Structure 3.1 · The periodic table: classification of elements · supported focus

International Baccalaureate · IB Diploma · Chemistry · HL

Scope and prerequisites

Supported HL/SL core focus. First assessment 2025; current brief acquired; full Chemistry guide not acquired. Remaining guide, assessment and practical requirements retain their recorded holds.

Prerequisites: electron configurations from Structure 1.3 and the nuclear-atom model from Structure 1.2. Each lesson develops its own method before independent transfer.

These are original or explicitly fictional teaching examples, not actual measurements or completed assessed learner investigations.

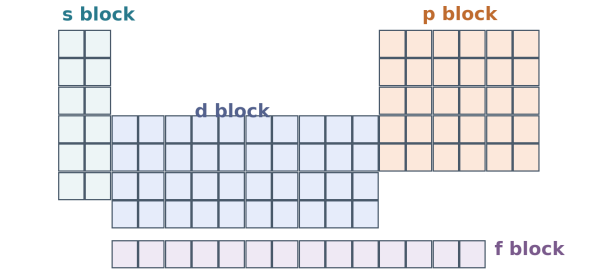
The periodic table: classification of elements

What would explain this observation?

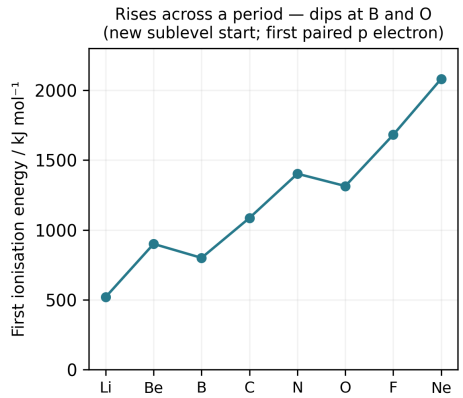
- Lithium, sodium and potassium all fizz with water – and each more violently than the last. Why do these elements behave like a family?
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

Build the model

- Elements are ordered by atomic number. A vertical **group** contains atoms with the same number of outer electrons, so they react alike. A horizontal **period** fills one more electron shell across its length. The **block** (s, p, d or f) names which sublevel is being filled.
- Across a period the **first ionisation energy** rises overall, because the nuclear charge grows at almost unchanged shielding; it dips where a new sublevel starts (B after Be) and where a p orbital first holds a paired electron (O after N). Down a group it falls as the outer electron is farther away and more shielded.
- group: A column of the periodic table whose atoms share an outer-electron count; period: A row of the table filling one electron shell; block: The region of the table named by the sublevel being filled; first ionisation energy: The energy needed to remove one electron from each atom in one mole of gaseous atoms.



Group = shared outer-electron count → similar reactions down a group



Choose evidence that can test it

- Compare the reactions of two or more members of one group under the same conditions, such as lithium and potassium with cold water: same products, different vigour – evidence that shared outer configuration drives the chemistry.
- Plot measured first ionisation energies across a period. The model predicts the rise and the two dips at the sublevel boundary and the first paired p electron; check whether the data show exactly those dips.

Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: the first ionisation energies of magnesium and aluminium are 738 and 578 kJ/mol. The trend rises across a period, yet Al lies below Mg. The electron removed from aluminium is in 3p, while magnesium loses from 3s: the 3p electron is higher in energy and better shielded, so less energy is needed – a difference of $738 - 578 = 160$ kJ/mol.

Example:

The first ionisation energies of sodium and magnesium are 496 and 738 kJ/mol. Find the difference and explain its direction using the same sequence: known quantities → model → relation → substitution → unit and interpretation. (Answer: $738 - 496 = 242$ kJ/mol higher for magnesium; the 3s electron in Mg feels one more proton at nearly the same shielding, so it is held more tightly.)

■ Check the conclusion and its limits

- The block model explains the MAIN trends; transition-metal chemistry has additional d-orbital detail beyond this classification lesson, and ionisation values are measured for gaseous atoms, not for reacting solids.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Elements in the same group react alike because they have the same number of electrons. This claim is false: they share the number of OUTER electrons – sodium has 11 electrons in total and potassium 19, yet both react as Group 1 metals because each has one outer electron.

Key:

The periodic table: classification of elements: group = shared outer-electron count and similar reactions; period = a filling shell; block = the sublevel being filled. Ionisation energy rises across a period with dips at the sublevel boundary and the first paired p electron, and falls down a group.