Sample Question Paper - 10
Chemistry (043)
Class- XII, Session: 2021-22
TERM II

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

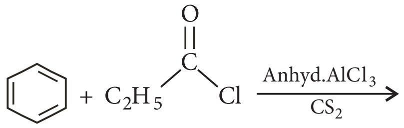
General Instructions :

Read the following instructions carefully.

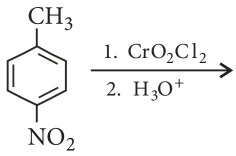
1. *There are 12 questions in this question paper with internal choice.*
2. *SECTION A - Q. No. 1 to 3 are very short answer questions carrying 2 marks each.*
3. *SECTION B - Q. No. 4 to 11 are short answer questions carrying 3 marks each.*
4. *SECTION C - Q. No. 12 is case based question carrying 5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

SECTION - A

1. Write the structures of the products of the following reactions (*any two*):

(a) 

(b) $H_3C-C\equiv C-H \xrightarrow{Hg^{2+},\ H_2SO_4}$

(c) 

2. (a) Define 'order of a reaction'.

(b) Identify the reaction order from the following rate constant :

$k = 2.3 \times 10^{-5}$ L mol^{-1}s^{-1}

3. Calculate $\Delta_r G°$ for the reaction :

$Mg_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$

Given : $E°_{cell} = +2.71$ V, 1 F = 96500 C mol^{-1}

SECTION - B

4. Give reasons :

(a) Acetylation of aniline reduces its activation effect.

(b) CH_3NH_2 is more basic than $C_6H_5NH_2$.

(c) Although $—NH_2$ is *o*/*p* directing group, yet aniline on nitration gives a significant amount of *m*-nitroaniline.

OR

How will you convert :

(a) Benzene into aniline,

(b) Benzene into *N,N*-dimethylaniline,

(c) $Cl(CH_2)_4Cl$ into hexan-1,6-diamine?

5. Following data are obtained for the reaction :

$$N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$$

t/s	0	300	600
$[N_2O_5]$/mol L^{-1}	1.6×10^{-2}	0.8×10^{-2}	0.4×10^{-2}

(a) Show that it follows first order reaction.

(b) Calculate the half-life of the reaction.
(Given : log 2 = 0.3010, log 4 = 0.6021)

OR

From the rate expression for the following reactions, determine their order of reaction and the dimensions of the rate constants.

(i) $3NO_{(g)} \rightarrow N_2O_{(g)} + NO_{2(g)}$; Rate = $k[NO]^2$

(ii) $H_2O_{2(aq)} + 3I^-_{(aq)} + 2H^+ \rightarrow 2H_2O_{(l)} + I_3^-$; Rate = $k[H_2O_2][I^-]$

(iii) $CH_3CHO_{(g)} \rightarrow CH_{4(g)} + CO_{(g)}$; Rate = $k[CH_3CHO]^{3/2}$

6. 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*.

7. (a) What happens when a beam of light is passed through colloidal sol?

(b) The flocculation value of HCl for arsenic sulphide sol is 30 mmol L^{-1}. If H_2SO_4 is used for the flocculation of arsenic sulphide, what will be the amount (in grams), of H_2SO_4 in 250 mL required for the above purpose?
(Molecular mass of H_2SO_4 = 98 g/mol)

8. (a) What are bidentate ligands? Explain with examples.

(b) Explain the coordination sites of polydentate ligands taking an example of EDTA.

(c) Calculate charge on the central metal in the following complexes:

(i) $[Cu(NH_3)_6]^{2+}$

(ii) $[Ag(CN)_2]^-$

9. Define conductivity and molar conductivity for the solution of an electrolyte. Discuss their variation with concentration.

OR

The molar conductivity of 0.025 mol L^{-1} methanoic acid is 46.1 S cm^2 mol^{-1}. Calculate its degree of dissociation and dissociation constant. (Given : $\lambda(H^+)$ = 349.6 S cm^2 mol^{-1} and $\lambda(HCOO^-)$ = 54.6 S cm^2 mol^{-1}.)

10. Give reasons :

(a) E° value for Mn^{3+}/Mn^{2+} couple is much more positive than that for Fe^{3+}/Fe^{2+}.

(b) Iron has higher enthalpy of atomization than that of copper.

(c) Sc^{3+} is colourless in aqueous solution whereas Ti^{3+} is coloured.

11. Write down the IUPAC name for each of the following complexes :

(a) $[Co(NH_3)_5Cl]Cl_2$

(b) $K_3[Fe(CN)_6]$

(c) $[NiCl_4]^{2-}$

OR

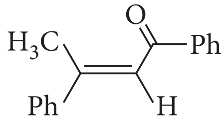
Give the electronic configuration of the following complexes on the basis of crystal field splitting theory. $[CoF_6]^{3-}$, $[Fe(CN)_6]^{4-}$ and $[Cu(NH_3)_6]^{2+}$.

SECTION - C

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

A tertiary alcohol *H* upon acid catalysed dehydration gives a product *I*. Ozonolysis of *I* leads to compounds *J* and *K*. Compound *J* upon reaction with KOH gives benzyl alcohol and a compound *L*, whereas *K* on reaction with KOH gives only *M*.

M =



(a) Write down a method to synthesis compound *H*.

(b) What are the structures of compound *J*, *K* and *L*?

(c) What is the product obtained when *J* is treated with acetic anhydride, in the presence of corresponding salt of an acid?

(d) Write the structural formula of compound *I*?

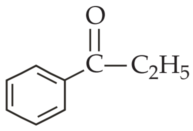
OR

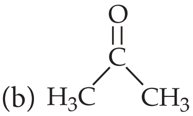
Name the product formed when compound *K* reacts with iodine and NaOH.

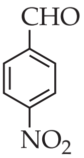
Solution

CHEMISTRY - 043

Class 12 - Chemistry

1. (a) 

(b) 

(c) 

2. (a) It is defined as "the sum of the powers or exponents to which the concentration terms are raised in the rate law expression."

If rate = $k[A]^m [B]^n$, then order = $m + n$.

(b) Second order reaction :

$$\text{Unit of rate constant} = \frac{\text{mol L}^{-1}}{\text{s}} \times \frac{1}{(\text{mol L}^{-1})^2}$$

$$= \text{L mol}^{-1}\text{s}^{-1}$$

3. Given : $E°_{cell} = 2.71$ V

For the reaction,

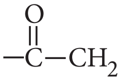
$Mg_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$

$n = 2, \Delta_r G° = ?$

Using formula, $\Delta_r G° = -nFE°_{cell}$

$\Delta_r G° = -2 \times 96500 \text{ C mol}^{-1} \times 2.71 \text{ V}$

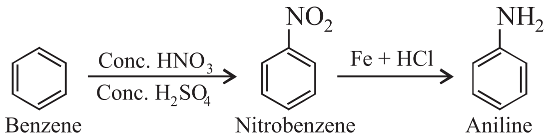
or $\Delta_r G° = 523.03 \text{ kJ mol}^{-1}$

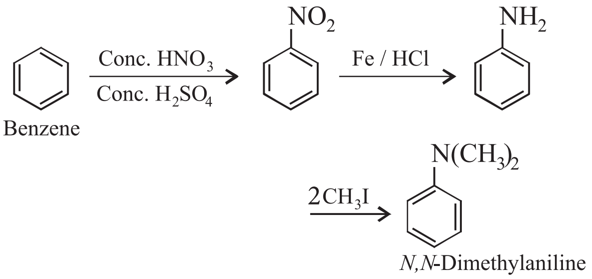
4. (a) After acetylation of aniline, acetanilide is formed in which due to the presence of  $-\overset{\overset{O}{||}}{C}-CH_2$ group having $-I$ effect, electron density on N-atom decreases and hence, activation effect of aniline gets reduced.

(b) CH_3NH_2 is more basic than $C_6H_5NH_2$, because its lone pair of nitrogen is available for donation while in $C_6H_5NH_2$, the lone pair of nitrogen is delocalised in the ring due to resonance and hence not available for donation.

(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.

OR

(a) 

(b) 

(c) $Cl-(CH_2)_4-Cl \xrightarrow[\text{Alcoholic}]{KCN} NC-(CH_2)_4-CN$

$\xrightarrow{LiAlH_4} H_2N-(CH_2)_6-NH_2$

Hexane - 1,6 - diamine

5. (a) The formula of rate constant for first order reaction is

$$k = \frac{2.303}{t} \log \frac{[A]_0}{[A]_t}$$

$$k_1 = \frac{2.303}{300 \text{ s}} \log \frac{(1.6 \times 10^{-2}) \text{ mol L}^{-1}}{(0.8 \times 10^{-2}) \text{ mol L}^{-1}} = 2.3 \times 10^{-3} \text{ s}^{-1}$$

$$\text{Similarly, } k_2 = \frac{2.303}{600 \text{ s}} \log \frac{(1.6 \times 10^{-2}) \text{ mol L}^{-1}}{(0.4 \times 10^{-2}) \text{ mol L}^{-1}}$$

$$= 2.3 \times 10^{-3} \text{ s}^{-1}$$

Unit and magnitude of rate constant shows the given reaction is of first order.

(b) The formula for half-life for first order reaction is

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{2.3 \times 10^{-3} \text{ s}^{-1}} = 301.30 \text{ s}$$

OR

(i) From rate law : Rate = $k[NO]^2$

$\therefore$ Order = 2

Dimension of k :

$$k = \frac{\text{Rate}}{[NO]^2} = \frac{\text{mol L}^{-1}\text{s}^{-1}}{(\text{mol L}^{-1})^2} = \text{L mol}^{-1}\text{s}^{-1}$$

(ii) From rate law : Rate = $k[H_2O_2][I^-]$

$\therefore$ Order = 1 + 1 = 2

Dimension of k :

$$k = \frac{\text{Rate}}{[H_2O_2][I^-]} = \frac{\text{mol L}^{-1}\text{s}^{-1}}{(\text{mol L}^{-1})^2} = \text{L mol}^{-1}\text{s}^{-1}$$

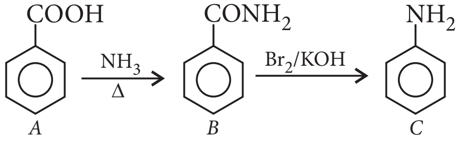
(iii) From rate law : Rate = $k[CH_3CHO]^{3/2}$

$\therefore$ Order = $\frac{3}{2}$

Dimension of k :

$$k = \frac{\text{Rate}}{[CH_3CHO]^{3/2}} = \frac{\text{mol L}^{-1}\text{ s}^{-1}}{(\text{mol L}^{-1})^{\frac{3}{2}}} = \text{L}^{1/2}\text{mol}^{-1/2}\text{ s}^{-1}$$

6. Formula of the compound '*C*' indicates it is 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. As '*B*' is obtained from compound '*A*' by reaction with ammonia followed by heating so, compound '*A*' could be an aromatic acid. Formula of compound '*C*' shows it to be aniline, then '*B*' is benzamide and compound '*A*' is benzoic acid. The sequence of reactions can be written as follows :



7. (a) Path of light becomes visible and colloidal particles scatter the light (Tyndall effect).

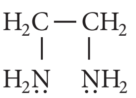
(b) mmoles of HCl required for 1 L = 30

mmoles of H_2SO_4 required for 1 L = 15

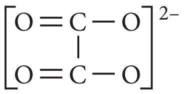
mmoles of H_2SO_4 in 250 mL = 15/4

$\therefore$ Weight of $H_2SO_4 = \frac{15}{4} \times 10^{-3} \times 98 = 0.367 \text{ g} \approx 0.37 \text{ g}$

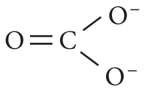
8. (a) Ligands which can coordinate with the central metal atom or ion through two donor atoms are known as bidentate ligands. Examples of bidentate ligands are:



Ethylene diamine (*en*)

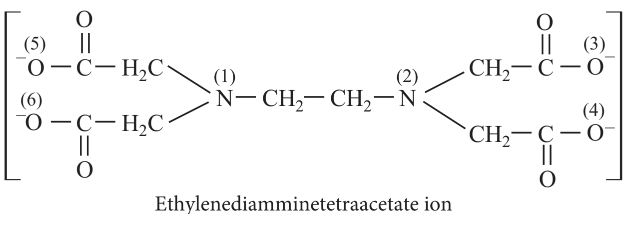


Oxalate anion



Carbonate ion

(b) Ligands which coordinate with the central ion through more than two donor atoms present in the molecule are called polydentate ligands. These are called tridentate (three), tetradentate (four), pentadentate (five) and hexadentate (six) ligands depending upon the number of coordinating donor atoms present in their molecules. A common example of hexadentate ligand is ethylenediamminetetraacetate ion as shown below:



Ethylenediamminetetraacetate ion

(c) The charge carried by a complex ion is the algebraic sum of charges carried by the central ion and the ligands coordinated to it. Thus $[Cu(NH_3)_6]^{2+}$ carries a charge of +2 so, Cu^{2+} carries a charge of +2 and ammonia molecule is neutral. $[Ag(CN)_2]^-$, ion carries a charge of –1 because Ag^+ carries a charge of +1 and two cyanide ions coordinated to it carry a charge of –1 each.

9. The reciprocal of resistivity is known as specific conductance or simply conductivity. It is denoted by κ (kappa).

$$\rho = \frac{1}{\kappa} \quad \text{or} \quad \kappa = G \times \frac{l}{a}$$

Hence, conductivity of a solution is defined as the conductance of a conductor of 1 cm length and having 1 cm^2 as the area of cross section. Alternatively, it may be defined as conductance of one centimetre cube of the solution of the electrolyte. Molar conductivity of a solution at a dilution V is the conductance of all the ions produced from 1 mole of the electrolyte dissolved in V cm^3 of the solution. It is represented by Λ_m.

$$\Lambda_m = \kappa V$$

Variation of conductivity and molar conductivity with concentration : Conductivity always decreases with decrease in concentration, for both weak and strong electrolytes. This is because the number of ions per unit volume that carry the current in a solution decreases on dilution.

Molar conductivity increases with decrease in concentration. This is because that total volume, V, of solution containing one mole of electrolyte also increases. It has been found that decrease in κ on dilution of a solution is more than compensated by increase in its volume.

OR

$$\Lambda^o_m(\text{HCOOH}) = \lambda^o(H^+) + \lambda^o(HCOO^-)$$
$$= 349.6 + 54.6 = 404.2 \text{ S cm}^2 \text{ mol}^{-1}$$

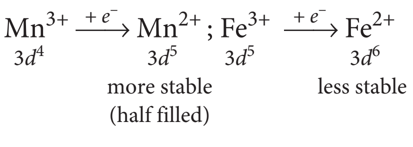
$$\alpha = \frac{\lambda_m}{\lambda^o_m} = \frac{46.1}{404.2} = 0.114 \Rightarrow \alpha = 11.4\%$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{0.025 \times (0.114)^2}{1 - 0.114}$$

$$= \frac{0.025 \times 0.114 \times 0.114}{0.886} = 3.67 \times 10^{-4}$$

10. (a) From the relation, $\Delta G° = -nFE°$

More positive is the value of $E°$, reaction will be feasible.



$$\underset{3d^4}{Mn^{3+}} \xrightarrow{+e^-} \underset{\substack{3d^5\\ \text{more stable}\\ \text{(half filled)}}}{Mn^{2+}}\ ;\ \underset{3d^5}{Fe^{3+}} \xrightarrow{+e^-} \underset{\substack{3d^6\\ \text{less stable}}}{Fe^{2+}}$$

Hence, E°_{value} for Mn^{3+}/Mn^{2+} couple is much more positive than that for Fe^{3+}/Fe^{2+}.

(b) Greater the number of unpaired electrons, stronger is the metallic bond and therefore, higher is the enthalpy of atomisation. Since, iron has greater number of unpaired electrons than copper hence has higher enthalpy of atomisation.

(c) Only those ions are coloured which have partially filled *d*-orbitals facilitating *d*-*d* transitions. Sc^{3+} does not have unpaired electron but Ti^{3+} has one unpaired electron and hence, Ti^{3+} is coloured.

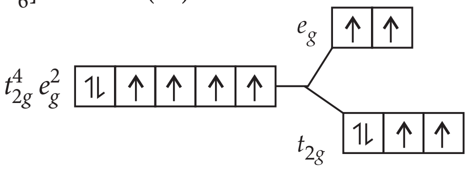
11. (a) Pentaamminechloridocobalt(III) chloride

(b) Potassium hexacyanoferrate(III)

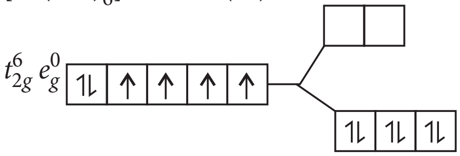
(c) Tetrachloridonickelate(II) ion

OR

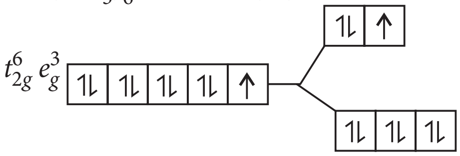
$[CoF_6]^{3-}$: Co^{3+} (d^6)



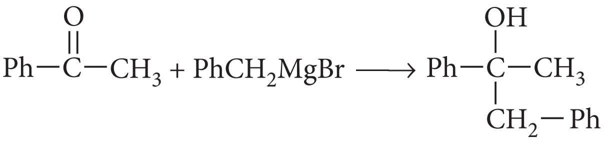
$[Fe(CN)_6]^{4-}$: Fe^{2+} (d^6)



$[Cu(NH_3)_6]^{2+}$: Cu^{2+} (d^9)

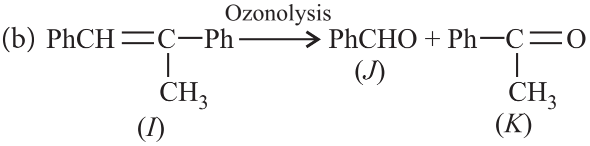


12. (a)



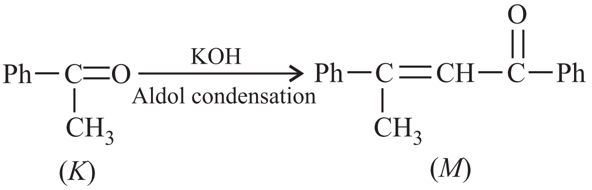
$$Ph-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 + PhCH_2MgBr \longrightarrow Ph-\underset{\underset{\displaystyle CH_2-Ph}{|}}{\overset{\overset{\displaystyle OH}{|}}{C}}-CH_3$$

(b)



$$\underset{(I)}{PhCH=\underset{\underset{\displaystyle CH_3}{|}}{C}-Ph} \xrightarrow{\text{Ozonolysis}} \underset{(J)}{PhCHO} + \underset{(K)}{Ph-\underset{\underset{\displaystyle CH_3}{|}}{C}=O}$$

$$\underset{(J)}{Ph-CHO} \xrightarrow[\text{Cannizzaro reaction}]{KOH} Ph-CH_2-OH + \underset{(L)}{Ph-COO^- K^+}$$

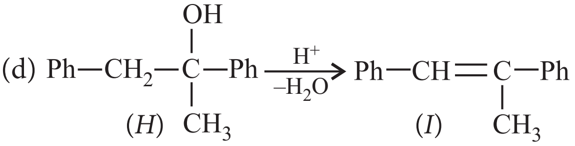


$$\underset{(K)}{Ph-\underset{\underset{\displaystyle CH_3}{|}}{C}=O} \xrightarrow[\text{Aldol condensation}]{KOH} \underset{(M)}{Ph-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH-\overset{\overset{\displaystyle O}{\|}}{C}-Ph}$$

(c) $\underset{\text{Benzaldehyde}}{C_6H_5CHO} + \underset{\text{Acetic anhydride}}{(CH_3CO)_2O} \xrightarrow[-CH_3COOH]{CH_3COONa}$

$$\underset{\text{Cinnamic acid}}{C_6H_5-CH=CH-COOH}$$

(d)



$$\underset{(H)}{Ph-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{\overset{\overset{\displaystyle OH}{|}}{C}}-Ph} \xrightarrow[-H_2O]{H^+} \underset{(I)}{Ph-CH=\underset{\underset{\displaystyle CH_3}{|}}{C}-Ph}$$

OR

Triiodomethane and sodium benzoate.