

NEET Important Questions with Solutions from Coordination Compounds

Q.1. Coordination compounds contain ligands attached to the central metal atom/ion through _____ bond.

- A) covalent
- B) ionic
- C) coordinate
- D) metallic

Answer: coordinate

Solution: In co-ordinate compounds, the central metal/ion behave as Lewis acid (lone pair acceptor) due to the presence of vacant orbitals.

The ligand is a Lewis base (lone pair donor) due to the presence of lone pair.

So, between the central atom/ion and ligand, there is a co-ordinate bond formation that takes place.

Q.2. Which of the following is NOT a coordination compound?

- A) Urea
- B) Haemoglobin
- C) Chlorophyll
- D) Cobalt (III) ammines

Answer: Urea

Solution: Urea is a normal covalent molecule formed by the normal covalent bonds.

Urea = NH_2CONH_2 .

Haemoglobin is a complex of Iron (Fe^{2+}), Chlorophyll is a complex of Mg^{2+} .

Q.3. According to Werner's theory, the most metallic elements exhibit _____ types of valence(s).

- A) two
- B) three
- C) five
- D) infinite

Answer: two

Solution: According to Werner's theory, the most metallic elements exhibit two types of valence, primary and secondary.

The primary valence is basically the ionic bond in which the positive charge of the metal is satisfied by anion and it is non-directional.

The secondary valence is due to the presence of vacant orbitals on metal, it is satisfied by ligands which donate lone pair to the central metal ion and form co-ordinate bonds. It is directional in nature.

Q.4. Which of the following is TRUE about secondary valence?

- A) It is denoted by solid lines.



- B) It corresponds to the oxidation state of the central metal
- C) It is non-directional and non-rigid
- D) It can be satisfied by negative ions or neutral molecules or both.

Answer: It can be satisfied by negative ions or neutral molecules or both.

Solution: According to Werner's theory, the secondary valence is due to the presence of vacant orbitals on the central metal ion. It is satisfied by the formation of coordinate bonds by ligands.

Ligands may be negative ions or neutral molecules or both.

Secondary valence is rigid, non-ionizable and directional in nature.

Q.5. In the compound $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$, there are _____.

- A) 3 chloride ions in coordination sphere, 6 ammonia molecules in ionization sphere
- B) 6 ammonia molecules in coordination sphere, 3 chloride ions in ionization sphere
- C) 3 ammonia and 3 chloride in coordination sphere, 3 ammonia in ionization sphere
- D) 6 ammonia molecules and 3 chloride ions in the coordination sphere

Answer: 6 ammonia molecules in coordination sphere, 3 chloride ions in ionization sphere

Solution: For the representation of the coordination sphere, brackets [] are used and the ionization sphere is outside the brackets.

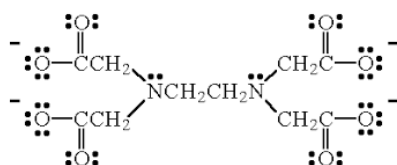
In $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$, there are 6 ammonia molecules in the coordination sphere, 3 chloride ions are in the ionization sphere.

Q.6. EDTA (Ethylenediaminetetraacetate) ion, $[\text{EDTA}]^{4-}$ is an example of _____ ligand.

- A) hexadentate
- B) tetradentate
- C) unidentate
- D) ambidentate

Answer: hexadentate

Solution: EDTA (Ethylenediaminetetraacetate) is a hexadentate ligand. It can donate lone pairs from two nitrogen and four oxygen atoms.



Q.7. Complex compounds with polydentate ligands involving ring structures are known as _____.

- A) metal chelates
- B) aromatic ligands
- C) alicyclic chelates



D) cyclic metals

Answer: metal chelates

Solution: The polydentate ligands can form rings around the central metal/ion in complex compounds. Such complex are also known as metal chelates. Here, the word chelate means ring or loop.

Q.8. The coordination number of $[\text{Co}(\text{en})_3]^{3+}$ is _____.

A) 3

B) 6

C) 4

D) 0

Answer: 6

Solution: In $[\text{Co}(\text{en})_3]^{3+}$, the cobalt atom is surrounded by three ethylenediamine (en) ligands.

Ethylenediamine is a bidentate ligand, so there are six coordinate bonds, hence the coordination number is 6 for the given complex.

Q.9. Factor(s) influencing the coordination number of metal ion is/are _____.

A) charge of metal ion and ligand

B) size of metal ion and ligand

C) inter-ligand repulsions

D) all of these

Answer: all of these

Solution: Coordination number of the central metal/ion depends on the following factors:

- (1) Size of the central metal/ion
- (2) Charge on the central metal/ion
- (3) Charge and size of the ligand
- (4) Inter-ligand repulsions

As the charge to size ratio of the central metal/ion increases its coordination number increases.

As the size of ligand increases, the coordination number decreases.

As the inter-ligand repulsion increases, the coordination number decreases.

Q.10. The IUPAC name for $\text{K}_2[\text{Pt}(\text{Cl})_6]$ is _____.

A) potassium platinumhexachloride

B) potassium hexachloridoplatinum (IV)

C) potassium hexachloridoplatinate (IV)

D) potassium hexachloridoplatinum (II)

Answer: potassium hexachloridoplatinate (IV)



Solution: For the complex $K_2 [Pt (Cl)_6]$, counter ion is K^+ and ligand is Cl^- .

The oxidation number of central metal is

$$x + 6(-1) = -2; x = +4$$

The complex part is anion, so name of central metal will be platinate(IV) and name of ligand is chlorido.

The IUPAC name of complex will be Potassium hexachloridoplatinate (IV).

Q.11. NH_3 group in a coordination compound is named as _____.

- A) ammonium
- B) ammine
- C) amino
- D) ammonia

Answer: ammine

Solution: The IUPAC name of NH_3 is "ammine". It is a neutral monodentate ligand and nitrogen atom is lone pair donor.

Q.12. Geometrical isomerism in coordination compounds is exhibited by _____ complexes.

- A) square planar and tetrahedral
- B) square planar and octahedral
- C) tetrahedral and octahedral
- D) square planar, tetrahedral and octahedral

Answer: square planar and octahedral

Solution: The geometrical isomerism arises when atoms or groups are arranged differently in space due to restricted rotation of a bond or bonds in a molecule.

The geometric isomerism is shown by square planar complex and octahedral complex only.

Q.13. The complex ions $[Co (NH_3)_5 (NO_2)]^{2+}$ and $[Co (NH_3)_5 (ONO)]^{2+}$ are called _____ isomers.

- A) ionization
- B) linkage
- C) coordination
- D) hydrate

Answer: linkage

Solution: Linkage isomerism is given by coordination compounds that have the same composition but differing with the connectivity of the metal to a ligand. Only ambidentate ligands give rise to linkage isomers.

$[Co (NH_3)_5 (NO_2)]^{2+}$ and $[Co (NH_3)_5 (ONO)]^{2+}$ are linkage isomers since NO_2^- is ambidentate ligand.

Q.14. Which of the following is incorrect according to the valence bond theory (VBT)?

- A) The bond formed between the metal atom/ion is purely ionic.
- B) The number of vacant orbitals provided by the central metal atom/ion is the same as its coordination number.



- C) Each ligand has at least one orbital containing a lone pair of electrons.
- D) The geometry of the complex depends on the hybridisation of the central metal atom/ion.

Answer: The bond formed between the metal atom/ion is purely ionic.

Solution: The main points for the valence bond theory (VBT) are:

- (1) Each ligand has at least one orbital containing a lone pair of electrons.
- (2) The number of vacant orbitals provided by the central metal atom/ion is the same as its coordination number.
- (3) The geometry of the complex depends on the hybridisation of the central metal atom/ion.
- (4) The bond formed between metal atom/ion and ligand is purely coordinate.

Q.15. The inner complexes are formed when _____ orbitals are used for hybridization.

- A) nd
- B) $(n - 1)d$
- C) $(n + 1)d$
- D) $(n - 2)d$

Answer: $(n - 1)d$

Solution: The complex can be classified as an inner complex and an outer complex based on the use of the d orbitals. If the nd orbital is used, it is called an outer complex, where, n = principal quantum number. If the $(n - 1)d$ orbital is used, the complex is called an inner complex.

Q.16. The energy difference between the t_{2g} & e_g levels in an octahedral crystal field is _____.

- A) $4Dq$
- B) $6Dq$
- C) $8Dq$
- D) $10Dq$

Answer: $10Dq$

Solution: The crystal field theory assumes that the interaction between the metal ion and ligand is purely electrostatic. In the presence of ligands, the degeneracy of d -orbitals is disturbed, and they split into t_{2g} & e_g levels. The difference of the energy between t_{2g} & e_g is known as the crystal field splitting energy, and it is $\Delta_o = 10 Dq$ in the case of the octahedral ligand field.

Q.17. Considering H_2O as a weak field ligand, the number of unpaired electrons in $[Mn(H_2O)_6]^{2+}$ will be _____.

(At. no. of $Mn = 25$)

- A) two
- B) four
- C) three



D) five

Answer: five

Solution: In $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$, the ligand is H_2O , which is a weak field as well as neutral, so, the central atom will be Mn^{2+} . The configuration of the central metal ion is $3d^5$.

The crystal field configuration of the complex will be $t_{2g}^{1,1,1} e_g^{1,1}$. So, there will be five unpaired electrons in this octahedral complex.

Q.18. Two $\text{Mn}(\text{CO})_5$ units are joined by the _____ bond to form decacarbonyl dimanganese (0).

A) $\text{Mn} - \text{CO}$

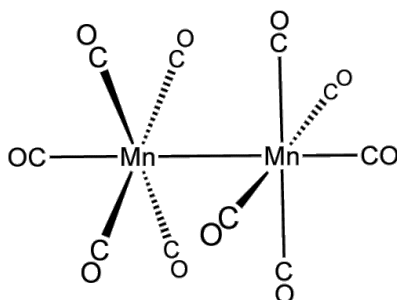
B) $\text{CO} - \text{CO}$

C) Hydrogen

D) $\text{Mn} - \text{Mn}$

Answer: $\text{Mn} - \text{Mn}$

Solution: In the decacarbonyl dimanganese (0), the two units of $\text{Mn}(\text{CO})_5$ are joined by the $\text{Mn} - \text{Mn}$ bond. Since, $\text{Mn}(\text{CO})_5$ contains one unpaired electron.



Q.19. In a metal carbonyl, there is _____.

A) no π bond between the CO and metal atom

B) Only σ bond between the metal atom and CO molecules

C) one σ and one π bond (back-donation) between the metal atom and CO molecules

D) the metal-carbon bonds does not exist at all

Answer: one σ and one π bond (back-donation) between the metal atom and CO molecules

Solution: The CO ligand is a σ donor and π acceptor. When a metal carbonyl is formed, the vacant orbitals of the metal accept lone pairs from CO, and forms a σ bond and donates its lone pair to CO and forms a π bond. It is also called synergic bonding.

So, there is one σ and one π bond (back-donation) between the metal atom and CO molecules.

Q.20. The stability of the coordination compound depends on _____.

A) nature of the ligand

B) charge of the central metal ion



- C) radius of the central metal ion
D) all of these

Answer: all of these

Solution: The stability of a complex depends on the following factors:

- (1) The size of the metal ion decreases, the stability of the complex increases.
- (2) The charge on the metal ion increases, its size decreases, and the stability increases with the decrease in the atomic radii of the metal ion.
- (3) The strength of a ligand field increases, the stability of the complex increases.
- (4) As the splitting energy of ligand field increases, the stability of the complex increases.
- (5) As the denticity of a ligand increases, the stability of the complex increases.

Q.21. Chlorophyll is a complex of _____.

- A) Mg
B) Mn
C) Co
D) Fe

Answer: Mg

Solution: Chlorophyll is the molecule that absorbs sunlight and uses its energy to synthesise carbohydrates from CO_2 and water. This process is known as photosynthesis and is the basis for sustaining the life processes of all plants.

Chlorophyll is a complex of Mg and has the formula $\text{C}_{55}\text{H}_{72}\text{O}_5\text{N}_4\text{Mg}$.

Q.22. Vitamin B_{12} is a complex of _____.

- A) Mg
B) Co
C) Fe
D) Mn

Answer: Co

Solution: Vitamin B_{12} , also known as cobalamin, is a water-soluble vitamin involved in the metabolism of every cell of the human body. It is one of eight types of B vitamins.

It is a complex of cobalt having the formula $\text{C}_{63}\text{H}_{88}\text{CoN}_{14}\text{O}_{14}\text{P}$.

Q.23. Which of the following statements is NOT TRUE about crystal field theory (CFT)?

- A) It does not explain the π -bonding in complexes.
B) It explains the kinetic and thermodynamic properties of some complexes.
C) It explains the colours exhibited by complexes due to the d – d transitions.
D) It explains only about the central metal ion with s and p-orbitals.



Answer: It explains only about the central metal ion with s and p-orbitals.

Solution: Crystal field theory is based on the electrostatic interaction of d-orbitals of metal and the ligand field. In the presence of such a ligand, filled and degenerated d-orbitals split into t_{2g} and e_g .

It explains the colours exhibited by complexes due to the d – d transition.

It explains the kinetic and thermodynamic stabilities of complexes.

It cannot explain the π -bonding in the complex.

So, it can explain only about the central metal ion with d-orbitals.

Q.24. Which of the following ligands is NOT a chelating agent?

- A) EDTA
- B) en
- C) Oxalate
- D) Pyridine

Answer: Pyridine

Solution: Chelating ligand is a ligand that is attached to a central metal ion by bonds from two or more donor atoms. So, ligand should have atleast 2 donor sites and the chelate formed should be a 5 or 6 member ring. Pyridine is a monodentate ligand, cannot be chelating.

Q.25. Which of the following complexes formed by Cu^{2+} ions is most stable?

- A) $\text{Cu}^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+}$, $\log K = 11.6$
- B) $\text{Cu}^{2+} + 4\text{CN}^- \rightleftharpoons [\text{Cu}(\text{CN})_4]^{2-}$, $\log K = 27.3$
- C) $\text{Cu}^{2+} + 2\text{en} \rightleftharpoons [\text{Cu}(\text{en})_2]^{2+}$, $\log K = 15.4$
- D) $\text{Cu}^{2+} + 4\text{H}_2\text{O} \rightleftharpoons [\text{Cu}(\text{H}_2\text{O})_4]^{2+}$, $\log K = 8.9$

Answer: $\text{Cu}^{2+} + 4\text{CN}^- \rightleftharpoons [\text{Cu}(\text{CN})_4]^{2-}$, $\log K = 27.3$

Solution: The stability of complexes is represented by the magnitude of its Stability constant (K). A higher value of stability constant of certain complex denotes its greater stability. Mathematically, the same holds good for log K values.

Among the given log K values of different complexes, it is noted that the log k value for complex at (II) is maximum (27.3). The equilibrium is favoured more towards the side of the formation of complex, which is possible only if it is very stable.

Hence, it is most stable.

Practice more on Coordination Compounds