

Answer **all** the questions.

1 The Group 2 element magnesium was first isolated by Sir Humphry Davy in 1808.

(a) Magnesium has three stable isotopes, which are ^{24}Mg , ^{25}Mg and ^{26}Mg .

(i) Complete the table below to show the atomic structures of ^{24}Mg and ^{25}Mg .

	protons	neutrons	electrons
^{24}Mg			
^{25}Mg			

[2]

(ii) A sample of magnesium contained ^{24}Mg : 78.60%; ^{25}Mg : 10.11%; ^{26}Mg : 11.29%.

Calculate the relative atomic mass of this sample of Mg.

Give your answer to **four** significant figures.

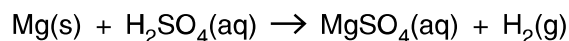
answer = [2]

(iii) Define the term *relative atomic mass*.

.....

 [3]

- (b) The reaction between magnesium and sulfuric acid is a redox reaction.



- (i) Use oxidation numbers to identify which element has been oxidised.

Explain your answer.

element oxidised

explanation

.....

..... [2]

- (ii) Describe what you would **see** when magnesium reacts with an excess of sulfuric acid.

.....

..... [2]

- (c) Epsom salts can be used as bath salts to help relieve aches and pains.

Epsom salts are crystals of hydrated magnesium sulfate, $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$.

A sample of Epsom salts was heated to remove the water. 1.57 g of water was removed leaving behind 1.51 g of anhydrous MgSO_4 .

- (i) Calculate the amount, in mol, of anhydrous MgSO_4 formed.

amount = mol [2]

- (ii) Calculate the amount, in mol, of H_2O removed.

amount = mol [1]

- (iii) Calculate the value of x in $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$.

x = [1]

[Total: 15]

2 This question compares the bonding, structure and properties of sodium and sodium oxide.

(a) Sodium, Na, is a metallic element.

Explain, with the aid of a labelled diagram, what is meant by the term *metallic bonding*.

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

(b) Sodium reacts with oxygen to form sodium oxide, Na₂O, which is an ionic compound.

(i) Write the equation for the reaction of sodium with oxygen to form sodium oxide.

..... [1]

(ii) State what is meant by the term *ionic bond*.

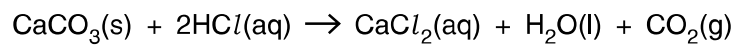
.....
..... [1]

(iii) Draw a 'dot-and-cross' diagram to show the bonding in Na₂O.

Show **outer** electrons only.

[2]

- 3 Calcium carbonate, CaCO_3 , reacts with hydrochloric acid as shown in the equation below.



- (a) 7.50×10^{-3} mol CaCO_3 reacts with $0.200 \text{ mol dm}^{-3}$ HCl .

- (i) Calculate the volume, in cm^3 , of $0.200 \text{ mol dm}^{-3}$ HCl required to react with 7.50×10^{-3} mol CaCO_3 .

answer = cm^3 [2]

- (ii) Calculate the volume, in cm^3 , of CO_2 formed at room temperature and pressure.

answer = cm^3 [1]

- (b) When heated strongly, CaCO_3 decomposes.

Write an equation, including state symbols, for the thermal decomposition of CaCO_3 .

..... [2]

- (c) Calcium oxide reacts with water and with nitric acid.

State the formula of the calcium compound formed when:

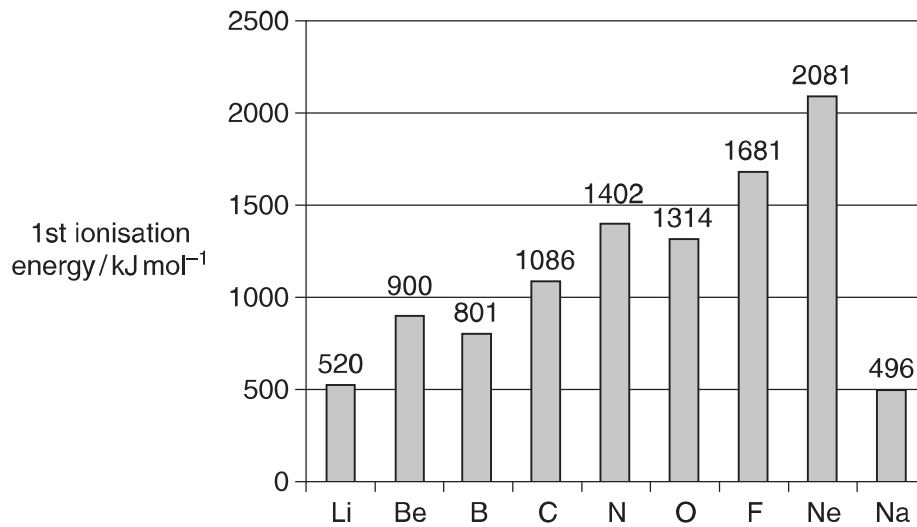
- (i) calcium oxide reacts with water, [1]

- (ii) calcium oxide reacts with nitric acid. [1]

[Total: 7]

- 4 Ionisation energies have been used to develop the model of the atom.

The first ionisation energies of the elements Li to Na are shown in the figure below.



- (a) Define the term *first ionisation energy*.

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

- (b) (i) Explain why the first ionisation energies show a general increase from Li to Ne.

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

- (ii) Explain the difference between the first ionisation energies of Li and Na.



In your answer, you should use appropriate technical terms, spelt correctly.

.....

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.....

..... [3]

- (c) The first ionisation energy of oxygen is 1314 kJ mol^{-1} and the second ionisation energy of oxygen is 3388 kJ mol^{-1} .

- (i) Write an equation to represent the **second** ionisation energy of oxygen.

Include state symbols.

..... [1]

- (ii) Suggest why the second ionisation energy of oxygen has a greater value than the first ionisation energy of oxygen.

.....

.....

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..... [1]

[Total: 11]

5 The Periodic Table is a table of elements arranged in order of atomic number. The elements are classified into blocks.

(a) (i) State what is meant by the term *atomic number*.

..... [1]

(ii) Complete the full electron configuration for a titanium atom.

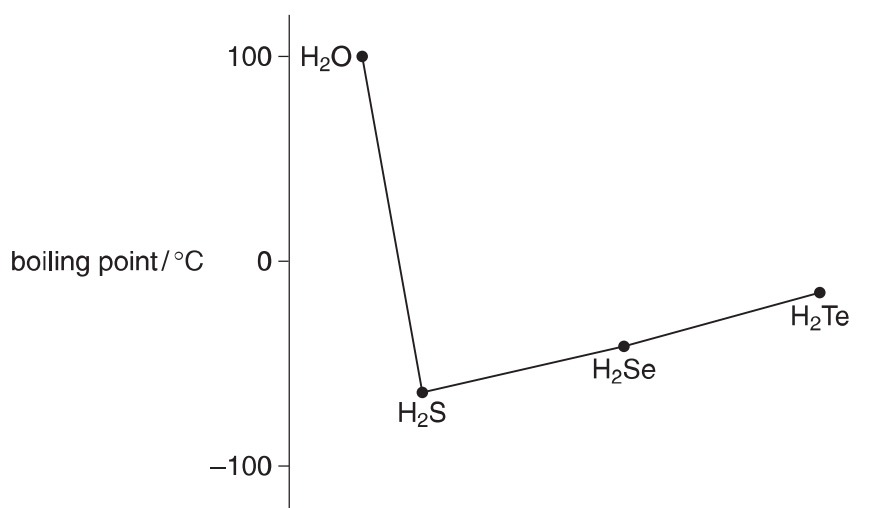
1s²

(iii) Identify the **seventh** element in the **fourth** period.

State which block this element is in.

element block

(b) The figure below shows the boiling points of four hydrides of Group 6 elements.



(i) Explain, with the aid of a diagram, the intermolecular forces in H₂O that lead to the relatively high boiling point of H₂O.

.....

(ii) Suggest why H_2S has a much lower boiling point than H_2O .

.....

.....

..... [1]

(c) The boiling points of some Group 7 elements are shown below.

Group 7 element	boiling point/ $^{\circ}\text{C}$
chlorine	-35
bromine	59
iodine	184

Explain why the halogens show this trend in boiling points.



In your answer, you should use appropriate technical terms, spelt correctly.

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..... [3]

TURN OVER FOR QUESTION 5(d)

- (d) During the extraction of bromine industrially, chlorine is bubbled through a solution of bromide ions. A student thought this principle would also work for extracting iodine and carried out the experiment below.

Stage 1 The student bubbled some chlorine through an aqueous solution of potassium iodide.

Stage 2 The student added an organic solvent and shook the mixture.

- (i) What would the student see at **stage 1**?

.....
 [1]

- (ii) Name the products and write an ionic equation for the reaction in **stage 1**.

names of products:
 ionic equation: [2]

- (iii) Why does the reaction in **stage 1** occur?

.....
 [1]

- (iv) What would the student see at **stage 2**?

..... [1]

[Total: 15]

END OF QUESTION PAPER



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