Coordination Compounds

Question1

Which from following complexes contains anionic ligand?

MHT CET 2025 5th May Evening Shift

Options:

A.

Tetraamminecopper (II) ion

B.

Pentaammineaquacobalt (III) iodide

C.

Tetracyanonickelate (II) ion

D.

Pentacarbonyliron(0)

Answer: C

Solution:

For an anionic complex, first the name of ligand is written followed by the name of the metal ion, ending with suffix "ate". Hence, tetracyanonickelate (II) ion i.e., $[Ni(CN)_4]^{2-}$ is an anionic complex.

Question2

Which from following complexes does $NO_{\uparrow}$ obey EAN rule?

MHT CET 2025 5th May Evening Shift

Options:

A.

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

B.

$Cr(CO)_6$

C.

$[Zn(NH_3)_4]^{2+}$

D.

$[Cu(NH_3)_4]^{2+}$

Answer: D

Solution:

If the effective atomic number (EAN) is equal to $18(Ar), 36(Kr), 54(Xe)$ or $86(Rn)$, then EAN rule is obeyed.

EAN = Atomic no. - oxidation no. + no. of electrons donated by ligands.

(A)	$[Co(NH_3)_6]^{3+}$: Oxidation state of Co is +3 and ligands donate 12 electrons.	$Z = 27, X = 3, Y = 12$ EAN of Co^{3+} $= Z - X + Y$ $= 27 - 3 + 12 = 36$
(B)	$Cr(CO)_{6:}$ Oxidation state of Cr is 0 and ligands donate 12	$Z = 24, X = 0, Y = 12$ EAN of Cr $= Z - X + Y$
	electrons.	$= 24 - 0 + 12 = 36$
(C)	$[Zn(NH_3)_4]^{2+}$: Oxidation state of Zn is +2 and ligands donate 8 electrons.	$Z = 30, X = 2, Y = 8$ EAN of Z^{2+} $= Z - X + Y$ $= 30 - 2 + 8 = 36$
(D)	$[Cu(NH_3)_4]^{2+}$: Oxidation state of Cu is +2 and ligands donate 8 electrons.	$Z = 29, X = 2, Y = 8$ EAN of Cu^{2+} $= Z - X + Y$ $= 29 - 2 + 8 = 35$

Question3

Identify weak field ligand from following.

MHT CET 2025 26th April Evening Shift

Options:

A. NH_3

B. NC^-

C. Br^-

D. CO

Answer: C

Solution:

In the spectrochemical series the order of field strength of ligands follows the order:

$I^- < Br^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O$
$< NCS^- < EDTA < NH_3 <$ en $< CN^- < CO$

Question4

Identify neutral complex from following.

MHT CET 2025 26th April Evening Shift

Options:

A.

Tetracyanonickelate (II) ion

B.

Sodiumhexafluoraluminate (III)

C.

Triamminetrinitrocobalt (III)

D.

Tetraamminecopper (II) ion

Answer: C

Solution:

Step 1: Analyze each option

Option A: Tetracyanonickelate (II) ion

Formula: $[Ni(CN)_4]^{2-}$

- Contains negative 2 charge.

→ Not neutral.

Option B: Sodium hexafluoroaluminate (III)

Formula: $Na_3[AlF_6]$

- This is an ionic compound, not a neutral coordination complex.

→ Not neutral.

Option C: Triamminetrinitrocobalt (III)

Formula: $[Co(NH_3)_3(NO_2)_3]$

- NH_3 is neutral, NO_2^- carries –1 charge, there are 3 of them (–3 total).
- Co^{3+} balances –3.
- Net charge = 0.

→ Neutral complex.

Option D: Tetraamminecopper (II) ion

Formula: $[Cu(NH_3)_4]^{2+}$

- Carries +2 charge.

→ Not neutral.

✅ Correct Answer:

Option C: Triamminetrinitrocobalt (III)

Question5

Which from following is a weak field ligand?

MHT CET 2025 26th April Morning Shift

Options:

A. EDTA

B. CO

C. F^-

D. NH_3

Answer: C

Solution:

Step 1: Recall ligand field strength

According to the **Spectrochemical Series** (from weak field → strong field):

$$I^- < Br^- < SCN^- < Cl^- < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < EDTA \approx NH_3 < en < NO_2^- < CN^- < CO$$

- **Weak field ligands** produce small splitting (Δ), leading to high-spin complexes.
- **Strong field ligands** produce large splitting (Δ), often leading to low-spin complexes.

Step 2: Check each option

- **Option A: EDTA** → EDTA is a multidentate ligand (chelating) with donor groups similar to amines and carboxylates; it is intermediate/stronger field ligand, not typically considered weak.
- **Option B: CO** → Carbon monoxide is a **very strong field ligand** (highest, along with CN^-).
- **Option C: F^-** → Fluoride is relatively high in the spectrochemical series, **weak field ligand** (small Δ).
- **Option D: NH_3** → Ammonia is a **stronger field ligand** (moderate-to-strong, stronger than H_2O).

✅ Correct Answer:

$\boxed{F^-}$

This is the weak field ligand among the given choices.

Question6

Which from following compounds contains complex anions?

MHT CET 2025 26th April Morning Shift

Options:

A. Sodium hexanitrocobaltate(III)

B. Triamminetrinitrocobalt(III)

C. Pentaammineaquacobalt(III)iodide

D. Triamminetrinitrocobalt(III)

Answer: A

Solution:

Sodium hexanitrocobaltate(III) $Na_3\,[Co(NO_2)_6]$ has negatively charged coordination sphere $[Co(NO_2)_6]^{3-}$. Hence, it is an anionic complex.

Question7

Find the EAN of Zn in $[Zn(NH_3)_4]^{2+}$?

MHT CET 2025 25th April Evening Shift

Options:

A. 38

B. 37

C. 36

D. 35

Answer: C

Solution:

Step 1: Recall formula of EAN

$\text{EAN} = Z - O + N$

Where:

- Z = atomic number of the metal
- O = oxidation state of the metal
- N = electrons donated by the ligands

Step 2: Values

- For Zn: $Z = 30$.

- Here complex is $[Zn(NH_3)_4]^{2+}$.
- Oxidation state: Let it be x. Neutral ligand NH_3 contributes 0 charge. Whole complex charge = +2. Thus, Zn oxidation = +2.

$O = +2$.

- Ligands: 4 × NH_3, each donating 2 electrons.

So $N = 4 \times 2 = 8$.

Step 3: Substitute

EAN $= 30 - 2 + 8 = 36$

Final Answer:

The EAN of Zn in $[Zn(NH_3)_4]^{2+}$ is:

Option C: 36 ✅

Question8

Identify the correct increasing order of field strength of ligands from following.

MHT CET 2025 25th April Evening Shift

Options:

A. $\mathrm{Cl^- < I^- < S^{2-} < OH^-}$

B. $\mathrm{I^- < Cl^- < S^{2-} < OH^-}$

C. $\mathrm{OH^- < Cl^- < I^- < S^{2-}}$

D. $\mathrm{S^{2-} < OH^- < I^- < Cl^-}$

Answer: B

Solution:

In the spectrochemical series the order of field strength of ligands follows the order :

$$\mathrm{I^- < Br^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O}$$
$$\mathrm{< NCS^- < EDTA < NH_3 < \ en \ < CN^- < CO}$$

Question9

What is the number of unpaired electrons in $\mathrm{[Co(NH_3)_6]^{3+}}$ complex?

MHT CET 2025 25th April Morning Shift

Options:

A. 4

B. 3

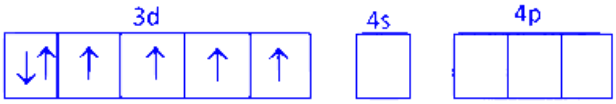
C. 2

D. Zero

Answer: D

Solution:

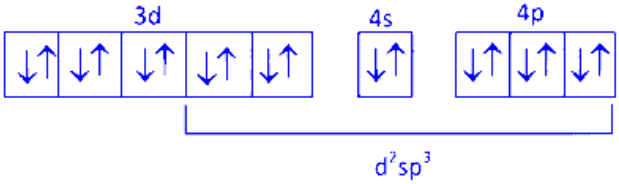
In $[Co(NH_3)_6]^{3+}$, oxidation state of cobalt is +3 . Valence shell electronic configuration of Co^{3+} :



Number of ammine ligands is 6 . Therefore, the number of vacant metal ion orbitals required for bonding with ligands must be six.

Complex is low spin, so pairing of electrons will take place prior to hybridisation.

Electronic configuration after complex formation:



∴ All electrons are paired in a given complex. No. of unpaired electrons for a given complex can also be calculated using crystal field theory.

Question10

Identify anionic ligand from following.

MHT CET 2025 25th April Morning Shift

Options:

A. Isothiocyanato

B. Ammine

C. Aqua

D. Ethylenediamine

Answer: A

Solution:

We are asked to **identify the anionic ligand** among the given options:

- **Option A: Isothiocyanato (–NCS^- or –SCN^-)**

  → This is an **anionic ligand** because it carries a negative charge.

- **Option B: Ammine (NH_3)**

→ Neutral ligand.

- **Option C: Aqua (H_2O)**

  → Neutral ligand.

- **Option D: Ethylenediamine (en, $H_2N–CH_2–CH_2–NH_2$)**

  → Neutral ligand.

✅ **Correct Answer: Option A (Isothiocyanato)**

Question11

What is EAN of Co in $[Co(NH_3)_6]^{3+}$?

MHT CET 2025 23rd April Evening Shift

Options:

A. 36

B. 34

C. 38

D. 32

Answer: A

Solution:

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

Oxidation state of cobalt is +3 and six ligands donate 12 electrons.

EAN = Atomic no. of metal (Z) - Number of electrons lost by metal to form the ion $(X)+$ Number of electrons donated by ligands (Y)

$$Z = 27; X = 3; Y = 12$$
$$\text{EAN of } Co^{3+} = Z - X + Y$$
$$= 27 - 3 + 12 = 36$$

Question12

Identify a lowest field strength ligand from following.

MHT CET 2025 23rd April Evening Shift

Options:

A. I^-

B. S^{2-}

C. en

D. CO

Answer: A

Solution:

Increasing order of ligand field strength is:
$I^- < Br^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O$
$< NCS^- < EDTA < NH_3 < en < CN^- < CO$

Question13

Identify a lowest field strength ligand from following.

MHT CET 2025 23rd April Evening Shift

Options:

A. I^-

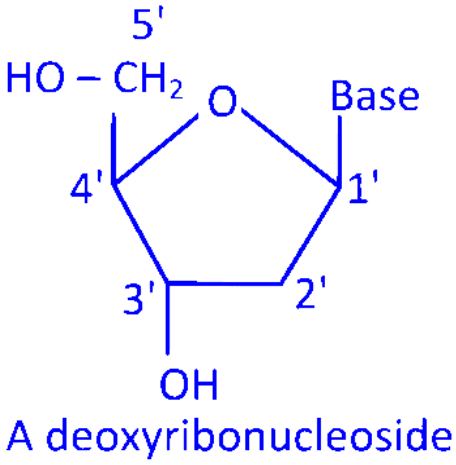
B. S^{2-}

C. en

D. CO

Answer: D

Solution:



Question14

Which among the following ligands has highest field strength?

MHT CET 2025 23rd April Morning Shift

Options:

A. H_2O

B. OH^-

C. $C_2O_4^{2-}$

D. CO

Answer: D

Solution:

Increasing order of ligand field strength is:
$I^- < Br^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-}$
$< H_2O < NCS^- < EDTA < NH_3 <$ en $< CN^- < CO$

Question15

What is EAN of metal ion in hexacyanoferrate (II) ion?

MHT CET 2025 23rd April Morning Shift

Options:

A. 36

B. 38

C. 37

D. 35

Answer: A

Solution:

In $[Fe(CN)_6]^{4-}$
$Z = 26, X = 2, Y = 12$

EAN = Atomic number of metal (Z)− No. of electrons lost by metal to form the ion (X) + No. of electrons donated by ligands (Y).

EAN of $Fe^{2+} = Z - X + Y = 26 - 2 + 12 = 36$

Question16

What is the coordination number of central metal ion if it forms octahedral complex?

MHT CET 2025 22nd April Evening Shift

Options:

A. 4

B. 6

C. 8

D. 12

Answer: B

Solution:

When the geometry of the complex is octahedral the hybridization is $d^2sp^3/sp^3\ d^2$.

The coordination number $= 6$.

Question17

Identify neutral ligand from following?

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Options:

A. Carbonyl

B. Sulphato

C. Oxalato

D. Bromo

Answer: A

Solution:

We need to identify the **neutral ligand** among the given options:

- **Carbonyl (CO)** → This is a neutral ligand.
- **Sulphato (SO_4^{2-})** → Negatively charged ligand.
- **Oxalato ($C_2O_4^{2-}$)** → Negatively charged ligand.
- **Bromo (Br^-)** → Negatively charged ligand.

✅ **Correct Answer: Option A – Carbonyl (CO)**

Question18

What type of hybridisation is present in square planar geometry of complex $[Ni(CN)_4]^{2-}$

MHT CET 2025 22nd April Morning Shift

Options:

A. sp^3

B. dsp^2

C. sp^3 d

D. sp^3 d^2

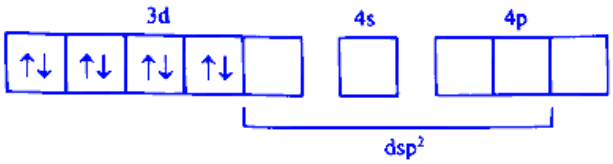
Answer: B

Solution:

complexes

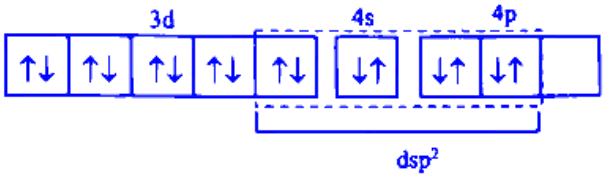
In $[Ni(CN)_4]^{2-}$, oxidation state of nickel is +2 . Valence shell electronic configuration of Ni^{2+} : [Ar] 3d ^{8}.

3d electrons are paired prior to the hybridisation and electronic configuration of Ni^{2+} becomes:



Four vacant dsp^2 hybrid orbitals of Ni^{2+} overlap with four orbitals of CN^- ions to form $Ni-CN$ coordinate bonds.

Configuration after the complex formation becomes:



Question19

Identify neutral ligand from following.

MHT CET 2025 22nd April Morning Shift

Options:

A. Nitrato

B. Cyano

C. Aqua

D. Iodo

Answer: C

Solution:

We want to identify the **neutral ligand** among the given options:

- **Nitrato (NO_3^-)** → negatively charged ligand.
- **Cyano (CN^-)** → negatively charged ligand.
- **Aqua (H_2O)** → neutral ligand.
- **Iodo (I^-)** → negatively charged ligand.

✅ Therefore, the **neutral ligand** is **Aqua (H_2O)**.

Answer: Option C — Aqua

Question20

What is the number of moles of silver chloride precipitated when excess silver nitrate is treated with one mole of pentaamminecarbonatocobalt (III) chloride?

MHT CET 2025 21st April Evening Shift

Options:

A. 4

B. 3

C. 2

D. 1

Answer: D

Solution:

Step 1: Understand the complex

The complex is **pentaamminecarbonatocobalt(III) chloride**:

$[Co(NH_3)_5CO_3]Cl$

So, there is **one chloride ion (Cl^-) outside the coordination sphere** as the counter ion.

Step 2: Which ions are free in solution?

When dissolved in water, it ionizes as:

$[Co(NH_3)_5CO_3]^+ + Cl^-$

Thus, **the carbonate ligand (CO_3^{2-}) is coordinated to Co and not free**.

So the only free anion outside is **1 Cl^-**.

Step 3: Reaction with $AgNO_3$

Excess $AgNO_3$ will precipitate silver chloride (AgCl) **only with free chloride ions**.

Since there is **1 free Cl^- per formula unit**,

from 1 mole of the complex, we get **1 mole of AgCl**.

✅ **Final Answer:**

Number of moles of $AgCl = 1$

Correct option: D (1).

Question21

Which from following cations forms least stable complex with same ligand?

MHT CET 2025 21st April Evening Shift

Options:

A. Co^{2+}

B. Fe^{2+}

C. Cd^{2+}

D. Cu^{2+}

Answer: C

Solution:

The stability order of divalent metal ion complexes is given by Irving-William order. The order is:

$Cu^{2+} > Ni^{2+} > Co^{2+} > Fe^{2+} > Mn^{2+} > Cd^{2+}$

Question22

Which from following cations will form most stable complex with same ligand?

MHT CET 2025 21st April Morning Shift

Options:

A. Cu^{2+}

B. Co^{2+}

C. Mn^{2+}

D. Fe^{2+}

Answer: A

Solution:

The stability order of divalent metal ion complexes is given by Irving-William order. The order is:

$Cu^{2+} > Ni^{2+} > Co^{2+} > Fe^{2+} > Mn^{2+} > Cd^{2}$

Question23

What is the coordination number of Pt in cisplatin?

MHT CET 2025 21st April Morning Shift

Options:

A. 4

B. 2

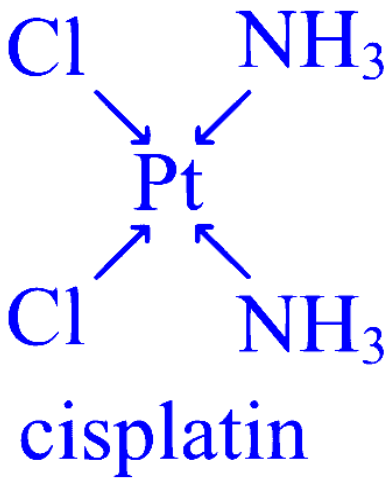
C. 6

D. 12

Answer: A

Solution:

In cisplatin, two ammonia molecules and two chloride ligands utilize their lone pairs of electrons to form coordinate bonds with the $Pt(II)$ ion. Thus, the coordination number of platinum (Pt) in cisplatin is 4 , as it is bonded to four unidentate ligands in total.



cisplatin

Question24

Which from following compounds contains complex cations and anions?

MHT CET 2025 20th April Evening Shift

Options:

A. Tetraamminecopper(II)ion

B. Triamminetrinitrocobalt(III)

C. Tetraamminedibromoplatinum(IV) bromide

D. Sodium hexafluoroaluminate(III)

Answer: C

Solution:

IUPAC name of compound	Formula	Type of complex
Teraammine copper(II)ion	$[Cu(NH_3)_4]^{2+}$	Cationic complex
Triamminetrinitrocobalt(III)	$[Co(NO_2)_3(NH_3)_3]$	Neutral complex
Tetraammine dibromoplatinum (IV)bromide	$[PtBr_2(NH_3)_4]Br_2$	Compound containing complex cation and anion
Sodium hexafluoroalumin ate(III)	$Na_3\,[AlF_6]$	Compound containing complex anion and metal cation

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Question25

Which from following is a strong field ligand?

MHT CET 2025 20th April Evening Shift

Options:

A. CN^-

B. SCN^-

C. I^-

D. ${C_2O_4}^{2-}$

Answer: A

Solution:

Increasing order of ligand field strength is:
$I^- < Br^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-}$
$< H_2O < NCS^- < EDTA < NH_3 <$ en $< CN^- < CO$

Question26

Identify the ligands present in cisplatin.

MHT CET 2025 20th April Morning Shift

Options:

A. Cl^- and CN^-

B. NH_3 and Cl^-

C. NH_3 and H_2O

D. Cl^- and H_2O

Answer: B

Solution:

Cisplatin has the chemical formula $[Pt(NH_3)_2Cl_2]$.

In this compound:

- NH_3 (ammonia) is a neutral ligand.
- Cl^- (chloride) is a monodentate anionic ligand.

So, the ligands present are **ammonia (NH_3) and chloride (Cl^-).**

Correct answer:

Option B

NH_3 and Cl^-

Question27

Identify the correct decreasing order of stability of complexes formed by divalent metal ions with same ligand.

MHT CET 2025 20th April Morning Shift

Options:

A. $Cu^{2+} > Mn^{2+} > Cd^{2+}$

B. $Cd^{2+} > Mn^{2+} > Cu^{2+}$

C. $Mn^{2+} > Cd^{2+} > Cu^{2+}$

D. $Cu^{2+} > Cd^{2+} > Mn^{2+}$

Answer: A

Solution:

To answer this, we use the concept of the **Irving–Williams order**, which tells us the relative stability of divalent metal ion complexes with the same ligand.

The Irving–Williams stability order for high-spin octahedral complexes of first-row transition metals (**with the same ligand**) is:

$Mn^{2+} < Fe^{2+} < Co^{2+} < Ni^{2+} < Cu^{2+} > Zn^{2+}$

Cd^{2+} is below Zn in the periodic table. Generally, stability further decreases from Zn^{2+} to Cd^{2+}.

Therefore, for Mn^{2+}, Cu^{2+}, Cd^{2+}:

1. Cu^{2+} forms the most stable complexes,
2. Then Mn^{2+},
3. Then Cd^{2+} is the least.

Stability order:

$Cu^{2+} > Mn^{2+} > Cd^{2+}$

Correct option:

Option A

$Cu^{2+} > Mn^{2+} > Cd^{2+}$

Question28

What is the total number of donor atoms present in Tetracyanonickelate(II) ion?

MHT CET 2025 19th April Evening Shift

Options:

A. 2

B. 4

C. 6

D. 1

Answer: B

Solution:

Let us first write the formula for tetracyanonickelate(II) ion:

- Tetra = 4
- Cyano = CN^-
- Nickelate(II) means Ni^{2+}

So, the formula is: $[Ni(CN)_4]^{2-}$

Step 1: Definition of donor atom

- A donor atom is the atom in a ligand that donates a lone pair to the central metal atom/ion to form a coordinate bond.

Step 2: Cyanide ion ligand

- Each cyanide ion (CN^-) acts as a ligand.
- In CN^-, the carbon atom donates the lone pair to the metal, so carbon is the donor atom.

Step 3: Number of cyanide ligands

- There are 4 CN^- ligands in $[Ni(CN)_4]^{2-}$.

Step 4: Total number of donor atoms

- Each CN^- contributes 1 donor atom (carbon).
- So, total number of donor atoms $= 4 \times 1 = 4$

Final Answer:

Option B

4

Question29

Identify pair of complexes that exhibits solvate isomerism.

MHT CET 2025 19th April Evening Shift

Options:

A.

$[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

B.

$[Co(NH_3)_5SO_4]Br$ and $[Co(NH_3)_5Br]SO_4$

C.

$[Co(NH_3)_6]\,[Cr(CN)_6]$ and $[Cr(NH_3)_6]\,[Co(CN)_6]$

D.

$[Fe(H_2O)_5SCN]^+$and $\left[Fe(H_2O)_5NCS^+\right.$

Answer: A

Solution:

Step 1: Understanding Solvate Isomerism

- Solvate isomerism is a type of hydrate isomerism.
- It occurs when water (or another solvent) is present either inside the coordination sphere (as a ligand) or outside the sphere (as a water of crystallization).

- The overall formula is same, but the position of the solvent molecule changes.

Step 2: Analyzing each option

Option A:

$[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

- In the first complex, all 6 water molecules are coordinated to Cr.
- In the second, 5 water molecules and 1 Cl^- is coordinated (inside), and one water is present as a water of crystallization (outside the coordination sphere).
- So, both complexes have same composition but differ in the position of water (ligand vs outside).
- **This is solvate (hydrate) isomerism.**

Option B:

$[Co(NH_3)_5SO_4]Br$ and $[Co(NH_3)_5Br]SO_4$

- Here, the difference is exchange of SO_4^{2-} and Br^- between inside and outside the coordination sphere.
- This is **ionisation isomerism**, not solvate isomerism.

Option C:

$[Co(NH_3)_6]\,[Cr(CN)_6]$ and $[Cr(NH_3)_6]\,[Co(CN)_6]$

- Here, the ligands and metals are exchanged.
- This is **coordination isomerism**.

Option D:

$[Fe(H_2O)_5SCN]^+$ and $[Fe(H_2O)_5NCS]^+$

- Here, the donor atom changes within the SCN^- ligand (S vs N).
- This is **linkage isomerism**.

Step 3: Final answer

The correct pair is:

Option A

$[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

These exhibit **solvate isomerism**.

Question30

Which from following coordinate complexes contains the ligand 'en'?

MHT CET 2025 19th April Morning Shift

Options:

A. Tetraamminecopper (II) ion

B. Bis(ethylenediamine)dithiocyanatoplatinum (IV)

C. Pentacarbonyliron (0)

D. Tetracyanonickelate (II)

Answer: B

Solution:

Step 1: Recall what 'en' means.

- 'en' = ethylenediamine ($NH_2CH_2CH_2NH_2$), a bidentate ligand.

Step 2: Check each option.

Option A: Tetraamminecopper(II) ion

- Formula: $[Cu(NH_3)_4]^{2+}$
- Ligand present: ammonia (NH_3), not 'en'.
- ❌ Does not contain 'en'.

Option B: Bis(ethylenediamine)dithiocyanatoplatinum(IV)

- Formula: $[Pt(en)_2(NCS)_2]$
- Here, the word "ethylenediamine" is present. "Bis(ethylenediamine)" means two 'en' groups.
- ✅ Contains 'en'.

Option C: Pentacarbonyliron(0)

- Formula: $[Fe(CO)_5]$
- Ligand present: carbonyl (CO), not 'en'.
- ❌ Does not contain 'en'.

Option D: Tetracyanonickelate(II)

- Formula: $[Ni(CN)_4]^{2-}$
- Ligand present: cyanide (CN^-), not 'en'.
- ❌ Does not contain 'en'.

Final Answer: Option B — Bis(ethylenediamine)dithiocyanatoplatinum(IV)

Question31

Which from following complexes is an example of $\mathrm{MA_2BC}$ type of distereoisomers?

MHT CET 2025 19th April Morning Shift

Options:

A. $[\mathrm{Co(en)_2Cl_2}]^+$

B. $[\mathrm{Pt\,(NH_3)\,(H_2O)Cl_2}]$

C. $\mathrm{Pt(NH_3)_2Cl_2}$

D. $[\mathrm{Co(NH_3)_4Cl_2}]^+$

Answer: B

Solution:

We want to identify the complex of type $\mathrm{MA_2BC}$ which can show **diastereoisomerism**.

Let us carefully analyze each option step by step.

Step 1: Recall General Form

- The type MA_2BC means:

  A central metal atom (M) surrounded by **4 ligands in a square planar complex** (since distereoisomers arise clearly there).

  Out of these:

- Two ligands are identical (A_2),
- Two ligands are different (B and C).

Thus overall arrangement: $M - A_2 - B - C$.

This type can exhibit **geometrical isomerism (cis / trans)** and sometimes diastereoisomerism.

Step 2: Check Each Option

(A) $[Co(en)_2Cl_2]^+$

- Here, coordination number is 6.
- Structure is octahedral with two bidentate ethylenediamine (en) ligands + 2 chlorides.
- Type: MA_2B_2 (not MA_2BC).
- Can show cis–trans and optical isomerism, but not MA_2BC type.
- ❌ Not correct.

(B) $[Pt(NH_3)(H_2O)Cl_2]$

- Coordination number is 4. Platinum generally forms **square planar** complexes.
- Ligands present: two Cl^- (identical = A_2), one NH_3 (B), one H_2O (C).
- So formula type = MA_2BC.
- Square planar arrangement gives both **cis** and **trans** isomers.
- These are **diastereoisomers**, since they are not mirror images but stereoisomers.
- ✅ Correct.

(C) $Pt(NH_3)_2Cl_2$

- Square planar again.
- This is MA_2B_2 type (not MA_2BC).
- Shows cis/trans geometrical but not MA_2BC.
- ❌ Not correct.

(D) $[Co(NH_3)_4Cl_2]^+$

- Coordination number 6 (octahedral).
- Type MA_4B_2.
- Can show cis/trans, but not MA_2BC.
- ❌ Not correct.

Final Answer:

The correct option is:

Option B: $[Pt(NH_3)(H_2O)Cl_2]$ ✅

Question32

What is the number of moles of donor atoms present in one mole oxalate ion?

MHT CET 2024 16th May Evening Shift

Options:

A. 1

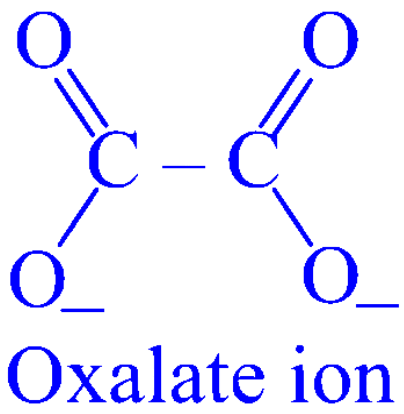
B. 2

C. 6

D. 4

Answer: B

Solution:



Oxalate ion

Question33

Which from following ligands is neutral?

MHT CET 2024 16th May Evening Shift

Options:

A. Ammine

B. Chloro

C. Sulphato

D. Nitrito

Answer: A

Solution:

NH_3 = Neutral

All other ligands are anionic

Question34

What is the EAN of Zn in $[Zn(NH_3)_4]^{2+}$?

MHT CET 2024 16th May Morning Shift

Options:

A. 32

B. 28

C. 30

D. 36

Answer: D

Solution:

$Z = 30, X = 2, Y = 8$

EAN of $Zn^{2+} = Z - X + Y = 30 - 2 + 8 = 36$

(Z = atomic number of metal, X = charge on metal, Y = electrons donated by ligand.)

Question35

Which from following complexes is having ambidentate ligand in it?

MHT CET 2024 16th May Morning Shift

Options:

A. Triamminetrinitrocobalt (III)

B. Pentacarbonyliron (0)

C. Tetraaminecopper (II) ion

D. Trioxalatocobaltate (III) ion

Answer: A

Solution:

A ligand is referred to as ambidentate if it can bind to the central metal atom through two different atoms. Among the given options, an ambidentate ligand is present in the following complex:

Option A: Triamminetrinitrocobalt (III)

In this compound, the nitro group (NO_2) is an ambidentate ligand. It can coordinate with the central metal atom either through the nitrogen atom (as a nitro group, $-NO_2$) or through an oxygen atom (as a nitrito group, -ONO).

Here's a brief explanation of why the other complexes do not contain ambidentate ligands:

Option B: Pentacarbonyliron (0)

The ligand here is CO, which is a monodentate ligand that binds through the carbon atom.

Option C: Tetraaminecopper (II) ion

The ligand NH_3 is monodentate, coordinating through a single nitrogen atom.

Option D: Trioxalatocobaltate (III) ion

The oxalate ion is a bidentate ligand but not ambidentate, as it consistently coordinates through two oxygen atoms.

To sum up, **Triamminetrinitrocobalt (III)** is the complex featuring an ambidentate ligand in the form of the nitro group.

Question36

Which among the following is a cationic complex?

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Options:

A. $\mathrm{Na_4\,[Fe(CN)_6]}$

B. $\mathrm{[Co(NH_3)_5Cl]SO_4}$

C. $\mathrm{[Ni(CO)_4]}$

D. $\mathrm{K_3\,[Fe(CN)_6]}$

Answer: B

Solution:

The option that represents a cationic complex is **Option B**, $\mathrm{[Co(NH_3)_5Cl]SO_4}$.

Explanation:

A cationic complex is a coordination compound in which the complex ion has a positive charge. Let's analyze the given options to determine which comprises a cationic complex:

Option A: $\mathrm{Na_4\,[Fe(CN)_6]}$

This consists of $\mathrm{[Fe(CN)_6]^{4-}}$ as the anion tetrasodium cation, making it an anionic complex.

Option B: $\mathrm{[Co(NH_3)_5Cl]SO_4}$

Here, $\mathrm{[Co(NH_3)_5Cl]^{+}}$ is the cation and $\mathrm{SO_4^{2-}}$ is the anion, which means it is a cationic complex.

Option C: $\mathrm{[Ni(CO)_4]}$

This neutral complex (having no charge) is formed by carbon monoxide Ligands which are neutral.

Option D: $K_3\,[Fe(CN)_6]$

This involves $[Fe(CN)_6]^{3-}$ complex anion, paired with K^+, which is an anionic complex formed by tripotassium cation.

Thus, Option B is the correct cationic complex.

Question37

What type of hybridization is present in $[Co(NH_3)_6]^{3+}$ complex?

MHT CET 2024 15th May Evening Shift

Options:

A. d^2sp^3

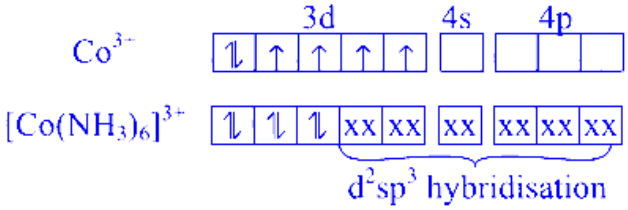
B. $sp^3\ d^2$

C. sp^3

D. dsp^3

Answer: A

Solution:



Question38

Which from following is a correct stability order of complex formed by metal ions if the ligand remains same?

MHT CET 2024 15th May Morning Shift

Options:

A. $Fe^{2+} > Mn^{2+} > Co^{2+}$

B. $Co^{2+} > Fe^{2+} > Mn^{2+}$

C. $Co^{2+} > Mn^{2+} > Fe^{2+}$

D. $Fe^{2+} > Co^{2+} > Mn^{2+}$

Answer: B

Solution:

The stability order of divalent metal ion complexes is given by Irving William series. Higher the charge to size ratio, greater is the stability of complex.Hence, the order is $Co^{2+} > Fe^{2+} > Mn^{2+}$.

Question39

What is the number of electrons lost by Cr in a complex $[Cr(CO)_6]$?

MHT CET 2024 15th May Morning Shift

Options:

A. 0

B. 4

C. 6

D. 2

Answer: A

Solution:

Since carbonyl (CO) is a neutral ligand, oxidation state of Cr in $[Cr(CO)_6]$ is 0 . Hence, no electron will be lost by Cr in the complex.

Question40

Which among the following is a correct decreasing order of thermodynamic stability of the complexes?

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Options:

A. $[Co(NH_3)_6]^{3+} > [Ag(CN)_2]^- > [Cu(CN)_4]^{2-}$

B. $[Co(NH_3)_6]^{3+} > [Cu(CN)_4]^{2-} > [Ag(CN)_2]^-$

C. $[Ag(CN)_2]^- > [Co(NH_3)_6]^{3+} > [Cu(CN)_4]^{2-}$

D. $[Cu(CN)_4]^{2-} > [Ag(CN)_2]^- > [Co(NH_3)_6]^{3+}$

Answer: B

Solution:

Higher the charge on the central metal ion, higher is the stability of the complex. The order of oxidation state of metal ions in the given complex is $Co^{3+} > Cu^{2+} > Ag^{+}$.

Question41

What type of ligand is the oxalate ion?

MHT CET 2024 11th May Evening Shift

Options:

A. Monodentate

B. Bidentate

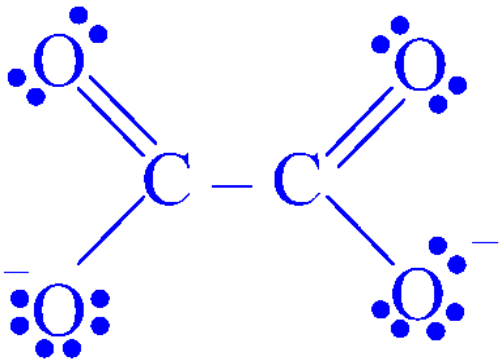
C. Ambidentate

D. Hexadentate

Answer: B

Solution:

Oxalate ion is a bidentate ligand as it has two negatively charged oxygen as donor atoms.



Question42

Identify the type of hybridization present in $[Ni(CN)_4]^{2-}$.

MHT CET 2024 11th May Morning Shift

Options:

A. $sp^3\ d^2$

B. dsp^2

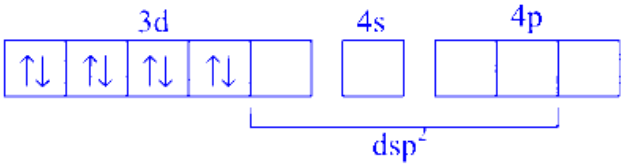
C. sp^3

D. d^2sp^3

Answer: B

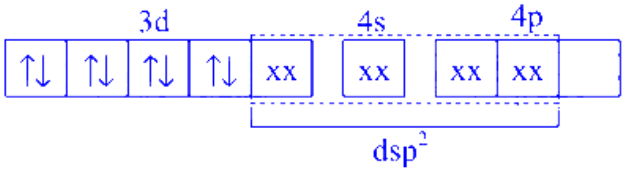
Solution:

In $[Ni(CN)_4]^{2-}$, oxidation state of nickel is +2 . Valence shell electronic configuration of Ni^{2+} : $[Ar]3\ d^8$.3 d electrons are paired prior to the hybridisation and electronic configuration of Ni^{2+} becomes:



Four CN^- ions donate their electron in four vacant dsp^2 hybrid orbitals of Ni^{2+}.

Configuration after the complex formation becomes:



Question43

What is the number of unpaired electrons present in $[CoF_6]^{3-}$?

MHT CET 2024 11th May Morning Shift

Options:

A. 4

B. 3

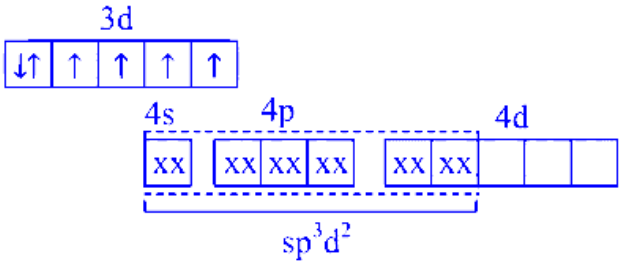
C. 2

D. 1

Answer: A

Solution:

Electronic configuration of Co^{3+} after formation of complex would be



There are 4 unpaired electrons in 3d orbitals.

Question44

What is the number of moles of ionisable Cl^- ions in a coordinate complex if it forms two moles of $AgCl$ when treated with silver nitrate solution in excess?

MHT CET 2024 10th May Evening Shift

Options:

A. 1

B. 2

C. 3

D. 4

Answer: B

Solution:

$[M(X)_n]Cl_2 \rightleftharpoons [M(X)_n]^{2+} + 2Cl^{\ominus}$

$[M(X)_n]Cl_2 + 2AgNO_3 \rightleftharpoons [M(X)_n](NO_3)_2 + 2AgCl$

Question45

Identify a complex having monodentate ligand from following :

MHT CET 2024 10th May Evening Shift

Options:

A. Tetracyanonickelate(II) ion

B. Potassium trioxalatoaluminate(III)

C. Trioxalatocobaltate(III) ion

D. bis(ethylenediamine)dithiocyanato platinum(IV)

Answer: A

Solution:

CN^-(cyanide): Monodentate ligand

$C_2O_4^{2-}$ (oxalate): Bidentate ligand

en (ethylenediamine): Bidentate ligand

SCN^-(thiocyanato): Ambidentate ligand

Question46

What type of isomerism is exhibited by $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$

MHT CET 2024 10th May Morning Shift

Options:

A. Coordinate

B. Solvate

C. Ionization

D. Linkage

Answer: B

Solution:

$$[Cr(H_2O)_6]Cl_3 \text{ and } [Cr(H_2O)_5Cl]Cl_2.H_2O$$
$$\text{(I)} \qquad\qquad \text{(II)}$$

In compound I, the solvent water is directly bonded to Cr.

In compound II, H_2O appears as the free solvent molecule.

$\therefore$ I and II represent solvate isomers.

Question47

Identify heteroleptic complex from following.

MHT CET 2024 10th May Morning Shift

Options:

A. $Na_3[Co(NO_2)_6]$

B. $[Fe(H_2O)_5(NSC)]^{2+}$

C. $[Cu(NH_3)_4]^{2+}$

D. $[Co(C_2O_4)_3]^{3-}$

Answer: B

Solution:

In $[Fe(H_2O)_5(NSC)]^{2+}$, two different ligands are attached to the central metal ion. Therefore, it is a heteroleptic complex.

Question48

What is the oxidation state of central metal ion in $[Fe(CN)_6]^{4-}$ complex?

MHT CET 2024 9th May Evening Shift

Options:

A. +2

B. -6

C. -4

D. +3

Answer: A

Solution:

To determine the oxidation state of the central metal ion in the complex $[Fe(CN)_6]^{4-}$, analyze the charges of the ligands and the overall charge of the complex:

The cyanide ion, CN^-, has a charge of -1.

There are 6 cyanide ions in the complex, which contribute a total charge of $6 \times (-1) = -6$.

The overall charge of the complex is -4. Let the oxidation state of iron (Fe) be x. The sum of the oxidation state of iron and the total charge contributed by the cyanide ions must equal the overall charge of the complex:

$x + (-6) = -4$

Solving for x:

$x - 6 = -4$

$x = -4 + 6 = +2$

Thus, the oxidation state of the central metal ion (Fe) in the complex $[Fe(CN)_6]^{4-}$ is $+2$.

Correct Answer: Option A: +2

Question49

Which from following is a formula of sodium hexafluoroaluminate(III)?

MHT CET 2024 9th May Evening Shift

Options:

A. $Na_3\,[AlF_6]$

B. $Na\,[AlF_6]$

C. $Na_2[AlF_6]^{2+}$

D. $[Al(NaF)_6]^{2+}$

Answer: A

Solution:

The formula for sodium hexafluoroaluminate(III) is represented by Option A:

$Na_3\,[AlF_6]$

This compound consists of three sodium ions (Na^+) and one hexafluoroaluminate anion ($[AlF_6]^{3-}$). The sodium ions balance the charge of the complex anion. The compound is typically encountered in the context of the Hall-Héroult process for aluminum production, where it is often referred to as cryolite.

Question50

Which from following coordinate complexes is a heteroleptic complex?

MHT CET 2024 9th May Morning Shift

Options:

A. Pentacarbonyliron(0)

B. Triamminetrinitrocobalt(III)

C. Tetraamminecopper(II) ion

D. Tetracyanonickelate(II) ion

Answer: B

Solution:

Option B, Triamminetrinitrocobalt(III), is a heteroleptic complex.

In coordination chemistry, a heteroleptic complex is a metal complex in which the central metal atom or ion is coordinated to more than one type of ligand.

Here's the breakdown of each option:

Option A: Pentacarbonyliron(0)

The coordination sphere contains only carbonyl (CO) ligands, making it a homoleptic complex.

Option B: Triamminetrinitrocobalt(III)

This complex consists of two different types of ligands, ammonia (NH_3) and nitro (NO_2), bonded to the cobalt(III) ion. Therefore, it is heteroleptic.

Option C: Tetraamminecopper(II) ion

This complex contains only ammonia (NH_3) ligands coordinating to the copper(II) ion, making it a homoleptic complex.

Option D: Tetracyanonickelate(II) ion

The coordination here involves only cyanide (CN^-) ligands, making it a homoleptic complex.

Thus, the heteroleptic complex among the options provided is Option B, Triamminetrinitrocobalt(III).

Question51

Which from the following statements about $[Co(NH_3)_6]^{3+}$ complex is NOT correct?

MHT CET 2024 9th May Morning Shift

Options:

A. Prior to hybridization Co^{3+} possesses four unpaired electrons.

B. This complex has all electrons paired.

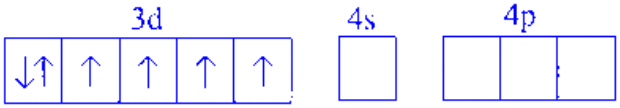
C. It is a high spin complex.

D. It is a diamagnetic complex.

Answer: C

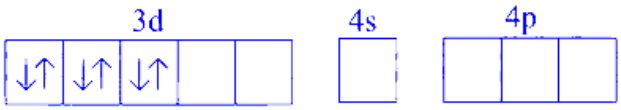
Solution:

In $[Co(NH_3)_6]^{3+}$, oxidation state of cobalt is +3 . Valence shell electronic configuration of Co^{3+} is represented in box diagram as shown:

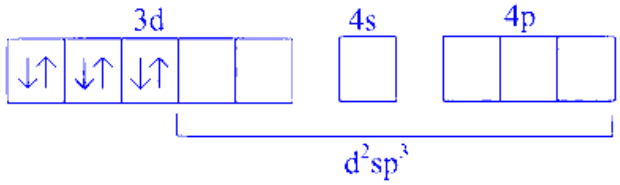


Thus, prior to hybridisation, Co^{3+} possesses 4 unpaired electrons.

Complex is low spin, so pairing of electrons will take place and electronic configuration after pairing would be



Six orbitals available for hybridisation are two 3d, one 4s, three 4p orbitals.



As all electrons are paired, the complex is diamagnetic.

Question52

Which from following ligands is able to form linkage isomers?

MHT CET 2024 4th May Evening Shift

Options:

A. Aqua

B. Ammine

C. Iodo

D. Nitro

Answer: D

Solution:

Linkage isomerism is exhibited by ambidentate ligands. Among the given options, only nitro is an ambidentate ligand which gets attached through two different donor atoms, whereas others are monodentate ligands.

Question53

Identify the total number of complexes having bidentate ligands in them from following list of complexes.

a) Tetracyanonickelate(II) ion

b) Trioxalatocobaltate(III) ion

c) Sodium hexafluoroaluminate(III)

d) bis(ethylenediamine)dithiocyanatoplatinum(IV)

MHT CET 2024 4th May Evening Shift

Options:

A. 1

B. 2

C. 3

D. 4

Answer: B

Solution:

Ligand	Type of ligand
Cyanide ion	Monodentate
Oxalate ion	Bidentate
Fluoride	Monodentate
Ethylenediamine	Bidentate

Question54

Identify neutral sphere complex from following.

MHT CET 2024 4th May Morning Shift

Options:

A. Pentaamminecobalt(III) sulphate

B. Potassiumtrioxalatoaluminate(III)

C. Diamminedichloroplatinum(II)

D. Potassiumhexacyanoferrate(III)

Answer: C

Solution:

The complexes in which the coordination sphere does not carry any charge are called neutral complexes.

Diamminedichloroplatinum(II): $[Pt(NH_3)_2Cl_2]$ is a neutral complex.

Pentamminecobalt(III) sulphate is a cationic complex,

Potassiumhexacyanoferrate(II) and Potassium trioxalatoaluminate(III) are anionic complexes.

Question55

Identify a ligand having two donor atoms but uses a pair of electrons of either donor atom to form coordinate bond.

MHT CET 2024 4th May Morning Shift

Options:

A. Aqua

B. Ethylenediamine

C. Sulphato

D. Nitrito

Answer: D

Solution:

NO_2^-(nitrite) is an ambidentate ligand which has two donor atoms, N and O , but uses either of them to form a coordinate bond. It is termed as 'nitro'(for N -bonded ligand) and 'nitrito' (for O-bonded ligand)

Question56

Which from following ligands is able to form linkage isomers?

MHT CET 2024 3rd May Evening Shift

Options:

A. SCN

B. H_2O

C. CN^-

D. $C_2O_4^{2-}$

Answer: A

Solution:

Linkage isomers occur when a ligand can bind to a central metal atom through different atoms. Among the ligands provided:

SCN **(thiocyanate ion)** is capable of forming linkage isomers. It can bind to a metal center either through the sulfur atom (as S-bonded thiocyanate) or through the nitrogen atom (as N-bonded isothiocyanate).

Therefore, the answer is **Option A:** SCN.

Here's why the other options don't form linkage isomers:

H_2O: This is a monodentate ligand that can only coordinate through the oxygen atom.

CN^- **(cyanide ion)**: This ligand typically binds through the carbon atom, making it not possible for linkage isomerism.

$C_2O_4^{2-}$ **(oxalate ion)**: This is a bidentate ligand that coordinates through its two oxygen atoms, thus not capable of forming linkage isomers.

In summary, the ability to form linkage isomers is a characteristic of ligands having multiple potential donor atoms, as SCN does.

Question57

Which from following ligands has highest field strength?

MHT CET 2024 3rd May Evening Shift

Options:

A. S^{--}

B. OH^{-}

C. EDTA

D. en

Answer: D

Solution:

Increasing order of ligand field strength is:
$I < Br^{-} < Cl^{-} < S^{2-} < F^{-} < OH^{-} < C_2O_4{}^{2-}$
$< H_2O < NCS^{-} < EDTA < NH_3 < en < CN^{-} < CO$

Question58

Identify the formula of pentaaquaisothiocyanatoiron(III) ion from following.

MHT CET 2024 3rd May Morning Shift

Options:

A. $Fe[(H_2O)_5(SCN)]^{3+}$

B. $[Fe(H_2O)_5(NCS)]^{2+}$

C. $Fe[(H_2O)_3(NCS)_2]^{3+}$

D. $\left[Fe[(H_2O)_2(SCN)_3\right]^{5+}$

Answer: B

Solution:

The formula for pentaaquaisothiocyanatoiron(III) ion is:

$[Fe(H_2O)_5(NCS)]^{2+}$

The correct formula is Option B. Here's the breakdown:

Pentaaqua - This means there are five water molecules, $(H_2O)_5$, ligated to the central metal.

Isothiocyanato - This refers to the presence of one isothiocyanate ion, represented as (NCS).

Iron(III) ion - This indicates that the oxidation state of iron is +3. However, because of ligands and their charges, the net charge on the complex ion should be reconciled. Thus, the stated charge in the problem is a critical clue, as this aligns with the options provided.

Option B aligns with these points, providing the correct formula for the pentaaquaisothiocyanatoiron(III) ion.

Question59

What is the coordination number of central metal ion in $[Fe(C_2O_4)_3]^{3-}$?

MHT CET 2024 3rd May Morning Shift

Options:

A. 2

B. 4

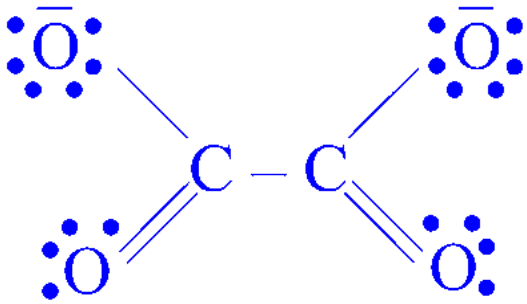
C. 6

D. 12

Answer: C

Solution:

Oxalate ligand (bidentate) $C_2O_4^{2-}$ utilizes electron pair on each of its negatively charged oxygen atoms for linking with central metal. Hence, at a time, it coordinates with the metal ion through 2 oxygen atoms.



Therefore, on binding with 3 oxalate ions, the coordination number of Fe^{3+} will be 6.

Question60

What is EAN of Cu in $[Cu(NH_3)_4]^{2+}$?

MHT CET 2024 2nd May Evening Shift

Options:

A. 36

B. 29

C. 30

D. 35

Answer: D

Solution:

The Effective Atomic Number (EAN) of a metal in a complex is calculated using the formula:

$\text{EAN} = Z - X + 2Y$

where:

Z is the atomic number of the metal,

X is the oxidation state of the metal in the complex, and

Y is the number of ligands attached to the metal.

For the complex $[\text{Cu}(\text{NH}_3)_4]^{2+}$:

The atomic number of copper (Cu) is $Z = 29$.

The oxidation state (X) of copper in the complex is +2.

The number of ammonia ligands (Y) is 4.

Substitute these values into the formula:

$\text{EAN} = 29 - 2 + 2(4)$

$\text{EAN} = 29 - 2 + 8$

$\text{EAN} = 35$

Thus, the Effective Atomic Number (EAN) of copper in the given complex is 35.

Option D: 35

Question61

Find the total number of moles of donor atoms present in one mole trioxalatocobaltate(III) ion.

MHT CET 2024 2nd May Evening Shift

Options:

A. 6

B. 3

C. 12

D. 4

Answer: A

Solution:

In $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$, three oxalate ligands are attached to the cobalt ion. Since oxalate is a bidentate ligand, each $(\text{C}_2\text{O}_4)^{2-}$ has two donor oxygen atoms.

1 mole of $(C_2O_4)^{2-} \equiv 2$ moles of donor atoms.

$\therefore$ 1 mole of $[Co(C_2O_4)_3]^{3-} \equiv 3 \times 2 = 6$ moles of donor atoms.

Question62

Identify the number of donor atoms in EDTA molecule that form coordinate bond with central metal atom or ion in a complex.

MHT CET 2024 2nd May Morning Shift

Options:

A. 3

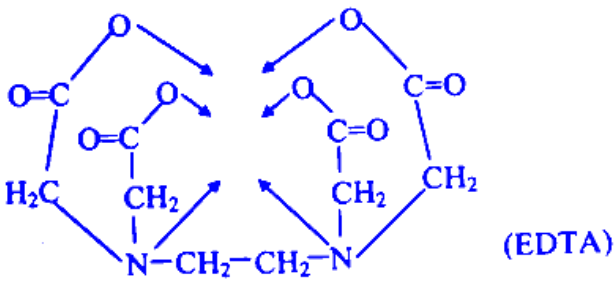
B. 1

C. 6

D. 4

Answer: C

Solution:



Question63

Which from following complexes contains only neutral ligands in it?

MHT CET 2024 2nd May Morning Shift

Options:

A. Pentaammineaquacobalt(III) chloride

B. Triamminetrithiocyanatorhodium(III)

C. Bis(ethylenediamine) dithiocyanatoplatinum(IV)

D. Triamminetrinitrocobalt(III)

Answer: A

Solution:

Complexes that contain only neutral ligands have ligands that do not possess a charge. To determine which of the given options contains only neutral ligands, consider the charges associated with each ligand in the complexes:

Ammonia (NH_3) and **water (H_2O)** are neutral ligands.

Thiocyanate (SCN^-) and **nitro group (NO_2^-)** are negatively charged ligands.

Analyzing each option:

Option A: Pentaammineaquacobalt(III) chloride

This complex contains five ammonia ligands (NH_3) and one water ligand (H_2O). Both are neutral ligands. Therefore, this complex only contains neutral ligands.

Option B: Triamminetrithiocyanatorhodium(III)

This complex contains three ammonia ligands (NH_3), which are neutral, and three thiocyanate ligands (SCN^-), which are negatively charged. Thus, it does not contain only neutral ligands.

Option C: Bis(ethylenediamine) dithiocyanatoplatinum(IV)

This complex has ethylenediamine (en), a neutral ligand, but contains two thiocyanate ligands (SCN^-), which are negatively charged. Hence, it does not contain only neutral ligands.

Option D: Triamminetrinitrocobalt(III)

This complex consists of three ammonia ligands (NH_3), which are neutral, and three nitro ligands (NO_2^-), which are negatively charged. Therefore, it does not contain only neutral ligands.

The complex **Pentaammineaquacobalt(III) chloride** (Option A) is the one that contains only neutral ligands.

Question64

Identify anionic sphere complex from following.

MHT CET 2023 14th May Evening Shift

Options:

A. Hexaamminecobalt(III) chloride

B. Potassium hexacyanoferrate(II)

C. Tetraamminedichlorocobalt(III) ion

D. Pentaamminechlorocobalt(III) sulphate

Answer: B

Solution:

The term "anionic sphere complex" refers to a complex ion that carries a net negative charge. To identify an anionic sphere complex among the options provided, we need to look at the complex ions and see which ones are negatively charged.

Option A: Hexaamminecobalt(III) chloride. This complex is $[Co(NH_3)_6]^{3+}$ and carries a net positive charge. Therefore, it is not an anionic sphere complex.

Option B: Potassium hexacyanoferrate(II). This complex is $[Fe(CN)_6]^{4-}$, which carries a net negative charge. Therefore, it is an anionic sphere complex.

Option C: Tetraamminedichlorocobalt(III) ion. This complex ion is $[Co(NH_3)_4Cl_2]^{+}$, which carries a net positive charge. Thus, it is not an anionic sphere complex.

Option D: Pentaamminechlorocobalt(III) sulphate. This complex itself is $[Co(NH_3)_5Cl]^{2+}$ and carries a net positive charge. So, it is not an anionic sphere complex.

The correct answer is **Option B**: Potassium hexacyanoferrate(II), which features the anionic complex $[Fe(CN)_6]^{4-}$.

Question65

What is the oxidation number of Pt in PtCl_6^{2-} ?

MHT CET 2023 14th May Evening Shift

Options:

A. $+6$

B. $+4$

C. -6

D. -4

Answer: B

Solution:

To determine the oxidation number of platinum (Pt) in the complex ion PtCl_6^{2-}, we need to consider the oxidation numbers of the other atoms in the ion and the overall charge.

Chlorine (Cl) is a halogen and typically has an oxidation number of -1 when it's a part of a compound but not in a neutral elemental state.

The complex ion PtCl_6^{2-} has a total charge of -2. There are six chlorine atoms, each contributing an oxidation number of -1. This means the total contribution of the chlorines to the charge is $6 \times (-1) = -6$.

Now, let's set up an equation to solve for the oxidation number of platinum (Pt), which we'll call x:

$x + (6 \times -1) = -2$

Solve for x:

$x - 6 = -2$

$x = -2 + 6$

$x = 4$

Thus, the oxidation number of platinum in the complex ion PtCl_6^{2-} is +4.

The correct answer is:

Option B: +4

Question66

Which coordination complex from following contains neutral ligand?

MHT CET 2023 14th May Evening Shift

Options:

A. Pentacarbonyl iron(0)

B. Trioxalatocobaltate(III) ion

C. Sodium hexanitrocobaltate(III)

D. Tetracyanonickelate(II) ion

Answer: A

Solution:

The coordination complex that contains a neutral ligand among the given options is:

Option A: Pentacarbonyl iron(0), which has the formula $Fe(CO)_5$

Ligands can be neutral molecules or anions that donate a pair of electrons to the metal center to form coordinate bonds. Carbonyl (CO) is a common example of a neutral ligand, as it contains a carbon atom triple-bonded to an oxygen atom and has a lone pair of electrons that can be donated to a metal atom. In the complex $Fe(CO)_5$, the iron atom is surrounded by five carbonyl ligands, all of which are neutral.

Option B: Trioxalatocobaltate(III) ion contains oxalate ligands ($C_2O_4^{2-}$), which are anionic.

Option C: Sodium hexanitrocobaltate(III), $Na_3[Co(NO_2)_6]$, contains nitro (NO_2^-) ligands, which are also anionic.

Option D: Tetracyanonickelate(II) ion, $[Ni(CN)_4]^{2-}$, contains cyanide ligands (CN^-), which are anionic as well.

Hence, the complex with a neutral ligand is Option A: Pentacarbonyl iron(0).

Question67

What is coordination number of central metal ion in $[Fe(C_2O_4)_3]^{3-}$?

MHT CET 2023 14th May Morning Shift

Options:

A. 3

B. 5

C. 4

D. 6

Answer: D

Solution:

In $[Fe(C_2O_4)_3]^{3-}$, three bidentate $C_2O_4^{2-}$ ligands, that is, total six donor atoms are attached to ferric ion $\left(Fe^{3+}\right)$. Therefore, the coordination number of Fe^{3+} ion in the complex is six.

When coordination number (C.N.) of the metal ion in the complex is to be determined, always check the type of the ligands.

In case of monodentate ligands, C.N. $= 1\times$ (No. of monodentate ligands bound to the metal) and in case of bidentate ligands, C.N. $= 2\times$ (No. of bidentate ligands bound to the metal).

Question68

Which from following formulae is of sodium hexanitrocobaltate(III)?

MHT CET 2023 14th May Morning Shift

Options:

A. $Na_3\left[Co(NO_2)_6\right]$

B. $Na_2\left[Co(NO_2)_6\right]$

C. $\left[Co(NaNO_2)_6\right]$

D. $Na_3\left[Co(ONO)_6\right]$

Answer: A

Solution:

The oxidation state of metal ion is +3 . Hence, Sodium hexanitrocobaltate(III) : $Na_3\left[Co(NO_2)_6\right]$

Question69

Which from following species is NOT a monodentate ligand?

MHT CET 2023 13th May Evening Shift

Options:

A. CN^-

B. $H_2N(CH_2)_2NH_2$

C. OH^-

D. Cl^-

Answer: B

Solution:

Among the given options $H_2N(CH_2)_2NH_2$ is not a monodentate ligand. Instead it is a bidentate ligand.

Question70

Identify homoleptic complex from following.

MHT CET 2023 13th May Evening Shift

Options:

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

B. $[Co(NH_3)_4Cl_2]^{+}$

C. $[Pt(NH_3)_2Cl_2]$

D. $[Co(NH_3)_5Cl]SO_4$

Answer: A

Solution:

Complexes in which a metal is bound to only one kind of donor groups are called as homoleptic complex. Thus, $[Co(NH_3)_6]^{3+}$ is a homoleptic complex.

Question71

Identify cationic sphere complex from following.

MHT CET 2023 13th May Morning Shift

Options:

A. Tetraaminecopper(II) ion

B. Tetracyanonickelate(II) ion

C. Trioxalatocobaltate(III) ion

D. Triamminetrinitrocobalt(III)

Answer: A

Solution:

Tetraaminecopper(II) ion : $[Cu(NH_3)_4]^{2+}$

Tetracyanonickelate(II) ion : $[Ni(CN)_4]^{2-}$

Trioxalatocobaltate(III) ion : $[Co(C_2O_4)_3]^{3-}$

Triamminetrinitrocobalt(III) : $[Co(NH_3)_3(NO_2)_3]$

Tetraaminecopper(II) ion is a cationic sphere complex.

Question72

Which from following formulae is of trioxalatocobaltate(III) ion?

MHT CET 2023 13th May Morning Shift

Options:

A. $[CO_3\,(C_2O_4)]^{3-}$

B. $[Co(C_2O_4)_3]^{3+}$

C. $[Co_3\,(C_2O_4)]^{3+}$

D. $[Co(C_2O_4)_3]^{3-}$

Answer: D

Solution:

Trioxalatocobaltate(III) ion : $[Co(C_2O_4)_3]^{3-}$

Question73

What is the number of moles of donor atoms in n mole of NO_2^- ?

MHT CET 2023 12th May Evening Shift

Options:

A. 3n

B. 0

C. 2n

D. n

Answer: C

Solution:

The ligand NO_2^- links to metal ion through nitrogen or oxygen. Hence, there are two donor atoms per molecule and 2n moles donor atoms per n mole.

Question74

What type of ligand the EDTA is?

MHT CET 2023 12th May Evening Shift

Options:

A. Monodentate

B. Bidentate

C. Tetradentate

D. Hexadentate

Answer: D

Solution:

EDTA, which stands for ethylenediaminetetraacetic acid, is a chelating agent that can bind to metal ions through multiple atoms. Each molecule of EDTA4- can bind to a single metal ion through six donor atoms: the two nitrogen atoms from the ethylenediamine part and the four oxygen atoms from the carboxylic acid groups (tetraacetate part).

These donor atoms allow EDTA to form complex structures with metal ions, effectively "grabbing" the metal at six points, which is why EDTA is termed a hexadentate ligand. In coordination chemistry, a hexadentate ligand is one that uses six pairs of electrons to form bonds with a metal ion. When EDTA forms these complexes, it typically results in an octahedral geometry around the metal ion.

So the correct answer to the type of ligand that EDTA is:

Option D: Hexadentate

Question75

Which from following is a neutral ligand?

MHT CET 2023 12th May Morning Shift

Options:

A. Aqua

B. Sulphato

C. Carbonato

D. Bromo

Answer: A

Solution:

In coordination chemistry, a ligand is an ion or molecule that binds to a central metal atom to form a coordination complex. Ligands can be classified based on their charge as neutral, anionic, or cationic. Let's analyze each of the given options:

Option A: Aqua

The aqua ligand refers to water (H_2O), which is a neutral molecule. It does not carry any charge, thus making it a neutral ligand.

Option B: Sulphato

The sulphato ligand refers to the sulfate ion (SO_4^{2-}). Since it carries a negative charge, it is an anionic ligand.

Option C: Carbonato

The carbonato ligand refers to the carbonate ion (CO_3^{2-}). Similar to sulphato, it also carries a negative charge, making it an anionic ligand.

Option D: Bromo

The bromo ligand refers to the bromide ion (Br^-). It carries a single negative charge, making it an anionic ligand as well.

Therefore, the neutral ligand among the given options is:

Option A: Aqua

Question76

Which from following complexes contains only anionic ligands?

MHT CET 2023 12th May Morning Shift

Options:

A. Tetraamminedibromoplatinum (IV) bromide

B. Potassium trioxalatoaluminate (III)

C. Pentaaquaisothiocyanatoiron (III) ion

D. Pentaammineaquacobalt (III) iodide

Answer: B

Solution:

Potassium trioxalatoaluminate (III): $\mathrm{K_3\,[Al(C_2O_4)_3]}$ Oxalate ion $\left(\mathrm{C_2O_4^{2-}}\right)$ is an anionic ligand.

Question77

Identify the formula of potassium trioxalatoaluminate(III).

MHT CET 2023 11th May Evening Shift

Options:

A. $\mathrm{K_3\,[Al(C_2O_4)_3]}$

B. $Al\left[K_3(C_2O_4)_3\right]$

C. $K_3[Al(C_2O_4)_3]^{2-}$

D. $K_4[Al_3(C_2O_4)_3]^{2+}$

Answer: A

Solution:

The formula for potassium trioxalatoaluminate(III) is correctly represented by Option A :

$K_3\left[Al(C_2O_4)_3\right]$

This formula indicates that the compound is composed of a complex ion of aluminum trioxalato (with aluminum in a +3 oxidation state, as indicated by the "(III)" in the name) and three potassium ions (K^+) to balance the charge of the complex ion. The oxalate ion $C_2O_4^{2-}$ is a bidentate ligand, meaning it forms two bonds with the central aluminum ion. Since there are three oxalate ions, each carrying a -2 charge, the total charge of the complex ion is -6, which is balanced by three K^+ ions, each carrying a +1 charge, resulting in a neutral overall compound.

Question78

Identify anionic complex from following.

MHT CET 2023 11th May Evening Shift

Options:

A. Pentaammineaquacobalt(III) iodide

B. Pentamminecarbonatocabalt(III) chloride

C. Tetracyanonickelate(II) ion

D. Triamminetrinitrocobalt(III)

Answer: C

Solution:

Tetracyanonickelate(II) ion: $[Ni(CN)_4]^{2-}$

Question79

Identify a CORRECT formula for spin only magnetic moment.

MHT CET 2023 11th May Morning Shift

Options:

A. $\mu = \left(n^2 + 2\right) BM$

B. $\mu = \sqrt{\mathrm{n}^2 + 2}\mathrm{BM}$

C. $\mu = \sqrt{\mathrm{n}(\mathrm{n} + 2)}\ \mathrm{BM}$

D. $\mu = (\mathrm{n} + 2)^2\mathrm{BM}$

Answer: C

Solution:

The correct formula for spin-only magnetic moment is:

✅ C. $\mu = \sqrt{n(n+2)}\,\mathrm{BM}$

Explanation:

- n = number of unpaired electrons
- This formula is derived assuming **only spin contribution** (no orbital contribution) to magnetism.
- It is widely used for **transition metal complexes**.

✔ Correct answer: C

Question80

What is total number of donor atoms in $[\mathrm{Co}\,(\mathrm{H_2O})(\mathrm{NH_3})_5]\mathrm{I_3}$?

MHT CET 2023 11th May Morning Shift

Options:

A. 5

B. 9

C. 6

D. 3

Answer: C

Solution:

In $[\mathrm{Co}\,(\mathrm{H_2O})(\mathrm{NH_3})_5]\mathrm{I_3}$, five ammonia molecules and one water molecule, that is, total six ligands are attached to cobalt ion. All these ligands are monodentate since each has only one donor atom. Therefore, there are six donor atoms in the complex.

Question81

Which among following complexes is a neutral complex?

MHT CET 2023 11th May Morning Shift

Options:

A. $[\mathrm{Co}\,(\mathrm{H_2O})(\mathrm{NH_3})_5]\mathrm{I_3}$

B. $[\mathrm{Co}(\mathrm{NO_2})_3(\mathrm{NH_3})_3]$

C. $\mathrm{Na}\,[\mathrm{Co}(\mathrm{NO_2})_6]$

D. $[\mathrm{Fe}(\mathrm{H_2O})_3(\mathrm{NCS})]\mathrm{Cl_2}$

Answer: B

Solution:

The complexes in which the coordination sphere does not carry any charge are called neutral complexes. $[\mathrm{Co}(\mathrm{NO_2})_3(\mathrm{NH_3})_3]$ is a neutral complex. $[\mathrm{Co}\,(\mathrm{H_2O})(\mathrm{NH_3})_5]\mathrm{I_3}$ and $[\mathrm{Fe}(\mathrm{H_2O})_3(\mathrm{NCS})]\mathrm{Cl_2}$ are cationic complexes whereas $\mathrm{Na}\,[\mathrm{Co}(\mathrm{NO_2})_6]$ is an anionic complex.

A neutral complex does not have any counter ion (either positive or negative). So, options (A), (C) and (D) can be eliminated.

Question82

What is the calculated value of spin only magnetic moment in terms of BM if only one unpaired electron is present in a species?

MHT CET 2023 10th May Evening Shift

Options:

A. 2.76

B. 2.84

C. 2.2

D. 1.73

Answer: D

Solution:

No. of unpaired $\mathrm{e}^- = 1$

$\mu = \sqrt{\mathrm{n}(\mathrm{n}+2)} = \sqrt{1(1+2)} = \sqrt{3} = 1.73$ BM

Question83

What type of ligand does the ethylenediamine is?

MHT CET 2023 10th May Evening Shift

Options:

A. Monodentate

B. Bidentate

C. Tetradentate

D. Hexadentate

Answer: B

Solution:

Ethylenediamine is a bidentate ligand. This means it has two donor atoms, which in the case of ethylenediamine, are the two nitrogen atoms. Each of these nitrogen atoms has a lone pair of electrons that can be donated to a central metal ion in a coordination complex. Therefore, the correct option is :

Option B : Bidentate

Question84

Which from following complexes is heteroleptic?

MHT CET 2023 10th May Evening Shift

Options:

A. $\mathrm{K_3\left[Al(C_2O_4)_3\right]}$

B. $\mathrm{[Co(C_2O_4)_3]^{3-}}$

C. $\mathrm{Na_3\left[AlF_6\right]}$

D. $\mathrm{\left[Co\left(H_2O\right)(NH_3)_5\right]_3}$

Answer: D

Solution:

Complexes in which metal ion is surrounded by more than one type of ligands are heteroleptic. Among the given complexes, option (D) is a heteroleptic complex.

Question85

What is the value of effective atomic number of cobalt in $\mathrm{[Co(NH_3)_6]^{3+}}$ complex if $\mathrm{Co(Z=27)}$?

MHT CET 2023 10th May Morning Shift

Options:

A. 30

B. 32

C. 35

D. 36

Answer: D

Solution:

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

Oxidation state of cobalt is +3 and six ligands donate 12 electrons.

$Z = 27; X = 3; Y = 12$

$\text{EAN of } Co^{3+} = Z - X + Y$

$= 27 - 3 + 12 = 36$

Question86

Identify heteroleptic complex from following.

MHT CET 2023 10th May Morning Shift

Options:

A. Tetraamminediaquacobalt (III) chloride

B. Hexaamminecobalt (III) bromide

C. Potassium tetrahydroxozincate (II)

D. Tetracarbonyl nickel (0)

Answer: A

Solution:

Complex	Formula
Tetraamminediaquacobalt(III) chloride	$[Co(NH_3)_4(H_2O)_2]Cl_3$
Hexaamminecobalt(III)	$[Co(NH_3)_6]Br_3$
Potassium tetrahydroxozincate(II)	$K_2[Zn(OH)_4]$

Complex	Formula
Tetracarbonyl nickel(0)	$[Ni(CO)_4]$

Question87

Identify monodentate ligand from the following.

MHT CET 2023 9th May Evening Shift

Options:

A. Cyanide ion

B. Ethylenediamine

C. Oxalate ion

D. Ethylendiaminetetraacetate

Answer: A

Solution:

Ligand	Type of ligand
CN^-	Monodentate
Ethylenediamine	Bidentate
Oxalate ion	Bidentate
Ethylendiaminetetraacetate	Hexadentate

Question88

Which from the following coordinate complexes contains anionic and neutral ligands in it?

MHT CET 2023 9th May Evening Shift

Options:

A. Potassium trioxalatoaluminate(III)

B. Hexacyanoferrate (II)

C. Pentaamminecarbonatocobalt (III) chloride

D. Tetraamminecopper(II) ion

Answer: C

Solution:

Pentaamminecarbonatocobalt(III) chloride: $[Co(NH_3)_5(CO_3)]Cl$

It contains anionic ligand $\left(CO_3^{2-}\right)$ and neutral ligand (NH_3).

NH_3 (named as ammine) is a neutral ligand. Both (C) and (D) contain NH_3 ligand. However, (D) contains only NH_3. Hence, option (C) should be valid.

Question89

Identify neutral ligand from following

MHT CET 2023 9th May Morning Shift

Options:

A. Ammine

B. Nitrato

C. Cyano

D. Chloro

Answer: A

Solution:

The neutral ligand from the options provided is :

Option A

Ammine

An ammine in coordination chemistry refers to an ammonia molecule acting as a ligand, attached to the central metal atom/ion through a lone pair of electrons. It is neutral because the ammonia molecule itself does not carry any net charge.

Question90

Identify the type of hybridization involved in hexaaminecobalt (III) complex ion.

MHT CET 2022 11th August Evening Shift

Options:

A. sp^3

B. dsp^2

C. d^2sp^3

D. sp^3d^2

Answer: C

Solution:

The hexaaminecobalt(III) complex ion has the formula $[Co(NH_3)_6]^{3+}$. The cobalt in this complex is in the +3 oxidation state, which means it has lost three electrons from its valence shell. Cobalt as a transition metal has the electronic configuration of $[Ar]3d^74s^2$ in its neutral state. When it loses three electrons to become Co^{3+}, it has an electronic configuration of $[Ar]3d^6$.

In this complex, cobalt is surrounded by six NH_3 (ammonia) ligands, which are all monodentate and donate a pair of electrons to the metal center for bonding. Due to this, cobalt needs to have six hybridized orbitals to accommodate the bond formation with these six ligands.

This coordination number of 6 typically leads to octahedral geometry, and the hybridization of the orbitals in cobalt required to form this geometry is d^2sp^3. This includes two d orbitals, one s orbital, and three p orbitals mixing to give six hybridized orbitals. Each of the hybrid orbitals will overlap with the s orbital of the nitrogen in ammonia to form a sigma bond.

Hence, the correct hybridization for the cobalt in the hexaaminecobalt(III) complex ion is d^2sp^3.

Therefore, the correct answer is:

Option C

d^2sp^3

Question91

What is the number of unpaired electrons in $[Co(NH_3)_6]^{3+}$ complex?

MHT CET 2022 11th August Evening Shift

Options:

A. Four

B. Two

C. Zero

D. Six

Answer: C

Solution:

Configuration of Co^{3+} is $1\,s^2, 2\,s^2, 2p^6, 3\,s^2, 3p^6, 3\,d^6, 4\,s^0$

Question92

What is oxidation state of cobalt in a coordination complex if it's EAN is 36 and the value of C.N. is 6 (Given: Atomic number of cobalt = 27).

MHT CET 2021 24th September Evening Shift

Options:

A. +4

B. +2

C. +1

D. +3

Answer: D

Solution:

$\mathrm{EAN} = \mathrm{Z} - \mathrm{X} + \mathrm{Y}$

Here, $\mathrm{EAN} = 36, \mathrm{Z} = 27, \mathrm{Y} = 12 (\because \mathrm{C.N.} = 6)$

$\therefore$ Oxidation state (X) of $\mathrm{Co} = \mathrm{Z} + \mathrm{Y} - \mathrm{EAN} = 27 + 12 - 36 = +3$

Question93

Which among the following is a correct order of increasing field strength of ligands?

MHT CET 2021 24th September Evening Shift

Options:

A. $\mathrm{I^- < OH^- < NH_3 < S^{2-}}$

B. $\mathrm{NH_3 < OH^- < I < S^{2-}}$

C. $\mathrm{OH^- < S^{2-} < \Gamma < NH_3}$

D. $\mathrm{I^- < S^{2-} < OH^- < NH_3}$

Answer: D

Solution:

The field strength of ligands is an important concept in coordination chemistry and is often determined using the spectrochemical series. The spectrochemical series is a list of ligands ordered by the strength of the field they produce around a central metal ion. The series generally runs as follows (from weak field to strong field ligands):

$\mathrm{I^- < Br^- < S^{2-} < SCN^- \approx Cl^- < NO_3^- \approx F^- < OH^- < H_2O < NCS^- < NH_3 < en < bipy < phen < NO_2^- < PR_3 < CN^- \approx CO}$

Based on this series, we can identify the correct order of increasing field strength among the given options:

Option A:

$\mathrm{I^- < OH^- < NH_3 < S^{2-}}$

Option B:

$NH_3 < OH^- < I < S^{2-}$

Option C:

$OH^- < S^{2-} < \Gamma < NH_3$

Option D:

$I^- < S^{2-} < OH^- < NH_3$

Referring to the spectrochemical series, the correct order of increasing field strength should be:

$I^- < S^{2-} < OH^- < NH_3$

Therefore, Option D is the correct answer.

Question94

Which among the following cations will form lowest stability complex if the ligand remains the same?

MHT CET 2021 24th September Morning Shift

Options:

A. Cu^{2+}

B. Fe^{2+}

C. Cd^{2+}

D. Ni^{2+}

Answer: C

Solution:

Stability order for given divalent metal ions is :

$Cu^{2+} > Ni^{2+} > Fe^{2+} > Cd^{2+}$

The charge to size ratio of Cd^{2+} is lower and hence it forms lowest stability complex if the ligand remains same.

Question95

Which among following statements is true about $Na_4\,[Fe(CN)_6]$?

MHT CET 2021 24th September Morning Shift

Options:

A. The complex ion carries -4 charge.

B. It is a neutral complex.

C. The oxidation state of Fe in this complex is +6.

D. The C.N. of Fe in this complex is 10.

Answer: A

Solution:

To determine which statement is true about the complex $\mathrm{Na_4\,[Fe(CN)_6]}$, let's analyze the complex step by step.

Option A: The complex ion carries -4 charge.

Consider the complex ion $[\mathrm{Fe(CN)_6}]^{n-}$. We know that sodium (Na) is a monovalent cation with a $+1$ charge. Since there are 4 sodium ions, the total positive charge contributed by sodium is $+4$. For the compound to be neutral, the charge on the complex ion must be -4 to balance the $+4$ from the sodium ions.

Hence, $[\mathrm{Fe(CN)_6}]$ does carry a -4 charge.

Option A is correct.

Option B: It is a neutral complex.

The complex $\mathrm{Na_4\,[Fe(CN)_6]}$ is composed of the $[\mathrm{Fe(CN)_6}]$ complex ion and 4 sodium ions. The $[\mathrm{Fe(CN)_6}]$ complex carries a -4 charge, which is balanced by the $+4$ from the sodium ions, making the entire compound neutral.

Option B is correct in context of compound being overall neutral, but the question pertains to complex ion itself.

Option C: The oxidation state of Fe in this complex is +6.

To determine the oxidation state of Fe, let's consider the charge on the cyanide ligands (CN). Each CN ligand carries a -1 charge. There are 6 cyanide ligands, contributing a total of -6 charge.

Let x be the oxidation state of Fe. The charge on the complex ion is -4:

$x + 6 \cdot (-1) = -4$

$x - 6 = -4$

$x = +2$

Therefore, the oxidation state of Fe is +2, not +6.

Option C is incorrect.

Option D: The coordination number (C.N.) of Fe in this complex is 10.

The coordination number refers to the number of ligand donor atoms to which the metal is directly bonded. In this case, Fe is bonded to 6 cyanide ligands. Therefore, the coordination number of Fe is 6.

Option D is incorrect.

Thus, the correct statement is:

Option A The complex ion carries -4 charge.

Question96

What is IUPAC name of $\mathrm{[Co(H_2O)(NH_3)_5]I_3}$?

MHT CET 2021 23rd September Evening Shift

Options:

A. Pentaammineaquacobalt (III) iodide

B. Pentaammineaquocobalt iodide

C. Monoaquapentaammine triiodo cobaltate

D. Pentaammineaquatriiodo cobaltate

Answer: A

Solution:

To determine the IUPAC name of the complex $[Co(H_2O)(NH_3)_5]I_3$, we need to follow the rules for naming coordination compounds:

1. First, identify the ligands and the central metal atom in the complex. In this case, the ligands are H_2O (aqua) and NH_3 (ammine), and the central metal atom is cobalt (Co).

2. The cationic complex name should list ligands in alphabetical order. Here, 'aqua' comes before 'ammine' alphabetically.

3. The name of the central metal is followed by its oxidation state in parentheses in Roman numerals. Cobalt in this complex has an oxidation state of +3. This is because the overall charge of the complex is balanced by three iodide ions, each with a -1 charge, making the metal center +3 to offset the charges.

4. Write the names of counter-ions (here, iodide) as separate words after naming the complex ion.

Given these rules, the name of the complex is constructed as follows:

- "Aqua" for H_2O

- "Pentaammine" for 5 NH_3 molecules

- "Cobalt(III)" for the central metal with its oxidation state

- "Iodide" for the counter-ion

Thus, the IUPAC name for $[Co(H_2O)(NH_3)_5]I_3$ is:

Pentaammineaquacobalt(III) iodide

Therefore, the correct option is:

Option A: Pentaammineaquacobalt (III) iodide

Question97

What is effective atomic number of Pt in $\left[\mathrm{Pt}(\mathrm{NH_3})_4\right]^{2+}$? (Given atomic number of $\mathrm{Pt} = 78$)

MHT CET 2021 23rd September Evening Shift

Options:

A. 76

B. 84

C. 72

D. 86

Answer: B

Solution:

The Effective Atomic Number (EAN) of a metal in a complex is calculated as follows:

EAN = (Atomic number of the metal) − (Oxidation state of the metal) + (Number of electrons donated by ligands)

Given:

Atomic number of $\mathrm{Pt} = 78$

In the complex $[\mathrm{Pt(NH_3)_4}]^{2+}$, the oxidation state of Pt is +2.

Each $\mathrm{NH_3}$ ligand donates 2 electrons, and there are 4 such ligands.

Using the formula, we can calculate the EAN:

$\mathrm{EAN} = 78 - 2 + 4 \times 2$

$\mathrm{EAN} = 78 - 2 + 8$

$\mathrm{EAN} = 84$

Therefore, the effective atomic number of Pt in $[\mathrm{Pt(NH_3)_4}]^{2+}$ is 84.

The correct option is **Option B: 84**.

Question98

Which of the following complexes is diamagnetic and square planar?

MHT CET 2021 23th September Morning Shift

Options:

A. $[\mathrm{CoF_6}]^{3-}$

B. $[\mathrm{Co(NH_3)_6}]^{3+}$

C. $[\mathrm{NiCl_4}]^{2-}$

D. $[\mathrm{Ni(CN)_4}]^{2-}$

Answer: D

Solution:

$[\mathrm{CoF_6}]^{3-} \rightarrow$ Paramagnetic and octahedral

$[\mathrm{Co(NH_3)_6}]^{3+} \rightarrow$ Diamagnetic and octahedral

$[\mathrm{NiCl_4}]^{2-} \rightarrow$ Paramagnetic and tetrahedral

$[\mathrm{Ni(CN)_4}]^{2-} \rightarrow$ Diamagnetic and square planar

---

Question99

Identify the number of unpaired electrons present and geometry respectively of $[Co(NH_3)_6]^{3+}$ complex.

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Options:

A. 0, square planar

B. 2, square planar

C. 4, octahedral

D. 0, octahedral

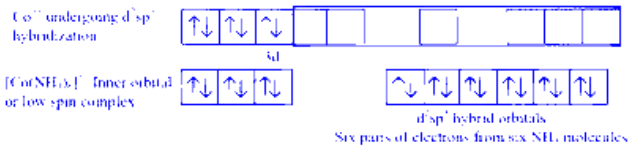
Answer: D

Solution:

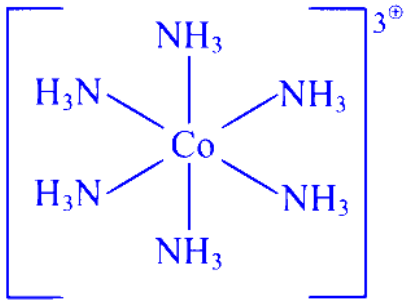
Consider the diamagnetic octahedral complex, $[Co(NH_3)_6]^{3+}$. In this complex ion, oxidation state of cobalt is +3. It has electronic configuration as 3 d^6. This complex involves the d^2sp^3 hybridization. The hybridization scheme is shown in diagram.

Orbitals of Co^{3+} ion

Since NH_3 is a strong ligand, due to spin pairing effect, all the four unpaired electrons in 3d orbital are paired giving two vacant 3d orbitals.



The six pairs of electrons, one from each NH_3 molecule, occupy the six hybrid orbitals. It proves that complex has octahedral geometry. Absence of unpaired electron makes this complex diamagnetic in nature.



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

Question100

Which among the following statements about $[Ni(CN)_4]^{2-}$ is NOT true?

MHT CET 2021 22th September Evening Shift

Options:

A. In this electrons are paired prior to hybridization.

B. Ni undergoes dsp^2 hybridization.

C. Oxidation state of Ni is +6 .

D. It is a square planar complex.

Answer: C

Solution:

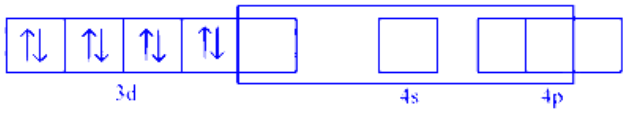
Structure of $[Ni(CN)_4]^{2-}$:

It is an example of square planar complex. The hybridisation involved is dsp^2. Nickel is in +2 oxidation state. It has electronic configuration $3d^8$. The hybridisation scheme is shown in diagram.

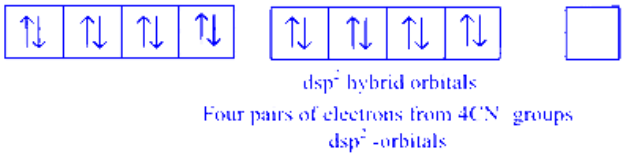
Orbitals of Ni^{2+} ion

Since CN^- is a strong ligand, one of the unpaired electrons in 3d orbital is promoted giving two paired electrons and one vacant 3d orbital.

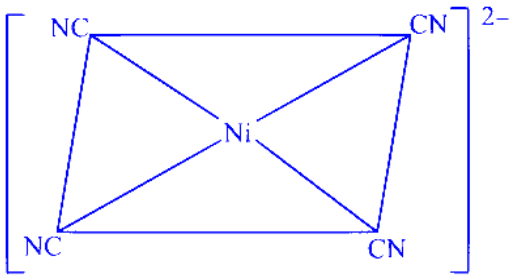
One 3d, one 4s and two 4*p* orbitals undergoing dsp^2 hybridization of Ni^{2+}



$[Ni(CN)_4]^{2-}$



Each of the hybridized orbitals receives a pair of electrons from a cyanide ion. The resulting complex ion is diamagnetic, since all the electrons are paired.



Structure of $[Ni(CN)_4]^{2-}$

Question101

Identify homoleptic complex from following.

MHT CET 2021 22th September Evening Shift

Options:

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

B. $[Co(NH_3)_5Cl]SO_4$

C. $[Co(NH_3)_4Cl_2]^{+}$

D. $[Co\,(H_2O)(NH_3)_5]I_3$

Answer: A

Solution:

$[Co(NH_3)_6]^{3+}$ - Here only one type of ligands surrounds the Co^{3+} ion, hence it is homoleptic complex.

Question102

What is the number of N atoms present in EDTA?

MHT CET 2021 22th September Morning Shift

Options:

A. 2

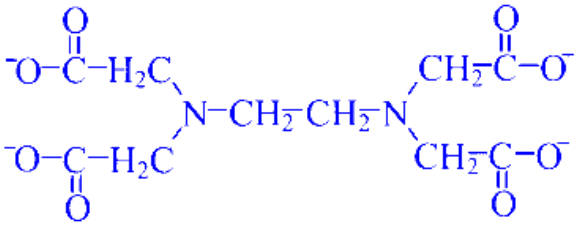
B. 3

C. 4

D. 1

Answer: A

Solution:



Ethylenediaminetetraacetate ion

Two N atoms are present in EDTA.

Question103

What type of hybridization is present in Ni of $[Ni(Cl)_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ respectively?

MHT CET 2021 22th September Morning Shift

Options:

A. $d\text{sp}^2$ and $d\text{dp}^2$

B. sp^3 and dsp^2

C. dsp^2 and sp^3

D. sp^3 and sp^3

Answer: B

Solution:

To determine the type of hybridization in Ni in $[Ni(Cl)_4]^{2-}$ and $[Ni(CN)_4]^{2-}$, we need to examine the nature of the ligands and the electronic configuration of Ni in these complexes.

First, let's consider the electronic configuration of Ni. The atomic number of nickel is 28, so the ground state electron configuration is:

$[Ar]3d^8 4s^2$

In the formation of both complexes, nickel is in the +2 oxidation state, so it loses two electrons from the 4s orbital:

Ni^{2+} : $[Ar]3d^8$

1. For $[Ni(Cl)_4]^{2-}$:

- The chloride ion, Cl^-, is a weak field ligand. It does not cause a significant splitting of the d-orbitals.

- Because of this, the $3d$ orbitals remain paired, and hybridization involves the 4s and 4p orbitals.

Thus, the hybridization for $[Ni(Cl)_4]^{2-}$ is sp^3.

2. For $[Ni(CN)_4]^{2-}$:

- The cyanide ion, CN^-, is a strong field ligand. It causes a significant splitting of the d-orbitals.

- This strong field splits the $3d$ orbitals to the point where pairing of electrons occurs within the $3d$ orbitals, and one $3d$ orbital is available for hybridization.

- The hybridization involves one $3d$, one $4s$, and two $4p$ orbitals.

Thus, the hybridization for $[Ni(CN)_4]^{2-}$ is dsp^2.

Therefore, the correct answer is:

Option B sp^3 and dsp^2

Question104

Identify cationic complex from following.

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Options:

A. $Na_3[AlF_6]$

B. $[Pt(NH_3)_2Cl_2]$

C. $K_4[Fe(CN)_6]$

D. $[PtBr_2(NH_3)_4]Br_2$

Answer: D

Solution:

$[PtBr_2(NH_3)_4]Br_2 \longrightarrow [PtBr_2(NH_3)_4]^{2+} + 2Br^-$

Question105

What is effective atomic number of cobalt in $[Co(NH_3)_6]^{3+}$ if Co(Z = 27) ?

MHT CET 2021 21th September Evening Shift

Options:

A. 30

B. 33

C. 27

D. 36

Answer: D

Solution:

$[Co(NH_3)_6]^{3+} \Rightarrow Z = 27, X = 3, Y = 12$

EAN of $Co^{3+} \Rightarrow Z - X + Y = 27 - 3 + 12 = 36$

Question106

Which among the following is NOT a neutral ligand?

MHT CET 2021 21th September Morning Shift

Options:

A. Thiocyanate

B. Ammine

C. Aqua

D. Carbon monoxide

Answer: A

Solution:

Thiocyanate (SCN^-) is a neutral ligand.

Question107

Identify homoleptic complex from following :

MHT CET 2021 21th September Morning Shift

Options:

A. $[Co(NH_3)_6]Cl_3$

B. $[Co(NH_3)_4Cl_2]$

C. $[Co(NH_3)_5Cl]SO_4$

D. $[Co(ONO)(NH_3)_5Cl_2]$

Answer: A

Solution:

$[Co(NH_3)_6]Cl_3 \rightarrow$ Here, only one type of ligand i.e. NH_3 surrounds the Co^{3+} ion. Hence, it is homoleptic complex.

Question108

What type of hybridization is exhibited by $[CoF_6]^{3-}$?

MHT CET 2021 20th September Evening Shift

Options:

A. sp^3

B. sp^3d^2

C. dsp^2

D. d^2sp^3

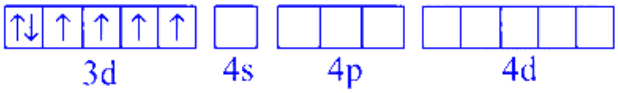
Answer: B

Solution:

Formation of $[CoF_6]^{3-}$

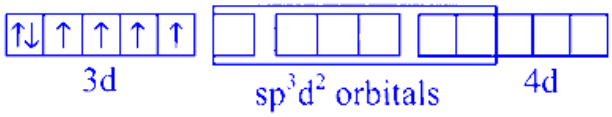
It is an example of sp^3d^2 hybridization. An octahedral complex shows paramagnetic behaviour. It is therefore called outer orbital or high spin or spin free complex.

Orbitals of Co^{3+} ion

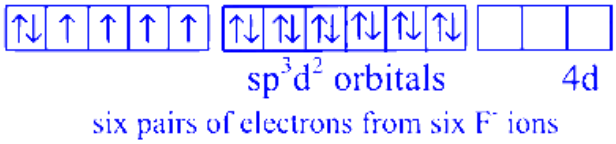


Since F^- is a weak ligand, there is no spin pairing effect and Co^{3+} possesses 4 unpaired electrons.

Co^{3+} undergoing sp^3d^2 hybridization



$[CoF_6]^{3-}$ (Outer orbital or High spin complex)



Question109

Identify neutral complex from following.

MHT CET 2021 20th September Evening Shift

Options:

A. $Na_3\,[AlF_6]$

B. $[Co(NO_2)_3(NH_3)_3]$

C. $[Cu(NH_3)_4]^{2+}$

D. $[Fe(CN)_6]^{4-}$

Answer: B

Solution:

(A) $Na_3\,[AlF_6]$ - Anionic

(B) $[Co(NO_2)_3(NH_3)_3]-$ Neutral

(C) $[Cu(NH_3)_4]^{2+}$ - Cationic

(D) $[Fe(CN)_6]^{4-}$ - Anionic

Question110

Which among the following statements is true for $Pt[(NH_3)_2Cl_2]$?

MHT CET 2021 20th September Morning Shift

Options:

A. It is a neutral complex.

B. In this complex chlorine atoms are in ionization sphere.

C. The coordination number of Pt in this complex is 2.

D. The oxidation state of Pt in this complex is +4.

Answer: A

Solution:

$Pt[(NH_3)_2Cl_2] \rightarrow$ It is a neutral complex. In this complex, chlorine atoms are in coordination sphere. Coordination number of Pt = 4, oxidation state of Pt = +2.

Question111

Identify highest field strength ligand from following.

MHT CET 2021 20th September Morning Shift

Options:

A. H_2O

B. EDTA

C. en

D. S^{--}

Answer: C

Solution:

Ligands strength $\Rightarrow S^{2-} < H_2O <$ EDTA < en

Question112

Identify the number of donor groups present in EDTA.

MHT CET 2020 19th October Evening Shift

Options:

A. Six

B. Three

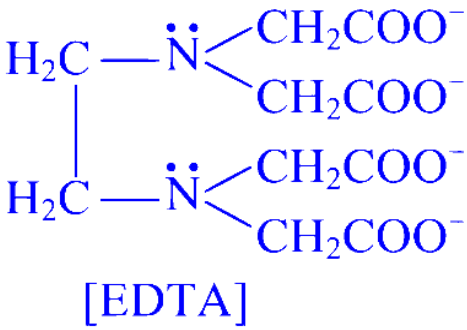
C. Four

D. Two

Answer: A

Solution:

Ethylenediaminetetraacetate [EDTA] is an hexadentate ligand. It can bind through two nitrogen and four oxygen atoms to a central metal ion.



[EDTA]

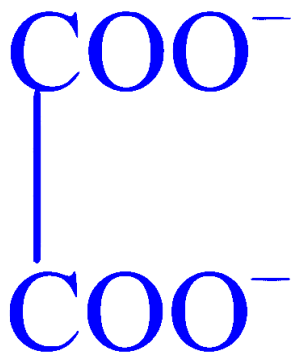
Question113

Which among the following is an ambidentate ligand?

MHT CET 2020 19th October Evening Shift

Options:

A.



B. NO_2^-

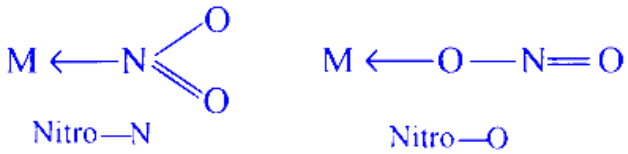
C.

D. H_2O

Answer: B

Solution:

NO_2^- is an ambidentate ligand. Ligand, which has two different donor atoms and either of the two ligands in the complex is called ambidentate ligand.



In NO_2^- ion can coordinate either through nitrogen or through oxygen to a central metal atom/ion.

Question114

What is the number of $= N - OH$ groups present in dimethyl glyoximato?

MHT CET 2020 16th October Evening Shift

Options:

A. 4

B. 1

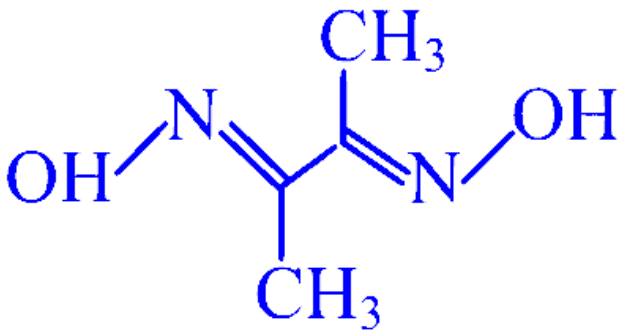
C. 2

D. 3

Answer: C

Solution:

,Two $=\mathrm{N}-\mathrm{OH}$ groups present in dimethy glyoximato.



Dimethyl glyoximato is a bidentate ligand. It is commonly known as DMG. Chemical formula $\mathrm{C_4H_8N_2O_2}$.

Question115

What is the secondary valence of $\mathrm{Co^{3+}}$ ion according to Werner's theory in $\mathrm{[Co(NH_3)_4Cl_2]^+}$?

MHT CET 2020 16th October Evening Shift

Options:

A. 3

B. 6

C. 5

D. 4

Answer: B

Solution:

In the complex $[Co(NH_3)_4Cl_2]^+$, the secondary valence of Co^{3+} ion according to Warner's theory is 6. The secondary valences are non-ionisable. These are satisfied by neutral molecules or negative ions. The secondary valence is equal to the coordination number and is fixed for a metal.

Question116

What is the effective atomic number of Zn in $[Zn(NH_3)_4]SO_4$?

MHT CET 2020 16th October Morning Shift

Options:

A. 30

B. 27

C. 28

D. 36

Answer: D

Solution:

$[Zn(NH_3)_4]SO_4$

EAN = [atomic number of metal atom − oxidation number of metal atom) + 2× number of ligands $[Zn(NH_3)_4SO_4]$ can be written as $[Zn(NH_3)_4]^{2+}SO_4^{2-}$

$$\begin{aligned} \text{EAN } &= [30-(+2)+(2\times 4)] \\ &= [28+8] \\ &= 36 \end{aligned}$$

Thus, EAN of Zn in $[Zn(NH_3)_4]SO_4$ is 36.

Question117

Identify the tetradentate ligand from the following.

MHT CET 2020 16th October Morning Shift

Options:

A. Triethylene tetramine

B. Ethylene diamine tetracetato

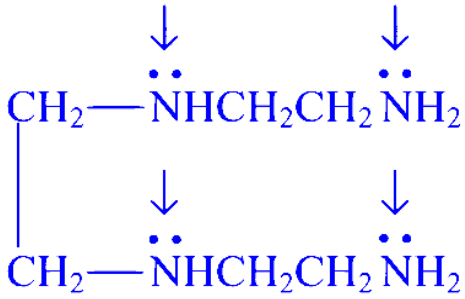
C. Dimethyl glyoximato

D. Oxalato

Answer: A

Solution:

Triethylene tetramine is a tetradentate ligand with the formula $[CH_2NHCH_2CH_2NH_2]_2$. This bind with four donor atoms to a central atom to form a coordination complex. This number of donor atoms that bind is called denticity and is a way to classify ligands.



Triethylene tetramine (trien)

Question118

Which of the following salt contain interstitial water molecule in it?

MHT CET 2020 16th October Morning Shift

Options:

A. $BaCl_2 \cdot 2H_2O$

B. $[Cu(H_2O)_2(NH_3)_5]Cl_2$

C. $CuSO_4 \cdot 5H_2O$

D. $[Cr(H_2O)_6]^{3+} \cdot 3Cl^-$

Answer: A

Solution:

$BaCl_2 \cdot 2H_2O$ salt contain interstitial water molecule in it. They are the water molecules that are mainly trapped between the first and second solvation shells. It is present in the interstitial sites of a crystal lattice. Barium chloride dihydrate having two interstitial water molecule.

Question119

The effective atomic number of $\text{Iron}(z = 26)$ in $[Fe(CN)_6]^{-3}$ is

MHT CET 2019 3rd May Morning Shift

Options:

A. 36

B. 33

C. 35

D. 34

Answer: C

Solution:

In the given complex ion $[Fe(CN)_6]^{3-}$, the Fe is in +3 oxidation state. As we know that atomic number of iron is 26 . The number of electron in Fe^{3+} is 23 . Each of the six cyanide molecules donates a pair of electrons so that EAN becomes $23 + 2 \times 6 \Rightarrow 35$.

Question120

IUPAC name of the complex Ba[$CuCl_4$] is

MHT CET 2019 3rd May Morning Shift

Options:

A. barium tetrachlorocuprate (II)

B. tetrachlorobariumcuprate (III)

C. barium tetrachlorocuprate (III)

D. tetrachlorobarium copper (II)

Answer: A

Solution:

IUPAC name of the complex $Ba[CuCl_4]$ is barium tetrachlorocuprate (II). While naming a complex, the cation is named first and ligands are named in an alphabetical order before the name of the central atom or ion.

Question121

According to Werner's theory the geometry of the complex is determined by

MHT CET 2019 2nd May Evening Shift

Options:

A. only from the primary valence in space

B. number and position of the primary valences in space

C. number and position of the secondary valences in space

D. only from the position of secondary valence in space

Answer: C

Solution:

Werner's theory was used to describe the structure and formation of complex compounds or coordination compounds. According to this theory the primary valeney gives the oxidation number and the secondary valency gives the coordination number. Also, the geometry of the complex is determined by number and position of secondary valences in space as the ligand satisfying secondary valences are always directed towards fixed position in space.

Question122

Which among the following is a neutral complex?

MHT CET 2019 2nd May Evening Shift

Options:

A. $[Fe(H_2O)_6]Cl_3$

B. $[Ni(NH_3)_6]Cl_2$

C. $[Pt(NH_3)_2Cl_2]$

D. $K\,[Ag(CN)_2]$

Answer: C

Solution:

A neutral complex is a complex ion which have no charge on it. Among the given options $[Pt(NH_3)_2Cl_2]$ is a neutral complex. The type of complexes in other options are as follows:

(a) $[Fe(H_2O)_6]Cl_3$ - cationic complexes

(b) $[Ni(NH_3)_6]Cl_6$ - cationic complexes

(d) $K\,[Ag\,(CN_2)]$ - anionic complexes

Question123

Which complex among the following gives a white precipitate on treatment with an aqueous solution of barium chloride?

MHT CET 2019 2nd May Morning Shift

Options:

A. $[Pt(NH_3)_4Br_2]Cl_2$

B. $[Co(NH_3)_5SO_4]NO_2$

C. $[Co(NH_3)_5NO_2]SO_4$

D. $[Pt(NH_3)_4Cl_2]Br_2$

Answer: C

Solution:

Among the given coordination compounds, $[Co(NH_3)_5NO_2]SO_4$ gives a white precipitate on treatment with an aqueous solution of barium chloride. This can be explained by the following reaction.

$$[Co(NH_3)_5NO_2]SO_4 + BaCl_2(aq) \longrightarrow [Co(NH_3)_5NO_2]Cl_2 + \underset{\text{White ppt.}}{BaSO_4(s)}$$

The other given compounds do not give white ppt. due to absence of SO_4^{2-} ions.

Question124

Which among the following is used in the treatment of cancer?

MHT CET 2019 2nd May Morning Shift

Options:

A. cis $\{Pt(en)_2Cl_2]$

B. cis $\{PtCl_2(NH_3)_2]$

C. trans $\{Pt(en)_2Cl_2]$

D. trans $[Pt(NH_3)_2Cl_2]$

Answer: B

Solution:

Answer: B ***cis*-$[PtCl_2(NH_3)_2]$**

The compound used in the treatment of cancer is **cisplatin**, which has the chemical formula ***cis*-$[PtCl_2(NH_3)_2]$**. It is a well-known platinum-based chemotherapy drug that was approved for medical use in the 1970s.
