
	<b>INDIAN SCHOOL AL WADI AL KABIR</b>	
<b>Class: XII</b>	<b>Department: SCIENCE (CHEMISTRY)</b> <b>2023-2024</b>	<b>Date : 04/11/2023</b>
<b>Worksheet No: 10</b>	<b>Chapter: Coordination Compounds</b>	<b>Note:</b> <b>A4 FILE FORMAT</b>
<b>NAME OF THE STUDENT</b>	<b>CLASS &amp; SEC:</b>	<b>ROLL NO.</b>

### MULTIPLE CHOICE QUESTIONS

- Find the secondary valence of Pd if  $\text{PdCl}_2 \cdot 4\text{NH}_3$  gives 2 moles of AgCl precipitate per mole of the compound with excess  $\text{AgNO}_3$ .
  - 4
  - 2
  - 6
  - 3
- Write the formulae for Tetraammineaquabromidocobalt(III) bromide
  - $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Br}]\text{Br}$
  - $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Br}]\text{Br}_2$
  - $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Br}]\text{Br}_3$
  - $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Br}_2]$
- Which of the following compounds has tetrahedral geometry?
  - $[\text{Ni}(\text{CN})_4]^{2-}$
  - $[\text{Pd}(\text{CN})_4]^{2-}$
  - $[\text{Cr}(\text{NH}_3)_6]^{3+}$
  - $[\text{NiCl}_4]^{2-}$
- Among the following which are ambidentate ligands?
  - $\text{SCN}^-$
  - $\text{NO}_3^-$
  - $\text{NO}_2^-$
  - $\text{C}_2\text{O}_4^{2-}$
  - i and iii
  - i and iv
  - ii and iii
  - ii and iv

5. In spectrochemical series, which of the following ligand has greatest field strength?
- I<sup>-</sup>
  - NH<sub>3</sub>
  - OH<sup>-</sup>
  - CO

6. On the basis of CFT, the electronic configuration for d<sup>6</sup> ion, if  $\Delta_o > P$  is .....
- t<sub>2g</sub><sup>6</sup> e<sub>g</sub><sup>0</sup>
  - t<sub>2g</sub><sup>4</sup> e<sub>g</sub><sup>2</sup>
  - t<sub>2g</sub><sup>5</sup> e<sub>g</sub><sup>1</sup>
  - t<sub>2g</sub><sup>3</sup> e<sub>g</sub><sup>0</sup>

**ASSERTION REASON TYPE**

7. Assertion: [Fe(CN)<sub>6</sub>]<sup>4-</sup> is a heteroleptic complex.

Reason: [Fe(CN)<sub>6</sub>]<sup>4-</sup> is a complex ion in which the metal is bound to only one kind of donor groups.

- Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
- Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
- Assertion is correct, but reason is wrong statement.
- Assertion is wrong, but reason is correct statement.

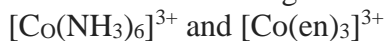
8. Assertion: [Ni(CO)<sub>4</sub>] has tetrahedral geometry.

Reason: IUPAC name of [Ni(CO)<sub>4</sub>] is Tetracarbonylnickel(0)

- Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
- Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
- Assertion is correct, but reason is wrong statement.
- Assertion is wrong, but reason is correct statement.

**VERY SHORT ANSWER TYPE ( 2 M)**

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



- b. The molecular shape of Ni(CO)<sub>4</sub> is not the same as Ni(CN)<sub>4</sub>. Give reason.

10. a. What is crystal field splitting energy?

b. How does the magnitude of  $\Delta_o$  decide the actual configuration of d orbitals in a coordination entity?

11. Using IUPAC nomenclature, write the formula for the following coordination compounds.

- Hexaamminecobalt(III) chloride
- Potassium tetrachloridonickelate(II)

12. A coordination compound with molecular formula  $\text{CrCl}_3 \cdot 4\text{H}_2\text{O}$  precipitates one mole of  $\text{AgCl}$  with  $\text{AgNO}_3$  solution. Its molar conductivity is found to be equivalent to two ions. What is the structural formula and name of the compound?
13. Out of  $[\text{CoF}_6]^{3-}$  and  $[\text{Co}(\text{en})_3]^{3+}$ , which one complex is
- paramagnetic
  - inner orbital complex

### **SHORT ANSWER TYPE (3 M)**

14. Answer the following questions.
- $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$  (aq) is green in colour whereas  $[\text{Ni}(\text{H}_2\text{O})_4(\text{en})]^{2+}$ (aq) is blue in colour ,
  - Write the formula and hybridization of the following compound: tris(ethane-1,2-diamine)cobalt(III) sulphate
15. In a coordination entity, the electronic configuration of the central metal ion is  $t_{2g}^3 e_g^1$
- Is the coordination compound a high spin or low spin complex?
  - Draw the crystal field splitting diagram for the above complex.
16. Write the hybridisation and magnetic character of the following complexes.
- $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
  - $[\text{Fe}(\text{CO})_5]$  (Atomic no. of Fe = 26)
17. Give the formula of each of the following coordination entities:
- $\text{CO}^{3+}$  ion is bound to one  $\text{Cl}^-$ , one  $\text{NH}_3$  molecule and two bidentate ethylene diamine (en) molecules.
  - $\text{Ni}^{2+}$  ion is bound to two water molecules and two oxalate ions. Write the name and magnetic behaviour of each of the above coordination entities. (At. nos. CO = 27, Ni = 28)

### **CASE BASED QUESTIONS(4 M)**

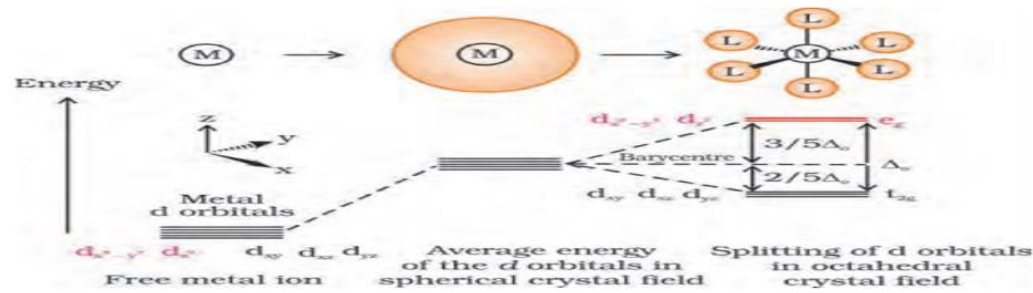
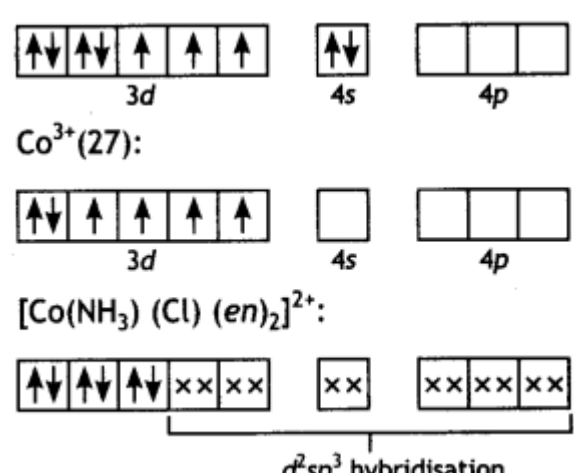
- 18.
- Metal carbonyl is an example of coordination compounds in which carbon monoxide (CO) acts as ligand. These are also called homoleptic carbonyls. These compounds contain both  $\sigma$  and  $\pi$  character. Some carbonyls have metal-metal bonds. The reactivity of metal carbonyls is due to (i) the metal centre and (ii) the CO ligands. CO is capable of accepting an appreciable amount of electron density from the metal atom into their empty  $\pi$  or  $\pi^*$  orbitals. These types of ligands are called  $\pi$ -acceptor or  $\pi$ -acid ligands. These interactions increase the  $\Delta_o$  value.
- What is the oxidation state of metal in  $[\text{Mn}_2(\text{CO})_{10}]$ ?
  - Write the geometry of  $\text{Ni}(\text{CO})_4$
  - CO is a stronger complexing reagent than  $\text{NH}_3$ . Give reason.
  - Explain the term synergic effect with a neat diagram

## LONG ANSWER TYPE (5 M)

19. a. Write the IUPAC name of the ionisation isomer  $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$   
 b. Giving a suitable example, explain the term ambidentate ligand.  
 c. Low spin tetrahedral complexes are not formed. Give reason.  
 d. Give evidence that  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$  and  $[\text{Co}(\text{NH}_3)_5(\text{SO}_4)]\text{Cl}$  are ionisation isomers.

### Answers

Q.No	Answers	Marks
1	a	1
2	b	1
3	d	1
4	a	1
5	d	1
6	a	1
7	d	1
8	b	1
9	a. $[\text{Co}(\text{en})_3]^{3+}$ because bidentate ligand (ethane-1,2-diamine) forms chelate which is more stable.  b. $\text{Ni}(\text{CO})_4 - \text{sp}^3$ , tetrahedral, $\text{Ni}(\text{CN})_4 - \text{dsp}^2$ square planar	1  1
10	a. The splitting of degenerate levels due to the presence of ligands is called crystal field splitting and the energy difference between the two levels $t_{2g}$ and $e_g$ is called crystal field splitting energy $\Delta_o$ .  b. The formation of a complex depends on crystal field splitting $\Delta_o$ and pairing energy P. If $\Delta_o > P$ , strong ligand, the 4 <sup>th</sup> electron enters $t_{2g}$ for pairing, $t_{2g}^4 e_g^0$ low spin complex If $\Delta_o < P$ , weak ligand, the 4 <sup>th</sup> electron enters $t_{2g}$ for pairing, $t_{2g}^4$ , high spin complex.	1  1
11	a. $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ b. $\text{K}_2[\text{NiCl}_4]$	1 1
12	$[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$ : Tetraaquadichloridochromium(III) chloride	2
13	a. $[\text{CoF}_6]^{3-}$ is paramagnetic due to the presence of 4 unpaired electrons. b. $[\text{Co}(\text{en})_3]^{3+}$ forms inner orbital complex involving $d^2sp^3$ hybridisation	1 1
14	a. $\text{H}_2\text{O}$ weak ligand, less splitting, lower energy light (red) absorbed, appears to be in complementary colour. But en is a didentate ligand which causes more splitting and hence comparatively higher energy light is absorbed. b. $[\text{Co}(\text{en})_3]_2(\text{SO}_4)_3 d^2sp^3$	1 2

15	<p>a. high spin complex b. fill the electron in <math>t_{2g}</math> and <math>e_g</math></p>  <p style="text-align: center;"><i>d orbital splitting in an octahedral crystal field</i></p>	1 2
16	<p><math>[\text{Fe}(\text{H}_2\text{O})_6]^{2+}</math> Hybridisation: <math>sp^3d^2</math> Magnetic character: Paramagnetic due to 4 unpaired electrons. <math>\text{Fe}(\text{CO})_5</math> Hybridisation: <math>dsp^3</math> Magnetic character: It is diamagnetic.</p>	1 ½ 1 ½
17	<p>a. <math>[\text{Co}(\text{NH}_3)_4(\text{Cl})(\text{en})_2]^{2+}</math> Amminechloridobis(ethane -1, 2-diamine)cobalt(III) ion</p> <p><math>^{27}\text{Co}</math>:</p>  <p style="text-align: center;"><math>d^2sp^3</math> hybridisation</p> <p>Since there are no unpaired electrons, complex is diamagnetic.</p> <p>b. <math>[\text{Ni}(\text{H}_2\text{O})_2(\text{C}_2\text{O}_4)_2]^{2-}</math> Diaquadioxatatonickelate(II) ion</p> <p><math>^{28}\text{Ni}</math>:</p>	1 ½

	<div style="text-align: center;"> <p><b>Ni<sup>2+</sup> (28):</b></p> <p><b>[Ni(H<sub>2</sub>O)<sub>2</sub> (C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>]<sup>2-</sup>:</b></p> <p><i>sp<sup>3</sup>d<sup>2</sup> Hybridisation</i></p> </div> <p>The complex has two unpaired electrons, therefore, it will be paramagnetic.</p>	
18	<p>a. Zero  b. Tetrahedral, sp<sup>3</sup>  c. Synergic effect explanation</p> <p>The M–C σ bond is formed by the donation of lone pair of electrons on the carbonyl carbon into a vacant orbital of the metal. The M–C π bond is formed by the donation of a pair of electrons from a filled d orbital of metal into the vacant antibonding π* orbital of carbon monoxide. The metal to ligand bonding creates a synergic effect which strengthens the bond between CO and the metal</p> <div style="text-align: center;"> <p>Synergic bonding</p> </div>	1 1 2
19	<p>a. Pentaamminesulphatocobalt(III)chloride  b. Ligand which has two different donor atoms and either of the two ligates in the complex is called ambidentate ligand. Eg-NO<sub>2</sub><sup>-</sup>, SCN<sup>-</sup>  c. The CFSE for tetrahedral complexes is lesser than pairing energy. There are only 4 ligands instead of six (octahedral) ligands. So, the ligand field is only two-third the size of octahedral splitting. Also, the direction of orbital dies not coincide with the direction of ligand in tetrahedral field.  d.</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <math display="block">[\text{Co}(\text{NH}_3)_5 \text{Cl}] \text{SO}_4 + \text{Ba}^{2+} \longrightarrow \text{BaSO}_4 \downarrow</math> <p style="text-align: center;">White precipitate</p> <math display="block">[\text{Co}(\text{NH}_3)_5 \text{Cl}] \text{SO}_4 + \text{Ag}^+ \longrightarrow \text{No reaction}</math> <math display="block">[\text{Co}(\text{NH}_3)_5 \text{SO}_4] \text{Cl} + \text{Ba}^{2+} \longrightarrow \text{No reaction}</math> <math display="block">[\text{Co}(\text{NH}_3)_5 \text{SO}_4] \text{Cl} + \text{Ag}^+ \longrightarrow \text{AgCl} \downarrow</math> <p style="text-align: center;">White precipitate</p> </div>	1 1 1 2