Q1.(a) A student investigated the acid content of a different crater-lake solution. The student used a 50.0 cm^3 burette to measure out different volumes of this crater-lake solution. Each volume of crater-lake solution was titrated with a 0.100 mol dm^{-3} sodium hydroxide solution. Each titration was repeated. The results are shown below.

Volume of crater-lake solution / cm^3		10.0	20.0	30.0	40.0	50.0
Volume of sodium hydroxide solution / cm^3	Experiment 1	5.85	17.00	20.00	26.50	32.45
	Experiment 2	6.15	13.00	19.90	26.50	32.55
Average titre / cm^3		6.00	15.00	19.95	26.50	32.50

(i) On the graph paper below, plot a graph of average titre (y-axis) against volume of crater-lake solution. Both axes must start at zero.

(3)

(ii) Draw a line of best fit on the graph.

(1)

(iii) Use the graph to determine the titre that the student would have obtained using a 25.0 cm^3 sample of crater-lake solution.

....

(1)

(iv) Excluding any anomalous points, which average titre value would you expect to be the least accurate value? Give **one** reason for your choice.

Least accurate average titre ....

Reason ....

....

(2)

(b) Another 100 cm^3 sample of crater-lake solution was reacted with an excess of powdered limestone. The gas produced was collected in a gas syringe. The equation for the reaction between the sulfuric(IV) acid in the crater-lake solution and the calcium carbonate in the powdered limestone is shown below.

$$H_2SO_3 + CaCO_3 \longrightarrow CaSO_3 + H_2O + CO_2$$

The volume of gas collected from the reaction of the sulfuric(IV) acid in 100 cm^3 of crater-lake solution with an excess of powdered limestone was 81.0 cm^3 at 298 K and 1.00×10^5 Pa.

(i) State the ideal gas equation.

....

(1)

(ii) Use the ideal gas equation to calculate the amount, in moles, of carbon dioxide formed.
Show your working.
(The gas constant R = 8.31 J K^{-1} mol^{-1})

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(3)

(iii) Use the equation for the reaction and your answer from part (b)(ii) to calculate the minimum mass of calcium carbonate needed to neutralise the sulfuric(IV) acid in 1.00 dm^3 of crater-lake solution.
Show your working.

(If you could not complete the calculation in part (b)(ii) assume that the amount of carbon dioxide is 1.25×10^{-2} mol. This is **not** the correct value.)

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(3)

(iv) The percentage by mass of calcium carbonate in the powdered limestone was 95.0%.
Calculate the minimum mass of this powdered limestone needed to neutralise the sulfuric(IV) acid in 1.00 dm^3 of this crater-lake solution.

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(2)

(v) Give **one** reason, other than cost, why limestone rather than solid sodium hydroxide is often used to neutralise acidity in lakes.

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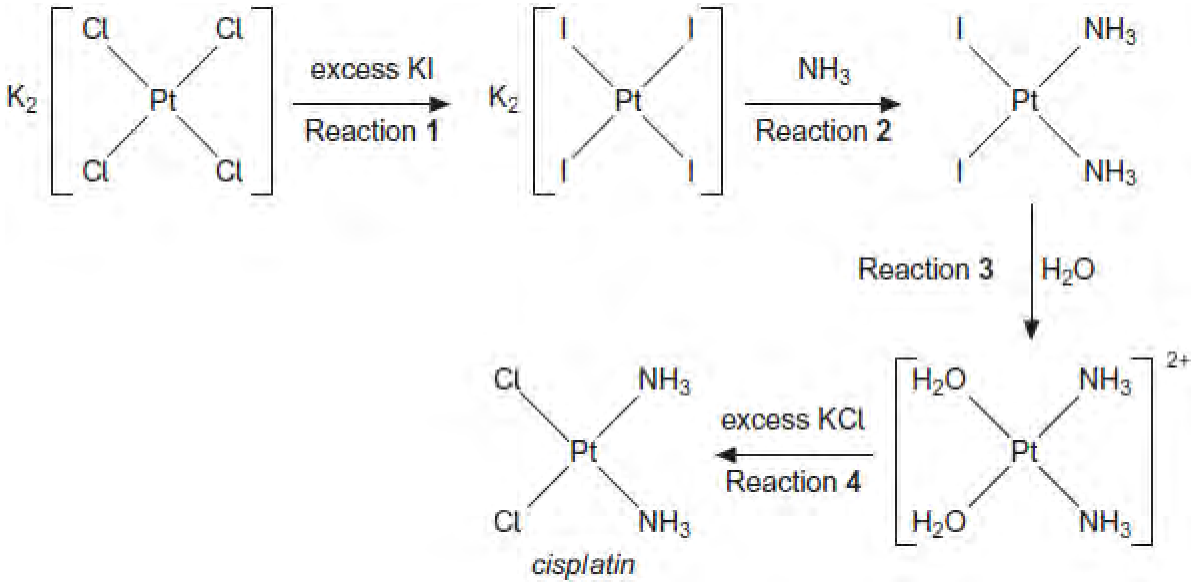
(1)
(Total 17 marks)

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.

....

(1)

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

....

....

....

(2)

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

....

....

(1)

(ii) Calculate the percentage atom economy for the formation of K_2PtI_4 in Reaction **1**.
Show your working.

....

....

....

....

(2)

(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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(1)

(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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....

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(3)

(g) Platinum compounds are highly toxic.

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

....

....

(1)

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

....

(1)

(Total 15 marks)

Q3. In this question give all your answers to three significant figures.

Magnesium nitrate decomposes on heating to form magnesium oxide, nitrogen dioxide and oxygen as shown in the following equation.

$$2Mg(NO_3)_2(s) \rightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

(a) Thermal decomposition of a sample of magnesium nitrate produced 0.741 g of magnesium oxide.

(i) Calculate the amount, in moles, of MgO in 0.741 g of magnesium oxide.

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....

(2)

(ii) Calculate the total amount, in moles, of gas produced from this sample of magnesium nitrate.

....

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(1)

(b) In another experiment, a different sample of magnesium nitrate decomposed to

produce 0.402 mol of gas. Calculate the volume, in dm^3, that this gas would occupy at 333 K and 1.00×10^5 Pa.
(The gas constant $R = 8.31$ J K^{-1} mol^{-1})

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(3)

(c) A 0.0152 mol sample of magnesium oxide, produced from the decomposition of magnesium nitrate, was reacted with hydrochloric acid.

$$MgO + 2HCl \rightarrow MgCl_2 + H_2O$$

(i) Calculate the amount, in moles, of HCl needed to react completely with the 0.0152 mol sample of magnesium oxide.

....

(1)

(ii) This 0.0152 mol sample of magnesium oxide required 32.4 cm^3 of hydrochloric acid for complete reaction. Use this information and your answer to part (c) (i) to calculate the concentration, in mol dm^{-3}, of the hydrochloric acid.

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(1)
(Total 8 marks)