Sample Question Paper -1
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. The complexation of Fe^{2+} and chelating agent dipyridyl has been studied kinetically in both forward and reverse directions.

$Fe^{2+} + 3(dipy) \longrightarrow [Fe(dipy)_3]^{2+}$

Rate of forward reaction = (1.45×10^{13}) $[Fe^{2+}][dipy]^3$ and rate of reverse reaction = (1.22×10^{-4}) $[Fe\ (dipy)_3]^{2+}$ Find the rate constant for the complex.

2. Account for the following :

(a) Aromatic carboxylic acids do not undergo Friedel–Crafts reaction.

(b) pK_a value of 4-nitrobenzoic acid is lower than that of benzoic acid.

3. What do the following reactions produce? (*any two*).

(a) Reaction of benzaldehyde with methyl amine.

(b) Reaction of propanal with dilute NaOH.

(c) Reaction of cyclohexanone in presence of H_2/Ni.

SECTION - B

4. Classify the following as primary, secondary or tertiary amine :

(a) Allylamine

(b) Aniline

(c) Trimethylamine

OR

$$CH_3Cl \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow{CHCl_3 + KOH\ (alc.)} C$$

(a) Identify product *A*.

(b) Identify product *B*.

(c) Identify product *C*.

5. (a) Is $[Zn(NH_3)_6]^{2+}$ outer orbital complex or inner orbital complex?

(b) Is $[Ni(H_2O)_6]^{2+}$ paramagnetic or diamagnetic?

OR

Arrange the following in increasing order according to the properties indicated :

(a) $[Fe(H_2O)_6]^{2+}$, $[Fe(CN)_2(H_2O)_4]$, $[Fe(CN)_4(H_2O)_2]^{2-}$
(Order of Δ_o)

(b) $[Cu(H_2O)_4]^{+}$, $[Cu(NH_3)_4]^{2+}$, $[CoF_6]^{3-}$
(Number of unpaired electrons)

6. How does amount of gas absorbed by solid depend upon nature of gas? Why is adsorption of CO_2 on tungsten higher in comparison to O_2?

7. The half life for the reaction, $N_2O_{5(g)} \rightarrow 2NO_{2(g)} + O_{2(g)}$ is 2.4 hr at 30°C.

(a) Starting with 10 g, what is the mass of N_2O_5 left after 9.6 hr?

(b) How much time is required to reduce 5.0×10^{10} molecules of N_2O_5 to 1.0×10^8 molecules?

8. How are the following conversions carried out?

(a) Ethyl cyanide to ethanoic acid.

(b) Butan-1-ol to butanoic acid.

(c) Benzoic acid to *m*-bromobenzoic acid.

9. Give the structures of products *A*, *B* and *C* in the following reactions :

(a) $CH_3CH_2Br \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0°C]{HNO_2} C$

(b) $CH_3COOH \xrightarrow[\Delta]{NH_3} A \xrightarrow{NaOH + Br_2} B \xrightarrow[Alc.\ NaOH]{CHCl_3 +} C$

OR

In the following reaction, identify *X*, *Y* and *Z*.

$X \xrightarrow{\text{Bromination}} Y \xrightarrow{NaNO_2/HCl} Z \xrightarrow[C_2H_5OH]{\text{Boiling}}$ *sym*-Tribromobenzene

10. Following ions are given : Cr^{2+}, Cu^{2+}, Cu^{+}, Fe^{2+}, Fe^{3+}, Mn^{3+}

Identify the ion which is

(a) a strong reducing agent.

(b) unstable in aqueous solution.

(c) a strong oxidising agent.

Give suitable reason in each.

11. Explain the hybridisation in following complexes :

(a) $[Mn(CN)_6]^{4-}$

(b) $[Cr(NH_3)_6]^{3+}$

(c) $[Co(NH_3)_6]^{3+}$

OR

Write the state of hybridization, the shape and the magnetic behaviour of the following complex entities :

(a) $[Cr(NH_3)_4Cl_2]Cl$

(b) $[Co(en)_3]Cl_3$

(c) $K_2[Ni(CN)_4]$

SECTION - C

12. Read the passage given below and answer the following questions.

The concentration of potassium ions inside a biological cell is at least twenty times higher than the outside. The resulting potential difference across the cell is important in several processes such as transmission of nerve impulses and maintaining the ion balance. A simple model for such a concentration cell involving a metal *M* is

$M_{(s)} \mid M^+(aq.;\ 0.05 \text{ molar}) \parallel M^+(aq.;\ 1 \text{ molar}) \mid M_{(s)}$

(a) What is value of ΔE for the cell?

(b) What will be the magnitude of cell potential if 0.05 M solution of M^+ is replaced by 0.0025 M solution?

(c) What are the conditions for a reaction to be feasible in term of electrochemistry?

(d) What is the emf of the cell when the cell reaction attains equilibrium?

OR

Does the potential of cell change with concentration of ions in solution or voltage of cell?

Solution

CHEMISTRY - 043

Class 12 - Chemistry

1. At dynamic equilibrium,

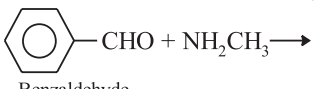
Rate of formation of complex = Rate of disappearance of complex

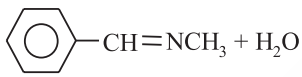
$(1.45 \times 10^{13})[Fe^{2+}][dipy]^3 = (1.22 \times 10^{-4})[Fe(dipy)_3]^{2+}$

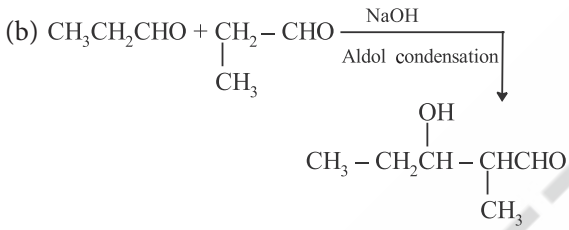
$\therefore \quad k = \dfrac{[Fe(dipy)_3]^{2+}}{[Fe^{2+}][dipy]^3} = \dfrac{1.45 \times 10^{13}}{1.22 \times 10^{-4}} = 1.19 \times 10^{17}$

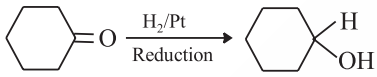
2. (a) Due to presence of electron withdrawing group (—COOH) in aromatic carboxylic acids, they do not undergo Friedel–Crafts reaction.

(b) Due to presence of strong electron withdrawing group ($—NO_2$), 4-nitrobenzoic acid is more acidic than benzoic acid and therefore, pK_a value is lower.

3. (a) 



(b) 

(c) 

4. (a) Primary amine

(b) Primary amine

(c) Tertiary amine

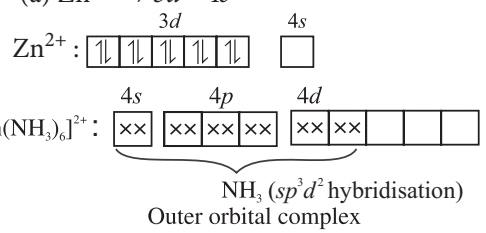
OR

(a) $CH_3Cl \xrightarrow{KCN} \underset{(A)}{CH_3CN}$

(b) $CH_3CN \xrightarrow{LiAlH_4} \underset{(B)}{CH_3CH_2NH_2}$

(c) $CH_3CH_2NH_2 \xrightarrow{CHCl_3 + \text{alc. KOH}} \underset{(C)}{CH_3CH_2NC}$

5. (a) $Zn^{2+} \rightarrow 3d^{10}\ 4s^0$



In other cases NH_3 being strong field ligand causes pairing of electrons and the resulting complexes will be inner orbital. But in case of Zn, their is no availability of inner *d*-orbital due to fully filled *d*-orbital.

(b) Oxidation state of Ni in $[Ni(H_2O)_6]^{2+} = +2$

$Ni^{2+}\ (Z = 28) \rightarrow 3d^8$

Since, H_2O is a weak field ligand, electrons remain unpaired hence, the compound is paramagnetic.

OR

(a) $[Fe(H_2O)_6]^{2+} < [Fe(CN)_2(H_2O)_4] < [Fe(CN)_4(H_2O)_2]^{2-}$

The value of Δ_o for mixed ligands depends on the additive contributions of the ligand strength. Since CN^- has greater ligand strength than H_2O, the strength increases as the number of CN^- ions increases.

(b) $\underset{(n=0)}{[Cu(H_2O)_4]^+} < \underset{(n=1)}{[Cu(NH_3)_4]^{2+}} < \underset{(n=3)}{[CoF_6]^{3-}}$

6. The amount of gas adsorbed by a solid depends on the nature of gas. In general, more easily liquefiable gases (*i.e.*, higher critical temperature) are readily adsorbed as van der Waals' forces are stronger near the critical temperature.

More easily liquefiable gases, (*e.g.*, NH_3, CO_2) are readily adsorbed, as van der Waals forces are stronger near the critical temperatures. So, adsorption of CO_2 will be highest.

7. For a first order reaction

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{2.4 \times 60 \times 60} = 8.02 \times 10^{-5}\ s^{-1}$$

(a) Now using the expression

$$k = \frac{2.303}{t}\log\frac{a}{a-x}$$

$a = 10$ g; $t = 9.6$ hr $= 9.6 \times 60 \times 60$ s; $k = 8.02 \times 10^{-5}\ s^{-1}$

$$8.02 \times 10^{-5} = \frac{2.303}{9.6 \times 60 \times 60}\log\frac{10}{a-x}$$

$$\log\frac{10}{a-x} = \frac{8.02 \times 10^{-5} \times 9.6 \times 60 \times 60}{2.303}$$

$$\log\frac{10}{a-x} = \frac{2.77171}{2.303} \Rightarrow \frac{10}{a-x} = 15.9$$

$$\underset{\text{(amount left)}}{a-x} = \frac{10}{15.9} = 0.628\ \text{g}$$

(b) $$t = \frac{2.303}{k}\log\frac{a}{a-x}$$

$$t = \frac{2.303}{8.02 \times 10^{-5}}\log\left(\frac{5.0 \times 10^{10}}{1.0 \times 10^{8}}\right) = \frac{2.303 \times 2.698}{8.02 \times 10^{-5}}$$

$= 77503$ s $= 21.52$ hr

8. (a) $CH_3CH_2CN \xrightarrow[\text{Partial hydrolysis}]{H^+ \text{ or } OH^-} CH_3CH_2\overset{O}{\overset{\|}{C}}NH_2$

Ethyl cyanide — Propanamide

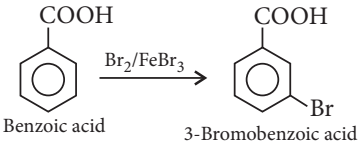
Propanamide $\xrightarrow{Br_2-NaOH}$ $CH_3CH_2NH_2$ (Ethylamine)

$CH_3CH_2NH_2 \xrightarrow[-N_2, -H_2O]{HONO} CH_3CH_2OH$ (Ethanol)

Ethanol $\xrightarrow[\text{Oxidation}]{K_2Cr_2O_7/H_2SO_4} CH_3COOH$ (Ethanoic acid)

(b) $CH_3CH_2CH_2CH_2OH \xrightarrow[\text{Oxidation}]{K_2Cr_2O_7/H_2SO_4} CH_3CH_2CH_2COOH$

Butan-1-ol — Butanoic acid

(c) 

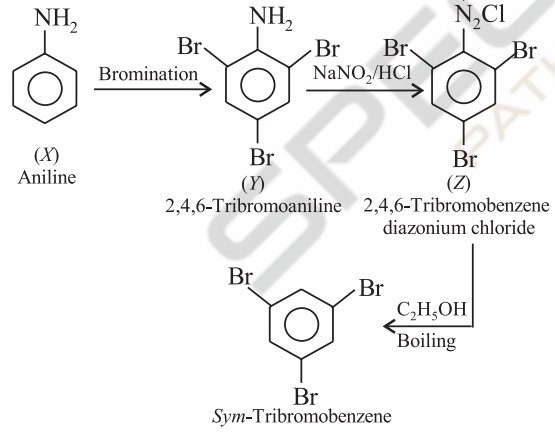
Benzoic acid — 3-Bromobenzoic acid

9. (a) $CH_3CH_2Br \xrightarrow{KCN} \underset{(A)}{CH_3CH_2CN} \xrightarrow{LiAlH_4} CH_3CH_2CH_2NH_2$ (*B*)

$CH_3CH_2CH_2NH_2 \xrightarrow[HNO_2]{273\ K} CH_3CH_2CH_2OH$ (*C*)

(b) $CH_3COOH \xrightarrow[\Delta]{NH_3} \underset{(A)}{CH_3CONH_2} \xrightarrow{Br_2 + NaOH} \underset{(B)}{CH_3NH_2} \xrightarrow{CHCl_3 + NaOH} \underset{(C)}{CH_3NC}$

OR



(*X*) Aniline — (*Y*) 2,4,6-Tribromoaniline — (*Z*) 2,4,6-Tribromobenzene diazonium chloride

Sym-Tribromobenzene

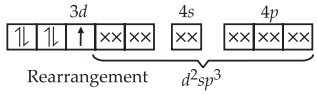
10. (a) Cr^{2+} is reducing since its configuration is converted to d^3 from d^4. d^3 has half filled t_{2g} configuration with higher stability.

(b) Cu^+ is unstable in aqueous solution. In aqueous solutions, Cu^+ undergoes disproportionation to form a more stable Cu^{2+} ion.

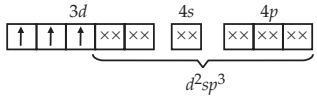
$2Cu^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Cu_{(s)}$

(c) Mn^{3+} is a strong oxidising agent because electronic configuration of Mn^{2+} is $3d^5$ which is half filled and hence stable. Therefore, third ionization enthalpy is very high, *i.e.*, 3rd electron cannot be lost easily.

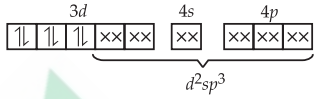
11. (a) $[Mn(CN)_6]^{4-}$:



(b) $[Cr(NH_3)_6]^{3+}$:



(c) $[Co(NH_3)_6]^{3+}$:



OR

	Complex	Central metal ion atom	Hybridisation of metal ion involved	Geometry of complex	Magnetic behaviour
(a)	$[Cr(NH_3)_4Cl_2]Cl$	Cr^{3+}	d^2sp^3	Octahedral	Paramagnetic
(b)	$[Co(en)_3]Cl_3$	Co^{3+}	d^2sp^3	Octahedral	Diamagnetic
(c)	$K_2[Ni(CN)_4]$	Ni^{2+}	dsp^2	Square planar	Diamagnetic

12. (a) $\underset{(1\ M)}{M} \longrightarrow \underset{(0.05\ M)}{M^+} + e^-$

For concentration cell, $E_{cell} = -\frac{0.059}{1}\log\frac{0.05}{1}$

$E_{cell} = -\frac{0.059}{1}\log(5\times10^{-2})$

$E_{cell} = -\frac{0.059}{1}[(-2)+\log 5]$ $-0.059(-2 + 0.698)$

$= -0.059(-1.302) = 0.0768$ mV

(b) $\frac{E_1}{E_2} = \frac{\log 0.05}{\log 0.0025}$

$\frac{E_1}{E_2} = \frac{\log 5\times10^{-2}}{\log 25\times10^{-4}}$

$E_1 = 0.0768$ mV

$\frac{0.0768}{E_2} = \frac{-1.3}{-2.6} = \frac{1}{2}$ or $E_2 = 154$ mV

(c) $K = \text{antilog}\left(\frac{nE^\circ}{0.0591}\right)$

For feasible cell, E° is positive, hence from the above equation, $K > 1$ for a feasible cell reaction.

(d) The emf of the cell is 0 at equilibrium.

OR

Yes, the potential of electrode changes with change in concentration of ions in solution.