Coordination Compounds

Question1

Ethylene diaminetetraacetate ion is a/an:

[NEET 2024 Re]

Options:

A.

hexadentate ligand

B.

ambidentate ligand

C.

monodentate ligand

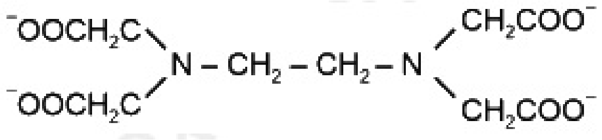
D.

bidentate ligand

Answer: A

Solution:

Ethylene diaminetetraacetate



It is hexadentate as it can bind through two nitrogen and four oxygen atoms to a central metal ion.

Question2

Which of the following is not an ambidentate ligand?

[NEET 2024 Re]

Options:

A.

$C_2O_4^{2-}$

B.

SCN^-

C.

NO_2^-

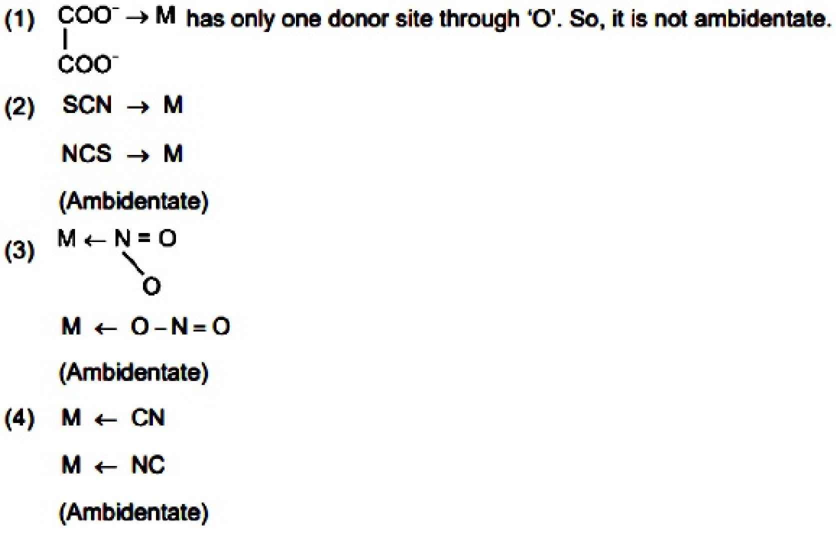
D.

CN^-

Answer: A

Solution:

Ambidentate ligands are those ligands which have two different donor atoms and either of two donor atom is attached to the metal during complex formation.



(1) $COO^- \rightarrow M$ has only one donor site through 'O'. So, it is not ambidentate.
COO^-

(2) $SCN \rightarrow M$

$NCS \rightarrow M$

(Ambidentate)

(3) $M \leftarrow N = O$
O

$M \leftarrow O-N=O$

(Ambidentate)

(4) $M \leftarrow CN$

$M \leftarrow NC$

(Ambidentate)

Question3

$[Mn_2(CO)_{10}]$ and $[Co_2(CO)_8]$ structures have

A. Metal-Metal linkage
B. Terminal CO groups
C. Bridging CO groups
D. Metal in zero oxidation state

Choose the correct answer from the options given below

[NEET 2024 Re]

Options:

A.

Only A, B, C

B.

Only B, C, D

C.

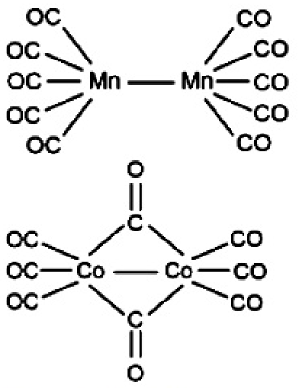
Only A, C, D

D.

Only A, B, D

Answer: D

Solution:



A. Metal-Metal linkage present.

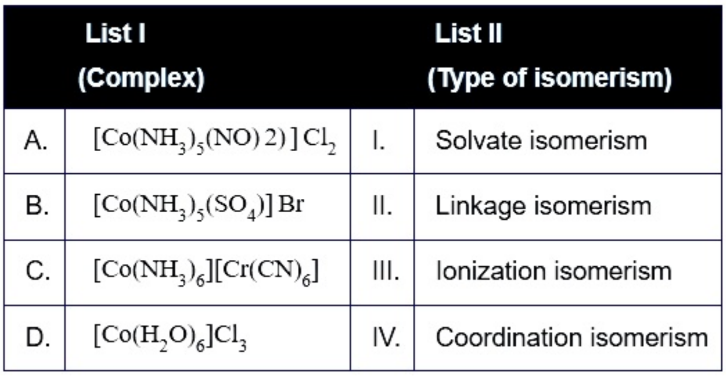
B. Terminal CO groups are present

C. In $[Mn_2(CO)_{10}]$ bridging CO groups are not present.

D. Metal is in zero oxidation state.

Question4

Match List I with List II.



	List I (Complex)		List II (Type of isomerism)
A.	$[Co(NH_3)_5(NO)2)]Cl_2$	I.	Solvate isomerism
B.	$[Co(NH_3)_5(SO_4)]Br$	II.	Linkage isomerism
C.	$[Co(NH_3)_6][Cr(CN)_6]$	III.	Ionization isomerism
D.	$[Co(H_2O)_6]Cl_3$	IV.	Coordination isomerism

Choose the correct answer from the options given below:

[NEET 2024]

Options:

A.

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

B.

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

C.

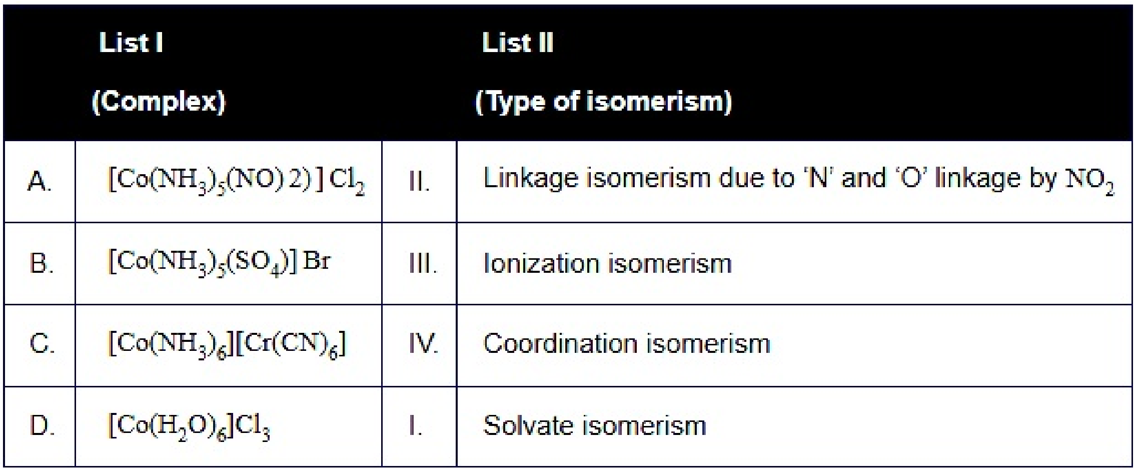
A-I, B-IV, C-III, D-II

D.

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

Answer: A

Solution:



List I (Complex)		List II (Type of isomerism)	
A.	$[Co(NH_3)_5(NO)2)]Cl_2$	II.	Linkage isomerism due to 'N' and 'O' linkage by NO_2
B.	$[Co(NH_3)_5(SO_4)]Br$	III.	Ionization isomerism
C.	$[Co(NH_3)_6][Cr(CN)_6]$	IV.	Coordination isomerism
D.	$[Co(H_2O)_6]Cl_3$	I.	Solvate isomerism

Question5

Given below are two statements :

Statement I: Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behaviour.

Statement II: $[Co(NH_3)_6]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic.

In the light of the above statements, choose the correct answer from the options given below:

[NEET 2024]

Options:

A.

Both Statement I and Statement II are true

B.

Both Statement I and Statement II are false

C.

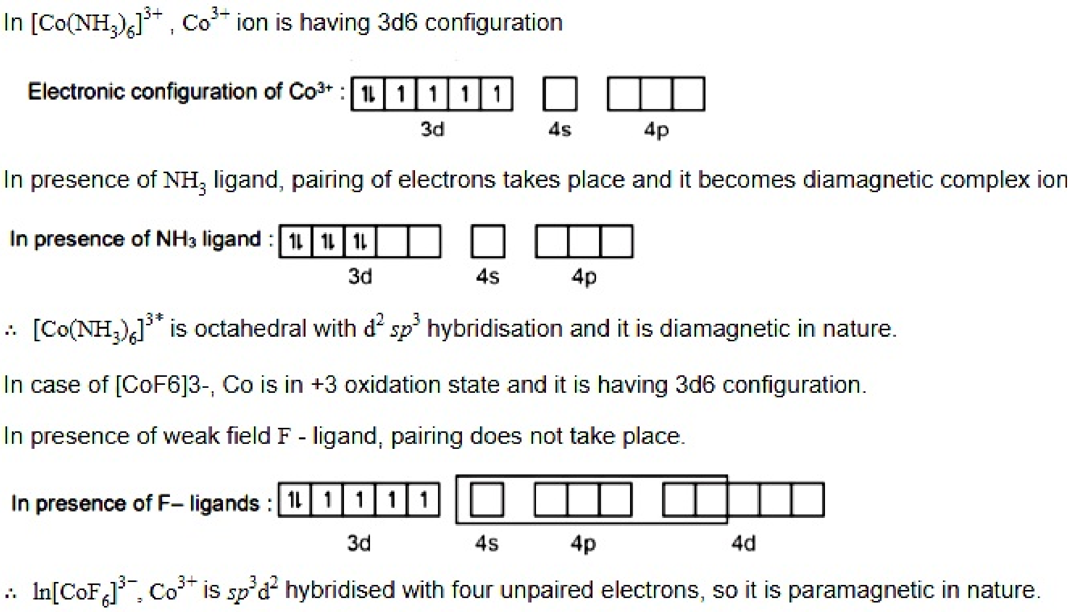
Statement I is true but Statement II is false

D.

Statement I is false but Statement II is true

Answer: A

Solution:



In $[Co(NH_3)_6]^{3+}$, Co^{3+} ion is having 3d6 configuration

Electronic configuration of Co^{3+} : ⥮ 1 1 1 1 ☐ ☐☐☐

3d 4s 4p

In presence of NH_3 ligand, pairing of electrons takes place and it becomes diamagnetic complex ion

In presence of NH_3 ligand : ⥮ ⥮ ⥮ ☐☐ ☐ ☐☐☐

3d 4s 4p

∴ $[Co(NH_3)_6]^{3*}$ is octahedral with d^2sp^3 hybridisation and it is diamagnetic in nature.

In case of [CoF6]3-, Co is in +3 oxidation state and it is having 3d6 configuration.

In presence of weak field F - ligand, pairing does not take place.

In presence of F– ligands : ⥮ 1 1 1 1 ☐ ☐☐☐ ☐☐☐☐☐

3d 4s 4p 4d

∴ In$[CoF_6]^{3-}$, Co^{3+} is sp^3d^2 hybridised with four unpaired electrons, so it is paramagnetic in nature.

Question6

Given below are two statements :

Statement I : $[Co(NH_3)_6]^{3+}$ is a homoleptic complex whereas $[Co(NH_3)_4Cl_2]^+$ is a heteroleptic complex.

Statement II : Complex $[Co(NH_3)_6]^{3+}$ has only one kind of ligands but $[Co(NH_3)_4Cl_2]^+$ has more than one kind of ligands.

In the light of the above statements, choose the correct answer from the options given below.

[NEET 2024]

Options:

A.

Both Statement I and Statement II are true

B.

Both Statement I and Statement II are false

C.

Statement I is true but Statement II is false

D.

Statement I is false but Statement II is true

Answer: A

Solution:

$[Co(NH_3)_6]^{3+}$ is a homoleptic complex as only one type of ligands (NH_3) is coordinated with Co^{3+} ion. While $[Co(NH_3)_4Cl_2]+$ is a heteroleptic complex in which Co^{3+} ion is ligatedwith more than one type of ligands, i.e., NH_3 and Cl^-.

Question7

Homoleptic complex from the following complexes is

[NEET 2023]

Options:

A.

Diamminechloridonitrito-N-platinum (II)

B.

Pentaamminecarbonatocobalt (III) chloride

C.

Triamminetriaquachromium (III) chloride

D.

Potassium trioxalatoaluminate (III)

Answer: D

Solution:

Complexes in which a metal is bound to only one kind of donor groups are called as homoleptic complexes
Potassium trioxalatoaluminate (III)
$K_3[Al(OX)_3]$
It is a homoleptic complex

Question8

Which complex compound is most stable?

[NEET 2023]

Options:

A.

$[Co(NH_3)_3(NO_3)_3]$

B.

$[CoCl_2(en)_2]NO_3$

C.

$[Co(NH_3)_6]_2(SO_4)_3$

D.

$[Co(NH_3)_4(H_2O)Br](NO_3)_2$

Answer: B

Solution:

Chelating ligands in general form more stable complexes than their monodentate analogs

∴ The most stable complex is

$[CoCl_2(en)_2]NO_3$

Question9

Select the element (M) whose trihalides cannot be hydrolysed to produce an ion of the form $[M(H_2O)_6]^{3+}$

[NEET 2023 mpr]

Options:

A.

Ga

B.

In

C.

Al

D.

B

Answer: D

Solution:

Maximum covalency of boron is four.

Question10

Which of the following forms a set of complex and a double salt, respectively?

[NEET 2023 mpr]

Options:

A.

$CuSO_4.5H_2O$ and $CuCl_2,4NH_3$

B.

$PtCl_2 \cdot 2NH_3$ and $PtCl_4 \cdot 2HCl$

C.

$K_2PtCl_2 \cdot 2NH_3$ and $KAl(SO_4)2 \cdot 1_2H_2O$

D.

$NiCl_2 \cdot 6H_2O$ and $NiCl_2(H_2O)_4$

Answer: C

Solution:

Complex salt is $K_2[Pt(NH_3)_2Cl_2]$

Double salt is $KAl(SO_4)_2 \cdot 12H_2O$ (potash alum)

Question11

Type of isomerism exhibited by compounds

$[Cr(H_2O)_6Cl_3, [Cr(H_2O)_5Cl]Cl_2 \cdot H_2O.,$

$[Cr(H_2O)_4Cl_2]Cl._2H_2O$ and the value of coordination number (CN) of central metal ion in all these compounds, respectively is :

[NEET 2023 mpr]

Options:

A.

Geometrical isomerism, CN = 2

B.

Optical isomerism, CN = 4

C.

Ionisation isomerism, CN = 4

D.

Solvate isomerism, CN = 6

Answer: D

Solution:

Given complex compounds exhibit solvate isomerism having co-ordination number = 6.

Question12

The IUPAC name of the complex- $[Ag(H_2O)_2][Ag(CN)_2]$ is:
[NEET-2022]

Options:

A. dicyanidosilver(II) diaquaargentate(II)

B. diaquasilver(II) dicyanidoargentate(II)

C. dicyanidosilver(I) diaquaargentate(I)

D. diaquasilver(I) dicyanidoargentate(I)

Answer: D

Solution:

$[Ag(H_2O)_2][Ag(CN)_2]$

IUPAC name : diaquasilver(I)dicyanidoargentate(I)

Question13

The order of energy absorbed which is responsible for the color of complexes
(A) $[Ni(H_2O)_2(en)_2]^{2+}$
(B) $[Ni(H_2O)_4(en)]^{2+}$ and
(C) $[Ni(en)_3]^{2+}$ is
[NEET-2022]

Options:

A. (A) > (B) > (C)

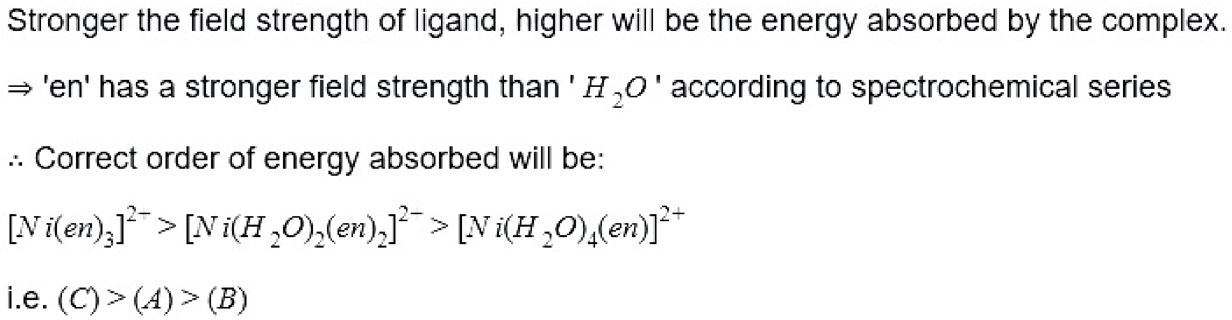
B. (C) > (B) > (A)

C. (C) > (A) > (B)

D. (B) > (A) > (C)

Answer: C

Solution:



Stronger the field strength of ligand, higher will be the energy absorbed by the complex.

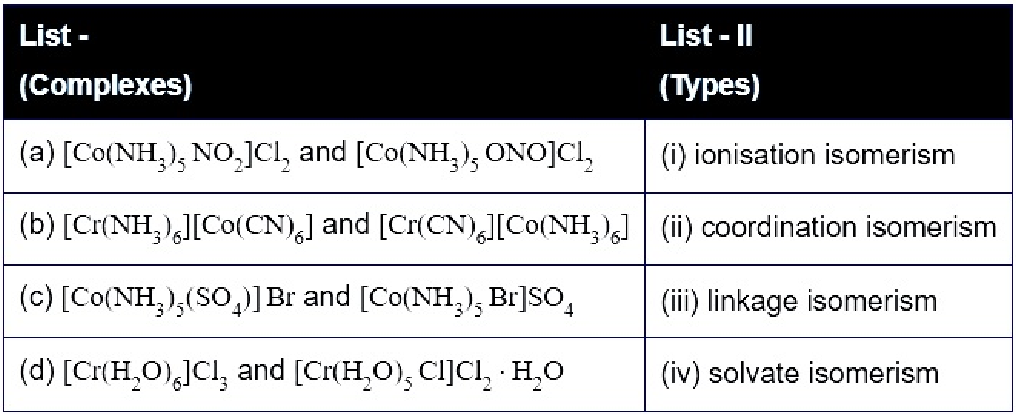
⇒ 'en' has a stronger field strength than 'H_2O' according to spectrochemical series

∴ Correct order of energy absorbed will be:

$[Ni(en)_3]^{2+} > [Ni(H_2O)_2(en)_2]^{2+} > [Ni(H_2O)_4(en)]^{2+}$

i.e. $(C) > (A) > (B)$

Question14



List - (Complexes)	List - II (Types)
(a) $[Co(NH_3)_5NO_2]Cl_2$ and $[Co(NH_3)_5ONO]Cl_2$	(i) ionisation isomerism
(b) $[Cr(NH_3)_6][Co(CN)_6]$ and $[Cr(CN)_6][Co(NH_3)_6]$	(ii) coordination isomerism
(c) $[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$	(iii) linkage isomerism
(d) $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$	(iv) solvate isomerism

Choose the correct answer from the options given below :
[NEET Re-2022]

Options:

A. (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

B. (a) - (iii), (b) - (i), (c) - (ii), (d) - (iv)

C. (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

D. (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

Answer: D

Solution:

- (a) $[Co(NH_3)_5NO_2]Cl_2$ and $[Co(NH_3)_5ONO]Cl_2$- (iii) Linkage isomerism due to ambidentate ligand
- (b) $[Cr(NH_3)_6][Co(CN)_6]$ $[Cr(CN)_6][Co(NH_3)_6]$- (ii) coordination and isomerism due to exchange of ligands between coordination spheres
- (c) $[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$ -(i) ionisation isomerism due to formation of different ions on

ionisation

- (d) $[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$-(iv) solvate isomerism as no. of water molecules as ligand and water of crystalisation is different

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Question15

Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The metal carbon bond in metal carbonyls possesses both σ and π character.
Reason (R): The ligand to metal bond is a π bond and metal to ligand bond is a σ bond.
In the Light of the above statements, choose the most appropriate answer from the options given below:
[NEET Re-2022]

Options:

A. (A) is not correct but (R) is correct

B. Both (A) and (R) are correct and (R) is the correct explanation of (A)

C. Both (A) and (R) are correct but (R) is not the correct explanation of (A)

D. (A) is correct but (R) is not correct

Answer: D

Solution:

Solution:

Metal-carbon bond in metal carbonyls possesses both σ and π character, So the assertion is correct.

The ligand to metal bond is σ bond and metal to ligand bond is π bond, So the reason is correct.

Question16

Ethylene diamine tetraacetate (EDTA) ion is :
[NEET 2021]

Options:

A. Hexadentate ligand with four "O" and two "N" donor atoms

B. Unidentate ligand

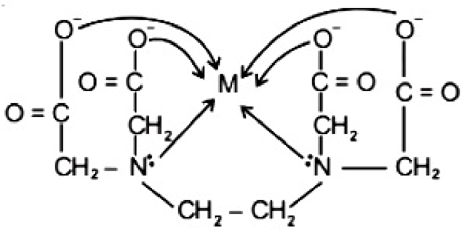
C. Bidentate ligand with two "N" donor atoms

D. Tridentate ligand with three "N" donor atoms

Answer: A

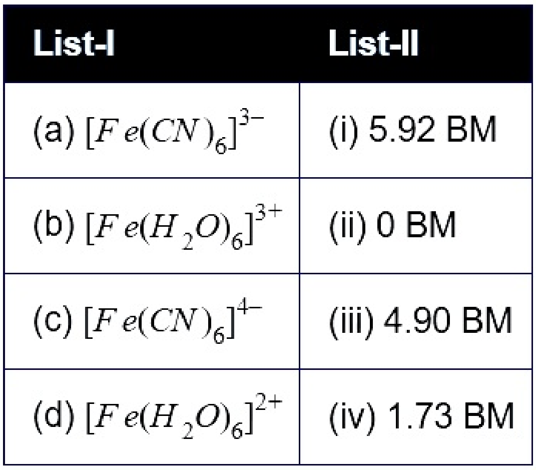
Solution:

Ethylene diamine tetraacetate (EDTA) ion is a hexadented ligand having four donor oxygen atoms and two donor nitrogen atoms



Question17

Match List-I with List-II



List-I	List-II
(a) $[Fe(CN)_6]^{3-}$	(i) 5.92 BM
(b) $[Fe(H_2O)_6]^{3+}$	(ii) 0 BM
(c) $[Fe(CN)_6]^{4-}$	(iii) 4.90 BM
(d) $[Fe(H_2O)_6]^{2+}$	(iv) 1.73 BM

Choose the correct answer from the options given below. [NEET 2021]

Options:

A. (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

B. (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

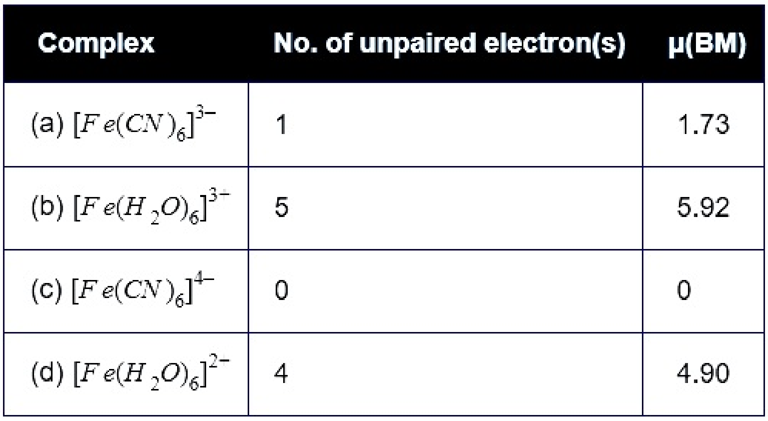
C. (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

D. (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)

Answer: D

Solution:

Magnetic moment, $\mu = \sqrt{n(n+2)}\,\mathrm{BM}$ (where $n =$ number of unpaired electrons)



Complex	No. of unpaired electron(s)	μ(BM)
(a) $[Fe(CN)_6]^{3-}$	1	1.73
(b) $[Fe(H_2O)_6]^{3+}$	5	5.92
(c) $[Fe(CN)_6]^{4-}$	0	0
(d) $[Fe(H_2O)_6]^{2+}$	4	4.90

Question18

Which of the following is the correct order of increasing field strength of ligands to form coordination compounds?
(2020)

Options:

A. $SCN^- < F^- < CN^- < C_2O_4^{2}$

B. $F^- < SCN^- < C_2O_4^{2-} < CN^-$

C. $CN^- < C_2O_4^{2-} < SCN^- < F^-$

D. $SCN^- < F^- < C_2O_4^{2-} < CN^-$

Answer: D

Solution:

(d) According to spectrochemical series, the order of ligand field strength is
$I^- < Br^- < SCN^{\ominus} < Cl^- < S^{2-} < F^- < OH < C_2O_4^{2-}$
$< H_2O < NCS < EDTA^{4-} < NH_3 < en < CN < CO$
So, correct order is
$SCN^- < F^- < C_2O_4^{2-} < CN^-$

Question19

The calculated spin only magnetic moment of Cr^{2+} ion is
(2020)

Options:

A. 4.90BM

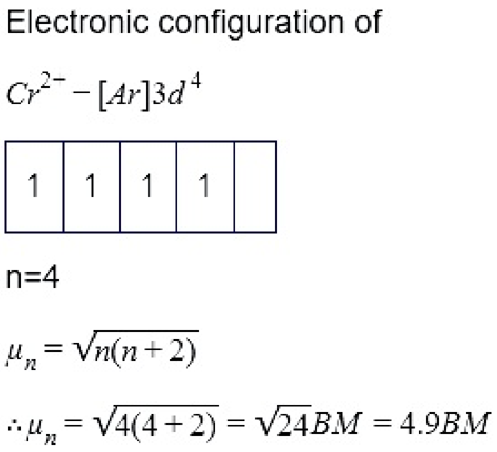
B. 5.92BM

C. 2.84BM

D. 3.87BM

Answer: A

Solution:



Electronic configuration of

$Cr^{2+} - [Ar]3d^4$

n=4

$\mu_n = \sqrt{n(n+2)}$

$\therefore \mu_n = \sqrt{4(4+2)} = \sqrt{24}BM = 4.9BM$

Question20

What is the correct electronic configuration of the central atom in $K_4[Fe(CN)_6]$ based on crystal field theory?
(NEET 2019)

Options:

A. $e^4t_2^{\,2}$

B. $t_2^{\,4}e_g^{\,2}$

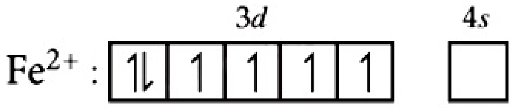
C. $t_{2g}^{\,6}e_g^{\,0}$

D. $e^3t_2^{\,3}$

Answer: C

Solution:

In $K_4[Fe(CN)_6]$ complex, Fe is in +2 oxidation state.



As CN^- is a strong field ligand, it causes pairing of electrons therefore, electronic configuration of Fe^{2+} in $K_4[Fe(CN)_6]$ is $t_{2g}^{\,6}e_g^{\,0}$

Question21

Aluminium chloride in acidified aqueous solution forms a complex 'A', in which hybridisation state of Al is 'B'. What are 'A' and 'B', respectively?
(Odisha NEET 2019)

Options:

A. $[Al(H_2O)_6]^{3+}$, sp^3d^2

B. $[Al(H_2O)_4]^{3+}$, sp^3

C. $[Al(H_2O)_4]^{3+}$, $d\,sp^2$

D. $[Al(H_2O)_6]^{3+}$, d^2sp^3

Answer: A

Solution:

Complex compounds are also known as coordination compounds. These are special type of compounds that can retain or do not lose their identity even dissolved in water or any other organic solvents. These compounds contain a metal atom as a central metal atom and ligands which are negatively or neutrally charged atoms or groups.
Aluminium is an element and undergoes oxidation to form an ion which can be called as a metal atom. Aluminium chloride is a salt and when treated with water forms a complex.
The complex formed will be $[Al\,(H_2O)_6]^{3+}$, which has an aluminium as a central metal atom and water molecules as ligands.
The aluminium is in +3 oxidation state and forms $6sp^3d^2$ hybrid orbitals.
Thus, the hybridisation is sp^3d^2 and the complex is $[Al\,(H_2O)_6]^{3+}$.
A and B are $[Al\,(H_2O)_6]^{3+}$ and sp^3d^2.

Question22

The crystal field stabilisation energy (CFSE) for $[CoCl_6]^{4-}$ is $18000cm^{-1}$. The CFSE for $[CoCl_4]^{2-}$ will be
(Odisha NEET 2019)

Options:

A. $6000cm^{-1}$

B. $16000cm^{-1}$

C. $18000cm^{-1}$

D. $8000cm^{-1}$

Answer: D

Solution:

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

Question23

The type of isomerism shown by the complex $[CoCl_2(en)_2]$ is (Odisha NEET 2018)

Options:

A. geometrical isomerism

B. coordination isomerism

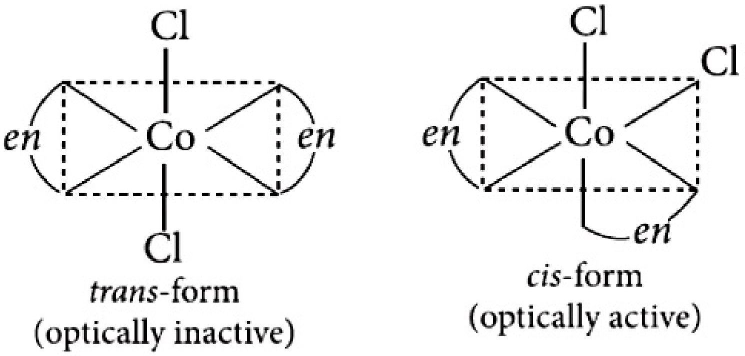
C. ionization isomerism

D. linkage isomerism

Answer: A

Solution:

$[CoCl_2(en)_2]$, geometrical isomerism, as the coordination number of Co is 6 and this compound has octahedral geometry.



Question24

The geometry and magnetic behaviour of the complex $[Ni(CO)_4]$ are (NEET 2018)

Options:

A. square planar geometry and diamagnetic

B. tetrahedral geometry and diamagnetic

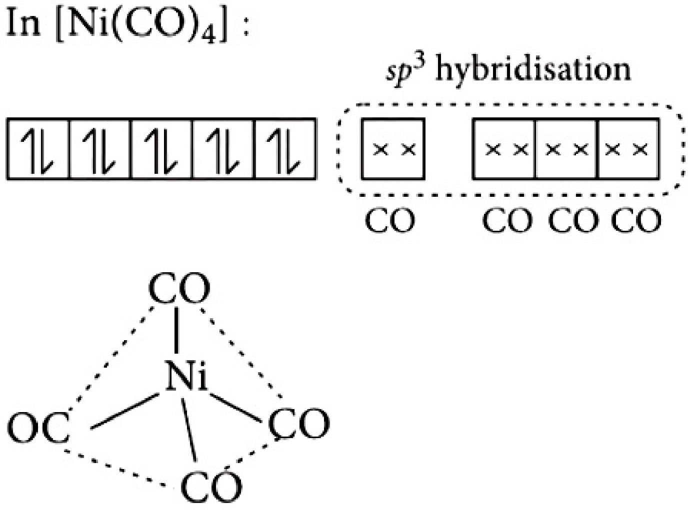
C. square planar geometry and paramagnetic

D. tetrahedral geometry and paramagnetic.

Answer: B

Solution:

Ni(28) : [Ar]$3d^8 4s^2$
∵ CO is a strong field ligand, so, unpaired electrons get paired.



Thus, the complex is sp^3 hybridised with tetrahedral geometry and diamagnetic in nature.

Question25

Iron carbonyl, $Fe(CO)_5$ is (NEET 2018)

Options:

A. tetranuclear

B. mononuclear

C. trinuclear

D. dinuclear.

Answer: B

Solution:

Based on the number of metal atoms present in a complex, they are classified as :
e.g., : $Fe(CO)_5$: mononuclear

Question26

An example of a sigma bonded organometallic compound is (NEET 2017)

Options:

A. Grignard's reagent

B. ferrocene

C. cobaltocene

D. ruthenocene.

Answer: A

Solution:

An example of a sigma bonded organometallic compound is grignard's reagent. Grignard's reagent is represented by $R-MgX$. An example is methyl magnesium iodide. A sigma bond is present between C atom and Mg atom.

Question27

The correct order of the stoichiometries of AgCl formed when $AgNO_3$ in excess is treated with the complexes : $CoCl_3.6NH_3$, $CoCl_3.5NH_3$, $CoCl_3.4NH_3$ respectively is (NEET 2017)

Options:

A. 3 AgCl, 1 AgCl, 2 AgCl

B. 3 AgCl, 2 AgCl, 1 AgCl

C. 2 AgCl, 3 AgCl, 2 AgCl

D. 1 AgCl, 3 AgCl, 2 AgCl

Answer: B

Solution:

$$[Co(NH_3)_6]Cl_3 + 3AgNO_3 \rightarrow 3\,AgCl \downarrow + [Co(NH_3)_6](NO_3)_3$$
$$[Co(NH_3)_5\,Cl]Cl_2 + 2AgNO_3 \rightarrow 2\,AgCl \downarrow + [Co(NH_3)_5\,Cl](NO_3)_2$$
$$[Co(NH_3)_4\,Cl_2]\,Cl + AgNO_3 \rightarrow AgCl \downarrow + [Co(NH_3)_4\,Cl_2]NO_3$$

Question28

Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is (NEET 2017)

Options:

A. $[CO(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$

B. $[CO(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$

C. $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[CO(H_2O)_6]^{3+}$

D. $[Co(en)_3]^{3+}$,$[Co(NH_3)_6]^{3+}$, $[CO(H_2O)_6]^{3+}$

Answer: D

Solution:

Increasing order of crystal field splitting energy is :$H_2O < NH_3 < en$
Thus, increasing order of energy for the given complexes is :
$[CO(H_2O)_6]^{3+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$
As, $E = \frac{hc}{\lambda}$
Thus, increasing order of wavelength of absorption is :
$[Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+} < [CO(H_2O)_6]^{3+}$

Question29

Pick out the correct statement with respect to $[Mn(CN)_6]^{3-}$ (NEET 2017)

Options:

A. It is sp^3d^2 hybridised and tetrahedral.

B. It is d^2sp^3 hybridised and octahedral.

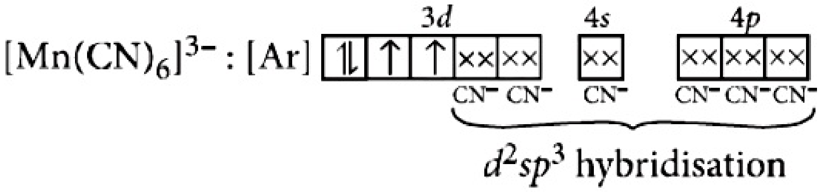
C. It is $d\,sp^2$ hybridised and square planar.

D. It is sp^3d^2 hybridised and octahedral.

Answer: B

Solution:

$[Mn(CN)_6]^{3-}$: Let oxidation state of Mn be x.
$x + 6 \times (-1) = -3 \Rightarrow x = +3$
Electronic configuration of Mn : $[Ar]4s^2 3d^5$
Electronic configuration of Mn^{3+} : $[Ar]3d^4$
CN^- is a strong field ligand thus, it causes pairing of electrons in 3d -orbital.



Then, $[Mn(CN)_6]^{3-}$ has d^2sp^3 hybridisation and has octahedral geometry.

Question30

The correct increasing order of trans-effect of the following species is (NEET-II 2016)

Options:

A. $NH_3 > CN^- > Br^- > C_6H_5^-$

B. $CN^- > C_6H_5^- > Br^- > NH_3$

C. $Br^- > CN^- > NH_3 > C_6H_5^-$

D. $CN^- > Br^- > C_6H_5^- > NH_3$

Answer: B

Solution:

The intensity of the trans-effect (as measured by the increase in rate of substitution of the trans ligand follows the sequence:
$CN^- > C_6H_5^- > Br^- > NH_3$

Question31

Jahn-Teller effect is not observed in high spin complexes of (NEET-II 2016)

Options:

A. d^7

B. d^8

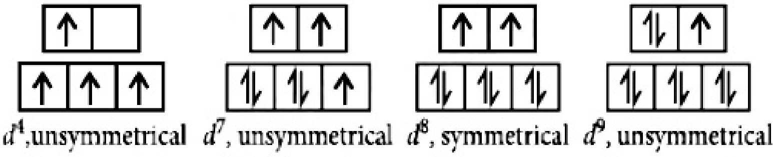
C. d^4

D. d^9

Answer: B

Solution:

Jahn-Teller distortion is usually significant for asymmetrically occupied e_g orbitals since they are directed towards the ligands and the energy gain is considerably more. In case of unevenly occupied t_{2g} orbitals, the Jahn-Teller distortion is very weak since the t_{2g} set does not point directly at the ligands and therefore, the energy gain is much less. High spin complexes :



Question32

Which of the following has longest $C - O$ bond length? (Free $C - O$ bond length in CO is 1.128Å.)
(NEET-I 2016)

Options:

A. $[Fe(CO)_4]^{2-}$

B. $[Mn(CO)_6]^{+}$

C. $Ni(CO)_4$

D. $[Co(CO)_4]^{-}$

Answer: A

Solution:

Solution:
The greater the negative charge on the carbonyl complex, the more easy it would be for the metal to permit its electrons to participate in the back bonding, the higher would be the $M - C$ bond order and simultaneously there would be larger reduction in the $C - O$ bond order. Thus, $[Fe(CO)_4]^{2-}$ has the lowest $C - O$ bond order means the longest bond length.

Question33

The hybridization involved in complex $[Ni(CN)_4]^{2-}$ is (At. No. Ni = 28)
(2015)

Options:

A. sp^3

B. d^2sp^2

C. d^2sp^3

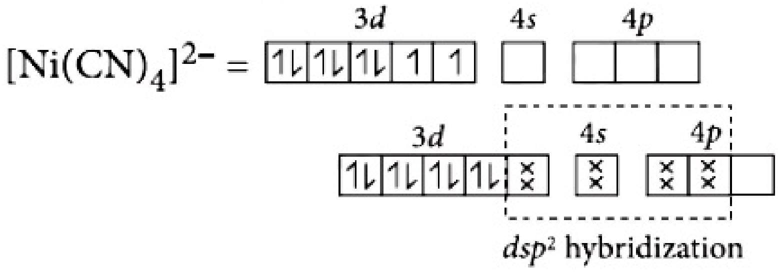
D. dsp^2

Answer: D

Solution:

$[Ni(CN)_4]^{2-}$: Oxidation number of Ni = +2

Electronic configuration of Ni^{2+} : $3d^8 4s^0$



Question34

The name of complex ion, $[Fe(CN)_6]^{3-}$ is (2015)

Options:

A. hexacyanitoferrate (III) ion

B. tricyanoferrate (III) ion

C. hexacyanidoferrate (III) ion

D. hexacyanoiron (III) ion.

Answer: C

Question35

The sum of coordination number and oxidation number of metal M in the complex $[M(en)_2(C_2O_4)]Cl$ (where en is ethylenediamine) is (2015)

Options:

A. 6

B. 7

C. 8

D. 9

Answer: D

Solution:

$[M(en)_2(C_2O_4)]Cl$:
Oxidation number of metal = +3
Coordination number of metal = 6
∴ Sum of oxidation number and coordination number $= 3 + 6 = 9$

Question36

Number of possible isomers for the complex $[Co(en)_2 Cl_2] Cl$ will be (en = ethylenediamine)
(2015)©

Options:

A. 1

B. 3

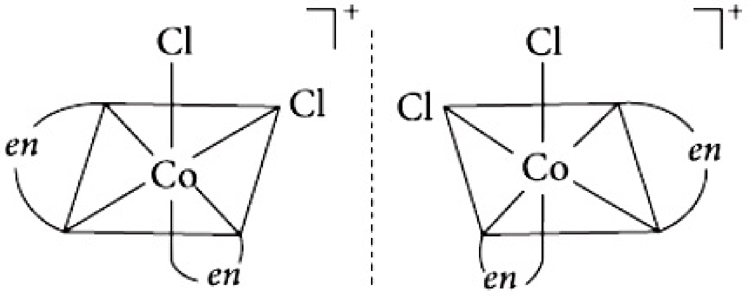
C. 4

D. 2

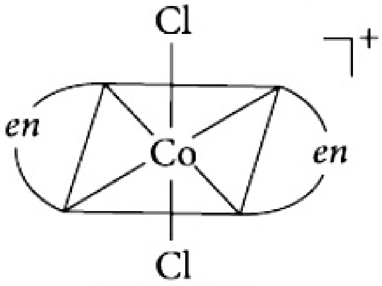
Answer: B

Solution:

Possible isomers of $[Co(en)_2Cl_2]Cl$:



cis-isomer
(*d* and *l* forms)



trans-isomer

Question37

Cobalt (III) chloride forms several octahedral complexes with ammonia. Which of the following will not give test for chloride ions with silver nitrate at 25°C?
(2015 Cancelled)

©

Options:

A. $CoCl_3 \cdot 5NH_3$

B. $CoCl_3 \cdot 6NH_3$

C. $CoCl_3 \cdot 3NH_3$

D. $CoCl_3 \cdot 4NH_3$

Answer: C

Solution:

Solution:
For octahedral complexes, coordination number is 6.
Hence $CoCl_3 \cdot 3NH_3$ i.e., $[Co(NH_3)_3Cl_3]$ will not ionise and will not give test for Cl^- ion with silver nitrate

---

Question38

Among the following complexes the one which shows zero crystal field stabilization energy (CFSE) is
(2014)

©

Options:

A. $[Mn(H_2O)_6]^{3+}$

B. $[Fe(H_2O)_6]^{3+}$

C. $[Co(H_2O)_6]^{2+}$

D. $[Co(H_2O)_6]^{3+}$

Answer: B

Solution:

H_2O is a weak field ligand,hence $\Delta_o <$ pairing energy.
$CFSE = (-0.4x + 0.6y)\Delta_o$
where, x and y are no. of electrons occupying t_{2g} and e_g orbitals respectively
For $[Fe(H_2O)_6]^{3+}$ complex ion, $Fe^{3+}(3d^5) = t_{2g}{}^3 e_g{}^2 = -0.4 \times 3 + 0.6 \times 2 = 0.0$ or 0 Dq

---

Question39

Which of the following complexes is used to be as an anticancer agent? (2014)

Options:

A. $\text{mer} - [Co(NH_3)_3Cl_3]$

B. $\text{cis} - [PtCl_2(NH_3)_2]$

C. $\text{cis} - K_2[PtCl_2Br_2]$

D. Na_2CoCl_4

Answer: B

Question40

A magnetic moment at 1.73 BM will be shown by one among the following
(2013 NEET)

Options:

A. $TiCl_4$

B. $[CoCl_6]^{4-}$

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

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

Answer: C

Solution:

Oxidation state of Cu in $[Cu(NH_3)_4]^{2+}$ is +2

$Cu^{2-} = 3d^9$

It has one unpaired electrons (n=1).

$\mu = \sqrt{n(n+2)}$

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

Question41

An excess of $AgNO_3$ is added to 100mL of a 0.01M solution of dichlorotetraaquachromium (III) chloride. The number of moles of AgCl precipitated would be:
(2013 NEET)

Options:

A. 0.003

B. 0.01

C. 0.001

D. 0.002

Answer: C

Solution:

$$[Cr(H_2O)_4(Cl)_2]Cl \xrightarrow{excessAgNO_3} [Cr(H_2O)_4(Cl)_2]^+ + AgCl \downarrow$$

Using formula, Molarity $= \frac{\text{No.of moles}}{\text{Volume}} \times 1000$

$0.01 = \frac{\text{No.of moles}}{100} \times 1000$

No. of moles of AgCl $= 0.001$

Question42

Crystal field splitting energy for high spin d^4 octahedral complex is
(Karnataka NEET 2013)

Options:

A. $-1.2\Delta_0$

B. $-0.6\Delta_0$

C. $-0.8\Delta_0$

D. $-1.6\Delta_0$

Answer: B

Solution:

$\text{CFSE} = (-0.4x + 0.6y)\Delta_0$
where, $x =$ No. of electrons occupying t_{2g} orbitals
$y =$ no. of electrons occupying e_g orbitals
$= (-0.4 \times 3 + 0.6 \times 1)\Delta_0$ [$\because$ High spin $d^4 = t_{2g}{}^3 e_g{}^1$]
$= (-1.2 + 0.6)\Delta_0 = -0.6\Delta_0$

Question43

The anion of acetylacetone (acac) forms $Co(acac)_3$ chelate with Co^{3+}. The rings of the chelate are
(Karnataka NEET 2013)

Options:

A. five membered

B. four membered

C. six membered

D. three membered.

Answer: C

Solution:

Solution:
Chelating ligands having conjugated double bonds form more stable six membered rings.

Question44

The correct IUPAC name for $[CrF_2(en)_2]Cl$ is
(Karnataka NEET 2013)

Options:

A. chloro difluorido ethylene diaminechromium (III) chloride

B. difluoridobis (ethylene diamine) chromium (III) chloride

C. difluorobis-(ethylene diamine) chromium (III) chloride

D. chlorodifluoridobis (ethylene diamine) chromium (III)

Answer: B

Question45

Which among the following is a paramagnetic complex?
(At. No. Mo = 42, Pt = 78)
(Karnataka NEET 2013)

Options:

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

B. $[Pt(en)\,Cl_2]$

C. $[CoBr_4]^{2-}$

D. $Mo(CO)_6$

Answer: C

Solution:

Solution:
$Co^{2+} = (3d^5)$
Bromine is a weak ligand but it is known that all tetrahedral complexes are high-spin regardless of the splitting power of the ligand. The low spin arrangement has five unpaired electrons in the d -orbital. So it is paramagnetic in nature.

Question46

Which is diamagnetic?
(Karnataka NEET 2013)

Options:

A. $[Co(F)_6]^{3-}$

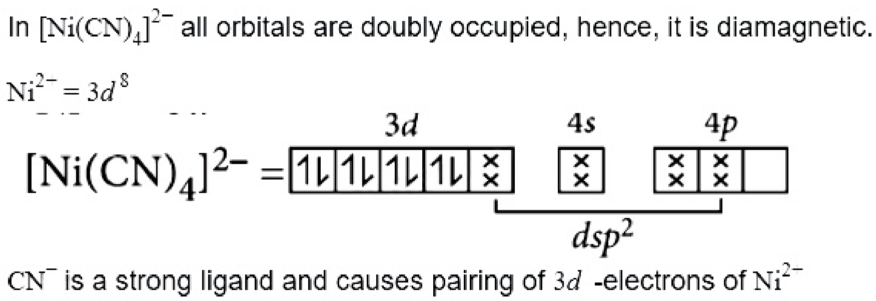
B. $[Ni(CN)_4]^{2-}$

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

D. $[Fe(CN)_6]^{3-}$

Answer: B

Solution:



In $[Ni(CN)_4]^{2-}$ all orbitals are doubly occupied, hence, it is diamagnetic.

$Ni^{2-} = 3d^8$

CN^- is a strong ligand and causes pairing of $3d$ -electrons of Ni^{2-}

Question47

Which one of the following is an outer orbital complex and exhibits paramagnetic behaviour?
(2012)

Options:

A. $[Ni(NH_3)_6]^{2+}$

B. $[Zn(NH_3)_6]^{2+}$

C. $[Cr(NH_3)_6]^{3+}$

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

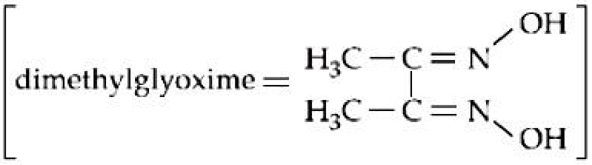
Answer: A

Solution:

$[Ni(NH_3)_6]^{2+}$ sp^3d^2 (outer), octahedral, paramagnetic
$[Zn(NH_3)_6]^{2+}$ sp^3d^2 (outer), octahedral, diamagnetic
$[Cr(NH_3)_6]^{3+}$ d^2sp^3 (inner), octahedral, paramagnetic
$[Co(NH_3)_6]^{3+}$ d^2sp^3 (inner), octahedral, diamagnetic

Question48

Red precipitate is obtained when ethanol solution of dimethylglyoxime is added to ammoniacal Ni(II). Which of the following statements is not true?



(2012 Mains)

Options:

A. Red complex has a square planar geometry.

B. Complex has symmetrical H-bonding.

C. Red complex has a tetrahedral geometry.

D. Dimethylglyoxime functions as bidentate ligand.

Answer: C

Solution:

$[N\,i(d\,mg)_2{}^-]$ is square planar in structure not tetrahedral.

Question49

Low spin complex of d ^{6} cation in an octahedral field will have the following energy (Δ_0= crystal field splitting energy in an octahedral field, P = Electron pairing energy) (2012 Mains)

Options:

A. $\frac{-12}{5}\Delta_o + P$

B. $\frac{-12}{5}\Delta_o + 3P$

C. $\frac{-2}{5}\Delta_o + 2P$

D. $\frac{-2}{5}\Delta_o + P$

Answer: B

Solution:

$C.F.S.E = (-0.4x + 0.6y)\Delta_o + zP$
where x = number of electrons occupying t_{2g} orbital
y = number of electrons occupying e_g orbital
z = number of electrons occupying eg orbital
For low spin d^6 complex electronic configuration
$= t_{2g}^6 e_g^0$ or $t_{2g}^{2,2,2} e_g^0$
$\therefore x = 6, y = 0, z = 3$
$C.F.S.E = (-0.4 \times 6 + 0 \times 06)\Delta_o + 3P = \frac{-12}{5}\Delta_o + 3P$

Question50

Of the following complex ions, which is diamagnetic in nature? (2011)

Options:

A. $[NiCl_4]$

B. $[Ni(CN)_4]$

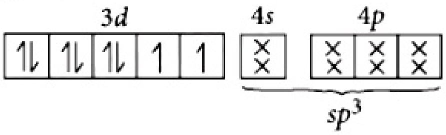
C. $[CuCl_4]$

D. CoF_6

Answer: B

Solution:

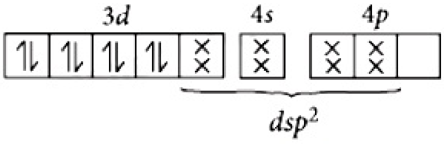
$[NiCl_4]^{2-}$:



Number of unpaired electrons = 2

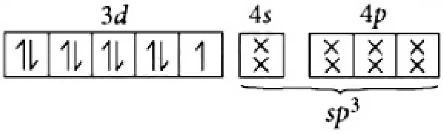
Hence $[NiCl_4]^{2-}$ is paramagnetic

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

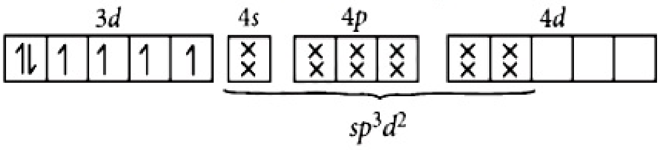


Number of unpaired electrons = 0, so it is diamagnetic in nature.

$[CuCl_4]^{2-}$:



No. of unpaired electron = 1, so it is paramagnetic.



No. of unpaired electrons = 4,so it is paramagnetic.

Question51

The complexes $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$ are the examples of which type of isomerism?
(2011)

Options:

A. Linkage isomerism

B. Ionization isomerism

C. Coordination isomerism

D. Geometrical isomerism

Answer: C

Solution:

Coordination isomerism arises from the interchange of ligands between cationic and anionic entities of different metal ions present in the complex, e.g., $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$

Question52

The complex,$[Pt(Py)(NH)_3)BrCl]$ will have how many geometrical isomers
(2011)

Options:

A. 3

B. 4

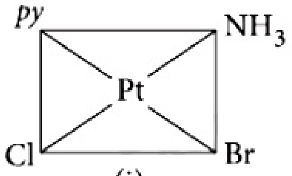
C. 0

D. 2

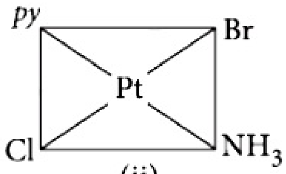
Answer: A

Solution:

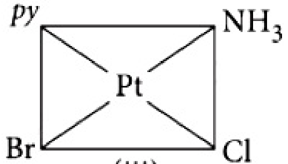
$[Pt(Py)(NH)_3)BrCl$] can have three isomers



(i)



(ii)



(iii)

Question53

The d -electron configurations of Cr^{2+}, Mn^{2+}, Fe^{2+} and Co^{2+} are d^4, d^5, d^6 and d^7 respectively.which one of the following will exhibit minimum paramagnetic behaviour
(At. nos. Cr = 24, Mn = 25, Fe = 26. Co = 27)
(2011)

Options:

A. $[Mn(H_2O)_6]^{2+}$

B. $[Fe(H_2O)_6]^{2+}$

C. $[Co(H_2O)_6]^{2+}$

D. $[Cr(H_2O)_6]^{2+}$

Answer: C

Solution:

$[Mn(H_2O)_6]^{2+}$: $Mn^{2+} = 3d^5$.
∴ Number of unpaired electrons = 5
$[Fe(H_2O)_6]^{2+}$: $Fe^{2+} = 3d^6$
∴ Number of unpaired electrons = 4
$[Co(H_2O)_6]^{2+}$: $Co^{2+} = 3d^7$
∴ Number of unpaired electrons = 3
$[Cr(H_2O)_6]^{2+}$: $Cr^{2+} = 3d^4$
∴ Number of unpaired electrons = 4
Minimum paramagnetic behaviour is shown by $[Co(H_2O)_6]^{2+}$

Question54

Which of the following carbonyls will have the strongest C - O bond?

(2011 Mains)

Options:

A. $Mn(CO)_6{}^{+}$

B. $Cr(CO)_6$

C. $V(CO)_6$

D. $Fe(CO_5)$

Answer: A

Solution:

The presence of positive charge on the metal carbonyl would resist the flow of the metal electron charge to π* orbitals of CO. This would increase the CO bond order and hence CO in a metal carbonyl cation would absorb at a higher frequency compared to its absorption in a neutral metal carbonyl.

Question55

Which of the following complex compounds will exhibit highest paramagnetic behaviour?
(At. No. Ti = 22, Cr = 24, Co = 27, Zn = 30)
(2011 Mains)

Options:

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

B. $[Cr(NH_3)_6]^{3+}$

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

D. $[Zn(NH_3)_6]^{2+}$

Answer: B

Solution:

$Ti \rightarrow [Ar]3d^2 4s^2$, $Ti^{3+} \rightarrow [Ar]3d^1 4s^0$ (1 unpaired electrons)
$Cr \rightarrow [Ar]3d^4 4s^2$, $Cr^{3+} \rightarrow [Ar]3d^3 4s^0$ (3 unpaired electrons)
$Co \rightarrow [Ar]3d^7 4s^2$, $Co^{3+} \rightarrow [Ar]3d^6 4s^0$ (0 unpaired electrons because of pairing)
$Zn \rightarrow [Ar]3d^{10} 4s^2$, $Zn^{2+} \rightarrow [Ar]3d^{10}$ (no unpaired electrons)
$[Cr(NH_3)_6]^{3+}$ exhibits highest paramagnetic behaviour as it contains 3 unpaired electrons.

Question56

Which of the following complex ions is not expected to absorb visible light ?
(2010)

Options:

A. $[Ni(CN)_4]$

B. $[Cr(NH_3)_6]$

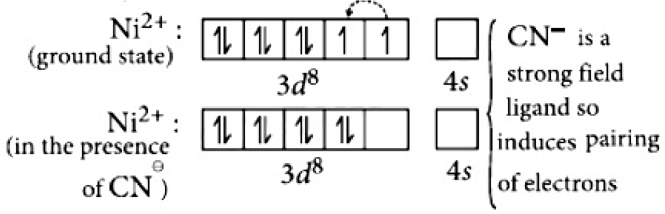
C. $[Fe(H_2O)_6]$

D. $[Ni(H_2O)_6]$

Answer: A

Solution:

A transition metal complex absorbs visible light only if it has unpaired electrons.



No unpaired electron so does not absorb visible light.

Question57

Crystal field stabilization energy for high spin d octahedral complex is
(2010)

Options:

A. $-1.8\Delta_o$

B. $-1.6\Delta_o + P$

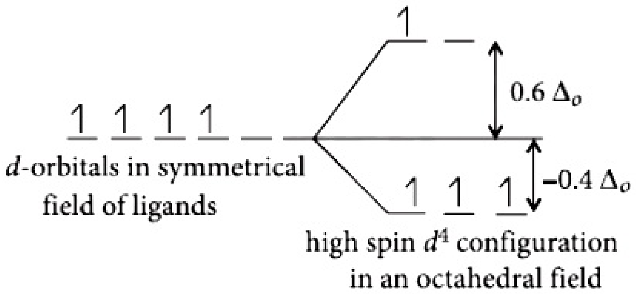
C. $-1.2\Delta_o$

D. $-0.6\Delta_o$

Answer: D

Solution:

$-0.6\Delta_o$



$\text{CFSE} = 3(-0.4)\Delta_o + 0.6\Delta_o = 1.2\Delta_o + 0.6\Delta_o$

$\text{CFSE} = -0.6\Delta_o$

Question58

The existence of two different coloured complexes with the composition of $[Co(NH_3)_4Cl_2]$ is due to
(2010)

Options:

A. linkage isomerism

B. geometrical isomerism

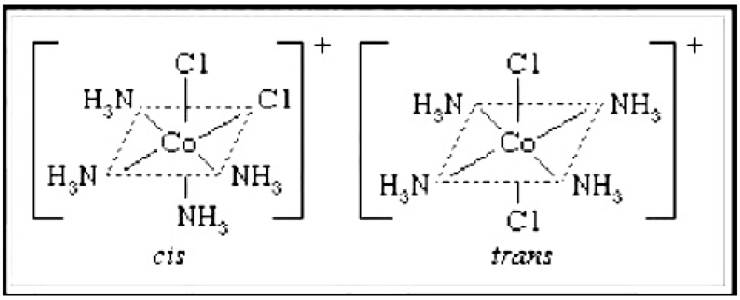
C. coordination isomerism

D. ionization isomerism

Answer: B

Solution:

$[Co(NH_3)_4Cl_2]^+$ is an octahedral complex, in the form of $[MA_4B_2]$ exhibiting two geometrical isomers (cis and trans). This results in two different coloured complexes.Compounds which possess the same structural formula, but differ with respect to the positions of the identical groups in space are called cis-trans isomers and the phenomenon is known as Geometrical isomerism.



Question59

Which one of the following complexes is not expected to exhibit isomerism?
(2010 Mains)

Options:

A. $[Ni(NH_3)_4(H_2O)_2]^{2+}$

B. $[Pt(NH_3)_2Cl_2]$

C. $[Ni(NH_3)_2Cl_2]$

D. $[Ni(en)_3]^{2+}$

Answer: C

Solution:

Solution:
$[Ni(NH_3)_2Cl_2]$ has tetrahedral geometry and thus, does not exhibit isomerism due to the presence of symmetry elements.
Hence, $[Ni(NH_3)_2Cl_2]$ is not expected to exhibit isomerism.

Question60

out of TiF_6^{2-}, CoF_6^{3-}, $CuCl_2$ and $NiCl_4^{2-}$ (Z of Ti = 2,Co=27,Cu=29,Ni=28) the colourless species are (2009)

Options:

A. Cu_2Cl_2 and $NiCl_4^{2-}$

B. TiF_6^{2-} and Cu_2Cl_2

C. CoF_6^{3-} and $NiCl_4^{2-}$

D. TiF_6^{2-} and CoF_6^{3-}

Answer: B

Solution:

A species is coloured when it contains unpaired d-electrons which are capable of undergoing d-d transition on adsorption of light of a particular wavelength.
In TiF_6^{2-}, Ti^{4+} : $3d^0$, colourless
In CoF_6^{3-}, Co^{3+} : $3d^6$ coloured
In Cu_2Cl_2, Cu^+ : $3d^{10}$ colourless
In $NiCl_4^{2-}$, Ni^{2+} : $3d^8$ coloured
Thus $TiF_6^{2-}(3d^0)$ and $Cu_2Cl_2(3d^{10})$ with empty and fully filled d-orbitals appear colourless asa they are not capable of undergoing d-d transition

Question61

Which of the following does not show optical isomerism? (en = ethylenediamine)
(2009)

Options:

A. $[Co(NH_3)_3Cl_3]^0$

B. $[Co(en)Cl_2(NH_3)_2]^+$

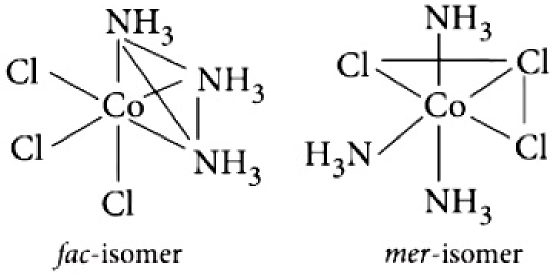
C. $[Co(en)_3]^{3+}$

D. $[Co(en)_2Cl_2]^+$

Answer: A

Solution:

Optical isomerism is shown by :
(i) Complexes of the type $[M(AA)X_2Y_2]$
i.e., $[Co(en)Cl_2(NH_3)_2]^+$ containing one symmetrical bidentate ligand.
(ii) complexes of the type $[M(AA)_3]$,i.e., $[Co(en)_3]^{3+}$ containing a symmetrical bidentate ligand.
(iii) complexes of the type $[M(AA)_2X_2]$ i.e.,$[Co(en_2)Cl_2]^+$
However complexes of the type $[MA_3B_3]$ show geometrical isomerism,know as fac-mer isomerism.
$\therefore$ $[Co(NH_3)_3Cl_3]$ exhibit fac-mer isomerism



Question62

Which of the following complex ions is expected to absorb visible light? [At. no. Zn = 30, Sc = 21, Ti = 22, Cr = 24]
(2009)

Options:

A. $[Ti(en)_2(NH_3)_2]^{4+}$

B. $[Cr(NH_3)_6]^{3+}$

C. $[Zn(NH_3)_6]^{2+}$

D. $[Sc(H_2O)_3(NH_3)_3]^{3+}$

Answer: B

Solution:

$Ti^{4+} \rightarrow 3d^0, \quad Cr^{3+} \rightarrow 3d^3$
$Zn^{2+} \rightarrow 3d^{10}, \quad Sc^{3+} \rightarrow 3d^0$
Transition metal ions containing completely filled d-orbitals or empty d-orbitals are colourless species.

Question63

Which of the following complexes exhibits the highest paramagnetic behaviour? (Where gly = glycine,en= ethylenediamine and bpy = bipyridyl moities). (At number $Ti = 22, V = 23, Fe = 26, Co = 27$) (2008)

Options:

A. $[Co(ox)_2(OH)_2]$

B. $[Ti(NH_3)_6]^{3+}$

C. $[V(gly)_2(OH)_2(NH_3)_2]^{2+}$

D. $[Fe(en)(py)(NH_3)_2]^{2+}$

Answer: A

Solution:

The electronic configuration of $V(23) = [Ar]4s^2, 3d^3$
Let in $[V(gly)_2(OH)_2(NH_3)_2]^+$oxidation state of V is x.
$x + (-1) \times 2 + (-1)2 + (0 \times 2) = +1$
$x = +5$
$V^{5+} = [Ar]4s^0, 3d^0$ (no unpaired electrons)

The electronic configuration of
$Fe(26) = [Ar]4s^2, 3d^6$
Let the oxidation state of $[Fe(en)(ppy)(NH_3)_2]^{2+}$ is x.
$[x + (0) + (0) + (0) \times 2] = +2$
$x = +2$
$Fe^{2+} = [Ar], 3d^6 (\because 4$ unpaired electron)
but, bpy, en and NH_3 all are strong field ligands, so pairing occurs and thus,
Fe^{2+} contains no unpaired electron

The electronic configuration of $Co(27) = [Ar]4s^2, 3d^7$
Let the oxidation state Co in $[Co(ox)_2(OH)_2]^-$is x
$x + (-2) \times 2 + (-1) \times 2 = -1$
$x = +5$
$Co^{5+} = [Ar].3d^4[4$ unpaired electrons]

ox and OH are weak field ligands, thus pairing of electron units does not occur.

The electronic configuration of $Ti(22) = [Ar]4s^2, 3d^2$
Oxidation state of Ti in $[Ti(NH_3)_6]^{3+}$ is 3 .
$Ti^{3+} = [Ar]3d^1$ (one unpaired electron)

Hence, complex $[Co(ox)_2(OH)_2]^-$has maximum number of unpaired electrons, thus show maximum paramagnetism

---

Question64

In which of the following coordination entities the magnitude of Δ_o (CFSE in octahedral field) will be maximum?
(At. No. Co = 27)
(2008)

Options:

A. $[Co(CN)_6]^{3-}$

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

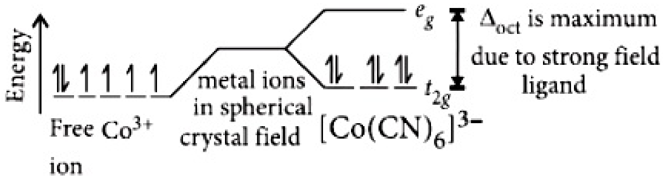
C. $[Co(H_2O)_6]^{3+}$

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

Answer: A

Solution:

When the ligands are arranged in order of the magnitude of crystal field splitting, the arrangement, thus, obtained is called spectrochemical series.
Arranged in increasing field strength as
$I^- < Br^- < Cl^- < NO_3^- < F^- < OH^- < C_2O_4^{2-} < H_2O < NH_3 < en < NO_2 < CN^- < CO$



It has been observed that ligands before H_2O are weak fields ligands while ligands after H_2O are strong field ligands. CFSE in octahedral field depends upon the nature of ligands. Stronger the ligands larger will be the value of Δ_{oct}

Question65

Which of the following will give a pair of enantiomorphs?
(en = $NH_2CH_2CH_2NH_2$)
(2007)

Options:

A. $[Cr(NH_3)_6][Co(CN)_6]$

B. $[Co(en)_2Cl_2]Cl$

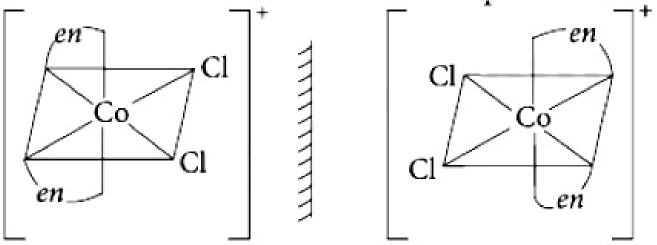
C. $Pt(NH_3)_4[PtCl_6]$

D. $[Co(NH_3)_4Cl_2]NO_2$

Answer: B

Solution:

Either a pair of crystals, molecules or compounds that are mirror images of each other but are not identical, and that rotate the plane of polarised light equally, but in opposite directions arc called as enantiomorphs.



cis-d-isomer cis-l-isomer

Question66

The d electron configurations of Cr^{2+}, Mn^{2+}, Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively. Which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour?
(At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28)
(2007)

Options:

A. $[Fe(H_2O)_6]^{2+}$

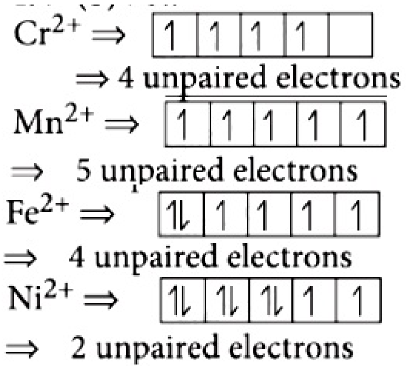
B. $[Ni(H_2O)_6]^{2+}$

C. $[Cr(H_2O)_6]^{2+}$

D. $[Mn(H_2O)_6]^{2+}$

Answer: B

Solution:



$Cr^{2+} \Rightarrow$ 1 1 1 1

$\Rightarrow$ 4 unpaired electrons

$Mn^{2+} \Rightarrow$ 1 1 1 1 1

$\Rightarrow$ 5 unpaired electrons

$Fe^{2+} \Rightarrow$ ⇅ 1 1 1 1

$\Rightarrow$ 4 unpaired electrons

$Ni^{2+} \Rightarrow$ ⇅ ⇅ ⇅ 1 1

$\Rightarrow$ 2 unpaired electrons

Greater the number of unpaired electrons, higher is the paramagnetism. Hence Ni^{2+} will exhibit the minimum paramagnetic behaviour.

Question67

$[Cr(H_2O)_6]Cl_3$(At. no. of Cr = 24) has a magnetic moment of 3.83 B.M. The correct distribution of 3d electrons in the chromium of the complex is (2006)

Options:

A. $3d_{xy}^1, 3d_{yz}^1, 3d_{z^2}^1$

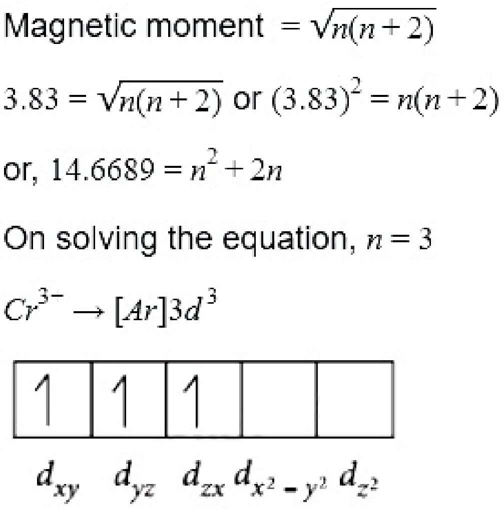
B. $3d_{(x^2-y^2)}^1, 3d_{z^2}^1, 3d_{xz}^1$

C. $3d_{xy}^1, 3d_{(x^2-y^2)}^1, 3d_{xz}^1$

D. $3d_{xy}^1, 3d_{yz}^1, 3d_{xz}^1$

Answer: D

Solution:



Magnetic moment $= \sqrt{n(n+2)}$

$3.83 = \sqrt{n(n+2)}$ or $(3.83)^2 = n(n+2)$

or, $14.6689 = n^2 + 2n$

On solving the equation, $n = 3$

$Cr^{3+} \rightarrow [Ar]3d^3$

Question68

$[Co(NH_3)_4(NO_2)_2]Cl$ exhibits

(2006)

Options:

A. linkage isomerism, geometrical isomerism and optical isomerism

B. linkage isomerism, ionization isomerism and optical isomerism

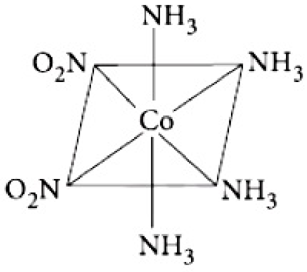
C. linkage isomerism, ionization isomerism and geometrical isomerism

D. ionization isomerism, geometrical isomerism and optical isomerism.

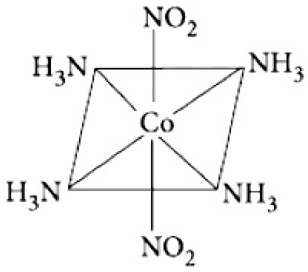
Answer: C

Solution:

Ionization isomerism arises when the coordination compounds give different ions in solution.
$[Co(NH_3)_4(NO_2)_2]Cl \rightleftharpoons [Co(NH_3)_4(NO_2)_2]^+ + Cl^-$
Linkage isomerism occurs in complex compounds which contain ambidentate ligands like NO_2^-, SCN^-, CN^-, $S_2O_3^{2-}$ and CO
$[Co(NH_3)_4(NO_2)_2]Cl$ and $[Co(NH_3)_4(ONO)_2]Cl$ are linkage isomers as NO_2^- is linked through N or through O
Octahedral complexes of the type Ma_4b_2 exhibit geometrical isomerism



cis-



trans-

Question69

Which one of the following is an inner orbital complex as well as diamagnetic in bebaviour?
(Atomic number : Zn = 30, Cr = 24, Co = 27, Ni = 28)
(2005)

Options:

A. $[Zn(NH_3)_6]^{2+}$

B. $[Cr(NH_3)_6]^{3+}$

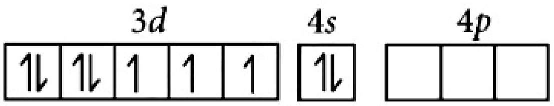
C. $[Co(NH_3)_6]^{3+}$

D. $[Ni(NH_3)_6]^{2+}$

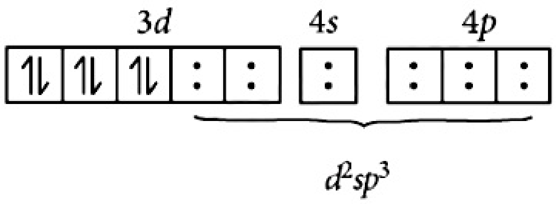
Answer: C

Solution:

$[Co(NH_3)_6]^{3-}$: Co(27)$[Ar]^{18}$



Co^{3-} : (24)$[Ar]^{18}$



$d^2sp^3 \rightarrow$ inner octahedral complex and diamagnetic.

$[Zn(NH_3)_6]^{2-} \rightarrow sp^3d^2$(outer) and diamagnetic.

$[Cr(NH_3)_6]^{3-} \rightarrow d^2sp^3$(inner) and paramagnetic.

$[Ni(NH_3)_6]^{2-} \rightarrow sp^3d^2$(outer) and paramagnetic.

Question70

Which one of the following is expected to exhibit optical isomerism? (en = ethylenediamine)
(2005)

Options:

A. cis $-[Pt(NH_3)_2Cl_2]$

B. trans $-[Pt(NH_3)_2Cl_2]$

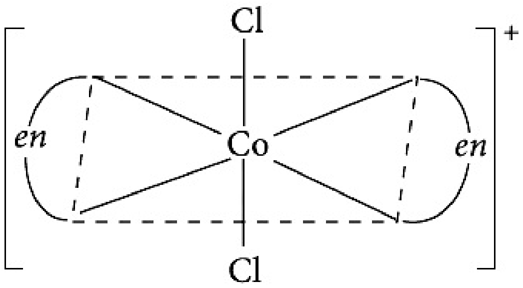
C. cis $-[CO(en)_2Cl_2]^+$

D. trans $-[CO(en)_2Cl_2]^+$

Answer: C

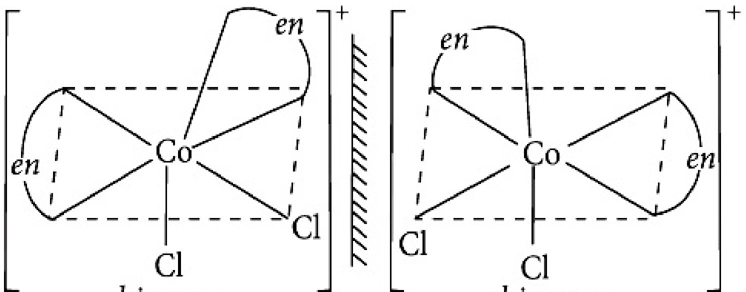
Solution:

Optical isomerism is not shown by square planar complexes.
Octahedral complexes of general formulae,
$[M\,a_2b_2c_2]^{n\pm}$, $[M\,abcd\,ef\,]$, $[M\,(AA)_3]^{n\pm}$, $[M\,(AA)_2a_2]^{n\pm}$
(where AA = symmetrical bidentate ligand),
$[M\,(AA)_2ab]^{n\pm}$ and $[M\,(AB)_3]^{n\pm}$
(where AB = unsymmetrical ligands) show optical isomerism.



trans-$[Co(en)_2Cl_2]^+$

does not show optical isomerism (superimposable mirror image). But cis-form shows optical isomerism.



l-isomer *d*-isomer

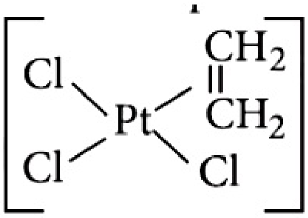
cis-$[Co(en)_2Cl_2]^+$

Question71

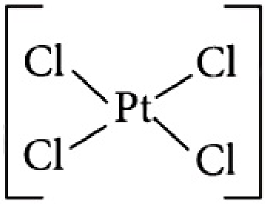
Which of the following is considered to be an anticancer species? (2004)

Options:

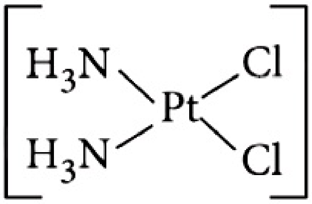
A.



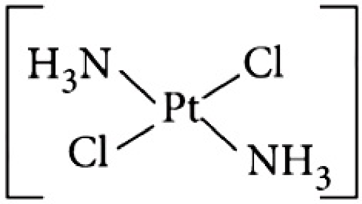
B.



C.



D.



Answer: C

Solution:

Cis isomer of $[Pt(NH_3)_2Cl_2]$ is used as an anticancer drug for treating several types of malignant tumours. When it is injected into the blood stream, the more reactive Cl groups are lost. So the Pt atom bonds to a Natom in guanosine (a part of DNA). This molecule can bond to two different guanosine units and by bridging between them it upsets the normal reproduction of DNA.

Question72

Which of the following coordination compounds would exhibit optical isomerism?
(2004)

Options:

A. Pentaamminenitrocobalt(III) iodide

B. Diamminedichloroplatinum(II)

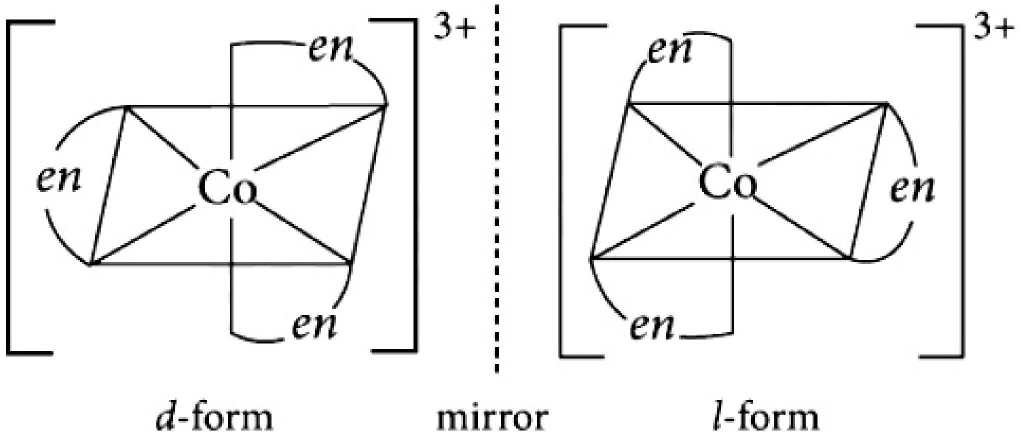
C. trans-Dicyanobis(ethylenediamine) chromium (III) chloride

D. tris-(Ethylenediamine) cobalt(III) bromide

Answer: D

Solution:

$[Co(en)_3]^{3+}$:



Question73

Among $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ species, the hybridisation states at the mathrm N i atom are, respectively
[Atomic number of Ni = 28]
(2004)

Options:

A. sp^3, $d\,sp^2$, $d\,sp^2$

B. sp^3, $d\,sp^2$, sp^3

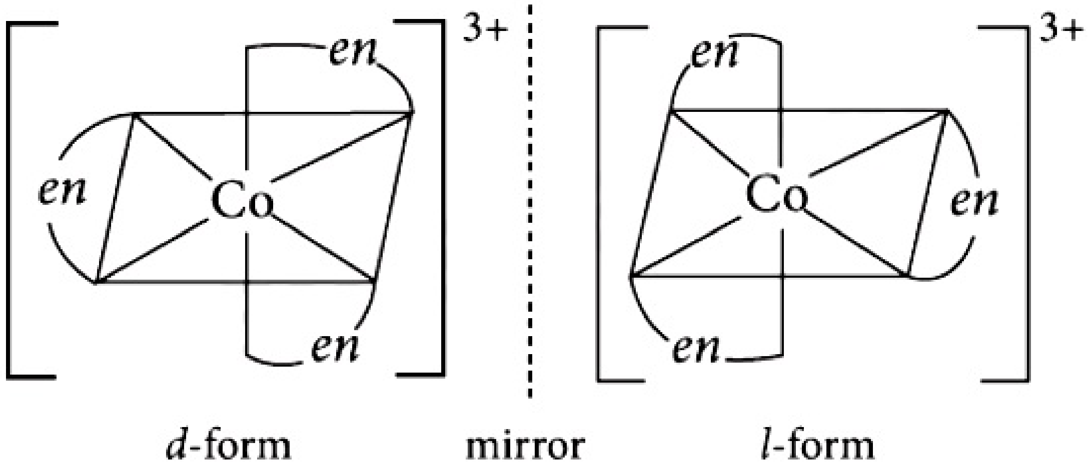
C. sp^3, sp^3, $d\,sp^2$

D. $d\,sp^2$, sp^3, sp^3.

Answer: B

Solution:

$[Co(en)_3]^{3+}$:



Question74

CN^- is a strong field ligand. This is due to the fact that
(2004)

Options:

A. it carries negative charge

B. it is a pseudohalide

C. it can accept electrons from metal species

D. it forms high spin complexes with metal species.

Answer: B

Solution:

Cyanide ion is strong field ligand because it is a pseudohalide ion. Pseudohalide ions are stronger coordinating ligands and they have the ability to form σ -bond (from the pseudohalide to the metal) and π bond (from the metal to pseudohalide).

Question75

Considering H_2O as a weak field ligand, the number of unpaired electrons in $[Mn(H_2O)_6]^{2+}$ will be (atomic number of Mn = 25) (2004)

Options:

A. three

B. five

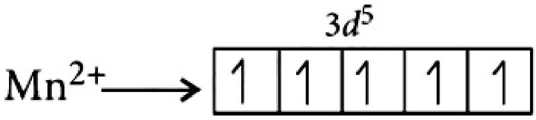
C. two

D. four.

Answer: B

Solution:

$Mn(25) \rightarrow 3d^5 4s^2$



In presence of weak field ligand, there will be no pairing of electrons. So it will form a high spin complex, i.e., the number of unpaired electrons = 5.

Question76

Which of the following does not have a metal - carbon bond? (2004)

Options:

A. $Al(OC_2H_5)_3$

B. C_2H_5MgBr

C. $K[Pt(C_2H_4)Cl_3]$

D. $Ni(CO)_4$

Answer: A

Solution:

$Al(OC_2H_5)_3$ contains bonding through O and thus it does not have metal carbon bond.

Question77

In an octahedral structure, the pair of d orbitals involved in d^2sp^3 hybridisation is
(2004)

Options:

A. $d_{x^2-y^2}$, d_{z^2}

B. d_{xz}, $d_{x^2-y^2}$

C. d_{z^2}, d_{xz}

D. d_{xy}, d_{yz}

Answer: A

Solution:

Solution:
In the formation of d^2sp^3 hybrid orbitals, two $(n-1)d$ orbitals of e_g set[i . e . $(n-1)d_z{}^2$ and $(n-1)d_{x^2-y^2}$ orbitals)], one ns and three np(np_x, np_y and np_z) orbitals combine together and form six d^2sp^3 hybrid orbitals.

Question78

The number of unpaired electrons in the complex ion $[CoF_6]^{3-}$ is....... (Atomic no. : Co = 27)
(2003)

Options:

A. 2

B. 3

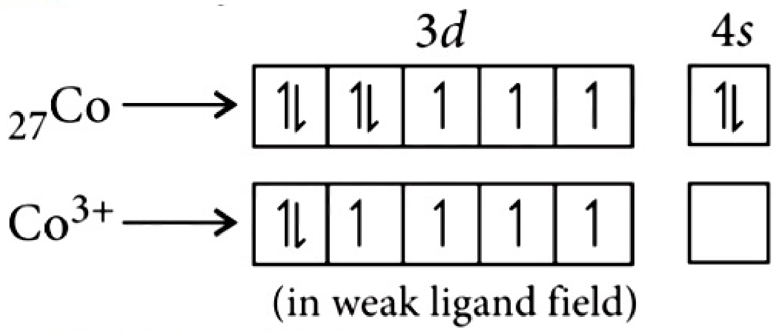
C. 4

D. zero

Answer: C

Solution:

$[CoF_6]^{3-}$:



Thus, the number of unpaired electrons = 4.

Question79

Among the following which is not the π -bonded organometallic compound?
(2003)

Options:

A. $K[PtCl_3(\eta^2 - C_2H_4)]$

B. $Fe(\eta^5 - C_5H_5)_2$

C. $Cr(\eta^6 - C_6H_6)_2$

D. $(CH_3)_4 Sn$

Answer: D

Solution:

π-bonded organometallic compound includes organometallic compounds of alkenes, alkynes and some other carbon containing compounds having electrons in their p -orbitals.

Question80

Atomic number of Cr and Fe are respectively 24 and 26, which of the following is paramagnetic with the spin of electron?
(2002)

Options:

A. $[Cr(CO)_6]$

B. $[Fe(CO)_5]$

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

D. $[Cr(NH_3)_6]^{3+}$

Answer: D

Solution:

Odd electrons, ions and molecules are paramagnetic.
In $Cr(CO)_6$ molecule 12 electrons are contributed by CO group and it contains no odd electron.
$Cr \rightarrow 3d^5 4s^1$
$Fe(CO)_5$ molecule also does not contain odd electron.
$Fe \rightarrow 3d^6 4s^2$
In$[Fe(CN)_6]^{4-}$ ion $Fe(+2) \rightarrow 3d^6 4s^0$
∴ No odd electrons.
In$[Cr(NH_3)_6]^{3+}$ ion $Cr(+3) \rightarrow 3d^3 4s^0$
This ion contains odd electron so it is paramagnetic.

Question81

The hypothetical complex chloro diaquatriammine cobalt(III) chloride can be represented as (2002)

Options:

A. $[CoCl(NH_3)_3(H_2O)_2]Cl_2$

B. $[Co(NH_3)_3(H_2O)\,Cl_3]$

C. $[Co(NH_2)_3(H_2O)_2\,Cl]$

D. $[Co(NH_3)_3(H_2O)_3]Cl_3$

Answer: A

Solution:

Solution:
Chlorodiaquatriamminecobalt (III) chloride can be represented as $[CoCl(NH_3)_3(H_2O)_2]Cl_2$

Question82

In the silver plating of copper, $K[Ag(CN)_2]$ is used instead of $AgNO_3$. The reason is (2002)

Options:

A. a thin layer of Ag is formed on Cu

B. more voltage is required

C. Ag^+ ions are completely removed from solution

D. less availability of Ag^+ ions, as Cu can not displace Ag from $[Ag(CN)_2]^-$ ion.

Answer: D

Solution:

Solution:
Copper being more electropositive readily precipitate silver from their salt (Ag^+) solution.
$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + Ag$
In $K[Ag(CN)_2]$ solution a complex anion $[Ag(CN)_2]^-$ is formed so Ag^+ ions are less available in the solution and Cu cannot displace Ag from this complex ion.

Question83

$CuSO_4$ when reacts with KCN forms CuCN, which is insoluble in water. It is soluble in excess of KCN, due to formation of the following complex (2002)

Options:

A. $K_2[Cu(CN)_4]$

B. $K_3[Cu(CN)_4]$

C. $CuCN_2$

D. $Cu[KCu(CN)_4]$

Answer: B

Solution:

Solution:
Copper sulphate reacts with potassium cyanide giving a white precipitate of cuprous cyanide and cyanogen gas. The cuprous cyanide dissolves in excess of KCN forming potassium cuprocyanide $K_3[Cu(CN)_4]$.
$2CuSO_4 + 4\,KCN \rightarrow 2\,CuCN + (CN)_2 + 2K_2SO_4$
$CuCN + 3\,KCN \rightarrow K_3[Cu(CN)_4]$

Question84

Which of the following will give maximum number of isomers?

(2001)

Options:

A. $[Co(NH_3)_4Cl_2]$

B. $[Ni(en)(NH_3)_4]^{2+}$

C. $[Ni(C_2O_4)(en)_2]^{2-}$

D. $[Cr(SCN)_2(NH_3)_4]^+$

Answer: D

Solution:

Solution:
$[Cr(SCN)_2(NH_3)_4]^+$ shows linkage geometrical and optical isomerism.

Question85

Coordination number of Ni in $[Ni(C_2O_4)_3]^{4-}$ is (2001)

Options:

A. 3

B. 6

C. 4

D. 2

Answer: B

Solution:

$C_2O_4 \rightarrow$ bidentate ligand.
3 molecules attached from two sides with Ni makes coordination number 6 .

Question86

Which of the following organometallic compounds is σ and π -bonded? (2001)

Options:

A. $[Fe(\eta^5 - C_5H_5)_2]$

B. $K[PtCl_3(\eta^2 - C_2H_4)]$

C. $[Co(CO)_5NH_3]^{2+}$

D. $Fe(CH_3)_3$

Answer: C

Solution:

Solution:
$[Co(CO)_5NH_3]^{2+}$: In this complex, Co-atom is attached with NH_3 through σ bonding and with CO with dative π -bond.

Question87

Which statement is incorrect?
(2001)

Options:

A. $Ni(CO)_4$ - tetrahedral, paramagnetic

B. $Ni(CN)_4^{2-}$ - square planar, diamagnetic

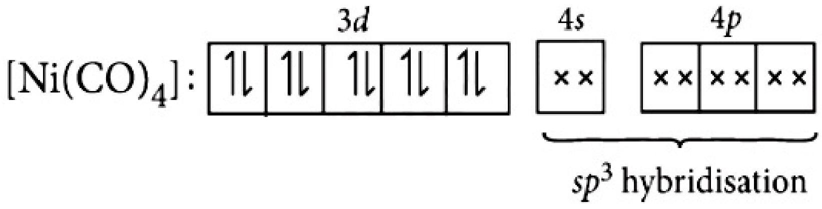
C. $Ni(CO)_4$ - tetrahedral, diamagnetic

D. $[Ni(Cl)_4]^{2-}$ - tetrahedral, paramagnetic

Answer: A

Solution:

In $Ni(CO)_4$ complex, $Ni(CO)_4$ will have $3d^{10}$ configuration.



Hence $[Ni(CO)_4]$ will have tetrahedral geometry and diamagnetic as there are no unpaired electrons.

Question88

Which of the following will exhibit maximum ionic conductivity?

(2001)

Options:

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

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

C. $[Cu(NH_3)_4]Cl_2$

D. $[Ni(CO)_4]$

Answer: A

Solution:

Ionic conductance increases with increasing the number of ions, produced after decomposition.

Compound	No. of ions produced
$K_4[Fe(CN)_6]$	5
$[Co(NH_3)_6]Cl_3$	4
$[Cu(NH_3)_4]Cl_2$	3
$[Ni(CO)_4]$	0

Question89

Shape of $Fe(CO)_5$ is
(2000)

Options:

A. octahedral

B. square planar

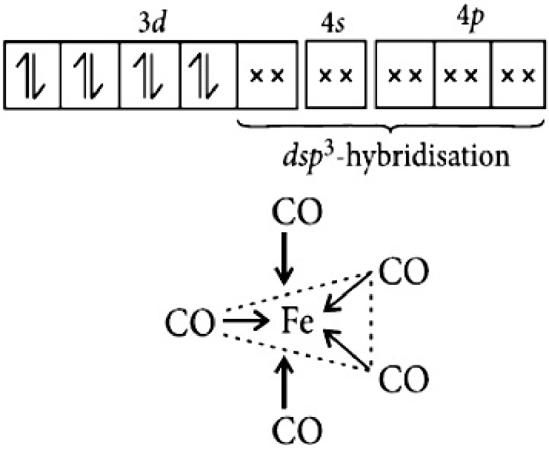
C. trigonal bipyramidal

D. square pyramidal.

Answer: C

Solution:

$Fe(CO)_5$, the ′Fe′ atom is $d\,sp^3$ hybridised, therefore shape of the molecule is trigonal bipyramidal.
Fe atom in ′Fe′$(CO)_5$



Question90

Which complex compound will give four isomers?
(2000)

Options:

A. $[Fe(en)_3]Cl_3$

B. $[Co(en)_2 Cl_2] Cl$

C. $[Fe(PPh_3)_3 NH_3 ClBr] Cl$

D. $[Co(PPh_3)_3 Cl]Cl_3$

Answer: C

Solution:

$[Fe(PPh_3)_3 NH_3 ClBr] Cl$ can give two optical and two geometrical isomers. While other complexes do not form geometrical isomers.

Question91

The total number of possible isomers for the complex compound $[Cu^{II}(NH_3)_4][Pt^{II}Cl_4]$ are
(1998)

Options:

A. 5

B. 6

C. 3

D. 4

Answer: D

Solution:

The isomers of the complex compound $[Cu^{II}(NH_3)_4][Pt^{II}Cl_4]$ are
(i) $[Cu(NH_3)_3Cl][Pt(NH_3)Cl_3]$
(ii) $[Pt(NH_3)_3Cl][Pt(NH_3)Cl_3]$
(iii) $[Pt(NH_3)_4][CuCl_4]$
So, the total no. of isomers are $= 4$

Question92

A coordination complex compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution. On reacting this solution with excess of $AgNO_3$ solution, we get two moles of AgCl precipitate. The ionic formula for this complex would be
(1998)

Options:

A. $[Co(NH_3)_5(NO_2)]Cl_2$

B. $[Co(NH_3)_5Cl][Cl(NO_2)]$

C. $[Co(NH_3)_4(NO_2)Cl][NH_3)Cl]$

D. $[Co(NH_3)_5][(NO_2)_2Cl_2]$

Answer: A

Solution:

As the complex gives two moles of AgCl ppt. with $AgNO_3$ solution, so the complex must have two ionisable Cl atoms.
Hence the probable complex, which gives three mole ions may be $[Co(NH_3)_5NO_2]Cl_2$.
$[Co(NH_3)_5(NO_2)]Cl_2 \rightarrow [Co(NH_3)_5(NO_2)]^{2+} + 2Cl^-$
one mole →3 mole ions.

Question93

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

(1998)

Options:

A. Triamminebromochloronitroplatinum (IV) chloride

B. Triamminebromonitrochloroplatinum (IV) chloride

C. Triamminechlorobromonitroplatinum (IV) chloride

D. Triamminenitrochlorobromoplatinum (IV) chloride

Answer: A

Solution:

The ligands are named in the alphabatic order according to latest IUPAC system. So the name of $[Pt(NH_3)_3(Br)(NO_2)\,Cl]\,Cl$ is Triamminebromochloronitroplatinum (IV) chloride.
(The oxidation no. of 'Pt' is $+4$)

Question94

The formula of dichlorobis(urea)copper(II) is (1997)

Options:

A. $[Cu\{O = C(NH_2)_2\}\,Cl]\,Cl$

B. $[CuCl_2]\{O = C(NH_2)_2\}$

C. $[\,Cu\{O = C(NH_2)_2\}\,Cl_2$

D. $[CuCl_2\{O = C(NH_2)_2\}_2]$

Answer: B

Question95

The number of geometrical isomers of the complex $[Co(NO_2)_3(NH_3)_3]$ is (1997)

Options:

A. 4

B. 0

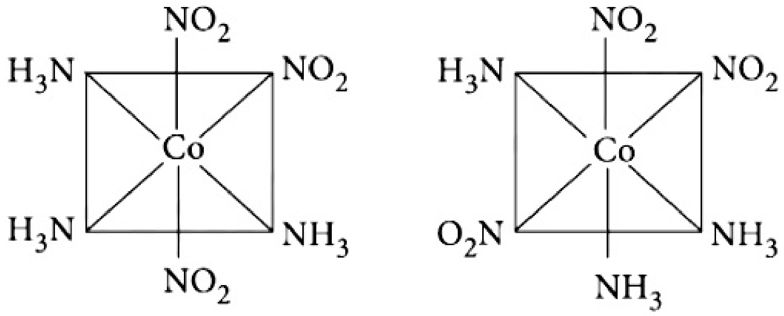
C. 2

D. 3

Answer: C

Solution:

Possible geometrical isomers are :



Question96

The number of geometrical isomers for $[Pt(NH_3)_2Cl_2]$ is (1995)

Options:

A. 3

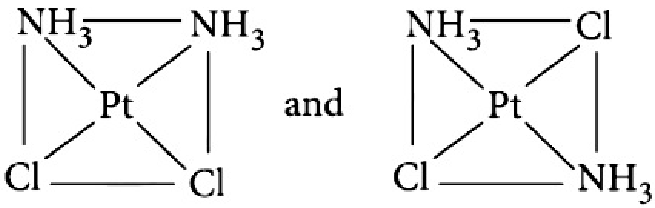
B. 4

C. 1

D. 2

Answer: D

Solution:



The two geometrical isomers are given above.

Question97

The coordination number and oxidation state of Cr in $K_3Cr(C_2O_4)_3$ are respectively
(1995)

Options:

A. 3 and +3

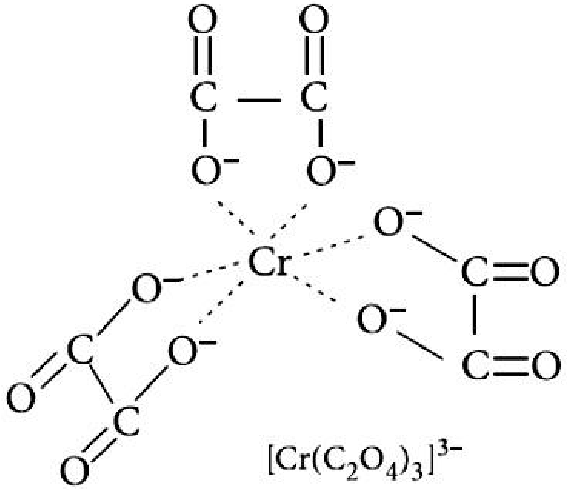
B. 3 and 0

C. 6 and +3

D. 4 and +2

Answer: C

Solution:



As the number of atoms of the ligands that are directly bound to the central metal is known as coordination number. It is six here (see in figure).
Oxidation state :
Let oxidation state of Cr be x.
$\Rightarrow 3(+1) + x + 3(-2) = 0 \Rightarrow 3 + x - 6 = 0$
$\Rightarrow x = +3$

Question98

In metal carbonyl having general formula $M(CO)_x$ where M = metal, x = 4 and the metal is bonded to
(1995)

Options:

A. carbon and oxygen

B. $C \equiv O$

C. oxygen

D. carbon.

Answer: D

Solution:

In $M(CO)_4$ metal is bonded to the ligands via carbon atoms with both σ and π -bond character. Both metal to ligand and ligand to metal bonding are possible.

Question99

Which of the following ligands is expected to be bidentate? (1994)

Options:

A. CH_3NH_2

B. $CH_3C \equiv N$

C. Br

D. $C_2O_4^{2-}$

Answer: D

Solution:

When a ligand has two groups that are capable of bonding to the central atom, it is said to be bidentate. Thus, the only ligand, which is expected to be bidentate is $C_2O_4^{2-}$ as