Marks
8

- Transition metals are often found in coordination complexes such as $[NiCl_4]^{2-}$. What is a complex?

How does the bonding in the complex $[NiCl_4]^{2-}$ differ from the bonding in CCl_4?

What is a chelate complex?

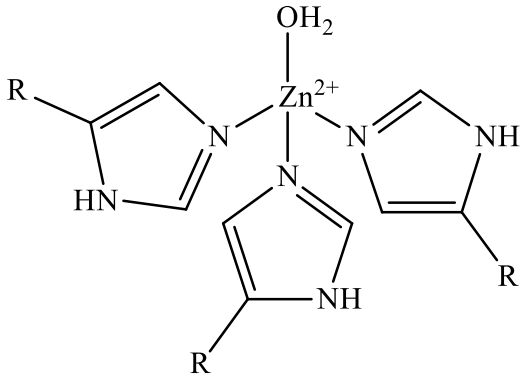
Why is a chelate complex generally more stable than a comparable complex without chelate ligands?

	Marks
• An aqueous solution of iron(III) nitrate is pale yellow/brown. Upon addition of three mole equivalents of potassium thiocyanate (KSCN) a bright red colour develops. Draw the metal complex responsible for the red colour, including any stereoisomers.	**2**

	Marks
• Compounds of *d*-block elements are frequently paramagnetic. Using the box notation to represent atomic orbitals, account for this property in compounds of Co^{2+}.	**2**

Marks
5

- The structure below represents the active site in carbonic anhydrase, which features a Zn^{2+} ion bonded to three histidine residues and a water molecule.



The pK_a of uncoordinated water is 15.7 but the pK_a of the water in carbonic anhydrase is around 7. Suggest an explanation for this large change.

When studying zinc-containing metalloenzymes such as this, chemists often replace Zn^{2+} with Co^{2+} because of their different magnetic properties. Predict which of these species, if either, is attracted by a magnetic field. Explain your reasoning.

- Dissolution of iron(II) chloride in water leads to formation of $Fe^{2+}(aq)$ and $Cl^{-}(aq)$ ions. Draw a picture of the complex ion present, clearly showing the stereochemistry and which atoms are bonded to the Fe(II) ion.

This complex is paramagnetic. Using the box notation to represent atomic orbitals, account for this property.

Solutions containing the $Fe^{2+}(aq)$ ion are acidic. Account for this property and write the chemical equation for the reaction that leads to this acidity.

- Compounds of *d*-block elements are frequently paramagnetic. Using the box notation to represent atomic orbitals, account for this property in compounds of Ni^{2+}. **2**

- Complete the following table. **6**

Formula	Oxidation state of transition metal	Coordination number of transition metal	Number of *d*-electrons in the complex ion	Species formed upon dissolving in water
$K_3[Mn(CN)_6]$				
$[Ru(NH_3)_5(OH_2)](NO_3)_2$				
$[Cr(en)_3]Cl_3$				

en = ethylenediamine = $NH_2CH_2CH_2NH_2$

Marks 6

- Complete the following table.

Formula	Oxidation state of transition metal	Coordination number of transition metal	Number of *d*-electrons in transition metal	Species formed upon dissolving in water
$Na_2[Ni(CN)_4]$				
$[Cr(NH_3)_5Cl]Cl_2$				
$[Cu(en)_3]Br_2$				

en = ethylenediamine = $NH_2CH_2CH_2NH_2$

Marks 3

- Consider the compound with formula $[Ni(en)_2(H_2O)_2]Br_2 \cdot 2H_2O$.
  (en = ethylenediamine = $NH_2CH_2CH_2NH_2$).

  Write the formula of the complex ion.

  Write the symbols of the ligand donor atoms.

  What is the *d* electron configuration of the metal ion in this complex?

Marks

- Explain in terms of their electronic configurations and trends in ionisation energies across a period why the alkali metals (Group 1) are powerful *reducing* agents. **2**

- Compounds of *d*-block elements are frequently paramagnetic. Using the box notation to represent atomic orbitals, account for this property in compounds of Cu^{2+}. **2**

- Complete the following table. **6**

Formula	Oxidation state of transition metal	Coordination number of transition metal	Number of *d*-electrons in metal in complex ion	Species formed upon dissolving in water
$K_2[Ni(CN)_4]$				
$[Cr(NH_3)_5Cl]Cl_2$				
$[Co(en)_3]Br_3$				

en = ethylenediamine = $NH_2CH_2CH_2NH_2$