

**Q1.** This question is about copper chemistry.

(a) Aqueous copper(II) ions  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}(\text{aq})$  are blue.

(i) With reference to electrons, explain why aqueous copper(II) ions are blue.

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**(3)**

(ii) By reference to aqueous copper(II) ions, state the meaning of each of the **three** terms in the equation  $\Delta E = h\nu$ .

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**(3)**

(iii) Write an equation for the reaction, in aqueous solution, between  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  and an excess of chloride ions.

State the shape of the complex produced and explain why the shape differs from that of the  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  ion.

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(3)

- (b) Draw the structure of the ethanedioate ion ( $\text{C}_2\text{O}_4^{2-}$ ). Explain how this ion is able to act as a ligand.

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(2)

- (c) When a dilute aqueous solution containing ethanedioate ions is added to a solution containing aqueous copper(II) ions, a substitution reaction occurs. In this reaction four water molecules are replaced and a new complex is formed.

- (i) Write an ionic equation for the reaction. Give the co-ordination number of the complex formed and name its shape.

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(4)

- (ii) In the complex formed, the two water molecules are opposite each other. Draw a diagram to show how the ethanedioate ions are bonded to a copper ion and give a value for one of the O–Cu–O bond angles. You are **not** required to show the water molecules.

(2)

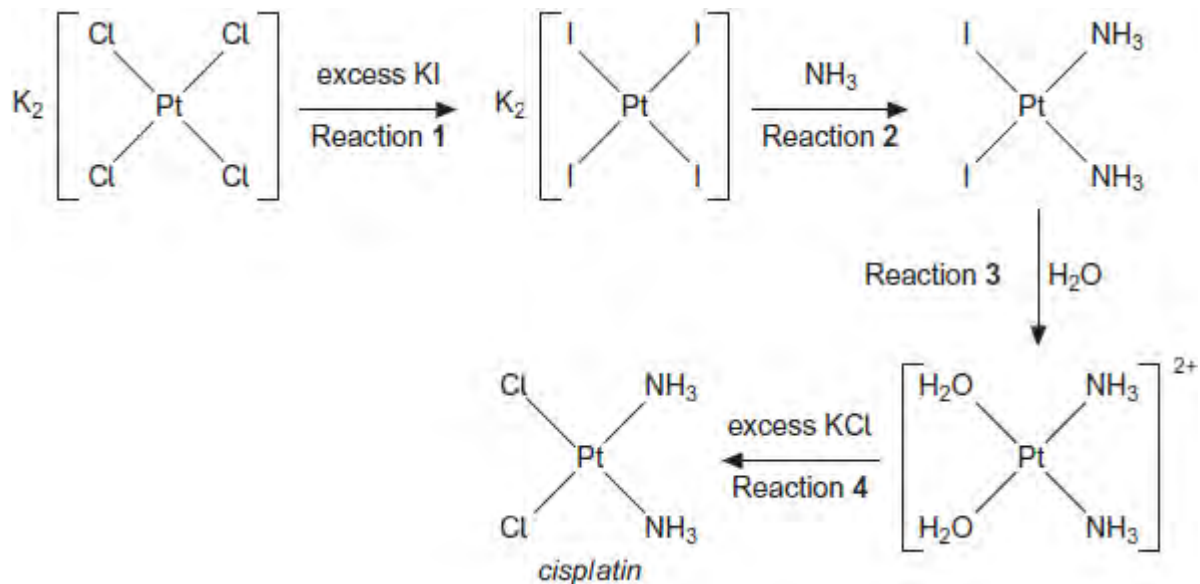
(Total 17 marks)

**Q2.** Complexes containing transition elements have a wide variety of uses including acting as dyestuffs like *Prussian Blue*.

*Cisplatin* is a platinum-based chemotherapy drug used to treat various types of cancers. It was the first member of a class of anti-cancer drugs that react with DNA in tumour cells.

*Cisplatin* is prepared from  $K_2PtCl_4$  according to the following scheme.

**All the reactions shown are reversible.**



(a) Name the type of reaction occurring in all four steps of the scheme.

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(1)

(b) Explain why an excess of potassium iodide is used in Reaction 1.

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(2)

(c) (i) Write an equation for Reaction 1.

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(1)

(ii) Calculate the percentage atom economy for the formation of  $\text{K}_2\text{PtI}_4$  in Reaction 1. Show your working.

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(d) In Reaction 3, silver nitrate solution is added to improve the yield of product.

(i) Write the **simplest ionic** equation for the reaction of iodide ions with silver nitrate.

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(ii) Suggest why addition of silver nitrate improves the yield of product from Reaction 3.

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..... (1)

(e) Suggest two reasons, other than poor practical technique, why the overall yield of *cisplatin* in this synthesis may be low.

Reason 1 .....

Reason 2 .....

(2)

(f) The *cisplatin* formed in Reaction 4 is impure. Outline how the impure solid is purified by recrystallisation.

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(g) Platinum compounds are highly toxic.

(i) State why *cisplatin* is used in cancer treatment despite its toxicity.

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(1)

(ii) Suggest a suitable precaution that should be taken by medical staff when using *cisplatin*.

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(1)

(Total 15 marks)

**Q3.(a)** Some metal ions are toxic to humans. A substance that can be used to treat such poisoning contains the ion  $\text{EDTA}^{4-}$ .  
 $\text{EDTA}^{4-}$  forms very stable complexes with metal ions. These complexes are **not** toxic.

(i) Write an equation for the reaction of  $\text{EDTA}^{4-}$  with aqueous copper(II) ions,  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ .

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(1)

(ii) A solution containing  $\text{EDTA}^{4-}$  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  $25.0 \text{ cm}^3$  sample of the river water was titrated with a  $0.0150 \text{ mol dm}^{-3}$  solution of  $\text{EDTA}^{4-}$ ,  $6.45 \text{ cm}^3$  were required for complete reaction.  
Calculate the concentration, in  $\text{mol dm}^{-3}$ , 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)