explanation:
Ethyl chloride can be converted to diethyl ether via Williamson's ether synthesis, a classic method for preparing ethers. In this reaction, ethyl chloride (C_2H_5Cl) is first converted to sodium ethoxide (C_2H_5ONa), which then reacts with another molecule of ethyl chloride in an SN2 reaction, displacing the chloride ion and forming diethyl ether ($C_2H_5–O–C_2H_5$). This method involves the reaction of an alkoxide ion with a primary alkyl halide, making Williamson's synthesis the correct and most efficient route. The other options (Perkin, Kucherov, and Wurtz) are used for different types of organic reactions unrelated to ether formation.

12.

(c) $NH_3 < CH_3NH_2 < (CH_3)_2NH < (CH_3)_3\ N$
Explanation:
$NH_3 < CH_3NH_2 < (CH_3)_2NH < (CH_3)_3\ N$

13.

(d) A is false but R is true.
Explanation:
A is false but R is true.

14.

(c) A is true but R is false.
Explanation:
Addition of KCN solution to carbonyl compounds increases the pH of solution. KCN hydrolysis to give HCN and KOH as shown below
$KCN + H_2O \rightleftharpoons KOH + HCN$
HCN formed attacks carbonyl group, to form cyanohydrins and thus to maintain hydrolysis constant, the hydrolysis of KCN increases to give more KOH and thus solution becomes more alkaline.

15. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation:
The greater the molecular mass, the stronger the van der Waals' forces of attraction and hence higher is the melting point/boiling point.

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

Section B

17. The various quantities known to us are as follows osmotic pressure of solution $\Pi = 2.57 \times 10^{-3}$ bar.

$V = 200\ cm^3 = 0.200$ litre

$T = 300$ K

$R = 0.083$ L bar mol^{-1} K^{-1}

Substituting these values in equation (2.42) we get

$$M_2 = \frac{1.26g \times 0.083 L bar K^{-1} mol^{-1} \times 300K}{2.57 \times 10^{-3} bar \times 0.200L} = 61.022\ g\ mol^{-1}$$

OR

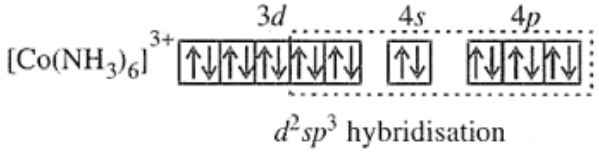
a. Due to high pressure inside the pressure cooker, higher is the boiling point and faster is the cooking.

b. Negative deviation
Temperature increases.

18. Electronic configuration of Co : $[Ar]4s^2 3d^7$

Electronic configuration of Co^{3+} : $[Ar]^4s^0 3d^6$

NH_3 is strong field ligand, it will cause pairing of electrons. Hence,



d^2sp^3 hybridisation

It has octahedral shape and is diamagnetic due to the absence of unpaired electrons.

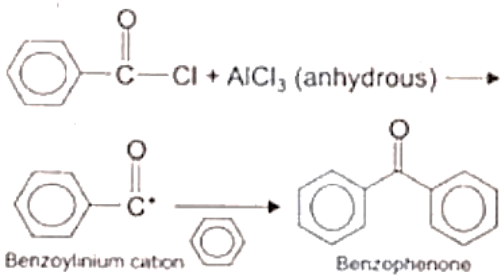
19. In neutral and slight alkaline medium MnO_4^- will reduce to MnO_2 and thiosulphate is oxidised almost quantitatively to sulphate.

$$8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$$

20. Answer the following:
(a) First order reaction.
(b) Zero order reactions are relatively uncommon but they occur under special conditions, for example the decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure. $2NH_3(g) \xrightarrow[Pt\ catalyst]{1130\ K} N_2(g) + H_2(g)$

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

21. Benzene, on reaction with benzoyl chloride, undergoes the formation of benzophenone in the presence of anhydrous aluminium chloride through intermediate benzoylinium cation.



This is an example of a Friedel-Craft acylation reaction.

Section C

22. Mathematical expression for Kohlrausch's law is

Λ_m^∞ or μ^∞ = Molar conductance at infinite dilution

$= m\lambda_+^\infty + n\lambda_-^\infty$

Where m and n are number of ions formed.

23. If volume of the reaction vessel is reduced to one third of its initial value the concentration per unit volume will become 3 times.

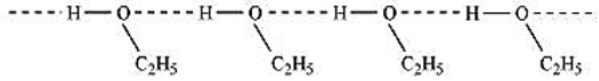
Rate = $K[NO_2]^2[O_2]^1$

$= K[3A]^2[3A]1$

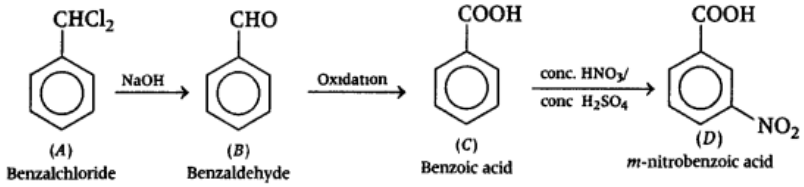
$27 \times K[A]^3$

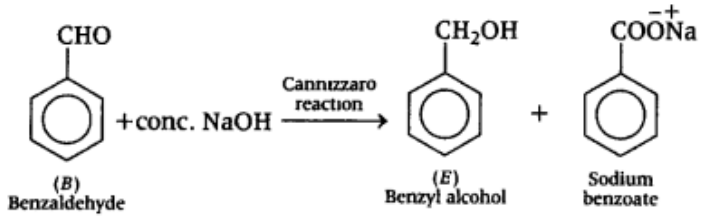
The rate will become 27 times.

24. Ethanol undergoes intermolecular H-bonding due to the presence of -OH group, resulting in the association of molecules. Extra energy is required to break these hydrogen bonds. On the other hand, methoxymethane does not undergo H-bonding. Hence, the boiling point of ethanol is higher than that of methoxymethane.



25. Since, compound A on treatment with NaOH gives C_7H_6O,i.e. only one O-atom is introduced, both the Cl-atoms must be present on the same carbon atom. The molecular formula C_7H_6O suggest that degree of unsaturation is (5) so, the structure of B is C_6H_5CHO. Thus, A must be $C_6H_5CHCl_2$. The relevant equations are as:





26. a. Because of the formation of $NaOH/$ Due to the formation of OH^- ions.
    b. Because the overall reaction does not involve any ion in solution whose concentration can change during its life time.
    c. Because the number of ions per unit volume that carry current in a solution decreases.

27. i. In the S_N^2 mechanism, the reactivity of halides for the same alkyl group increases in the order R-F << R-Cl < R-Br < R-I. This happens because as the size increases, the halide ion becomes a better leaving group. Therefore, CH_3I will react faster than CH_3Br in S_N^2 reactions with OH^-.

    ii. The S_N^2 mechanism involves the attack of the nucleophile at the atom bearing the leaving group. But, in case of $(CH_3)_3CCl$,the attack of the nucleophile at the carbon atom is hindered because of the presence of bulky substituents on the carbon atom bearing the leaving group. On the other hand, there are no bulky substituents on the carbon atom bearing the leaving group in CH_3Cl. Hence, CH_3Cl reacts faster than $(CH_3)_3CCl$ in S_N^2 reaction with OH^-.

28.

Electrochemical cell	Electrolytic cell
(1) It is a device to convert chemical	(1) It is a device to convert electrical energy into

energy into electrical energy.	chemical energy.
(2) It is based upon the redox reaction which is spontaneous.	(2) The redox reaction is non-spontaneous and takes place only when electric energy is supplied.
(3) To set up this cell, a salt bridge or porous pot is used.	(3) No salt bridge is used in this case.

Section D

29. i. Copper readily loses one electron from its 4s orbital, to form stable 3d electronic configuration.
    ii. The lower oxide of transition metal has low oxidation states. This means some of the valence electrons of the metal atoms do not participate in bonding. Thus, they can donate electrons and can behave as bases.
    iii. In p-block, lower oxidation state is more stable due to inert pair effect, whereas in d-block elements higher oxidation states states are more stable. In d-block, oxidation states differ by one, whereas in p-block, it differs by two.

    OR

    The actual oxide structures, generally show departures from a regular arrays due in part to distortions caused by packing of ions of different size and to ligand field effects.
30. i. CH_3OH is a better reagent for depression in freezing point but not for elevation in boiling point.
    ii. The depression in freezing point will be the same in both the solutions because both are non-electrolytes and gives the same number of solutes.
    iii. Glycol will be better than glycerol because it is more volatile than glycerol.

    OR

    The sequence of the economy to use these compounds as antifreeze is Methanol > Glycol > Glycerol.

Section E

31. Attempt either A or B

    (a) Answer the following questions:

    i. **Starch:** It is a branched chain polymer of α-glucose and consists of two components: Amylose(water soluble) and Amylopectin (water insoluble).

    Cellulose: It is a straight chain polysaccharide composed only of β-D-glucose units which are joined by glycosidic linkage between C_1 of one glucose unit and C_4 of the next glucose unit.

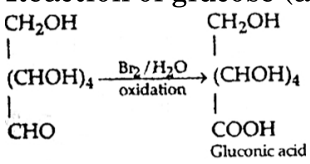
    ii. **Pyrimidines:** These are three bases derived from pyrimidines. These are cytosine (C), thymine (T) and uracil (U).In DNA, T is present but in RNA, U is present.

    Purines: There are two bases derived from purine. These are adenine (A) and guanine (G).

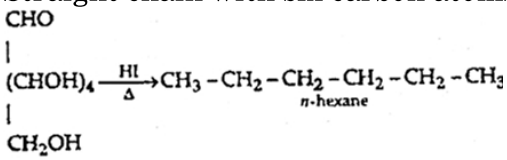
    In DNA, Purines present are Adenine (A) and Guanine (G) and Pyrimidines present are Cytosine (C) and Thymine (T) while in RNA, Purines are the same while Pyrimidines present in RNA includes Cytosine (C) and Uracil (U).

    iii. The catalysts present in the living organisms which speed down or fastens down the process are known as biocatalysts. Eg:- Hormones in our body.

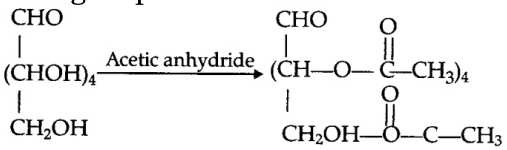
    iv. i. Reaction of glucose (a carbonyl group)



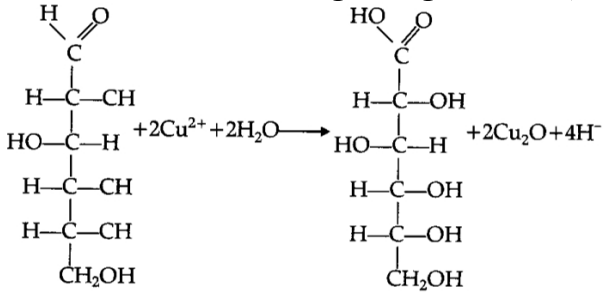
ii. Straight chain with six carbon atoms



v. a. Acetylation of glucose with acetic anhydride gives glucose pentaacetate which confirms the presence of five -OH groups. Since, it exists as a stable compound, five -OH groups should be attached to different carbon atoms.



b. Glucose reduces Fehling's reagent. Thus, it is considered as reducing sugar.



(b) Answer the following questions:

i. An anomeric carbon can be identified as the carbonyl carbon (of the aldehyde or ketone functional group) in the open-chain form of the sugar. It can also be identified as the carbon bonded to the ring oxygen and a hydroxyl group in the cyclic form.

ii. a. Nitrogeneous base linked with pentose sugar called as nucleoside while Nucleoside linked with phosphate group is called as nucleotide.

b. Amylose is water soluble while amylopectin is water insoluble.

iii. i. A linkage between two monosaccharide units through oxygen atom.

ii. Protein having a unique three-dimensional structure and biological activity.

iv. Glucose on prolonged heating with HI and red phosphorus gives n-hexane HI (excess) suggest that all six carbon atom are in straight chain.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow[\Delta]{H1(excess)} \underset{n-Hexane\ (straight\ chain)}{CH_3CH_2CH_2CH_2CH_2CH_3}$$

v. The three components of nucleic acid are base, sugar and phosphate group..

32. Attempt either A or B

(a) Answer the following questions:

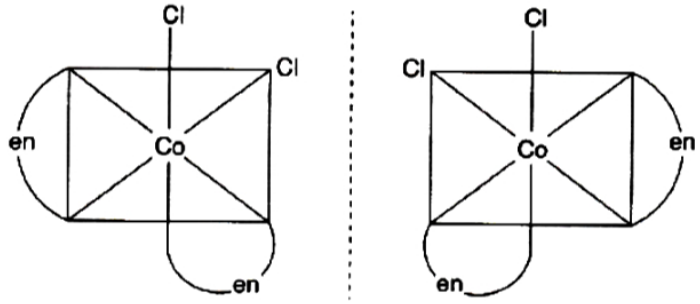
i. $[Cr(H_2O)_4Cl_2]CI$

Tetraaquadichloridochromium (III) chloride.

ii. Double salt dissociates in simple ions completely when dissolved in water while Complex salt does not.

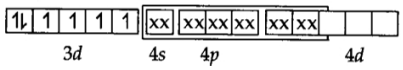
Cis-$[Co(en)_2Cl_2]^+$ is optically active.

iii.



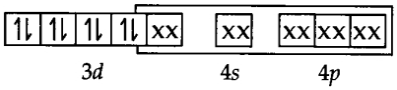
iv. i. In $[Fe(H_2O)_6]^{2+}$ the oxidation state of Fe is +2.

The outermost electronic configuration of Fe is $3d^6\ 4s^2\ 4p^0$. H_2O is weak field ligand and do not cause pairing up of electrons.



In this complex, there are 4 unpaired electrons. Therefore, it involves sp^3d^2 hybridisation and is paramagnetic.

ii. In $[Fe(CO)_5]$ the oxidation state of Fe is zero. The outermost electronic configuration of Fe is $3d^64s^24p^0$. CO is strong field ligand, causes pairing up of 4s electrons into the 3d orbitals.



In this complex, there is no unpaired electron.

Therefore, it involves dsp^3 hybridization and is diamagnetic.

v. sp^3, diamagnetic

(b) Answer the following questions:

i. EDTA (Ethylene diammine tetraacetate)

ii. Tetrahedral complexes do not show geometrical isomerism(a type of stereoisomerism) because the relative positions of the unidentate ligands attached to the central metal atom are the same with respect to each other.

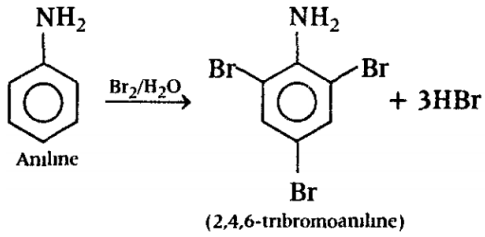
iii. Complex compounds or coordination compounds are those compounds in which the metal atoms are bound to a number of anions or neutral molecules.

iv. Aquacyanidobis(ethane-1,2-diamine)cobalt(III) ion

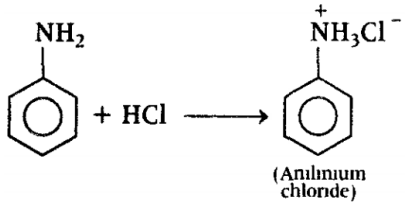
v. For tetrahedral complexes, the crystal field stabilization energy is less (not sufficient) and is always lower than pairing energy.

$\Delta_t = \frac{4}{9}\Delta_0$

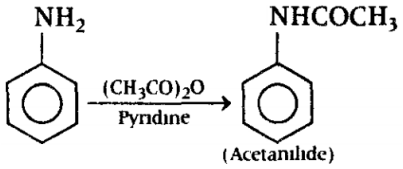
33. i. a.



b.

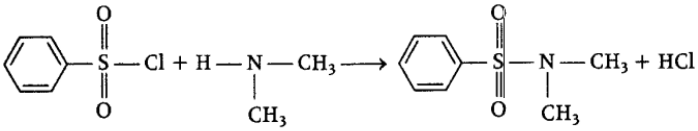


c.



ii. Increasing order of boiling point $(CH_3)_3N < C_2H_5NH_2 < C_2H_5OH$ Alcohols have a higher boiling point as compared to that of amines because oxygen being more electronegative forms stronger hydrogen bond as compared to that of nitrogen. In tertiary amine, there is no hydrogen bond formation due to the absence of H-atoms and hence, has the lowest boiling point.

iii. $(CH_3)_2NH$ and $(CH_3)_3N$ are secondary and tertiary amines respectively. These are distinguished by Hinsberg's reagent which gives sulphonamide with secondary amines and no reaction with tertiary amines. $(CH_3)_2NH$ reacts with benzene sulphonyl chloride to give N, N-dimethyl benzene sulphonamide, which is insoluble in alkali. The reaction is as follows:



N,N-dimethylbenzene sulphonamide
(insoluble alkali)

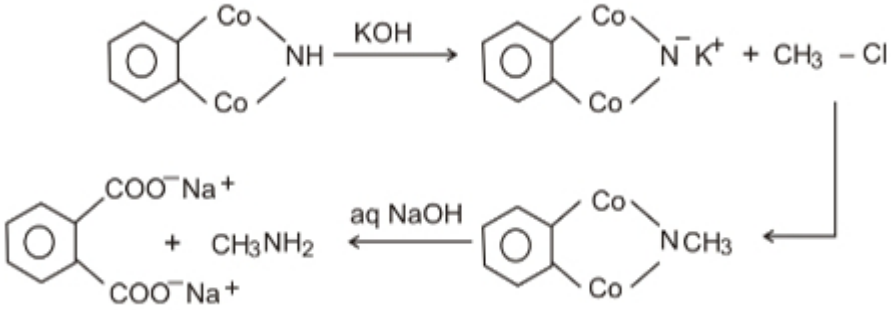
OR

a. i. Hoffmann bromamide reaction:

$$Ar/R\text{-}CONH_2 + Br_2 + 4NaOH \rightarrow Ar/RNH_2 + 2NaBr + Na_2CO_3 + 2H_2O$$

ii. $C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{273-278K} C_6H_5\overset{+}{N_2}Cl^- + NaCl + 2H_2O$

iii. Gabriel phthalimide synthesis:



b. i. Because of the combined factors of inductive effect and solvation or hydration effect.

ii. Due to resonance stabilisation or structural representation /resonating structures.