

What are Coordination Compounds?

Worksheet

A coordination compound is formed when ligands (Lewis bases) bond to a central metal ion (Lewis acid) through coordinate covalent bonds. Ligands donate electron pairs to the metal, forming complex ions like $[\text{Fe}(\text{CN})_6]^{4-}$ or $[\text{Cu}(\text{NH}_3)_4]^{2+}$.

Questions

1. In the complex $[\text{Cu}(\text{NH}_3)_4]^{2+}$, what is the coordination number?
A) 2
B) 4
C) 8
D) 6
2. Which of the following is a bidentate ligand?
A) Cl^-
B) NH_3
C) H_2O
D) ethylenediamine (en)
3. Calculate the charge on the complex $[\text{Fe}(\text{CN})_6]$ if the central Fe is Fe^{2+} .
A) $2+$
B) $4-$
C) $6-$
D) $8-$
4. What geometry is typical for coordination number 4?
A) Octahedral
B) Tetrahedral or square planar
C) Linear
D) Trigonal
5. Determine the coordination number and identify the ligands in $[\text{Ni}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$.
6. Write the formula for a complex formed by Fe^{3+} ion with 6 cyanide ligands.
7. Is $[\text{CuCl}_4]^{2-}$ octahedral or tetrahedral?
8. Define: What is a ligand?
9. Define: What is a coordination number?
10. Define: What are common ligands?

Answer Key

1. B) 4 — Four ammonia ligands are bonded to Cu, so CN = 4.
2. D) ethylenediamine (en) — Ethylenediamine (en) has two donor atoms, making it bidentate.
3. B) 4- — Charge = $2+ (\text{Fe}^{2+}) - 6(1-) (\text{CN}^-) = 2- - 6- = 4-$. Formula: $[\text{Fe}(\text{CN})_6]^{4-}$.
4. B) Tetrahedral or square planar — CN = 4 usually gives tetrahedral or square planar geometry.
5. Count the number of ligands bonded to the central metal (Ni). Ligands: 4 NH_3 molecules + 2 H_2O molecules = 6 total. Coordination number (CN) = 6. Ligands are: ammonia (NH_3) and water (H_2O).
6. Central metal: Fe^{3+} Ligand: CN^- (cyanide, charge -1) Number of ligands: 6 Formula: $[\text{Fe}(\text{CN})_6]^{n+}$ Charge on complex: $3+ - 6(1-) = 3-$ charge. Complete formula: $[\text{Fe}(\text{CN})_6]^{3-}$
7. Count the coordination number. Cl^- ligands: 4 Coordination number = 4. With CN = 4, the geometry is tetrahedral. $[\text{CuCl}_4]^{2-}$ is tetrahedral, not octahedral.
8. A molecule or anion that donates an electron pair to a central metal ion, forming a coordinate covalent bond.
9. The number of ligands bonded to the central metal atom or ion.
10. Water (H_2O), ammonia (NH_3), cyanide (CN^-), chloride (Cl^-), carbon monoxide (CO), and other polar molecules or anions.

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