Topic 2: Inorganic chemistry

Edexcel International GCSE Chemistry 4CH1 · Section 2 · statements 2.1–2.50 · sheets 2.1–2.3

Lithium fizzes, potassium ignites

Your turn

Lithium, sodium and potassium are each dropped into water.

A. Which reacts most vigorously, and what gas is made?

B. Predict how rubidium, below potassium, would react.

C. Why is gold found as the metal in the ground, but iron is not?

Group 1 and Group 7 trends

Group 1 (Li, Na, K)

With water: hydroxide + hydrogen; faster down the group.

(C) The outer electron is further from the nucleus, so it is lost more easily.

Group 7 (Cl_2, Br_2, I_2)

Pale green gas, orange-brown liquid, grey-black solid: darker down the group.

(C) The outer shell is further away, so gaining an electron is harder.

Halogen displacement

1. **Mix** Chlorine water is added to colourless potassium bromide solution.
2. **See** The solution turns orange.
3. **Explain** Chlorine is more reactive than bromine, so it displaces bromine.
4. **Equation** $\mathrm{Cl_2} + 2\mathrm{KBr} \rightarrow 2\mathrm{KCl} + \mathrm{Br_2}$

Decision

Iodine solution added to potassium chloride shows no change.

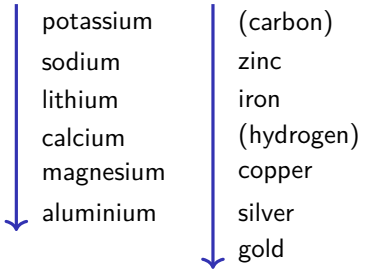
Air, oxygen and combustion

Element burned in oxygen	Observation and product
magnesium	bright white flame; white MgO
hydrogen	burns with a pop; steam
sulfur	blue flame; choking SO_2

Use the evidence

Dry air: N_2 78%, O_2 21%, Ar 0.93%, CO_2 0.04%. Iron **rusting** over water uses up the oxygen: the water rises one-fifth. $CuCO_3 \rightarrow CuO + CO_2$ on heating.

The reactivity series



Carbon reduces oxides of metals below it; metals above hydrogen give hydrogen with dilute acids.

- Metals above hydrogen react with dilute acids.
- A metal displaces any less reactive metal.

Rusting and redox

Preventing rust

Barrier: paint, oil, plastic.

Galvanising (zinc coat); **sacrificial protection**: zinc or magnesium corrodes instead.

Redox

Oxidation: loss of electrons or gain of oxygen. Reduction: the reverse.

The oxidising agent is reduced; the reducing agent is oxidised.

(C) Extraction matches reactivity

Metal	Position	Extraction
gold, silver	very unreactive	found native, as the metal
iron	below carbon	reduced by carbon in a blast furnace
aluminium	above carbon	electrolysis of molten ore

Use the evidence

Alloys are harder: atoms of different sizes stop the layers sliding.

Acids, alkalis and indicators

Indicator	In acid	In alkali
litmus	red	blue
phenolphthalein	colourless	pink
methyl orange	red	yellow

Use the evidence

pH 0–14: below 7 acidic, 7 neutral, above 7 alkaline. Acid + alkali → salt + water. (C) Titrate to concordant results.

Solubility rules

Salts	**Soluble?**
sodium, potassium, ammonium	all soluble
nitrates	all soluble
chlorides	soluble except AgCl and $PbCl_2$
sulfates	soluble except $BaSO_4$, $CaSO_4$, $PbSO_4$
carbonates	insoluble except Na, K, ammonium
hydroxides	insoluble except Na, K ($Ca(OH)_2$ slightly)

Three routes to a salt

Route	**Example**	**Steps**
insoluble base	CuO + warm H_2SO_4	add excess base, filter, evaporate, crystallise
(C) acid + alkali	$HCl + NaOH$	titrate, then repeat without indicator and evaporate
(C) insoluble salt	$Pb(NO_3)_2 + Na_2SO_4$	mix solutions, filter the **precipitate**, wash, dry

Tests for gases and water

Gas	Test and positive result
hydrogen	lit splint gives a squeaky pop
oxygen	relights a glowing splint
carbon dioxide	turns limewater milky
ammonia	turns damp red litmus blue
chlorine	bleaches damp litmus paper white

Use the evidence

Water turns anhydrous copper(II) sulfate from white to blue; pure water boils at exactly 100 °C.

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Tests for cations and anions

Ion	Test	Positive result
Li^+, Na^+, K^+	**flame test**	red, yellow, lilac
Ca^{2+}, Cu^{2+}	flame test	orange-red, blue-green
Cu^{2+}, Fe^{2+}, Fe^{3+}	NaOH(aq)	blue, green, rust-brown **precipitate**
Cl^-, Br^-, I^-	acidified $AgNO_3$	white, cream, yellow precipitate
$SO_4{}^{2-}$	acidified $BaCl_2$	white precipitate
$CO_3{}^{2-}$	dilute HCl	fizzes; CO_2 turns limewater milky

Check yourself

Your turn

Answer without notes, then check.

A. Describe the trend in Group 1 reactivity and give the (C) reason.

B. State the two conditions for rusting and two ways to prevent it.

C. (C) Why is aluminium extracted by electrolysis but iron by carbon?

D. Write the equation for copper(II) oxide with sulfuric acid.

E. Describe the test for sulfate ions and the positive result.