

Group 7

Question Paper 2

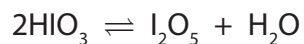
Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Group 7
Booklet	Question Paper 2

Time Allowed: 50 minutes
Score: /41
Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Iodine pentoxide, I_2O_5 , is a white crystalline solid. It is formed by heating HIO_3 to about $200\text{ }^\circ\text{C}$ in a stream of dry air. The reaction is shown below.



- (a) (i) Is this production of iodine pentoxide a redox reaction? Justify your answer by stating the oxidation number of iodine in both of these compounds.

(1)

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- (ii) Suggest why it is important to have a stream of **dry** air.

(1)

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- (iii) Above $300\text{ }^\circ\text{C}$, iodine pentoxide decomposes to form iodine and oxygen. Write the equation for this decomposition. State symbols are not required.

(1)

- (iv) In iodine pentoxide, each iodine atom is bonded to three oxygen atoms and one of these oxygen atoms is bonded to both iodine atoms as shown in the layout below.

Complete the dot and cross diagram for the molecule, using dots for the oxygen electrons and crosses for the iodine electrons.

In this molecule, each iodine atom has twelve electrons in its outer shell. Show outer shell electrons only.

(2)



- (v) The shape around the iodine is similar to that around the nitrogen in ammonia, NH_3 . Suggest a value for the $\text{O} - \text{I} - \text{O}$ bond angle and the name of the shape around the iodine atom.

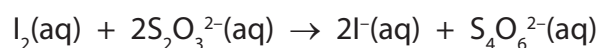
(2)

$\text{O} - \text{I} - \text{O}$ bond angle

Shape

- (b) Iodine pentoxide is used as a reagent to determine the amount of carbon monoxide present in a gaseous sample. The sample is passed over heated iodine pentoxide. The products of this process are carbon dioxide and iodine.

The iodine formed is extracted and added to an excess of sodium thiosulfate solution of known concentration. The remaining sodium thiosulfate is then determined by titration with a solution of iodine of known concentration.



In an analysis, a 2.00 m³ sample of gas was used and the resultant iodine extracted and added to 20 cm³ of a 0.0400 mol dm⁻³ solution of sodium thiosulfate, an excess.

The resultant solution was then titrated against a solution of iodine of concentration 0.0100 mol dm⁻³. The volume of iodine solution required for complete reaction was 21.60 cm³.

- (i) Calculate the number of moles of iodine present in 21.60 cm³ of the iodine solution. Give your answer to **three** significant figures. (1)
- (ii) Deduce the number of moles of sodium thiosulfate that reacted with this titrated amount of iodine. (1)
- (iii) Calculate the number of moles of sodium thiosulfate to which the iodine was **initially** added. (1)
- (iv) From your answers to parts (b)(ii) and (b)(iii), determine the number of moles of sodium thiosulfate that reacted with the extracted iodine. (1)
- (v) Use your answer to part (b)(iv) to determine the number of moles of extracted iodine. (1)

(vi) Write the balanced equation for the reaction between iodine pentoxide and carbon monoxide. State symbols are not required. (1)

(vii) Calculate the volume, in dm^3 , of carbon monoxide in the original gaseous sample. Assume that the molar gas volume of any gas under the experimental conditions is $24 \text{ dm}^3 \text{ mol}^{-1}$. (2)

(viii) State how this procedure could be amended to produce results that are more reliable. (1)

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*(c) Carbon monoxide is an atmospheric pollutant arising from the incomplete combustion of fossil fuels. (i) State how motor vehicles have been adapted to reduce the production of this pollutant. (1)

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(ii) Explain the meaning of the term 'carbon-neutral' and give an example of a motor vehicle fuel that can be classified in this way. (2)

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(Total for Question 1 = 19 marks)

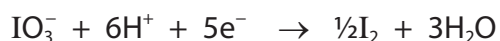
2 This question is about some aspects of the chemistry of iodine and its compounds.

In industry, the main source of iodine is sodium iodate(V), NaIO_3 , which occurs in deposits found in Chile.

In the human body, iodide ions, I^- , are needed for the thyroid gland to function properly. In many countries, potassium iodide, KI , is added to table salt as a source of iodide ions.

(a) In the production of iodine, the final stage involves the reaction between sodium iodate(V) and sodium iodide in acidic solution.

The ionic half-equations for the redox processes are as follows.



(i) Use these half-equations to deduce the full ionic equation for the production of iodine by this process. State symbols are not required.

(2)

(ii) Identify, by its **formula**, the oxidizing agent in the reaction in (a)(i). Justify your answer in terms of electron transfer.

(1)

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(b) On addition of concentrated sulfuric acid to crystals of potassium iodide, solid sulfur and a black solid are observed amongst the products formed.

(i) Identify, by name or formula, the black solid.

(1)

(ii) Construct the ionic half-equation for the formation of sulfur from concentrated sulfuric acid.

State symbols are not required.

(2)

(iii) When iodide ions react with concentrated sulfuric acid, another product, **X**, can also be detected. **X** is a toxic gas with a smell of rotten eggs.

Identify **X**, by name or formula, and give the oxidation numbers of sulfur when **X** is formed from concentrated sulfuric acid.

(3)

Identity of gas **X**:

Oxidation number of S in sulfuric acid is

Oxidation number of S in **X** is

(c) The Recommended Dietary Allowance, RDA, of iodide ions in a balanced diet is 140 μg per day.

(1 μg = 1×10^{-6} g).

(i) Calculate the mass, in μg , of potassium iodide, KI, needed to supply the RDA of iodide ions.

Give your answer to **three** significant figures.

(2)

Mass of KI = μg

(ii) Suggest a reason, other than cost, why some countries do **not** add potassium iodide to table salt.

(1)

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- (d) (i) When chlorine is passed over iodine crystals, iodine monochloride, ICl , is formed.

Iodine monochloride, ICl , is a liquid at room temperature whereas chlorine, Cl_2 , is a gas.

Explain, in terms of intermolecular forces, why this is so.

(4)

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- (ii) When excess chlorine is passed over iodine monochloride, iodine trichloride, ICl_3 , is formed. Draw the dot and cross diagram of ICl_3 , showing only the outer electrons.

(2)

(e) When chlorine gas is bubbled into aqueous potassium iodide solution, a redox reaction occurs.

(i) Give the **ionic** equation for this reaction. State symbols are **not** required.

(1)

(ii) In a further experiment, 0.50 mol of chlorine gas was bubbled into an aqueous solution containing a mixture of 0.66 mol of sodium iodide and 0.66 mol of sodium bromide.

Assuming that **all the chlorine gas reacted**, calculate the number of moles of iodine and bromine produced. Justify your answer in terms of the relative reducing power of bromide and iodide ions.

(3)

The number of moles of iodine produced:

The number of moles of bromine produced:

Justification

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(Total for Question 2 = 22 marks)