Sample Question Paper - 3
Chemistry (043)
Class- XII, Session: 2021-22
TERM II

Time allowed : 2 hours ***Maximum marks : 35***

General Instructions :

Read the following instructions carefully.

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 in the increasing order of their reactivity in nucleophilic addition reactions (*any two*).
   (a) Ethanal, Propanal, Propanone, Butanone
   (b) Formaldehyde, Acetaldehyde, Benzaldehyde, Propanaldehyde
   (c) Acetone, Benzophenone, Acetophenone, Formaldehyde

2. The standard reduction potential $E°$ for half reactions are
$Zn \rightarrow Zn^{2+} + 2e^- ; E° = +0.76$ V
$Fe \rightarrow Fe^{2+} + 2e^- ; E° = +0.41$ V
What is the EMF of the following cell reaction:
$Fe^{2+} + Zn \rightarrow Zn^{2+} + Fe$?

3. Define half-life of a reaction. Write the expression of half-life for
   (a) zero order reaction and
   (b) first order reaction.

SECTION - B

4. Write the hybridisation and magnetic character of the following complexes:
   (a) $[Fe(H_2O)_6]^{2+}$
   (b) $[Ni(CN)_4]^{2-}$
   [Atomic number : Fe = 26, Ni = 28]

OR

For the complex $[NiCl_4]^{2-}$, write
   (a) the IUPAC name
   (b) the hybridization type
   (c) the shape of the complex.
   (Atomic no. of Ni = 28)

5. Account the following :

(a) Why transition metals form large number of complex compounds?

(b) The lowest oxide of transition metal is basic whereas the highest oxide is amphoteric or acidic.

(c) Why $E°$ value for the Mn^{3+}/Mn^{2+} couple is highly positive (+1.57 V) as compared to Cr^{3+}/Cr^{2+}?

OR

Following are the transition metal ions of 3*d* series :

Ti^{4+}, V^{2+}, Mn^{3+}, Cr^{3+}

(Atomic numbers : Ti = 22, V = 23, Mn = 25, Cr = 24)

Answer the following :

(a) Which ion is most stable in aqueous solution and why?

(b) Which ion is strong oxidising agent and why?

(c) Which ion is colourless and why?

6. Account for the following :

(a) Why does Zn give H_2 gas with H_2SO_4 but not with HNO_3?

(b) Why is fluorine the best oxidising agent?

(c) $E°$ values of three metals are listed below :

$Zn^{2+}_{(aq)} + 2e^- \rightarrow Zn_{(s)}$; $E° = -0.76$ V

$Fe^{2+}_{(aq)} + 2e^- \rightarrow 2Fe_{(s)}$; $E° = -0.44$ V

$Sn^{2+}_{(aq)} + 2e^- \rightarrow Sn_{(s)}$; $E° = -\ 0.14$ V

If iron is coated with zinc it does not get rusted even after cracks appear as compared to when iron coated with tin. Give reason.

7. (a) For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$, how are the rate of reaction expressions inter-related $\frac{d[H_2]}{dt}$ and $\frac{d[NH_3]}{dt}$?

(b) Rate constant of two reactions are given below. Identify their order of reaction.

(i) $k = 5.3 \times 10^{-2}$ L^{-1} mol s^{-1}

(ii) $k = 3.8 \times 10^{-4}$ s^{-1}

8. Account for following :

(a) What is the role of adsorption in froth floatation process used especially for concentration of sulphide ores?

(b) Define multimolecular colloids with examples.

(c) What are the two processes involved in Bredig's arc method?

9. An aromatic compound '*A*' on treatment with aqueous ammonia and heating forms compound '*B*' which on heating with Br_2 and KOH forms a compound '*C*' of molecular formula C_6H_7N. Write the structures and IUPAC names of compounds *A*, *B* and *C*.

OR

Write the reactions of (a) aromatic and (b) aliphatic primary amines with nitrous acid.

10. Give the IUPAC Names of following complexes :

(a) $K_3[Fe(CN)_5NO]$

(b) $[Co(NH_3)_5NO_2]Cl_2$

(c) $[Cr(en)_2Br_2]Br$

11. Arrange the following as indicated :

(a) CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$, NH_3 (Decreasing order of basicity in aqueous state)

(b) Aniline, *p*-nitroaniline, *p*-toluidine (Increasing order of basicity)

(c) $C_6H_5NH_2$, $C_6H_5NHCH_3$, $C_6H_5CH_2NH_2$ (Increasing order of basicity)

OR

(a) Given a method by which the activation effect of aniline can be reduced.

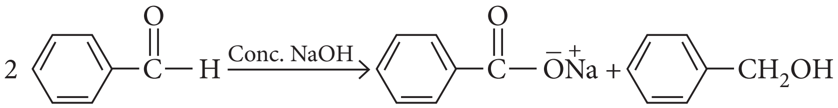
(b) The lone pair of CH_3NH_2 is more available for donation than $C_6H_5NH_2$. Why?

(c) Aniline on nitration gives a significant amount of *m*-nitroaniline. Give reason.

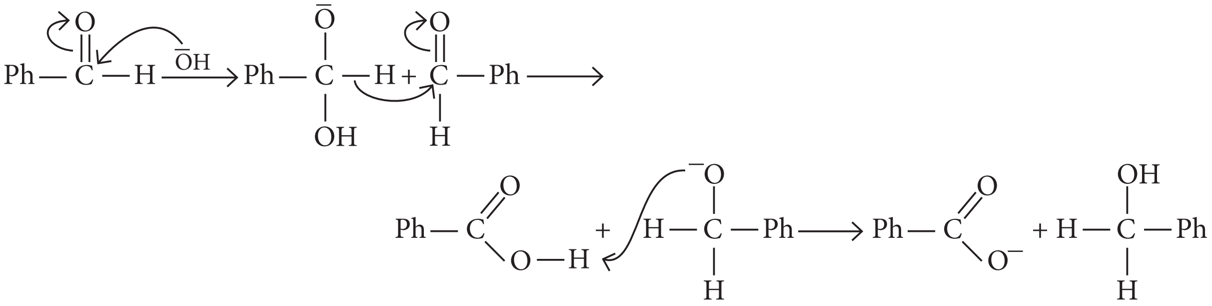
SECTION C

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

When an aldehyde with no α-hydrogen reacts with concentrated aqueous NaOH, half the aldehyde is converted to carboxylic acid salt and other half is converted to an alcohol. In other words, half of the reactant is oxidized and other half is reduced. This reaction is known as Cannizzaro reaction.



Mechanism :



(a) What does a mixture of benzaldehyde and formaldehyde produce on heating with aqueous NaOH?

(b) Out of benzaldehyde and acetaldehyde one gives Cannizzaro reaction and the other undergoes aldol condensation. Identify and give their respective reactions.

(c) For the Canizzaro reaction,

$2PhCHO \xrightarrow{OH^-} PhCH_2OH + PhCO_2^-$

Which is the slowest step?

(d) Does Cannizaro reaction results in the formation of C — C bond?

OR

What are the Cannizzaro product of trichloroacetaldehyde?

Solution

CHEMISTRY - 043

Class 12 - Chemistry

1. (a) Butanone < Propanone < Propanal< Ethanal

(b) Benzaldehyde < Propanaldehyde < Acetaldehyde < Formaldehyde

(c) Benzophenone < Acetophenone < Acetone < Formaldehyde

2. EMF = $E^\circ_{cathode} - E^\circ_{anode} = 0.76 - 0.41 = 0.35$ V

3. The time taken for half of the reaction to complete, *i.e.*, the time in which the concentration of a reactant is reduced to half of its original value is called half-life period of the reaction.

$$t = t_{1/2} \text{ when } [R] = \frac{[R_0]}{2}$$

(a) For zero order reaction rate constant is given by :

$$k = \frac{[R]_0 - [R]}{t}, \text{ At } t = t_{1/2}, [R] = \frac{[R]_0}{2}$$

$$k = \frac{[R]_0 - \frac{[R]_0}{2}}{t_{1/2}} \Rightarrow k = \frac{[R]_0}{2t_{1/2}} \Rightarrow t_{1/2} = \frac{[R]_0}{2k}$$

In zero order reaction, $t_{1/2}$ is directly proportional to $[R]_0$.

(b) For first order reaction,

$$k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}, \text{ At } t = t_{1/2}, [R] = \frac{[R]_0}{2}$$

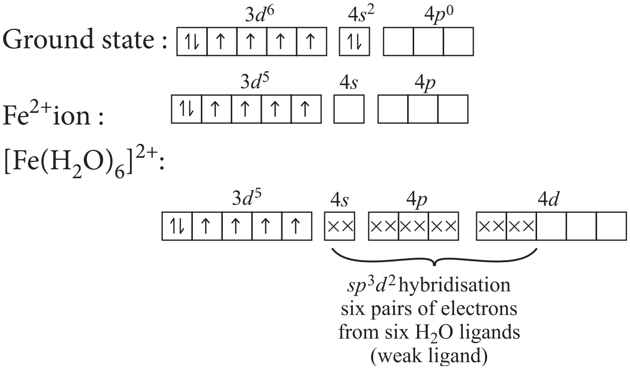
$$\therefore\ k = \frac{2.303}{t_{1/2}}\log\frac{[R]_0}{[R]_0/2} \text{ or, } t_{1/2} = \frac{2.303}{k}\log 2$$

$$t_{1/2} = \frac{2.303 \times 0.3010}{k} \Rightarrow t_{1/2} = \frac{0.693}{k}$$

In first order reaction, $t_{1/2}$ is independent of initial concentration.

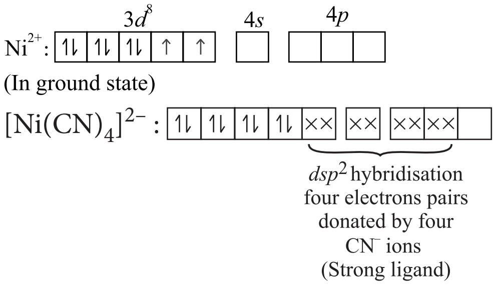
4. (a) $[Fe(H_2O)_6]^{2+}$:

Fe atom ($Z = 26$)



The complex ion has outer orbital octahedral geometry (high spin) and is paramagnetic due to the presence of four unpaired electrons.

(b) In $[Ni(CN)_4]^{2-}$: Ni is present as Ni(II) with $3d^8$ configuration.

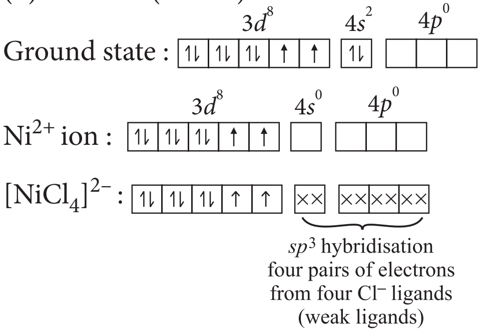


The complex ion has square planar geometry and is diamagnetic in nature.

OR

(a) Tetrachloridonickelate(II) ion

(b) Ni atom ($Z = 28$)



(c) The complex ion has tetrahedral geometry and is paramagnetic due to the presence of unpaired electrons.

5. (a) Transition metals form a large number of complex compounds due to following reasons :

- Comparatively smaller size of metal ions.
- High ionic charges.
- Availability of *d*-orbitals for bond formation.

(b) Lowest oxidation compounds of transition metals are basic due to their ability to get oxidised to higher oxidation states. Whereas, the higher oxidation state of metal and compounds gets reduced to lower ones and hence are acidic in nature.

e.g., MnO is basic whereas Mn_2O_7 is acidic.

(c) Much larger third ionisation energy of Mn(where change is d^5 to d^4) is mainly responsible for this. This also explains that +3 state of Mn is of little importance.

OR

(a) Ti^{4+} has highest oxidation state among the given ions. Ti^{4+} has stable inert gas configuration and hence, most stable in aqueous solution.

On the other hand, V^{2+}, Mn^{3+}, Cr^{3+} have unstable electronic configuration and hence, are less stable.

(b) Due to presence of highest oxidation state of Ti, it acts as the strongest oxidising agent among the given ions.

(c) Due to absence of unpaired electron in Ti^{4+}, it is a colourless ion.

E.C. of Ti^{4+} : $[Ar]3d^0 4s^0$

6. (a) Due to reduction of NO_3^- in preference to H^+ ion. H^+ ion is not reduced to give H_2 gas.

(b) Higher the reduction potential, stronger is the oxidising agent.

(c) Iron coated with zinc does not get rusted even if cracks appear on the surface because Zn will take part in redox reaction not Fe as Zn is more reactive than Fe. If iron is coated with tin and cracks appear on the surface, Fe will take part in redox reaction because Sn is less reactive than Fe.

7. (a) H_2 decreases three times as fast as that of N_2 while NH_3 increases twice as fast as that of N_2 decreases.

Hence, Rate $= -\frac{1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt}$

(b) For zero order reaction rate constant

$$= \frac{\text{mol L}^{-1}}{\text{s}} \times \frac{1}{(\text{mol L}^{-1})^0} = \text{mol L}^{-1}\ \text{s}^{-1}$$

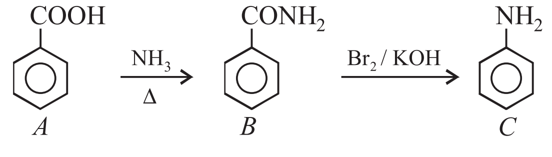
For first order, rate constant $= \frac{\text{mol L}^{-1}}{\text{s}} \times \frac{1}{\text{mol L}^{-1}} = \text{s}^{-1}$

8. (a) Pine oil is adsorbed on sulphide ore particles resulting in formation of emulsion and froth.

(b) In multimolecular colloids, the smaller particles aggregate and are held together by van der Waals' forces, *e.g.* sols of gold atoms and sulphur molecules.

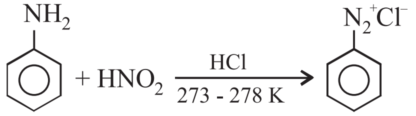
(c) The method involves both dispersion and condensation. The intense heat of arc vapourises some of the metal which condenses under cold water.

9. Formula of the compound '*C*' indicates it to be an amine. Since it is obtained by the reaction of Br_2 and KOH with the compound '*B*' so compound '*B*' can be an amide. It is also indicated because '*B*' is obtained from compound '*A*' by reaction with ammonia following by heating. So compound '*A*' could be an aromatic acid. Formula of compound '*C*' shows that it is aniline, then '*B*' is benzamide and compound '*A*' is benzoic acid. The sequence of reactions can be written as follows :



OR

(a) Aromatic primary amines react with nitrous acid to form diazonium salts.



(b) Aliphatic primary amines also form diazonium salts on reaction with nitrous acid but they are unstable and decompose to give the corresponding alcohols as the major product with the evolution of nitrogen.

$$R - NH_2 + HNO_2 \xrightarrow[273-278\text{ K}]{HCl} \left[R - N_2^+Cl^-\right]$$

$$\xrightarrow{H_2O} R - OH + N_2 + HCl$$

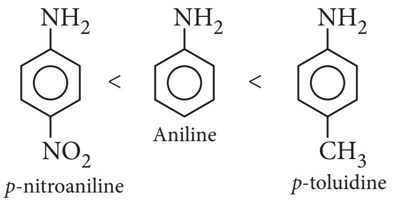
10. (a) Potassium pentacyanonitrosylferrate(II)

(b) Pentaamminenitrocobalt(III) chloride

(c) Dibromido*bis*(ethane-1,2-diamine)chromium(III) bromide

11. (a) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

(b)



Electron withdrawing group ($-NO_2$) on benzene ring decreases the basicity and electron donating group ($-CH_3$) on benzene ring increases the basicity of compound.

(c) $C_6H_5NH_2 < C_6H_5NHCH_3 < C_6H_5CH_2NH_2$

$C_6H_5NH_2$ and $C_6H_5NHCH_3$ are less basic than aliphatic amine, $C_6H_5CH_2NH_2$ since in aromatic amines lone pair of nitrogen is in conjugation with benzene ring. But due to *+I* effect of $-CH_3$ group in $C_6H_5NHCH_3$, it is more basic than $C_6H_5NH_2$.

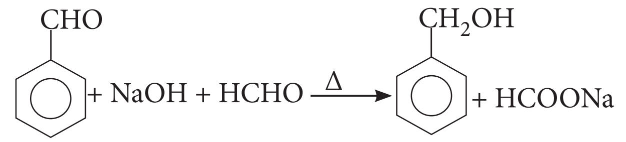
OR

(a) After acetylation of aniline, acetanilide is formed in which due to the presence of $-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$ group having *–I* effect, electron density on N-atom decreases and hence, activation effect of aniline gets reduced.

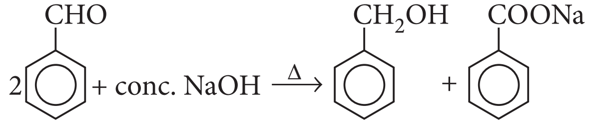
(b) CH_3NH_2 is more basic than $C_6H_5NH_2$ because in aniline the lone pair of electrons on nitrogen are involved in resonance.

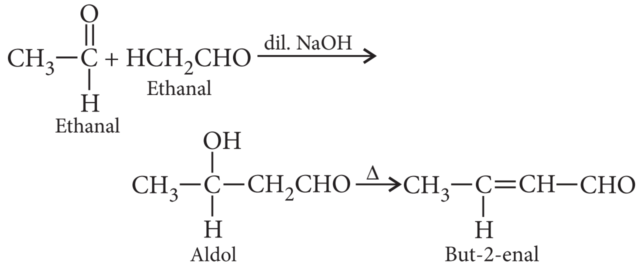
(c) Nitration is carried out with conc. HNO_3 in the presence of conc. H_2SO_4. In the presence of these acids, the $-NH_2$ group of aniline gets protonated and is converted into $-\overset{+}{N}H_3$ group. This positively charged group acts as a strong electron withdrawing and *meta*-directing group. Hence, the incoming electrophile goes to *m*-position.

12. (a) It is an example of cross Cannizzaro reaction where aromatic aldehyde gets reduced to alcohol and aliphatic aldehyde gets oxidised to its sodium salt (both aldehydes must not contain any α-hydrogen).



(b) Benzaldehyde undergoes Cannizarro reaction while acetaldehyde undergoes Aldol condensation.

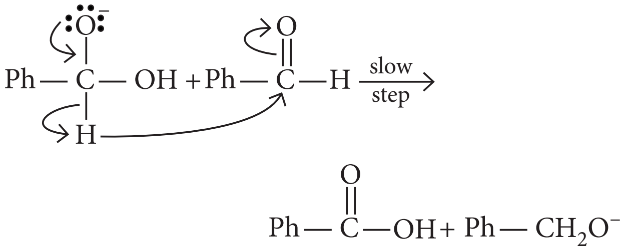




$$CH_3-\underset{\underset{\text{Ethanal}}{H}}{\overset{O}{\overset{||}{C}}} + \underset{\text{Ethanal}}{HCH_2CHO} \xrightarrow{\text{dil. NaOH}}$$

$$\underset{\text{Aldol}}{CH_3-\underset{H}{\overset{OH}{C}}-CH_2CHO} \xrightarrow{\Delta} \underset{\text{But-2-enal}}{CH_3-\underset{H}{C}=CH-CHO}$$

(c) Hydride transfer is the slowest step.



(d) C — C bond is not formed in Cannizzaro reaction while other reactions result in the formation of C — C bond.

OR

The Cannizzaro product of given reaction yields 2, 2, 2-trichloroethanol.