Shapes of Complex Ions

Question Paper 2

Level	A Level
Subject	Chemistry
Exam Board	AQA
Module	3.2 Inorganic Chemistry
Topic	3.2.5 Transition Metals (A-Level Only)
Sub-Topic	3.2.5.3 Shapes of Complex Ions
Booklet	Question Paper 2

Time Allowed: **40 minutes**

Score: **/39**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

Q1.(a) Some metal ions are toxic to humans. A substance that can be used to treat such poisoning contains the ion $EDTA^{4-}$.
$EDTA^{4-}$ forms very stable complexes with metal ions. These complexes are **not** toxic.

(i) Write an equation for the reaction of $EDTA^{4-}$ with aqueous copper(II) ions, $[Cu(H_2O)_6]^{2+}$.

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(1)

(ii) A solution containing $EDTA^{4-}$ can also be used in a titration to determine the concentration of metal ions in solution.
A river was polluted with copper(II) ions. When a 25.0 cm^3 sample of the river water was titrated with a 0.0150 mol dm^{-3} solution of $EDTA^{4-}$, 6.45 cm^3 were required for complete reaction.
Calculate the concentration, in mol dm^{-3}, of copper(II) ions in the river water.
Show your working.

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(2)

(b) The determination of the concentration of copper(II) ions in a single sample of river water gives an unreliable value for the copper(II) ion pollution in the river.
Give one reason why this value is unreliable.

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(1)

(c) Silver complexes can be used to identify a particular organic functional group.
Give **one** example of a silver complex that can be used in this way and state the organic functional group it identifies.

Silver complex .....

Organic functional group .....

(2)
(Total 6 marks)

Q2. Transition elements form complex ions with a range of colours and shapes.

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

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(1)

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

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(2)

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

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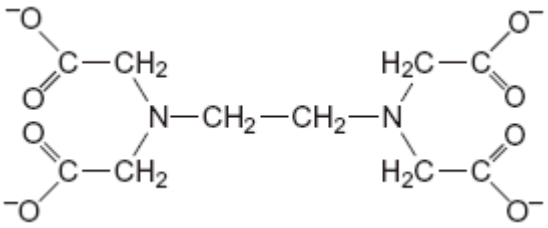
(3)

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



(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)

(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)

(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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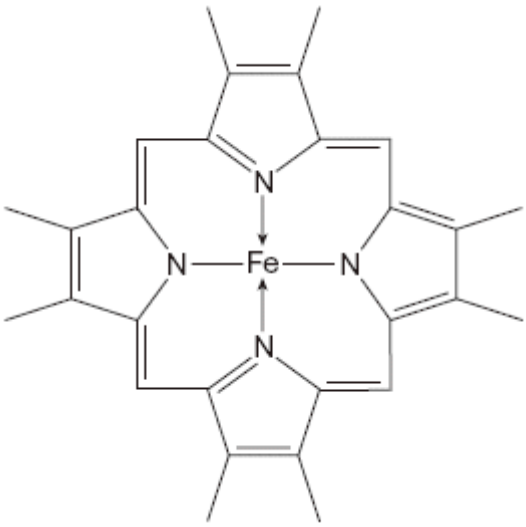
(2)

(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.

(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)

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

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(1)

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

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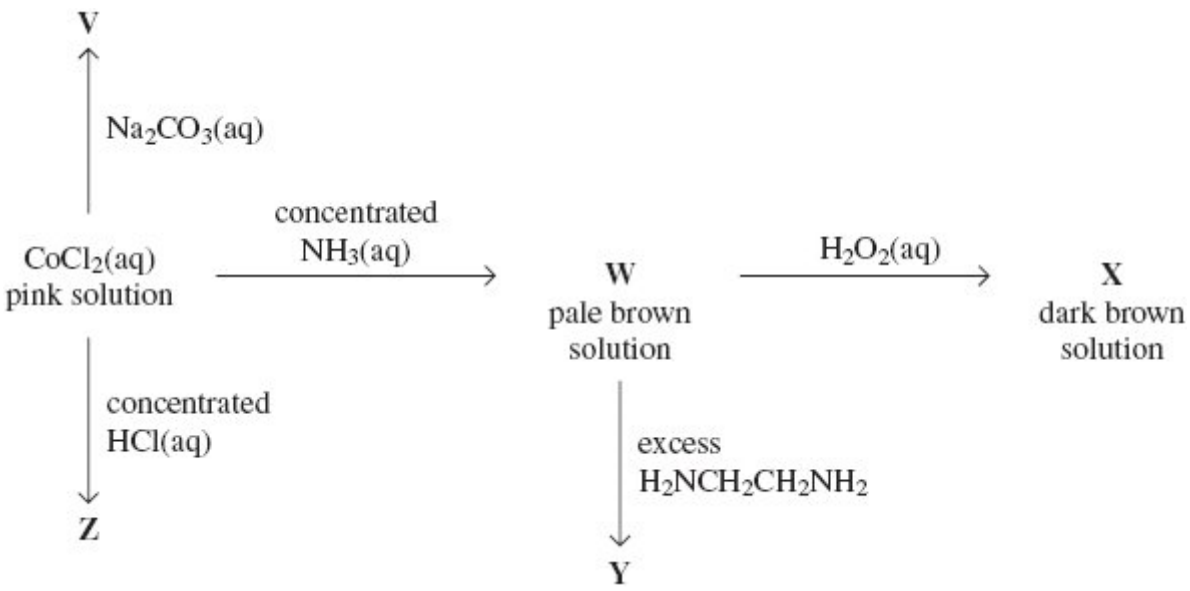
(2)
(Total 16 marks)

Q3. Transition metals form complex ions. Using actual examples of complex ions formed by transition metal ions, give the formula of

- a linear complex ion,
- a tetrahedral complex ion and
- an octahedral complex ion formed by using a bidentate ligand.

(Total 4 marks)

Q4. This question is about some reactions of cobalt compounds.



(a) Give the formula of the complex responsible for the pink colour in aqueous $CoCl_2$ and name its shape.

Formula .....

Name of shape .....

(2)

(b) Give the formula of the cobalt-containing compound **V** and describe its appearance.

Formula .....

Appearance .....

(2)

(c) Write an equation for the reaction that occurs when the pink solution is converted into **W**.

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(2)

(d) Give the formula of the cobalt-containing complex in **X** and state the role of the H_2O_2 in this reaction.

Formula .....

Role of H_2O_2 .....

(2)

(e) Give the formula of the cobalt-containing complex in **Y** and explain why this complex is more stable than the cobalt-containing complex in **W**.

Formula .....

Explanation .....

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(3)

(f) Identify the cobalt-containing complex in solution **Z** and explain why its co-ordination number is different from that in the pink solution of $CoCl_2$

Complex .....

Explanation .....

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(2)
(Total 13 marks)