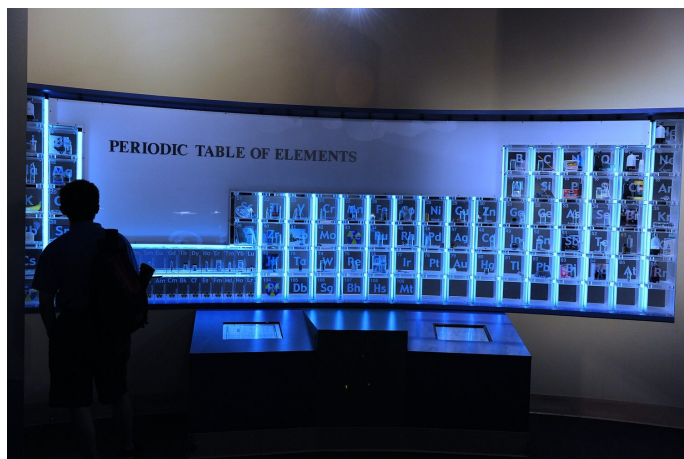


# The Periodic Table

IGCSE Chemistry

## Arrangement of the elements



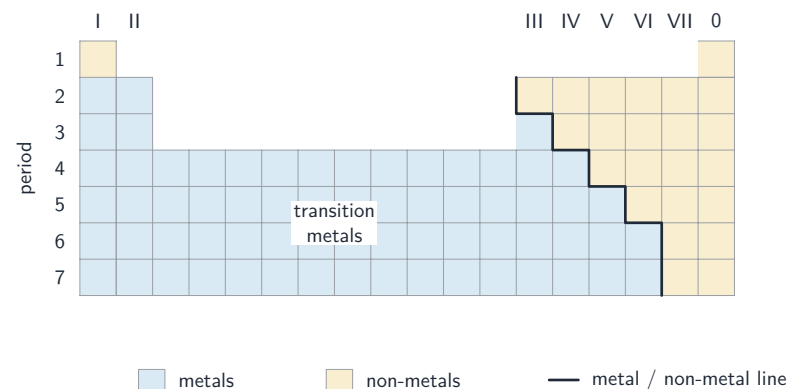
*The periodic table arranges the elements in order of atomic number.*

The **Periodic Table** 周期表 arranges all the **elements** 元素 in order of increasing **proton number** 质子数 (the **atomic number** 原子序数). The horizontal rows are called **periods** 周期 and the vertical columns are called **groups** 族.

A few key patterns:

- Across a period, the elements change from **metals** 金属 on the left to **non-metals** 非金属 on the right.
- The group number tells you the charge of the **ions** 离子 that the elements form. Group I forms +1 ions, Group II forms +2 ions, and Group VII forms -1 ions.
- Elements in the same group have similar chemical properties. This is because they have the same number of outer-shell **electrons** 电子 (the same outer **electronic configuration** 电子排布).

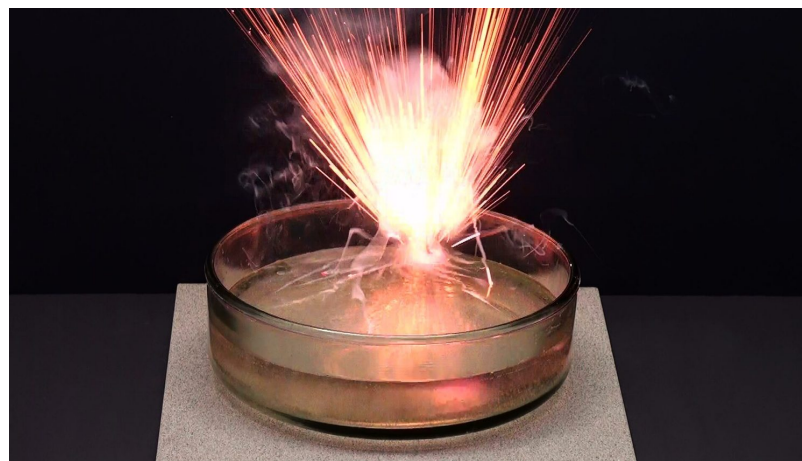
Because of these patterns, you can use an element's position to predict its properties.



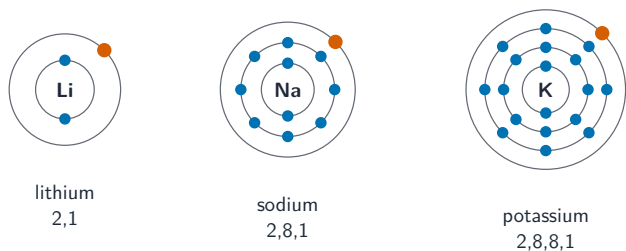
*Groups are the columns and periods are the rows; metals lie to the left of the staircase, non-metals to the right*

## Group I — the alkali metals

Group I elements are the **alkali metals** 碱金属: **lithium** 锂, **sodium** 钠 and **potassium** 钾. They are **soft** 柔软 metals (you can cut them with a knife).



*Potassium reacts violently with water, giving off hydrogen that burns with a lilac flame — reactivity increases down Group I*



every Group I atom has **one** electron in its outer shell (shown in orange), so they react in similar ways

*Every Group I atom has one electron in its outer shell, which is why they react in similar ways*

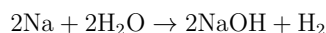
Going down the group, there are clear **trends** 趋势:

| Property                | Trend going down the group |
|-------------------------|----------------------------|
| <b>melting point</b> 熔点 | decreases                  |
| <b>density</b> 密度       | increases                  |
| <b>reactivity</b> 活泼性   | increases                  |

You can use these trends to predict the properties of other Group I elements. For example, rubidium (below potassium) would be even more reactive and have an even lower melting point.

## Reaction with water, and what you see

This is the reaction the exam asks about most. Every Group I metal reacts with water to give an **alkali** (the metal hydroxide) plus **hydrogen** - which is exactly why they are called the alkali metals:



“Describe what you see” is worth marks of its own, so learn the list for **sodium on water**:

- it **floats** - the metal is less dense than water.
- it **melts into a ball** - the reaction gives out heat, and the metal’s melting point is low.
- it **moves about** on the surface - the hydrogen jetting off pushes it around.
- there is **effervescence** 泡腾 (fizzing) - the hydrogen gas escaping.
- it **gets smaller and disappears** as it is used up.

- the solution turns **alkaline**, so universal indicator goes **purple** (it is now NaOH).

The trend shows up in how violent this is: **lithium** fizzes steadily but does not melt; **sodium** melts into a ball and darts around; **potassium** is fast enough to ignite its own hydrogen, burning with a **lilac flame**. Two answers to avoid: “hydrogen is given off” is not an observation (you cannot see it - say **effervescence**), and the metal melts because the **reaction is exothermic**, not because “water is hot”.

## Group VII — the halogens

Group VII elements are the **halogens** 卤素: **chlorine** 氯气, **bromine** 溴 and **iodine** 碘. They are **diatomic** 双原子 non-metals (each molecule is made of two atoms, such as Cl<sub>2</sub>).

Their appearance at room temperature and pressure:

| Halogen  | Appearance              |
|----------|-------------------------|
| chlorine | a pale yellow-green gas |
| bromine  | a red-brown liquid      |
| iodine   | a grey-black solid      |

Going down the group, the density increases but the reactivity **decreases** (the opposite trend to Group I).

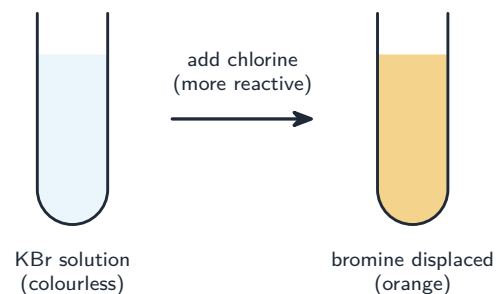
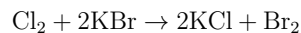


*Group I gets more reactive down the group, while Group VII gets less reactive down — opposite trends*

## Displacement reactions

A more reactive halogen pushes out (displaces) a less reactive **halide** 卤化物 ion from its solution. This is a **displacement reaction** 置换反应.

For example, chlorine is more reactive than bromine, so chlorine displaces bromine from potassium bromide:



*Chlorine is more reactive, so it displaces bromine from the solution; the released bromine turns the colourless solution orange*

**Worked example.** Aqueous chlorine is added to potassium iodide solution; then aqueous iodine is added to potassium bromide solution. What happens in each? Reactivity falls **down** Group VII: chlorine, then bromine, then iodine. (a) Chlorine is above iodine, so it is more reactive and displaces it:  $\text{Cl}_2 + 2\text{KI} \rightarrow 2\text{KCl} + \text{I}_2$ , and the solution turns red-brown as iodine is released. (b) Iodine is **below** bromine, so it is less reactive and cannot displace it - there is **no reaction** and no colour change. "No reaction" is a complete answer worth marks: check the order in the group before you write any equation.

## Transition elements

The **transition elements** 过渡元素 are the block of metals in the middle of the Periodic Table. Compared with Group I metals, they:

- have high densities;
- have high melting points;
- form **coloured** 有色 **compounds** 化合物;
- often act as catalysts, both as elements and in compounds.

They can also have **variable** 可变 **oxidation numbers** 氧化数. For example, **iron** 铁 forms both iron(II) and iron(III) compounds.

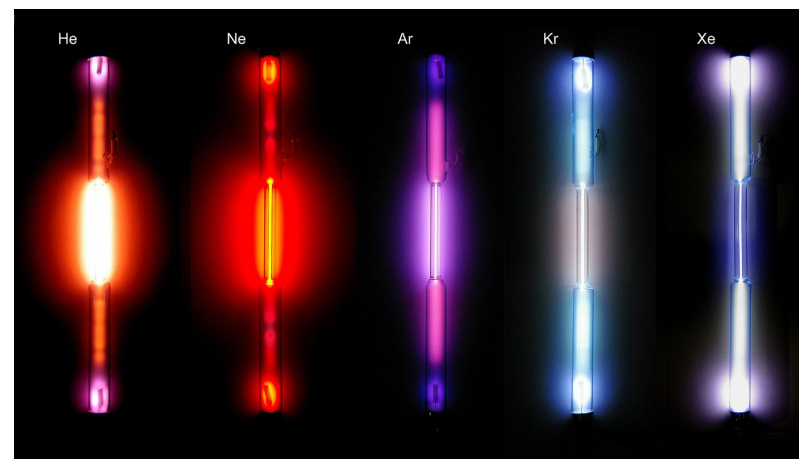


*Transition metals form coloured compounds: each of these solutions contains a different transition-metal ion*

## Group VIII — the noble gases

The Group VIII **noble gases** 稀有气体 are **unreactive** 不活泼, **monatomic** 单原子 gases (they exist as single atoms, not as molecules).

They are unreactive because they already have a full outer shell of electrons. This makes them stable, so they do not need to gain, lose or share electrons.



*Passing electricity through each noble gas makes it glow a characteristic colour — this is how neon signs and other lights work*

## Exam tips

- The Periodic Table is ordered by **proton number**. Elements in the same **group** (column) have the same number of outer electrons, so they react in similar ways; **periods** are the rows.
- **Group I** (alkali metals) get *more* reactive going down; **Group VII** (halogens) get *less* reactive going down — opposite trends.
- A more reactive **halogen displaces** a less reactive one from a solution of its salt — for example chlorine displaces bromine.
- **Noble gases** are unreactive because they have a full outer shell. **Transition elements** are hard and dense, form coloured compounds, act as catalysts and have variable oxidation numbers.