

Solutions

Each answer shows the steps, then the **result**.

2.1

- a species with a lone pair of electrons that forms a dative (coordinate) bond to a central metal ion

2.2

- coordination number 6; octahedral

2.3

- A ligand is a molecule or ion that donates a lone pair of electrons to a metal ion; the bond formed is a dative, or coordinate, bond

2.4

- Three bidentate ligands form six dative bonds, so the coordination number is 6; the shape is octahedral

2.5

- $+3 + 6(-1) = -3$; the complex is $[\text{Fe}(\text{CN})_6]^{3-}$

3.1 C

- 1,2-diaminoethane (en) forms two dative bonds — bidentate

3.2 B

- $x + 4(-1) = -2 \Rightarrow x = +2$

3.3

(a)

- $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$; deep blue

(b)

- one ligand is replaced by another ligand around the central metal ion, often with a colour change

3.4

- coordination number 4; tetrahedral

3.5

(a)

- A ligand is a molecule or ion that donates a lone pair of electrons to a metal ion, forming a dative bond; it must have a lone pair because the metal ion supplies no electrons to the bond — both electrons come from the ligand

(b)

- $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$: 6, octahedral, 2+. $[\text{CoCl}_4]^{2-}$: 4, tetrahedral, 2-. $[\text{Co}(\text{en})_3]^{3+}$: 6, octahedral, 3+

(c)

- Ligand exchange has occurred: chloride ions have replaced the water ligands; the coordination number falls from 6 to 4 because chloride is a larger ligand and fewer fit around the ion; the shape changes from octahedral to tetrahedral, which is what changes the colour from pink to blue

(d)

- 1,2-diaminoethane has two nitrogen atoms, each with a lone pair, so one molecule forms two dative bonds to the same metal ion; ammonia has only one nitrogen with one lone pair, so it forms one bond