Coordination Compounds

1. Select the element (M) whose trihalides cannot be hydrolysed to produce an ion of the form $[M(H_2O_6]^{3+}$ **(2023)**
   (a) Ga
   (b) In
   (c) Al
   (d) B

2. Which of the following forms a set of complex and a double salt, respectively? **(2023)**
   (a) $CuSO_4 \cdot 5H_2O$ and $CuCl_2 \cdot 4NH_3$
   (b) $PtCl_2 \cdot 2NH_3$ and $PtCl_4 \cdot 2HCl$
   (c) $K_2PtCl_2 \cdot 2NH_3$ and $KAl(SO_4)_2 \cdot 12H_2O$
   (d) $NiCl_2 \cdot 6H_2O$ and $NiCl_2(H_2O)_4$

3. Type of isomerism exhibited by compounds $[Cr(H_2O)_6Cl_3$, $[Cr(H_2O)_5Cl_2Cl_2 \cdot H_2O$, $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$ and the value of coordination number (CN) of central metal ion in all these compounds, respectively is: **(2023)**
   (a) Geometrical isomerism, CN = 2
   (b) Optical isomerism, CN = 4
   (c) Ionisation isomerism, CN = 4
   (d) Solvate isomerism, CN = 6

4. Homoleptic complex from the following complexes is: **(2023)**
   (a) Diamminechloridonitrito-N-platinum(II)
   (b) Pentaamminecarbonatocobalt(III) chloride
   (c) Triamminetriaquachromium(III) chloride
   (d) Potassium trioxalatoaluminate(III)

5. Which complex compound is most stable? **(2023)**
   (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) $[Co(NH_3)_4(H_2O)Br](NO_3)_2$

6. Match List I with List II:

	List I (Complexes)		List II (Types)
A.	$[Co(NH_3)_5NO_2]Cl_2$ and $[Co(NH_3)_5ONO]Cl_2$	1.	Ionisation isomerism
B.	$[Cr(NH_3)_6][Co(CN)_6]$ and $[Cr(CN)_6][Co(NH3)_6$	2.	Coordination isomerism
C.	$[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$	3.	Linkage isomerism
D.	$[Cr(H_2O)_6]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$	4.	Solvate isomerism

   Choose the correct answer from the options given below: **(2022)**
   (a) A-4, B-3, C-2, D-1
   (b) A-3, B-1, C-2, D-4
   (c) A-2, B-3, C-4, D-1
   (d) A-3, B-2, C-1, D-4

7. 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: **(2022)**
   (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 the not the correct explanation of (A).
   (d) (A) is correct but (R) is not correct.

8. The IUPAC name of the complex- $[Ag(H_2O)_2][Ag(CN)_2]$ is: **(2022)**
   (a) dicyanidosilver(II) diaquaargentate(II)
   (b) diaquasilver(II) dicyanidoargentate(II)
   (c) dicyanidosilver(I) diaquaargentate(I)
   (d) diaquasilver(I) dicyanidoargentate(I)

9. 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: **(2022)**
   (a) A > B > C
   (b) C > B > A
   (c) C > A > B
   (d) B > A > C

10. Ethylene diaminetetraacetate (EDTA) ion is: **(2021)**
    (a) Unidentate ligand
    (b) Bidentate ligand with two "N" donor atoms
    (c) Tridentate ligand with three "N" donor atoms
    (d) Dexadentate ligand with four "O" and two "N" donor atoms

11. Match List-I with List-II: **(2021)**

	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
    (a) A-(ii) B-(iv) C-(iii) D-(i)
    (b) A-(i) B-(iii) C-(iv) D-(ii)
    (c) A-(iv) B-(i) C-(ii) D-(iii)
    (d) A-(iv) B-(ii) C-(i) D-(iii)

12. Which of the following is the correct order of increasing field strength of ligands to form coordination compounds? **(2020)**
    (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) $SCN^- < F^- < C_2O_4^{2-} < CN$

13. Match the coordination number and type of hybridization with distribution of hybrid orbitals in space based on Valence bond theory: **(2020 Covid Re-NEET)**

	Coordination number and type of hybridization		**Distribution of hybrid orbitals in space**
(A)	$4, sp^3$	(i)	Trigonal bipyramidal
(B)	$4, dsp^2$	(ii)	Octahedral
(C)	$5, sp^3d$	(iii)	Tetrahedral
(D)	$6, d^2sp^3$	(iv)	Square planar

    Select the correct option:
    (a) A-(iii) B-(iv) C-(i) D-(ii)
    (b) A-(iv) B-(i) C-(ii) D-(iii)
    (c) A-(iii) B-(i) C-(iv) D-(ii)
    (d) A-(ii) B-(iii) C-(iv) D-(i)

14. What is the correct electronic configuration of the central atom in $K_4[Fe(CN)_6]$ based on crystal field theory? **(2019)**
    (a) $t_{2g}^4e_g^2$
    (b) $t_{2g}^6e_g^0$
    (c) $e^3t_{2g}^3$
    (d) $e^4t_{2g}^2$

15. Iron carbonyl, $Fe(CO)_5$ is **(2018)**
    (a) Tetranuclear
    (b) Mononuclear
    (c) Dinuclear
    (d) Trinuclear

16. The type of isomerism shown by the complex $[CoCl_2(en)_2]$ is: **(2018)**
    (a) Geometrical isomerism
    (b) Coordination isomerism
    (c) Linkage isomerism
    (d) Ionization isomerism

17. The geometry and magnetic behaviour of the complex $[Ni(CO)_4]$ are? **(2018)**
    (a) Square planar geometry and diamagnetic
    (b) Tetrahedral geometry and diamagnetic
    (c) Tetrahedral geometry and paramagnetic
    (d) Square planar geometry and paramagnetic

18. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is: **(2017-Delhi)**
    (a) $[Co(NH_3)_6]^{3+}, [Co(en)_3]^{3+}, [Co(H_2O)_6]^{3+}$
    (b) $[Co(en)_3]^{3+}, [Co(NH_3)_6]^{3+}, [Co(H_2O)_6]^{3+}$
    (c) $[Co(H_2O)_6]^{3+}, [Co(en)_3]^{3+}, [Co(NH_3)_6]^{3+}$
    (d) $[Co(H_2O)_6]^{3+}, [Co(NH_3)_6]^{3+}, [Co(en)_3]^{3+}$

19. Pick out the correct statement with respect to $[Mn(CN)_6]^{3-}$ **(2017-Delhi)**
    (a) It is dsp^2 hybridised and square planar
    (b) It is sp^3d^2 hybridised and octahedral
    (c) It is sp^3d^2 hybridised and tetrahedral
    (d) It is d^2sp^3 hybridised and octahedral

20. 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: **(2017-Delhi)**
    (a) $2AgCl, 3AgCl, 1AgCl$
    (b) $1AgCl, 3AgCl, 2AgCl$
    (c) $3AgCl, 1AgCl, 2AgCl$
    (d) $3AgCl, 2AgCl, 1AgCl$

21. Which of the following complex ions is not diamagnetic? **(2017-Gujarat)**
(a) $[Sc(H_2O)_3(NH_3)_3]^{3+}$
(b) $[Ti(en)_2(NH_3)_2]^{4+}$
(c) $[Cr(NH_3)_6]^{3+}$
(d) $[Zn(NH_3)_6]^{2+}$

22. For the tetrahedral complex $[MnBr_4]^{2-}$, the spin only magnetic moment value is: **(2017-Gujarat)**
(a) 2.4
(b) 1.7
(c) 5.9
(d) 4.8

23. The electron distribution in d^n coordination complexes depends on magnitude of crystal field splitting, (Δ_0) and pairing energy (P). The condition which favours formation of high spin complexes is: **(2017-Gujarat)**
(a) $t_{2g}{}^4 e_g^0$
(b) $\Delta_0 > P$
(c) $\Delta_0 < P$
(d) $\Delta_0 = P$

24. The $[Co(H_2O)_6]^{2+}$ ion has three unpaired electrons. The hybridization of Co in $[Co(H_2O)_6]^{2+}$ is: **(2017-Gujarat)**
(a) d^2sp^3
(b) sp^3
(c) dsp^2
(d) sp^3d^2

25. The correct increasing order of trans-effect of the following species is:
(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) $CN^- > Br^- > C_6H_5^- > NH_3$

26. Jahn-Teller effect is not observed in high spin complexes of:
(a) d^7
(b) d^8
(c) d^4
(d) d^9

27. Which of the following has longest C-O bond length?
(Free C–O bond length in CO is 1.128Å) **(2016-I)**
(a) $[Mn(CO)_6]^+$
(b) $Ni(CO)_4$
(c) $[Co(CO)_4]^-$
(d) $[Fe(CO)_4]^{2-}$

28. The name of complex ion, $[Fe(CN)_6]^{3-}$ is: **(2015 Re)**
(a) Hexacyanidoferrate (III) ion
(b) Hexacyanoiron (III) ion
(c) Hexacyanoferrate (III) ion
(d) Tricyanoferrate (III) ion

29. The hybridization involved in complex $[Ni(CN)_4]^2$ is
(Atomic Number Ni = 28) **(2015 Re)**
(a) d^2sp^3
(b) dsp^2
(c) sp^3
(d) d^2sp^2

30. Number of possible isomers for the complex $[Co(en)_2Cl_2]$ Cl will be:
(en = ethylenediamine) **(2015 Re)**
(a) 4
(b) 2
(c) 1
(d) 3

31. Which of these statements about $[Co(CN)_6]^{3-}$ is true? **(2015)**
(a) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a low-spin configuration
(b) $[Co(CN)_6]^{3-}$ has four unpaired electrons and will be in a high-spin configuration
(c) $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a high-spin configuration
(d) $[Co(CN)_6]^{3-}$ has no unpaired electrons and will be in a low-spin configuration

32. 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)**
(a) $CoCl_3.4NH_3$
(b) $CoCl_3.5NH_3$
(c) $CoCl_3.6NH_3$
(d) $CoCl_3.3NH_3$

33. The sum of corrdination number and oxidation number of the metal M in the complex $[M(en)_2(C_2O_4)]Cl$ (where en is ethylenediamine) is: **(2017 Re)**
(a) 6
(b) 7
(c) 8
(d) 9

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

(a) $[Fe(H_2O)_6]^{3+}$
(b) $[Co(H_2O)_6]^{2+}$
(c) $[Co(H_2O)_6]^{3+}$
(d) $[Mn(H_2O)_6]^{3+}$

35. Which of the following complexes is used to be as an anticancer agent? **(2014)**
(a) $cis-[PtCl_2(NH_3)_2]$
(b) $cis-K_2[PtCl_2Br_2]$
(c) $Na_2[CoCl_4]$
(d) $mer-[Co(NH_3)_3Cl_3]$

Answer Key

S1. Ans. (b)

S2. Ans. (c)

S3. Ans. (d)

S4. Ans. (d)

S5. Ans. (b)

S6. Ans. (d)

S7. Ans. (d)

S8. Ans. (d)

S9. Ans. (c)

S10. Ans. (d)

S11. Ans. (c)

S12. Ans. (d)

S13. Ans. (a)

S14. Ans. (b)

S15. Ans. (b)

S16. Ans. (a)

S17. Ans. (b)

S18. Ans. (b)

S19. Ans. (d)

S20. Ans. (d)

S21. Ans. (c)

S22. Ans. (c)

S23. Ans. (c)

S24. Ans. (d)

S25. Ans. (b)

S26. Ans. (b)

S27. Ans. (d)

S28. Ans. (a)

S29. Ans. (b)

S30. Ans. (d)

S31. Ans. (d)

S32. Ans. (d)

S33. Ans. (d)

S34. Ans. (a)

S35. Ans. (a)

Solutions

S1. Ans.(b)

Maximum covalency of boron is four.

S2. Ans.(c)

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

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

S3. Ans.(d)

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

S4. Ans.(d)

(1) $[Pt(NH_3)_2Cl(NO_2)]$

(2) $[Co(NH_3)_5(CO_3)]Cl$

(3) $[Cr(NH_3)_3(H_2O)_3]Cl_3$

(4) $K_3[Al(C_3O_4)_3]$

Option 4 contain all ligands are of same type i.e., why complex will be homoleptic.

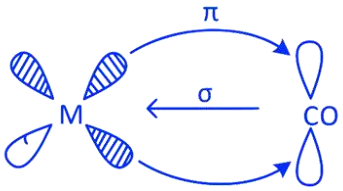
S5. Ans.(b)

Due to Chelation effect of (en).

S6. Ans.(d)

A-3, B-2, C-1, D-4

S7. Ans.(d)



In case of metal carbonyls, the bonding has both σ and π nature, where ligand to metal bond is 'σ' (coordinate) bond and metal to ligand bond is 'π' (synergic) bond.

S8. Ans.(d)

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

IUPAC name:

diaquasilver(I) dicyanidoargentate(I)

S9. Ans.(c)

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

$\Rightarrow$ 'en' has a stronger field strength than 'H_2O' according to spectrochemical series.

$\therefore$ 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

S10. Ans.(d)

S11. Ans.(c)

S12. Ans.(d)

Spectrochemical series the correct order of increasing field strength of ligands to form coordination compounds

$$I^- < Br^- < S^{2-} < SCN^- < Cl^- < N_3^-$$

$$< F^- < OH^- < C_2O_4^{2-} < H_2O <$$

$$NCS^- < EDTA^{4-} < NH_3 < en < CN^-$$

$$< CO$$

Thus option d is correct.

S13. Ans.(a)

Hybridisation	**Geometry**	**Coordination number**
Sp^3	Tetrahedral	4
dsp^2	Square planar	4
Sp^3d	Trigonal bipyramidal	5
d^2sp^3	Octahedral	6

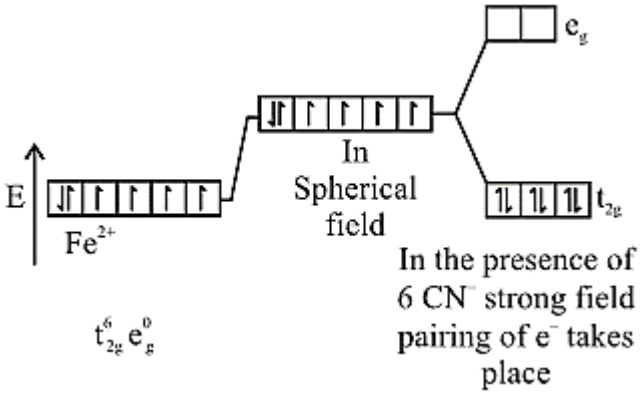
Spectrochemical

S14. Ans.(b)

$K_4[Fe(CN)_6]$

Fe ground state : $[Ar]3d^64s^2$

$Fe^{2+}: 3d^64s^0$



S15. Ans.(d)

Based on the number of metal atoms present in a complex, they are classified into mononuclear, dinuclear, trinuclear and so on.

Eg: $Fe(CO)_5$: mononuclear

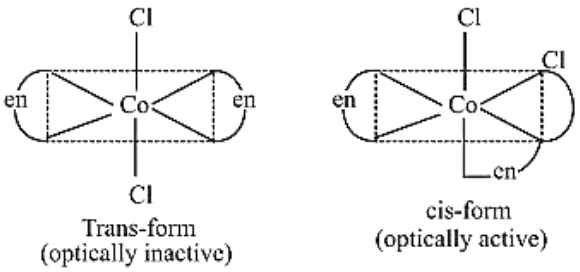
$Co_2(CO)_8$: dinuclear

$Fe_3(CO)_{12}$: trinuclear

Hence, option (b) should be the right answer.

S16. Ans.(a)

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

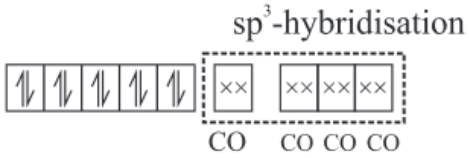


As per given option, type of isomerism is geometrical isomerism.

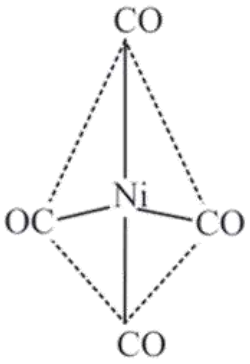
S17. Ans.(b)

$Ni(28): [Ar]3d^8 4s^2$

$\because$ Co is a strong field ligand configuration would be:



For, four 'CO'-ligands hybridization would be sp^3 and thus the complex would be diamagnetic and of tetrahedral geometry.



S18. Ans.(d)

The increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is:-

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

As the spectro chemical series is:

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^-$

$< OH^- < C_2O_4^{2-} < H_2O < NCS^- < EDTA^{4+}$

$< NH_3 < en < CN^- < CO.$

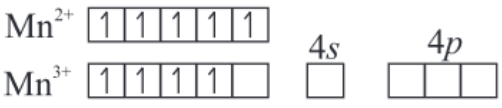
S19. Ans.(d)

$[Mn(CN)_6]^{3-}$

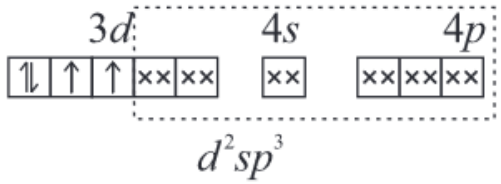
$x + 6(-1) = -3$

$x - 6 = -3$

$x = -3 + 6 \quad \Rightarrow \quad x = +3$



In presence of CN^- causes pairing



d^2sp^3

$\therefore$ d^2sp^3 is required

Hence, it is octahedral in shape.

S20. Ans.(d)

Complexes are respectively $[Co(NH_3)_6]Cl_3, [Co(NH_3)_5Cl]\ Cl_2$ and $[Co(NH_3)_4Cl_2]Cl$.

S21. Ans.(c)

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

$\therefore$ They have 3 unpaired electron.

$\therefore$ They are paramagnetic in nature.

S22. Ans.(c)

In $[MnBr_4]^{2-}$

$Mn^{2+} = [Ar]^{18}3d^54s^0$.

$[MnBr_4]^{2-}$ is tetrahedral complex

$n = 5$

$\mu = \sqrt{n(n+2)} = \sqrt{5(5+2)} = \sqrt{5(7)} = \sqrt{35}$

= 5.9

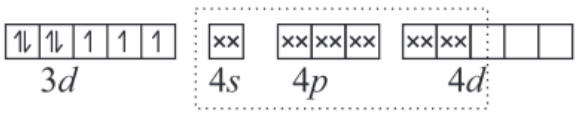
S23. Ans.(c)

$P > \Delta_0$ is a condition which favours formation of high spin complexes.

S24. Ans.(d)

$[CO(H_2O)_6]^{2+}$, N = 3 unpaired electrons.

$Co^{2+}: [Ar]3d^7$



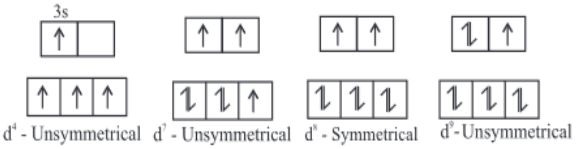
sp^3d^2

S25. Ans.(b)

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

S26. Ans.(b)

Jahn – teller distortion is usually significant for asymmetrically occupied e_g orbital. In case unevenly occupied t_{2g} orbital & Jahn-teller distortion is very weak.



S27. Ans.(d)

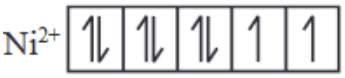
Due to back bonding between metal carbonyl bond, length of $C - O$ increase. Also, higher the charge on central metal atom higher will be the back bonding (synergic effect).

S28. Ans.(a)

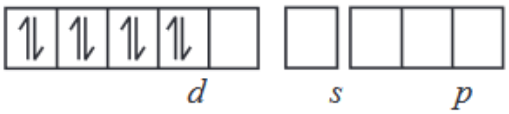
Name of complex ion $[Fe(CN)_6]^{3-}$ is Hexacyaniodoferrate (III) ion

Oxidation state of Fe is +3.

S29. Ans.(b)

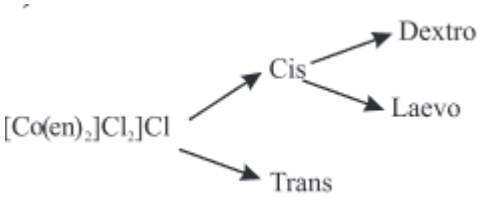


Electronic configuration of $[Ni(CN)_4]^{2-}$



As CN^- is a strong field ligand it will form a low spin complex with dsp^2 hybridization.

S30. Ans.(d)



S31. Ans.(d)

As CN^- being a strong field ligand will form a low-spin complex.

S32. Ans.(d)

Cobalt III Chloride means that the coordinate ion number of Co^{3+} is 6, so compound must be $[Co(NH_3)Cl_3]$.

S33. Ans.(d)

$[M(en_2)(C_2O_4)]Cl$

Oxidation number of metal = 3

Coordination number of metal = 6

Sum of oxidation and coordination number

= 3 + 6

= 9

S34. Ans.(a)

In $[Fe(H_2O)_6]^{3+}$, Fe has oxidation state of +3

$d^5 = t_{2g}^3$ & e_g^2

C.F.S.E. = 0

A high spin complex is formed because H_2O is a weak field ligand.

$+0.6 \times 2 - 0.4 \times 3 = 0$

S35. Ans.(a)

Cis platin: Cis $[PtCl_2(NH_3)_2]$ is used as an anticancer agent.