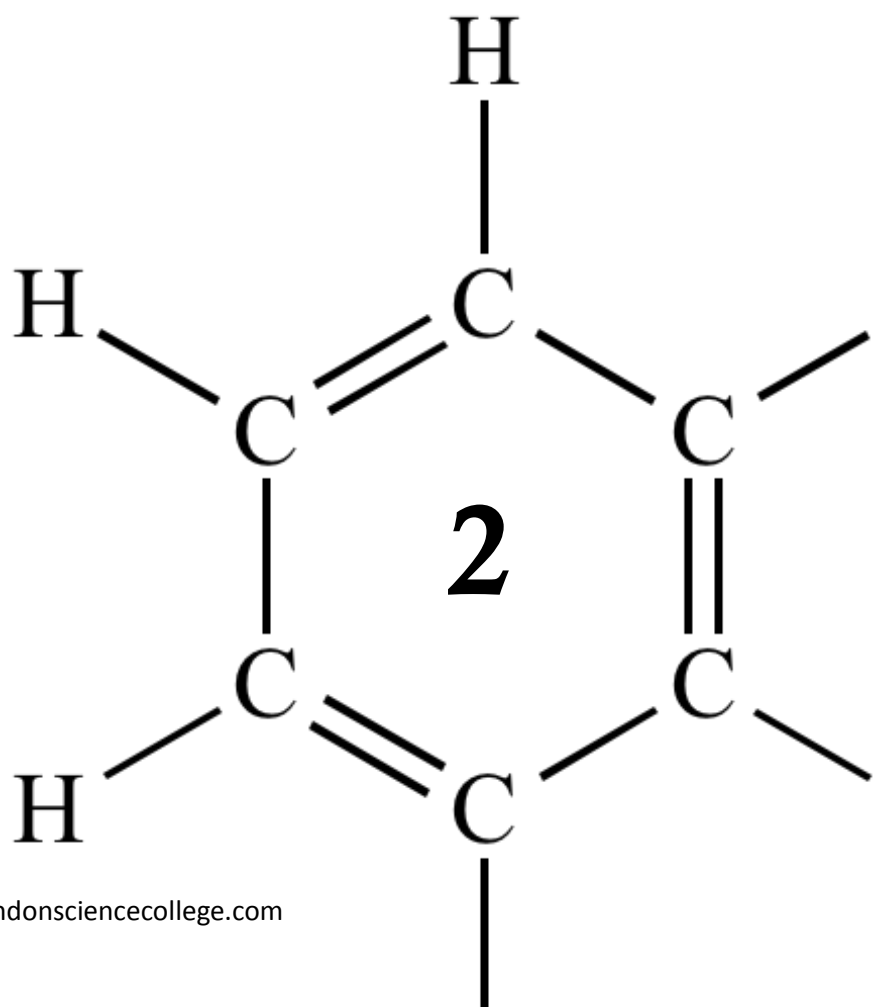


AQA AS CHEMISTRY

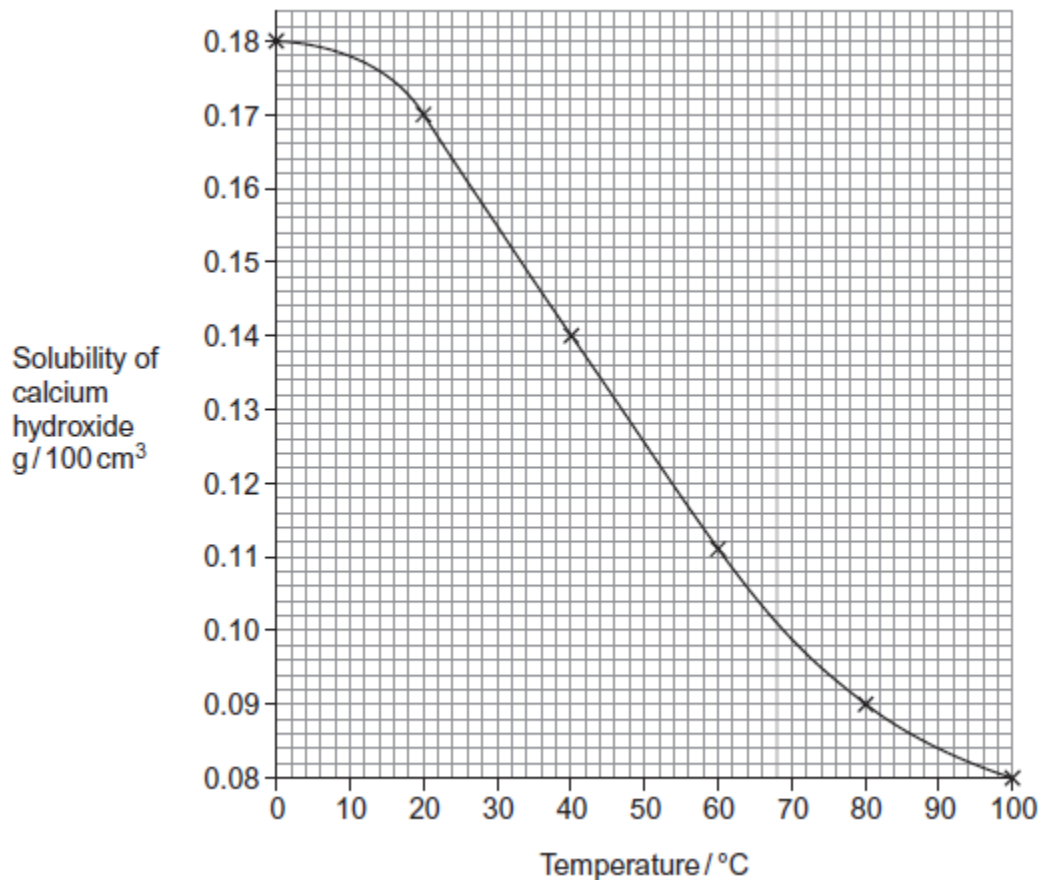
GROUP 2



1

Calcium hydroxide is slightly soluble in water at room temperature. As the temperature rises, the solubility decreases. When the maximum amount of solid has dissolved at a particular temperature the solution is said to be **saturated**.

In an experiment, the solubility of calcium hydroxide was measured over a range of temperatures. The results are shown in the graph.



- (a) Use data from the graph to calculate the concentration, in mol dm⁻³, of a saturated solution of calcium hydroxide at 30 °C. Give your answer to 3 significant figures.

Show your working.

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(3)

- (b) You are given a sample of saturated calcium hydroxide solution. Outline the practical steps that you would take to determine the solubility of calcium hydroxide in this solution.

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(3)
(Total 6 marks)

2

There are many uses for Group 2 metals and their compounds.

- (a) State a medical use of barium sulfate.
State why this use of barium sulfate is safe, given that solutions containing barium ions are poisonous.

Use

Why this use is safe

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(2)

- (b) Magnesium hydroxide is used in antacid preparations to neutralise excess stomach acid.
Write an equation for the reaction of magnesium hydroxide with hydrochloric acid.

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(1)

- (c) Solutions of barium hydroxide are used in the titration of weak acids.
State why magnesium hydroxide solution could **not** be used for this purpose.

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(1)

(d) Magnesium metal is used to make titanium from titanium(IV) chloride.

Write an equation for this reaction of magnesium with titanium(IV) chloride.

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(1)

(e) Magnesium burns with a bright white light and is used in flares and fireworks.

Use your knowledge of the reactions of Group 2 metals with water to explain why water should **not** be used to put out a fire in which magnesium metal is burning.

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(Extra space)

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(2)

(Total 7 marks)

3

(a) Strontium chloride is used in toothpaste for sensitive teeth.

Both strontium carbonate and strontium sulfate are white solids that are insoluble in water.

(i) Write an equation for the reaction between strontium chloride solution and sodium sulfate solution.

Include state symbols in your equation.

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(1)

(ii) Strontium carbonate reacts with nitric acid to produce a solution of strontium nitrate. Strontium sulfate does not react with nitric acid.

Describe briefly how you could obtain strontium sulfate from a mixture of strontium carbonate and strontium sulfate.

You are **not** required to describe the purification of the strontium sulfate.

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(2)

- (b) A solution of magnesium sulfate is sometimes given as first aid to someone who has swallowed barium chloride.

Explain why drinking magnesium sulfate solution is effective in the treatment of barium poisoning.

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(1)

- (c) Medicines for the treatment of nervous disorders often contain calcium bromide. Silver nitrate, acidified with dilute nitric acid, can be used together with another reagent to test for the presence of bromide ions in a solution of a medicine.

Describe briefly how you would carry out this test and state what you would observe.

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(3)

(Total 7 marks)

4

- (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)

5

A student investigated how the initial rate of reaction between sulfuric acid and magnesium at 20 °C is affected by the concentration of the acid.

The equation for the reaction is



- (a) The student made measurements every 20 seconds for 5 minutes. The student then repeated the experiment using double the concentration of sulfuric acid.

State a measurement that the student should make every 20 seconds. Identify the apparatus that the student could use to make this measurement.

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(2)

- (b) State **one** condition, other than temperature and pressure, that would need to be kept constant in this investigation.

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(1)

- (c) When the student had finished the investigation, an excess of sodium hydroxide solution was added to the reaction mixture. This was to neutralise any unreacted sulfuric acid. The student found that a further reaction took place, producing magnesium hydroxide.
- (i) Draw a diagram to show how the student could separate the magnesium hydroxide from the reaction mixture.

(2)

- (ii) Suggest **one** method the student could use for removing soluble impurities from the sample of magnesium hydroxide that has been separated.

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(1)

(Total 6 marks)

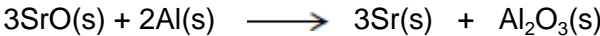
6

Group 2 metals and their compounds are used commercially in a variety of processes.

- (a) Strontium is extracted from strontium oxide (SrO) by heating a mixture of powdered strontium oxide and powdered aluminium.

Consider these standard enthalpies of formation.

	SrO(s)	Al ₂ O ₃ (s)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	- 590	- 1669



Use these data and the equation to calculate the standard enthalpy change for this extraction of strontium.

The use of powdered strontium oxide and powdered aluminium increases the surface area of the reactants.

Suggest **one** reason why this increases the reaction rate.

Suggest **one** major reason why this method of extracting strontium is expensive.

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(5)

(b) Explain why calcium has a higher melting point than strontium.

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(2)

(c) Magnesium is used in fireworks. It reacts rapidly with oxygen, burning with a bright white light. Magnesium reacts slowly with cold water.

Write an equation for the reaction of magnesium with oxygen.

Write an equation for the reaction of magnesium with cold water.

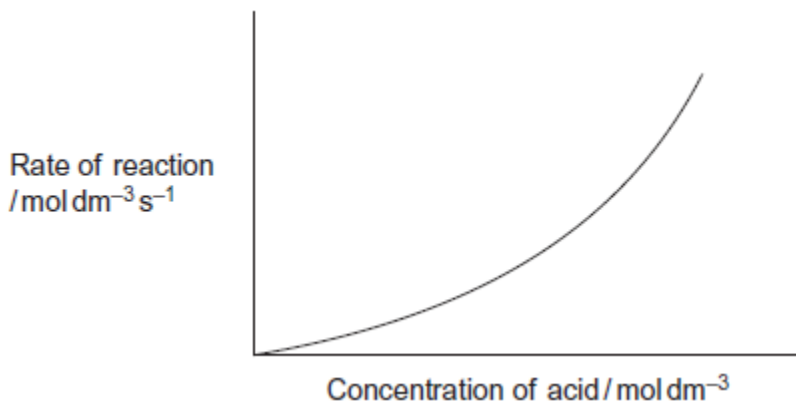
Give a medical use for the magnesium compound formed in the reaction of magnesium with cold water.

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(3)
(Total 10 marks)

7

(a) In an investigation of the rate of reaction between hydrochloric acid and pure magnesium, a student obtained the following curve.



The reaction of magnesium with dilute hydrochloric acid is exothermic.

Use your understanding of collision theory to explain why the student did **not** obtain a straight line.

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(3)

(b) The magnesium used in a laboratory experiment was supplied as a ribbon. The ribbon was stored in an open plastic bag exposed to the air.

Explain why it is important to clean the surface of this magnesium ribbon when investigating the rate of its reaction with hydrochloric acid.

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(2)

- (c) Magnesium ribbon reacts with hot water. Heated magnesium ribbon reacts with steam. State **two** differences between these reactions.

Difference 1

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Difference 2

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(2)

- (d) Pure magnesium reacts completely with an excess of dilute sulfuric acid. The reaction of pure calcium with an excess of dilute sulfuric acid is very rapid initially. This reaction slows down and stops before all of the calcium has reacted.

Use your knowledge of the solubilities of Group 2 sulfates to explain why these reactions of magnesium and calcium with dilute sulfuric acid are so different.

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(3)

(Total 10 marks)

- 8** Barium chloride solution was added, dropwise, to magnesium sulfate solution until no more white precipitate was formed. The mixture was filtered.

Give the formulae of the **two** main ions in the filtrate.

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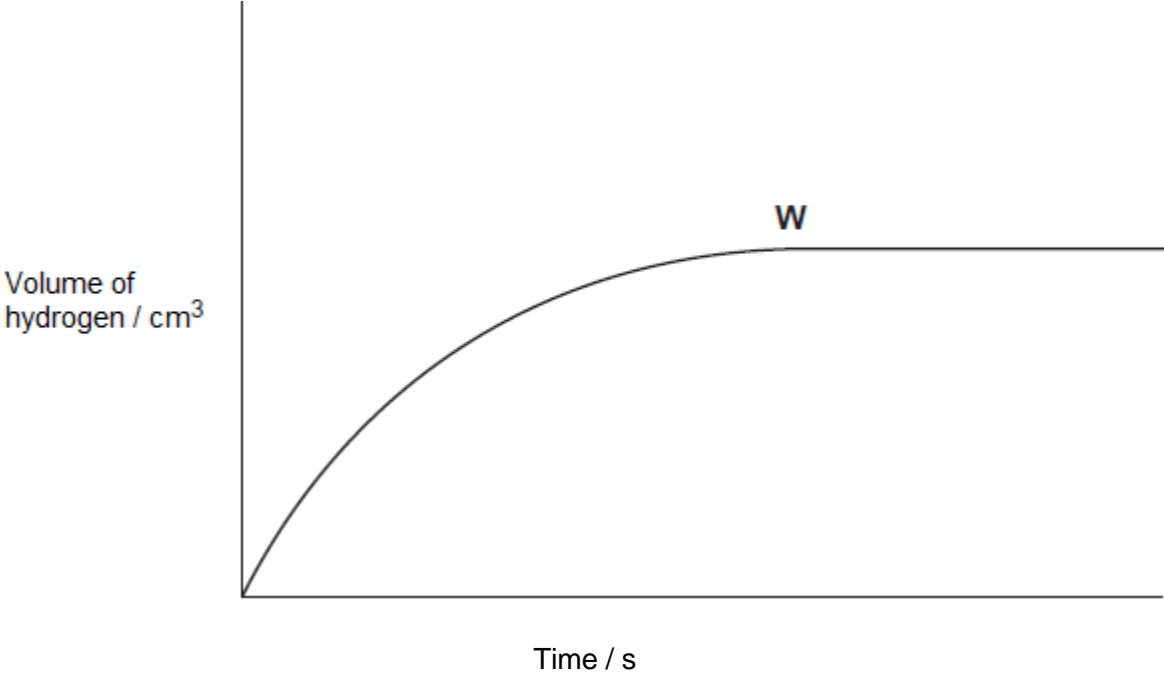
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9

(a) **Figure 1** shows the volume of hydrogen gas collected when a sample of magnesium reacted with an excess of dilute hydrochloric acid.

The rate of this reaction can be studied by measuring the time it takes for a given volume of hydrogen to be collected.

Figure 1



(i) State the meaning of the term *rate of reaction*.

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(1)

(ii) State and explain what has happened to the rate of this reaction at point **W** in **Figure 1**.

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(2)

- (iii) In terms of collision theory explain why, at a fixed temperature, the rate of this reaction doubles when the concentration of the hydrochloric acid doubles.

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(2)

- (b) In a study of the reaction in part (a), a student referred to activation energy.

- (i) State the meaning of the term *activation energy*.

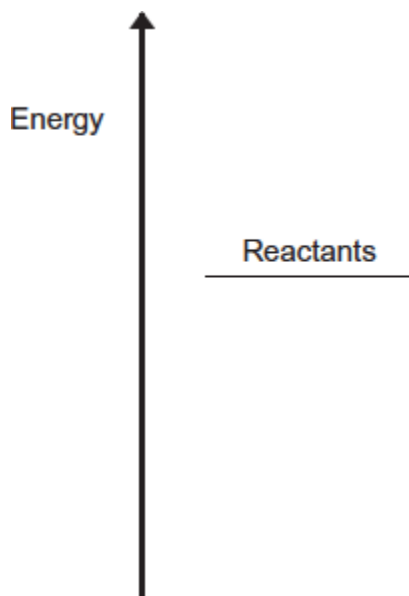
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(1)

- (ii) Complete **Figure 2** by drawing the shape of the reaction profile from reactants to products for an exothermic reaction. Show the position of the products. Show and label the activation energy.

Figure 2



(2)

(c) Barium metal reacts very quickly with dilute hydrochloric acid, but it reacts more slowly with water.

(i) Write an equation for the reaction of barium with water.

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(1)

(ii) A solution containing barium ions can be used to show the presence of sulfate ions in an aqueous solution of sodium sulfate.

Write the **simplest ionic** equation for the reaction that occurs and state what is observed.

Simplest ionic equation

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Observation

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(2)

(iii) State **one** use of barium sulfate in medicine.
Explain why this use is possible, given that solutions containing barium ions are poisonous.

Use

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Explanation

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(2)

(Total 13 marks)

10

There are many uses for compounds of barium.

(a) (i) Write an equation for the reaction of barium with water.

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(1)

(ii) State the trend in reactivity with water of the Group 2 metals from Mg to Ba

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(1)

(b) Give the formula of the **least** soluble hydroxide of the Group 2 metals from Mg to Ba

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(1)

(c) State how barium sulfate is used in medicine.
Explain why this use is possible, given that solutions containing barium ions are poisonous.

Use

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Explanation

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(Extra space)

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(2)
(Total 5 marks)