2.1 Groups and the air

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

Objective

Build the skills to answer exam questions on **Group 1, Group 7 and the air** 1 、 7 : alkali metals with water, halogen displacement reactions, the composition of air and the percentage of oxygen.

You must be able to:

- describe and explain trends in Groups 1 and 7
- write equations for alkali metals with water and halogen displacement
- calculate the percentage of oxygen in air from results
- plan an experiment to find the percentage of oxygen in air

1 Key knowledge and worked examples

Trends and air

idea	rule
Group 1 down the group	more reactive: the outer electron is further from the nucleus, so it is lost more easily
Group 7 down the group	less reactive: an extra electron is gained less easily
displacement	a more reactive halogen displaces a less reactive one from its salt
air	78% nitrogen, 21% oxygen, about 1% argon, 0.04% carbon dioxide
percentage of oxygen	fall in gas volume ÷ starting volume ×100

Worked example 1: oxygen in air. 100 cm^3 of air is passed over hot copper. 79 cm^3 of gas is left. Find the percentage of oxygen.

1. Known: $100 \to 79$ cm^3.
2. Rule: fall ÷ start ×100.
3. Numbers: $21 \div 100 \times 100$.
4. Result: 21%.

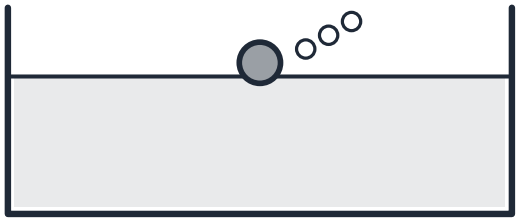
Worked example 2: displacement. Chlorine is bubbled into potassium bromide solution. Write the equation.

1. Known: chlorine is more reactive than bromine.
2. Rule: the more reactive halogen takes the place of the less reactive one.
3. Numbers: $Cl_2 + 2KBr$.
4. Result: $\mathbf{Cl_2} + 2\mathbf{KBr} \to 2\mathbf{KCl} + \mathbf{Br_2}$ (solution turns orange).

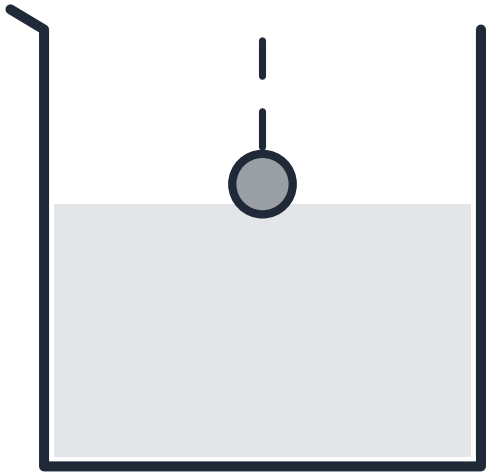
Answer shapes: explain trends with distance of the outer shell from the nucleus and shielding by inner shells.

2 Practice

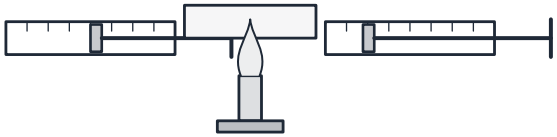
2.1 Describe **two** things you would see when a small piece of sodium is added to water. [2]



2.2 Write the balanced equation for the reaction of potassium with water. [2]

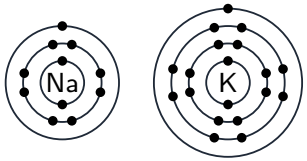


2.3 50.0 cm^3 of air is passed backwards and forwards over hot copper. 39.5 cm^3 of gas is left. Calculate the percentage of oxygen in the air. [2]



3 Exam-style questions

3.1 Explain why potassium is more reactive than sodium. [3]



3.2 Bromine water is added to potassium iodide solution. Predict what you would see, and explain your answer. [3]



3.3 A student adds solutions of chlorine, bromine and iodine to solutions of potassium chloride, potassium bromide and potassium iodide. The results table is shown (yes = a reaction happens, no = no reaction).

	KCl	KBr	KI
chlorine	–	yes	yes
bromine	no	–	yes
iodine	no	no	–

(a) Write the ionic equation for chlorine reacting with bromide ions, and state which substance is oxidised. [3]

(b) Astatine is below iodine in Group 7. Predict its state at room temperature and how its reactivity compares with iodine, giving a reason. [3]

(c) Describe an experiment to find the percentage of oxygen in air using damp iron wool, and explain how the result is calculated. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

Any two (1 mark each):

- it floats
- it fizzes (bubbles of gas)
- it melts into a ball
- it moves around on the surface

2.2

- correct formulae: $\mathrm{K + H_2O \rightarrow KOH + H_2}$
- balanced: $\mathrm{2K + 2H_2O \rightarrow 2KOH + H_2}$

2.3

- $10.5 \div 50.0 \times 100$
- **21**%

3.1

- potassium's outer electron is in a shell further from the nucleus
- there is more shielding by inner shells, so the attraction to the nucleus is weaker
- so the outer electron is lost more easily

3.2

- the solution turns from colourless to brown
- bromine is more reactive than iodine
- so bromine displaces iodine from potassium iodide

3.3

(a) $\mathrm{Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2}$; bromide ions are oxidised

(b) solid; less reactive than iodine; its atoms gain an electron less easily, as the outer shell is further from the nucleus

(c) points to include:

- push damp iron wool into the bottom of a measuring cylinder (or a graduated tube) (K)
- stand it upside down in a trough of water and record the starting volume of air (K)
- leave for about a week; the iron rusts and uses up the oxygen (K)
- water rises up the tube to replace the oxygen; record the final volume (K)
- percentage of oxygen = fall in volume ÷ starting volume ×100 (App)
- keep the temperature the same at the start and end, as gas volume changes with temperature (An)

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.