ISC SEMESTER 2 EXAMINATION
SPECIMEN QUESTION PAPER
CHEMISTRY PAPER 1 (THEORY)

Maximum Marks: 35

Time allowed: One and a half hour

*Candidates are allowed an additional **10 minutes** for **only** reading the paper.*

*They must **NOT** start writing during this time.*

All questions are compulsory

The intended marks for questions or parts of questions are given in brackets. [ ]

All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.

Balanced equations must be given wherever possible and diagrams where they are helpful.

When solving numerical problems, all essential working must be shown.

In working out problems, use the following data:

Gas constant R = 1·987 cal deg^{-1} mol^{-1} = 8·314 JK^{-1} mol^{-1} = 0·0821 dm^3 atm K^{-1}mol^{-1}

1 l atm = 1 dm^3 atm = 101·3 J. 1 Faraday = 96500 coulombs.

Avogadro's number = 6·023 ·10^{23}.

SECTION A – 7 MARKS

Question 1

Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:

(two, four, sec^{-1}, diamagnetic, acetaldehyde, mol^{-1}L sec^{-1}, paramagnetic, formaldehyde, acetone, ethanol)

(i) When the concentration of a reactant of first order reaction is doubled, the rate of reaction becomes _____ times. The unit of rate constant (k) for the first order reaction is _____. **[1]**

(ii) The transition metals show _____ character because of the presence of unpaired electrons while Cu^+ is _____ because its electronic configuration is [Ar]3d^{10}. **[1]**

(iii) Calcium formate on distillation gives _____ but the distillation of calcium formate and calcium acetate gives _____. **[1]**

Question 2

Select and write the correct alternative from the choices given below.

(i) The type of hybridization involved in Octahedral complexes is: **[1]**

(a) sp^3

(b) dsp^2

(c) sp^3d

(d) d^2sp^3

(ii) One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde having a molecular mass of 44 amu. The alkene is: **[1]**

(a) ethene

(b) propene

(c) 1-butene

(d) 2-butene

(iii) Primary amine when warmed with chloroform and alc. KOH yields: **[1]**

(a) cyanides

(b) isocyanides

(c) benzene diazonium chloride

(d) secondary amines

(iv) **Assertion**: The conversion of fresh precipitate to colloidal state is called peptization. **[1]**

Reason: It is caused by addition of common ions.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.

(b) Both assertion and reason are true but reason is not the correct explanation for assertion.

(c) Assertion is true but reason is false.

(d) Assertion is false but reason is true.

SECTION B – 16 MARKS

Question 3 **[2]**

Name the type of isomerism shown by each of the following pairs of compounds:

(i) $[CoCl_2(NH_3)_4]Cl.H_2O$ and $[CoCl(H_2O)(NH_3)_4]Cl_2$

(ii) $[Cr(NH_3)_5Br]SO_4$ and $[Cr(NH_3)_5SO_4]Br$

Question 4 **[2]**

(i) Write chemical equations to illustrate each of the following name reactions:

(a) Rosenmund's reduction

(b) Clemmensen's reduction

OR

(ii) How will you bring about the following conversions? (Give equation).

(a) Acetic acid to acetone

(b) Formaldehyde to urotropine

Question 5 **[2]**

What is a *zwitter ion*? Represent the zwitter ion of glycine.

Question 6 **[2]**

(i) Arrange the following in the increasing order of their basic strength: $C_2H_5NH_2$, $C_6H_5NH_2$, $(C_2H_5)_2NH$.

(ii) What are the products formed when benzene diazonium chloride reacts with phenol in weak alkaline medium? (Give equation).

Question 7 **[2]**

Give reasons for the following:

(i) Diabetic patients are advised to take artificial sweeteners instead of natural sweeteners.

(ii) The use of aspartame is limited to cold foods and drinks.

Question 8 **[2]**

The rate of reaction becomes four times when the temperature changes from 293K to 313K. Calculate the energy of activation (E_a) of the reaction assuming that it does not change with temperature. ($R = 8{\cdot}314\ JK^{-1}mol^{-1}$)

Question 9 **[2]**

Give balanced equation for each of the following:

(i) Ethylamine and nitrous acid

(ii) Aniline and acetyl chloride

Question 10 **[2]**

Give one chemical test for each to distinguish between the following pairs of compound:

(i) Acetaldehyde and benzaldehyde

(ii) Acetone and acetic acid

SECTION C – 12 MARKS

Question 11 **[3]**

(i) **Answer the following:**

(a) Define molecularity of a reaction. Give one difference between the order of reaction and its molecularity.

(b) The rate constant (k) of a first order reaction is $4{\cdot}5 \times 10^{-2}\ sec^{-1}$. What will be the time required for the initial concentration of 0·4 M of the reactant to be reduced to 0·2 M?

OR

(ii) **Answer the following:**

(a) For a first order reaction, show that the time required for the completion of 99% reaction is twice the time required for the completion of 90% of the reaction.

(b) For a reaction, rate = $k[A]^1[B]^{1.5}[C]^0$. What is the overall order of reaction?

Question 12 **[3]**

(i) What is the basic difference between the *electronic configuration of transition and inner transition elements*?

(ii) Why are Zn^{2+} ions colourless while Ni^{2+} ions are green in colour?

Question 13 **[3]**

(i) Write the formula of each of the following compounds:

(a) Potassium trioxalatoaluminate (III)

(b) Triammine triaquachromium (III) chloride

(ii) For the complex ion $[Co(NH_3)_6]^{3+}$, state the oxidation state of central metal atom and the coordination number of the complex ion.

Question 14 **[3]**

Give reason for each of the following:

(i) For ferric hydroxide sol. the coagulating power of phosphate ion is more than chloride ion.

(ii) Lyophilic colloidal solutions are more stable than lyophobic colloidal solutions.

(iii) Gelatin is added to ice cream.

Answers

Section-A

Answer 1.

(i) two, sec^{-1}

Explanation :

For I^{st} order reaction $\quad Rate = k[A]$

$$\text{Initial Rate } (R_1) = k[A]$$

$$\text{Final Rate } (R_2) = k[2A] = 2k[A]$$

$$= 2k_1$$

For Ist order reaction when concentration of reactant is doubled, rate becomes **two** times.

$$\text{Unit of rate constant } k = M^{(1-n)}\ sec^{-1}$$

$$M = \text{mole lit}^{-1}$$

For I^{st} order $n = 1$

$\therefore \quad k = sec^{-1}$.

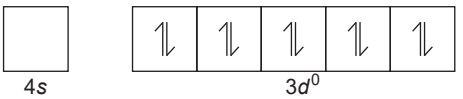
(ii) Paramagnetic, diamagnetic

Explanation :

Atoms with unpaired electron are paramagnetic while atoms with paired electron are diamagnetic.

Most of the transition metal ions have unpaired electrons in their'd' orbitals. Hence, most of the transition metal ions are paramagnetic in nature. Ex. Ti^{+2} $[Ar]3d^2$, Ti^{+3} $[Ar]3d^1$. $V^{+2}[Ar]^3d^3$, $Cr^{+3}[Ar]^3d^3$. On the other hand, Cu^+ has stable $3d^{10}$ electronic configuration, therefore, it is diamagnetic.

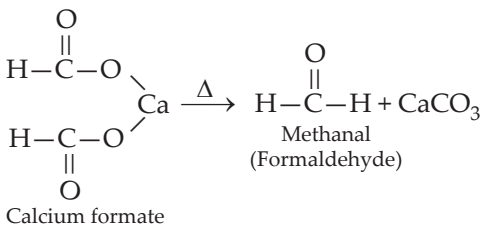
$Cu^+ = [Ar]\ 3d^{10}\ 4s^0$

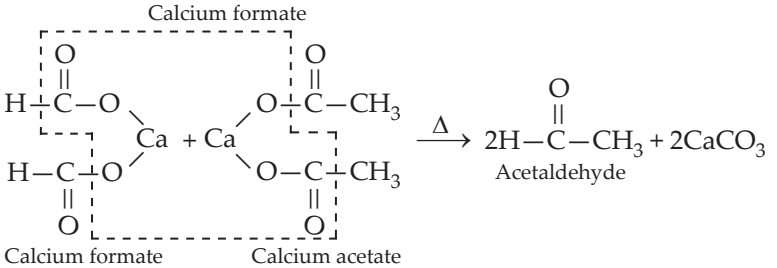


Thus, no unpaired electron is present in Cu^+. Therefore, Cu^+ is diamagnetic.

(iii) Formaldehyde, acetaldehyde

Explanation :





Answer 2.

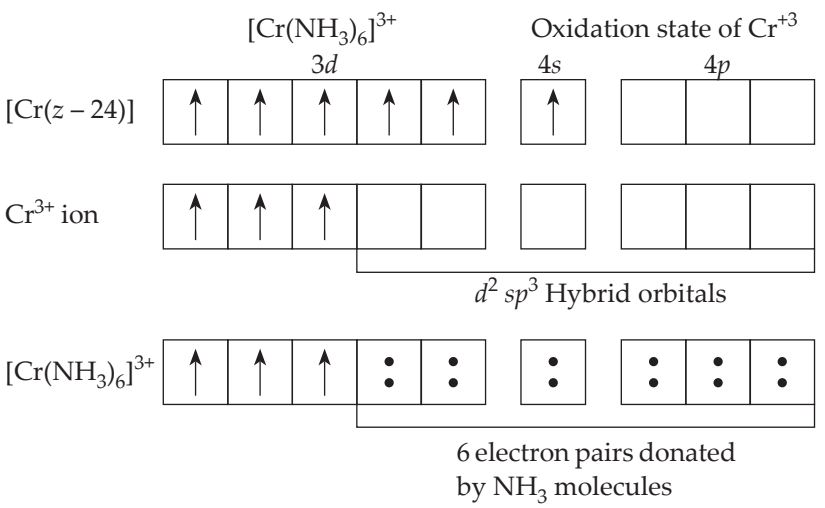
(i) (d) d^2sp^3

Explanation :

The hybridisation in octahedral complexes are d^2sp^3 or sp^3d^2.

All the complex ions having a coordination number of central metal atom as six show octahedral geometry. This octahedral geometry arises due to d^2sp^3 or sp^3d^2 hybridisation of the central metal atom or ion. The type of hybridisation (i.e. d^2sp^3 or sp^3d^2) depends on the number of unpaired or paired electrons present in the complex ion.

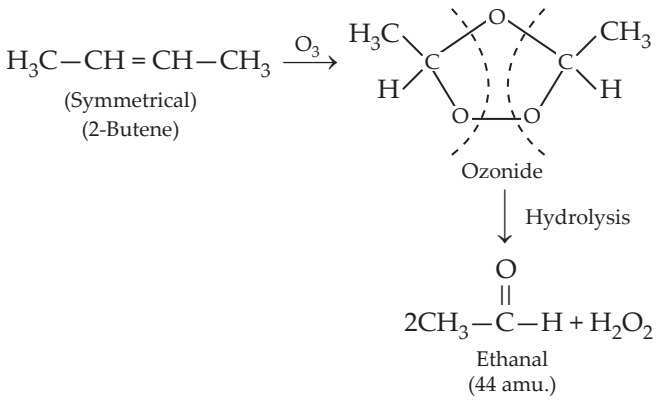
Octahedral complexes in which the central atom is d^2sp^3 are called inner -orbital octahedral complexes while octahedral complexes in which the central atom is sp^3d^2 are called outer-orbital octahedral complexes.



(ii) (d) 2-Butene

Explanation :

One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde having a molecular mass of 44 g/mol. The alkene is 2-butene. Both the cis and trans form of 2-Butene on ozonolysis give 2 moles of ethanal or acetaldehyde with the molecular mass of 44 g/mol. In this process of ozonolysis, ozone reacts with alkenes to break the double bond and forms two carbonyl groups.



(iii) (b) Isocyanides

Explanation :

Primary amines when treated with chloroform and ethanolic (alc.) KOH gives carbylamines or isocyanides.

$$\underset{1^\circ \text{ amine}}{RNH_2} \xrightarrow[\text{KOH, }\Delta\text{ (alc.)}]{CHCl_3} \underset{\text{Isocyanide}}{R-NC} + 3KCl + 3H_2O$$

(iv) (b) Both assertion and reason are true but reason is not the correct explanation for assertion.

Explanation :

The conversion of freshly precipitated substance into colloidal solution by shaking with the suitable electrolyte is called peptisation. Thus, it is clear that peptisation is caused by addition of suitable electrolyte of specific ions, not by any common ions. Thus, both assertion and reason are correct but reason is not the correct explanation for assertion.

Section-B

Answer 3.

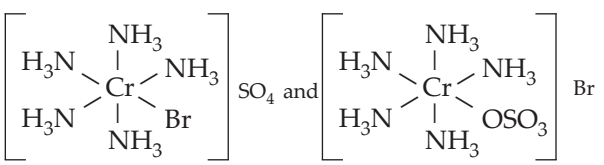
(i) The given pair of compounds shows hydrate isomerism

Hydrate isomerism : Isomers which have same composition but differ with reference to the number of solvent, ligand molecules as well as counter ion in the crystal lattice.

$[CoCl_2(NH_3)_4]Cl.H_2O$ and $[CoCl(H_2O)(NH_3)_4]Cl_2$

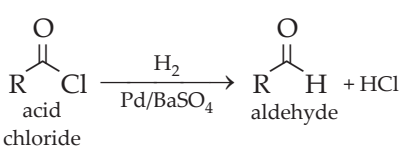
(ii) Ionisation isomerism

Ionisation isomerism : Compounds which give different ions in solution although they have same composition.



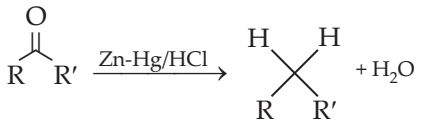
Answer 4.

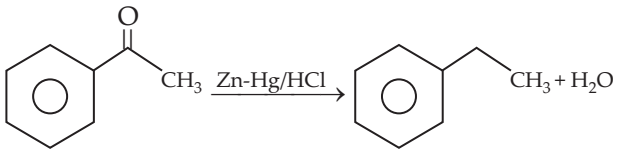
(i) (a) Rosenmund reduction



$$\underset{\substack{\text{Ethanoyl Chloride}\\\text{(Acetyl chloride)}}}{CH_3COCl} + H_2 \xrightarrow[\text{Boiling Xylene}]{Pd/BaSO_4,\ S} \underset{\substack{\text{Ethanal}\\\text{(Acetaldehyde)}}}{CH_3CHO} + HCl$$

(b) Clemenson's reduction

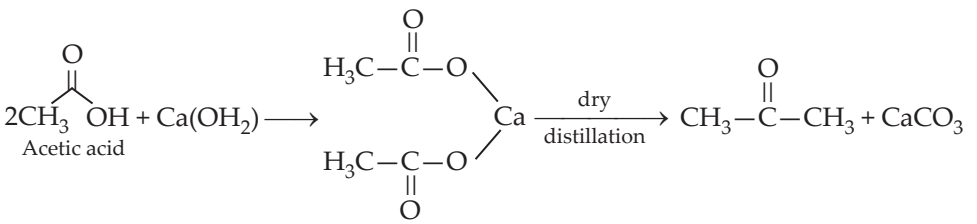




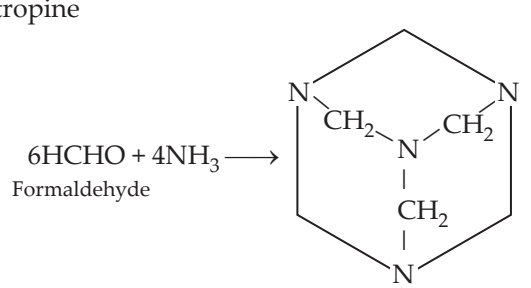
Acetophenone Ethyl benzene

OR

(ii) (a) Acetic acid to acetone



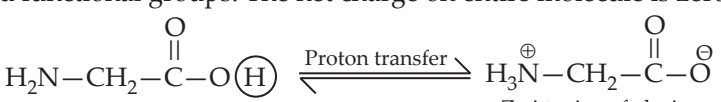
(b) Formaldehyde to urotropine



Urotropine
(Hexamethylenetetramine)

Answer 5.

A Zwitter ion (also known as dipolar ions) is a molecule that contains an equal number of positively and negatively charged functional groups. The net charge on entire molecule is zero.

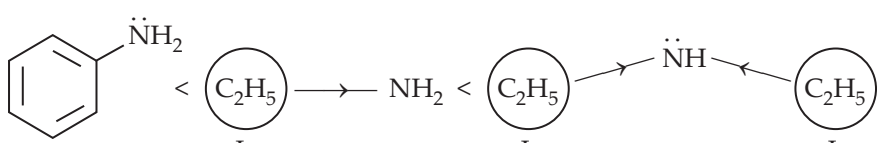


Glycine Zwitter ion of glycine

Answer 6.

(i) Increasing order of Basic strength

$$C_6H_5-NH_2 < C_2H_5-NH_2 < (C_2H_5)_2NH$$

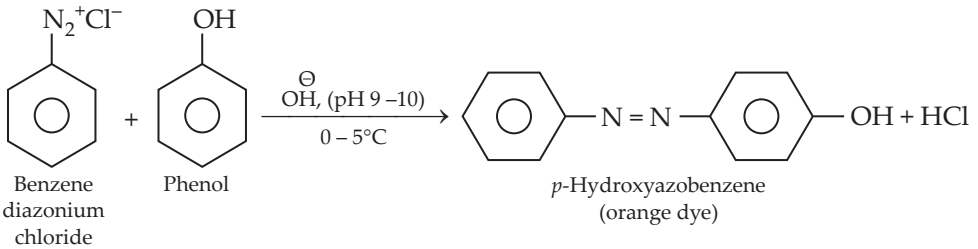


Here lone pair of N is involved in conjugation.
∴ Lone pair is not free for donation.
Thus Least Basic.

+I effect of C_2H_5 increase the electron density on N.
∴ Easy to donate lone pair of N.

Two + I effect exerting groups present.
∴ High electron density on N.
Thus Most basic.

(ii) Benzene diazonium chloride on reaction with phenol in weakly basic medium gives p-Hydroxyazobenzene which is an orange dye. The reaction can be represented as follows:



Answer 7.

(i) Diabetic patients do not produce enough insulin to metabolise the natural sugar. As a result, the blood sugar level increases which affects liver, kidney and heart. Therefore, diabetic patients are advised to take artificial sweetners, because they reduce both calorie and carbohydrate intake and keeps the blood sugar level stable.

(ii) Aspartame is unstable to heat. At high temperature, it break down and looses sweetness. Due to this reason, the use of aspartame is limited to cold foods and drinks.

Answer 8.

According to Arrhenius equation:

$$\text{Rate constant } (k) = Ae^{-E_a/RT} \qquad \ldots(1)$$

$$\log \frac{k_2}{k_1} = \frac{E_a}{2{\cdot}303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad \ldots(2)$$

where

k_1 = rate constant at temperature T_1

k_2 = rate constant at temperature T_2

E_a = Activation energy

R = Gas constant

$= 8{\cdot}314\ JK^{-1}\ mol^{-1}$

Given that,

$k_2 = 4k_1$

$T_1 = 293\ K$

$T_2 = 313\ K$

Putting the values in equation (2),

$$\log \frac{4k_1}{k_1} = \frac{E_a}{2{\cdot}303 \times 8{\cdot}314}\left(\frac{1}{293} - \frac{1}{313}\right) \qquad (\because \log 4 = 0{\cdot}6021)$$

$$\log 4 = \frac{E_a}{2{\cdot}303 \times 8{\cdot}314}\left(\frac{313 - 293}{293 \times 313}\right)$$

$$E_a = 0{\cdot}6021 \times 2{\cdot}303 \times 8{\cdot}314 \times \left(\frac{293 \times 313}{20}\right)$$

$$= 52{,}863\ J\ mol^{-1}$$

Energy of activation for the reaction will be:

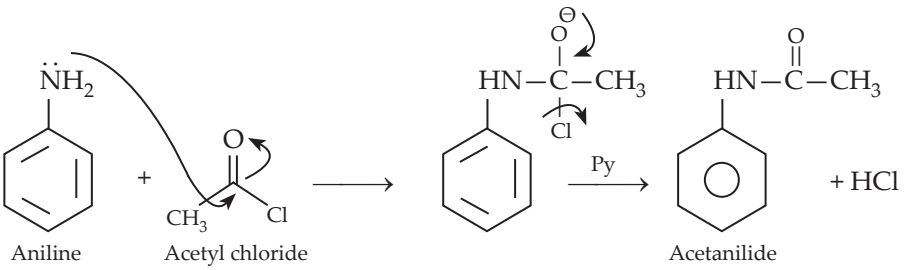
$$E_a = 52{\cdot}863\ KJ\ mol^{-1}.$$

Answer 9.

(i) $CH_3CH_2{-}NH_2 + HNO_2 \longrightarrow CH_3CH_2{-}OH + N_2\,(g) + H_2O$

Ethylamine Nitrous acid (Ethanol)

(ii)



Answer 10.

(i) Acetaldehyde and benzaldehyde

Acetaldehyde gives red precipitate with Fehling's solution but benzaldehyde does not.

$$CH_3CHO + \underbrace{2Cu^{2+} + 5OH^-}_{\text{Fehling's solution}} \xrightarrow{\Delta} CH_3COO^- + \underbrace{Cu_2O\downarrow}_{\text{red ppt}} + 3H_2O$$

$$C_6H_5CHO + \underbrace{2Cu^{2+} + 5OH^-}_{\text{Fehling's solution}} \xrightarrow{\Delta} \text{No reaction}$$

(ii) Acetone and Acetic acid

Acetone will not react with sodium carbonate but acetic acid will react with sodium bicarbonate and produces brisk effervescence of CO_2 which will turn lime water milky.

Sodium bicarbonate Test :

$$Ca(OH)_2 + CO_2 \longrightarrow \underbrace{CaCO_3\downarrow}_{\text{White ppt}} + H_2O$$

Lime water

(Insoluble in H_2O)

$$CaCO_3 + CO_2 + H_2O \longrightarrow \underbrace{Ca(HCO_3)_2}_{\text{Calcium bicarbonate (soluble in } H_2O)}$$

Section-C

Answer 11.

(i) (a) The number of reactants such as ions or molecules that take part in the rate-determining step is known as molecularity of the reaction.

Example : $H_2O_2 \longrightarrow H_2O + O_2$

Proposed mechanism $H_2O_2 \longrightarrow H_2O + O$ (slow)

$H_2O_2 + O \longrightarrow H_2O + O_2$ (fast)

Rate $= k[H_2O_2]$

$\therefore$ Unimolecular.

Difference between molecularity and order of the reaction:

Molecularity	Order
1. Total number of reacting species that are involved in elementary step.	It is the sum of powers of concentration terms involved in the experimentally determined rate law.
2. Always a whole number.	Can be zero, fraction or integer.

(b) For first order reaction $k = \frac{2.303}{t} \log \frac{[A_0]}{[A_t]}$ …(1)

where, k = rate constant = 4.5×10^{-2} sec^{-1}

$[A_0]$ = Initial concentration = 0.4 M of reactant

$[A_t]$ = Final concentration = 0.2 M of reactant after time t sec

Putting values in equation 1,

$$t = \frac{2.303}{4.5 \times 10^{-2}} \log \frac{0.4}{0.2}$$

$$t = \frac{2.303}{4.5 \times 10^{-2}} \log 2 \qquad (\because \log 2 = 0.3010)$$

$$t = \frac{2.303}{4.5 \times 10^{-2}} \times 0.3010 = 15.4 \text{ sec}$$

$\therefore$ Time required = 15.4 sec.

OR

(ii) (a) For Ist order reaction $k = \frac{2.303}{t} \log \frac{[A_0]}{[A_t]}$

For 99% completion : If $[A_0] = 100$

$[A_t] = 100 - 99$

$= 1$

$\therefore$ $t_{99\%} = \frac{2.303}{k} \log \frac{100}{1}$

$t_{99\%} = \frac{2.303}{k} \times 2$ …(1)

$\because$ $\log 100 = 2$

For 90% completion : If $[A_0] = 100$

$[A_t] = 100 - 90$

$= 10$

$t_{90\%} = \frac{2.303}{k} \log \frac{100}{10}$

$t_{90\%} = \frac{2.303}{k}$ …(2)

$\because$ $\log 10 = 1$

From (1) and (2), $t_{99\%} = 2t_{90\%}$

(b) Rate = $k[A]^1 [B]^{1-5} [C]^0$

Overall order = Sum of power of concentration terms

$= 1 + 1{\cdot}5 + 0 = 2{\cdot}5$

Overall order of the reaction = 2·5

Answer 12.

(i) General electronic configuration of:

Transition elements = $(n-1)d^{1-10}\, ns^{(1-2)}$

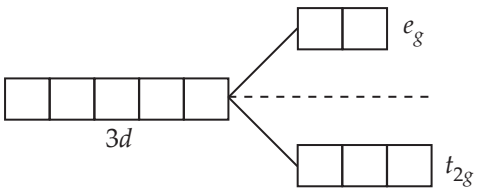
In transition elements last electron enters in *d*-orbitals of penultimate shell.

Inner transition elements = $(n-2)\, f^{(1-14)}\, (n-1)d^{(0-1)}\, ns^{0-2}$

In inner transition elements last electron enters in *f*-orbital of anti-penultimate shell.

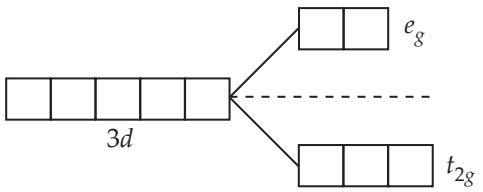
(ii) Zn^{2+} ions are colourless due to the absence of any unpaired electrons in its 3*d*-orbital.
whereas, Ni^{2+} ions are green in colour due to the presence of 2 unpaired electrons *d-d* transitions are possible.

$Zn^{2+} = 3d^{10}\ 4s^0$



No unpaired electron in Zn^{2+}.
$\therefore$ No *d-d* transition, colourless

$Ni^{2+} = 3d^8\ 4s^0$



Unpaired electron present in Ni^{2+}
$\therefore$ *d-d* transition possible and are coloured

Answer 13.

(i) (a) $K_3[Al(C_2O_4)_3]$
(b) $[Cr(NH_3)_3(H_2O)_3]Cl_3$

(ii) $[Co(NH_3)_6]^{3+}$
Let oxidation state of Co = x $\quad NH_3 = 0$
$x + 6(0) = +3$
$x = +3$
Oxidation state of Co = +3
6 NH_3 ligands are attached to central metal Co
$\therefore$ Coordination number = 6

Answer 14.

(i) Ferric hydroxide is a positively charged sol, therefore it will coagulate upon addition of an anion. According to Hardy-Schulze rule, greater the valence of the flocculating ion (charge on ion) added, the greater is its power to cause precipitation or coagulation. Therefore, phosphate ion PO_4^{3-} being trivalent will coagulate the sol more readily than monovalent chloride ion Cl^-.
Negative charge on $PO_4^{3-} > Cl^-$
$\therefore$ Coagulating power of $PO_4^{3-} > Cl^-$

(ii) Lyophilic colloidal solutions are more stable than lyophobic colloidal solutions because lyophilic colloids are extensively solvated, i.e., the colloidal particles are covered by a sheath of the liquid in which they are dispersed. When a lyophilic sol is added to the lyophobic sol, the lyophilic particles form a layer around lyophobic particles and, thus, protect the latter from electrolytes. In lyophillic colloids, disperse phase has high affinity for dispersion medium whereas in lyophobic colloids, disperse phase has low affinity for dispersion medium.

(iii) Gelatin is an emulsifier that is added to ice cream to stabilise the emulsion and give it a soft texture and a fresh look. In the emulsifying action, it also prevents the crystallisation in ice cream by reducing the water content. Hence, the emulsion ice cream is stabilised by adding gelatin to it.

❑❑