4 Transition elements form complex ions with a range of colours and shapes.

4 (a) By considering its electron arrangement, state how an element can be classified as a transition element.

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(1 mark)

4 (b) Explain the meaning of the term *complex ion*.

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(2 marks)

4 (c) In terms of electrons, explain why an aqueous solution of cobalt(II) sulfate has a red colour.

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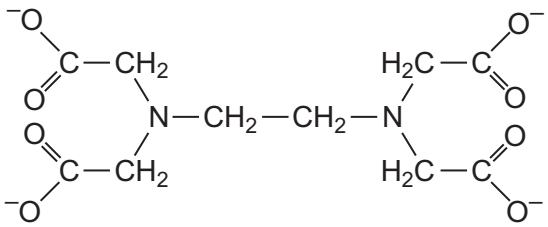
(3 marks)

4 (d) The ligand $EDTA^{4-}$ is shown below.



4 (d) (i) Draw circles around the atoms of **two** different elements that link to a transition metal ion by a co-ordinate bond when $EDTA^{4-}$ behaves as a ligand.

(2 marks)

4 (d) (ii) Write an equation for the reaction between $EDTA^{4-}$ and a $[Co(H_2O)_6]^{2+}$ ion. Use the abbreviation $EDTA^{4-}$ in your equation.

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(1 mark)

4 (d) (iii) Explain why the complex ion, formed as a product of the reaction in part **(d) (ii)**, is more stable than the $[Co(H_2O)_6]^{2+}$ ion.

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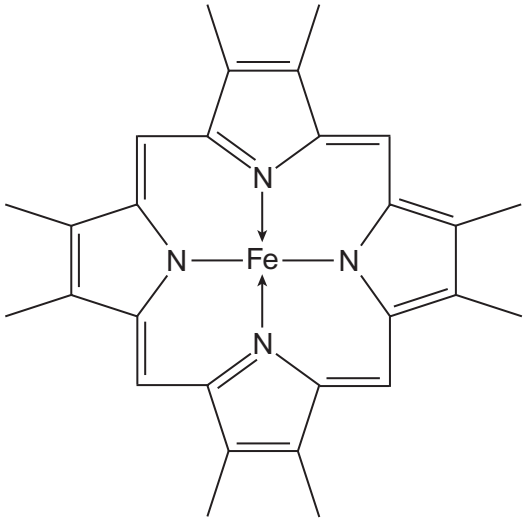
(2 marks)

4 (e) The diagram below shows part of the structure of haemoglobin.



Haemoglobin contains an iron(II) ion bonded to five nitrogen atoms and one other ligand. The fifth nitrogen atom and the additional ligand are not shown in this diagram.

4 (e) (i) In this diagram, bonds between nitrogen and iron are shown as N→Fe and as N—Fe. State the meaning of each of these symbols.

Meaning of → .....

Meaning of — .....

(2 marks)

4 (e) (ii) State the function of haemoglobin in the blood.

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(1 mark)

4 (e) (iii) With reference to haemoglobin, explain why carbon monoxide is toxic.

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(2 marks)

16