

1 The table gives information about the first four elements in Group 7 of the Periodic Table.

Element	Atomic number	Electronic configuration	Physical state at 20 °C	Colour at 20 °C
fluorine	9	2.7	gas	pale yellow
chlorine	17	2.8.7	gas	pale green
bromine	35	2.8.18.7	liquid	red-brown
iodine	53	2.8.18.18.7	solid	dark grey

(a) Astatine (At) has an atomic number of 85 and is the fifth element in Group 7.

It is possible to make predictions about astatine by comparison with the other elements in Group 7.

(i) How many electrons does an atom of astatine have in its outer shell?

(1)

7

(ii) What physical state and colour would you expect for astatine at 20 °C?

(2)

Physical state..... **solid**

Colour..... **dark gray**

(iii) Predict the formula of the compound formed between astatine and hydrogen.

Suggest a name for this compound.

(2)

Formula..... **AtH**

Name..... **Hydrogen Astatide**

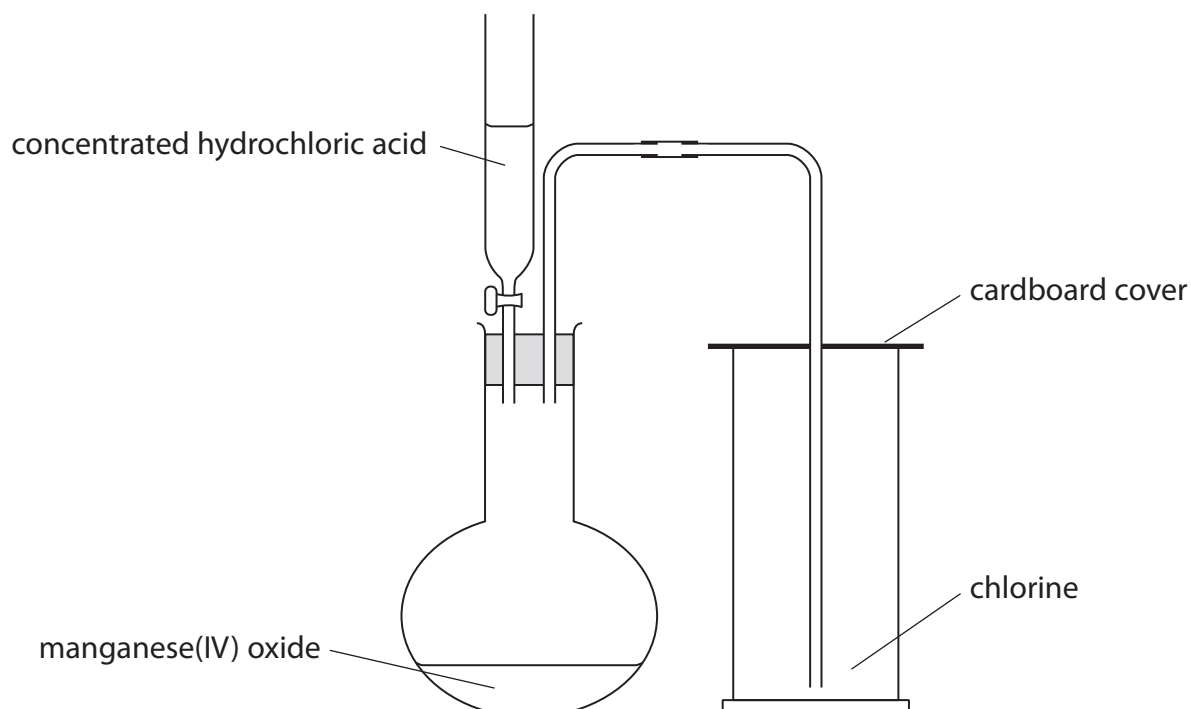
(iv) Suggest how the reactivity of astatine compares to that of iodine.

Explain your answer.

(2)

Astatine is less reactive than iodine because its outermost shell is further from the nucleus than in iodine so it attracts electrons more weakly.

- (b) Chlorine gas can be prepared by heating a mixture of concentrated hydrochloric acid and manganese(IV) oxide using this apparatus.



- (i) Balance the equation for the reaction.

(1)



- (ii) State what you would observe when a piece of damp litmus paper is placed into the gas jar containing chlorine.

(1)

The paper would be bleached and turn white.

(c) Chlorine can be used to obtain bromine (Br_2) from sea water.

Sea water contains bromide ions, Br^-

The pH of sea water is usually within the range of 7.5 to 8.4

The stages in the extraction of bromine from sea water are

Stage 1 The pH of the sea water is lowered to about 3.5

Stage 2 An excess of chlorine is bubbled through the sea water

Stage 3 The bromine (Br_2) is removed from the mixture and reacted with sulfur dioxide (SO_2) and water. This reaction converts the bromine to hydrogen bromide (HBr) and sulfuric acid (H_2SO_4)

Stage 4 The hydrogen bromide is reacted with chlorine to form bromine (Br_2)

(i) Suggest a substance that could be added to lower the pH of sea water in Stage 1. (1)

any acid such as HCl

(ii) Why is an excess of chlorine added in Stage 2? (1)

to displace the bromide ions so that they form Br_2

(iii) Write a chemical equation for the reaction in Stage 3. (2)

$\text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{HBr} + \text{H}_2\text{SO}_4$

(iv) Write a chemical equation for the reaction in Stage 4. (1)

$2\text{HBr} + \text{Cl}_2 \rightarrow \text{Br}_2 + 2\text{HCl}$

(d) State the colour change observed when bromine is added to an aqueous solution of potassium iodide. (2)

Colour of potassium iodide solution at start colourless (clear/transparent/like water are ignored)

Colour of final reaction mixture a brown solution with a dark grey precipitate.

(Total for Question 1 = 16 marks)

1 This question is about halogens and halides.

(a) At room temperature bromine is

(1)

- ☐ A a brown gas
- ☒ B a red-brown liquid
- ☐ C a colourless liquid
- ☐ D a grey solid

(b) Sodium reacts with bromine to form sodium bromide.

Balance the equation for this reaction.

(1)



(c) A student carries out some experiments to investigate displacement reactions.

She adds some halogen solutions to halide solutions and observes whether a reaction occurs.

The table shows her results.

Halide solution	Halogen solution added		
	bromine	chlorine	iodine
lithium chloride	no reaction	(not done)	no reaction
sodium bromide	(not done)	reaction occurs	no reaction
potassium iodide	reaction occurs	reaction occurs	(not done)

(i) The table shows that she did not do three experiments.

Suggest why she did not do these experiments.

(1)

No halogen can displace itself so there was no point doing the reactions.

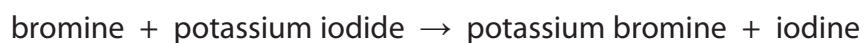
(ii) The table shows that there was no reaction in three experiments.

Why was there no reaction in these experiments?

(1)

She knew there would be no reaction because the halide solution contains a less reactive halide than the solution to be added.

- (iii) The student writes this word equation for one of the experiments in which a reaction occurs.



The name of one of the substances is incorrect.

Write the correct name of this substance.

(1)

potassium bromide

- (iv) A reaction occurs when the student adds chlorine solution to potassium iodide solution.

Complete the chemical equation for this reaction.

(2)



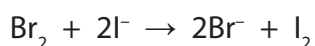
- (v) All displacement reactions are examples of redox reactions.

State the meaning of the term **redox**.

(1)

reduction and oxidation occur in the same reaction OR Gain and loss of electrons in the same reaction

- (vi) The ionic equation for another reaction is



Explain which species is oxidised in this reaction.

(2)

I- because it goes from being negative to neutral so it lost electrons.

(Total for Question 1= 10 marks)