

# Group 1 & 2

## Question Paper 2

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Application of Core Principles of Chemistry
Sub Topic	Group 1 & 2
Booklet	Question Paper 2

**Time Allowed:** 52 minutes  
**Score:** /43  
**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 This question is about Group 2 elements and their compounds.

\*(a) Give **two** reasons why the first ionization energy of calcium is less than that of magnesium, even though the atomic number of calcium is greater than that of magnesium.

(2)

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(b) A flame test was carried out on a solid calcium compound. Explain the origin of the flame colour in terms of electron movement.

(3)

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(c) (i) Calcium oxide reacts with dilute nitric acid to form calcium nitrate. Write the equation for this reaction. State symbols are not required.

(1)

(ii) Identify **two** ways, one of which should be an observation, in which the thermal decomposition of anhydrous calcium nitrate is different from that of anhydrous potassium nitrate.

(2)

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- (d) (i) Calcium reacts with water to produce calcium hydroxide and a gas. Give the name or formula of this gas.

(1)

- (ii) An aqueous solution of calcium hydroxide is used for a common laboratory test. Give the observation for a positive result for this test and complete the equation for the reaction that occurs. State symbols are **not** required.

(2)

Observation .....



- (iii) Give the name or formula of a Group 2 hydroxide which is more soluble than calcium hydroxide.

(1)

- (e) (i) Describe what you would see if a solution of barium chloride was added to dilute sulfuric acid. State why this observation would differ if magnesium chloride solution was used instead of barium chloride.

(2)

- (ii) Barium compounds are toxic. However, it is safe to give patients a 'barium meal' of barium sulfate when trying to diagnose intestinal disorders. Suggest why this is so.

(1)

- \*f) Calcium carbonate,  $\text{CaCO}_3$ , readily reacts with hydrochloric acid. State **two** factors, other than a change in temperature, which would affect the rate of this reaction.

Neither pressure nor the use of a catalyst should be considered.

Explain how each of the **two** factors you have chosen alters the reaction rate.

(4)

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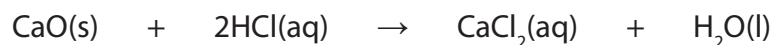
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- g) Suggest why pressure has little or no effect on the rate of the reaction of calcium oxide and hydrochloric acid, the equation for which is given below.



(1)

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**(Total for Question 2 = 20 marks)**

2 Magnesium is the eighth most abundant element in the Earth's crust and is found in a number of mineral deposits such as:

Kieserite,  $\text{MgSO}_4 \cdot \text{H}_2\text{O}$    Dolomite,  $\text{CaMg}(\text{CO}_3)_2$    Magnesite,  $\text{MgCO}_3$

These minerals have a number of uses. For example, Magnesite is used as a catalyst in the production of synthetic rubber and also to make magnesium oxide which is an important refractory lining for furnaces and kilns.

In addition, magnesium ions are found in significant quantities in sea water, from which magnesium chloride,  $\text{MgCl}_2$ , can be obtained. Magnesium chloride is used as a raw material for the production of the compound magnesium hydroxide.

Epsom salts contain magnesium sulfate and have a range of medicinal and other uses, including soothing aches and pains in a relaxing bath, as a topical gel for sore joints, as a laxative and as a first-aid remedy for barium chloride poisoning.

In green plants, magnesium ions,  $\text{Mg}^{2+}$ , are at the centre of the chlorophyll molecule and are vital to the process of photosynthesis. Hence magnesium compounds are commonly included in fertilizers to ensure healthy crops.

The pure form of magnesium metal also has various uses, including being a sacrificial anode for underground piping, and in flares and fireworks.

(a) Draw a labelled diagram of the experimental apparatus that you could use to form magnesium oxide from the mineral Magnesite.

Include in the diagram how you would test for any other product of the reaction. State the expected observation from the test.

(3)

Observation .....

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(b) Magnesium oxide can also be produced by heating magnesium hydroxide. Write an equation for this reaction. Include state symbols. (2)

(c) Suggest the **formula** of a Group 2 hydroxide which is more soluble than magnesium hydroxide. (1)

\* (d) Magnesium oxide can also be easily produced by heating magnesium in air. However, magnesium oxide is not the only product as magnesium also reacts with nitrogen in the air. Suggest the formula of the compound formed when magnesium reacts with nitrogen gas. Explain how this product forms even though nitrogen gas is a very stable molecule. Give **one** practical suggestion for how this alternative product could be avoided. (3)

\* (e) The flame test on a magnesium salt, such as magnesium chloride, produces no colour. Describe the electronic transitions involved in a flame test and suggest why there is no flame colour for magnesium chloride. (4)

- (f) Magnesium nitrate is another salt of magnesium. It decomposes when heated to produce nitrogen dioxide and oxygen.

Balance the following equation. State symbols are not required.

(1)



- (g) Give the **formula** of a reagent that could be used to produce magnesium sulfate from magnesium oxide.

(1)

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- (h) Hydrated magnesium sulfates have the formula  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ , where  $x$  varies for different minerals. In Epsom salts, the value of  $x$  is 7.

The value of  $x$  can be determined by heating a known mass of Epsom salts to remove the water of crystallization.

- (i) A student carried out this determination and obtained the following results.

5.00 g of the Epsom salts was heated and the mass decreased to 2.55 g.

Calculate the number of moles of water of crystallization,  $x$ , obtained by the student. Use the Periodic Table as a source of data.

You **must** show your working. Give your answer to **three** significant figures.

(3)

Value of  $x$  = .....

- \*(ii) Suggest a way of improving the accuracy of the result, other than by repeating the experiment or using more precise measurements. Justify your answer.

(2)

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- (i) In chlorophyll, a magnesium ion is bonded to four nitrogen atoms which are in the same plane as the magnesium.

Suggest a value for the NMgN bond angle and explain how you have arrived at your suggestion.

(2)

NMgN bond angle .....

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- (j) Magnesium metal is very reactive, but, unlike Group 1 elements, it is not stored under oil. Suggest a reason for this.

(1)

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**(Total for Question 2 = 23 marks)**