Sample Question Paper - 15
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. $E°$ values for the half cell reactions are given below:

$Cu^{2+} + e^- \rightarrow Cu^+$; $E° = 0.15$ V

$Cu^{2+} + 2e^- \rightarrow Cu$; $E° = 0.34$ V

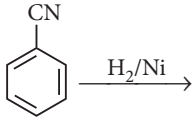
What will be the $E°$ of the half-cell : $Cu^+ + e^- \rightarrow Cu$?

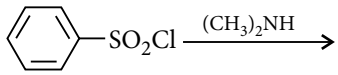
2. How are the following conversions carried out?

(a) CH_3CH_2Cl to $CH_3CH_2CH_2NH_2$

(b) Benzene to aniline

3. Write the structures of the main products of the following reactions :

(a) 

(b) 

SECTION - B

4. Explain the following :

(a) Anhydrous $CuSO_4$ is white while hydrated $CuSO_4$ is blue in colour.

(b) $[Ti(H_2O)_6]Cl_3$ is violet in colour but becomes colourless on heating.

OR

Give reason : $[CoF_6]^{3-}$ is outer orbital but $[Co(NH_3)_6]^{3+}$ is inner orbital complex.

5. Write the structures of main products when aniline reacts with the following reagents :

(a) Br_2 water

(b) HCl

(c) $(CH_3CO)_2O$/pyridine

6. (a) Explain what is observed when, a beam of light is passed through a colloidal solution.

(b) Write one difference in each of the following:

(i) Multimolecular colloid and associated colloid

(ii) Coagulation and peptization

OR

Define the following terms :

(a) Lyophilic colloid

(b) Zeta potential

(c) Associated colloids

7. Write chemical equations for the following reactions :

(a) Propanone is treated with dilute $Ba(OH)_2$.

(b) Acetophenone is treated with Zn(Hg)/Conc. HCl.

OR

Give reasons :

(a) Electrophilic substitution in benzoic acid takes place at *meta*-position.

(b) Carboxylic acids do not give the characteristic reactions of carbonyl group.

8. Considering that $\Delta_o > P$, estimate the magnetic moment (in B.M.) of $[Ru(H_2O)_6]^{2+}$.

9. Find the equilibrium constant for the reaction,

$In^{2+} + Cu^{2+} \rightleftharpoons In^{3+} + Cu^{+}$ at 298 K.

(Given: $E^{\circ}_{Cu^{2+}/Cu^{+}} = 0.15\ V; E^{\circ}_{In^{2+}/In^{+}} = -0.40\ V;\ E^{\circ}_{In^{3+}/In^{+}} = -0.42\ V$)

OR

0.04 N solution of a weak acid has a specific conductivity 4.23×10^{-4} mho cm^{-1}. The degree of dissociation of acid at this dilution is 0.0612. Calculate the equivalent conductivity of weak acid at infinite dilution.

10. Give reasons for the following :

(a) Silver bromide is used in photography.

(b) Most transition metal compounds are coloured.

(c) Zinc and not copper is used for the recovery of metallic silver from complex $[Ag(CN)_2]^{-}$.

11. Write the products formed when ethanal reacts with the following reagents :

(a) CH_3MgBr and then H_3O^{+}

(b) Zn-Hg/conc. HCl

(c) C_6H_5CHO in the presence of dilute NaOH

SECTION - C

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

For the reaction : $2NO_{(g)} + Cl_{2(g)} \rightarrow 2NOCl_{(g)}$, the following data were collected. All the measurements were taken at 263 K.

Experiment No.	Initial [NO] (M)	Initial [Cl_2] (M)	Initial rate of disapp. of Cl_2 (M/min)
1.	0.15	0.15	0.60
2.	0.15	0.30	1.20
3.	0.30	0.15	2.40
4.	0.25	0.25	?

(a) What is the molecularity of the reaction : $2NO_{(g)} + Cl_{2(g)} \longrightarrow 2NOCl_{(g)}$

(b) Write down the expression for rate law.

OR

Calculate the overall order of reaction.

(c) Find out the value of rate constant of the reaction of formation of NOCl by NO and Cl.

(d) What is the initial rate of disappearance of Cl_2 in experiment 4?

Solution

CHEMISTRY - 043

Class 12 - Chemistry

1. $Cu^{2+} + e^- \rightarrow Cu^+ ; E_1^\circ = 0.15\ V, \Delta G_1^\circ, n_1 = 1$

$Cu^{2+} + 2e^- \rightarrow Cu ; E_2^\circ = 0.34\ V, \Delta G_2^\circ, n_2 = 2$

$Cu^+ + e^- \rightarrow Cu ; E_3^\circ = ?, \Delta G_3^\circ, n_3 = 1$

$\Delta G_3^\circ = \Delta G_2^\circ - \Delta G_1^\circ$

$-n_3FE_3^\circ = -n_2FE_2^\circ + n_1FE^\circ{}_1$

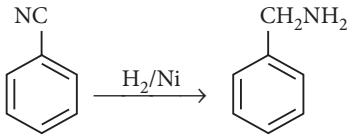
$-E_3^\circ = -2 \times 0.34 + 1 \times 0.15$

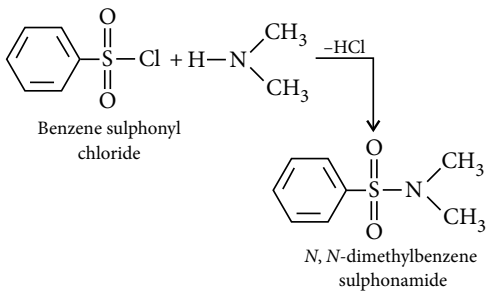
$E_3^\circ = 0.68 - 0.15 = +0.53\ V$

2. (a) $CH_3CH_2Cl \xrightarrow{NaCN} CH_3CH_2C{\equiv}N \xrightarrow[Ni/H_2]{Reduction} CH_3CH_2CH_2NH_2$

Chloroethane — Propane nitrile — 1-Propanamine

(b) Benzene $\xrightarrow{Nitration}$ Nitrobenzene (NO_2) $\xrightarrow{Fe/HCl}$ Aniline (NH_2)

3. (a) 

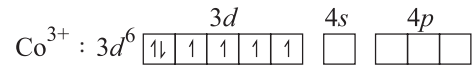
(b) 

4. (a) Anhydrous $CuSO_4$ does not have any ligand attached. So, crystal field splitting does not occur so, it does not show any colour but in hydrated form it is linked with H_2O ligand so, it shows colour due to *d-d* transition.

(b) $[Ti(H_2O)_6]Cl_3$ is a complex compound. In presence of six H_2O molecules the *d*-orbitals of Ti^{3+} undergo splitting. The compound is coloured (violet) due to *d-d* transition. On heating water molecules escape, *d*-orbitals become degenerate. There is no *d-d* transition. Hence compound becomes colourless.

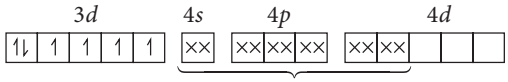
OR

In $[CoF_6]^{3-}$, Co is in +3 state and has $3d^6$ configuration.



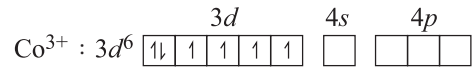
Ground state

Since F^- is a weak field ligand. So, outer *d*-orbitals will be used for bonding.



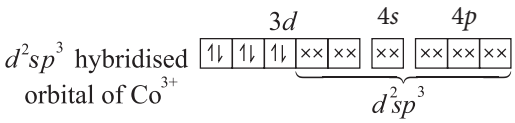
Since, outer *d*-orbitals are used for hybridisation. So, it is outer orbital complex.

In $[Co(NH_3)_6]^{3+}$, Co is in +3 state.

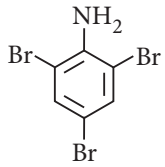


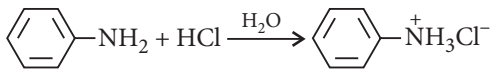
Ground state

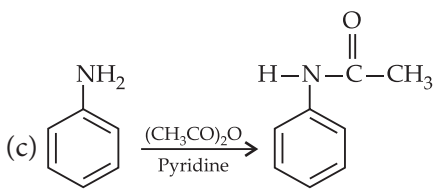
Since NH_3 is a strong field ligand pairing of electrons in 3*d*-orbital takes place to make two 3*d*-orbitals vacant.



Since it uses inner *d*-orbitals for its hybridisation so, it is inner orbital complex.

5. (a) $C_6H_5NH_2 + Br_{2(aq)} \longrightarrow$  $+ HBr$

(b) 

(c) 

6. (a) Scattering of light by the colloidal particles takes place and the path of light becomes visible (Tyndall effect).

(b) (i)

Multimolecular colloid	Associated colloid
The particles of this type of colloids are aggregates of large number of atoms or smaller molecules. *e.g.*, sulphur sol consists of colloidal particles which are aggregate of S_8 molecules.	They are substances which at low concentration behave as electrolytes but at higher concentration exhibit colloidal behaviour due to formation of aggregated particles.*e.g.*, micelles are associated colloids.

(ii)

Coagulation	Peptization
It is the process of settling of colloidal particles.	It is the process of converting a precipitate into colloidal sol.

OR

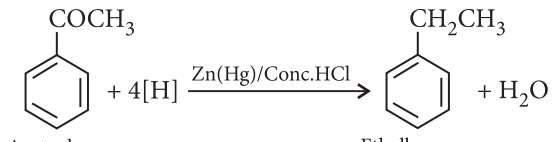
(a) A colloidal sol in which dispersed phase and dispersion medium attract each other is called lyophilic colloid. *e.g.*, gum. A colloidal sol in which dispersed phase and dispersion medium repel each other is called lyophobic colloid. *e.g.*, gold solution.

(b) The difference of potential between fixed layer and diffused layer of a colloidal sol is known as electrokinetic or zeta potential.

(c) The substances which when dissolved in a medium at low concentrations behave as normal, strong electrolytes but at higher concentrations exhibit colloidal state properties due to formation of aggregated particles are called associated colloids *e.g.*, soap.

7. (a) $2\,CH_3COCH_3 \xrightarrow{Ba(OH)_2} CH_3-\underset{CH_3}{\overset{OH}{C}}-CH_2COCH_3$

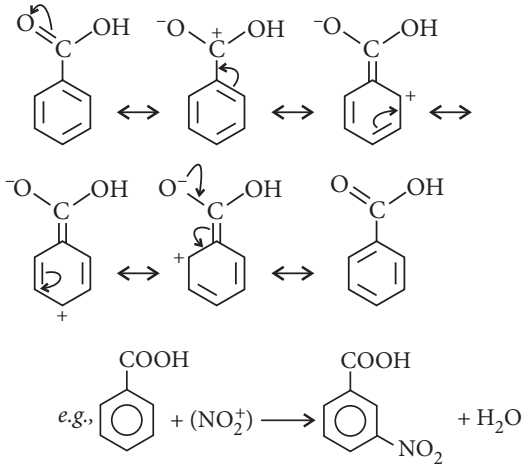
4-Hydroxy-4-methyl-pentane-2-one

(b) 

Acetophenone Ethylbenzene

OR

(a) Electrophilic substitution in benzoic acid takes place at *meta*-position. Due to resonance in benzoic acid, there is high electron density at *meta*-position. Therefore, electrophilic substitution in benzoic acid takes place at *meta*-position.



(b) The carbonyl group in —COOH is inert and does not show nucleophilic addition reaction like carbonyl compound. It is due to resonance stabilisation of carboxylate ion :

$$R-\underset{O^-}{\overset{|}{C}}=O \longleftrightarrow R-\underset{O}{\overset{||}{C}}-O^-$$

8. Oxidation state of Ru in $[Ru(H_2O)_6]^{2+}$ is + 2.

$\therefore$ Ru^{2+} in $[Ru(H_2O)_6]^{2+}$: $4d^6$

$\Rightarrow$ $t_{2g}^6\, e_g^0$, Since $\Delta_o > P$

As number of unpaired electron is zero, therefore, magnetic moment is zero.

9. $Cu^{2+}_{(aq)} + In^{2+}_{(aq)} \rightleftharpoons Cu^{+}_{(aq)} + In^{3+}_{(aq)}$

$$E^\circ_{cell} = E^\circ_{Cu^{2+}|Cu^+} - E^\circ_{In^{3+}|In^{2+}}$$

$$E^\circ_{cell} = 0.15 - E^\circ_{In^{3+}|In^{2+}} \quad \text{... (i)}$$

For : $E^\circ_{In^{3+}/\,In^{2+}}$

$In^{3+} + 2e^- \rightarrow In^+$; $E^\circ = -0.42$ V

$In^+ \rightarrow In^{2+} + e^-$; $E^\circ = +0.40$ V

$In^{3+} + e^- \rightarrow In^{2+}$; $E^\circ = ?$

Applying, $\Delta G^\circ = \Delta G_1^\circ + \Delta G_2^\circ$

or, $-nFE^\circ = -2F(-0.42) - 1F(0.40)$

or, $-E^\circ = 0.84 - 0.40$; $E^\circ_{In^{3+}|In^{2+}} = -0.44$ V

$\therefore$ $E^\circ_{cell} = 0.15 + 0.44 = 0.59$ V

$$E^\circ = \frac{2.303RT}{nF}\log K_c$$

$$\therefore \quad 0.59 = \frac{0.059}{1}\log K_c$$

$\Rightarrow$ $K_c = \text{antilog } 10 = 10^{10}$

OR

$$\text{As } \Lambda_{eq} = (\kappa) \times \frac{1000}{N} = 4.23 \times 10^{-4} \times \frac{1000}{0.04}$$

$$= 10.575 \text{ mho cm}^2 \text{ g eq}^{-1}$$

Also $\alpha = \frac{\Lambda_V}{\Lambda_\infty}$ or $0.0612 = \frac{10.575}{\Lambda_\infty}$

$\therefore \quad \Lambda_\infty = 172.79 \text{ mho cm}^2 \text{ g eq}^{-1}$

10. (a) Silver bromide is used in photography because of its sensitivity to sunlight. In light, AgBr reduces to metallic silver.

(b) The colour of transition metal compounds is due to the presence of incompletely filled *d*-orbitals in transition metal ions/atoms, because of this *d-d* transition can occur in them. The colour is due to *d-d* transition for which the energy is absorbed from visible region. The visible colour of a compound is the complementary colour of the absorbed light.

(c) Zinc is a cheaper and stronger reducing agent as compared to copper hence, used for recovery of metallic silver.

11. (a) $CH_3-CHO + CH_3MgBr \xrightarrow{H_3O^+} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(b) $CH_3CHO \xrightarrow[\text{Conc. HCl}]{\text{Zn-Hg}} CH_3-CH_3$

(c) $CH_3-CHO + C_6H_5CHO \xrightarrow{\text{dil. NaOH}} C_6H_5-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2CHO$

12. (a) $2NO_{(g)} + Cl_{2(g)} \rightarrow 2NOCl_{(g)}$

Molecularity = 3

(b) Let the rate of this reaction, $r = k[NO]^m[Cl_2]^n$

then $\frac{r_1}{r_2} = \frac{0.60}{1.20} = \frac{k(0.15)^m(0.15)^n}{k(0.15)^m(0.30)^n}$

or, $\frac{1}{2} = \left(\frac{1}{2}\right)^n \quad \Rightarrow \quad n = 1$

Again from $\frac{r_2}{r_3} = \frac{1.20}{2.40} = \frac{k(0.15)^m(0.30)^n}{k(0.30)^m(0.15)^n}$

or $\frac{1}{2} = \left(\frac{1}{2}\right)^m \cdot \frac{2}{1}$ or $\frac{1}{4} = \left(\frac{1}{2}\right)^m \quad \Rightarrow \quad m = 2$

Hence, expression for rate law is

$r = k[NO]^2 [Cl_2]^1$

OR

As the order *w.r.t.* NO is 2 and order *w.r.t.* Cl_2 is 1, hence the overall order is 3.

(c) Substituting the values of experiment 1 in rate law expression

$0.60 \text{ M min}^{-1} = k(0.15 \text{ M})^2 (0.15 \text{ M})^1$

or $k = \frac{0.60 \text{ M min}^{-1}}{0.0225 \times 0.15 \text{ M}^3} = 177.77 \text{ M}^{-2} \text{ min}^{-1}$

(d) $r = 177.7 \text{ M}^{-2} \text{ min}^{-1} \times (0.25 \text{ M})^2 (0.25 \text{ M})$
$= 2.77 \text{ M min}^{-1}$