

Q1.(a) Anhydrous strontium chloride is not used in toothpaste because it absorbs water from the atmosphere. The hexahydrate, $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$, is preferred.

A chemist was asked to determine the purity of a sample of strontium chloride hexahydrate. The chemist weighed out 2.25 g of the sample and added it to 100 cm³ of water. The mixture was warmed and stirred for several minutes to dissolve all of the strontium chloride in the sample. The mixture was then filtered into a conical flask. An excess of silver nitrate solution was added to the flask and the contents swirled for 1 minute to make sure that the precipitation was complete.

The silver chloride precipitate was separated from the mixture by filtration. The precipitate was washed several times with deionised water and dried carefully. The chemist weighed the dry precipitate and recorded a mass of 1.55 g.

(i) Calculate the amount, in moles, of AgCl in 1.55 g of silver chloride ($M_r = 143.4$).

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(1)

(ii) The equation for the reaction between strontium chloride and silver nitrate is



Use your answer from part (i) and this equation to calculate the amount, in moles, of SrCl_2 needed to form 1.55 g of silver chloride.

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(1)

(iii) Use data from the Periodic Table to calculate the M_r of strontium chloride hexahydrate. Give your answer to 1 decimal place.

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(1)

(iv) Use your answers from parts (a)(ii) and (a)(iii) to calculate the percentage by mass of strontium chloride hexahydrate in the sample. Show your working. Give your answer to the appropriate precision.

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(2)

(v) Several steps in the practical procedure were designed to ensure an accurate value for the percentage by mass of strontium chloride hexahydrate in the sample.

1 Explain why the solution of strontium chloride was filtered to remove insoluble impurities before the addition of silver nitrate.

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(1)

2 Explain why the precipitate of silver chloride was washed several times with deionised water.

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(1)

(b) Magnesium hydroxide and magnesium carbonate are used to reduce acidity in the stomach. Magnesium hydroxide can be prepared by the reaction of solutions of magnesium chloride and sodium hydroxide.

(i) Write the **simplest ionic** equation for the reaction that occurs between magnesium chloride and sodium hydroxide. Include state symbols in your equation.

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(1)

(ii) Other than cost, explain one advantage of using magnesium hydroxide rather than magnesium carbonate to reduce acidity in the stomach.

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(1)

- (c) Calcium ethanoate, $(\text{CH}_3\text{COO})_2\text{Ca}$, is used in the treatment of kidney disease. Thermal decomposition of calcium ethanoate under certain conditions gives propanone and **one** other product.

Write an equation for the thermal decomposition of calcium ethanoate.

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(1)

- (d) Salts containing the chromate(VI) ion are usually yellow in colour.
Calcium chromate(VI) is soluble in water.
Strontium chromate(VI) is insoluble in water, but will dissolve in a solution of ethanoic acid.
Barium chromate(VI) is insoluble in water and is also insoluble in a solution of ethanoic acid.

Describe a series of tests using solutions of sodium chromate(VI) and ethanoic acid that would allow you to distinguish between separate solutions of calcium chloride, strontium chloride and barium chloride.

State what you would observe in each test.

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(3)

- (e) The strontium salt of ranelic acid is used to promote bone growth. Analysis of a pure sample of ranelic acid showed that it contained 42.09% of carbon, 2.92% of hydrogen, 8.18% of nitrogen, 37.42% of oxygen and 9.39% of sulfur by mass.

Use these data to calculate the empirical formula of ranelic acid.
Show your working.

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(2)
(Total 15 marks)

Q2.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.

(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)

(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)

(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.

(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)

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



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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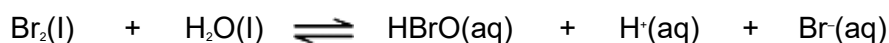
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(4)

- (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.



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)
(Total 15 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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(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.

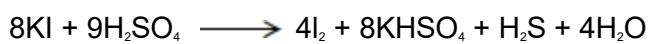
In your answer, give a reagent, **one** observation and the **simplest ionic** equation for the reaction with the reagent.

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(3)
(Total 10 marks)

Q4. Concentrated sulfuric acid reacts with solid potassium iodide as shown in the equation.



Give **two** observations that you would make when this reaction occurs.

In terms of electrons, state what happens to the iodide ions in this reaction.

State the **change** in oxidation state of sulfur that occurs during this formation of H₂S and deduce the half-equation for the conversion of H₂SO₄ into H₂S

(Total 5 marks)

Q5. Aldehydes can be prepared from acyl chlorides.

State how an aldehyde could be tested to show whether it is contaminated with traces of unreacted acyl chloride.

State what you would observe.

Test

Observation

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(Total 2 marks)

Q6.(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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(Total 5 marks)