COORDINATION COMPOUNDS

1) The ligand called π-acid is

1) NH_3 2) $C_2O_4^{2-}$ 3) CO 4) ethylene diamine

Sol.:(3)

The ligands which have vacant π -type orbital and that can receive back donated π -electrons from metals are called π -acid ligands or π -acceptor ligands e.g. CO, NO have lone pairs as well as π or π * orbitals which take part in the formation of π -bond with central metal atom as is observed in carbonyls.

2) In which of the following complexes metal is in highest oxidation state?

1) $[Ni(CO)_4]$ 2) $[Ni(NH_3)_6](BF_4)_2$ 3) $K_2[NiF_6]$ 4) $K_4[Ni(CN)_6]$

Sol.:(3)

Oxidation state of Ni=+4

3) Fac-Mer isomerism is associated with which of the following complexes? (M=Central metal)

1) $[M(AA)_3]$ 2) $[MA_3B_3]$ 3) $[M(AA)_2]$ 4) [MABCD]

Sol.: (2)

$[MA_3B_3]$ type of complexes shows fac-mer geometrical isomerism.

4) The number of chloride ions produced by complex tetraaminechloroplatinum(IV) chloride in an aqueous solution is

1) four 2) one 3) three 4) two

Sol.:(3)

$[Pt(NH_3)_4Cl]Cl_3 \rightleftharpoons [Pt(NH_3)_4Cl]^{3+}+3Cl^-$; the complex products three Cl^- ions in aqueous solution on dissociation.

5) Which of the following carbonyls will have the strongest C—O bond?

1) $V(CO)_6^-$ 2) $Cr(Co)_6$ 3) $Fr(CO)_5$ 4) $[Mn(CO)_6]^+$

Sol.:(4)

The presence of positive charge on the metal carbonyl would resist the flow of metal electron charge to π-orbital of CO. This would increase the CO bond order and hence

CO in a metal carbonyl cation would absorb at a higher frequency as compared to its absorption in a neutral metal carbonyl.

6) An excess of $AgNO_3$ is added to 100 ml of 0.01 M solution of dichlorotetraaquachromium (III) chloride. The number of moles of AgCl precipitated would be

1) 0.001 2) 0.01 3) 0.003 4) 0.002

Sol.: (1)

The formula of the complex is $[Cr(H_2O)_4Cl_2]Cl$

$[Cr(H_2O)_4Cl_2Cl \rightleftharpoons [Cr(H_2O)_4Cl_2]^+ + Cl^-$

1 mole 1 mole

It has only one ionizable Cl^- ion

$AgNO_3 + Cl^- \rightarrow AgCl \downarrow$

1mole 1mole

Number of moles of the complex $=\frac{100x0.01}{1000} = 0.001$ mole

7) Which of the following complex has same oxidation state of the central metal atom in the cationic and anionic part?

1) $[Pt(NH_3)_4\ Cl_2]$ 2) $[Pt(Py)_4]\ [Pt\ Cl_4]$

3) $[Pt(NH_3)_4]\ [Pt\ Cl_6]$ 4) In all the above

Sol.:(2)

Oxidation state of Pt = +2 in cationic and anionic part.

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

1) three 2) five 3) two 4) four

Sol.:(2)

In $[Mn(H_2O)_6]^{2+}$, H_2O acts as a weak field ligand and the number of unpaired electrons in the complex (outer orbit) will be due to Mn^{2+} ion, i.e. five

9) In $Fe(CO)_5$, the Fe → CO σ bond results by the overlap between filled sp-hybrid orbital of C-atom of CO molecule and vacant

1) d^2sp^3 2) dsp^3

3) sp^3 4) dsp^2 hybrid orbital of Fe

Sol.:(2)

$Fe(CO)_5$, $Fe=3d^64s^2$

10) $[Co(CN)_6]^{3-}$, a complex ion of cobalt (III) absorbs radiation in violet region of the visible light. Its aqueous solution therefore appears.

1) orange 2) yellow 3) blue 4) pink

Sol.:(2)

Yellow is complementary colour to the violet.

11) The pair in which both species have the same magnetic moment (spin only value) is

1) $[CoCl_4]^{2-}$, $[Fe(H_2O)_6]^{2+}$ 2) $[Cr(H_2O)_6)^{2+}$, $[Fe(H_2O)_6]^{2+}$

3) $[Mn(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{2+}$ 4) $[Cr(H_2O)_6]^{2+}$, $[CoCl_4]^{2-}$

Sol.:(2)

In $[Cr(H_2O)_6]^{2+}$, Cr is in +2 oxidation state with d^4 configuration. In $[Fe(H_2O)_6]^{2+}$, Fe is in +2 oxidation state with d^6 configuration. A H_2O is a weak ligand, no forcible pairing will take place in both the complexes. Hence, the complexes will be outer orbital with 4 unpaired electrons each and the magnetic moment value will also be the same.

12) The ion which is not tetrahedral in shape is

1) BF_4^- 2) $NiCl_4^{2-}$ 3) $[Cu(NH_3)_4]^{2+}$ 4) $\overset{+}{N}H_4$

Sol.:(3)

In $[Cu(NH_3)_4]^{2+}$, Cu^{2+} has dsp^2 hybridization and square planar geometry.

13) Tetrahedral complexes are generally high spin. This is because

1) $\Delta_t > P$ 2) $\Delta_t < P$ 3) $\Delta_t = P$ 4) none of these

Sol.: (2)

In case of tetrahedral complexes, $\Delta_t < P$ and the complexes are mostly high spin.

14) Which complex compound obeys 18 electrons rule?

1) $[Mn(H_2O)_6]^{2+}$ 2) $[V(CO)_5]$ 3) $[Ni(CN)_4]^{2-}$ 4) $[Fe(NH_3)_6]^{2+}$

Sol.: (4)

EAN= Z—X + Y=26—2 + 6x2=36 ≃Kr

Value shell contain 18 electrons to similar to Kr

15) In $[Co(NH_3)_6]Cl_3$, the number of covalent bond is

1) 3 2) 18 3) 9 4) 6

Sol.:(2)

In each NH_3 molecule 3N—H covalent bonds.

∴ $6NH_3$ ligands contain 18 covalent bonds.

16) Ink contains Fe^{3+} ions. The spot of ink is removed by aqueous solution containing oxalate ions. It is due to formation of colourless complex entity, the formula of which is

1) $[Fe(C_2O_4)_3]^{3-}$ 2) $[Fe(C_2O_4)_3]^{4-}$ 3) $[Fe(C_2O_4)_3]^{2-}$ 4) $[Fe(C_2O_4)_6]^{3-}$

Sol.:(1)

The correct formula of complex entity formed between Fe^{3+} and $C_2O_4^{2+}$ ions is $[Fe(C_2O_4)_3]^{3-}$

17) Dimethylglyoxime is used for estimation of

1) cobalt 2) zine 3) nickel 4) manganese

Sol.:(3)

DMG is used to estimate Ni^{2+}

18) A reagent used for identifying nickel ion is

1) Potassium ferrocyanide 2) Neutral ferric chloride

3) Phenolpthalein 4) dimethyl glyoxime

Sol.:(4)

Ni^{2+} form red ppt of complex with dimethyl glyoxime.

19) Which of the following coordination entities should be expected to absorb light of lowest frequency?

1) $[Cr(en)_3]^{3+}$ 2) $[Cr(CN)_6]^{3-}$ 3) $[Cr(NH_3)_6]^{3+}$ 4) $[CrCl_6]^{3-}$

Sol.: (4)

The coordination entity for which crystal field splitting is smaller absorbs light of lowest frequency. Weaker the ligand field strength, smaller will be the crystal field splitting. The order of field strength of various ligands is $CN^- > en > NH_3 > Cl^-$. Hence $[CrCl_6]^{3-}$ due to the presence of weak ligands (Cl^-) absorbs light of lowest frequency.

20) Which of the following is diamagnetic in nature?

1) Co^{3+} octahedral complex with strong field ligands

2) Co^{2+} in tetrahedral complex

3) CO^{3+} octahedral complex with weak field ligands

4) Co^{2+} in square planar complex

Sol.: (1)

Co^{3+}—$[Ar]3d^6$. In the strong field d^2sp^3 hybridisation.

21) Both geometrical and optical isomerisms are exhibited by

1) pentaamminechlorocobalt (III) ion

2) tetraamminedichlorocobalt(III) ion

3) dichlorobis (ethylenediamine) cobalt (III) ion

4) triamminotrichlorocobalt (III) ion

Sol.: (3)

$[CoCl_2(en)_2]^+$ shows geometrical cis-and trans-isomerism. The cis isomer is also optically active.

22) Which of the following complex has σ and π bonds

1) $[Co(CO)_5NH_3]^{2+}$ 2) $[Cr(C_2O_4)_3]^{3-}$ 3) $[Co(en)_3]^{3+}$ 4) $[Sn(CH_3)_4]$

Sol.: (1)

In metal carbonyls metal ion donate electron pair from filled d orbital to vacant orbital of carbonyl ligand to form π bond. Ligand by donating lone pair of electron forms σ bond.

23) Among the following, the species having square planar geometry for central atom are

i) XeF_4 ii) SF_4 iii) $[NiCl_4]^{2-}$ iv) $[PdCl_4]^{2-}$

1) i and ii 2) i and iv 3) i and iii 4) iii and iv

Sol.:(2)

xeF_4 is square planar, and $[PdCl_4]^{2-}$ is also square Planar with dsp^2 hybridization.

24) Which among the following complex entities will have dipole moment=0?

I) $[Ni(CN)_4]^{2-}$ II) Cis-$[Pt(NH_3)_2Cl_2]$ III)trans-$[Pt(NH_3)_2Cl_2]$

1) I 2) I, III 3) III 4) II, III

Sol.:(2)

The structures I and III will have resultant $\mu=0$

25) The co-ordination number of cobalt in $[Co(en)_2Br_2]Cl_2$ is

1) 6 2) 2 3) 4 4) 8

Sol.:(1)

In $[Co(en)_2Br_2]Cl_2$, en is bidentate and Br is monodentate.

Hence C.N of Co=2 x 2 + 2(1) = 6

26) The ligands in anticancer drug cis-platin are

1) NO, Cl^- 2) NH_3, Cl^- 3) Cl^-, H_2O 4) NH_3, H_2O

Sol.:(2)

Cis-platin is $[Pt(NH_3)_2Cl_2]$

27) The total number of ions produced by Tollen's reagent on ionization are

1) 0 2) 1 3) 4 4) 2

Sol.:(4)

$[Ag(NH_3)_2]OH \rightarrow [Ag(NH_3)_2]^+ + OH^-$

28) The complexes , $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4Cl_2$ are

1) Co-ordination isomers 2) Linkage isomers

3) Geometrical isomers 4) Ionisation isomers

Sol.:(4)

These are ionization isomers

29) Which of the following complexes as a pair of enantiomers ?

1) trans-$[Co(en)_2Cl]^+$ 2) $[Cp\{P(C_2H_5)_3\}ClBr]$

3) $[Cr(en)_3]^{3+}$ 4) $[Co(NH_3)_4Cl_2]^+$

Sol.:(3)

Optical isomerism generally occurs in octahedral complexes with coordination number 6. Further, trans form does not show optical isomerism.

30) The hexafluorocobaltate (III) ion is high spin complex. The hybrid state of cobalt is

1) d^2sp^3 2) sp^3d 3) sp^3d^2 4) dsp^2

Sol.:(3)

The formula of the ion is $[CoF_6]^{3-}$. It is octahedral with high spin. This reflects that the hybrid state should be sp^3d.

31) Which of the following complex has same oxidation state of the central metal atom in the cationic and anionic part?

1) $[Pt(NH_3)_4Cl_2][PtCl_4]$ 2) $[Pt(Py)_4]\ [PtCl_4]$

3) $[Pt(NH_3)_4][PtCl_6]$ 4) In all the above

Sol.:(2)

$[Pt(py)_4]^{2+}\ [PtCl_4]^{2-}$. In both the parts the O.N. of Pt is +2.

32) All octahedral complexes of Ni^{2+} are

1) inner orbital 2) outer orbital

3) inner as well as outer orbital depending upon the strength of the ligand field

4) none of the above

Sol.:(2)

In Ni^{2+}, d^8 electronic configuration, only one 3d-orbital is available if all electrons pair up due to strong ligand field. Therefore, d^2sp^3 – hybridization is not possible. Only sp^3d^2 – hybridization is possible which gives outer orbital complexes.

33) Which of the following complex ions is expected to absorb visible light

1) $[Cr(NH_3)_6]^{3+}$ 2) $[Sc(H_2O)_3(NH_3)_3]^{3+}$

3) $[Ti(en)_2(NH_3)_2]^{4+}$ 4) $[Zn(NH_3)_6]^{2+}$

Sol.:(1)

Cr^{3+} in $[Cr(NH_3)_6]^{3+}$ has $3d^3$ configuration and 3-unpaired electrons d-d transition takes place by absorbing visible light.

34) Out of the following metals, which forms polynuclear carbonyl?

1) Mg 2) Mn 3) Na 4) All

Sol.:(2)

$[Mn_2(CO)_{10}]$

35) The oxidation number of cobalt in $K[Co(CN)_4]$ is

1) -1 2) +3 3) +1 4) -3

Sol.: (2)

O.N. of Co in $K[Co(CN)_4]$ is +3

36) The complex which is maximum stable is

1) $[Fe(H_2O)_6]^{3+}$ 2) $[Fe(C_2O_4)_3]^{3-}$ 3) $[Fe(Cl_6]^{3-}$ 4) $[Fe(CN)_6]^{3-}$

Sol.: (2)

$C_2\ O_4^{2-}$ is chelating ligand.

37) Which of the following complex compounds will exhibit highest paramagnetic behaviour?

1) $[Co(NH_3)_6]^{3+}$ 2) $[Ti(NH_3)_6]^{3+}$ 3) $[Cr(NH_3)_6]^{3+}$ 4) $[Zn(NH_3)_6]^{2+}$

Sol.:(3)

$[Ti(NH_3)6]^{3+}$, $Ti^{3+} = 3\ d^1$, 1 unpaired electron

$[Cr(NH_3)_6$, $Cr^{3+} = 3d^3$, 3 unpaired electrons

$[Co(NH_3)_6]^{3+}$, $Co^{3+} = 3d^6$, 0 unpaired electron because of pairing

$[Zn(NH_3)_6]^{2+}$, $Zn^{2+} = 3d^{10}$, no unpaired electron

Hence, $[Cr(NH_3)_6]^{3+}$ exhibits highest paramagnetic behaviour due to the presence of 3 unpaired electrons.

38) In which of the following pairs of species the number of unpaired electrons is same?

1) $[CoF_3]^{3-}$ and $[Fe(CN)_6]^{3-}$ 2) $[Fe(CN)_6]^{3-}$ & $[Fe(CN)_6]^{4-}$

3) $[CoF_6]^{3-}$ and $[FeF_6]^{3-}$ 4) $[Fe(CN)_6]^{4-}$ and $[Ni(CN)_4]^{2-}$

Sol.:(4)

In $[Fe(CN)_6]^{4+}$ d^2sp^3 hybridization is present in Fe^{2+}

In $[Ni(CN)_4]^{2-}$ Ni^{2+} has dsp^2 hybridization. Hence both has no unpaired electrons.

39) Number of unpaired electrons in d^4 low spin octahedral complex are

1) 1 2) 3 3) zero 4) 2

Sol.:(4)

d^4 low spin octahedral complex has $t_{2g}^4\ e_g^0$ configuration and the number of unpaired electrons is 2.

40) Which of the following complex will give white precipitate with barium chloride solution?

1) $[Cr(NH_3)_5SO_4]Cl$ 2) $[Cr(NH_3)_5Cl]SO_4$ 3) $[Co(NH_3)_6]Br_3$ 4) None of these

Sol.:(2)

$[Cr(NH_3)_5\ Cl]SO_4$ ionise as $[Cr(NH_3)_5Cl]^{2+}$ and SO_4^{2-} and its aqueous solution will give test for SO_4^{2-} ions.

41) $[Fe(CN)_6]^{3-}$ ion has magnetic moment of 1.73 B.M. While $[Fe(H_2O)_6]^{3+}$ ha a magnetic moment of 5.92 B.M. Thus, hybridization of Fe in both the complexes are respectively

1) sp^3d^3, sp^3d^2 2) sp^3d^3, d^2sp^3 3) d^2sp^3, $sp^3\ d^2$ 4) d^2sp^3, d^2sp^3

Sol.: (3)

$[Fe(CN)_6]^{3-}$ is an inner orbital complex (d^2sp^3 hybridization) involving spin pairing of d^5 (Fe^{3+}). So only one unpaired electron is there and magnetic moment is 1.73 B.M. $[Fe(H_2O)_6]^{3+}$ is an outer orbital complex (sp^3d^2 hybridization) and there is no spin pairing.

So, there are five unpaired electrons and magnetic moment

$\mu=\sqrt{n(n+2)}=\sqrt{35}=5.92B.M.$

42) In $[Ag(CN)_2]^-$, the number of π-bonds is

1) 2 2) 6 3) 4 4) 3

Sol.:(3)

Each CN^- ion has 2π bonds. ∴4π bonds.

43) How many $EDTA^{4-}$ ligands can surround calcium ion in the complex

1) 3 2) 2 3) 1 4) 8

Sol.:(3)

Coordination number of Ca^{2+} is 6 and $EDTA^{4-}$ is hexadentate ligand.

44) The hypothetical complex chlorodiaaquatriamminecobalt (III) chloride can be represented as

1) $[Co(NH_3)_3(H_2O)_2Cl]Cl_2$ 2) $[Co(NH_3)_3(H_2O)Cl_3]$

3) $[Co(NH_3)_3(H_2O)_3]Cl_3$ 4) $[Co(NH_3)_3(H_2O)_2Cl]$

Sol.: (1)

$[Co(NH_3)_3\ (H_2O)_2\ Cl]Cl_2$

45) EAN of Zn in $[Zn(OH)_4]^{2-}$ complex is

1) 36 2) 26 3) 16 4) 46

Sol.:(1)

EAN=Z—X+Y=30-2+4x2=36

46) When 0.1 mol $CoCl_3(NH_3)_5$ is combined with excess $AgNO_3$, then 0.2 mol AgCl is obtained. The conductivity of the solution suits the

1) 1:2 electrolyte 2) 3:1 electrolyte 3) 1:1 electrolyte 4) 1:3 electrolyte

Sol.:(1)

When 0.1 mol $CoCl_3(NH_3)_5$ is treated with excess of $AgNO_3$, 0.2 mol of AgCl are obtained. When 1 mol $CoCl_3(NH_3)_5$ is treated with excess of $AgNO_3$, 2 mol of AgCl will be obtained. Hence, one molecule of $CoCl_3(NH_3)_5$ dissociates to form two chloride ions. $CoCl_3(NH_3)_5$ can be represented as $[Co(NH_3)_5Cl]Cl_2$.

$[Co(NH_3)_5Cl]Cl_2 \rightarrow [Co(NH_3)_5Cl]_2{+}{+} + 2Cl^-$.

47) The most stable complex among the following is

1) $K_3[Al(C_2O_4)_3]$ 2) $[Ag(NH_3)_2]Cl$ 3) $K_2[Ni(EDTA)]$ 4) $[Pt(en)_2]Cl_2$

Sol.: (3)

In K_2 [Ni(EDTA)], there are five rings in the structure and thus it is the most stable complex.

48) Which of the following coordination entities should be expected to absorb light of lowest frequency?

1) $[CrCl_6]^{3-}$ 2) $[Cr(CN)_6]^{3-}$ 3) $[Cr(NH_3)_6]^{3+}$ 4) $[Cr(en)_3]^{3+}$

Sol.:(1)

CN^- is weakest field ligand.

49) The ion which is not tetrahedral in shape is?

1) $[Cu(NH_3)_4]^{2+}$ 2) BF_4^- 3) NH_4^+ 4) $NiCl_4^{2-}$

Sol.: (1)

$[Cu(NH_3)_4]^{2+}$ is square planar in shape.

50) Which of the following complex will show geometrical as well as optical isomerism ?

1) $[Pt(NH_3)Cl_4]$ 2) $[Pt(NH_3)_2Cl_2]$ 3) $Pt(en)_3]^{4+}$ 4) $[Pt(en)_2Cl_2]$

Sol.:(4)

Heteroleptic complex can form geometrical isomer. Cis isomer is chiral and form optical isomerism.