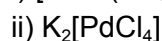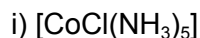# Chemistry Worksheet on Chapter 9 Coordination Compounds with Answers -Set 2

Q-1: What is the solution for washing photographic film? What is the reaction?

Answer: Hypo solution is used for washing photographic film. The following reaction takes place:

$AgBr + 2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2] + NaBr$

Q-2: A) Provide the IUPAC names for the following complexes:

i) $[CoCl(NH_3)_5]$
ii) $K_2[PdCl_4]$

B) The magnetic moment of $[Mn(H_2O)_6](NO_3)_2$ is approximately 6.0 B.M. Find the number of unpaired electrons, show crystal field splitting and calculate the CFSE.

Answer:
A) Rules: In a coordination compound, when naming entities within the coordination sphere, always name the ligands first in alphabetical order, followed by the metal name and its oxidation state in roman numerals in parentheses. If the complex ion is a cation, the metal is designated by the same name as the element. Co in a complex cation is known as cobalt. If the complex ion is an anion, the metal's name ends in ate. Pd in a complex anion is known as a palladate.

i) Pentamminechlorocobalt (I)
ii) Potassium tetrachloropalladate (II)

B) Mn is in the +2 oxidation state with d^5 configuration in the complex $[Mn(H_2O)_6](NO_3)_2$. Because water is a weak field ligand, when electrons are filled in the d-orbital, all five electrons remain unpaired.

CF splitting:

Degenerate 3d orbitals
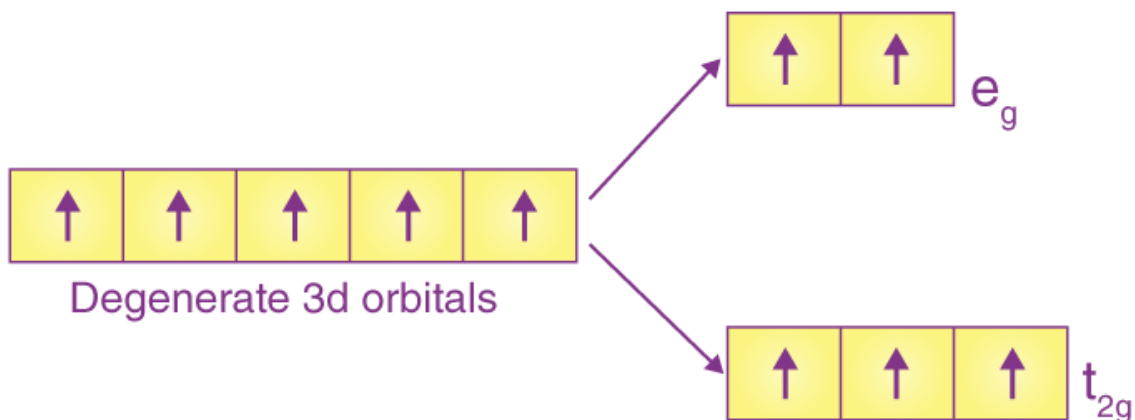
CFSE calculation:

$$CFSE = n_{t_{2g}}\left(\frac{-2}{5}\right)\Delta_o + n_{e_g}\left(\frac{+3}{5}\right)\Delta_o + P$$

$$CFSE = 3\left(\frac{-2}{5}\right)\Delta_o + 2\left(\frac{+3}{5}\right)\Delta_o = 0$$

In the presence of a weak field ligand, HS complexes are formed with zero pairing energy.

Q-3: The complex $[Co(H_2O)_4Cl_2]NO_2$ and $[Co(H_2O)_4Cl(NO_2)]Cl$ are examples of

a) Linkage isomer
b) Positional isomer
c) Ionisation isomer
d) Optical isomer

Answer: c) Ionisation isomer

Explanation: This form of isomerism arises when the counterion(NO_2^-) in a complex salt($[Co(H_2O)_4Cl_2]NO_2$) is itself a potential ligand and can displace a ligand(Cl^-) which can then become the counter ion as in $[Co(H_2O)_4Cl(NO_2)]Cl$.

As a result, they are both ionisation isomers.

Q-4: Give the increasing order of absorption wavelength for the following complex ions.

i) $[Cr(NH_3)_6]^{3+}$ ii) $[CrF_6]^{3-}$ iii) $[Cr(OH_2)_6]^{3+}$ iv) $[Cr(CN)_6]^{3-}$

Answer: iv<i<iii<ii

Explanation: The wavelength decreases as the ligand strength increases. The order of ligand strength in the spectrochemical series is as follows:

$F^-<H_2O<NH_3<CN^-$

As a result, the complex ions' absorption wavelengths are listed in the following order:

$[Cr(CN)_6]^{3-}<[Cr(NH_3)_6]^{3+}< [Cr(OH_2)_6]^{3+}< [CrF_6]^{3-}$

Q-5: If w and z are total number of electrons which are present in non axial and axial set of d-orbital respectively in Ni cation of $[Ni(dmg)_2]$, then calculate value of z^2/w

Answer: The non axial sets of d-orbitals are d_{xy}, d_{yz}, d_{xz} . The axial sets are $d_{x^2-y^2}$ and d_{z^2}.

In the complex, $[Ni(dmg)_2]$ Ni is in +2 oxidation state with d^8 configuration. The electron filling in d-orbitals is shown below:
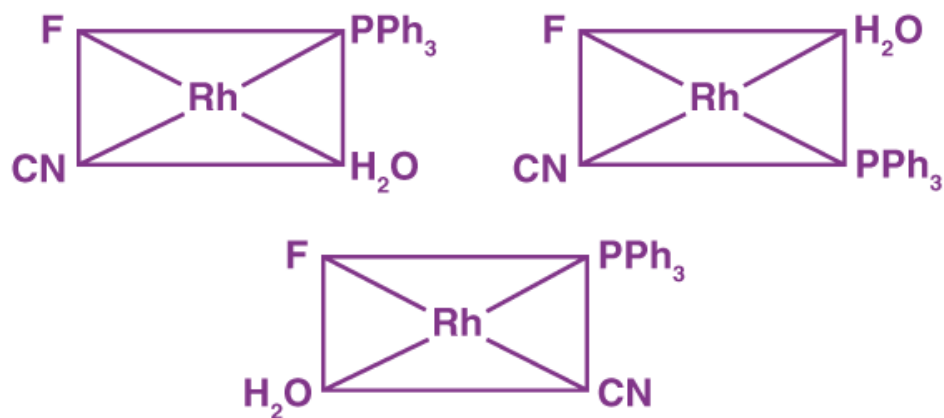
dxy dyz dzx dx²-y² dz²
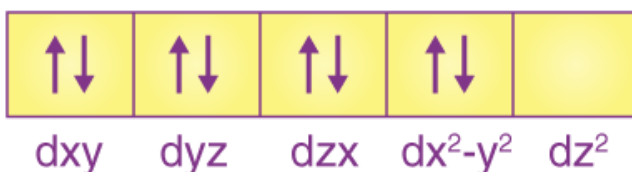
We can clearly see that w = 6 and z = 2.

Thus, $z^2/w = ⅔$

Q-6: Find the total number of geometrical isomers for the complex $[Rh(F)(CN)(PPh_3)(H_2O)]$. Draw their structures. How many of these will exhibit optical isomerism?

Answer: 3
Monodentate ligand in square planar complex do not show optical isomerism
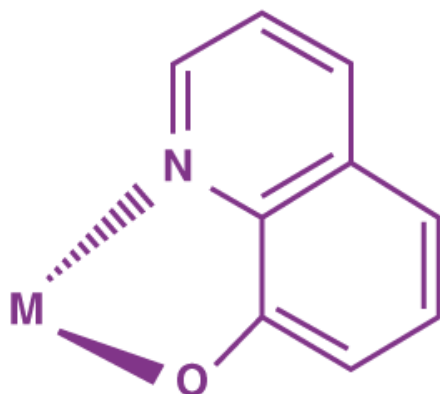
**Q-7:** Which ligand forms O-M-N chelation?

a) Benzyl actanato
b) 8-hydroxy quinoline
c) acac
d) en

Answer: b) 8-hydroxy quinoline

Explanation: The figure illustrates the 8-hydroxy quinoline ligand interaction with metal.

Q-8: For a paramagnetic complex which strictly follows Curie law, the plot of χT versus T (where χ is the molar magnetic susceptibility and T is the temperature) is:

(a) x^T

T

(b) x^T

T

(c) x^T

T

(d) x^T

T
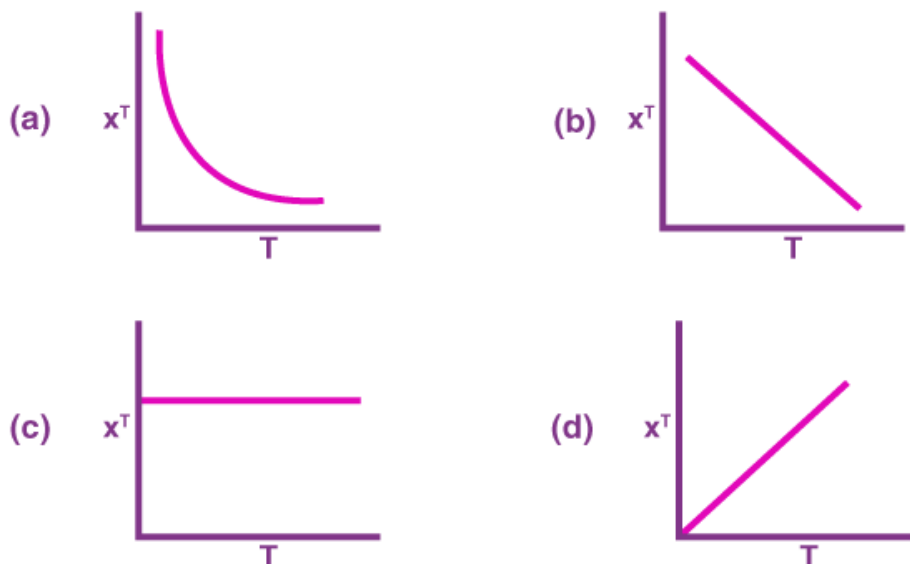
Answer: c)

Explanation:

We know that $\chi = C/T$ where C is the curies constant.
This implies, $\chi T = C$, that means χT is independent of T. As a result, variation will be similar to that shown in plot c).

Q-9: The correct statement for the complexes is

$$[Ru(CN)_6]^{4-}, [Pd(CN)_4]^{2-} \text{ and } [Pd(CO)_4]$$

a) All have the different number of unpaired electrons
b) All are paramagnetic
c) All are diamagnetic
d) All have same hybridisation

Answer: c) All are diamagnetic

Explanation: In the given complexes, metal Ru and Pd are in +2,+2 and 0 oxidation states with d^6, d^8 and d^{10} electronic configuration respectively. CN^- and CO are strong field ligands which will cause pairing of the electrons in the d-orbital leaving no unpaired electrons. Since all electrons are paired, therefore all are diamagnetic complexes.

Q-10: In the complex $[Co(NH_3)_4(en)]SO_4$,

  a) Identify the ligand
  b) Coordination number of metal ion
  c) Oxidation state of the metal ion
  d) Counter ion

Answer:

a) Ligands are always present inside the coordination sphere. Therefore,NH_3 and en are the ligands.
b) Coordination number is equal to the number of atoms the metal is directly bonded to. This makes the coordination number of metal Co equal to 6.
c) +2 (both ammonia and en are neutral ligands)
d) SO_4^{2-}

Q-11: What is the difference between inner and outer orbital complexes?

Answer:

Inner orbital complexes	Outer orbital complexes
When the d-orbital of the inner shell takes part in hybridisation,then inner orbital complexes are formed.	When the d-orbital of outer shells take part in hybridisation, then outer orbital complexes are formed.
Example: $[NiF_6]^{2-}$	Example: $[NiF_6]^{4-}$

Q-12: Which of the following ligands does not behave as ambidentate ligand?

  a) NO_2^-
  b) SCN^-
  c) en
  d) NO_3^-

Answer: d) NO_3^-

 Explanation: Any monodentate ligand that has two different atoms for donating electrons to metal ion is termed as ambidentate ligand.

NO_3^- cannot act as ambidentate as it can only donate from O-atom and not from N-atom

NO_2^- ion can coordinate either through nitrogen or through oxygen to a central metal atom/ion. SCN^- ion can coordinate through the sulphur or nitrogen atom.
en is bidentate ligand.

Q-13: CH_3^- is a

  a) Sigma donor
  b) Sigma donor and pi donor
  c) Pi donor
  d) Sigma donor and pi acceptor

Answer: a) Sigma donor

Explanation: Sigma donor ligands are those which have a second period element with no pi bonds. It should also not have two filled p-orbitals of high energy.

This makes CH_3^- a sigma donor as carbon is from the second period with no pi bond.

Q-14: Match the following items of column I with the appropriate items in Column II

Column I	Column II
P) Cytochrome C	I) Molybdenum
Q) Calmodulin	II) Potassium
R) Chlorophyll	III) Magnesium
S) Alcohol dehydrogenase	IV) Zinc V) Iron VI) Calcium

Answer: P)-V, Q)-VI, R)-III, S)-IV

Q-15: The experimental value of HE for cobalt(II) ion is -800kJ/mol. Theoretical value of HE is -700kJ/mol. What will the CFSE(in cm^{-1})? (approximate value)

Answer: CFSE = Observed HE - Theoretical HE = -800+700= -100kJ/mol = -8370 cm^{-1}

Note : 1kJ/mol = 83.7 cm^{-1}

Q-16: How is the stability of the coordination compound determined in an aqueous solution?

Answer: The stability constant can be used to determine the stability of a coordination compound in an aqueous solution. The higher the stability constant, the more stable the coordination compound.

Q-17: What are t_{2g} and e_g orbitals?

Answer: In a free transition metal ion, the d-orbitals are degenerate. When it forms complexes, the degeneracy is split and yields three orbitals of lower energy, t_{2g} set and two orbitals of higher energy, e_g set.

Q-18: Why do tetrahedral,linear and trigonal planar geometry compounds do not exhibit geometrical isomerism?

Answer: Those geometries which do not have more than one kind of bond angle do not show geometrical isomers. As a result, each of the given geometries has only one type of angle, namely 109.5°, 180° and 120° respectively.

Q-19: How do coordination compounds contribute to water hardness estimation?

Answer: The hardness of water is determined using a simple titration with Na_2EDTA.
With EDTA, the Ca^{2+} and Mg^{2+} ions form stable complexes. The difference in the stability constants of calcium and magnesium complexes allows for the selective estimation of these ions.

Q-20: Many children who worked in the lead industry were rescued by NGO activists.
The children were taken to the hospital and discovered to have excessive lead exposure, also known as lead poisoning. Lead is extremely toxic.

   a) Name the ligand used for the treatment of lead poisoning.
   b) How many such ligands are required for the formation of an octahedral complex with lead?
   c) Draw the structure of an octahedral complex.
   d) During this rescue operation, which values are shown by NGOs activists ?

Answer: a) EDTA

b) One
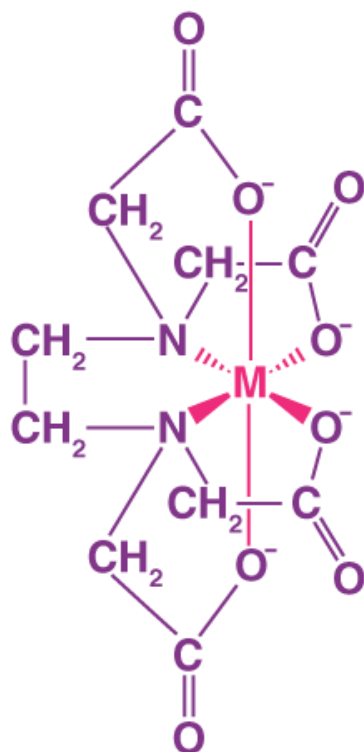
c)
M= Pb

d) NGOs activists being responsible citizens showed their concern towards the children and their health.