# CBSE
# Class XII Chemistry
# Sample Paper 2
# Term 2 – 2021 - 22

**Time: 2 Hrs** **Total marks: 35**

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***General Instructions:***

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

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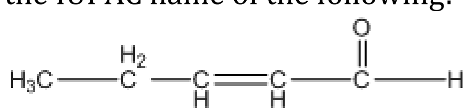
## Section A

**1.** How is acetone obtained from ethanol?

**2.** Write the electrode reactions taking place in the Ni–Cd cell.

**3.** Write the IUPAC name of the following:

(a) 

(b) 

## Section B

**4.** In the following cases, rearrange the compounds as directed:

(a) In the increasing order of basic strength:
$C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$ and $CH_3NH_2$

(b) In the decreasing order of basic strength:
Aniline, p-nitroaniline and p-toluidine

(c) In the increasing order of p$K_b$ value:
$C_2H_5NH_2$, $C_6H_5NHCH_3$, $(C_2H_5)_2NH$ and $C_6H_5NH_2$

**OR**

Complete the equations:

(a) $C_6H_5CONH_2 \xrightarrow[\Delta]{H_3O^+}$

(b) $CH_3CN + H_2O \xrightarrow{H^+}$

(c) $C_6H_5COO^-NH_4^+ \xrightarrow{heat}$

**5.**

(a) Find the cooridinaton number of copper in cuprammonium sulphate.

(b) Why is EDTA Hexadentate ligand?

(c) Calculate number of ions present in $K_4FeCN_6$.

**OR**

(a) What is IUPAC name of $[Pt(NH_3)_3(Br)(NO_2)Cl]Cl$.

(b) Write IUPAC name of $K_3[Al(C_2O_4)_3]$.

(c) What is IUPAC name of $K_2[Cr(CN)_2O_2(O)_2NH_3)]$.

**6.** Write the chemical equations involved in the following:

1) $FeCr_2O_4 + 8Na_2CO_3 + O_2 \rightarrow$

2) $2KMnO_4 \xrightarrow[\Delta]{513\,K}$

3) $2CrO_4^{2-} + H^+ \rightarrow$

**7.** Complete the equations:

(a) $CH_3CH_2COOH \xrightarrow{NH_3} A \xrightarrow{Br_2/KOH} B$

(b) $(CH_3)C{=}O \xrightarrow{HCN} X \xrightarrow{H_2/Ni} Y$

(c) $C_6H_5CHO + CH_3COCH_3 \xrightarrow{dil\ OH^-} C + D$

**8.**

(a) Why are deltas formed at places where the river meets the sea?

(b) List two characteristics of catalysts.

(c) What are macromolecular colloids? Give an example.

**9.**

(a) Nitration of aniline gives a substantial amount of m-nitroaniline. Explain.

(b) $pK_b$ of aniline is more than that of methylamine. Explain the reason.

(c) What is Hinsberg reagent?

**10.**

The emf of the cell reaction

$3Sn^{4+} + 2\,Cr \rightarrow 3Sn^{2+} + 2Cr^{3+}$ is 0.89 V.

Calculate:

(a) $\Delta G^\theta$ for the reaction.

(b) Equilibrium constant for the reaction relating to

(i) $\Delta G^\theta$

(ii) $E^{\theta}$ cell

**OR**

Given:
$Cu^{2+} + 2e^{-} \rightarrow Cu \quad E^{\theta} = +0.34$ V
$Ag^{+} + e^{-} \rightarrow Ag \quad E^{\theta} = +0.80$ V

(a) Write the cell reaction.
(b) Construct the galvanic cell.
(c) For what concentration of Ag+ ions will the emf of the cell be zero at 25°C if the concentration of $Cu^{2+}$ is 0.01 M?

**11.** Give reasons:
(a) $Cr^{2+}$ is a strong reducing agent, whereas $Mn^{2+}$ is not. (Cr = 24, Mn = 25).
(b) Transition metal ions such as $Cu^{+}$, $Ag^{+}$ and $Sc^{3+}$ are colourless.
(c) Enthalpies of atomisation of transition metals of the 3d series do not follow a regular trend throughout the series.

**OR**

Use Hund's rule to derive the electronic configuration of $Ce^{3+}$ ion, and calculate its magnetic moment on the basis of the 'spin only' formula.

## Section C

**12.** The number of reacting species (atoms, ions or molecules) taking part in an elementary reaction which must collide simultaneously to bring about a chemical reaction is called molecularity of a reaction.
Order of a reaction is an experimental quantity; it can be zero and even a fraction but molecularity cannot be zero or a non-integer. The sum of powers of the concentration of the reactants in the rate law expression is called the order of that chemical reaction. The overall rate of the reaction is controlled by the slowest step in a reaction called the rate-determining step. So, in a complex reaction, molecularity of the slowest step is the same as the order of the reaction step in a reaction called the rate-determining step. So, in a complex reaction, molecularity of the slowest step is the same as the order of the reaction.\
For a general reaction
$aA + bB \rightarrow cC + dD$
Rate = $k\,[A]x\,[B]^{y}$
X + y = Order of reaction
K = rate constant
(i) What is the molecularity of the reaction
$2NO + O_2 \rightarrow 2NO_2$

(ii) Find the order of the given reaction.
$H_2\,(g) + 2\,ICI\,(g) \rightarrow I_2\,(g) + 2HCI\,(g)$
Steps –
1. Slow reaction: $H_2 + ICI \rightarrow HI + HCI$
2. Fast reaction: $HI + ICI \rightarrow I_2 + HCI$

(iii) For the second-order reaction $A + B \rightarrow \text{Product}$, the rate law is given by Rate = k$[A]^2$ $[B]^x$. What is the value of x?

(iv) For the zero-order reaction $A + B \rightarrow \text{Product}$, if the concentration of A becomes double, then what will be the change in the rate of reaction?

(v) Calculate the overall order of a reaction which has the rate expression
(a) Rate = k$[A]^{1/2}$ $[B]^{3/2}$
(b) Rate = k $[A]^{3/2}$ $[B]^{-1}$

# Solution

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## Section A

**1.** $$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[\text{Oxidation}]{K_2Cr_2O_7/H_2SO_4} \underset{\text{Ethanoicacid}}{CH_3COOH} \xrightarrow{CaCO_3} \underset{\text{Ca.Ethanoate}}{(CH_3COO)_2Ca} \longrightarrow \underset{\text{Ethanol}}{CH_3COCH_3}$$

**2.** $$Cd_{(s)} + 2OH^-_{(aq)} \longrightarrow Cd(OH)_{2(s)} + 2e^-$$
$$NiO_{2(s)} + 2H_2O + 2e^- \longrightarrow Ni(OH)_{2(s)} + 2OH^-$$

**3.**
(a) pent-2-enal
(b) 3-phenyl prop-2-enol

## Section B

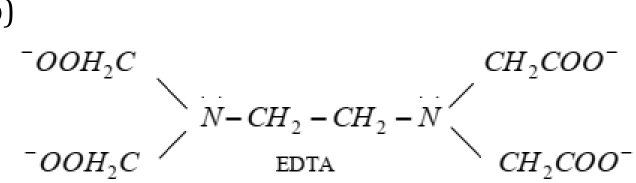
**4.**
(a) In the increasing order of basic strength: $C_6H_5NH_2 < C_6H_5N(CH_3)_2 < CH_3NH_2 < (C_2H_5)_2NH$
(b) In the decreasing order of basic strength: p-toluidine > Aniline > p-nitroaniline
(c) In the increasing order of p$K_b$ value: $(C_2H_5)_2NH < C_2H_5NH_2 < C_6H_5NHCH_3 < C_6H_5NH_2$

**OR**

(a) $C_6H_5CONH_2 \xrightarrow[\Delta]{H_3O^+} C_6H_5COOH + NH_3$
(b) $CH_3CN + 2H_2O \xrightarrow{H^+} CH_3COOH + NH_3$
(c) $C_6H_5COO^-NH_4^+ \xrightarrow{\text{heat}} C_6H_5CONH_2 + H_2O$

**5.**
(a) The formula for cuprammonium sulphate is $[Cu(NH_3)_4]\ SO_4$. Here, copper is carrying a charge of +2 and is co-ordinately bonded to four $NH_3$ ligands. The $SO_4^{-2}$ unit is outside the coordination sphere.
So, the total number of electron pairs accepted by copper will be 4.

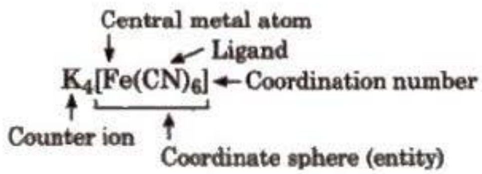
(b)



A hexadentate ligand needs to have 6 points of attachment. When we see the structures of these options, we find only one ligand which shows six points of attachment, that is, EDTA-Ethylene diaaminetetraacetate ion.

(c)

$$K_4[Fe(CN)_6] \overset{aq}{\rightleftharpoons} 4K^+ + [Fe(CN)_6]^{4-}$$




The given species is a complex salt. On ionisation, it will dissociate in 4 $K^+$ and $Fe(CN)_6^{4-}$ ion. So, a total of 5 ions will be present.

**OR**

(a) A of amine comes first, followed by b of bromo, c of chloro and last is n of nitro. So, the name is **Tri ammine bromo chloro nitro platinum (IV) chloride**.

(b) $C_2O_4$ is oxalato. Three oxalate groups and one aluminium give us the name potassium tri oxalato aluminate three.

(c) CN means cyano and O2 means peroxo. Hence, the correct name is **Potassium ammine di cyano di oxo per oxo chromate (VI)**

**6.**

1) $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$

2) $2KMnO_4 \xrightarrow[\Delta]{513\,K} K_2MnO_4 + MnO_2 + O_2$

3) $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$

**7.** (a) $CH_3CH_2COOH \xrightarrow{NH_3} CH_3CH_2CONH_2 \xrightarrow{Br_2/KOH} CH_3CH_2NH_2$

(b)

$$(CH_3)_2C{=}O \xrightarrow{HCN} \underset{\displaystyle CN}{\underset{|}{(CH_3)_2C\text{-}OH}} \xrightarrow{H_2/Ni} \underset{\displaystyle CH_2NH_2}{\underset{|}{(CH_3)_2C\text{-}OH}}$$

(c)

$$C_6H_5CHO + CH_3COCH_3 \xrightarrow{dil.OH^-} \underset{\displaystyle OH}{\underset{|}{C_6H_5CH}}\text{-}CH_2COCH_3 + CH_3\text{-}\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle OH}{\underset{|}{C}}}}\text{-}CH_2COCH_3$$

**8.**

(a) River water is muddy and contains charged colloidal particles of clay, sand and many other materials. Sea water contains a number of dissolved electrolytes. When sea water and river water come in contact with each other, the electrolytes present in sea water coagulate the suspended colloidal particles which ultimately settle at the point of contact. Thus, a delta is formed at the point where the river meets the sea.

(b) Characteristics of catalysts:

(i) Catalysts are highly selective. A catalyst is able to direct a reaction to give a particular product.

(ii) Catalysts are highly active. A catalyst is able to increase the rate of a chemical reaction.

(c) A colloid in which the particles of the dispersed phase are sufficiently large to be of colloidal dimensions is called a macromolecular colloid. Example: Starch

**9.**

(a) In the presence of nitrating mixture $(HNO_3 + H_2SO_4)$, aniline gets protonated to form anilinium ion, which is a meta-directing group, thus giving a substantial amount of m-nitroaniline.

(b) In aniline, a lone pair of electrons on the N atom is delocalised over the benzene ring, resulting in lowering its basic strength. Hence, its $K_b$ value will be lower and its $pK_b$ value will be higher. On the other hand, the +I effect of the $-CH_3$ group increases the electron density on the N atom in $CH_3NH_2$ making it a stronger base. Hence, its $K_b$ value will be higher and its $pK_b$ value will be lower.

(c) Hinsberg reagent is alternative name for benzene sulfonyl chloride($C_6H_5SO_2Cl$). It is an organosulfur compound. It is used in detection of primary, secondary and tertiary amines.

**10.**

(a) The cell reaction is

$3Sn^{4+} + 2Cr \rightarrow 3Sn^{2+} + 2Cr^{3+}$

$\Delta G^{\theta} = -nFE^{\theta}_{cell}$

$E^{\theta}_{cell} = 0.89$ V

$n = 6$

$F = 96500$ C mol$^{-1}$

$\Delta G^{\theta} = -(6) \times (96500) \times (0.89)$

$= -5.15 \times 10^5$

$= -5.15 \times 10^5$ J

(b) Calculation of K

(i) $\Delta G^{\theta} = -2.303\ RT \log K$

$\Delta G^{\theta} = -5.15 \times 10^5$ J , R = 8.314 J mol$^{-1}$ K$^{-1}$, T = 298 K

$\log K = -\Delta G^\theta / 2.303\ RT$

$= -(-5.15 \times 10^5\ J)/ (2.303 \times 8.314\ J\ mol^{-1}\ K^{-1} \times 298\ K)$

$\log K = 90.259$

$K = 1.8 \times 10^{90}$

(ii) $\log K = n\ F\ E^\theta_{cell}/2.303\ RT$

$$= \frac{(6) \times (96500\ C\ mol^{-1}) \times (0.89\ V)}{2.303 \times (8.314\ J\ mol^{-1}\ K^{-1}) \times (298\ K)}$$

$= 90.313$

$K = 2.05 \times 10^{90}$

**OR**

(a) Since the reduction potential of $Ag^+/Ag$ is more than that of $Cu^{2+}/Cu$, $Ag^+$ gets reduced to Ag at the cathode and Cu gets oxidised to $Cu^{2+}$ at the anode.

At the cathode:

$2\ Ag^+ + 2\ e^- \rightarrow 2\ Ag$

At the anode:

$Cu \rightarrow Cu^{2+} + 2\ e^-$

Therefore, the net reaction is

$2Ag^+ + Cu \rightarrow 2Ag + Cu^{2+}$

(b) The cell is

$Cu(s)\ |\ Cu^{2+}(aq)\ ||\ Ag^+(aq)\ |\ Ag\ (s)$

(c) $E^\theta_{cell} = E^\theta_{Ag^+/Ag} - E^\theta_{Cu^{2+}/Cu}$

$= 0.80 - 0.34$

$= 0.46\ V$

$$E_{cell} = E^\theta_{cell} - \frac{0.059}{n} \log \frac{[Cu^{2+}]}{[Ag^+]^2}$$

$$E_{cell} = E^\theta_{cell} - \frac{0.059}{n} \log \frac{[Cu^{2+}]}{[Ag^+]^2}$$

$$0 = 0.46 - \frac{0.059}{2} \log \frac{0.01}{[Ag^+]^2}$$

$[Ag^+] = 1.59 \times 10^{-9}\ M$

**11.**

(a) $Cr^{2+}$ is less stable than $Cr^{3+}$; therefore, it is a good reducing agent, whereas $Mn^{2+}$ is stable due to half-filled d-orbital; therefore, it is not a reducing agent.

(b) $Cu^+$, $Ag^+$ and $Sc^{3+}$ are colourless because they do not have unpaired electrons and cannot undergo d–d transitions.

(c) It is due to an irregular trend of atomic size that the number of unpaired electrons first increase and then decrease.

**OR**

Electronic configuration of Ce and $Ce^{3+}$ ions:

Ce (Z = 58) = [Xe] $4f^1\ 5d^1\ 6s^2$

$Ce^{3+}$ = [Xe] $4f^1$

It has one unpaired electron.

'Spin only' formula for magnetic moment of a species is $\mu = \sqrt{n(n+2)}$ B.M.

where n = no. of unpaired electrons

Magnetic moment of $Ce^{3+}$

$\mu = \sqrt{1(1+2)} = \sqrt{3}$ B.M. = 1.732 B.M.

## Section C

**12.**

(i) 2 NO and 1 $O_2$ molecules are taking part in an elementary reaction.
So, molecularity = 2 + 1 = 3

(ii) Molecularity of the slowest step: 1 + 1 = 2

(iii) Order of reaction = 2
$2 + x = 2$
$x = 0$

(iv) In the zero-order reaction, rate of reaction = k
So, there will be no change in the rate of reaction.

(v) (a) $\text{Order} = \frac{1}{2} + \frac{3}{2} = 2$, i.e., second order

(b) $\text{Order} = \frac{3}{2} + (-1) = \frac{1}{2}$, i.e., half order