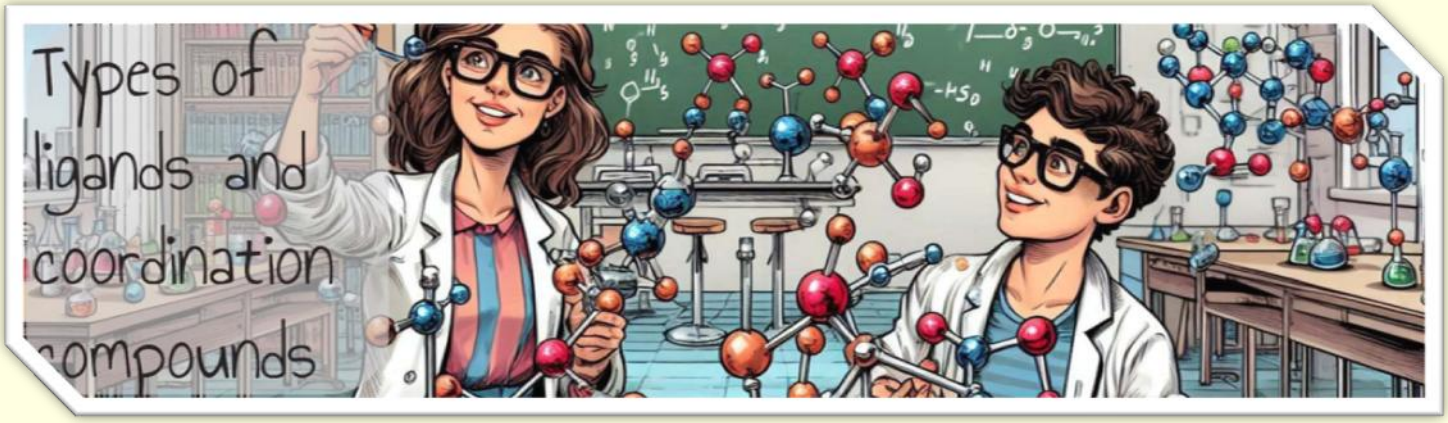


Answer all the questions below as fully as you can then check your answers

1. Define the term ligand and explain the difference between a monodentate ligand and a bidentate ligand.

2. Give two examples of monodentate ligands and two examples of bidentate ligands.

3. Explain why ethylenediamine can act as a bidentate ligand.

4. What is the chelating effect, and why do complexes with chelating ligands tend to be more stable?

5. Describe the role of EDTA as a chelating agent in preventing boiler scale formation.

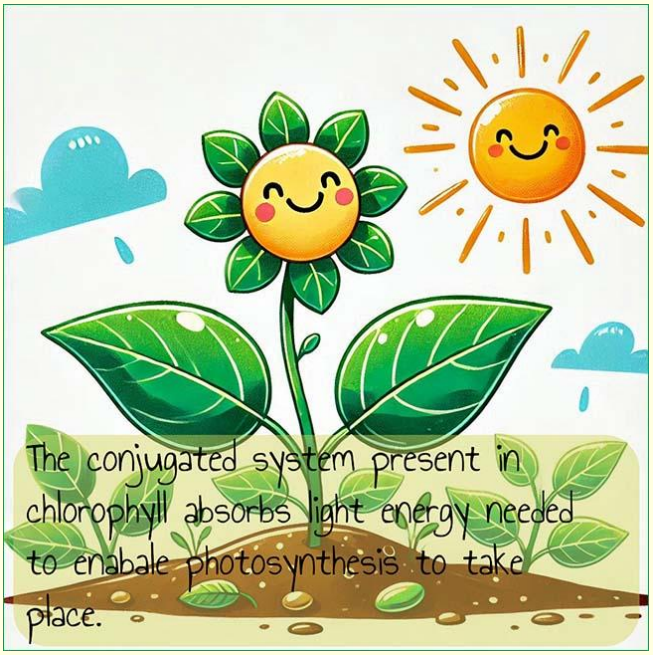
6. In haemoglobin, what is the role of the heme molecule, and how does oxygen bind to it?

7. Why is carbon monoxide (CO) poisoning dangerous in terms of its interaction with haemoglobin?

8. List two uses of EDTA and explain how its chelating properties are beneficial in each application.

9. Explain how the structure of chlorophyll allows it to absorb light for photosynthesis.

10. Compare the coordination environment of Fe^{2+} in oxyhaemoglobin and carboxyhaemoglobin.



11. Explain why EDTA can form six coordinate bonds, but ethylenediamine forms only two.

Answers

1. Define the term ligand and explain the difference between a monodentate ligand and a bidentate ligand.

Answer: A ligand is a Lewis base that donates a lone pair of electrons to form a coordinate bond with a metal atom or ion. A monodentate ligand forms only one coordinate bond, while a bidentate ligand forms two coordinate bonds with the metal ion.

2. Give two examples of monodentate ligands and two examples of bidentate ligands.

Answer:

Monodentate ligands could include: Water (H_2O), Ammonia (NH_3), Chloride (Cl^-), cyanide (CN^-)

Bidentate ligands could include: Ethylenediamine (en), Oxalate ion ($C_2O_4^{2-}$), Bipy

3. Explain why ethylenediamine can act as a bidentate ligand.

Answer: Ethylenediamine has two nitrogen atoms, each with a lone pair of electrons, allowing it to form two coordinate bonds with a metal ion.

4. What is the chelating effect, and why do complexes with chelating ligands tend to be more stable?

Answer: The chelating effect refers to the increased stability of complexes formed with polydentate ligands. This stability arises because multiple coordinate bonds reduce the likelihood of ligand displacement, and the entropy increase upon complex formation makes the reaction more favourable.

5. Describe the role of EDTA as a chelating agent in preventing boiler scale formation.

Answer: EDTA binds to metal ions in water, forming stable complexes that prevent the metal ions from reacting with other substances to form insoluble deposits (scale).

6. In haemoglobin, what is the role of the heme molecule, and how does oxygen bind to it?

Answer: The heme molecule contains a porphyrin ring that acts as a tetradentate ligand, binding to an Fe^{2+} ion. Oxygen acts as a monodentate ligand, forming a temporary and reversible coordinate bond with the Fe^{2+} ion.

7. Why is carbon monoxide (CO) poisoning dangerous in terms of its interaction with haemoglobin?

Answer: Carbon monoxide forms a much stronger bond with the Fe^{2+} ion in haemoglobin than oxygen does, creating carboxyhaemoglobin. This prevents oxygen from binding and being transported to body tissues, leading to oxygen deprivation.

8. List two uses of EDTA and explain how its chelating properties are beneficial in each application.

Answer:

Medical use: EDTA removes toxic heavy metals like lead from the body by forming stable, water-soluble complexes that can be excreted.

Food preservation: EDTA binds to metal ions that catalyze oxidation, preventing spoilage and extending shelf life.

9. Explain how the structure of chlorophyll allows it to absorb light for photosynthesis.

Answer: The conjugated ring system in the porphyrin ring allows chlorophyll to absorb light energy, as alternating single and double bonds enable electronic transitions in the visible spectrum.

10. Compare the coordination environment of Fe^{2+} in oxyhaemoglobin and carboxyhaemoglobin.

Answer: In oxyhaemoglobin, the Fe^{2+} ion is coordinated by four nitrogen atoms from the porphyrin ring, one histidine residue, and one oxygen molecule. In carboxyhaemoglobin, the oxygen molecule is replaced by carbon monoxide, which forms a much stronger bond with Fe^{2+}.

11. Explain why EDTA can form six coordinate bonds, but ethylenediamine forms only two.

Answer: EDTA has six lone pairs of electrons available for bonding: four from oxygen atoms and two from nitrogen atoms. Ethylenediamine has only two nitrogen atoms, each providing one lone pair for bonding.