Periodic Table, Group 2 & The Halogens AS & A Level

Question Paper 5

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Periodic Table & Energy
Topic	Periodic Table, Group 2 & The Halogens
Paper	AS & A Level
Booklet	Question Paper 5

Time allowed: **68 minutes**

Score: **/50**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

Group 2 elements are metals that react with oxygen and water.

(a) Magnesium is oxidised when it burns in oxygen to form an ionic compound.

(i) Write the electron configuration, in terms of sub-shells, of a magnesium atom.

[1]

(ii) Explain what happens when magnesium is oxidised in terms of electron transfer.

[1]

(b) The trend in the first and second ionisation energies of Group 2 elements can be linked to the increase in chemical reactivity down the group.

The first and second ionisation energies of calcium and strontium are given in the table.

Element	First ionisation energy / kJ mol^{-1}	Second ionisation energy / kJ mol^{-1}
Ca	590	1145
Sr	550	1064

(i) Write an equation, including state symbols, to represent the **second** ionisation energy of strontium.

[1]

(ii) Explain why the first ionisation energy of strontium is less than the first ionisation energy of calcium.

[3]

(c) A student reacts a Group 2 metal, M, with water.

$$M(s) + 2H_2O(l) \rightarrow M(OH)_2(aq) + H_2(g)$$

The student measures the volume of hydrogen gas produced.

0.162 g of the metal produces 97.0 cm^3 of gas measured at room temperature and pressure.

(i) Draw a labelled diagram of the apparatus that can be used to carry out this experiment. **[2]**

(ii) Identify the Group 2 metal, M.

Show your working. **[3]**

(d) The student plans to repeat the experiment using the same mass of a Group 2 metal from further down the group.

Predict whether the volume of hydrogen produced would be greater than, less than or the same as the volume in the first experiment.

[1]

Explain your answer.

(Total 12 marks)

This question is about halogens.

(a) Solid chlorine and solid bromine have a similar structure.

Name this structure. [1]

(b) The intermolecular attractions in halogens are van der Waals' forces.

(i) Explain how van der Waals' forces arise between halogen molecules. [3]

(ii) The boiling points of chlorine and bromine are shown in the table.

Halogen	Boiling point / °C
chlorine	–34
bromine	59

Explain why bromine has a higher boiling point than chlorine. [2]

(c) A student carries out test-tube experiments to prove the trend in reactivity of halogens.

The student is provided with the following solutions:

- bromine water
- aqueous iodine
- aqueous barium chloride
- aqueous magnesium bromide
- aqueous calcium iodide.

Chlorine gas and chlorine water are **not** available.

The student carries out the **minimum** number of test-tube experiments using these solutions in the presence of cyclohexane (an organic solvent).

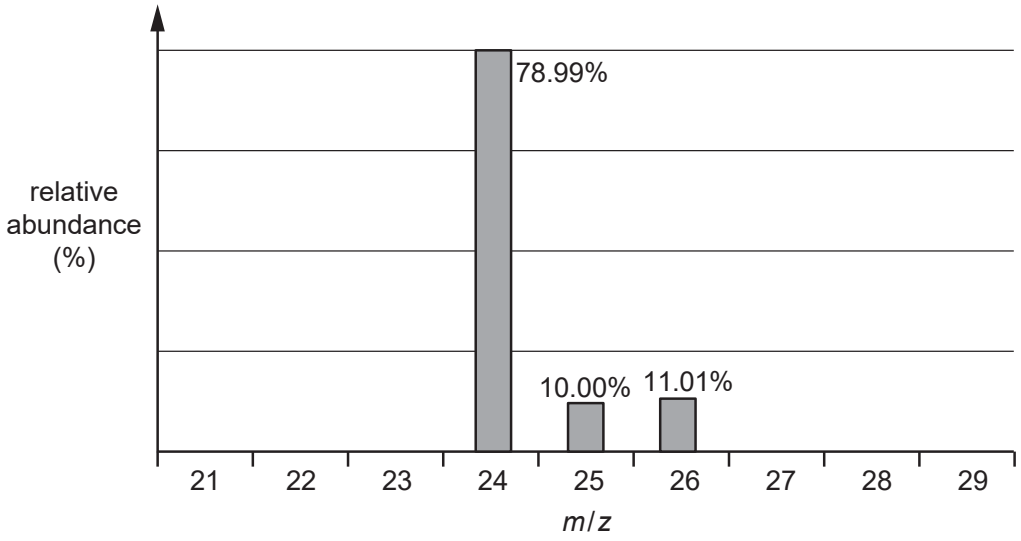
- State the solutions that need to be added together in order to prove the trend in reactivity of the halogens, using the **minimum** number of test-tube experiments.
- Describe the colour seen in the organic solvent at the end of each test-tube experiment.
- Write an ionic equation for **one** reaction that takes place.

[5]

[Total: 11 Marks]

This question is about elements from the s-block and p-block of the periodic table.

(a) A sample of magnesium is analysed by mass spectrometry. The mass spectrum is shown below.



(i) The species causing the peaks in the mass spectrum are 1+ ions of magnesium.

Complete the table to show the number of protons, neutrons and electrons in each **1+ ion** of magnesium.

m/*z*	protons	neutrons	electrons
24			
25			
26			

[2]

(ii) Calculate the relative atomic mass of the magnesium in the sample.

Give your answer to **two** decimal places.

[1]

(b) **B** and **C** are ionic compounds of two different Group 1 elements.
The molar masses of **B** and **C** are both approximately 140 g mol^{-1}.

A student dissolves **B** and **C** in water in separate test tubes and analyses the solutions.

The observations are shown below.

Test	**Observation**	
	B(aq)	**C(aq)**
Addition of HNO_3(aq)	bubbles	no change
followed by $BaCl_2$(aq)	no change	white precipitate

Use this information and the observations to identify the formulae of **B** and **C**.

Explain your reasoning. **[5]**

(c) Fig. 22.1 shows first ionisation energies for elements across Period 3.

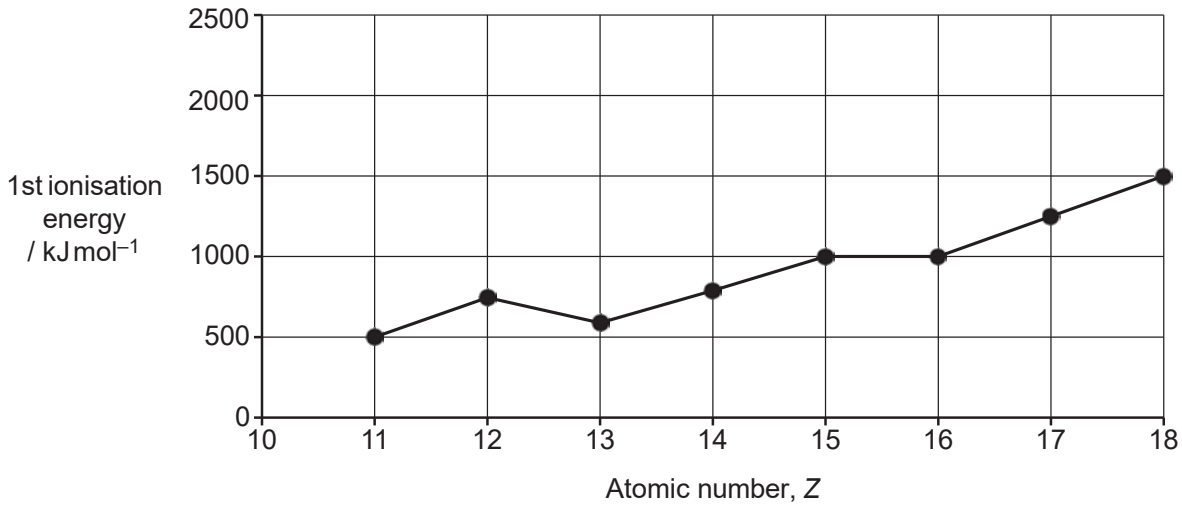


Fig. 22.1

(i) Add a point to **Fig. 22.1** for the first ionisation energy of the element with $Z = 10$.

[1]

(ii) Estimate the energy required to form **one** $Na^+(g)$ ion from one Na(g) atom.

Give your answer in kJ, in standard form, and to **two** significant figures.

[1]

(iii) Explain why the first ionisation energies in **Fig. 22.1** show a general increase across Period 3 (Na–Ar).

[3]

(iv) Explain why the general increase in first ionisation energies across Period 3 is **not** followed for Mg ($Z = 12$) to Al ($Z = 13$).

[2]

(Total 15 marks)

This question is about Group 2 and Group 17 (7).

(a) Barium chloride can be prepared from barium hydroxide in a neutralisation reaction.

Write the equation for this reaction. State symbols are **not** required.

[1]

(b) The reactivity of the Group 2 elements Mg–Ba increases down the group.

Explain why. **[3]**

(c) On gently heating, the compound $KClO_3$ reacts as shown in the equation.

$$4KClO_3(s) \rightarrow KCl(s) + 3KClO_4(s)$$

This reaction is an example of disproportionation.

(i) State what is meant by *disproportionation* and use oxidation numbers to show that disproportionation has taken place.

[3]

(ii) What is the systematic name for $KClO_4$? **[1]**

(d) Two changes are described below.

For each change,
- write an equation, including state symbols,
- state and explain how the entropy changes.

(i) The reaction of aqueous barium nitrate with aqueous sodium sulfate.

[2]

(ii) The change that accompanies the standard enthalpy change of atomisation of iodine.

[2]

(Total 12 marks)