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)

.....

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

(2)

Physical state .....

Colour .....

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

Suggest a name for this compound.

(2)

Formula .....

Name .....

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

Explain your answer.

(2)

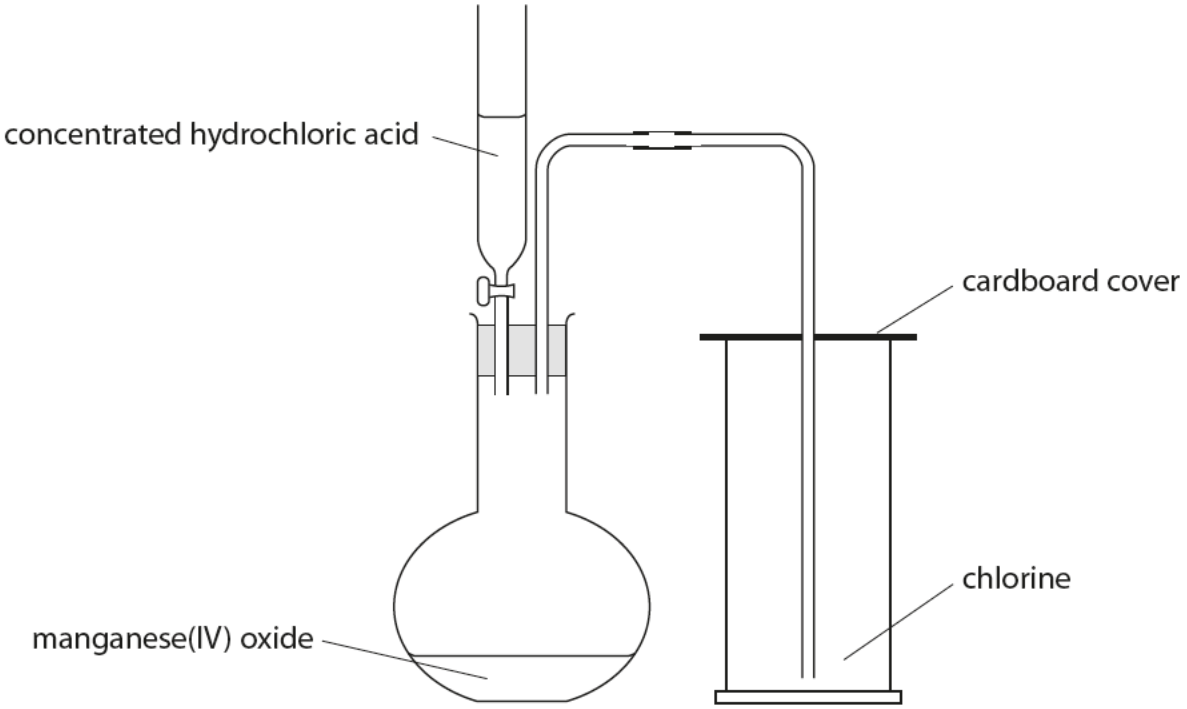
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(b) Chlorine gas can be prepared by heating a mixture of concentrated hydrochloric acid and manganese(IV) oxide using this apparatus.



(i) Balance the equation for the reaction.

(1)

..... $HCl(aq)$ + ... $MnO_2(s)$ → ..... $MnCl_2(aq)$ + ... $H_2O(l)$ + ... $Cl_2(g)$

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

(1)

.....

.....

(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)

.....

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

(1)

.....

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

(2)

.....

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

(1)

.....

(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.....

Colour of final reaction mixture.....

(Total for Question 1 = 16 marks)

2 Bromine is an element in Group 7 of the Periodic Table.

(a) (i) State the number of outer electrons in an atom of bromine.

(1)

(ii) Identify an element in Group 7 that is a solid at room temperature.

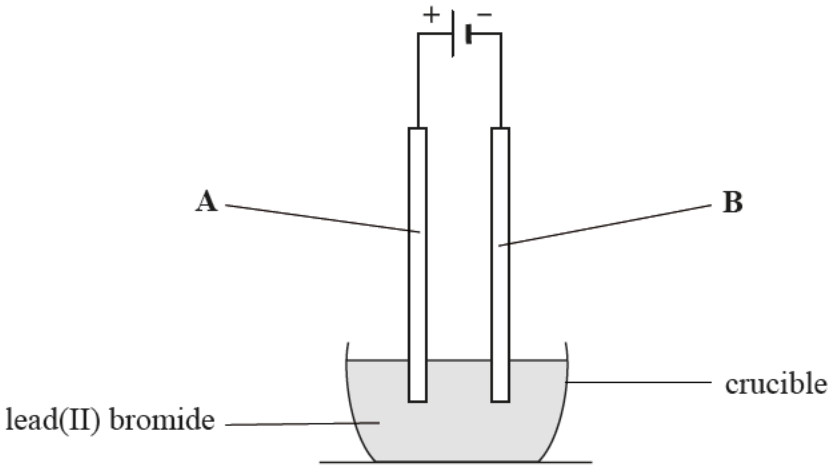
(1)

(iii) Identify an element in Group 7 that is more reactive than bromine.

(1)

(b) Bromine is formed by the electrolysis of molten lead(II) bromide.

The diagram shows the apparatus used.



(i) Solid lead(II) bromide contains ions.

Why does solid lead(II) bromide not conduct electricity?

(1)

(ii) The formula of lead(II) bromide is $PbBr_2$.

During electrolysis, brown fumes of bromine appear at electrode **A**.

The ionic half-equation for the reaction at electrode **A** is

$$2Br^- \rightarrow Br_2 + 2e^-$$

Why is this reaction described as oxidation?

(1)

(iii) Write an ionic half-equation for the reaction at electrode **B** and describe the appearance of the product.

(2)

Ionic half-equation

Appearance of product

(c) Sodium bromate is a compound of sodium, bromine and oxygen.

A sample of sodium bromate contains 2.3 g of sodium, 8.0 g of bromine and 4.8 g of oxygen.

Calculate the empirical formula of sodium bromate.

(3)

Empirical formula is

(Total for Question 2 = 10 marks)

3 Bromine is an element in Group 7 of the Periodic Table.

(a) What is the name given to the Group 7 elements?

(1)

☒ **A** alkali metals ☒ **B** alkaline earth metals ☒ **C** halogens ☒ **D** noble gases

(b) The symbols of two isotopes of bromine are $^{79}_{35}Br$ and $^{81}_{35}Br$.

(i) State what is meant by the term **isotopes**.

(2)

.....

.....

.....

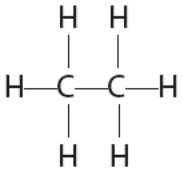
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(ii) Complete the table to show the number of protons, neutrons and electrons in one atom of $^{79}_{35}Br$ and in one atom of $^{81}_{35}Br$.

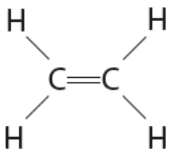
(3)

Isotope	Number of protons	Number of neutrons	Number of electrons
$^{79}_{35}Br$			
$^{81}_{35}Br$			

(c) Bromine water can be used to distinguish between ethane and ethene.



ethane



Describe what you would observe when orange bromine water is added separately to ethane and ethene, in the absence of UV light.

(2)

observation with ethane.....

observation with ethene.....

(Total for Question 3 = 8 marks)

4 The halogens are elements in Group 7 of the Periodic Table.

(a) Put a cross ☒ in the box to indicate your answer.

(i) Chlorine gas is

(1)

☐ **A** brown

☐ **B** colourless

☐ **C** green

☐ **D** violet

(ii) At room temperature, the physical state of bromine is

(1)

☐ **A** solid

☐ **B** liquid

☐ **C** gas

☐ **D** aqueous solution

(b) Which is the most reactive element in Group 7?

(1)

.....

(c) Chlorine reacts with hydrogen to form a colourless gas that dissolves in water to form an acid.

(i) What is the name of the colourless gas?

(1)

.....

(ii) What is the name of the acid?

(1)

.....

(iii) What is the formula that is used to represent both the colourless gas and the acid?

(1)

.....

(Total for Question 4 = 6 marks)

5 Bromine, chlorine and iodine are elements in Group 7 of the Periodic Table.

(a) (i) Identify which of these elements has

(2)

the palest colour .....

the highest melting point .....

(ii) Give the name of another Group 7 element that is a solid at room temperature.

(1)

.....

(b) When chlorine and hydrogen react together, hydrogen chloride gas forms.

Write a chemical equation for this reaction.

(2)

.....

(c) Some hydrogen chloride gas is bubbled into separate samples of water and methylbenzene. A piece of blue litmus paper is dipped into each solution.

(i) State, with a reason, the final colour of the litmus paper in the solution in water.

(2)

.....

.....

.....

.....

(ii) State, with a reason, the final colour of the litmus paper in the solution in methylbenzene.

(2)

.....

.....

.....

.....

(Total for Question 5 9 marks)