

(b) The elements in Group 2 all react with oxygen and with water.

(i) State and explain the conditions needed for magnesium to react with oxygen.

.....
..... [2]

(c) The carbonates and nitrates of the elements in Group 2 can all be decomposed by heating.

(i) Write an equation for the thermal decomposition of magnesium nitrate.

..... [1]

(ii) The thermal decomposition of calcium carbonate forms a solid product that is industrially important. This solid product reacts with water to form a compound commonly known as slaked lime.

Write equations for the thermal decomposition of calcium carbonate and the reaction of the solid product to form slaked lime.

thermal decomposition
formation of slaked lime [2]

(d) Calcium carbonate and calcium hydroxide both have an important use in agriculture.

(i) Describe this use and explain what makes these two compounds suitable for it.

.....
.....
..... [2]

May/June 2017 9701/21 · Q3 (b)(i), (c)(i), (c)(ii), (d)(i), (d)(ii) (continued ·)

(ii) Write an ionic equation to illustrate this use of calcium carbonate.

..... [1]

[Total: 16]

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May/June 2017 9701/21 · Q3 (b)(i), (c)(i), (c)(ii), (d)(i), (d)(ii) (cont.)

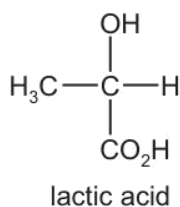
- (ii) When calcium metal is placed in dilute sulfuric acid, it reacts vigorously at first.

After a short time, a crust of calcium sulfate forms on the calcium metal and the reaction stops. Some of the calcium metal and dilute sulfuric acid remain unreacted.

Suggest an explanation for these observations.

.....
.....
.....
..... [2]

- (d) Calcium lactate is used in some medicines. It forms when lactic acid (2-hydroxypropanoic acid) reacts with calcium carbonate.

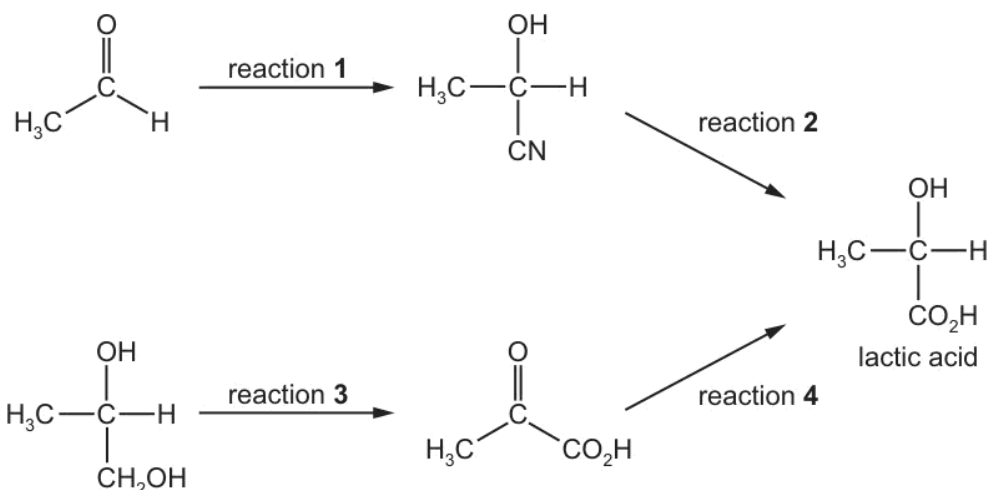


- (i) Identify the **two** other products of the reaction of lactic acid with calcium carbonate.

..... [1]

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Two possible methods of making lactic acid are shown.



March 2018 9701/22 · Q3 (a)(ii), (d)(i) (cont.)

- (b) Group 2 elements, including magnesium, react with oxygen and with dilute acids. There are trends in both the physical and chemical properties of the elements and their compounds down the group. Reactivity generally increases from Mg to Ba.

- (i) Explain why there is a general increase in reactivity from Mg to Ba.

.....

 [2]

- (iv) Suggest why there is a general **decrease** in the melting points of the elements down Group 2.

.....

 [3]

[Total: 11]

(ii) NO_2 can be formed by different chemical reactions.

Write equations for the formation of NO_2 by:

- the reaction of N_2 with O_2

.....

- the thermal decomposition of magnesium nitrate.

.....

[2]

March 2019 9701/22 · Q1 (d)(ii)

(iv) $\text{CaF}_2(\text{aq})$ can be made by the reaction of calcium carbonate with hydrofluoric acid, $\text{HF}(\text{aq})$.

Write an equation for this reaction. Include state symbols.

..... [2]

March 2019 9701/22 · Q2 (a)(iv)

1 (a) Group 2 elements share common chemical properties.

- (i) Calcium reacts in cold water more quickly than magnesium because more energy is required to remove the outer electrons in magnesium. This occurs even though calcium atoms have a greater nuclear charge.

Explain why more energy is required to remove the outer electrons in magnesium than in calcium.

.....
.....
..... [2]

- (ii) 0.001 mol of strontium reacts with an excess of cold water. When the reaction is complete a colourless solution is seen.

Construct the equation for the reaction of strontium with cold water. Include state symbols.

..... [2]

- (iii) 0.005 mol of calcium and 0.005 mol of strontium are added separately to two beakers. Each beaker contains 100 cm³ of cold water.
At the end of each reaction a white solid and a colourless solution are seen in both beakers.

Predict which element, calcium or strontium, produces the more alkaline solution. Explain your answer.

.....
.....
..... [2]

- (iv) Describe one observation when magnesium carbonate is added to excess dilute sulfuric acid.

.....
..... [1]

(ii) Write the formula of the oxide of **X**.

..... [1]

(iii) Write an equation for the reaction of XCO_3 when it is heated.

..... [1]

[Total: 12]

- 3 (a) Magnesium reacts with oxygen to form magnesium oxide.

State **two** observations that would be made when magnesium is heated strongly and placed in a gas jar of pure oxygen.

.....
..... [1]

- (b) Acid indigestion is caused by an excess of hydrochloric acid in the stomach.
Magnesium oxide is commonly found in indigestion tablets.

- (i) Give the equation to show how magnesium oxide relieves acid indigestion.

..... [1]

- (ii) Name the type of reaction that occurs in (b)(i).

..... [1]

- (c) Magnesium oxide is described as a ceramic material. It has a high melting point.

State and explain why ceramic materials such as magnesium oxide have high melting points.

.....
.....
..... [2]

- (d) Magnesium oxide can be made from magnesium carbonate in a one-step reaction using heat.

- (i) Write an equation for this reaction. Include state symbols.

..... [1]

- (ii) Name the type of reaction occurring during this process.

..... [1]

[Total: 7]

7

May/June 2019 9701/23 · Q3 (a), (b)(i), (b)(ii), (c), (d)(i), (d)(ii) (cont.)

(b) Group 2 elements form stable hydroxides, with general formula $M(\text{OH})_2$, where M is the Group 2 element.

(i) Beryllium hydroxide, $\text{Be}(\text{OH})_2$, is an amphoteric compound that shows similar chemical reactions to aluminium oxide.

State the meaning of the term *amphoteric*.

.....
..... [1]

(ii) Write an **ionic** equation for the reaction of magnesium hydroxide, $\text{Mg}(\text{OH})_2$, with hydrochloric acid.

..... [1]

(iv) State how the solubility of the Group 2 hydroxides changes down the group.

..... [1]

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Oct/Nov 2019 9701/22 · Q2 (b)(i), (b)(ii), (b)(iv)

- (a) (i) Write the equation for the reaction of calcium oxide with water.

..... [1]

- (ii) Identify the ion that causes an aqueous solution to be alkaline.

..... [1]

- (b) The table shows the melting points of some Group 2 metal oxides.

compound	melting point/°C
MgO	2825
CaO	2613
SrO	2531
BaO	1923

Explain the trend in the melting points of the oxides down Group 2.

.....
.....
..... [2]

- (c) Oxygen reacts readily with some metals, but each Group 2 metal requires strong heating to start the reaction with oxygen.

Suggest why strong heating is required to start these reactions.

.....
..... [1]

- (e) Unlike the other oxides of Group 2 metals, beryllium oxide is amphoteric.

- (i) Give the meaning of the term *amphoteric*.

.....
..... [1]

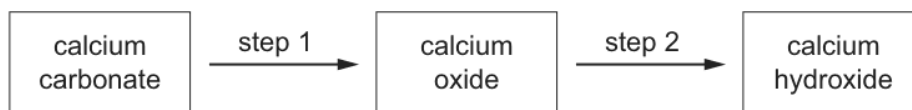
- (ii) Beryllium oxide and aluminium oxide have similar chemical properties.

The $\text{Be}(\text{OH})_4^{2-}$ anion is a product of the reaction between beryllium oxide and excess concentrated $\text{OH}^-(\text{aq})$.

Construct an equation for this reaction.

..... [1]

(b) Calcium carbonate can be converted into calcium hydroxide in a two-step process.



(i) Describe how the two-step process is carried out to convert calcium carbonate into calcium hydroxide. Include relevant equations.

.....
.....
.....
..... [3]

(ii) Name the type of reaction occurring when calcium carbonate is converted into calcium oxide.

..... [1]

(iii) State **one** common use for both calcium carbonate and calcium hydroxide.

..... [1]

- (g) Sodium oxide and silicon(IV) oxide react to form sodium silicate(IV), Na_2SiO_3 .

Sodium oxide is obtained from the thermal decomposition of sodium carbonate.

Write equations for the following reactions:

- (i) sodium oxide with silicon(IV) oxide

..... [1]

- (ii) the thermal decomposition of sodium carbonate, forming sodium oxide and carbon dioxide.

..... [1]

[Total: 14]

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Oct/Nov 2020 9701/22 · Q2 (g)(i), (g)(ii)

- (iii) Identify another compound containing calcium ions which will also produce carbon dioxide and calcium oxide when it is heated.

..... [1]

[Total: 10]

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May/June 2021 9701/21 · Q1 (b)(iii)

- (a) (i) Use the observations in the table to identify each sample as one of $\text{Ba}(\text{OH})_2$, NaCl , P_4O_{10} and SiCl_4 . Write your answers in the table.

	state at room temperature	observations on addition of sample to water	identity of sample
R	solid	alkaline, colourless solution is produced, some white solid remains	
S	solid	white solid disappears, solution is neutral	
T	liquid	misty fumes produced, white solid is made in vigorous reaction	
U	solid	acidic, colourless solution produced in vigorous reaction	

[4]

- (ii) Identify the formula of the white solid made when sample **T** reacts with water.

..... [1]

- (iii) Name the solution formed when sample **U** reacts with water.

..... [1]

- (b) Magnesium oxide and aluminium oxide have properties typical of ceramic materials.

- (i) Name **one** physical property typical of ceramic materials.

..... [1]

May/June 2021 9701/23 · Q3 (a)(i), (a)(ii), (a)(iii), (b)(i)

(iii) State the trend in the thermal stability of the Group 2 nitrates down the group.

..... [1]

(b) Describe how $\text{Ca}(\text{OH})_2$ is used in agriculture.

.....
..... [1]

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Oct/Nov 2021 9701/21 · Q2 (a)(iii), (b)

(b) (i) Write the equation for the thermal decomposition of calcium nitrate.

..... [1]

(ii) Suggest which of the Group 2 nitrates, calcium, magnesium or radium, requires the highest temperature to decompose. Explain your answer.

.....
.....
..... [1]

May/June 2022 9701/21 · Q1 (b)(i), (b)(ii)

(ii) Reaction 3 is used to form a precipitate of $\text{Mg}(\text{OH})_2$ from $\text{MgCl}_2(\text{aq})$.

State why $\text{Ca}(\text{OH})_2(\text{aq})$ would **not** form a precipitate of $\text{Ba}(\text{OH})_2$ from $\text{BaCl}_2(\text{aq})$.

.....
..... [1]

Oct/Nov 2022 9701/23 · Q2 (b)(ii)

- (ii) Magnesium nitride reacts with an excess of water to produce ammonia and magnesium hydroxide only. Construct an equation to describe this reaction.

..... [1]

May/June 2024 9701/21 · Q2 (c)(ii)

- (c) **Z** is a salt that contains a Period 4 element from Group 2. When **Z** is heated brown gas forms.

Identify the formula of **Z** and use it to write an equation for the reaction.

..... [2]

[Total: 10]



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May/June 2024 9701/22 · Q2 (c)

- (b) Carbon is found in inorganic compounds such as carbonates.

- (i) Write an equation for the reaction of magnesium carbonate with dilute HCl(aq) .

..... [1]

- (ii) Describe the thermal stability of the carbonates down Group 2.

..... [1]

Oct/Nov 2024 9701/21 · Q3 (b)(i), (b)(ii)

- 2 (a) The Group 2 elements show metallic bonding.

Define metallic bonding.

.....
..... [2]

- (b) The Group 2 elements form stable 2+ cations.

- (i) State and explain the variation in ionic radius of the Group 2 elements down the group.

.....
.....
.....
..... [2]

- (c) All the Group 2 elements except beryllium have more than one stable isotope.

- (i) Beryllium exists as the single isotope ${}^9_4\text{Be}$.

Describe the distribution of mass within an atom of ${}^9_4\text{Be}$.

.....
.....
.....
..... [2]

March 2025 9701/22 · Q2 (a), (b)(i), (c)(i), (c)(iii), (d)(ii), (d)(iii) (continued ·)

- (iii) Fig. 2.1 shows the behaviour of a beam of protons in an electric field.

Complete Fig. 2.1 to show the behaviour of separate beams of neutrons and electrons in the same electric field.

Label your diagram clearly. Assume that the beams of each particle are moving at the same velocity.

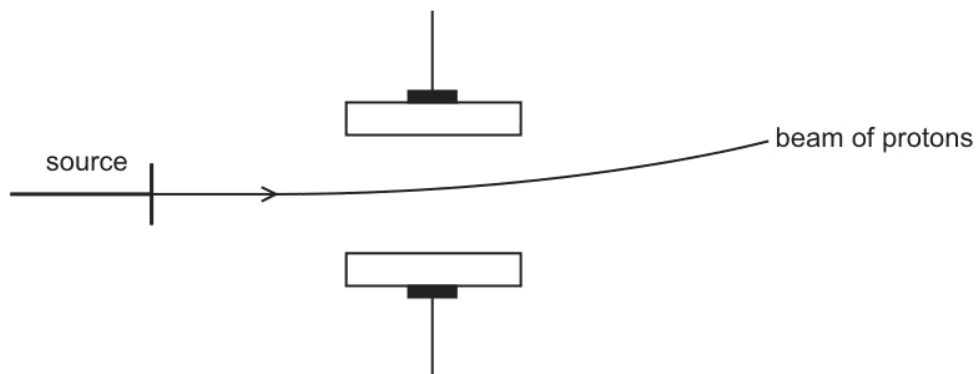


Fig. 2.1

[3]

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- (d) (i) State what is observed when dilute hydrochloric acid is added to separate samples of barium oxide and barium carbonate.

barium oxide

barium carbonate [2]

- (ii) Write an equation for the reaction of strontium, Sr, with an excess of cold water.

..... [1]

(iii) State the variation in solubility of the Group 2 sulfates down the group.

..... [1]

[Total: 17]

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[Turn over]

(d) Group 2 nitrates decompose on heating to form oxides.

(i) State the trend in thermal stability of the Group 2 nitrates down the group.

..... [1]

(ii) Identify the other products of the thermal decomposition of Group 2 nitrates.

..... [1]

[Total: 11]

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Oct/Nov 2025 9701/21 · Q2 (d)(i), (d)(ii)

(iii) State the trend in thermal stability of the Group 2 carbonates down the group.

..... [1]

[Total: 20]

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Oct/Nov 2025 9701/22 · Q2 (f)(iii) (cont.)

(ii) Identify the other products of the thermal decomposition of Group 2 nitrates.

..... [1]

[Total: 11]



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Oct/Nov 2025 9701/23 · Q2 (d)(ii)