

Exercise walk-through

1.2

The periodic table (4.1.2.1–4.1.2.3)

AQA · GCSE · Chemistry

1

The method

Method — Worked example

Elements are ordered by **atomic (proton) number**; a **group** is a column of elements with the same number of **outer-shell electrons**, giving similar properties.

Development: early tables used **atomic weight** – incomplete and sometimes misplaced elements. **Mendeleev** left **gaps** for undiscovered elements and swapped some orders; the predictions were confirmed. **Isotopes** explained why atomic-weight order sometimes failed (average masses can invert).

Metals form positive ions – left and lower; **non-metals** do not – right and upper.

- **Group 0:** full outer shells → **unreactive**; boiling points increase down.
- **Group 1** (Li, Na, K): 1 outer electron; react with oxygen, chlorine and water ($2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$). Reactivity **increases down** – the outer electron is further out and lost more easily.

Method — Worked example

- **Group 7** (halogens, diatomic): 7 outer electrons; melting/boiling points increase down; reactivity **decreases down** – an outer electron is gained less easily. A more reactive halogen **displaces** a less reactive one: $\text{Cl}_2 + 2 \text{KBr} \rightarrow 2 \text{KCl} + \text{Br}_2$.

Worked example (3 marks). Explain why potassium reacts more vigorously with water than sodium.

Both lose their one outer electron to the water (B1); in potassium the outer electron is further from the nucleus, so the attraction is weaker (B1); the electron is lost more easily, so the reaction is faster/more vigorous (B1).

Exercises 2.1·2.3

2.1 Why do elements in the same group have similar chemical properties? [1]

2.2 Give the formula of the compound formed when lithium reacts with chlorine. [1]

2.3 Predict whether astatine is more or less reactive than iodine, with a reason. [2]

Exercises 2.1·2.3

2.1 Why do elements in the same group have similar chemical properties? [1]

2.1 They have the same number of electrons in their outer shell.

2.2 Give the formula of the compound formed when lithium reacts with chlorine. [1]

2.2 LiCl.

2.3 Predict whether astatine is more or less reactive than iodine, with a reason. [2]

2.3 Less reactive; astatine's outer shell is furthest from the nucleus, so it attracts an extra electron least strongly.

Exercises 3.1·3.2

3.1 Describe how Mendeleev arranged his periodic table and why his predictions mattered. [5]

3.2 Chlorine is added to potassium bromide solution. Write the equation and explain, in terms of electrons, why this reaction happens. [4]

Exercises 3.1·3.2

3.1 Describe how Mendeleev arranged his periodic table and why his predictions mattered. [5]

3.1 Mendeleev ordered elements (mostly) by atomic weight, putting elements with similar properties in the same group; he left gaps for elements he believed were undiscovered and predicted their properties; when those elements were found with the properties predicted, his table and periodic law were accepted.

3.2 Chlorine is added to potassium bromide solution. Write the equation and explain, in terms of electrons, why this reaction happens. [4]

3.2 $\text{Cl}_2 + 2 \text{KBr} \rightarrow 2 \text{KCl} + \text{Br}_2$. Chlorine is more reactive than bromine because it gains an electron more easily – a stronger attraction for the outer shell being closer to the nucleus; so chlorine displaces bromide ions from solution.

Exercise 3.3

3.3 Explain why the noble gases are unreactive and why their boiling points increase down the group. [4]

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3.3 Their atoms have stable (full) outer shells – eight electrons, or two for helium; so they neither lose, gain nor share electrons. Going down the group, relative atomic mass and the number of electrons increase; intermolecular forces grow stronger, so more energy is needed to boil the liquid – boiling points rise.