CHAPTER 10 HALOGENS

1 (a) State the trend in electronegativity of the elements down Group VII. Explain this trend.

Trend .....

Explanation .....

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(3 marks)

(b) (i) State the trend in reducing ability of the halide ions down Group VII.

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(ii) Give an example of a reagent which could be used to show that the reducing ability of bromide ions is different from that of chloride ions.

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(2 marks)

(c) The addition of silver nitrate solution followed by dilute aqueous ammonia can be used as a test to distinguish between chloride and bromide ions. For each ion, state what you would observe if an aqueous solution containing the ion was tested in this way.

Observations with chloride ions .....

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Observations with bromide ions .....

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(4 marks)

(d) Write an equation for the reaction between chlorine and cold, dilute aqueous sodium hydroxide. Give two uses of the resulting solution.

Equation .....

Use 1 .....

Use 2 .....

(3 marks)

2 (a) Explain, by referring to electrons, the meaning of the terms *reduction* and *reducing agent*. *(2 marks)*

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(b) Iodide ions can reduce sulphuric acid to three different products.

(i) Name the **three** reduction products and give the oxidation state of sulphur in each of these products.

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(ii) Describe how observations of the reaction between solid potassium iodide and concentrated sulphuric acid can be used to indicate the presence of any **two** of these reduction products.

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(iii) Write half-equations to show how two of these products are formed by reduction of sulphuric acid. *(10 marks)*

(c) Write an equation for the reaction that occurs when chlorine is added to cold water. State whether or not the water is oxidised and explain your answer. *(3 marks)*

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3 (a) State the trend in the boiling points of the halogens from fluorine to iodine and explain this trend.

Trend .....

Explanation .....

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(4 marks)

(b) Each of the following reactions may be used to identify bromide ions. For each reaction, state what you would observe and, where indicated, write an appropriate equation.

(i) The reaction of aqueous bromide ions with chlorine gas

Observation .....

Equation .....

(ii) The reaction of aqueous bromide ions with aqueous silver nitrate followed by the addition of concentrated aqueous ammonia

Observation with aqueous silver nitrate .....

Equation .....

Observation with concentrated aqueous ammonia .....

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(iii) The reaction of solid potassium bromide with concentrated sulphuric acid

Observation 1 .....

Observation 2 .....

(7 marks)

(c) Write an equation for the redox reaction that occurs when potassium bromide reacts with concentrated sulphuric acid.

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(2 marks)

4 (a) State and explain the trend in electronegativity down Group VII from fluorine to iodine.

Trend .....

Explanation .....

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(3 marks)

(b) State what you would observe when chlorine gas is bubbled into an aqueous solution of potassium iodide. Write an equation for the reaction that occurs.

Observation .....

Equation .....

(2 marks)

(c) Identify **two** sulphur-containing reduction products formed when concentrated sulphuric acid oxidises iodide ions. For each reduction product, write a half-equation to illustrate its formation from sulphuric acid.

Reduction product 1 .....

Half-equation .....

Reduction product 2 .....

Half-equation .....

(4 marks)

(d) Write an equation for the reaction between chlorine gas and dilute aqueous sodium hydroxide. Name the **two** chlorine-containing products of this reaction and give the oxidation state of chlorine in each of these products.

Equation .....

Name of product 1 .....

Oxidation state of chlorine in product 1 .....

Name of product 2 .....

Oxidation state of chlorine in product 2 .....

(5 marks)

5 A student investigated the chemistry of the halogens and the halide ions.

(a) In the first two tests, the student made the following observations.

Test	Observation
1. Add chlorine water to aqueous potassium iodide solution.	The colourless solution turned a brown colour.
2. Add silver nitrate solution to aqueous potassium chloride solution.	The colourless solution produced a white precipitate.

(a) (i) Identify the species responsible for the brown colour in Test **1**.

Write the **simplest ionic** equation for the reaction that has taken place in Test **1**.

State the type of reaction that has taken place in Test **1**.

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(3 marks)

(Extra space) .....

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(a) (ii) Name the species responsible for the white precipitate in Test **2**.

Write the **simplest ionic** equation for the reaction that has taken place in Test **2**.

State what would be observed when an excess of dilute ammonia solution is added to the white precipitate obtained in Test **2**.

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(3 marks)

(b) In two further tests, the student made the following observations.

Test	Observation
3. Add concentrated sulfuric acid to solid potassium chloride.	The white solid produced misty white fumes which turned blue litmus paper to red.
4. Add concentrated sulfuric acid to solid potassium iodide.	The white solid turned black. A gas was released that smelled of rotten eggs. A yellow solid was formed.

(b) (i) Write the **simplest ionic** equation for the reaction that has taken place in Test **3**.

Identify the species responsible for the misty white fumes produced in Test **3**.

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(2 marks)

(Extra space) .....

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(b) (ii) The student had read in a textbook that the equation for one of the reactions in Test **4** is as follows.

$$8H^+ + 8I^- + H_2SO_4 \longrightarrow 4I_2 + H_2S + 4H_2O$$

Write the **two** half-equations for this reaction.

State the role of the sulfuric acid and identify the yellow solid that is also observed in Test **4**.

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(4 marks)

(iii) The student knew that bromine can be used for killing microorganisms in swimming pool water.
The following equilibrium is established when bromine is added to cold water.

$$Br_2(l) + H_2O(l) \rightleftharpoons HBrO(aq) + H^+(aq) + Br^-(aq)$$

Use Le Chatelier's principle to explain why this equilibrium moves to the right when sodium hydroxide solution is added to a solution containing dissolved bromine.

Deduce why bromine can be used for killing microorganisms in swimming pool water, even though bromine is toxic.

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(3 marks)