CHEMISTRY

BOOKS - PRADEEP CHEMISTRY (HINGLISH)

CORDINATION COMPOUNDS

Sample Paper

1. The formula of the coordination compound Tetraammineaquachloridocobalt (III) chloride is

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2. Write the formulate of the following coordination compounds :

(i) sodium pentacyanonitrosylsulphidoferrate (III)

(ii) potassium tetrahydroxozincate (II)

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Curiosity Questions

1. Green colour of leaves is due to presence of chlorophyll which is a complex compound. Which metal is present in it?

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2. The metal present in chlorophyll is ..... And the metal present in vitamin B_{12} is ..... .

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3. Explain the consequences of deficiency of haemoglobin in our body (any three).

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4. KCN is highly poisonous while $K_4\left[Fe(CN)_6\right]$ is not. Why ?

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5. White light consists of seven colours (VIBGYOR). If orange light is absorbed by a substance. What will be the colour of the substance and if blue is absorbed, what will be the colour and why ?

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6. Name any three gemstones. Give their colours and name the metals present in each of them which is responsible for the colour.

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7. Which one of the following is used to remove ink and rust stains on cloth?

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Problems For Practice

1. Name the following coordination compounds using I.U.P.A.C. system

(i) $\left[Cr\left(NH_3\right)_6\right]^{3+}$ (ii) $\left[Mn\left(H_2O\right)_6\right]^{2+}$ (iii) $\left[Fe(CN)_6\right]^{4-}$ (iv) $\left[Ni\left(NH_3\right)_6\right]Cl_2$

(v) $\left[Co(CN)_6\right]^{3-}$ (vi) $Ca_2\left[Fe(CN)_6\right]$ (vii) $\left[Co\left(NH_3\right)_6\right]Cl_3$ (viii) $\left[Cr\left(H_2O\right)_4Cl_2\right]NO_3$

(ix) $\left[Co\left(NH_3\right)_4Cl\left(NO_2\right)\right]NO_3$

(xii) $K\left[Pt\left(NH_3\right)Cl_3\right]$

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2. Write I.U.P.A.C name of (i) $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$ (ii) $\left[Co(en)_2Cl(ONO)\right]^+$

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3. Write IUPAC names for : (i) $\left[Cr\left(NH_3\right)_6\right]^{3+}$ (ii) $\left[Ni\left(NH_3\right)_6\right]Cl_2$

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4. Write the IUPAC name of (i) $Hg\left[Co(CNS)_4\right]$ (ii) $K\left[Co(CN)(CO)_2(NO)\right]$

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5. Name the complexes (i) $K_4\left[Fe(CN)_6\right]$ (ii) $\left[Pt\left(NH_3\right)_3(NO)Cl_2\right]Br$

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6. The IUPAC name of $\left[Ni(CN)_4\right]^{2-}$ is

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7. Write IUPAC name of $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$.

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8. Give IUPAC name of : (i) $\left[Mn\left(H_2O\right)_6\right]SO_4$ (ii) $\left[Co(en)_3\right]Cl_3$

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9. Name the complexes : (i) $K_3\left[Al\left(C_2O_4\right)_3\right]$ (ii) $\left[Co\left(NH_3\right)_5CO_3\right]Cl.$

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10. The compound $K_3\left[Co\left(NO_2\right)_6\right]$ is called

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11. Name the complex $K_2\left[Cu(CN)_4\right]$.

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12. IUPAC name of $K_3\left[Fe\left(C_2O_4\right)_3\right]$ is

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13. Write the IUPAC name of

(i) $\left[Co\left(NH_3\right)_5NO_2\right]Cl_2$ (ii) $\left[Cr\left(H_2O\right)_5SCN\right]^{2+}$ (iii) $\left[CoCl\left(NO_2\right)(en)_2\right]^+$

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14. Write IUPAC names of the following

(i) $\left[CoCl_2(en)_2\right]SO_4$ (ii) $\left[Ni(CO)_4\right]$ (iii) $K\left[PtCl_3\left(NH_3\right)\right]$ (iv) $\left[Cr(en)_3\right]Cl_3$

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15. Write IUPAC name of

$\left[PtBrCl\left(NO_2\right)NH_3\right]^-$ or $\left[PtCl\left(NH_2CH_3\right)\left(NH_3\right)_2\right]Cl$ or $\left[CoCl\left(NO_2\right)\left(NH_3\right)\right.$

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16. The correct IUPAC name of $\left[Pt\left(NH_3\right)_2Cl_2\right]$ is

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17. Name the following compounds according to IUPAC system

i) $\left[Co\left(NH_3\right)_4\left(H_2O\right)\right]Cl_2$

ii) $\left[CrCl_2(en)_2\right]Cl$

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18. Write IUPAC name of (i) $K_3\left[Ag\left(S_2O_3\right)_2\right]$ (ii) $\left[Fe\left(H_2O\right)_4\left(C_2O_4\right)_2\right]SO_4$

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19. Using IUPAC nomenclature, write systematic names of the following :

(a) $\left[Co\left(NH_3\right)_6\right]\left(SO_4\right)_3$ (b) $\left[Pt\left(NH_3\right)_2Cl_2\right]$ (c) $K_3\left[Cr\left(C_2O_4\right)_3\right]$

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20. Write the IUPAC names of the following coordination compounds :

(i) $\left[Cr\left(NH_3\right)_3Cl_3\right]$

(ii) $K_3\left[Fe(CN)_6\right]$

(iii) $\left[CoBr_2(en)_2\right]^+$, (en = ethylenediamine)

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21. Write down the IUPAC name of the following complex :

$\left[Cr\left(NH_3\right)_2(en)\right]Cl$ (en = ethylenediamine)

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22. Write down the formulae of the following coordination compounds :

(i) hexaaquairon (II) sulphate (ii) potassium tetracyanonickelate (III)

(iii) chloronitrodiammineplatinum (II) (iv) potassium hexacyanoferrate (III)

(v) chlorodiammineplatinum (II) ion (vi) dichlorotetraamminecobalt (III) ion

(vii) potassium pentacyanonitrosylcobaltate (III) (viii) bis(acetylacetonato) oxovanadium (IV).

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23. Write down the formulae of the following coordination compounds.

(i) hexaammineplatinum (IV) chloride

(ii) sodium ethylenediamminetetraacetato chromate (II)

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24. Give the structural formulae of the following :

(i) potassium hexacyanoferrate (III)

(ii) chloro-bis(ethylenediamine)nitro cobalt (III) ion

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25. Write down the formula of the complex : Pentaamminenitrito-O-cobalt (III).

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26. Using IUPAC norms write the formulae for the following :

(i) Sodium dicyanidourate

(ii) Tetraammine chloridonitrito-N-platinum (IV) sulphate

or (i) Tris(ethane-1, 2-diamine) chromium (III) chloride

(ii) Potassium tetrahydroxozincate (II)

or (i) Potassium trioxalatoaluminate (III)

(ii) Dichloridobis (ethane-1, 2-diamine) cobalt (III)

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Advanced Problems

1. A complex has empirical formula, $PtCl_2.2NH_3$. When mixed with $AgNO_3$, it gives $\left[Pt\left(NH_3\right)_4\left(NO_3\right)_2\right]$ and an insoluble slid $Ag_2\left[PtCl_4\right]$ was also obtained. Name and mention the structure of the complex.

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2. Explain the following about the complexes $\left[Fe(CN)_6\right]^{4-}$ and $\left[Fe\left(H_2O\right)_6\right]^{2+}$:

(i) What type of shapes do they have ?

(ii) What type of hybridisation is involved in each case ?

(iii) Which of them is outer orbital complex and which one is inner orbital complex ?

(iv) Which of them is low spin complex and which one is high spin

complex ?

(v) Compare their magnetic behaviour.

(vi) Why do they have different colours in dilute solution ?

(vii) Write the electronic configuration of metal ion in each case in terms of t_{2g} and e_g orbitals.

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3. Write equations to represent the following observations: When $NaOH$ is added to aqueous $CuSO_4$ solution, a pale blue precipitate is formed. On adding aqueous NH_3 solution, When $NaOH$ is added to give a deep blue solution. If the solution is made acidic with dilute HNO_3, the colour is converted back to pale blue solution.

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4. A, B and C are three complexes of chromium(III) with the empirical formula $H_{12}O_6C_{13}Cr$. All the three complexes not react with concentrated H_2SO_4 whereas complexes B and C lose $6.75\,\%$ and $13.5\,\%$

of their original mass respectively, on treatment on treatment with concentrated H_2SO_4 Identify A, B and C .

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5. 2.665 g of a complex with molecular formula $CrCl_3.6H_2O$ was dissolved in water. The solution was passed through a cation exchanger such that all ionizable Cl^- ions passed into the solution. The solution was collected and treated with $AgNO_3$ solution. The precipitate of $AgCl$ was filtered, dried and weighed. Its mass found to be 2.87 g. Find out the structural formula of the complex and name it on IUPAC system (Atomic mass : Cr = 52, Ag = 108, Cl = 35.5, N = 14).

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6. Name a hexadentate ligand and draw its structure. Write the formula of the complex which it forms with $Co(III)$. Also draw the structure of this complex.

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7. Calculate : (i) Ratio of $\left[Ag\left(NH_3\right)_2\right]^+$ and $\left[Ag^+\right]$ in 0.1M NH_3 solution (ii) Ratio of $\left[Ag\left(S_2O_3\right)_2\right]^{3-}$ and $\left[Ag^+\right]$ in 0.1M $S_2O_3^{2-}$ solution. Given that the stability/formation constants $\left(K_f\right)$ for $\left[Ag\left(NH_3\right)_2\right]^+$ and $\left[Ag\left(S_2O_3\right)_2\right]^{3-}$ are 1.7×10^7 and 1.0×10^{13} respectively.

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8. Calculate the crystal field stabilization energy and spin only magnetic moment for the following configuration of octahedral complexes.

(i) d^3 (in weak as well as strong ligand field)

(ii) d^5 (in weak as well as strong ligand field)

(iii) d^7 (in weak ligand field)

(iv) d^9 (in weak as well as strong ligand field)

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9. When $\left[Ni\left(NH_3\right)_4\right]^{2+}$ is treated with conc HCI, two compounds having the formula $Ni\left(NH_3\right)(2)CI_2$ are formed. A solution of I reacts with oxalic acid to form $Ni\left(NH_3\right)_2\left(C_2O_4\right)$. II does not react with oxalic acid. Deduce the configuration of I and II and the geometry of Ni (II) complexes .

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10. A mixture x containing 0.02 mol of $\left[Co\left(NH_3\right)_5SO_4\right]Br$ and 0.02 mol of $\left[Co\left(NH_3\right)_5Br\right]SO_4$ was prepared in $2L$ of solution.

$1L$ of mixture X + excess $AgNO_3 \rightarrow Y$

$1L$ of mixture X + excess $BaCl_2 \rightarrow Z$

The number of moles of Y and Z are

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11. 1.502 g sample of steel yields 0.259 g of nickel dimethylglyoximate $NiC_8H_{14}N_4O_4$ (molar mass 289 g mol^{-1}). What is the percentage of nickel

in the steel? (Atomic mass of Ni=59)

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Test Your Grip

1. Which of the following is a tridentate ligand?

A. NO_2^-

B. oxalate ion

C. glycinate ion

D. dien

Answer: D

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2. An example of ambidentate ligand is

A. Ammine

B. Aquo

C. Oxalato

D. Thiacyanato

Answer: D

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3. The IUPAC name of $\left[Pt\left(NH_3\right)(Br)(CI)\left(NO_2\right)\right]CI$ is

A. Triamminechloridobromidonitroplatinum (IV) chloride

B. Triamminebromidonitrochloridoplatinum (IV) chloride

C. Triamminebromidochloridonitroplatinum (IV) chloride

D. Triamminenitrochloridobromidoplatinum (IV) chloride

Answer: A

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4. The number of possible isomers for the complex $\left[Co\left(C_2O_4\right)\left(NH_3\right)_2\right]$ is

A. 1

B. 2

C. 3

D. 4

Answer: D

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5. The complexes $\left[Co\left(NH_3\right)_6\right]\left[Cr(CN)_6\right]$ and $\left[Cr\left(NH_3\right)_6\right]\left[Co(CN)_6\right]$ are the examples of which type of isomerism ?

A. Geometrical isomerism

B. Linkage isomerism

C. Ionization isomerism

D. Coordination isomerism

Answer: C

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6. Which kind of isomerism is exhibited by octahedral $\left[Co\left(NH_3\right)_4Br_2\right]Cl$?

A. Geometrical and ionization

B. Geometrical and optical

C. Optical and ionization

D. Geometrical only

Answer: A

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7. The ionisation isomer of $\left[Cr\left(H_2O\right)_4Cl\left(NO_2\right)\right]Cl$

A. $\left[Cr\left(H_2O\right)_4\left(O_2N\right)\right]Cl_2$

B. $\left[Cr\left(H_2O\right)_4Cl_2\right]\left(NO_2\right)$

C. $\left[Cr\left(H_2O\right)_4Cl(ONO)\right]Cl$

D. $\left[Cr\left(H_2O\right)_4Cl_2\left(NO_2\right)\right]H_2O$

Answer: B

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8. Which of the following has an optical isomer?

(en=ethylenediamine) ?

A. $\left[Co\left(H_2O\right)_4(en)\right]^{3+}$

(en = ethylenediamine)

B. $\left[Zn(en)_2\right]^{2+}$

C. $\left[Zn(en)\left(NH_3\right)_2\right]^{2+}$

D. $\left[Co(en)_3\right]^{3+}$

Answer: D

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9. Which of the following has highest molar conductivity

A. Diamminedichloro platinum (II)

B. Tetraamminedichlorocobalt (III) chloride

C. Potassium hexacyanoferrate (II)

D. Hexaaquochromium (III) chloride

Answer: B

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10. The primary and secondary valencies of chromium in the complex ion, dichlotodioxalatochromoium (III), are respectrively

A. 3, 4

B. 4, 3

C. 3, 6

D. 6, 3

Answer: C

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11. The hybridisation of Fe in $K_4\left[Fe(CN)_6\right]$ is

A. dsp^2

B. sp^3

C. d^2sp^3

D. sp^3d^2

Answer: C

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12. Among the following ions which one has the highest paramagnetism?

A. $\left[Cr\left(H_2O\right)_6\right]^{3+}$

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

C. $\left[Cu\left(H_2O\right)_6\right]^{2+}$

D. $\left[Zn\left(H_2O\right)_6\right]^{2+}$

Answer: B

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13. Which of the following is an outer orbital complex ?

A. $\left[Fe(CN)_6\right]^{4-}$

B. $\left[FeF_6\right]^{3-}$

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

D. $\left[Co(CN)_6\right]^{2+}$

Answer: B

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14. Which of the following compound has tetrahedral geometry?

A. $\left[Ni(CN)_4\right]^{2-}$

B. $\left[Pd(CN)_4\right]^{2-}$

C. $\left[PdCl_4\right]^{2-}$

D. $\left[NiCl_4\right]^{2-}$

Answer: D

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15. Which of the following statement is correct ? (CFSE = Crystal Field Splitting Energy)

A. Lower CFSE favours formation of low spin complex

B. Higher CFSE favours formation of high spin complex

C. A particular metal ion in a particular oxidation state can form diamagnetic complexes only or paramagnetic complexes only

D. t_{2g} orbitals are three-fold degenerate while e_g orbitals are two-fold degenerate

Answer: D

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16. The increasing order of the crystal field splitting power of some common ligands is

A. $H_2O < OH^- < Cl^- < F^- < CN^-$

B. $CN^- < H_2O < OH^- < F^- < Cl^-$

C. $F^- < CN^- < OH^- < Cl^- < H_2O$

D. $Cl^- < F^- < OH^- < H_2O < CN^-$

Answer: D

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17. Which of the following configuration of ions has zero CFSE in both strong and weak ligand fields ?

A. d^{10}

B. d^8

C. d^6

D. d^4

Answer: A

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18. The most stable complex among the following is

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

B. $\left[Pt(en)_2\right]Cl_2$

C. $\left[Ag\left(NH_3\right)_2\right]Cl$

D. $K_2[Ni(EDTA)]$

Answer: D

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19. $Ag^+ + \Leftrightarrow \ |Ag\left(NH_3\right)_2|^+, k_1 = 6.8 \times 10^{-3}$

$\left[Ag\left(NH_3\right)\right]^+ + NH_3 \Leftrightarrow \ |Ag\left(NH_3\right)_2|, k_2 = 1.6 \times 10^{-3}$

Then the formation constant or $|Ag\left(NH_3\right)_2|^+$ is

A. 1.08×10^{-7}

B. 1.08×10^{-5}

C. 1.08×10^{-9}

D. none of these

Answer: B

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20. The dark blue colour of the solution formed when excess of ammonia is added to a solution of copper (II) sulphate is due to the presence of the ion

A. $\left[Cu(OH)_4\left(H_2O\right)_2\right]^{2-}$

B. $\left[Cu\left(H_2O\right)_6\right]^{2+}$

C. $\left[Cu\left(NH_3\right)_2\left(H_2O\right)_4\right]^{2+}$

D. $\left[Cu\left(NH_3\right)_4\left(H_2O\right)_2\right]^{2+}$

Answer: D

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21. Prussian blue is obtained by mixing together aqueous solution of Fe^{3+} salt with

A. Ferricyanide

B. Ferocyanide

C. Hydrogen cyanide

D. Sodium cyanide

Answer: B

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22. The correct formula of Zeise's salt is

A. $\left[Fe\left(C_5H_5\right)_2\right]$

B. $\left[Pb\left(C_2H_5\right)_4\right]$

C. $K\left[PtCl_3\left(C_2H_4\right)\right]$

D. $\left[Ni(CO)_4\right]$

Answer: C

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23. Which of the following is a π-acid ligand?

A. NH_3

B. CO

C. F^-

D. ethylene diamine.

Answer: B

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24. The correct structure of $Fe(CO)_5$ is ?

A. octahedral

B. tetrahedral

C. square pyramidal

D. trigonal bipyramidal

Answer: D

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25. The oxidation state of nickel in $\left[Ni(CO)_4\right]$ is

A. 4

B. 0

C. 2

D. 3

Answer: B

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26. The non -existant metal carbonyl among the following is `

A. $Cr(CO)_6$

B. $Mn(CO)_5$

C. $Ni(CO)_4$

D. $Fe(CO)_5$

Answer: B

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27. The metal-carbon bond in metal carbonyls prossesses :

A. only σ-character

B. only π-character

C. both σ and πcharater

D. ionic character

Answer: C

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28. Which of the following is not considered as an organometallic compounds ? .

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29. The coordination compound of which one of the following compositions will produce two equivalents of AgCl on reaction with aqueous silver nitrate solution ?

A. $CoCl_3.3NH_3$

B. $CoCl_3.6NH_3$

C. $CoCl_3.4NH_3$

D. $CoCl_3.5NH_3$

Answer: D

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Fill In The Blanks

1. The solution of the compound, $K_4Fe(CN)_6$ will not given the tests of ..... and ..... ions.

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2. The number of coordinating or ligating groups present in a ligand is called its ..... . '

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3. $[Pt(\text{trien})]^{2+}$ is a ..... Ligand on the basis of its denticity.

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4. When a ligand forms a closed ring with the metal atom, the complex formed is called ..... .

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5. Unidentate ligands containing more than one coordinating atoms are called ..... Ligands.

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6. The total number of Ligands attached to the central metal ion through coordinate bond is called–

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7. The spatial arrangement of the ligands attached to the central metal atom is called

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8. Complexes in which the metal atom or ion is linked to only one type of ligands are called ..... whereas those in which metal atom is linked to more than one type of ligands are called ..... .

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9. The ligands SCN linked to the metal atom through S is called ..... whereas when linked through N, it is called ..... .

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10. The formula of sodium hexanitrite cobalt is ..... and its IUPAC name is ..... .

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11. The formula of sodium nitroprusside is ..... and its IUPAC name is .....

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12. $\left[CoCl\left(NH_3\right)_4\left(H_2O\right)\right]Br_2$ and $\left[Co\left(NH_3\right)_4Br_2\right]Cl.\,H_2O$ are .... Isomers as well as ..... .

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13. The cis form of the complex $\left[RhCl_3(py)_3\right]$ is called ..... isomer whereas its trans form is called ..... isomer.

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14. Two compounds with the formula $\left[Co\left(NH_3\right)_4Cl_2\right]^+Cl^-$ exist. One of the has violet colour whereas the other has green colour. One of them is ..... Isomer whereas the other is ..... isomer.

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15. Octahedral complexes involving d^2sp^3 hybridisation are called ..... complexes whereas those involving sp^3d^2 hybridisation are called ..... .

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16. $\left[Ni(CN)_4\right]^{2-}$ complex has the shape ..... and is ..... In terms of magnetic nature whereas $\left[NiCl_4\right]$^(2-)` has the shape ..... and is ..... .

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17. In an octahedral crystal field, d - orbitals split into ..... Orbitals collectively called ..... And ..... Orbitals collectively called .....

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18. The difference of energy between two sets of d-orbitals obtained due to splitting in a crystal field is called ..... .

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19. The arrangement of ligands in order of their crystal field splitting energies is called _____ .

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20. The average energy level of the perturbed d-orbitals in the crystal field for which the energy is taken as zero is called ..... .

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21. If Δ_0 represents CFSE in an octahedral field, e_g orbitals lie ..... The bari centre and t_{2g} orbitals lie ..... the bari centre.

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22. If $CFSE\left(\Delta_0\right)$ is less than pairing energy (P), the ligand is a ..... ligand and the complex formed is a ..... complex.

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23. In a tetrahedral crystal field, the d-orbitals split into ..... orbitals collectively called ..... and ..... orbitals collectively called ..... .

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24. If Δ_t represents CFSE in a tetrahedral crystal field t_2_____ .The bari centre and e lies _____ the bari centre.

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25. The common name of $K\left[PtCl_3\left(\eta^2 - C_2H_4\right)\right]$ is ..... .

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26. The most common name of bis (cyclopentadienyl) iron is ..... .

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27. The C-O bond length in C $\equiv$ O ..... (decreases or increases or remains unchanged) when metal carbonyls are formed.

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28. The metal present in chlorophyll is ..... And the metal present in vitamin B_{12} is ..... .

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29. The brown ring formed in the test of nitrates with $FeSO_4$ solution and concentrated H_2SO_4 has the formula ..... .

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Conceptual Questions

1. Which type of ligands form chelates ?

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2. Which of the following is more stable complex and why?

$\left[CO\left(NH_3\right)_6\right]^{3+}$ and $\left[CO(en)_3\right]^{3+}$

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3. Why only transition metals are known to form π complexes ?

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4. Write the correct formulae for the following coordination compounds :

(a) $CrCl_3.6H_2O$ (violet, with 3 chloride ions/unit formula)

(b) $CrCl_3.6H_2O$ (light green colour with 2 chloride ions/unit formula)

(c) $CrCl_3.6H_2O$ (dark green colour with 1 chloride ion/unit formula)

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5. Write the formulae of the following :

(i) bis (acetylacetonato) oxovanadium (IV)

(ii) dichloridoplatinum (IV) tetrachloridoplatinate (II)

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6. Give the IUPAC names of the complexes (i) $K\left[BF_4\right]$ (ii) $\left[Fe\left(C_5H_5\right)_2\right]$ (iii) $\left[Mn_3(CO)_{12}\right]$

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7. The formula $Co\left(NH_3\right)_5CO_3Cl$ could represent a carbonate and a chloride. Give IUPAC names for them.

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8. Write the IUPAC name of 

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9. How many isomers are there for the complex $\left[Co\left(NH_3\right)_4Cl_2\right]Cl$?

or Draw cis and trans isomers of $\left[CoCl_2\left(NH_3\right)_4\right]^+$ ion.

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10. Write IUPAC name of the following complexes $\left[Cr\left(NH_3\right)_4Cl_2\right]^+$.

What type of isomerism does it exhibit ?

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11. Write all isomers of $\left[Co\left(NH_3\right)_5(SCN)\right]Cl.$

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12. Draw isomers of the complex ion $\left[Co(en)_2Cl_2\right]^+$

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13. How many isomers are possible for the neutral complex, $\left[Co\left(NH_3\right)_3Cl_3\right]$?

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14. How will you distinguish between the following isomer pairs ?

(a) (i) $\left[Cr\left(H_2O\right)_6\right]Cl_3$ and (ii) $\left[Cr\left(H_2O\right)_5Cl\right]Cl_2H_2O$

(b) (i) cis $\left[Pt\left(NH_3\right)_2Cl_2\right]$ and (ii) trans $\left[Pt\left(NH_3\right)_2Cl_2\right]$

(c) The two enantiomers of $\left[CoCl_2(en)_2\right]^+$

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15. Draw the structures of (a) cis-dichloridotetracyanochromate (III)

(b) Mer-triamminetrichloridocobalt (III) (c) Fac-triaquatrinitro-N-cobalt (III)

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16. Write the names and draw the structures of complex compounds lt(i)

$\left[Co\left(NH_3\right)_4\left(H_2O\right)_2\right]Cl_3$

(ii) $\left[Pt\left(NH_3\right)_4\right]^{2+}$ (iii) $\left[NiCl_4\right]$

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17. Write all the geometrical isomers of $\left[Pt\left(NH_3\right)(Br)(Cl)(py)\right]$ and how many of these will exhibit optical isomers?

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18. Square planar complexes with coordination number of four exhibit geometrical isomerism whereas tetrahedral complexes do not. Why ?

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19. Write the name (IUPAC norms) and draw the possible optical isomers of $\left[CrCl_2(en)\left(NH_3\right)_2\right]^+$.

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20. A coordination compound has the formula, $CoCl_3.4NH_3$. It does not liberate ammonia but precipitates chloride ions as silver chloride. Give the IUPAC name of the complex and write its structural formula.

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21. On the basis of valence bond theory, explain geometry, nature of hybridisation, magnetic property and optical isomerism of $\left[Co(ox)_3\right]^{3-}$ and $\left[CoF_6\right]^{3-}$.

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22. Arrange the following complexes in the increasing order of conductivity of their solution

$\left[Co\left(NH_3\right)_3Cl_3\right], \left[Co\left(NH_3\right)_4Cl_2\right]Cl, \left[Co\left(NH_3\right)_6\right]Cl_3, \left[Cr\left(NH_3\right)_5Cl\right]Cl_2$

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23. The molar conductivity of the complex $CoCl_3.4NH_3.2H_2O$ is found to be same as that of 3 : 1 electrolyte. What is the structural formula of the compelx ?

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24. A coordination compound $CrCI_3.4H_2O$ precipitates $AgCI$ when treated with $AgNO_3$ The molar conductance of its solution corresponds to a total of two ions Write the structural formula of the compound and name it .

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25. When a coordination compound $CrCl_3.6H_2O$ is mixed with $AgNO_3$, 2 moles of AgCl are precipitated per mole of the compound. Write

(i) Structural formula of the complex

(ii) IUPAC name of the complex.

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26. $\left[Co(CN)_6\right]^{3-}$ and $\left[CoF_6\right]^{3-}$ both are octahedral complexes. Then what is the difference between the two ?

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27. Account for the fact that $\left[Ni(CO)_4\right]$ has tetrahedral geometry whereas $\left[Ni(CN)_4\right]^{2-}$ has square planar geometry.

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28. Explain how two complexes of nickel, $\left[Ni(CN)_4\right]^{2-}$ and $Ni(CO)_4$ have different structures but do not differ in magnetic behaviour.

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29. Some square planar complexes of Ni(II) are diamagnetic while some others are paramagnetic. Justify.

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30. Account for different magnetic behaviour of hexacyanoferrate (III) and hexafluoroferrate (III).

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31. Out of tetracarbonyl nickel (0) and tetraamminecopper (II) sulphate, which is magnetic and why ?

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32. Describe for any two of the following complex ions , the type of hybridisation , shape and magnetic property.

(i) $\left[Fe\left(H_2O\right)_6\right]^{2+}$ (ii) $\left[Co\left(NH_3\right)_6\right]^{3+}$ (iii) $\left[NiCl_4\right]^{2-}$

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33. Define crystal field splitting energy. On the basis of crystal field theory, write the electronic configuration for d^4 ion if $\Delta_0 < P$.

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34. On the basis of crystal field theory, write the electronic configuration for d^4 ion if $\Delta_0 > P$.

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35. A metal ion M^{n+} HAVING D^4 valence electronic configuration combines with three bidentate ligands to form a complex compound . Assuming $\Delta_0 > P$:

(i) write the electronic configuration of d^4 ion .

(ii) what type of hybridisation will M^{n+} ion has ?

(iii) Nmae the type of isomerism exhibited by this complex .

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36. Draw a sketch to show the splitting of d-orbitals in an octahedral crystal field. State for a d^6 configuration, how the actual configuration of the split d-orbitals in an octahedral crystal field is decided by the relative values of Δ_0 and P ?

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37. $\left[Ti\left(H_2O\right)_6\right]^{3+}$ is coloured while $\left[Sc\left(H_2O\right)_6\right]^{3+}$ is colourless. Why?

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38. A solution of $\left[Ni\left(H_2O\right)_6\right]^{2+}$ is green but a solution of $\left[Ni(CN)_4\right]^{2-}$ is colourless Explain.

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39. With the help of crystal field theory, predict the number of unpaired electrons in $\left[Fe(CN)_6\right]^{4-}$ and $\left[Fe\left(H_2O\right)_6\right]^{2+}$ complexes.

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40. What happens to the colour of coordination compound $\left[Ti\left(H_2O\right)_6\right]Cl_3$ when heated gradually ?

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41. The values of dissociation constants of $\left[Cu\left(NH_3\right)_4\right]^{2+}$ and $\left[Co\left(NH_3\right)_6\right]^{3+}$ are 1.0×10^{-12} and 6.2×10^{-36} respectively. Which complex would be more stable and why ?

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42. Which of the two compounds are more stable and why . $K_4\left[Fe(CN)_6, K_3\left[Fe(CN)_6\right]\right.$?

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43. A chloride of fourth group cation in qualitative analysis gives a green coloured complex [A] in acqueous solution which when treated with ethane-1, 2-diamine (en) gives pale yellow solution [B] which on subsequent addition of ethane-1, 2-diamine turns to blue/purple [C] and finally to violet [D]. Write the structures of complexes [A], [B], [C], and [D]

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44. Write the correct formulae for the following coordination compounds :

(a) $CrCl_3.6H_2O$ (violet, with 3 chloride ions/unit formula)

(b) $CrCl_3.6H_2O$ (light green colour with 2 chloride ions/unit formula)

(c) $CrCl_3.6H_2O$ (dark green colour with 1 chloride ion/unit formula)

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45. Assertion: Metal carbonyls can be called organometallics

Reason: Metal carbonyls don't contain metal carbon bond .

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46. In the formation of metal carbonyls, which orbitals are involved in the overlap ?

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47. Draw the structures of the following :

(i) Pentaamminenitrito-N-cobalt (III) (ii) Hexamethyldialuminium.

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48. How is nickel detected and estimated in a salt ? Give the reaction involved.

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49. Why complexes are prefferred in the electrolytic bath for electroplating?

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50. Complete the equation :

$$\left[Fe\left(H_2O\right)_6\right]^{2+} + NO \rightarrow$$

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51. Explain the following cases giving appropriate reasons :

(i) Nickel does not form low spin octahedral complexes

(ii) Co^{2+} is easily oxidized to Co^{3+} in the presence of a strong ligand.

(iii) CO is a stronger ligand than NH_3 for many metals.

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Ncert Intext Questions

1. On the basis of the following observations made with aqueous solutions, how many of them have 6 secondary valencies ?

Formula	Moles of AgCl precipitated per mole of the compounds with exce
$(a) PdCl_2.4NH_3$	2
$(b) NiCl_2.6H_2O$	2
$(c) PtCl_4.2HCl$	0
$(d) CoCl_3.4NH_3$	1
$(e) PtCl_2.2NH_3$	0

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2. Write the formulas for the following coordination compounds:

(a) Tetraa mmineaqua chlorido cobalt (III) chloride

(b) Potassium tetrahydroxid ozincate (II)

(c) Potassium trioxalato aluminate (III)

(d) Dichloridobis (ethane-1,2-diamine) cobalt (III)

(e) Tetra carbonyl nickel (0)

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3. Write the IUPAC names of the following coordination compounds:

(a) $\left[Pt\left(NH_3\right)_2Cl\left(NO_2\right)\right]$

(b) $K_3\left[Cr\left(C_2O_4\right)_3\right]$

(c) $\left[CoCl_2(en)_2\right]Cl$

(d) $\left[Co\left(NH_3\right)\right]Cl$

(e) $Hg\left[Co(SCN)_4\right]$

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4. Why is geometrical isomerism not possible in tetrahedral complexes having two different types of unidentate ligands coordinated with central metal ion ? .

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5. Draw structures of geometrical isomers of $\left[Fe(CN)_4\left(NH_3\right)_2\right]^{\Theta}$.

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6. Out of the following two coordination entities Which is chiral (optically active)

(a) *cis* - $\left[CrCI_2(OX)_2\right]^{3-}$

(b) *trans* - $\left[CrCI_2(OX)_2\right)]^{3-}$.

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7. The spin only magnetic moment of $\left[MnBr_4\right]^{2-}$ is 5.9 BM. Predict the geometry of the complex ion.

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8. Wrtie the formulas for the following coordination compounds:

(i). Tetraamminediaquacobalt(III) chloride.

(ii). Potassium tetracyanidonichelate(II).

(iii). Tris(ethane-1,2-diamine) chromium(III) chloride.

(iv) Amminebromidochloridonitrito-N-Platinate(II).

(v). Dichlororidobis (ethane-1,2-diamine) platinum(IV) nitrate.

(vi). Iron(III) hexacyanidoferrate(II).

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9. Write the IUPAC names of the following coordiantion compounds:

(i) $\left[Co\left(NH_3\right)_6\right]Cl_3$

(ii) $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$

(iii) $K_3\left[Fe(CN)_6\right]$

(iv) $K_3\left[Fe\left(C_2O_4\right)_3\right]$

(v) $K_2\left[PdCl_4\right]$

(vi) $\left[Pt\left(NH_3\right)_2Cl\left(NH_2CH_3\right)\right]Cl$

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10. Indicate the type of isomerism exhibited by the following complexes and draw the structures for these isomers:

(i) $K\left[Cr\left(H_2O\right)_2\left(C_2O_4\right)_2\right.$

(ii) $\left[Co(en)_3\right]Cl_3$

(iii) $\left[Co\left(NH_3\right)_5\left(NO_2\right)\right]\left(NO_3\right)_2$

(iv) $\left[Pt\left(NH_3\right)\left(H_2O\right)Cl_2\right]$

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11. Give evidence that $\left[Co\left(NH_3\right)_5Cl\right]SO_4$ and $\left[Co\left(NH_3\right)_5SO_4\right]Cl$ are ionisation isomers.

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12. Explain on the basis of valence bond theory that $\left[Ni(CN)_4\right]^{2-}$ ion with square planar structure is diamagnetic and $\left[NiCl_4\right]^{2-}$ ion with tetrahedral geometry is paramagnetic.

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13. $\left[NiCl_4\right]^{2-}$ is paramagnetic while $\left[Ni(CO)_4\right]$ is diamagnetic though both are tetrahedral. Why?

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14. $\left[Fe\left(H_2O\right)_6\right]^{3+}$ is strongly paramagnetic whereas $\left[Fe(CN)_6\right]^{3-}$ is weakly paramagnetic. Explain.

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15. Explain $\left[Co\left(NH_3\right)_6\right]^{3+}$ is an inner orbital complex whereas $\left[Ni\left(NH_3\right)_6\right]^{2+}$ is an outer orbital complex.

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16. Predict the number of unpaired electrons in the square planar $\left[Pt(CN)_4\right]^{2-}$ ion.

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17. The hexaquo manganese(II) ion contains five unpaired electrons, while the hexacyanoion contains only one unpaired electron. Explain using the crystal field theory.

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18. Calculate the overall complex dissociation equilibrium constant for the $\left[Cu\left(NH_3\right)_4\right]^{2+}$ ion, given that β_4 for this complex is 2.1×10^{13}

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Ncert Exercises

1. According to Werner's theory of coordination compounds ,

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2. $FeSO_4$ solution mixed with $\left(NH_4\right)_2SO_4$ solution is $1:1$ molar ratio gives the test of Fe^{2+} ion but $CuSO_4$ solution mixed with aqueous ammonia in $1:4$ molar ratio does not give the test of Cu^{2+} ion. Explain why?

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3. Explain with two examples each of the following: coordination entity, ligand, coordination number, coordination polyhedron, homoleptic and heteroleptic

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4. What is meant by unidentate, didentate and ambidentate ligands ? Give two examples for each.

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5. Specify the oxidation numbers of metals in the following co-ordination entites :

(a) $\left[Co\left(H_2O\right)(CN)\left(en_2\right)\right]^{2+}$ (b) $\left[PtCI_4\right]^{2-}$

(c) $\left[Cr\left(NH_3\right)_3CI_3\right]$ (D) $\left[CoBr_2(en)_2\right]^+$

(e) $K_3\left[Fe(CN)_6\right]$.

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6. Using $IUPAC$ norms write the fomulas for the following

(i). Tetrahydroxozincate(II).

(ii). Potassium tetrachloridopalladate(II).

(iii). Diamminedlchloridoplatinum(II).

(iv). Potassium tetracyanidonickelate(II).

(v). Pentaamminenitrito-O-Cobalt(III).

(vi). Hexaamminecobalt(III) sulphate

(vii). Potassium tri(oxalato)chromate(III).

(viii). Hexaammlneplatinum(IV)

(ix). Tetrabromidocuprate(II).

(x). Pentaamminenitrito-N-cobalt(Ill).

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7. Using IUPAC norms write the systematic names of the following:

(i). $\left[Co\left(NH_3\right)_6\right]Cl_3$

(ii). $\left[Pt\left(NH_3\right)_2Cl\left(NH_2CH_3\right)\right]Cl$

(iii). $\left[Ti\left(H_2O\right)_6\right]^{3+}$

(iv). $\left[Co\left(NH_3\right)_4Cl\left(NO_2\right)\right]Cl$

(v). $\left[Mn\left(H_2O\right)_6\right]^{2+}$

(vi). $\left[NiCl_4\right]^{2-}$

(vii). $\left[Ni\left(NH_3\right)_6\right]Cl_2$

(viii). $\left[Co(en)_3\right]^{3+}$

(ix). $\left[Ni(CO)_4\right]$

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8. List various types of isomerism possible for coordination compounds, giving an example of each.

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9. How many geometrical isomers are possible in the following corrdination entities?

(i). $\left[Cr\left(C_2O_4\right)_3\right]^{3-}$

(ii). $\left[Co\left(NH_3\right)_3Cl_3\right]$

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10. Draw the structures of optical isomers of:

(i). $\left[Cr\left(C_2O_4\right)_3\right]^{3-}$

(ii). $\left[PtCl_2(en)_2\right]^{2+}$

(iii). $\left[Cr\left(NH_3\right)_2Cl_2(en)\right]^{\oplus}$

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11. Draw all the isomers (geometrical and optical) of:

(i) $\left[CoCl_2(en)_2\right]^{+}$

(ii) $\left[Co\left(NH_3\right)Cl(en)_2\right]^{2+}$

(iii) $\left[Co\left(NH_3\right)_2Cl_2(en)\right]^{+}$

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12. Write all the geometrical isomers of $\left[Pt\left(NH_3\right)(Br)(Cl)(py)\right]$ and how many of these will exhibit optical isomers?

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13. Aqueous copper sulphate solution (blue in colour) gives:

(i). A green precipitate with aqueous potassium fluoride and

(ii). A bright green solution with aqueous potassium chloride. Explain these experimental results.

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14. What is the coordination entity formed when excess of aqueous KCN is added to an aqueous solution of copper sulphate? Why is it that no precipitate of copper sulphide is obtained when H_2S (g) is passed through this solution?

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15. Discuss the nature of bonding in the following coordination entities on the basis of valence bond theory:

(i). $\left[Fe(CN)_6\right]^{4-}$

(ii). $\left[FeF_6\right]^{3-}$

(iii). $\left[Co\left(C_2O_4\right)_3\right]^{3-}$

(iv). $\left[CoF_6\right]^{3-}$

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16. Draw figure to show the splitting of d orbitals in an octahedral crystal field.

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17. What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand.

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18. What is crystal field splitting energy? How does the magnitude of $\triangle_0$ decide the actual configuration of d orbitals in a coordination entity?

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19. $\left[Cr\left(NH_3\right)_6\right]^{3+}$ is paramagnetic while $\left[Ni(CN)_4\right]^{2-}$ is diamagnetic. Explain why?

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20. A solution of $\left[Ni\left(H_2O\right)_6\right]^{2+}$ is green but a solution of $\left[Ni(CN)_4\right]^{2-}$ is colourless Explain.

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21. $\left[Fe(CN)_6\right]^{4-}$ and $\left[Fe\left(H_2O\right)_6\right]^{2+}$ are of different colours in dilute solutions why?

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22. Discuss the nature of bonding in metal carbonyis.

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23. Give the oxidation state , d-orbital occupation and coordination number iof the central metal ion in the following complexes :

(a) $K_3\left[Co\left(C_2O_4\right)_3\right]$ (b) $\left(NH_4\right)_2\left[CoF_4\right]$ (c) Cis - $\left[CrCl_2(en)_2\right]Cl$ (d) $\left[Mn\left(H_2O\right)_6\right]SO_4$

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24. Write down the IUPAC name for each of the following complexes and indicate the oxidation state, electronic configuration and coordination number. Also give stererochemistry and magnetic moment of the complex :

(i) $K\left[Cr\left(H_2O\right)_2\left(C_2O_4\right)_2\right].3H_2O$

(ii) $CrCl_3(py)_3$

(iii) $K_4\left[Mn(CN)_6\right]$

(iv) $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$

(v) $Cs\left[FeCl_4\right]$.

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25. What is meant by stability of a coordination compound in solution ? State the factors which govern stability of complexes.

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26. What is meant by the chelate effect? Give and example.

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27. Discuss briefly giving an example in each case the role of coordination compounds in: (i) biological systems (ii) medicinal chemistry (iii) analytical chemistry and (iv) extraction/metallurgy of metals

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28. How many ions are produced from the complex, $\left[Co\left(NH_3\right)_6\right]CI_2$ in solution ?

A. 6

B. 4

C. 3

D. 2

Answer:

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29. Amongst the following ions which one has the highest magnetic moment value?

(i). $\left[Cr\left(H_2O\right)_6\right]^{3+}$

(ii). $\left[Fe\left(H_2O\right)_6\right]^{2+}$

(iii). $\left[Zn\left(H_2O\right)\right]^{2+}$

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30. The oxidation number of cobalt in $K\left[Co(CO)_4\right]$ is:

A. $+1$

B. $+3$

C. -1

D. -3

Answer:

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31. Amongst the following, the most stable complex is

A. $\left[Fe\left(H_2O\right)_6\right]^{3+}$

B. $\left[Fe\left(NH_3\right)_6\right]^{3+}$

C. $\left[Fe\left(C_2O_4\right)_3\right]^{3-}$

D. $\left[FeCl_6\right]^{3-}$

Answer: C

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32. What will be the correct order for the wavelengths of absorption in the visible region for the following:

$\left[Ni\left(NO_2\right)_6\right]^{4-}, \left[Ni\left(NH_3\right)_6\right]^{2+}, \left[Ni\left(H_2O\right)_6\right]^{2+}$?

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Mcq

1. Which of the following complexes formed by Cu^{2+} ions is most stable ?

A. $Cu^{2+} + 4NH_3 \Leftrightarrow \left[Cu\left(NH_3\right)_4\right]^{2+}, \log K = 11.6$

B. $Cu^{2+} + 4CN^- \Leftrightarrow \left[Cu(CN)_4\right]^{2-} \log K = 27.3$

C. $Cu^{2+} + 2en \Leftrightarrow \left[Cu(en)_2\right]^{2+}, \log K = 15.4$

D. $Cu^{2+} + 4H_2O \Leftrightarrow \left[Cu\left(H_2O\right)_4\right]^{2+}, \log K = 8.9$

Answer: B

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2. The colour of the coordination compounds depends on the crystal field splitting. What will be the correct order of absorption of wavelength of light of the visible region, for the complexes, $\left[Co\left(NH_3\_(6)\right]^{3+}.\left[Co(CN)_6\right]^{3+}.\left[Co\left(H_2O\right)_6\right]^{3+}\right.$

A. $\left[Co(CN)_6\right]^{3-} > \left[Co\left(NH_3\right)_6\right]^{3+} > \left[Co\left(H_2O\right)_6\right]^{3+}$

B. $\left[Co\left(NH_3\right)_6\right]^{3+} > \left[Co\left(H_2O\right)_6\right]^{3+} > \left[Co(CN)_6\right]^{3-}$

C. $\left[Co\left(H_2O\right)_6\right]^{3+} > \left[Co\left(NH_3\right)_6\right]^{3+} > \left[Co(CN)_6\right]^{3-}$

D. $\left[Co(CN)_6\right]^{3-} > \left[Co\left(NH_3\right)_6\right]^{3+} > \left[Co\left(H_2O\right)_6\right]^{3+}$

Answer: C

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3. When 0.1 mol $CoCl_3\left(NH_3\right)_5$ is treated with excess of $AgNO_3$, 0.2 mole of AgCl are obtained. The conductivity of solution will correspond to

A. 1 : 3 electrolyte

B. 1 : 2 electrolyte

C. 1 : 1 electrolyte

D. 3 : 1 electrolyte

Answer: B

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4. When 1 mol $CrCl_3.6H_2O$ is treated with excess of $AgNO_3$, 3 mol of $AgCl$ are obtained. The formula of the coplex is

A. $\left[CrCl_3\left(H_2O\right)_3\right].3H_2O$

B. $\left[CrCl_2\left(H_2O\right)_4\right]Cl.2H_2O$

C. $\left[CrCl\left(H_2O\right)_5\right]Cl_2.H_2O$

D. $\left[Cr\left(H_2O\right)_6\right]Cl_3$

Answer: D

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5. The correct IUPAC name of $\left[Pt\left(NH_3\right)_2Cl_2\right]$ is

A. Diamminedichloridoplatinum (II)

B. Diamminedichloridoplatinum (IV)

C. Diamminedichloridoplatinum (0)

D. Dichloridodiammineplatinum (IV)

Answer: A

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6. The stabilization of coordination compound due to chelation is called the chelate effect. Which of the following is the most stable complex species?

A. $\left[Fe(CO)_5\right]$

B. $\left[Fe(CN)_6\right]^{3-}$

C. $\left[Fe\left(C_2O_4\right)_3\right]^{3-}$

D. $\left[Fe\left(H_2O\right)_6\right]^{3+}$

Answer: C

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7. Indicate the complex ion which shows geometrical isomerism :

A. $\left[Cr\left(H_2O\right)_4Cl_2\right]^+$

B. $\left[Pt\left(NH_3\right)_3Cl\right]$

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

D. $\left[Co(CN)_5(NC)\right]^{3-}$

Answer: A

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8. The CFSE for octahedral $\left[CoCl_6\right]^{4-}$ is 18,000 cm^{-1}. The CFSE for tetrahedral $\left[CoCl_4\right]^{2-}$ will be

A. 18,000 cm^{-1}

B. $16,000 cm^{-1}$

C. 8,000 cm^{-1}

D. 20,000 cm^{-1}

Answer: C

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9. Due to the presence of ambidenate ligands coordination compounds show isomerism. Palladium complexes of the type $\left[Pd\left(C_6H_5\right)_2(SCN)_2\right]$ & $\left[Pd\left(C_6H_5\right)_2(NCS)_2\right]$ are

A. linkage isomers

B. coordination isomers

C. ionisation isomers

D. geometrical isomers

Answer: A

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10. The two compounds $\left[Co\left(SO_4\right)\left(NH_3\right)_5\right]Br$ and $\left[Co\left(SO_4\right)\left(NH_3\right)_5\right]Cl$ represent:

A. linkage isomerism

B. ionisation isomerism

C. Coordination isomerism

D. no isomerism

Answer: D

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11. A chelating agent has two or more than two donor atoms to bind to a single metal ion. Which of the following is not a chelating agent?

A. thiosulphato

B. oxalato

C. gycinato

D. ethane-1, 2-diamine

Answer: A

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12. Which of the following species is not expected to be a ligand?

A. NO

B. NH_4^+

C. $NH_2CH_2CH_2NH_2$

D. CO

Answer: B

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13. What kind of isomerism exists between $\left[Cr\left(H_2O\right)_6\right]Cl_3$ (violet) and $\left[Cr\left(H_2O\right)_5Cl\right].H_2O$ (greyish-green)?

A. linkage isomerism

B. solvate isomerism

C. ionisation isomerism

D. coordination isomerism

Answer: B

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14. IUPAC name of $\left[Pt\left(NH_3\right)_2Cl\left(NO_2\right)\right]$ is

A. Platinum diaminechloronitrite

B. Chloronitrito-N-ammineplatinum (II)

C. Diamminechloridonitrito-N-platinum (II)

D. Diamminechloronitrito-N platinate (II)

Answer: C

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15. Atomic number of Mn. Fe and Co are 25, 26 and 27 respectively. Which of the following inner orbital octahedral complex ions are diamagnetic ?

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

B. $\left[Mn(CN)_6\right]^{3-}$

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

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

Answer: A::C

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16. Atomic number of Mn, Fe, Co and Ni are 25, 26, 27 and 28 respectively. Which of the following outer orbital octahedral complexes have same number of unpaired electrons ?

A. $\left[MnCl_6\right]^{3-}$

B. $\left[FeF_6\right]^{3-}$

C. $\left[CoF_6\right]^{3-}$

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

Answer: A::C

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17. Which of the following options are correct for $\left[Fe(CN)_6\right]^{3-}$ complex ?

A. d^2sp^3 hybridisation

B. sp^3d^2 hybridisation

C. paramagnetic

D. diamagnetic

Answer: A::C

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18. An aqueous pink solution of cobalt (II) chloride changes to deep blue on addition of excess of HCl. This is because ..... .

A. $\left[Co\left(H_2O\right)_6\right]^{2+}$ is transformed into $\left[CoCl_6\right]^{4-}$

B. $\left[Co\left(H_2O\right)_6\right]^{2+}$ is transformed into $\left[CoCl_4\right]^{2-}$

C. tetrahedral complexes have smaller crystal field splitting than octahedral complexes

D. tetrahedral complexes have larger crystal field splitting than octahedral complex.

Answer: B::C

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19. Which of the following complexes are homoleptic ?

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

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

C. $\left[Ni(CN)_4\right]^{2-}$

D. $\left[Ni\left(NH_3\right)_4Cl_2\right]$

Answer: A::C

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20. Which of the following complexes are heteroleptic ?

A. $\left[Cr\left(NH_3\right)_6\right]^{3+}$

B. $\left[Fe\left(NH_3\right)_4Cl_2\right]^{+}$

C. $\left[Mn(CN)_6\right]^{4-}$

D. $\left[Co\left(NH_3\right)_4Cl_2\right]$

Answer: B::D

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21. Identify the optically active compounds from the following :

A. $\left[Co(en)_3\right]^{3+}$

B. tans-$\left[Co(en)_2Cl_2\right]^{+}$

C. *cis* - $\left[Co(en)_2Cl_2\right]^{+}$

D. $\left[Cr\left(NH_3\right)_5Cl\right]$

Answer: A::C

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22. Identify the correct statements for the behaviour of ethane-1, 2-diamine as a ligand.

A. It is a neutral ligand

B. It is a didentate ligand

C. It is a chelating ligand

D. It is a unidentate ligand

Answer: A::B::C

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23. Which of the following complexes show linkage isomerism ?

A. $\left[Co\left(NH_3\right)_5\left(NO_2\right)\right]^{2+}$

B. $\left[Co\left(H_2O\right)_5CO\right]^{3+}$

C. $\left[Cr\left(NH_3\right)_5SCN\right]^{2+}$

D. $\left[Fe(en)_2Cl_2\right]^+$

Answer: A::C

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24. 2 : 4 Dinitrophenyl hydrazine is an example for

A. Tridentate ligand

B. Monodentate ligand

C. Polydentate ligand

D. Didentate ligand

Answer: B

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25. The correct structure of ethylenediamineteraacetic acid $(EDTA)$ is .

A. 

B. 

C. 

D. 

Answer: C

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26. In Tollen's reagent, the oxidation number, coordination number and effective atomic number of central metal ion are respectively [atomic number of Ag - 47] :

A. 1, 1

B. 2, 1

C. 2, 2

D. 1, 2

Answer: D

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27. The sum of coordination number and oxidation number of the metal M in the complex $\left[M(en)_2\left(C_2O_4\right)\right]Cl$ (where en is ethylenediamine) is :

A. 7

B. 8

C. 9

D. 6

Answer: C

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28. The ligand $N\left(CH_2CH_2NH_2\right)_3$ is

A. tridentate

B. pentadentate

C. tetradentate

D. bidentate

Answer: C

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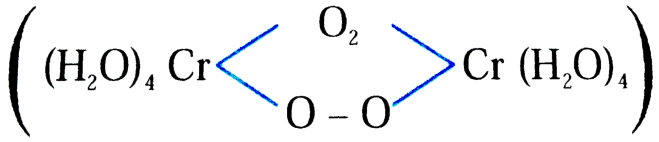
29. Oxidation number of *Cr* in the following complex is



A. 2

B. 3

C. 4

D. 5

Answer: B

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30. Which among the following is a homoleptic complex ?

A. tris(ethane-1, 2 - diamine) cobalt (III) chloride

B. triamminetriaquachromium (III) chloride

C. diamminechloridonitro-N-platinum (II)

D. dichlorido bis(ethane-1, 2-diamine) cobalt (III) chloride

Answer: A

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31. The formula of dichlorobis (urea) copper (II) is

A. $\left[Cu\left\{O=C\left(NH_2\right)\right\}_2\right]Cl_2$

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

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

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

Answer: B

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32. IUPAC name of sodium cobaltinitrite is

A. Sodium cobaltinitrite

B. Sodium hexanitritocobaltate (III)

C. Sodium hexanitrocobalt (III)

D. Sodium hexanitritocobaltate (II)

Answer: B

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33. According to IUPAC nomenclature sodium nitroprusside is named as

A. Sodium nitroferricyanide

B. Sodium nitroferrocyanide

C. Sodium pentacyanonitrosylferrate (II)

D. Sodium pentacyano nitrosylferrate (III)

Answer: D

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34. The name of the complex ion, $\left[Fe(CN)_6\right]^{3-}$ is _____.

A. tricyanoferrate (III) ion

B. hexacyanidoferrate (III) ion

C. hexacyano iron (III) ion

D. hexacyanitroferrate (III) ion

Answer: B

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35. Which one of the following has largest number of isomers?

A. $\left[Ru\left(NH_3\right)_4Cl_2\right]^+$

B. $\left[Co(en)_2Cl_2\right]^+$

C. $\left[Ir\left(PR_3\right)_2H(CO)\right]^{2+}$

D. $\left[Co\left(NH_3\right)_5Cl\right]^{2+}$

Answer: B

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36. Which one of the following complex is not expected to exhibit isomerism

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

B. $\left[Pt\left(NH_3\right)_2Cl_2\right]$

C. $\left[Ni\left(NH_3\right)_2Cl_2\right]$

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

Answer: C

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37. The existence of two different coloured complexes with the composition of $\left[Co\left(NH_3\right)_4Cl_2\right]^+$ is due to

A. Ionization isomerism

B. Linkage isomerism

C. Geometrical isomerism

D. Coordination isomerism

Answer: C

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38. For the given complex $\left[CoCl_2(en)\left(NH_3\right)_2\right]^+$, the number of geometrical isomers, the number of optical isomers and total number of isomers of all type possible respectively are

A. 2, 2 and 4

B. 2, 2 and 3

C. 2, 0 and 2

D. 0, 2 and 2

Answer: B

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39. Square planar complexes of the type MABXL (where A, B, X and L are unidentates) show

A. two cis and one trans isomer

B. two trans and one cis isomer

C. two cis and two trans isomers

D. one cis and one trans isomer

Answer: A

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40. The number of geometric isomers that can exist for square planar $\left[Pt(C1)(py)\left(NH_3\right)\left(NH_2OH\right)^+\right]$ is (py = pyridine).

A. 4

B. 6

C. 2

D. 3

Answer: D

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41. Which one of the following complexes will have four isomers?

(en = ethylenediamine)

A. $\left[Co(en)\left(NH_3\right)_2Cl_2\right]Cl$

B. $\left[Co\left(PPh_3\right)_2\left(NH_3\right)_2Cl_2\right]Cl$

C. $\left[Co(en)_3\right]Cl_3$

D. $\left[Co(en)_2Cl_2\right]Br.$

Answer: D

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42. The total number possible isomers for the complex compound $\left[Cu^{II}\left(NH_3\right)_4\left[Pt^{II}CI_4\right]\right.$ are

A. 3

B. 6

C. 5

D. 4

Answer: D

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43. Number of possible isomer for the complex $\left[Co(en)_2CI_2\right]CI$ will be: (em = ethylenediamine)

A. 3

B. 4

C. 2

D. 1

Answer: A

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44. $\left[Co\left(NH_3\right)_4\left(NO_2\right)_2\right]CI$ exhibits

A. ionization isomerism, geometrical isomerism and optical isomerism

B. linkage isomerism, geometrical isomerism and optical isomerism

C. linkage isomerism, ionization isomerism and optical isomerism

D. linkage isomerism, ionization isomerism and geometrical isomerism

Answer: D

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45. Facial-meridional isomers is associated with which one of the following complex (M = central metal).

A. $\left[M(AA)_2\right]$

B. $\left[MA_3B_3\right]$

C. $\left[M(AA)_3\right]$

D. $[MABCD]$

Answer: B

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46. Which of the following can exhibit geometrical isomerism

A. $\left[MnBr_4\right]^{2-}$

B. $\left[Pt\left(NH_3\right)_3Cl\right]^+$

C. $\left[PtCl_2P\left(C_2H_5\right)_3\right]_2$

D. $\left[Fe\left(H_2O\right)_5NO\right]^{2+}$

Answer: C

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47. Which of the following complex ions has geometrical isomers?

A. $\left[Co(en)_3\right]^{3+}$

B. $Ni\left(NH_3\right)_5Br]^{+}$

C. $\left[Co\left(NH_3\right)_2(en)_2\right]^{3+}$

D. $\left[Cr\left(NH_3\right)_4(en)\right]^{3+}$

Answer: C

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48. Which of the following complex species is not expected to exhibit optical isomerism ?

A. $\left[Co(en)\left(NH_3\right)_2Cl_2\right]^+$

B. $\left[Co(en)_3\right]^{3+}$

C. $\left[Co(en)_2Cl_2\right]^+$

D. $\left[Co\left(NH_3\right)_3Cl_3\right]$

Answer: D

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49. Which one of the following complexes shows optical isomerism ?

A. $\left[Co\left(NH_3\right)_3Cl_3\right]$

B. $\left[Co\left(en_2\right)Cl_2\right]Cl$

C. trans $\left[Co\left(en_2\right)Cl_2\right]Cl$

D. $\left[Co\left(NH_3\right)_4Cl_2\right]Cl$ (en = ethylenediamine)

Answer: B

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50. Cobalt (III) chloride forms several octahedral complexes with amonia. Which of the following will not give test for chloride ions with silver nitrate at $25^\circ C$?

A. $CoCl_3.5NH_3$

B. $CoCl_3.6NH_3$

C. $CoCl_3.3NH_3$

D. $CoCl_3.4NH_3$

Answer: C

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51. When 0.01 mole of a cobalt complex is treated with excess of silver nitrate solution 4.035 g of silver chloride is precipitated. The formula of the complex is :

A. $\left[Co\left(NH_3\right)_3Cl_3\right]$

B. $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$

C. $\left[Co\left(NH_3\right)_6\right]Cl_3$

D. $\left[Co\left(NH_3\right)_4Cl_2\right]NO_3$

Answer: C

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52. On treatment of 100 mL of 0.1 M solution of $COCl_3.6H_2O$ with excess of $AgNO_3$, 1.2×10^{22} ions are precipitated. The complex is

A. $\left[Co\left(H_2O\right)_6\right]Cl_3$

B. $\left[Co\left(H_2O\right)_5Cl\right]Cl_2.H_2O$

C. $\left[Co\left(H_2O\right)_4Cl_2\right]Cl.2H_2O$

D. $\left[Co\left(H_2O\right)_3Cl_3\right].3H_2O$

Answer: B

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

A. 0.001

B. 0.002

C. 0.003

D. 0.01

Answer: A

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54. 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:

A. 1 AgCl, 3 AgCl, 2 AgCl

B. 3 AgCl, 1 AgCl, 2 AgCl

C. 3 AgCl, 2 AgCl, 1 AgCl

D. 2 AgCl, 3 AgCl, 1 AgCl

Answer: C

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55. A solution containing 0.319 g of complex $CrCl_3.6H_2O$ was passed through cation exchanger and the solution given out was neutralised by 28.5 ml of 0.125 m NaOH. The correct formula of the complex will be: [molecular weight of complex =266.5]

A. $\left[Cr\left(H_2O\right)_6\right]Cl_3$

B. $\left[Cr\left(H_2O\right)_5Cl\right]H_2O.\,Cl_2$

C. $\left[Cr\left(H_2O\right)_4Cl_2\right]Cl.2H_2O$

D. $\left[Cr\left(H_2O\right)_3Cl_3\right].3H_2O$

Answer: A

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56. Both Co^{3+} and Pt^{4+} have a coordination number of six. Which of the following pair of complexes will show approximately the same electrical conductance for their 0.001 M aqueous solution ?

A. $CoCl_3.\,4NH_3$ and $PtCl_4.\,4NH_3$

B. $CoCl_3.3NH_3$ and $PtCl_4.5NH_3$

C. $CoCl_3.6NH_3$ and $PtCl_4.5NH_3$

D. $CoCl_3.6NH_3$ and $PtCl_4.3NH_3$

Answer: C

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57. The two isomers X and Y with the formula $Cr\left(H_2O\right)_5ClBr$ were taken for experiment on depression in freezing point. It was found that one mole of X gave depression corresponding to 2 moles of particles and one mole of Y gave depression to 3 moles of particles. The structural formulae of X and Y raspectively are

A. $\left[Cr\left(H_2O\right)_5Cl\right]Br_2, \left[Cr\left(H_2O\right)_4Br_2\right]Cl.H_2O$

B. $\left[Cr\left(H_2O\right)_5Br\right]BrCl, \left[Cr\left(H_2O\right)_4ClBr\right]Br.H_2O$

C. $\left[Cr\left(H_2O\right)_5Cl\right]Br_2, \left[Cr\left(H_2O\right)_4ClBr\right]Br.H_2O$

D. $\left[Cr\left(H_2O\right)_4Br_2\right]Cl.H_2O, \left[Cr\left(H_2O\right)_5Cl\right]Br_2$

Answer: D

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58. The correct statement with respect to the complexes $Ni(CO)_4$ and $\left[Ni(CN)_4\right)^{2-}$ is :

A. nickel is in the same oxidation state in both

B. both have tetrahedral geometry

C. both have square planar geometry

D. have tetrahedral and square planar geometry respectively

Answer:

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59. The complex which has the highest magnetic moment among the following is

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

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

C. $\left[Ni\left(NH_3\right)_4\right]^{2+}$

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

Answer: A

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60. Amongst $Ni(CO)_4$, $\left[Ni(CN)_4\right]^{2-}$ and $\left[NiCl_4\right]^{2-}$

A. $Ni(CO)_4$ and $\left[Ni(CN)_4\right]^{2-}$ are diamagnetic and $\left[Ni(CN)_4\right]^{2-}$ is paramagnetic

B. $\left[NiCl_4\right]^{2-}$ and $\left[Ni(CN)_4\right]^{2-}$ are diamagnetic and $Ni(CO)_4$ is paramagnetic

C. $Ni(CO)_4$ and $\left[Ni(CN)_4\right]^{2-}$ are diamagnetic and $\left[NiCl_4\right]^{2-}$ is paramagnetic

D. $Ni(CO)_4$ is diamagnetic and $\left[NiCl_4\right]^{2-}$ and $\left[Ni(CN)_4\right]^{2-}$ are paramagnetic

Answer: C

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61. Among $\left[Ni(CO)_4\right]$, $\left[Ni(CN)_4\right]^{2-}$, $\left[NiCl_4\right]^{2-}$ species, the hybridization states at the Ni atom are, respectively (At. no.of $Ni = 28$)

A. sp^3, dsp^2, dsp^2

B. sp^3, dsp^2, sp^3

C. sp^3, sp^3, dsp^2

D. dsp^2, sp^3, sp^3

Answer: B

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

A. d^2sp^2

B. d^2sp^3

C. dsp^2

D. sp^3

Answer: C

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63. Which of the following complexes are not correctly matched with the hybridisation of their central metal ion ?

(a) $\left[Ni(CO)_4\right], sp^3$ (b) $\left[Ni(CN)_4\right]^{2-}, sp^3$

(c) $\left[CoF_6\right]^{3-}, d^2sp^3$ (d) $\left[Fe(CN)_6\right]^{3-}, sp^3d^2$

Select the correct option :

A. (i) and (ii)

B. (i) and (iii)

C. (ii) and (iv)

D. (ii), (iii) and (iv)

Answer:

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64. Pick out the correct statement with respect to $\left[Mn(CN)_6\right]^{3-}$:

A. It is sp^3d^2-hybridized and octahedral

B. It is sp^3d^2-hybridized and tetrahedral

C. It is d^2sp^3-hybridized and octahedral

D. It is dsp^2-hybridized and square planar

Answer: C

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65. Which of the following complexes exhibits the highest paramagnetic behaviour?

where gly=glycine, en=ethylenediamine and bipy =bipyridyl

(At. no. $Ti = 22, V = 23, Fe = 26, Co = 27$)

A. $\left[V(gly)_2(OH)_2\left(NH_3\right)_2\right]^+$

B. $\left[Fe(en)(bpy)\left(NH_3\right)_2\right]^{2+}$

C. $\left[Co(OX)_2(OH)_2\right]^{2-}$

D. $\left[Ti\left(NH_3\right)_6\right]^{3+}$

Answer: C

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66. The pair having the same magnetic moment is

[at. No. $Cr = 24, Mn = 25, Fe = 26$ and $Co = 27$]

A. $\left[Cr\left(H_2O\right)_6\right]^{2+}$ and $\left[CoCl_4\right]^{2-}$

B. $\left[Cr\left(H_2O\right)_6\right]^{2+}$ and $\left[Fe\left(H_2O\right)_6\right]^{2+}$

C. $\left[Mn\left(H_2O\right)_6\right]^{2+}$ and $\left[Cr\left(H_2O\right)_6\right]^{2+}$

D. $\left[CoCl_4\right]^{2-}$ and $\left[Fe\left(H_2O\right)_6\right]^{2+}$

Answer: B

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67. Among $\left[Ni(CO)_4\right]$, $\left[NiCl_4\right]^{2-}$, $\left[Co\left(NH_3\right)_4Cl_2\right]Cl$, $Na_3\left[CoF_6\right]$, Na_2O_2 and CsO_2, the total number of paramagnetic compounds is

A. 2

B. 3

C. 4

D. 5

Answer: B

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68. Hybridization shape and magnetic moment of $K_3\left[Co(CO)_6\right]$ is

A. d^2sp^3, octahedral, 4.9 B.M.

B. sp^3d^2, octahedral, 4.9 B. M.

C. dsp^2, square planar, 4.9 B.M.

D. sp^3, tetrahedral, 4.9 B.M.

Answer: B

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69. Which one of the following is an outer orbital complex and exhibits paramagnetic behaviour ?

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

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

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

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

Answer: A

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70. Consider the follwing complexes ion P, Q and R

$P = \left[FeF_6\right]^{3-}$, $Q = \left[V\left(H_2O\right)_6\right]^{2+}$ and $R = \left[Fe\left(H_2O\right)_6\right]^{2+}$

The correct order of the complex ions, according to their spin only magnetic moment values (inBM) is .

A. $R < Q < P$

B. $Q < R < P$

C. $R < P < Q$

D. $Q < P < R$

Answer: B

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71. The spin only magnetic moment value of $Cr(CO)_6$ is

A. 0

B. 2.84

C. 4.90

D. 5.92

Answer: A

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72. A magnetic moment of 1.73 B.M. will be shown by one among the following:

A. $\left[Cu\left(NH_3\right)_4\right]^{2+}$

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

C. $TiCl_4$

D. $\left[CoCl_6\right]^{4-}$

Answer: A

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73. Which one of the following is wrongly matched ?

A. $\left[Cu\left(NH_3\right)_4\right]^{2+}$ - square planar

B. $\left[Ni(CO)_4\right]$ - neutral ligand

C. $\left[Fe(CN)_6\right]^{3-}$ - sp^3d^2

D. $\left[Cr(en)_3\right]^{3+}$-follows EAN rule

Answer: C

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74. Geometrical shapes of the complex formed by the reaction of Ni^{2+} with Cl^{Θ}, CN^{Θ} and H_2O are :

A. Octahedral, tetrahedral and square planar

B. Tetrahedral, square planar and octahedral

C. Square planar, tetrahedral and octahedral

D. Octahedral, square planar and octahedral

Answer: B

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75. Among the following complexes : $K_3\left[Fe(CN)_6\right]$, $\left[Co\left(NH_3\right)_6\right]Cl_3$, $Na_3\left[Co(ox)_3\right]$, $\left[Ni\left(H_2O\right)_6\right]Cl_2$, $K_2\left[Pt(CN)_4\right]$ and $\left[Zn\left(H_2O\right)_6\left(NO_3\right)_2\right]$ The diamagnetic are .

A. K, L, M, N

B. K, M, O, P

C. L, M, O, P

D. L, M, N, O

Answer: C

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76. Which of the following facts about the complex $\left[Cr\left(NH_3\right)_6\right]Cl_3$ is wrong?

A. The complex is paramagnetic

B. The complex is an outer orbital complex

C. The complex gives white precipitate with silver nitrate solution

D. The complex involves d^2sp^3 hybridization and is octahedral in shape

Answer: B

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77. Which of these statements about $\left[Co(CN)_6\right]^{3-}$ is true?

A. $\left[Co(CN)_6\right]^{3-}$ has four unpaired electrons and will be in a high-spin configuration

B. $\left[Co(CN)_6\right]^{3-}$ has no unpaired electrons and will be in a high-spin configuration

C. $\left[Co(CN)_6\right]^{3-}$ has no unpaired electrons and will be in a low-spin configuration

D. $\left[Co(CN)_6\right]^{3-}$ has four unpaired electrons and will be in a low-spin configuration

Answer: C

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78. Which of the following complex has minimum magnitude of Δ^0 ?

A. $\left[Cr(CN)_6\right]^{3-}$

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

C. $\left[CoCl_6\right]^{3-}$

D. $\left[Cr\left(H_2O\right)_6\right]^{3+}$

Answer: C

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79. Crystal field stabilization energy for high spin d^4 octahedral complex is

A. $-0.6\Delta_0$

B. $-1.8\Delta_0$

C. $-1.6\Delta_0 + P$

D. $-1.2\Delta_0$

Answer: A

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80. Low spin complex of d^6-cation in an octahedral field will have the following energy:

A. $-\frac{2}{5}\Delta_0 + 2P$

B. $-\frac{2}{5}\Delta_0 + P$

C. $-\frac{12}{5}\Delta_0 + P$

D. $-\frac{12}{5}\Delta_0 + 3P$

Answer: D

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81. Which of the following is diamagnetic in nature ?

A. Co^{3+}, octahedral complex with weak field ligands

B. Co^{3+}, octahedral complex with strong field ligand

C. Co^{2+} in tetrahedral complex

D. Co^{2+} in square planar complex

Answer: B

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82. In Spectrochemical series , chorine is above than water . I .e $Cl > H_2O$ this is due to

A. Good π-acceptor properties of Cl

B. Strong σ-donor and good π - acceptor properties of Cl

C. Good π-donor properties of Cl

D. Larger size of Cl than H_2O

Answer: C

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83. The magnitude of crystal field stabilisation energy (CFSE of Δ_1) in tetrahedral complexes is considerably less than that in the octahderal field. Because

A. There are only four ligands instead of six so the ligand field is only 2/3 the size hence the Δ_t is only 2/3 the size

B. The direction of the orbitals does not coincide with the direction of the ligands. This reduces the crystal field stabilization energy $\left(\Delta_t\right)$ by further 2/3

C. Both points (a) and (b) are correct

D. Both points (a) and (b) are wrong

Answer: C

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84. Which of the following complexions is expected to absorb visible light ? (Al. No. Zn=30, SC=21, Ti= 22, Cr= 24)

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

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

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

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

Answer: B

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85. Correct increasing order for the wavelength of absorption in the visible region for the complexes of Co^{3+} is:

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

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

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

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

Answer: A

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86. Which of the following compounds is not yellow coloured ?

A. $\left(NH_4\right)_3\left[\text{As}\ \left(Mo_3O_{10}\right)_4\right]$

B. $BaCrO_4$

C. $Zn_2\left[Fe(CN)_6\right]$

D. $K_3\left[Co\left(NO_2\right)_6\right]$

Answer: C

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87. Which of the following is high spin complex ?

A. $\left[CoCl_6\right]^{3-}$

B. $\left[FeF_6\right]^{3-}$

C. $\left[Co\left(NH_3\right)_6\right]^{2+}$

D. All of these

Answer: D

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88. Which one of the following ligand is capable of forming a low spin as well as a high spin complex ?

A. CO

B. F^-

C. NH_3

D. CN^-

Answer: C

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89. Which of the following shell from an octahedral complex

A. d^4 (low spin)

B. d^8 (high spin)

C. d^6 (low spin)

D. All of these

Answer: C

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90. $\left[NiCl_2\left\{P\left(C_2H_5\right)_2\left(C_6H_5\right)\right\}_2\right]$ exhibits temperature dependent magnetic behaviour. The coordination geometries of Ni^{2+} in the paramagnetic and diamagnetic states are:

A. tetrahedral and tetrahedral

B. square planar and square planar

C. tetrahedral and square planar

D. square planar and tetrahedral

Answer: C

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91. Coordination number of Cr is three. A comlex ion of Cr with $C_2O_4^{2-}$ end and superoxide ion, O_2^- has the fomula , $\left[Cr\left(CO_2O_4\right)_x(en)_y\left(O_2\right)_z\right]^-$ The ratio $x:y:z$ will be

A. $1:1:1$

B. $1:1:2$

C. $1:2:2$

D. $2:1:1$

Answer: B

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92. $\left[Cr\left(H_2O\right)_6\right]Cl_3$ (at no. of Cr = 24) has a magnetic moment of $3.83B.M$. The correct distribution of $3d$ electrons the chromium of the complex.

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

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

C. $3d_{\left(x^2-y^2\right)}^1, 3d_{z^2}^1, 3d_{xz}^1$

D. $3d_{xy}^1, 3d_{\left(x^2-y^2\right)}^1, 3d_{yz}^1$

Answer: A

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93. What is the ratio of uncomplexed to complexed to complexed Zn^{2+} ion in a solution that is $10MinNH_3$. If the stability constant of $\left[Zn\left(NH_3\right)_4\right]^{2+}$ is 3×10^9?

A. 3.3×10^{-9}

B. 3.3×10^{-11}

C. 3.3×10^{-13}

D. 3.3×10^{-14}

Answer: D

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94. Which of the following reactions are kinetically favourable ?

I. $\left[Cu\left(H_2O\right)_4\right]^{2+} + 4NH_3 \rightarrow \left[Cu\left(NH_3\right)_4\right]^{2+} + 4H_2O$

II. $\left[Cu\left(H_2O\right)_4\right]^{2+} + 4Cl^- \rightarrow \left[CuCl_4\right]^{2-} + 4H_2O$

III. $\left[Co\left(H_2O\right)_6\right]^{3+} + 6Cl^- \rightarrow \left[CoCl_6\right]^{3-} + 6H_2O$

A. I and II

B. II and III

C. I and III

D. I, II and III

Answer: A

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95. CuCl is insoluble in water but it dissolves in KCl solution. This is due to the formation of the complex.

A. $K_2\left[CuCl_3\right]$

B. $K_3\left[CuCl_4\right]$

C. $K\left[CuCl_2\right]$

D. All of these

Answer: D

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96. The octahedral complex of a metal ion M^{3+} with four monodentate ligands L_1, L_2, L_3 and L_4 absorb wavelengths in the region of red,green, yellow and bule, respectively The increasing order of ligand strengh of the four ligands is

A. $L_1 < L_2 < L_4 < L_3$

B. $L_4 < L_3 < L_2 < L_1$

C. $L_1 < L_3 < L_2 < L_4$

D. $L_3 < L_2 < L_4 < L_1$

Answer: C

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

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

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

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

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

Answer: B

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98. Consider the following complexes :

1. $Fe(CO)_5$ 2. $Ni(CO)_4$

3. $K_4\left[Fe(CN)_6\right]$ 4. $Na_3\left[Cu(SCN)_4\right]$

Which of the above complexes obey EAN rule ?

A. 1, and 2 only

B. 2, 3 and 4 only

C. 1, 2, 3 and 4

D. none of the above

Answer: C

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99. EAN of cobalt is 36 in $\left[Co\left(NH_3\right)_2O_2(en)Cl\right]$ thus ,O_2 is

A. peroxide ion

B. dioxide ion

C. superoxide ion

D. oxide ion

Answer: A

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100. An example of a sigma bonded organometallic compound is:

A. ruthenocene

B. Grignard's reagent

C. ferrocene

D. cobaltocene

Answer: B

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101. $Fe_2(CO)_9$ is diamagnetic. Which of the following reasons is correct?

A. One CO is present as bridge group

B. CO is a π-acceptor ligand

C. CO can form π-bond with Fe by back bonding

D. Metal-metal (Fe-Fe) bonding takes place.

Answer: D

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102. The value of n in the carbonyl is

$(CO)_n$ - Co - $Co(CO)_n$

A. 4

B. 5

C. 6

D. 8

Answer: A

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103. Among the following metal carbonyls the C - O bond order is lowest in .

A. $\left[Mn(CO)_6\right]^+$

B. $\left[Fe(CO)_5\right]$

C. $\left[Cr(CO)_6\right]$

D. $\left[V(CO)_6\right]^-$

Answer: D

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104. In $Fe(CO)_5$, the $Fe \leftarrow CO\sigma$ bond results by the overlap between filled sp hybrid orbital of C atom of CO molecule and vacant

A. d^2sp^3

B. sp^3

C. dsp^3

D. dsp^2 hybrid orbital of Fe

Answer: C

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

A. $Mn(CO)_6^+$

B. $Cr(CO)_6$

C. $V(CO)_6^-$

D. $Fe(CO)_5$

Answer: A

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106. If the bond length of CO bond in carbon monoxide is $1.128Å$, then what is the value of CO bond length in $Fe(CO)_5$?

A. $1.15Å$

B. $1.128Å$

C. $1.72Å$

D. $1.118Å$

Answer: A

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

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

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

C. $\left[Ni(CO)_4\right]$

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

Answer: A

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108. How many EDTA molecules are required to make an octahedral complex with a Ca^{2+} ion?

A. One

B. Two

C. Six

D. Three

Answer: A

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109. When EDTA solution is added to Mg^{2+} ion solution then the incorect statement regarding the reaction will be

A. Four coordinate sites of Mg^{2+} are occupied by EDTA and remaining two sites are occupied by water molecules

B. All six coordinate sites of Mg^{2+} are occupied

C. pH of the solution is decreased

D. Colourless $[Mg\text{ - }EDTA]^{2-}$ chelate is formed

Answer: A

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110. Cold ferrous sulphate solution on absorption of NO develops brown colour due to the formation of

A. paramagnetic $\left[Fe\left(H_2O\right)_5(NO)\right]SO_4$

B. diamagnetic $\left[Fe\left(H_2O\right)_5\left(N_3\right)\right]SO_4$

C. paramagnetic $\left[Fe\left(H_2O\right)_5\left(NO_3\right)\right]\left(SO_4\right)_2$

D. diamagnetic $\left[Fe\left(H_2O\right)_4\left(SO_4\right)\right]NO_3$

Answer: A

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111. The oxidation state of Fe in brown complex $\left[Fe\left(H_2O\right)_5NO\right]SO_4$ is

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112. Dipole moment will be zero in the complexes

I. $\left[Ni(CN)_4\right]^{2-}$

II. Cis-$Pt\left[\left(NH_3\right)_2Cl_2\right]$

trans-$\left[Pt\left(NH_3\right)_2Cl_2\right]$

A. I and II

B. I and III

C. II and III

D. I, II and III

Answer: B

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113. Which of the following complexes is used as an anti-cancer agent ?

A. mer-$\left[Co\left(NH_3\right)_3Cl_3\right]$

B. *cis* - $\left[PtCl_2\left(NH_3\right)_2\right]$

C. *cis* - $K_2\left[PtCl_2Br_2\right]$

D. Na_2CoCl_4

Answer: B

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114. Platinum dissolves in aqua regia to form

A. $PtCl_4$

B. H_2PtCl_6

C. $Pt\left(NO_3\right)_4$

D. $\left[PtCl_2\left(NO_3\right)_2\right]$

Answer: B

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115. Copper sulphate dissolved in excess of KCN to give:-

A. $\left[Cu(CN)_4\right]^{2-}$

B. $Cu(CN)_2$

C. $CuCN$

D. $\left[Cu(CN)_4\right]^{3-}$

Answer: D

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116. When excess ammonnia is added to $CuSO_4$ solution the deep blue complex obtained is

A. tetrahedral and paramagnetic

B. tetrahedral and diamagnetic

C. square planar and diamagnetic

D. square planar and paramagnetic

Answer: D

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117. Sodium nitroprusside reacts with sulphide ion to give a purple colour due to the formation of

A. $\left[Fe(CN)_5NO\right]^{3-}$

B. $\left[Fe(NO)_5CN\right]^{-}$

C. $\left[Fe(CN)_5NOS\right]^{4-}$

D. $\left[Fe(CN)_5NOS\right]^{3-}$

Answer: C

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118. In nitroprusside ion, the iron and NO exist as $Fe(II)$ and NO^+ rather than Fe^{III} and NO. These forms can be differentiated by

A. estimating the concentration of iron

B. measuring the concentration of CN^-

C. measuring the solid state magnetic moment

D. thermally decomposing the compound

Answer: C

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119. Specify the coordination geometry around and the hybridisation of N and B atoms in $1:1$ complex of BF_3 and NH_3.

A. N : tetrahedral, sp^3 , B : tetrahedral, sp^3

B. N : pyramidal, sp^3 , B : pyramidal, sp^3

C. N : pyramidal, sp^3 , B : planar, sp^2

D. N : pyramidal, sp^3 , B : tetrahedral, sp^3

Answer: A

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120. The equation which is balanced and represents the correct product(s) is .

A. $CuSO_4 + 4KCN \rightarrow K_2\left[Cu(CN)_4\right] + K_2SO_4$

B. $Li_2O + 2KCl \rightarrow 2LiCl + K_2O$

C. $\left[CoCl\left(NH_3\right)_5\right]^+ + 5H^+ \rightarrow Co^{2+} + 5NH_4^+ + Cl^-$

D. $\left[Mg\left(H_2O\right)_6\right]^{2+} + (EDTA)^{4-} \xrightarrow{\text{excess NaOH}} Mg(EDTA)^{2+} + 6H_2O$

Answer: C

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121. The complex $Na_2\left[Fe(CN)_5NO\right]$ is called :

A. sodium nitroprusside

B. sodium pentacyanonitrosonium ferrate (II)

C. sodium pentacyanonitrosylferrate (III)

D. sodium nitrosoferrocyanide

Answer: A::B

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122. The compound $K_3\left[Co(ONO)_6\right]$ is called

A. potassium cobaltinitrite

B. Fischer's salt

C. potassium hexanitritocobaltate (III)

D. potassium cobalt nitrate

Answer: A::B::C

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123. Which of the followng isomerism is /are shown by the complex $\left[CoCl_2(OH)_2\left(NH_3\right)_2\right]Br$?

A. Ionization

B. Linkage

C. Geometrical

D. Optical

Answer: A::C::D

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124. Which of the following statement is true about $\left[Cu\left(NH_3\right)_4\right]SO_4$

A. It is a square planar complex

B. It is paramagnetic with one unpaired electron in the d- subshell

C. It gives white precipitate with $BaCl_2$ solution

D. Its aqueous solution does not conduct electricity.

Answer: A::C

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125. Which of the following statements are not correct ?

A. If $\Delta_0 < P$, low spin state is more stable

B. CO is a very weak ligand

C. The colour of a complex depends only on the nature of metal ion

D. Tetrahedral complexes have nearly 50% CFSE value than octahedral complexes

Answer: A::B::C

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126. Which of the following are outer orbital complexes ?

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

B. $\left[Mn(CN)_6\right]^{3-}$

C. $\left[Ni\left(NH_3\right)_6\right]^{2+}$

D. $\left[FeF_6\right]^{3-}$

Answer: C::D

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127. Which of the following are π-bonded organometallic compounds ?

A. Zeise's salt

B. Furacene

C. Dibenzene chromium

D. Grignard reagent

Answer: A::C

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128. Which of the following complexes have tetrahedral shape ?

A. $\left[Cu\left(NH_3\right)_4\right]^{2+}$

B. $\left[Ni(CO)_4\right]$

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

D. $\left[Zn\left(NH_3\right)_4\right]^{2+}$

Answer: B::C::D

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129. Identify the complexes which are expected to be coloured.

a. $\left[Ti\left(NO_3\right)_4\right]$, b. $\left[Cu\left(NCCH_3\right)_4\right]^{\oplus} BF_4^{\ominus}$

c. $\left[Cr\left(NH_3\right)_6\right]^{3+} 3Cl^{\ominus}$, d. $K_3\left[VF_6\right]$

A. $\left[Ti\left(NO_3\right)_4\right]$

B. $\left[Cu\left(NCCH_3\right)_4\right]^{+} BF_4^{-}$

C. $\left[Cr\left(NH_3\right)_6\right]^{3+} 3Cl^{-}$

D. $K_3\left[VF_6\right]$

Answer: C::D

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130. The pair of coordination complex exhibiting the same kind of isomerism is .

A. $\left[Cr\left(NH_3\right)_5Cl\right]Cl_2$ and $\left[Cr\left(NH_3\right)_4Cl_2\right]Cl$

B. $\left[Co\left(NH_3\right)_4Cl_2\right]^+$ and $\left[Pt\left(NH_3\right)_2\left(H_2O\right)Cl\right]^-$

C. $\left[CoBr_2Cl_2\right]^{2-}$ and $\left[PtBr_2Cl_2\right]^{2-}$

D. $\left[Pt\left(NH_3\right)_3\left(NO_3\right)\right]Cl$ and $\left[Pt\left(NH_3\right)_3Cl\right]Br$

Answer: B::D

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131. Optical isomerism is exhibited by (ox = oxalate anion, en = ethylene diamine)

A. *cis* - $\left[CrCl_2(ox)_2\right]^{3-}$

B. $\left[Co(en)_3\right]^{3+}$

C. trans-$\left[CrCl_2(ox)_2\right]^{3-}$

D. $\left[Co(ox)(en)_2\right]^+$

Answer: A::B::D

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132. A coordiantion complex compound of cobalt has the molecular formula containing four ammonia molecules, one nitro group and two chlorine atoms. A solution of this complex was prepared by dissolving 2.44 g of it in water and making the volume to 200 mL. Excess of $AgNO_3$ solution was then added to it and the precipitate of AgCl formed was filtered and dried. The weight of AgCl thus obtained was found to be 1.435 g (Atomic mass of Co=59, Ag=108)

The formula of the complex would be

A. $\left[Co\left(NH_3\right)_4\left(NO_2\right)\right]Cl_2$

B. $\left[Co\left(NH_3\right)_4Cl\left(NO_2\right)\right]Cl$

C. $\left[Co\left(NH_3\right)_4Cl_2\right]NO_2$

D. $\left[Co\left(NH_3\right)_4Cl_2\left(NO_2\right)\right]$

Answer: B

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133. A coordiantion complex compound of cobalt has the molecular formula containing four ammonia molecules, one nitro group and two chlorine atoms. A solution of this complex was prepared by dissolving 2.44 g of it in water and making the volume to 200 mL. Excess of $AgNO_3$ solution was then added to it and the precipitate of AgCl formed was filtered and dried. The weight of AgCl thus obtained was found to be 1.435 g (Atomic mass of Co=59, Ag=108)

The name of the complex would be

A. tetraamminedichloridocobalt (III) nitrite

B. tetraamminenitrocobalt (III) chloride

C. tetraamminechloridonitrocobalt (III) chloride

D. tetraamminedichloridonitrocobalt (III)

Answer: C

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134. A coordiantion complex compound of cobalt has the molecular formula containing four ammonia molecules, one nitro group and two chlorine atoms. A solution of this complex was prepared by dissolving 2.44 g of it in water and making the volume to 200 mL. Excess of $AgNO_3$ solution was then added to it and the precipitate of AgCl formed was filtered and dried. The weight of AgCl thus obtained was found to be 1.435 g (Atomic mass of Co=59, Ag=108)

The type of isomerism shown by the complex will be

A. linkage isomerism

B. Geometrical isomerism

C. Ionization isomerism

D. All the three

Answer: D

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135. A, B and C are three complexes of chromium (III) with the empirical formula $H_{12}O_6Cl_3Cr$. All the three complexes have water and chloride ion as ligands. Complex A does not react with concentrated H_2SO_4, whereas complexes B and C lose 6.75% and 13.5% of their original weight, respectively, on treatment with concentrated H_2SO_4.

According to the Werner theory, the structure of complex A is represented by :

A. $\left[Cr\left(H_2O\right)_4(H)_4(O)_2\right]Cl_3$

B. $\left[Cr\left(H_2O_5\right)_5(H)_2(O)\right]Cl_3$

C. $\left[Cr\left(H_2O\right)_6\right]Cl_3$

D. $\left[Cr\left(H_2O\right)_5Cl\right]Cl_2.H_2O$

Answer: C

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136. A, B and C are three complexes of chromium(III) with the empirical formula $H_{12}O_6C_{13}Cr$ All the three complexes not react with concentrated H_2SO_4 whereas complexes B and C lose $6.75\,\%$ and $13.5\,\%$ of their original mass respectively, on treatment on treatment with conectrated H_2SO_4 Identify A, B and C .

A. $\left[Cr\left(H_2O\right)_4Cl_2\right]Cl.2H_2O$

B. $\left[Cr\left(H_2O\right)_3Cl_3\right].3H_2O$

C. $\left[Cr\left(H_2O\right)_5Cl\right]Cl_2.H_2O$

D. $\left[Cr\left(H_2O\right)_6\right]Cl_3$

Answer: C

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137. A, B and C are three complexes of chromium(III) with the empirical formula $H_{12}O_6C_{13}Cr$ All the three complexes not react with concentrated

H_2SO_4 whereas complexes B and C lose $6.75\,\%$ and $13.5\,\%$ of their original mass respectively, on treatment on treatment with conectrated H_2SO_4 Identify A, B and C.

A. $\left[Cr\left(H_2O\right)_4Cl_2\right].2H_2O$

B. $\left[Cr\left(H_2O\right)_5Cl\right]Cl_2.H_2O$

C. $\left[Cr\left(H_2O\right)_3Cl_3\right].3H_2O$

D. $\left[Cr\left(H_2O\right)_6\right]Cl_3$

Answer: A

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138. A metal complex having the composition Cr $\left(NH_3\right)_4Cl_2$ Br has been isolated in two forms A and B. The form A reacts with $AgNO_3$ to give a white precipitate readily soluble in dilute aqueous ammonia whereas B gives a pale yellow precipitate soluble in concentrated ammonia.

The formula of the complex A is

A. $\left[Cr\left(NH_3\right)_4Br\right]Cl_2$

B. $\left[Cr\left(NH_3\right)_4BrCl\right]Cl$

C. $\left[Cr\left(NH_3\right)_4Cl_2\right]Br$

D. Both (a) and (b) are possible

Answer: B

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139. A metal complex having the composition Cr $\left(NH_3\right)_4Cl_2$ Br has been isolated in two forms A and B. The form A reacts with $AgNO_3$ to give a white precipitate readily soluble in dilute aqueous ammonia whereas B gives a pale yellow precipitate soluble in concentrated ammonia.

The formula of the complex B is

A. $\left[Cr\left(NH_3\right)_4Br\right]Cl_2$

B. $\left[Cr\left(NH_3\right)_4ClBr\right]Cl$

C. $\left[Cr\left(NH_3\right)_4Cl_2\right]Br$

D. $\left[Cr\left(NH_3\right)_4\right]BrCl_2$

Answer: C

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140. A metal complex having the composition Cr $\left(NH_3\right)_4Cl_2$ Br has been isolated in two forms A and B. The form A reacts with $AgNO_3$ to give a white precipitate readily soluble in dilute aqueous ammonia whereas B gives a pale yellow precipitate soluble in concentrated ammonia.

The hybridisation of Cr in the complexes A and B respectively is

A. d^2sp^3 and sp^3d^2

B. sp^3d^2 and d^2sp^3

C. sp^3d and dsp^3

D. d^2sp^3 and d^2sp^3

Answer: D

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141. A metal complex having the composition Cr $\left(NH_3\right)_4 Cl_2$ Br has been isolated in two forms A and B. The form A reacts with $AgNO_3$ to give a white precipitate readily soluble in dilute aqueous ammonia whereas B gives a pale yellow precipitate soluble in concentrated ammonia.

The spin only value of the magnetic moment of the complex is

A. $\sqrt{3}$ B.M.

B. $\sqrt{8}$ B.M.

C. $\sqrt{15}$ B.M.

D. Zero

Answer: C

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142. The coordination number of Ni^{2+} is 4.

$NiCl_2 + KCN(\text{excess}) \rightarrow A(\text{cyano comples})$

$NiCl_2 + conc.\ HCl(\text{excess}) \rightarrow B(\text{chloro complex})$

The hybridisation of A and B are

A. Potassium tetracyanonickeltate(II), potassium tetrachloronickeltate(II)

B. Tetracyanopotassium nickelate(II), tetrachloro-potassiumnickelate(II)

C. Tetracyanonickel(II), tetrachloronickel(II)

D. Potassium tetracyanonickel(II), potassium tetrachloronickel(II)

Answer: A

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143. The coordination number of Ni^{2+} is 4.

$NiCl_2 + KCN(\text{excess}) \rightarrow A(\text{cyano comples})$

$NiCl_2 + conc.\ HCl(\text{excess}) \rightarrow B(\text{chloro complex})$

Predict the magnetic nature of A and B.

A. Both are diamagnetic

B. A is diamagnetic and B is paramagnetic with one unpaired electron

C. A is diamagnetic and B is paramagnetic with two unpaired electrons

D. Both are paramagnetic

Answer: C

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144. The coordination number of Ni^{2+} is 4.

$NiCl_2 + KCN(\text{excess}) \rightarrow A(\text{cyano comples})$

$NiCl_2 + conc.\ HCl(\text{excess}) \rightarrow B(\text{chloro complex})$

The hybridisation of A and B are

A. dsp^2, sp^3

B. sp^3, sp^3

C. dsp^2, dsp^2

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

Answer: A

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145. Match the entries of column I with appropriate entries of column II and choose the correct option out of the four option (a), (b), (c), (d) given at the end of each question.

Column I (Metal ion configuration in strong ligand field)		Column II (CFSE, Δ_0 value)	
(A)	d^4	(p)	-1.6
(B)	d^5	(q)	-1.8
(C)	d^6	(r)	-2.0
(D)	d^7	(s)	-2.4

A. A-p, B-s, C-r, D-q

B. A-q, B-r, C-p, D-s

C. A-p, B-r, C-s, D-q

D. A-r, B-s, C-p, D-q

Answer: C

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146.

Column I (Metal ion configuration in weak ligand field)		Column II (CFSE, Δ_0 value)	
(A)	d^4	(p)	0.0
(B)	d^5	(q)	-0.4
(C)	d^6	(r)	-0.6
(D)	d^7	(s)	-0.8

A. A - r, B - s, C - p, D - q

B. A - r, B - p, C - q, D - s

C. A - p, B - r, C - q, D - s

D. A - q, B - r, C - s, D - p

Answer: B

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147.

	Column I (Complex)		Column II (Magnetic moment)
(A)	$K\left[Cr\left(H_2O\right)_2\left(C_2O_4\right)_2\right].3H_2O$	(p)	$1.73BM$
(B)	$K_4\left[Mn(CN)_6\right]$	(q)	$5.92BM$
(C)	$\left[Co\left(NH_3\right)_5Cl\right]Cl_2$	(r)	$3.87BM$
(D)	$Cs\left[FeCl_4\right]$	(s)	Zero

A. A-r, B-p, C-s, D-q

B. A-p, B-r, C-q, D-s

C. A-q, B-r, C-p, D-s

D. A-s, B-r, C-q, D-p

Answer: A

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148. Match each coordination compound in List-I with an appropriate pair of characteristics from List - II and select the correct answer using the code given below the lists .

[en = $H_2NCH_2CH_2NH_2$, At Nos : Ti = 22 , Cr = 24 , Co = 27 , Pt = 78]

List- I	List- II
(P) $\left[Cr\left(NH_3\right)_4Cl_2\right]Cl$	1. Paramagnetic and exhibits ionisation isomeris
(Q) $\left[Ti\left(H_2O\right)_5Cl\right]\left(NO_3\right)_2$	2. Diamagnetic and exhibits cis- trans isomerism
(R) $\left[Pt(en)\left(NH_3\right)Cl\right]NO_3$	3. Paramagnetic and exhibits cis - trans
(S) $\left[Co\left(NH_3\right)_4\left(NO_3\right)_2\right]NO_3$	4. Diamagnetic and exhibits ionisation isomerism

	P	Q	R	S
A.	4	2	3	1
B.	3	1	4	2
C.	2	1	3	4
D.	1	3	4	2

Answer: B

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149.

	Column I		Column II
(A)	: CN : $^-$	(p)	Unidentate ligand
(B)	glycinate	(q)	Didentate ligand
(C)	ethylenediamine	(r)	Ambidentate ligand
(D)	carbonate ion	(s)	Chelating ligand

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150.

	Column I		Column II
(A)	$\left[CoCl_2(en)_2\right]^+$	(p)	Shows geometrical isomerism only
(B)	$\left[Cr(ox)_3\right]^{3-}$	(q)	Shows optical isomerism only
(C)	$\left[RhCl_3(py)_3\right]$	(r)	Shows geometrical as well as optical isomerism
(D)	$\left[ZnCl_2\left(NH_3\right)_2\right]$	(s)	Shows no isomerism

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151.

	Column I		Column II
(A)	$\left[Ni(CO)_4\right]$	(p)	Square planar
(B)	$\left[Ni(CN)_4\right]^{2-}$	(q)	Tetrahedral
(C)	$\left[Cu\left(NH_3\right)_4\right]^{2+}$	(r)	Paramagnetic
(D)	$\left[FeCl_4\right]^{2-}$	(s)	Diamagnetic

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152.

	Column I		Column II
(A)	$O_2^- \rightarrow O_2 + O_2^{2-}$	(p)	Redox reaction
(B)	$CrO_4^{2-} + H^+ \rightarrow$	(q)	one of the products has trigonal planar stru
(C)	$MnO_4^- + NO_2^- + H^+ \rightarrow$	(r)	dimeric bridged tetrahedral metal ion
(D)	$NO_3^- + H_2SO_4 + Fe^{2+} \rightarrow$	(s)	disproportionation

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153. The number of CO bridges present in $Fe_2(CO)_9$ is

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154. The number of chelate rings present in the complex K_2 [Ni(EDTA)] is

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155. Number of isomers formed by the coordination compound with the formula MABCD is

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156. Number of CO groups that can be attached to chromium is

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157. Taking CFSE value of octahedral complex $\left(\Delta_0\right)$ as 10 Dq, the e_g orbitals are ..... Dq above the bari centre

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158. The number of rings present in the structure of chlorophyll is

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159. Total number of geometrical isomers for the complex $\left[RhCl(CO)\left(PPh_3\right)\left(NH_3\right)\right]$ is

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160. The volume (in mL) of $0.1MAgNO_3$ required for complete precipitation of chloride ions present in $30mL$ of $0.01M$ solution of $\left[Cr\left(H_2O\right)_5Cl\right]Cl_2$, as silver chloride is close to:

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161. $EDTA^{4-}$ i9s ethylenediamine tetraacetate ion The total number of N - CO - O bond angles in $[Co(EDTA)]^{-1}$ complex ion is .

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162. For the octahedral complexes of Fe^{3+} is SCN^{-} (thiocyanato-S) and in CN^{-} ligand environments , the difference between the spin only magnetic moments in Bohr magnetons (when approximated to the nearest integer) is [atomic number of Fe = 26]

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163. In dilute aqueous H_2SO_4 the complete diaquadioxalatoferrate (II) is oxidised by MnO_4^-. For the reaction, the ratio of the rate of change of $\left[H^+\right]$ to the rate of change of $\left[MnO_4^-\right]$ is

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164. In the complex acetylbromidodicarbonylbis (triethylphosphine) iron (II), the number of Fe - C bond (s) is

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165. Among the complex ions,

$\left[Co\left(NH_2\text{-}CH_2\text{-}CH_2\text{-}NH_2\right)_2Cl_2\right]^+$, $\left[CrCl_2\left(C_2O_4\right)_2\right]^{3-}$, $\left[Fe\left(H_2O\right)_4(OH)_2\right.$

and $\left.\left[Co\left(NH_3\right)_4\left(H_2O\right)Cl\right]^{2+}\right]$, the number of complex ion (s) that show(s) cis-trans isomerism is

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166. The number of geometric isomers possible for the complex $\left[CoL_2Cl_2\right]^-\left(L = H_2NCH_2CH_2O^-\right)$ is

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167. The questions given below consist of Assertion (A) and Reason (R) . Use the following key to select the correct answer.

Assertion : Tetrahedral complexes donot show geometrical isomerism

Reason : The relative positions of the ligands in the tetrahedral complexes are the same with respect to each other .

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-1

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-1

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: A

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168. These questions consist of two statements each, printed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses:

Assertion: The number of unpaired electrons present in $\left[CuCl_2\right]^-$ complex is zero.

Reason: The complex is linear in the solid state with sp-hybridization.

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-2

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-2

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: C

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169. The question consist of two statements each, printed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses:

Assertion: Coordination entities with d^4 to d^7 ions are stable for high spin state.

Reason: If $\Delta_o > P$, high state is more stable.

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-3

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-3

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: D

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170. Assertion : $K_2[Ni(EDTA)]$ is more stable than $K_3\left[Al\left(C_2O_4\right)_3\right]$.

Reason : Ni is a transition element while Al is a non-transition element .

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-4

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-4

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: B

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171. The question consist of two statements each, printed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses:

Assertion: Ambidentate ligands lead to linkage isomerism.

Reason: The ionization sphere is different in different linkage isomers.

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-5

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-5

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: C

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172. Statement I $\left[Fe\left(H_2O\right)_5NO\right]SO_4$ is paramagnetic

Statement II The Fe in $\left[Fe\left(H_2O\right)_5NO\right]SO_4$ has three unpaired electrons .

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-6

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-6

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: A

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173. Statement-1: The geometrical isomers of the complex $\left[M\left(NH_3\right)_4Cl_2\right]$ are optically inactive.

Statement-2: Both geometrical isomers of the complex $\left[M\left[NH_3\right)_4Cl_2\right]$ possess axis of symmetry.

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-7

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-7

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: A

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174. STATEMENT-1: $\left[Co\left(NH_3\right)_3Cl_3\right]$ does not give white ppt . with $AgNO_3$ solution .

and

STATEMENT-2: Chlorine is not present in the ionisable part of the given complex .

A. Statement-1 is True, Statement-2 is True , Statement-2 is a correct explanation for Statement-8

B. Statement-1 is True, Statement is 2 is True , Statement-2 is NOT a correct explanation for Statement-8

C. Statement-1 is True, Statement-2 is False

D. Statement-1 is False, Statement-2 is True

Answer: C

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175. Assertion. EDTA is a hexadentate ligand.

Reason. Denticity of a ligand is given by number of lone pairs donated to central atom by a ligand.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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176. Assertion. Glycine forms a chelate with Cu^{2+} ion.

Reason. Glycine is a bidentate ligand and thus forms a closed ring structure with the metal ion.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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177. Assertion : The name of the complex $\left[Co\left(NH_3\right)_6\right]Cl_3$ is hexamminecobalt (III) chloride.

Reason. When a prefix like hexa ends in 'a' and the ligand like 'ammonia' starts with 'a', only one 'a' is retained.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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178. Assertion. Trans $\left[CoCl_2(en)_2\right]^+$ is optically inactive.

Reason. It is an octahedral complex.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: B

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179. Assertion : $\left[Co\left(NO_2\right)_3\left(NH_3\right)_3\right]$ does not show optical isomerism.

Reason : It has a plane of symmetry.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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180. The question consist of two statements each, printed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses:

Assertion: The complex $\left[Co\left(NH_3\right)_3Cl_3\right]$ does not give precipitate with

$AgNO_3$.

Reason: The given complex does not contain counter ions.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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181. Assertion. Both $\left[Ni(CN)_4\right]^{2-}$ and $\left[NiCl_4\right]^{2-}$ have same shape and same magnetic behaviour.

Reason. Both are square planar and diamagnetic.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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182. Assertion NF_3 is weaker ligands than $N\left(CH_3\right)_3$

Reason NF_3 ionises to give F^{Θ} ions in aqueous solution .

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: C

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183. Assertion: $\left[Ni(en)_3\right]Cl_2$ has lower stability than $\left[Ni\left(NH_3\right)_6\right]Cl_2$

Reason: In $\left[Ni(en)_3\right]CI_2$ the geometry of Ni is trigonal bipyramidal .

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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184. Assertion : Potassium ferrocyanide is diamagnetic whereas potassium ferricyanide is paramagnetic.

Reason : Crystal field splitting in ferrocyanide ion is greater than that of ferricyanide ion.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: C

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185. These questions consist of two statements each, printed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses:

Assertion: $\left[Al\left(H_2O\right)_6\right]^{3+}$ is a stronger acid than $\left[Mg\left(H_2O\right)_6\right]^{2+}$.

Reason: Size of $\left[Al\left(H_2O\right)_6\right]^{3+}$ is smaller than $\left[Mg\left(H_2O\right)_6\right]^{2+}$ and posseses more effective nuclear charge.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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186. Assertion : If β_4 for $\left[Cu\left(NH_3\right)_4\right]^{2+}$ is 2.1×10^{13} its instability constant is 4.76×10^{-14}.

Reason :Overall dissociation equilibrium constant varies inversely with formation constant.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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187. Assertion : $\left[Ni(Co)_4\right]$ is a diamagnetic complex.

Reason : All the electrons in the complex are paired

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: A

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188. Assertion. The oxidation number of platinum in Zeise's salt is + 4.

Reason. Zeise's salt is non-ionic complex.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: D

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189. STATEMENT-1: Oxidation state of Fe in $Fe(CO)_5$ is zero

and

STATEMENT-2: EAN of Fe in this complex is 36.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: B

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190. Assertion. When NO reacts with $FeSO_4$, a brown coloured complex is formed.

Reason. In the complex, the coordination number of Fe is + 6.

A. If both assertion and reason are true, but reason is not the true explanation of the assertion

B. If both assertion and reason are true, but reason is not the true explanation of the assertion

C. If assertion is true, but reason is false

D. If both assertion and reason are false

Answer: B

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Short Answer Questions

1. Arrange the following complexes in the increasing order of conductivity of their solution

$$\left[Co\left(NH_3\right)_3Cl_3\right], \left[Co\left(NH_3\right)_4Cl_2\right]Cl, \left[Co\left(NH_3\right)_6\right]Cl_3, \left[Cr\left(NH_3\right)_5Cl\right]Cl_2$$

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2. A coordination compound $CrCI_3.4H_2O$ precipitates $AgCI$ when treated with $AgNO_3$ The molar conductance of its solution corresponds to a total of two ions Write the structural formula of the compound and name it .

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3. A complex of the type $\left[M(AA)_2X_2\right]$ is known to the optically active. What does this indicate about the structure of the complex? Give one example of such complex .

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4. Magnetic moment of $\left[MnCl_4\right]^{2-}$ is 5.92 BM. Explain giving reason present.

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5. On the basis of crystal field theory explain why Co(III) Forms paramagnetic octahedral complex with weak field ligands whereas it forms diamagnetic octahedral complex with strong field ligands.

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6. Why are low spin tetrahedral complexes not formed ?

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7. Give the electronic configuration of the following complexes on the basis of crystal field splitting theory. $\left[CoF_6\right]^{3-}$, $\left[Fe(CN)_6\right]^{4-}$ and $\left[Cu\left(NH_3\right)_6\right]^{2+}$.

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8. Explain why $\left[Fe\left(H_2O\right)_6\right]^{3+}$ has magnetic moment value of 5.92 BM whereas $\left[Fe(CN)_6\right]^{3-}$ has a value of only 1.74 BM ?

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9. Arrange following complex ions in increasing order of crystal field splitting energy $\left(\Delta_0\right)$:

$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$

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10. Why do compounds having similar geometry have different magnetic moment ?

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11. $CuSO_4.5H_2O$ is blue in colour while $CuSO_4$ is colourless. Why ?

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12. Name the type of isomerism when ambidentate ligands are attched to central metal ion. Give two examples of ambidentate ligands.

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13. Double Salt and Coordination Compound

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14. Explain with examples the following :

(i) coordination number (ii) oxidation state (iii) ligand (iv) coordination sphere (v) chelate.

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15. What is meant by unidentate, bidentate and ambidentate ligands ? Illustrate with examples.

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16. Determine the oxidation states of central metal ions in the following complex compounds :

(i) (a) $K_4\left[Fe(CN)_6\right]$ (b) $\left[Co\left(NH_3\right)_6\right]Cl_3$

(ii) (a) $K_3[Fe(CN)_6]$ (b) $[PtCl_4]^{2-}$ (c) $[CoBr_2(CN)_2]^+$

(iii) (a) $[Pt(NH_3)_3Cl_3]$ ion (b) $Na_4[Ni(CN)_4]$ (c) $[Zn(H_2O)_3OH]^+$

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17. Write IUPAC name of the following coordination compounds :

(a) (i) $[Cu(NH_3)_4]SO_4$ (ii) $[Cr(H_2O)_6]Cl_3$

(iii) $[Ni(CO)_4]$ (iv) $K_2[HgI_4]$

(b) (i) $K_3[Fe(CN)_6]$ (ii) $[CoCl_2(NH_3)_4]^+$

(iii) $[Cr(NH_3)_4Cl_2]^+$ (iv) $[CoCl_2(en)_2]Cl.$

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18. (a) Write the IUPAC of the isomer of the following complex :

$[Pt(NH_3)_2Cl_2]$

(b) Write the formula of the following :

Tetraammineaquachloridocobalt (III) nitrate.

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19. (a) Write the IUPAC name of the isomer of the following complex :

$$\left[Co\left(NH_3\right)_5Cl\right]SO_4$$

(b) Write the formula for the following :

Diamminechloridonitrito-N-platinum (II)

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20. (a) Write the IUPAC name of the following complex :

$$\left[Co\left(NH_3\right)_4Cl\left(NO_2\right)\right]Cl$$

(b) Write the formula for the following :

Dichloridobis (ethane-1, 2-diamine) cobalt (III) chloride.

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21. What are chelates ? Giving one example write the importance of chelate.

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22. List various types of isomerism possible for coordination compounds, giving an example of each.

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23. Define cis and trans isomerism. Draw the cis and trans isomers of $\left[Co\left(NH_3\right)_4Cl_2\right]^+$ ion.

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24. Draw all the possible isomers (structural and stereoisomeric) having the composition $CrBr_2\left(NH_3\right)_4$.

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25. The aqueous solution of a complex compound having the formula $coBrCl_2.4NH_3$ conducts electricity and also gives white precipitate with $AgNO_3$. Write the IUPAC notation and IUPAC name of the compound.

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26. $\left[Ni(CO)_4\right]$ possess tetrahedral geometry while $\left[Pt\left(NH_3\right)_2Cl_2\right]$ has square planar geometry. Explain.

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27. Using the valence bond theory, predict the geometry and magnetic character of

(i) $\left[NiCl_4\right]^{2-}$ (ii) $\left[Ni(CO)_4\right]$ (iii) $\left[Ni(CN)_4\right]^{2-}$ (iv) $\left[Ni\left(NH_3\right)_6\right]^{2+}$ (v)

$\left[Ni\left(NH_3\right)_4\right]^{2+}$

(At No. of Ni = 28)

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28. Consider the coordination compound, $\left[Co\left(NH_3\right)_5SO_4\right]Br$

(i) Write IUPAC name of the above coordination compound

(ii) What is the primary valence and secondary valence of the central metal, cobalt, in the above coordination compound?

(iii) Which type of structural isomerism is exhibited by the above coordination compound ?

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29. Using the valence bond approach, deduce the shape and magnetic character of

(i) $\left[Cr(CO)_6\right]$ [At. No. of Cr = 24] (ii) $\left[Fe(CN)_6\right]^{3-}$ (At. No. of Fe = 26)

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30. On the basis of valence bond theory, account for the hybridisation, shape and magnetic property of cuprammonium ion.

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31. Write the name, stereochemistry and magnetic behaviour of the following :

(At.nos. Mn = 25, Co = 27 , Ni = 28)

(i) $K_4\left[Mn(CN)_6\right]$

(ii) $\left[Co\left(NH_3\right)_5Cl\right]Cl_2$

(iii) $k_2\left[Ni(CN)_4\right]$

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32. Give an example of each of the following :

(i) Outer orbital octahedral complex (ii) Tetrahedral complex (iii) Inner

orbital octahedral complex

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33. Compare the magnetic behaviour of the complex entities $\left[Fe(CN)_6\right]^{4-}$ and $\left[FeF_6\right]^{3-}(Fe = 26)$.

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34. Explain how two complexes of nickel, $\left[Ni(CN)_4\right]^{2-}$ and $Ni(CO)_4$ have different structures but do not differ in magnetic behaviour.

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35. Using valence bond theory , explain the geometry and magnetic behaviour of pentacarbonyl iron (0).

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36. With the help of VBT, explain the hybridisation in tetracarbonyl nickel(0) and sketch the shape of the complex.

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37. Discuss the formation, structure and magnetic behaviour of hexafluorocobaltate (II).

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38. Write the name, the state of hybridization, the shape and the magnetic behaviour of the following complexes :

$[CoCl_4]^{2-}$, $[Ni(CN_4]^{2-}$, $[Cr(H_2O)_2(C_2O_4)_2]^-$

(At.No. : $Co = 27, Ni = 28, Cr = 24$)

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39. (a) For the complex $\left[Fe(CN)_6\right]^{3-}$, write the hybridisation type, magnetic character and spin nature of the complex .(At. Number : $Fe = 26$)

(b) Draw one of the geometrical isomers of the complex $\left[Pt(en)_2Cl_2\right]^{2+}$ which is optically active .

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40. Explain on the basis of valence bond theory that $\left[Ni(CN)_4\right]^{2-}$ ion with square planar structure is diamagnetic and $\left[NiCl_4\right]^{2-}$ ion with tetrahedral geometry is paramagnetic.

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41. Discuss the nature of bonding in the following coordination entities on the basis of valence bond theory.

$\left[Fe(CN)_6\right]^{4-}$ (ii) $\left[CoF_6\right]^{3-}$

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42. Discuss the geometry of $\left[Cr\left(NH_3\right)_6\right]^{3+}$ ion by using V.B.T. and suggest whether this complex is inner orbital or outer orbital complex.

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43. How does crystal field theory explain.

(i) High spin and low spin states of complexes (ii) Magnetism of complexes

(iii) Colour of the complexes ?

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44. The magnitude of crystal field stabilisation energy in octaheral field depends on:

(I) the nature of the ligand

(II) the charge on the metal ion.

(III) whether the metal is in the first, second or third row of the transition elements

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45. (a) What is the basic of formation of the spectrochemical series?

(b) Draw the structures of geometrical isomers of the following coordination complexes : $\left[Co\left(NH_3\right)_3Cl_3\right]$ and $\left[CoCl_2(en)_2\right]^+$

(en= ethylenediamine and atomic number of Co is 27)

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46. a) Give the electronic configuration of the d-orbitals of Ti in $\left[Ti\left(H_2O\right)_6\right]^{3+}$ ion and explain why the complex is coloured? [At. No. Of Ti=22]

b) Write IUPAC name of $\left[Cr\left(NH_3\right)_3\left(H_2O\right)_3\right]Cl_3$

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47. What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand.

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48. Explain how the nature of ligand affects the stability of complex ion.

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49. Name two properties of the central metal ion which enable it to form stable complex entities.

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50. Write the structure of each of the following :

(i) trimethyl aluminium (ii) ferrocene (iii) dibenzene chromium (iv) Zeise's test.

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51. What are Zeise's salt and Ferrocene ? Explain with structure.

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52. Describe the nature of bonding : (i) in metal carbonyls and (ii) in π complexes.

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53. What are π complexes ? Explain with suitable examples.

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54. Giving a suitable example, describe the importance of the formation of complex compounds in

(i) the estimation of hardness of water

(ii) the extraction of a particular metal from its natural source.

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55. The formation of complex compounds finds application in the extraction of some metals. Furnish one example to support this statement.

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56. Define organometallic compound. Mention the application of such compounds in homogeneous catalysis.

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57. For the complex $\left[Fe(en)_2Cl_2\right]Cl$ (en = ethylene diamine) , identify

(i) the oxidation number of iron ,

(ii) the hybrid orbitals and the shape of the complex,

(iii) the magnetic behaviour of the complex ,

(iv) the number of geometrical isomers ,

(v) whether there is an optical isomer also , and

(vi) name of the complex . (At. no. of Fe = 26)

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58. a) State the hybridisation & magnetic behaviour of $\left[Cr(CO)_6\right]$

b) What are the various factors affecting crystal field splitting energy?

c) Which of the two is more stable and why?

$K_4\left[Fe(CN)_6\right]$ or $\left[K_3\left[Fe(CN)_6\right]\right.$

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59. Explain the following terms giving suitable examples in each case

(i) Ambidentate ligand

(ii) Denticity of a ligand

(iii) Crystal field splitting in an octahedral field.

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60. (a) Give reason : $\left[CoF_6\right]^{3-}$ is a high spin complex ion.

(b) Draw the two geometrical isomers of the complex compound, $\left[Pt\left(NH_3\right)_2Cl_2\right]$.

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61. (i) Draw the geometrical isomers of the complex $\left[Pt\left(NH_3\right)_2Cl_2\right]$.

(ii) On the basis of crystal field theory, write the electronic configuration of d^4 ion if $\Delta_o < P$.

(iii) Write the hybridisation and magnetic behaviour of the complex $\left[Ni(CO)_4\right]$ (At. no. of $Ni = 28$).

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62. (i) What type of isomerism is shown by the complex $\left[Co\left(NH_3\right)_6\right]\left[Cr(CN)_6\right]$?

(ii) Why a solution of $\left[Ni\left(H_2O\right)_6\right]^{2+}$ is colored while a solution of $\left[Ni(CN)_4\right]^{2-}$ colourless ? (At. No. of Ni = 28)

(iii) Write the IUPAC name of the following complex : $\left[Co\left(NH_3\right)_5(CO)\right]Cl_3$

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63. (i) What type of isomerism is shown by complex $\left[Co(en)_3\right]Cl_3$?

(ii) Write the hybridisation and magnetic character of $\left[Co\left(C_2O_4\right)_3\right]^{3-}$. (At.no. of Co = 27)

(iii) Write IUPAC name of the following Complex $\left[Cr\left(NH_3\right)_3Cl_3\right]$

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64. (a) What type of isomerism is shown by the complex $\left[Co\left(NH_3\right)_5(SCN)\right]^{2+}$?

(b) Why is $\left[NiCl_4\right]^{2-}$ paramagnetic while $\left[Ni(CN)_4\right]^{2-}$ is diamagnetic ? (Atomic number of Ni=28)

(c) Why are low spin tetrahedral complexes rarely observed?

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Matching Type Question

1. Match the complex ions given in Column I with the colours given the Column II and assign the correct code :

	Column I (Complex ion)		Column II (Colour)
A.	$\left[Co\left(NH_3\right)_6\right]^{3+}$	1.	Violet
B.	$\left[Ti\left(H_2O\right)_6\right]^{3+}$	2.	Green
C.	$\left[Ni\left(H_2O\right)_6\right]^{2+}$	3.	Pale blue
D.	$\left[Ni\left(H_2O\right)_4(en)\right]^{2+}(aq)$	4.	Yellowish organge
		5.	Blue

A. A (1) B (2) C (4) D (5)

B. A (4) B (3) C (2) D (1)

C. A (3) B (2) C (4) D (1)

D. A (4) B (1) C (2) D (3)

Answer: b

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2. Match the coordination compounds given in column I with the central metal atoms given in column II and assign the correct code.

	Column I (Coordination compound)		Column II (Central metal atom)
A.	Chlorophyll	1.	Rhodium
B.	Blood pigment	2.	Cobalt
C.	Wilkinson catalyst	3.	Magnesium
D.	Vitamin B_{12}	4.	Iron

A. A (5) B (4) C (1) D (2)

B. A (3) B (4) C (5) D (1)

C. A (4) B (3) C (2) D (1)

D. A (3) B (4) C (1) D (2)

Answer: a

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3. Match the complex ions given in column I with the hybridisation and number of unpaired electrons given in column II and assign the correct

code

	Column I (Complex ion)		Column II (Hybridisation, number of unpaired electrons)
A.	$[Cr(H_2O)_6]^{3+}$	1.	dsp^2, 1
B.	$[Co(CN)_4]^{2-}$	2.	sp^3d^2, 5
C.	$[Ni(NH_3)_6]^{2+}$	3.	d^2sp^3, 3
D.	$[MnF_6]^{4-}$	4.	sp^3d^2, 2

A. A (3) B (1) C (5) D (2)

B. A (4) B (3) C (2) D (1)

C. A (3) B (2) C (4) D (1)

D. A (4) B (1) C (2) D (3)

Answer: a

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4. Match the complex species given in Column I with the possible isomerism given in Column II and assign the correct code :

	Column I (Complex species)		Column II (Isomerism)
A.	$\left[Co\left(NH_3\right)_4Cl_2\right]^+$	1.	optical
B.	*cis* - $\left[Co(en)_2Cl_2\right]^+$	2.	ionisation
C.	$\left[Co\left(NH_3\right)_5\left(NO_2\right)\right]Cl_2$	3.	coordination
D.	$\left[Co\left(NH_3\right)_6\right]\left[Cr(CN)_6\right]$	4.	geometrical
		5.	linkage

A. A (1) B (2) C (4) D (5)

B. A (4) B (3) C (2) D (1)

C. A (4) B (1) C (5) D (3)

D. A (4) B (1) C (2) D (3)

Answer: d

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5. Match the compounds given in Column I with the oxidation state of cobalt present in it (given in Column II) and assign the correct code.

Column I (Compound)		Column I (Oxidation state of Co)
A.	$\left[Co(NCS)\left(NH_3\right)_5\right]\left(SO_3\right)$	1. +4
B.	$\left[Co\left(NH_3\right)_4Cl_2\right]SO_4$	2. 0
C.	$Na_4\left[Co\left(S_2O_3\right)_3\right]$	3. +1
D.	$\left[Co_2(CO)_8\right]$	4. +2
		5. +3

A. A (1) B (2) C (4) D (5)

B. A (4) B (3) C (2) D (1)

C. A (5) B (1) C (4) D (2)

D. A (4) B (1) C (2) D (3)

Answer: c

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Assertion And Reason Types Question

1. Assertion (A) Toxic metal ions are removed by the chelating ligands.

Reason (R) Chelate complexes tend to be more stable.

A. Assertion and reason both are true, reason both are true, reason is correct explanation of assertion.

B. Assertion and reason both are true but reason is not the correct explanation of assertion

C. Assertion is true, reason is false

D. Assertion is false, reason is true

Answer: a

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2. Assertion (A) $\left[Cr\left(H_2O_6\right)\right]Cl_2$ and $\left[Fe\left(H_2O\right)_6\right]Cl_2$ are reducing in nature.

Reason (R) Unpaired electrons are present in their d-orbitals.

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3. Assertion (A) Linkage isomerism arises in coordination compounds containing ambidnetate ligand.

Reason (R) Ambidentate ligand has two different donor atoms.

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4. Assertion (A) Complexes of MX_6 and MX_5L type (X and L are unidentate) do not show geometrical isomerism.

Reason (R) Geometrical isomerism is not shown by complexes of coordination number 6.

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5. Assertion (A) $\left[Fe(CN)_6\right]^{3-}$ ion shows magnetic moment corresponding to two unpaired electrons.

Reason (R) Because it has d^2sp^3 type hybridisation.

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Long Answer Questions

1. Using crystal field theory, draw energy level diagram, write electronic configuration of the central metal atom/ion and determine the magnetic moment value in the following

(a) $\left[CoF_6\right]^{3-}$, $\left[Co\left(H_2O\right)_6\right]^{2+}$, $\left[Co(CN)_6\right]^{3-}$

(b) FeF_6^{3-}, $\left[Fe\left(H_2O\right)_6\right]^{2+}$, $\left[Fe(CN)_6\right]^{4-}$

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2. Using valence bond theory, explain the following in relation to the complexes given below

$\left[Mn(CN)_6\right]^{3-}$, $\left[Co\left(NH_3\right)_6\right]^{3+}$, $\left[Cr\left(H_2O\right)_6\right]^{3+}$, $\left[FeCl_6\right]^{4-}$

(a) Type of hybridisation.

(b) Inner or outer orbital complex.

(c) Magnetic behaviour.

(d) Spin only magnetic moment value.

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3. $CoSO_4Cl.5NH_3$ exists in two isomeric forms 'A' and 'B'. Isomer 'A' reacts with $AgNO_3$ to give white precipitate, but does not react with $BaCl_2$. Isomer 'B' gives white precipitate with $BaCl_2$ but does not react with $AgNO_3$. Answer the following questions.

(a) Identify 'A' and 'B' and write their structural formulae.

(b) Name the type of isomerism involved.

(c) Give the IUPAC name of 'A' and 'B'.

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4. what is the relationsphip between observed colour of the complex and the wavelength of light absorbed by the complex ?

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5. Why are different colours observed in octahedral and tetrahedral complexes for the same metal and same ligands ?

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6. List various types of isomerism possible for coordination compounds, giving an example of each.

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7. LIMITATIONS OF VALENCE BOND THEORY

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Very Short Answer Questions

1. Define

coordination number. Draw optical isomers $\left[Co(en)_3\right]^{2+}$

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2. What is te coordination number of Fe in $[Fe(EDTA)]^{\ominus}$?

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3. What is oxidation state and coordination number of central metal ion in

(a) $\left(NH_4\right)\left[CoF_4\right]$?

(b) $\left[Pt\left(O_2\right)(en)_2Br\right]^{+}$

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4. What aer ambidentate ligands? Give an example.

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5. Give one example of a bidentate ligand.

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6. What is the name of the bidentate ligand 'dmg' ?

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7. Give an example of a hexadentate ligand.

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8. Give one example of chelate complex.

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9. Give one example of each :

(a) Neutral ligand of carbon (b) Positive ligand of nitrogen.

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10. Write the formula for dichlorotetraammine platinum (IV) ion

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11. Write the chemical formula of nitropentaamminecobalt (III) chloride.

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12. Write the formula of (i) hexaaquairon (II) sulphate

(ii) potassium hexacyanoferrate (III)

(iii) hexaammine platinum (IV) chloride

(iv) potassium trioxalatoaluminate (III).

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13. Write IUPAC name for $K_3\left[\left(Co\left(NO_3\right)_6\right]\right.$

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14. Write the IUPAC name of (i)$Zn_2\left[Fe(CN)_6\right]$

(ii) $Pt\left[Cl_2\left(NH_3\right)_2\right]$

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15. Write IUPAC name of (i) $Na_3\left[Co\left(NO_2\right)_6\right]$ (ii) $K_3\left[Fe(CN)_5NO\right]$

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16. Write the IUPAC names of the complexes (i) $Na_3\left[CrF_4(OH)_2\right]$ ii) $\left[Cr\left(H_2O\right)_5Cl\right]Cl_2$.

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17. As per IUPAC name , the name of the complex $\left[Co(en)_2(ONO)Cl\right]Cl$ is

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18. Write the structrue and the name of the co-oridnate isomer of $\left[Co(en)_3\right]Cr(CN)_6\Big]$

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19. Name the ionization isomer of $\left[Cr\left(H_2O\right)_5Br\right]SO_4$

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20. Write IUPAC name of the linkage isomer of (i) $\left[Co\left(NH_3\right)_5NO_2\right]Cl_2$ (ii) $\left[Cr\left(H_2O\right)_5SCN\right]^{2+}$

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21. What type of isomerism is shown by the following complexes ?

(i) $\left[Cr(en)_3\right]^{3+}$ (ii) $\left[Pt\left(NH_3\right)_4\right]\left[PtCl_4\right]$

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22. Draw the structure of isomes of $Pt\left(NH_3\right)_2Cl_2$

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23. Define hydrate isomerism or ionization isomerism or optical isomerism or geometrical isomerism or linkage isomerism with suitable

example.

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24. Give an example of linkage isomerism.

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25. An example of coordination isomerism is

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26. Give an example of ionization isomerism.

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27. Name the isomerism shown by the following pair of coordination compounds :

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28. Illustrate the geometrical isomers of $\left[Pt\left(NH_3\right)_4Cl_2\right]^{2+}$

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29. Which isomer of $\left[CoCl_2(en)_2\right]^+$ does not show optical isomerism ?

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30. Draw the structure and write the hybridisation in

(i) $\left[Fe(CO)_5\right]$ (ii) trans-$\left[Co\left(NH_3\right)_4Cl_2\right]^+$ (iii) $No(CO)_4$ (iv) *cis* - $\left[Co\left(NH_3\right)_4Cl_2\right]^+$ (v) $\left[NiCl_4\right]^{2-}$

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31. What is the difference between inner and outer orbital complexes?

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32. What are t_{2g} and e_g orbitals?

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33. Define crystal field splitting energy ?

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34. Among the octahedral and tetrahedral crystal fields, In which case the magnitude of crystal field splitting is larger?

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35. For the complexion $\left[CoF_6\right]^{3-}$ write the hybridization type, magnetic character and spin nature. [Atomic number : Co = 27].

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36. What happens when potassium ferrocyanide solution is added to a ferric salt solution?

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37. Name the different types of organometallic compounds.

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38. Draw structures of (i) Zeise's salt anion, $\left[PtCl_3\left(C_2H_4\right)\right]^-$ (ii) $\left[Al\left(CH_3\right)_3\right]_2$

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39. Write the structure of ferrocene.

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40. In the formula $Fe\left(\eta^5 - C_5H_5\right)$, what does the prefix η^5 denote?

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41. The oxidation state of Ni in $\left[Ni(CO)_4\right]$ is

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42. How is tetrabutyl tin prepared?

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43. Name the central atom present in haemoglobin, chlorophyll and vitamin B_{12}.

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44. What is the solution in which photographic film is washed? What reaction takes place?

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45. Give names of two complexes which are used in medicines.

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46. Write the name of an organometallic compounds which is used as a homogeneous catalyst

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47. Write down the heteroheneous catalyst involved in the polymerisation of ethylene.

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Hots Questions

1. A complex is prepared by mixing $CoCl_3$ and NH_3 in the molar ratio of $1:4$. 0.1 M solution of this complex was found to freeze at $-0.372\,^\circ C$. What is the formula of the complex ? Given that molal depression constant of water $\left(K_f\right) = 1.86\,^\circ C/m$

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2. How are octahedral complexes with high spin and low spin states formed ? What is the condition of their formation ?

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3. In the sequence of reactions

$$Fe^{3+}(aq) \xrightarrow{\text{Excess of } SCN^-} \text{Blood red colour}(A) \xrightarrow{\text{Excess of } F^-} \text{Colourless}(B)$$

Identify A and B. Write their IUPAC names. Explain the hybridisation involved in B and calculate spin only magnetic moment of B.

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4. Write the *IUPAC* nomenclature of the given complex along with its hybridisation and structure

$K_2\left[Cr(NO)\left(NH_3\right)(CN)_4\right], \mu = 1.73.\, BM$.

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5. Nickel chloride, when treated with dimethyl gyloxime in presence of ammonium hydroxide, a bright red precipitate is obtained Answer the following

(a) Draw the structure of the complex showing H-bonds

(b) Give oxidation state of nickel and its hybridization

(c) Predict the magnetic behaviour of the complex

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6. A metal ion M^{n+} having d^4 valence electronic configuration combines with three didentate ligands to form a complex compound. Assuming $\Delta_o > P$:

(i) Draw the diagram showing d-orbital splitting during this complexes formation.

(ii) What type of hybridisation will M^{n+} have?

(iii) Name the type of isomerism exhibited by this complex.

(iv) Write the electronic configuration of metal M^{n+}

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7. Arrange the following compounds in order of increasing molar conductivity

(a) $K\left[Co\left(NH_3\right)_2\left(NO_2\right)_4\right]$

(b) $\left[Cr\left(NH_3\right)_3\left(NO_2\right)_3\right]$

(c) $\left[Cr\left(NH_3\right)_5\left(NO_2\right)\right]_3\left[Co\left(NO_2\right)_6\right]_2$

(d) $Mg\left[Cr\left(NH_3\right)\left(NO_2\right)_5\right]$

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8. Draw the structures of $\left[Co\left(NH_3\right)_6\right]^{3+}$, $\left[Ni(CN)_4\right]^{2-}$ and $\left[Ni(CO)_4\right]$. Write shapes of the complexes and hybridisation of atomic orbitals of the transition metal in each case.

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9. $FeSO_4$ solution mixed with $\left(NH_4\right)_2SO_4$ solution is $1:1$ molar ratio gives the test of Fe^{2+} ion but $CuSO_4$ solution mixed with aqueous ammonia in $1:4$ molar ratio does not give the test of Cu^{2+} ion. Explain why?

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Value Based Questions

1. In Villages, people often wash their clothes with well water. They have to rub a lot of soap before lather is formed. This is because well water is hard water. Thus, a lot of soap is wasted. However, if they use detergent powder in place of soap, lather is formed easily and wastage is less.

Now, answer the following questions :

(i) What values are expressed in the above paragraph?

(ii) Why soap does not form lather with hard water?

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2. During war, arsenic containing poisonous gas called Lewisite is sometimes used. The soldiers may get affected due to poisoning by arsenic or it may affect the people living in the nearby areas. Similarly, we use a number of articles containing lead. If somehow it enters into our

body, e.g., along with water if lead pipes are used for transport of water, there may be lead poisoning. The person inflicted with arsenic or lead poisoning has to be given an antidote.

Now, answer the following questions :

(i) What values are expressed in the above paragraph?

(ii) Which antidote is given for arsenic poisoning and which one for lead poisoning?

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Important Questions

1. What aer ambidentate ligands? Give an example.

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2. What is oxidation number and coordination number of central metal ion in $\left[Pt\left(O_2\right)(en)_2Br\right]^+$

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3. Which of the following is more stable complex and why?

$\left[CO\left(NH_3\right)_6\right]^{3+}$ and $\left[CO(en)_3\right]^{3+}$

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4. Write the IUPAC names of the following coordination compounds:

(a) $\left[Pt\left(NH_3\right)_2Cl\left(NO_2\right)\right]$

(b) $K_3\left[Cr\left(C_2O_4\right)_3\right]$

(c) $\left[CoCl_2(en)_2\right]Cl$

(d) $\left[Co\left(NH_3\right)\right]Cl$

(e) $Hg\left[Co(SCN)_4\right]$

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5. Write the formulas for the following coordination compounds:

(a) Tetraa mmineaqua chlorido cobalt (III) chloride

(b) Potassium tetrahydroxid ozincate (II)

(c) Potassium trioxalato aluminate (III)

(d) Dichloridobis (ethane-1,2-diamine) cobalt (III)

(e) Tetra carbonyl nickel (0)

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6. Draw isomers of the complex ion $\left[Co(en)_2Cl_2\right]^+$

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7. Why is geometrical isomerism not possible in tetrahedral complexes having two different types of unidentate ligands coordinated with central metal ion ? .

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8. Draw all the isomers (geometrical and optical) of:

(i) $\left[CoCl_2(en)_2\right]^+$

(ii) $\left[Co\left(NH_3\right)Cl(en)_2\right]^{2+}$

(iii) $\left[Co\left(NH_3\right)_2Cl_2(en)\right]^+$

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9. A complex has empirical formula, $PtCl_2.2NH_3$. When mixed with $AgNO_3$, it gives $\left[Pt\left(NH_3\right)_4\left(NO_3\right)_2\right]$ and an insoluble slid $Ag_2\left[PtCl_4\right]$ was also obtained. Name and mention the structure of the complex.

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10. The molar conductivity of the complex $CoCl_3.4NH_3.2H_2O$ is found to be same as that of 3:1 electrolyte. What is the structural formula. Name and number of geometrical isomer of the complex.

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11. Account for different magnetic behaviour of hexacyanoferrate (III) and hexafluoroferrate (III).

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12. Explain on the basis of valence bond theory that $\left[Ni(CN)_4\right]^{2-}$ ion with square planar structure is diamagnetic and $\left[NiCl_4\right]^{2-}$ ion with tetrahedral geometry is paramagnetic.

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13. $\left[NiCl_4\right]^{2-}$ is paramagnetic while $\left[Ni(CO)_4\right]$ is diamagnetic though both are tetrahedral. Why?

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14. Explain $\left[Co\left(NH_3\right)_6\right]^{3+}$ is an inner orbital complex whereas $\left[Ni\left(NH_3\right)_6\right]^{2+}$ is an outer orbital complex.

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15. The spin only magnetic moment of $\left[MnBr_4\right]^{2-}$ is 5.9 B.M. Geometry of the complex ion is

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16. A solution of $\left[Ni\left(H_2O\right)_6\right]^{2+}$ is green but a solution of $\left[Ni(CN)_4\right]^{2-}$ is colourless Explain.

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17. Amongst the following ions, which one has the highest magnetic moment

$\left[Cr\left(H_2O\right)_6\right]^{3+}$

$\left[Fe\left(H_2O\right)_6\right]^{2+}$

$\left[Zn\left(H_2O\right)_6\right]^{2+}$

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18. For the complex $\left[Fe(en)_2Cl_2\right]Cl$ (en = ethylene diamine) , identify

(i) the oxidation number of iron ,

(ii) the hybrid orbitals and the shape of the complex,

(iii) the magnetic behaviour of the complex ,

(iv) the number of geometrical isomers ,

(v) whether there is an optical isomer also , and

(vi) name of the complex . (At. no. of Fe = 26)

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19. (a) What happens to the colour of coordination compound $\left[Ti\left(H_2O\right)_6\right]Cl_3$ when heated gradually?

(b) The values of dissociation constants of $\left[Cu\left(NH_3\right)_4\right]^{2+}$ and $\left[Co\left(NH_3\right)_6\right]^{3+}$ are 1.0×10 and 6.2×10^{-36} respectively. Which complex would be more stable and why ?

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20. Explain the following cases giving appropriate reasons :

(i) $CuSO_4.5H_2O$ is blue in colour while $CuSO_4$ is colourless. (ii) Low spin tetrahedral complexes are not formed.

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21. Aqueous copper sulphate solution (blue in colour) gives (i) a green precipitate with aqueous potassium fluoride, and (ii) a bright green

solution with aqueous potassium chloride. Explain these experimental results.

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22. (a) Draw a figure to show splitting of degenerate d- orbitals in an octahedral crystal field. How does the magnitude of Δ_0 decide the actual configuration of d- orbitals in a complex entity ?

(b) How is the magnitude of Δ_0 affected by (i) nature of the ligand (ii) oxidation state of the metal ion ?

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23. Why do compounds having similar geometry have different magnetic moment ?

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24. Using crystal field theory, draw energy level diagram, write electronic configuration of the central metal atom/ion and determine the magnetic moment value in the following :

(i) $\left[CoF_6\right]^{3-}$, $\left[Co\left(H_2O\right)_6\right]^{2+}$, $\left[Co(CN)_6\right]^{3-}$

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25. (a) Calculate the overall complex dissociation equilibrium constant for the $Cu\left(NH_3\right)_4^{2+}$ ion, given that β_4 for this complex is 2.1×10^{13}

(b) Draw the structures of the following :

(i) Pentaamminenitrito-N-cobalt (III) (ii) Hexamethyldialuminium.

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26. Draw the structures of (i) Zeise's salt (ii) Ferrocene

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27. Name the central atom present in haemoglobin, chlorophyll and vitamin-B_{12}.

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28. Discuss briefly giving an example in each case the role of coordination compounds in: (i) biological systems (ii) medicinal chemistry (iii) analytical chemistry and (iv) extraction/metallurgy of metals

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