

**Q1.**For many years, swimming pool water has been treated with chlorine gas. The chlorine is added to kill any harmful bacteria unintentionally introduced by swimmers. Pool managers are required to check that the chlorine concentration is high enough to kill the bacteria without being a health hazard to the swimmers.

When chlorine reacts with water in the absence of sunlight, the chlorine is both oxidised and reduced and an equilibrium is established.

(a) Write an equation for this equilibrium.

For each chlorine-containing species in the equation, write the oxidation state of chlorine below the species.

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(2)

(b) The pool manager maintains the water at a pH slightly greater than 7.0

Explain how this affects the equilibrium established when chlorine is added to water.

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(2)

(c) Explain why chlorine is used to kill bacteria in swimming pools, even though chlorine is toxic.

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(2)  
(Total 6 marks)

**Q2.** This question is about the chemical properties of chlorine, sodium chloride and sodium bromide.

- (a) Sodium bromide reacts with concentrated sulfuric acid in a different way from sodium chloride.

Write an equation for this reaction of sodium bromide and explain why bromide ions react differently from chloride ions.

Equation .....

Explanation .....

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(3)

- (b) A colourless solution contains a mixture of sodium chloride and sodium bromide.

Using aqueous silver nitrate and any other reagents of your choice, develop a procedure to prepare a pure sample of silver bromide from this mixture. Explain each step in the procedure and illustrate your explanations with equations, where appropriate.

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- (c) Write an ionic equation for the reaction between chlorine and cold dilute sodium hydroxide solution.  
Give the oxidation state of chlorine in each of the chlorine-containing ions formed.

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(2)  
(Total 11 marks)

**Q3.**Chlorine is a powerful oxidising agent.

- (a) Write the **simplest ionic** equation for the reaction between chlorine and aqueous potassium bromide.

State what is observed when this reaction occurs.

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(Extra space) .....  
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(2)

- (b) Write an equation for the reaction between chlorine and cold, dilute, aqueous sodium hydroxide.

Give a major use for the solution that is formed by this reaction.

Give the IUPAC name of the chlorine-containing compound formed in this reaction in which chlorine has an oxidation state of +1.

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(3)

(c) Write an equation for the equilibrium reaction that occurs when chlorine gas reacts with cold water.

Give **one** reason why chlorine is used for the treatment of drinking water even though the gas is very toxic.

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(2)

(d) State how you could test a sample of water to show that it contains chloride ions.

In your answer, give a reagent, **one** observation and the **simplest ionic** equation for the reaction with the reagent.

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(3)  
(Total 10 marks)

**Q4.(a)** Chlorine displaces iodine from aqueous potassium iodide.

(i) Write the **simplest ionic** equation for this reaction.

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(1)

(ii) Give **one** observation that you would make when this reaction occurs.

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(1)

(b) In bright sunlight, chlorine reacts with water to form oxygen as one of the products. Write an equation for this reaction.

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(1)

(c) Explain why chlorine has a lower boiling point than bromine.

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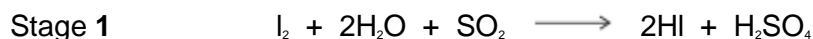
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**Q5.**This question is about Group 7 chemistry.

- (a) Sea water is a major source of iodine.  
The iodine extracted from sea water is impure. It is purified in a two-stage process.



- (i) State the initial oxidation state and the final oxidation state of sulfur in Stage 1.

Oxidation state of S in  $SO_2$  .....

Oxidation state of S in  $H_2SO_4$  .....

(2)

- (ii) State, in terms of electrons, what has happened to chlorine in Stage 2.

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(1)

- (b) When concentrated sulfuric acid is added to potassium iodide, iodine is formed in the following redox equations.



- (i) Balance the equation for the reaction that forms sulfur.

(1)

- (ii) Deduce the half-equation for the formation of iodine from iodide ions.

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(1)

(iii) Deduce the half-equation for the formation of hydrogen sulfide from concentrated sulfuric acid.

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(1)

(c) A yellow precipitate is formed when silver nitrate solution, acidified with dilute nitric acid, is added to an aqueous solution containing iodide ions.

(i) Write the **simplest ionic** equation for the formation of the yellow precipitate.

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(1)

(ii) State what is observed when concentrated ammonia solution is added to this yellow precipitate.

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(1)

(iii) State why the silver nitrate solution is acidified when testing for iodide ions.

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(iv) Explain why dilute hydrochloric acid is **not** used to acidify the silver nitrate solution in this test for iodide ions.

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(1)

(d) Chlorine is toxic to humans. This toxicity does not prevent the large-scale use of chlorine in water treatment.

(i) Give **one** reason why water is treated with chlorine.

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(1)

(ii) Explain why the toxicity of chlorine does **not** prevent this use.

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(1)

(iii) Write an equation for the reaction of chlorine with cold water.

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(1)

(e) Give the formulas of the **two** different chlorine-containing compounds that are formed when chlorine reacts with cold, dilute, aqueous sodium hydroxide.

Formula 1 .....

Formula 2 .....

(1)

(Total 14 marks)