

EDUCATALYSTS

Class(12th)

Sample Paper Chemistry

Class 12 - Chemistry
Term-2 Sample Paper-01

Maximum Marks: 35

Time Allowed: 2 hours

General Instructions:

1. There are 12 questions in this question paper with internal choice.
2. SECTION A - Q. No. 1 to 3 are very short answer questions carrying 2 marks each.
3. SECTION B - Q. No. 4 to 11 are short answer questions carrying 3 marks each.
4. SECTION C- Q. No. 12 is case-based question carrying 5 marks.
5. All questions are compulsory.
6. Use of log tables and calculators is not allowed

Section A

1. Arrange the following compounds in the decreasing order of their boiling points:
 $CH_3CH_2CH_2CHO$, $CH_3CH_2CH_2CH_2OH$, $H_5C_2 - O - C_2H_5$, $CH_3CH_2CH_2CH_2CH_3$
2. Define molar conductivity of a substance and describe how for weak and strong electrolytes, molar conductivity changes with concentration of solute. How is such change explained?
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3. Account for the following:
 - i. Ethers possess a dipole moment even if the alkyl radicals in the molecule are identical.
 - ii. Sodium bisulphite is used for the purification of aldehyde and ketones.

Section B

4.
 - i. Illustrate the following reactions giving suitable example in each case:
 - a. Ammonolysis
 - b. Coupling reaction
 - c. Acetylation of amines
 - ii. Describe Hinsberg method for the identification of primary, secondary and tertiary amines. Also write the chemical equations of the reactions involved.

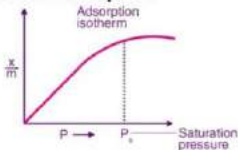
OR

Accomplish the following conversion: Aniline to benzyl alcohol.

5. Draw figure to show the splitting of d orbitals in an octahedral crystal field.

6. How would you account for the following:

- Of the d^4 species, Cr^{2+} is strongly reducing while manganese(III) is strongly oxidising.
 - Cobalt (II) is stable in an aqueous solution but in the presence of complexing reagents, it is easily oxidized.
 - The d^1 configuration is very unstable in ions.
7. An organic compound A on treatment with acetic acid in the presence of sulphuric acid produces an ester B. A on mild oxidation gives C. C with 50% KOH followed by acidification with dil. HCl generates A and D. D with PCl_5 followed by reaction with ammonia gives E. E on dehydration produces hydrocyanic acid. Identify the compounds A, B, C, D and E.
8. i. Write the expression for the Freundlich's adsorption isotherm for the adsorption of gases on solids, in the form of an equation.



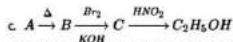
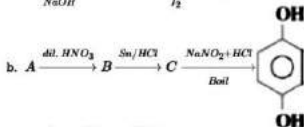
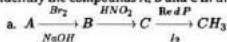
- What are the dispersed phase and dispersion medium of butter?
 - A delta is formed at the meeting place of sea and river water. Why?
9. i. Write structures of different isomeric amines corresponding to the molecular formula, $\text{C}_4\text{H}_{11}\text{N}$.
- Write IUPAC names of all the isomers.
 - What type of isomerism is exhibited by different pairs of amines?

OR

i. How will you convert:

- Nitrobenzene to phenol,
- Aniline to chlorobenzene

ii. Identify the compounds A, B and C in the following reactions:



10. A copper-silver cell is set-up. The copper ion concentration is 0.10 M. The concentration of silver ion is not known. The cell potential when measured was 0.422 V. Determine the concentration of silver ions in the cell.

[Given, $E_{\text{Ag}^+/\text{Ag}}^\ominus = +0.80 \text{ V}$, $E_{\text{Cu}^{2+}/\text{Cu}}^\ominus = -0.34 \text{ V}$]

11. i. Give reasons:
 - a. Transition metals and their compounds show catalytic activities.
 - b. Separation of a mixture of Lanthanoid elements is difficult.
 - c. Zn, Cd and Hg are soft and have low melting point.
- ii. Write the preparation of the following:
 - a. $\text{Na}_2\text{Cr}_2\text{O}_7$ from Na_2CrO_4
 - b. K_2MnO_4 from MnO_2

OR

- i. Account for the following:
 - a. Mn shows the highest oxidation state of +7 with oxygen but with fluorine, it shows the highest oxidation state of +4.
 - b. Cr^{2+} is a strong reducing agent.
 - c. Cu^{2+} salts are coloured while Zn^{2+} salts are white.
- ii. Complete the following equations:
 - a. $2\text{MnO}_2 + 4\text{KOH} + \text{O}_2 \xrightarrow{\Delta}$
 - b. $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{I}^- \longrightarrow$

Section C

12. Read the given passage and answer the questions that follow:

The concentration dependence of the rate is called a differential rate equation. It is not always convenient to determine the instantaneous rate, as it is measured by the determination of slope of the tangent at point 'r' in concentration vs. time plot. This makes it difficult to determine the rate law and hence the order of the reaction. In order to avoid this difficulty, we can integrate the differential rate equation to give a relation between directly measured experimental data, i.e., concentrations at different times and rate constant. The integrated rate equations are different for the reactions of different reaction orders. The half-life of a reaction is the time in which the concentration of a reactant is reduced to one half of its initial concentration. It is represented as $t_{50\%}$.

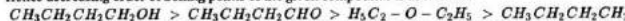
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- a. A first-order reaction has a rate constant $1.15 \times 10^{-3} \text{ s}^{-1}$. How long will 5g of this reactant take to reduce to 3g?
 - b. The half-life of a reaction becomes half when initial concentrations of reactants are made double. The order of the reaction will be:
 - a. 1
 - b. 2
 - c. 0
 - d. 3
 - c. The rate of reaction sometimes does not depend on concentration. Give reason.
 - d. For a reaction $\text{A} + \text{B} \rightarrow \text{Products}$, the rate law is; $\text{Rate} = k[\text{A}][\text{B}]^{3/2}$. Can the reaction be an elementary reaction? Explain?
- OR**
- e. The plot of concentration of reactant vs. time for a reaction is a straight line with a negative slope. Identify the order of the reaction.

Section A

- The molecular masses of these compounds are in the range of 72 to 74. Since only butan-1-ol molecules are associated due to extensive intermolecular hydrogen bonding, therefore, the boiling point of butan-1-ol would be the highest. Butanal is more polar than ethoxyethane. Therefore, the intermolecular dipole-dipole attraction is stronger in the former. n-Pentane molecules have only weak van der Waals force.

Hence decreasing order of boiling points of the given compounds is as follows:

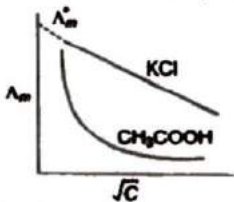


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- Molar conductivity:** Molar conductivity is the conducting power of all the ions produced by one mole of an electrolyte in a solution of specified concentration.

It is denoted by Λ_m and is related to conductivity (κ) by the relation: $\Lambda_m = \frac{\kappa}{C}$

Variation of Molar Conductivity with Concentration:



From Fig. we find that the increase in molar conductivity for a strong electrolyte like KCl is very gradual on dilution and also the value is high at all concentrations. Whereas for a weak electrolyte like CH_3COOH , there is a gradual increase in Λ_m on dilution which is followed by a sharper increase in further dilution.

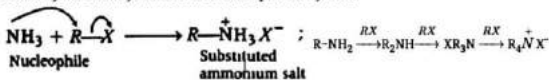
- Ethers are bent molecules where the oxygen-alkyl bond dipoles do not get cancelled. Therefore, ethers show a net dipole moment.
 - Aldehydes and ketones react with NaHSO_3 whereas the impurities do not react. The bisulphite salt thus obtained can be hydrolysed to get pure aldehydes and ketones back.

Section B

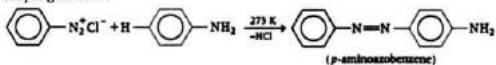
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- Ammonolysis** The process of cleavage of the C-X bond by ammonia molecule is known as ammonolysis. In this process, an alkyl or benzyl halide on reaction with an ethanolic solution of ammonia undergoes nucleophilic substitution reaction in which halogen atom is replaced

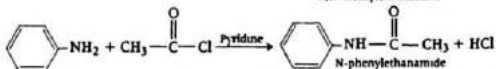
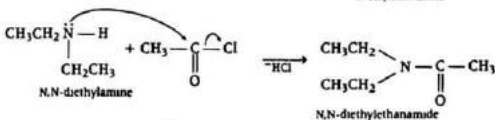
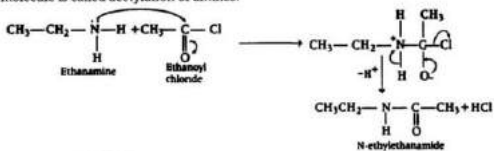
by an amino ($-\text{NH}_2$) group. The reaction is carried out in a sealed tube at 373 K. The primary amine thus obtained behaves as a nucleophile and can further react with alkyl halide to form secondary and tertiary amines and further quaternary salts.



- b. **Coupling reaction** Arenediazonium salts react with highly reactive (i.e. electron-rich) aromatic compounds such as aniline, phenols to form brightly coloured azo compounds, $\text{Ar}-\text{N}=\text{N}-\text{Ar}$. This reaction is called coupling reaction. e.g. Benzene diazonium chloride reacts with aniline in faintly acidic medium (pH 4-5) at 273-278K, in which the molecule at its para-position is coupled with the diazonium salt to form p-aminoazobenzene. This is an example of coupling reaction.

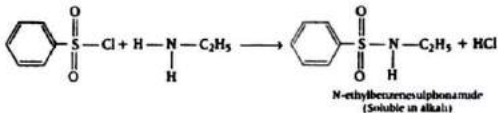


- c. **Acetylation of amines** The process of introducing an acetyl group $\left(\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\right)$ into the molecule is called acetylation of amines.



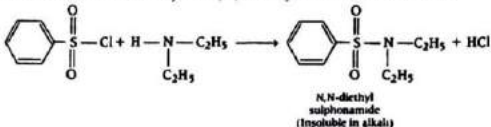
- ii. The reaction of primary and secondary amines with benzenesulphonyl chloride ($\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$), known as Hinsberg's reagent to form sulphonamides is known as Hinsberg's method (or reaction). This method (or reaction) is used for separating 1° , 2° and 3° amines.

- a. The reaction of benzenesulphonyl chloride with primary amine yields N-ethylbenzenesulphonamide.



The hydrogen attached to N-atom in sulphonamide is strongly acidic due to the presence of strong electron withdrawing sulphonyl group. Hence, it is soluble in alkali.

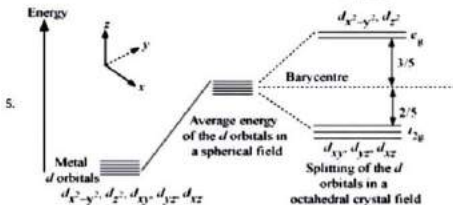
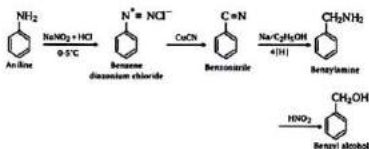
- b. In the reaction with secondary amine, *N, N*-diethylbenzenesulphonamide is formed.



Since, *N, N*-diethylbenzenesulphonamide does not contain any hydrogen atom attached to nitrogen atom, it is not acidic and hence, insoluble in alkali.

- c. Tertiary amines do not react with benzenesulphonyl chloride, as it doesn't contain replaceable hydrogens.

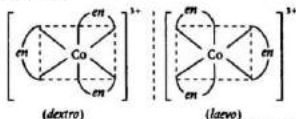
OR



The splitting of the *d* orbitals in an octahedral field takes place in such a way that $d_{x^2-y^2}$, d_{z^2} experience a rise in energy and form the e_g level, while d_{xy} , d_{yz} and d_{xz} experience a fall in energy and form the t_{2g} level.

Isomers: It shows optical isomers i.e. dextro and laevo forms as shown below:

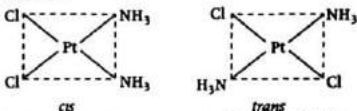
Structure



- ii. **IUPAC name of given complex,** $[Pt(NH_3)_2Cl_2]$ is diammine dichloridoplatinum(II)

Isomers: It shows geometrical isomers i.e. cis and trans as shown below:

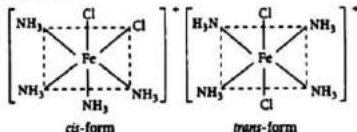
Structure



- iii. **IUPAC name of the given complex** $[Fe(NH_3)_4Cl_2]Cl$ is tetraaminedichloridoiron(III) chloride

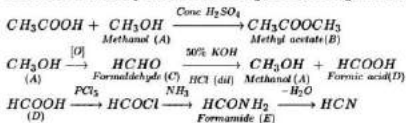
Isomers: It shows geometrical isomers i.e. cis and trans as shown in figure:

Structure



6. i. Cr^{2+} is strongly reducing because it changes to Cr^{3+} which is more stable because Cr^{3+} has a stable half-filled t_{2g} configuration whereas Mn^{3+} is strongly oxidizing because it changes to Mn^{2+} which is more stable due to half-filled d-orbitals.
- ii. Co (III) being more stable than Co(II), the change in the oxidation state of cobalt from +2 to +3 is easy in presence of the complexing agent.
- iii. d^1 configuration is very unstable in ions because after losing one more electron it will become stable. All elements with d^1 configuration are either reducing or undergo disproportionation. e.g.
- $$\underset{3d^1}{\overset{-6}{3MnO_4^{2-}}} + 4H^+ \rightarrow \underset{3d^0}{\overset{+7}{2MnO_4^-}} + \underset{+4}{MnO_2} + 2H_2O$$
7. Organic compound A gives ester with acetic acid, so it is an alcohol. A gives C on oxidation and C undergoes Cannizzaro reaction to give A and D Thus, C must be an aldehyde without α -H atom, i.e.

HCHO. It is obtained by the oxidation of CH_3OH . So, A is CH_3OH . The reactions are as follows:



Thus, (A) Methyl alcohol, (B) Methyl acetate, (C) Formaldehyde, (D) Formic acid, (E) Formamide.

8. i. Freundlich's adsorption isotherm: A graph drawn between the extent of adsorption and the pressure of the gas at constant temperature is called adsorption isotherm. A relationship between the amount of adsorbed (x/m) and the equilibrium pressure (p) can be given by an equation is $\frac{x}{m} = kp^{1/n}$, where, m = mass of adsorbent, x = mass of the gas adsorbed on mass m , p = pressure and k, n = constants.
- ii. Butter is a colloidal solution in which liquid is dispersed in solid as a dispersion medium. Dispersed phase-liquid and dispersion medium-solid.
- iii. River water is a colloidal solution of clay. Seawater contains lots of electrolytes. The river contains colloids of sand and clay. When river water meets the seawater, the electrolytes present in seawater coagulate the colloidal solution of clay resulting in a deposition with the formation of the delta.
9. (i), (ii) The structures and IUPAC names of different isomeric amines corresponding to the molecular formula, $\text{C}_4\text{H}_{11}\text{N}$ are given below:
 - a. $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{NH}_2$
Butanamine (1°)
 - b. $\text{CH}_3 - \text{CH}_2 - \overset{\text{NH}_2}{\underset{|}{\text{CH}}} - \text{CH}_3$
Butan-2-amine (1°)
 - c. $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{CH}_2 - \text{NH}_2$
2-Methylpropanamine (1°)
 - d. $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{C}}} - \text{NH}_2$
2-Methylpropan-2-amine (1°)
 - e. $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{NH} - \text{CH}_3$
N-Methylpropanamine (2°)
 - f. $\text{CH}_3 - \text{CH}_2 - \text{NH} - \text{CH}_2 - \text{CH}_3$
N-Ethylethanamine (2°)
 - g. $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{NH} - \text{CH}_3$
N-Methylpropan-2-amine (2°)
 - h. $\text{CH}_3 - \text{CH}_2 - \overset{\text{CH}_3}{\underset{|}{\text{N}}} - \text{CH}_3$
N, N-Dimethylethanamine (3°)

(iii) The pairs (a) and (b) and (e) and (g) exhibit position isomerism.

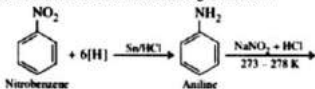
The pairs (a) and (c); (a) and (d); (b) and (c); (b) and (d) exhibit chain isomerism.

The pairs (e) and (f) and (f) and (g) exhibit metamerism.

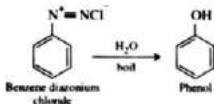
All primary amines exhibit functional isomerism with secondary and tertiary amines and vice-versa.

OR

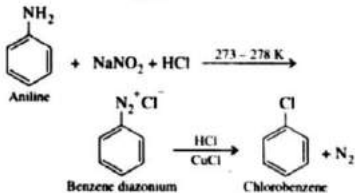
i. Steps involved in the conversions are given below:



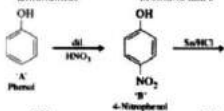
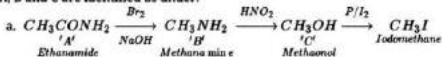
a.



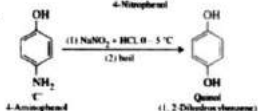
b.

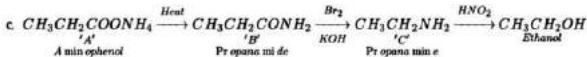


ii. A, B and C are identified as under:



b.



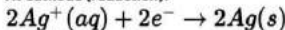


10. Cell Reaction is

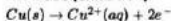


Half cell reaction of this reaction is:

At Cathode (reduction):



At Anode (oxidation):



for this reaction, **n=2 moles of electrons** takes place.

Now,

$$\begin{aligned}
 E_{\text{cell}}^{\ominus} &= E_R^{\ominus} - E_L^{\ominus} \\
 &= +0.80 - (+0.34) = 0.46 \text{ V}
 \end{aligned}$$

From Nernst Equation,

$$E_{\text{cell}} = E_{\text{cell}}^{\ominus} - \frac{0.0591 \text{ V}}{n} \log \frac{[\text{Cu}^{2+}]}{[\text{Ag}^+]^2}$$

for n = 2,

$$0.422 \text{ V} = 0.46 \text{ V} - \frac{0.0591}{2} \log \frac{[\text{Cu}^{2+}]}{[\text{Ag}^+]^2}$$

$$\log \frac{[\text{Cu}^{2+}]}{[\text{Ag}^+]^2} = \frac{0.46 - 0.422}{0.0295} = 1.288$$

$$\frac{[\text{Cu}^{2+}]}{[\text{Ag}^+]^2} = \text{Antilog } 1.288 = 19.41$$

$$\frac{0.10}{[\text{Ag}^+]^2} = 19.41 \Rightarrow [\text{Ag}^+]^2 = 0.00515$$

$$[\text{Ag}^+] = 0.0717 = 7.17 \times 10^{-2} \text{ M}$$

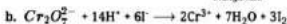
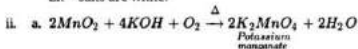
11. i. a. The catalytic activities of transition metals and their compounds is due to the ability of adopt variable oxidation states and to form complexes. It can also provide a large surface area for the reactants to be adsorbed.
- b. Separation of lanthanoid elements is difficult because all lanthanoid elements have almost similar physical as well as chemical properties. Due to the lanthanoid contraction, the change in the atomic or ionic radii is very small.
- c. Zn, Cd, and Mg are soft and have a low melting point because they have filled d-orbitals due to which the metallic bond formed is very weak.
- ii. a. The sodium chromate is acidified with H_2SO_4 to give orange sodium dichromate
- $$2\text{Na}_2\text{CrO}_4 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{Cr}_2\text{O}_7 + \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$$
- b. Potassium permanganate is prepared by fusion of MnO_2 with an alkali metal hydroxide
- $$2\text{MnO}_2 + 4\text{KOH} + \text{O}_2 \rightarrow 2\text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O}$$

OR

- i. a. In case of oxygen, Mn shows the highest oxidation state of +7. This is because Mn forms pπ-dπ multiple bonds using 2p orbitals of oxygen and 3d orbitals of Mn. Therefore, highest oxide of

Mn is Mn_2O_7 . Whereas, fluorine can only form single bonds with Mn. This is due non availability of 2p orbitals in F for multiple bonding. Therefore, highest fluoride of Mn is MnF_4 .

- b. Cr^{2+} is a stronger reducing agent, as on oxidation it becomes Cr^{3+} . In Cr^{3+} , three electrons are present in the t_{2g} level (Crystal field splitting due to weak field ligands). Hence, the e_g level is half-filled, Cr^{3+} is extremely stable.
- c. Cu^{2+} salts are coloured because Cu^{2+} ion has $3d^9 4s^0$ valence shell configuration with one unpaired electron and therefore, it is paramagnetic in nature. Hence, Cu^{2+} ion undergoes d-d transition and forms coloured salts. In contrast to Cu^{2+} , Zn^{2+} has all paired electrons due to $3d^{10} 4s^0$ valence shell configuration and therefore, it does not undergo d-d transition. Hence, Zn^{2+} salts are white.



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Section C

12. a. As $t = \frac{2.303}{k} \log \left[\frac{R_0}{R} \right]$;

$R_0 = 5g, R = 2, k = 1.15 \times 10^{-3}; t = 444s$

Therefore, 444s are required to reduce the reactant from the 5g to 3g.

b. $t_{1/2} \propto \frac{1}{a^{n-1}}$; if $n = 2$

Hence, the order of the reaction is 2.

- c. The rate of a reaction is defined as the proportionality constant that shows the relationship between the rate of a chemical reaction and concentration of the reacting species.

For example, $aA + bB \rightleftharpoons C + D$

$\therefore K = [A]^a [B]^b$

But, for zero-order reaction, $K = [A]^0$. Therefore, in that case, the rate of reaction will not depend on the concentration of the reactants.

- d. Order and molecularity are the same for an elementary reaction, but in this case, the order is 2.5, and molecularity is 2.
- e. First-order.