Exercise walk-through

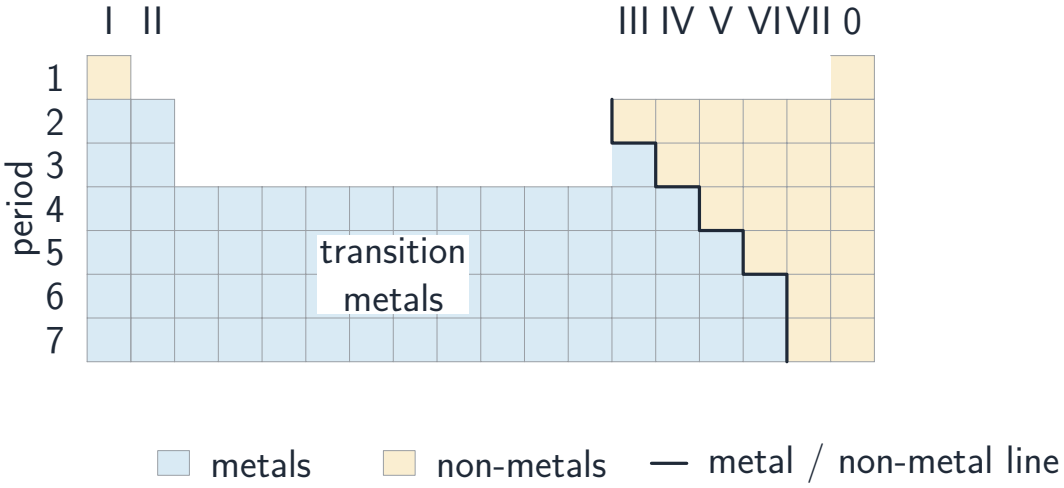
1.2
The periodic table (4.1.2.1–4.1.2.3)

AQA · GCSE · Chemistry

Building the periodic table; metals and non-metals

- In the early 1800s, chemists arranged the elements in order of atomic weight, since protons were not yet known.
- These early tables put some elements next to others with very different properties.
- **Mendeleev** solved this in two ways: he left gaps for elements not yet discovered, and in a few places he changed the order to keep elements with similar properties in the same **group**.
- When gallium (1875) and germanium (1886) were found with the properties he had predicted, scientists accepted his table.

Figure: Building the periodic table; metals and non-metals



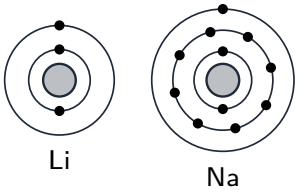
- Groups are the columns and periods are the rows; metals lie to the left of the staircase, non-metals to the right
- Match each part of the diagram to the text.

Transition metals (chemistry only)

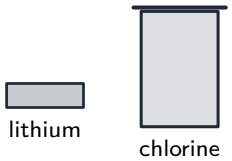
- they can form ions with different charges, such as Fe^{2+} and Fe^{3+};
- their compounds are often coloured: copper(II) sulfate solution is blue, iron(II) compounds are often pale green and iron(III) compounds orange-brown;
- they and their compounds are often useful as a **catalyst** : iron in the Haber process for making ammonia, and nickel for turning vegetable oils into margarine.

Exercises 2.1·2.2

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

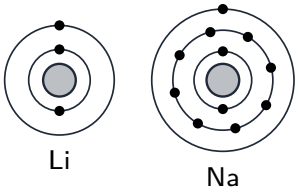


2.2 Give the formula of the compound formed when lithium reacts with chlorine. [1]



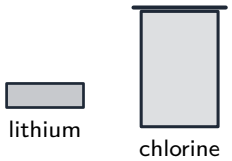
Exercises 2.1·2.2

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.

Exercises 2.3·3.1

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

F	Cl	Br	I	At

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

			gap		
		gap			

Exercises 2.3·3.1

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

F	Cl	Br	I	At

2.3 Less reactive; astatine has more occupied shells than iodine, so shielding/distance weaken attraction for an incoming electron.

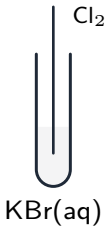
3.1 Describe how Mendeleev arranged his periodic table and why his predictions mattered. [5]

			gap		
		gap			

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.

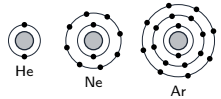
Setup for exercise 3.2 (1/3)

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



Setup for exercise 3.2 (2/3)

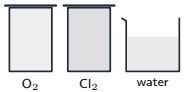
3.3 Explain why the noble gases are unreactive and why their boiling points increase down the group. [4]



3.4 Two supplied element records are X:atomic number 18, relative atomic mass 40.0; Y:atomic number 19, relative atomic mass 39.1. Give their modern order and explain why ordering only by average atomic mass would reverse it. What does isotope knowledge contribute to the explanation? [4]

	atomic no.	A_r
X	18	40.0
Y	19	39.1

3.5 Describe the products of lithium reacting separately with oxygen, chlorine and water. Balance $Li + O_2 \rightarrow Li_2O$ and $Li + H_2O \rightarrow LiOH + H_2$. Predict how potassium's water reaction compares with lithium's and explain using electron arrangements. [6]

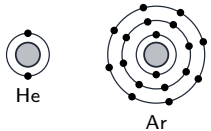


Setup for exercise 3.2 (3/3)

3.6 Halogen A displaces halogen B from aqueous B^-, but B does not displace A from A^-. Both displace iodine from iodide. Rank A, B and iodine by reactivity. Explain why iodine is diatomic but forms an ionic compound with sodium. Give the equation for chlorine displacing iodine from potassium iodide. [5]



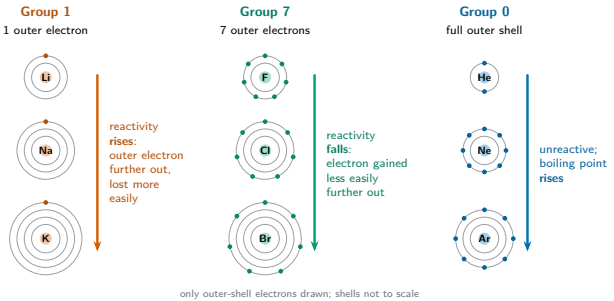
3.7 Helium has 2 electrons and argon has 18. Explain why both are in Group 0 even though they have different outer-electron numbers. Predict which has a higher boiling point and state how their particles are represented. [4]



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Exercise 3.2

3.8 The diagram summarises the trends in Groups 0, 1 and 7.



(a) Rubidium is below potassium in Group 1. Predict **two** observations when a small piece of rubidium is added to water, compared with potassium. [2]

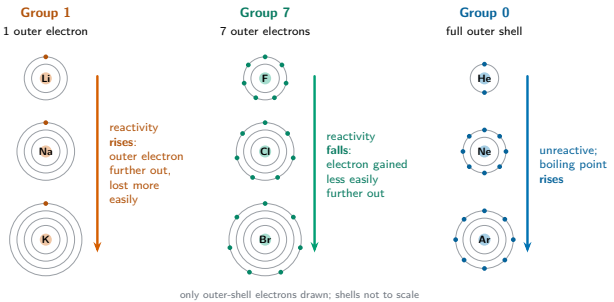
(b) Write a balanced equation for the reaction of rubidium (Rb) with water. [2]

(c) Astatine is below iodine in Group 7. Predict whether astatine displaces iodine from potassium iodide solution. Give a reason. [2]

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3.2 $Cl_2 + 2\ KBr \rightarrow 2\ KCl + Br_2$. 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 oxidises bromide ions to bromine molecules.

3.3 Their atoms have stable (full) outer shells – eight electrons, or two for helium; so they do not readily lose, gain or share electrons. Going down the group, relative atomic mass and the number of electrons increase; intermolecular forces grow stronger, so more

Full solution on next slide

Full solution 3.2 (1/2)

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3.3 Their atoms have stable (full) outer shells – eight electrons, or two for helium; so they do not readily lose, gain or 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.

3.4 X then Y because $18 < 19$ and modern order uses proton number. $39.1 < 40.0$ would put Y first by mass. Relative atomic mass is a weighted isotope average, so it need not rise strictly with proton number. Isotopes change neutrons/mass, not element identity.

3.5 Products: lithium oxide; lithium chloride; lithium hydroxide plus hydrogen. $4Li + O_2 \rightarrow 2Li_2O$; $2Li + 2H_2O \rightarrow 2LiOH + H_2$. Potassium reacts more vigorously; its outer

Full solution 3.2 (2/2)

electron is farther from the nucleus/more shielded, so is lost more easily. Use supplied oxide formula rather than claiming all alkali-metal oxygen products are identical.

3.6 A > B > iodine. Iodine element has I_2 molecules containing two iodine atoms; with sodium it forms Na^+/I^- ions in NaI. $Cl_2 + 2KI \rightarrow 2KCl + I_2$. An elemental molecule and a metal-halide compound have different structures.

3.7 Helium's first shell is full with 2; argon is 2,8,8 with a full outer shell. Argon has the higher boiling point from the Group 0 trend. Both gases are monatomic, separate atoms rather than diatomic molecules.

3.8 (a) Any two: it reacts more vigorously than potassium; it may explode or ignite / the hydrogen burns; it moves on the surface and fizzes faster / disappears faster. (b) $2Rb + 2H_2O \rightarrow 2RbOH + H_2$ (correct formulae B1; balanced B1). (c) No, it does not displace iodine; astatine is less reactive than iodine because reactivity decreases down Group 7 – its outer shell is farther from the nucleus, so it gains an electron less easily.