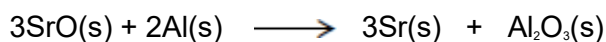


Q1. Group 2 metals and their compounds are used commercially in a variety of processes.

- (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)

- Q2.** (a) Give the **formula** of a Group 2 metal hydroxide used in agriculture.

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(1)

- (b) Identify a sodium halide that does **not** undergo a redox reaction when added as a solid to concentrated sulfuric acid.

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(1)

- (c) Chlorine gas reacts with cold dilute sodium hydroxide solution to form sodium chloride and another chlorine-containing compound, **X**.

Give the **formula** of **X**.

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(1)

- (d) Give the **formula** of the substance responsible for the orange colour when chlorine gas is bubbled through an aqueous solution of sodium bromide.

.....

(1)

- (e) Solid sodium iodide undergoes a redox reaction with concentrated sulfuric acid.

Give the **formula** for each of the following in this reaction.

Formula of the solid reduction product

Formula of the oxidation product

(2)

- (f) Draw the structure of each of the following organic compounds.

- (i) The hydrocarbon that is a chain isomer of methylpropene, but does **not** exhibit E–Z stereoisomerism.

(1)

- (ii) The alcohol that is a position isomer of butan-2-ol.

(1)

(iii) The hydrocarbon that has a peak, due to its molecular ion, at $m/z = 44$ in its mass spectrum.

(1)

(iv) The bromoalkane that reacts with sodium cyanide to produce propanenitrile.

(1)
(Total 10 marks)

Q3. 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

.....

Explanation

.....

(Extra space)

.....

(2)

(Total 5 marks)

Q4. Group 2 elements and their compounds have a wide range of uses.

- (a) For parts (a)(i) to (a)(iii), draw a ring around the correct answer to complete each sentence.

(i) From $\text{Mg}(\text{OH})_2$ to $\text{Ba}(\text{OH})_2$, the solubility in water

decreases.
increases.
stays the same.

(1)

(ii) From Mg to Ba, the first ionisation energy

decreases.
increases.
stays the same.

(1)

(iii) From Mg to Ba, the atomic radius

decreases.
increases.
stays the same.

(1)

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

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(Extra space)
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(2)

(c) Acidified barium chloride solution is used as a reagent to test for sulfate ions.

(i) State why sulfuric acid should **not** be used to acidify the barium chloride.

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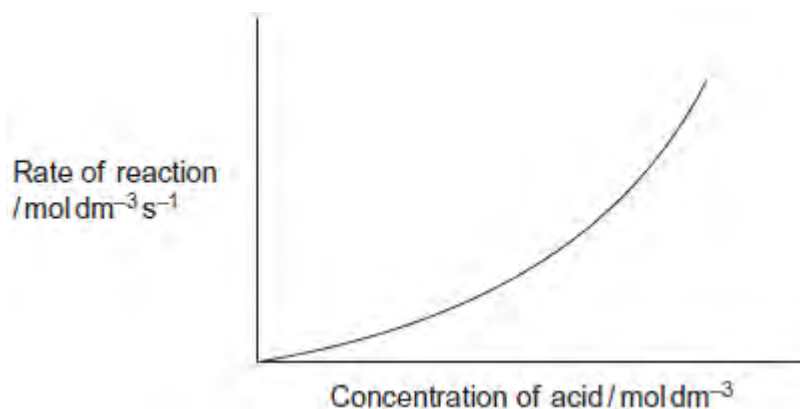
(1)

(ii) Write the **simplest ionic** equation for the reaction that occurs when acidified barium chloride solution is added to a solution containing sulfate ions.

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(1)
(Total 7 marks)

Q5.(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

.....

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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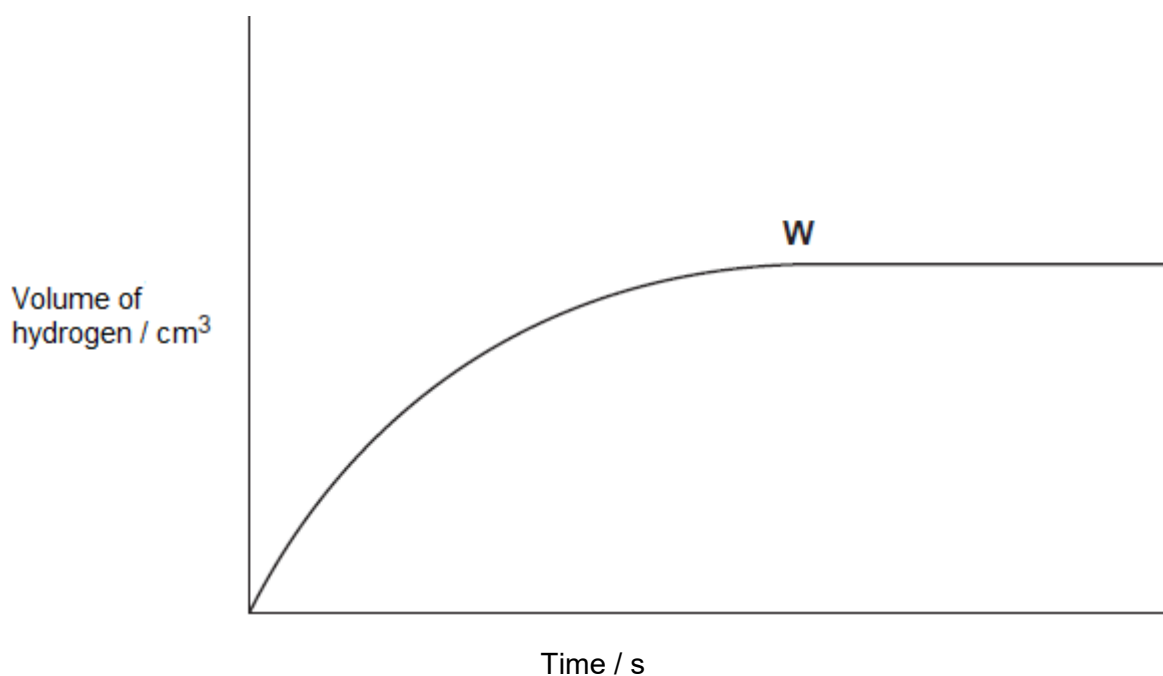
(3)

(Total 10 marks)

Q6.(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.

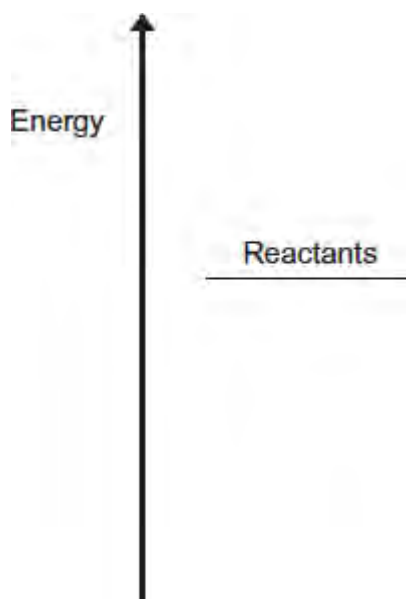
- (i) State the meaning of the term *activation energy*.

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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

.....

(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)

Q7. 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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(Total 1 mark)