

Coordination Compounds

Question1

A ligand which has two different donor atoms and either of the two ligates with the central metal atom/ion in the complex is called

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Options:

- A. Chelate ligand
- B. Unidentate ligand
- C. Polydentate ligand
- D. Ambidentate ligand

Answer: D

Solution:

The correct answer is **Option D: Ambidentate ligand.**

- An ambidentate ligand has two (or more) different donor atoms but binds through only one donor site at a time.
 - Classic examples include SCN^- (thiocyanate, which can bind through S or N) and NO_2^- (nitrite, which can bind through N or O).
-

Question2

Which of the following statements are true about $[\text{NiCl}_4]^{2-}$?



- (a) The complex has tetrahedral geometry
- (b) Co-ordination number of Ni is 2 and oxidation state is +4
- (c) The complex is sp^3 hybridised
- (d) It is a high spin complex
- (e) The complex is paramagnetic

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Options:

- A. a,c,d and e
- B. a,b,d and e
- C. b,c,d and e
- D. a,b,c and d

Answer: A

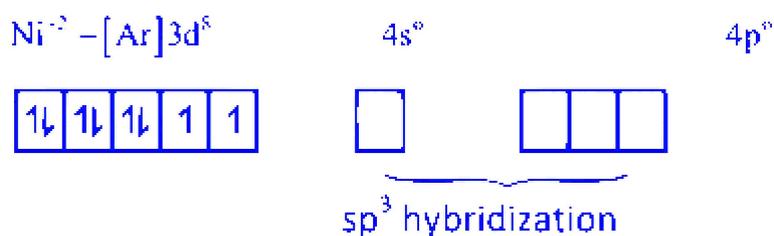
Solution:



O – S of Ni – +2

Coordination no. of Ni^{+2} – 4

Cl^- is weak field ligand, pairing does not take place



$[\text{NiCl}_4]^{-2}$ is paramagnetic



Question3

Which formula and its name combination is incorrect?

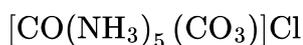
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Options:

- A. $K_3 [Cr(C_2O_4)_3]$, Potassium trioxalatochromate (III)
- B. $[CoCl_2(en)_2]Cl$, Dichloridobis (ethane - 1,2 - dimine) cobalt (III) chloride
- C. $[Co(NH_3)_5 (CO_3)]Cl$, Pentaamine carbonylcobalt (III) chloride
- D. $[Pt(NH_3)_2Cl (NO_2)]$ Diamine chloridonitrito - N - Platinum (II)

Answer: C

Solution:



Penta ammine carbonate cobalt (III) chloride.

Question4

In the complex ion $[Fe(C_2O_4)_3]^{3-}$, the co-ordination number of Fe is

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Options:

- A. 4
- B. 5
- C. 6
- D. 3

Answer: C

Solution:

The oxalate ion ($\text{C}_2\text{O}_4^{2-}$) is a bidentate ligand, meaning it donates two oxygen atoms to the central metal. In $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$:

Number of oxalate ligands = 3

Donor atoms per oxalate = 2

Thus, the coordination number of Fe is

$$3 \times 2 = 6.$$

Answer: 6 (Option C)

Question5

On treating 100 mL of 0.1 M aqueous solution of the complex $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ with excess of AgNO_3 , 2.86 g of AgCl was obtained. The complex is

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Options:

- A. $[\text{Cr}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot 3\text{H}_2\text{O}$
- B. $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}$
- C. $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}^2\text{Cl}_2] \cdot \text{H}_2\text{O}$
- D. $[\text{Cr}(\text{H}_2\text{O})_6\text{Cl}_3]$

Answer: C

Solution:

Given, Molarity of the complex = 0.1M

Volume of the complex = 100 mL

Mass of AgCl obtained = 2.86 g



Now, no. of moles in $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$

$$= \frac{\text{molarity} \times \text{volume}}{1000} = \frac{0.1 \times 100}{1000} = 0.01 \text{ moles}$$

$$\text{No. of moles of AgCl} = \frac{2.86}{143} = 0.02 \text{ moles}$$

Number of Cl^- ions present in the ionisation sphere

$$= \frac{\text{Moles of ions precipitated with excess AgNO}_3}{\text{Moles of complex}}$$
$$= \frac{0.02}{0.01} = 2$$

It means two chlorine ions must be present in the solution. So, the complex will be



Question 6

The complex compounds $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ and $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ are

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Options:

- A. coordination isomers
- B. geometrical isomers
- C. optical isomers
- D. ionisation isomers

Answer: D

Solution:

The complex $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$ and $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ are ionisation isomers of each other.

- This form of isomerism arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand which can then become the counter ion.
-



Question7

Which of the following statements are true about $[\text{CoF}_6]^{3-}$ ion ?

- I. The complex has octahedral geometry.
- II. Coordination number of Co is 3 and oxidation state is +6 .
- III. The complex is sp^3d^2 hybridised.
- IV. It is a high spin complex.

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Options:

- A. I, II and IV
- B. I, III and IV
- C. II and IV
- D. II, III and IV

Answer: B

Solution:

Statements given in I, III and IV are true regarding $[\text{CoF}_6]^{3-}$ ion while II is false. The correct form of statement II is coordination number of Co is 6 and its oxidation state is +3 .

Question8

If a didentate ligand ethane-1, 2-diamine is progressively added in the molar ratio en : Ni :: 1 : 1, 2 : 1, 3 : 1 to $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ aq solution, following co-ordination entities are formed.

- I. $[\text{Ni}(\text{H}_2\text{O})_4\text{en}]^{2+}$ (aq) - pale blue



II. $[\text{Ni}(\text{H}_2\text{O})_2(\text{en})_2]^{2+}(\text{aq})$ - blue/purple

III. $[\text{Ni}(\text{en})_3]^{2+}(\text{aq})$ - violet

The wavelength in nm of light absorbed in case of I and III are respectively

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Options:

A. 475 nm and 310 nm

B. 300 nm and 475 nm

C. 310 nm and 500 nm

D. 600 nm and 535 nm

Answer: D

Solution:

Given that, compound I shows pale blue colour. It means that, absorbed colour is orange whereas compound III shows violet colour then the absorbed colour is yellow. The wavelength of light absorbed by I and III are nearly 600 nm and 535 nm respectively.

Question9

Which of the following is an organometallic compound

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Options:

A. CH_3COONa

B. $\text{CH}_3\text{CH}_2\text{MgBr}$





Answer: B

Solution:

$\text{CH}_3\text{CH}_2\text{MgBr}$ is considered as an organometallic compound because it contains a direct bond between a carbon atom and a metal atom (magnesium). Organometallic compounds contains at least one carbon-metal bond.

They can participate in variety of reactions and often used as reagents or catalysts in organic synthesis.

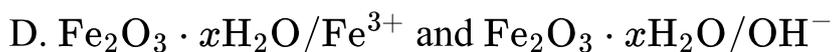
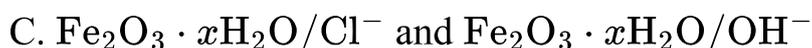
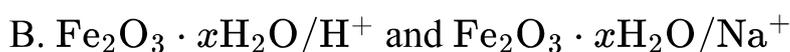
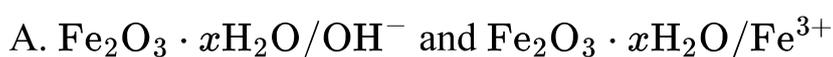
Question10

When FeCl_3 is added to excess of hot water gives a sol 'X'. When FeCl_3 is added to $\text{NaOH}(\text{aq})$ solution, gives sol 'Y'

X and Y formed in the above processes respectively are

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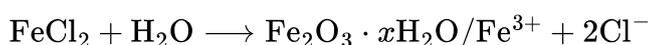
Options:



Answer: D

Solution:

When FeCl_3 is added to an excess of hot water, it hydrolyses to form a sol 'X' containing $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ and Fe^{3+} ions.



When FeCl_3 is added to $\text{NaOH}(\text{aq})$ solution, a precipitation reaction occurs. The Fe^{3+} ions from FeCl_3 react with OH^- ions from NaOH to form brown precipitate of $\text{Fe}(\text{OH})_3$. This brown precipitate forms a sol 'Y' containing $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ and OH^- ions.



Question11

Which formula and name combination is incorrect?

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Options:

- A. $\text{K}_3 [\text{Al}(\text{C}_2\text{O}_4)_3]$ - Potassium trioxalatoaluminate (III)
- B. $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{NO}_2)]$ - Diamminechloridonitrito - N-platinum (II)
- C. $[\text{CoCl}_2(\text{en})_2]\text{Cl}$ - Dichloridodiethylenediammine cobalt (II) chloride
- D. $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$ - Tetraammineaquachloridocobalt (III) chloride

Answer: C

Solution:

Formula and name combination given in option (c) is incorrect. Its correct form is as follows.

$[\text{CoCl}_2(\text{en})_2]\text{Cl}$ - Dichloridebis(ethylene diamine)- cobalt (III) chloride.

Question12

Which of the following system in an octahedral complex has maximum unpaired electrons?

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Options:

A. d^9 (high spin)

B. d^6 (low spin)

C. d^4 (low spin)

D. d^7 (high spin)

Answer: D

Solution:

	t_{2g}	e_g	Unpaired electrons
d^4 (low spin)	$\uparrow\downarrow \uparrow \uparrow$	$\square \square$	2
d^7 (high spin)	$\uparrow\downarrow \uparrow \uparrow$	$\uparrow \uparrow \uparrow$	3
d^9 (high spin)	$\uparrow\downarrow \uparrow \uparrow$	$\uparrow\downarrow \uparrow$	1
d^6 (low spin)	$\uparrow\downarrow \uparrow \uparrow$	$\square \square$	0

$\therefore d^7$ (high spin) system has maximum unpaired electrons.

Question13

The correct IUPAC name of cis-platin is

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Options:

A. diamminedichloridoplatinum (IV)

B. diamminedichloridoplatinum (0)

C. dichloridodiammineplatinum (IV)

D. diamminedichloridoplatinum (II)

Answer: D

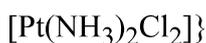
Solution:

The correct IUPAC name for cis-platin, a chemotherapy drug used to treat various types of cancers, is Option D: diamminedichloridoplatinum (II).

The reason for this naming is based on IUPAC rules for naming coordination complexes, which are as follows:

- First, the ligands are named in alphabetical order, regardless of charge or the number of each type of ligand present.
- The prefix "diammine" indicates the presence of two ammine (NH₃) ligands.
- The prefix "dichlorido" indicates the presence of two chlorido (Cl⁻) ligands.
- Following the ligands, the metal atom is named, which in this case is platinum. The oxidation state of the metal is indicated by Roman numerals in parentheses immediately following the metal's name.

In cis-platin, the platinum has an oxidation state of +2. We know this because there are two ammonia molecules and two chloride ions as ligands, each contributing either to the neutrality or the charge balance of the complex:



Solving for platinum's oxidation state:

Let x be the oxidation state of platinum. The ammonia ligands do not have a charge, but each chloride ion has a charge of -1. Therefore, we have:

$$x + 2(\text{charge of NH}_3) + 2(-1) = 0$$

$$x + 0 - 2 = 0$$

$$x = 2$$

Thus, Option D, diamminedichloridoplatinum (II), is the correct IUPAC name, where (II) reflects the +2 oxidation state of the platinum in the complex.

Question14

**Crystal field splitting energy (CFSE) for $[\text{CoCl}_6]^{4-}$ is 18000 cm^{-1} .
The crystal field splitting energy (CFSE) for $[\text{CoCl}_4]^{2-}$ will be**

KCET 2022

Options:

A. 16000 cm^{-1}

B. 8000 cm^{-1}

C. 10000 cm^{-1}



D. 18000 cm^{-1}

Answer: B

Solution:

$[\text{CoCl}_6]^{4-}$ is an octahedral complex, its CFSE value, $\Delta_0 = 18000 \text{ cm}^{-1}$

$[\text{CoCl}_4]^{2-}$ is a tetrahedral complex, $\Delta_t = ?$

We know that,

$$\Delta_t = \frac{4}{9} \Delta_0 = \frac{4}{9} \times 18000 = 8000 \text{ cm}^{-1}$$

Question15

The complex hexamineplatinum(IV)chloride will give _____ number of ions on ionisation.

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Options:

A. 4

B. 3

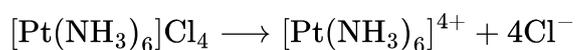
C. 2

D. 5

Answer: D

Solution:

The formula of hexamineplatinum (IV) chloride is $[\text{Pt}(\text{NH}_3)_6]\text{Cl}_4$.



Thus, five ions are produced.

Question16

For the crystal field splitting in octahedral complexes,

KCET 2021

Options:

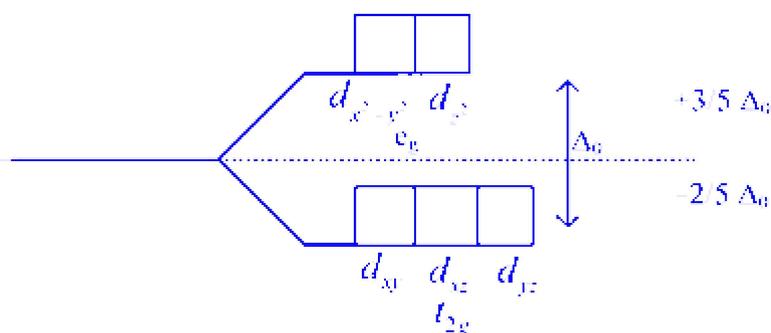
- A. the energy of the e_g orbitals will decrease by $(3/5)\Delta_o$ and that of the t_{2g} will increase by $(2/5)\Delta_o$
- B. the energy of the e_g orbitals will increase by $(3/5)\Delta_o$ and that of the t_{2g} will decrease by $(2/5)\Delta_o$
- C. the energy of the e_g orbitals will increase by $(3/5)\Delta_o$ and that of the t_{2g} will increase by $(2/5)\Delta_o$
- D. the energy of the e_g orbitals will decrease by $(3/5)\Delta_o$ and that of the t_{2g} will decrease by $(2/5)\Delta_o$

Answer: B

Solution:

For crystal field splitting in octahedral complexes, the energy of e_g orbitals will increase by $(\frac{3}{5})\Delta_o$ and that of t_{2g} will decrease by $(\frac{2}{5})\Delta_o$.

The splitting of degenerate d -orbital is as follows.



Question17

The IUPAC name of $[\text{Co}(\text{NH}_3)_5(\text{CO}_3)]\text{Cl}$ is



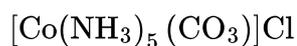
KCET 2021

Options:

- A. pentaamminecarbonatocobalt (III) chloride
- B. carbonatopentamminecobalt (III) chloride
- C. pentaamminecarbonatocobaltate (III) chloride
- D. pentaammine cobalt (III) carbonate chloride

Answer: A

Solution:



Oxidation state of Co(x) can be calculated

$$x + 0 + 0 - 3 = 0$$

$$\therefore x = 3$$

\therefore The IUPAC name is pentaamminecarbonatocobalt(III)chloride.

Question18

Homoleptic complexes among the following are



KCET 2021

Options:

- A. A only



B. A and B only

C. A and C only

D. C only

Answer: C

Solution:

In homoleptic complex, all the bounded ligands are identicals

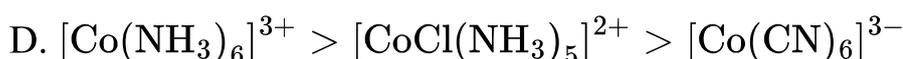
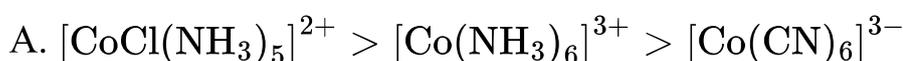
$\therefore K_3 [Al(C_2O_4)_3]$ and $K_2 [Zn(OH)_4]$ are homoleptic complex as they contain identical ligand i.e. (C_2O_4) and (OH) .

Question19

The correct order for wavelengths of light absorbed in the complex ions $[CoCl(NH_3)_5]^{2+}$, $[Co(NH_3)_6]^{3+}$ and $[Co(CN)_6]^{3-}$ is

KCET 2021

Options:



Answer: A

Solution:

Wavelengths of light absorbed is inversely proportional to strength of the ligand and order of strength of the given ligand is $CN^- > NH_3 > Cl^-$.

Therefore, the correct order for wavelength of light absorbed in the complex ions is



Question20

The coordination number of Fe and Co in the complex ions, $\text{Fe}(\text{C}_2\text{O}_4)_3^{3-}$ and $[\text{Co}(\text{SCN})_4]^{2-}$ are respectively

KCET 2020

Options:

- A. 3 and 4
- B. 6 and 8
- C. 4 and 6
- D. 6 and 4

Answer: D

Solution:

The coordination number of Fe in $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3+}$ is 6 and Co in $[\text{Co}(\text{SCN})_4]^{2-}$ is 4. It is because C_2O_4 is a bidentate ligand. So, $3 \times 2 = 6$

SCN is a monodentate ligand $4 \times 1 = 4$

So, depending upon the number of the ligands, we can calculate the coordination number of central metal atom.

Question21

Number of stereoisomers exhibited by $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ is

KCET 2020

Options:



A. 4

B. 2

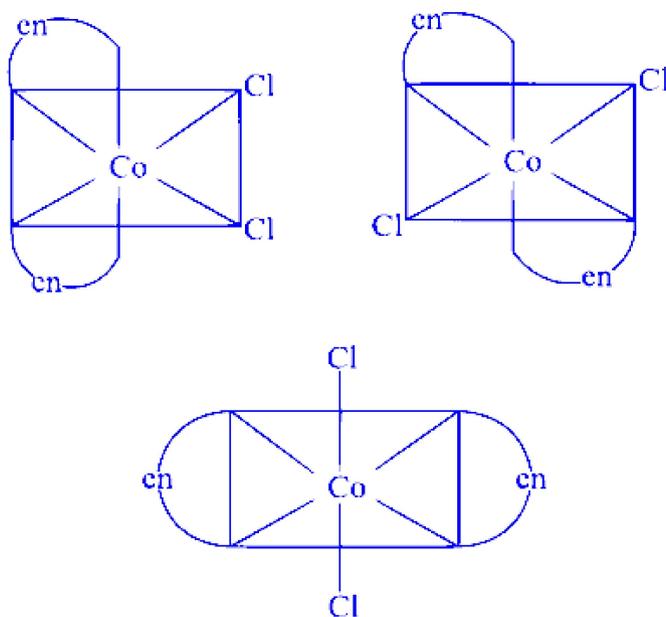
C. 5

D. 3

Answer: D

Solution:

The number of stereoisomers exhibited by $[\text{Co}(\text{en})_2\text{Cl}_2]$ is three.



Question22

Give the IUPAC name of $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_4]$ is

KCET 2020

Options:

A. tetraammine platinum (0) tetrachlorido platinum (IV)

- B. tetraammine palatinate(II)tetrachlorido platinum (II)
C. tetraammine palatinate (0) tetrachlorido platinum (IV)
D. tetraammine platinum (II) tetrachlorido palatinate (II)

Answer: D

Solution:

The IUPAC name of $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_4]$ is tetraammineplatinum (II) tetrachloridoplatinate (II).

Question23

Which among the following is the strongest ligand?

KCET 2019

Options:

- A. CN^-
B. NH_3
C. CO
D. En

Answer: C

Solution:

CO is the strongest ligand. It has empty π -orbitals with the correct symmetry to overlap with the metal t_{2g} -orbitals, forming π bonds. This is described as back bonding. Normally the π orbitals on the ligands are of higher energy than the metal t_{2g} orbitals. No more electrons are added to the scheme as the ligand π -orbitals are empty, but the π interaction increases the value of Δ_0 .

Question24

The formula of pentaquanitratochromium (III) nitrate is,

KCET 2019

Options:

- A. $[\text{Cr}(\text{H}_2\text{O})_6(\text{NO}_3)_3]$
- B. $[\text{Cr}(\text{H}_2\text{O})_6(\text{NO}_2)_2]$
- C. $[\text{Cr}(\text{H}_2\text{O})_5\text{NO}_3](\text{NO}_3)_2$
- D. $[\text{Cr}(\text{H}_2\text{O})_5\text{NO}_2]\text{NO}_3$

Answer: C

Solution:

The formula of pentaquanitratochromium (III) nitrate is $[\text{Cr}(\text{H}_2\text{O})_5(\text{NO}_3)](\text{NO}_3)_2$, while naming, the polydentate ligands are listed alphabetically. So, aqua is written first followed by nitrate.

Question 25

The IUPAC name of $[\text{Co}(\text{NH}_3)_4\text{Cl}(\text{NO}_2)]\text{Cl}$ is

KCET 2018

Options:

- A. tetraamminechloridonitrito- N -cobalt(III) chloride
- B. tetraamminechloridonitrocobalt(II) chloride
- C. tetraamminechloridonitrocobalt(I) chloride
- D. tetraamminechloridonitrocobalt(III) chloride

Answer: A

Solution:

The correct IUPAC name of the given coordinate compound is:

Tetraammine chloridonitrito-N-cobalt(III) chloride.



Hence, (a) is the correct option.

Question26

Square planar complex of the type M_{AXBL} (where A, B, X and L) are unidentate ligands shows following set of isomers

KCET 2017

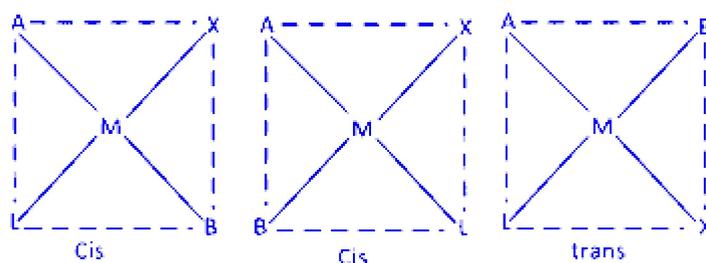
Options:

- A. two cis and one trans
- B. two trans and one cis
- C. two cis and two trans
- D. three cis and one trans

Answer: A

Solution:

Square planar complex of the type $M_{A \times B \times L}$ shows two cis and one trans isomers.



Question27

The coordination number and the oxidation state of the element ' M ' in the complex $[M(en)_2(C_2O_4)]NO_2$ {where (en) is ethan1, 2-diamine) are respectively



KCET 2017

Options:

A. 6 and 3

B. 4 and 3

C. 6 and 2

D. 4 and 2

Answer: A

Solution:

In the given coordination compound $[M(en)_2(C_2O_4)]NO_2$, analyze the following:

Coordination Number:

The ligands present are:

en (ethane-1,2-diamine): This is a bidentate ligand, which means it can attach at two points to the metal center. Here, there are two en ligands, contributing a total of $2 \times 2 = 4$ coordination sites.

$C_2O_4^{2-}$ (oxalate ion): This is also a bidentate ligand, contributing 2 coordination sites.

Adding these, the total coordination number is $4 + 2 = 6$.

Oxidation State of M :

Consider the charges:

The en ligand is neutral, contributing nothing to the net charge.

The oxalate ion ($C_2O_4^{2-}$) contributes -2 .

The nitrite ion outside the coordination sphere contributes -1 .

Overall charge of the complex is balanced by the nitrite ion NO_2^- .

Let the oxidation state of M be x :

Write the equation: $x + 0 + (-2) = -1$.

Simplify to find $x = +3$.

Therefore, the coordination number is 6, and the oxidation state of M is +3.



Question28

According to crystal field theory, the $M - L$ bond in a complex is

KCET 2017

Options:

- A. partially covalent
- B. purely ionic
- C. purely covalent
- D. purely coordinate

Answer: B

Solution:

According to crystal field theory considers the bond between metal ion and ligand as "purely electrostatic" i.e. this theory assumes that metal ion and ligands act as point charges and hence interaction between them is purely electrostatic or purely ionic in nature.

