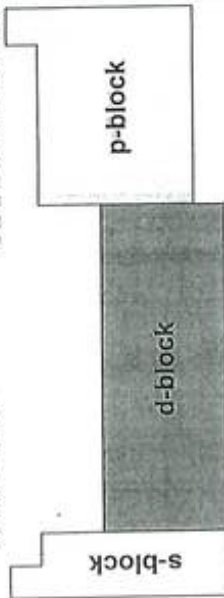


PERIODICITY

s, p, d AND f BLOCKS

The periodic table can be divided into four 'blocks': the s, p, d and f blocks.



ELECTRONIC STRUCTURE OF PERIOD 3 ELEMENTS

Period 3 is the third row of the periodic table, from Na to Ar.

Here are the electronic structures of the Period 3 elements:

Na	[Ne] 3s ¹
Mg	[Ne] 3s ²
Al	[Ne] 3s ² 3p ¹
Si	[Ne] 3s ² 3p ²
P	[Ne] 3s ² 3p ³
S	[Ne] 3s ² 3p ⁴
Cl	[Ne] 3s ² 3p ⁵
Ar	[Ne] 3s ² 3p ⁶

[Ne] is shorthand for the electronic structure of neon, 1s² 2s² 2p⁶.

PERIODICITY

Periodicity is another word for the trend you see across a period of the periodic table. In Period 3, there are noticeable trends in the atomic radius, first ionisation energy and the melting point.

Na Mg Al Si P S Cl Ar

ATOMIC RADIUS

Atomic radius decreases across Period 3.

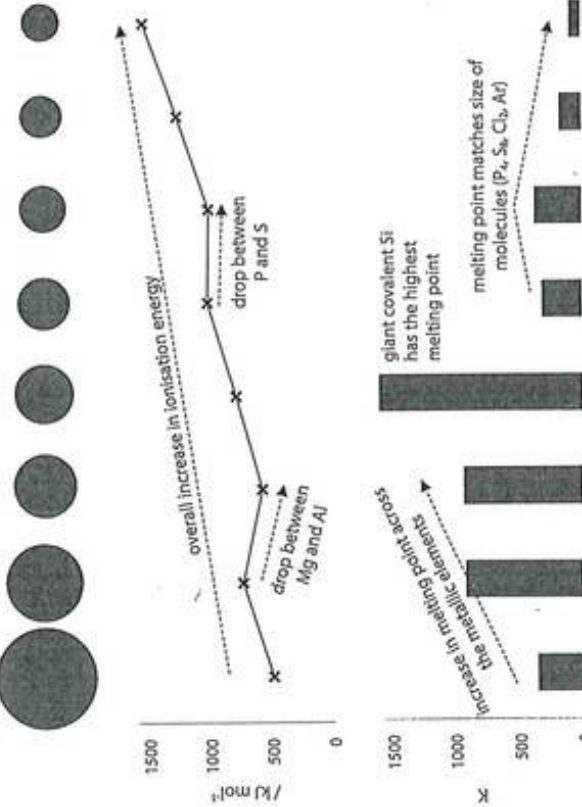
FIRST IONISATION ENERGY

Definition: the amount of energy required to remove one mole of electrons from one mole of atoms of an element to form one mole of ions.

MELTING POINT

Depends on the structure and bonding:

- Na, Mg and Al bond **metallically**
- Si has a **giant covalent** structure
- P, S, Cl and Ar form **small covalent molecules**



REASONS FOR PERIODICITY

ATOMIC RADIUS

The trend in atomic radius is a result of the **increasing nuclear charge** across Period 3.

Each new element has one more proton.

This increases the attraction between the nucleus and the outer electrons, so the electrons are pulled closer to the nucleus.

Note: screening by inner electrons (1s² 2s² 2p⁶) does not change across the period.

EXAM TIP

When explaining these decreases, always state that these factors **more than compensate** for the increase in nuclear charge.

FIRST IONISATION ENERGY

Four factors can affect the first ionisation energy:

- Nuclear charge
- Screening by inner electrons
- The distance between the nucleus and the outer electrons
- Whether the electron shares an orbital with another electron

OVERALL TREND

The overall increase in first ionisation energy is due to **increasing nuclear charge** across Period 3 (this also decreases the atomic radius, so there is less distance between the electrons and the nucleus).

DECREASE BETWEEN Mg AND Al

The dip between Mg and Al is because the additional electron in Al is in a **p-orbital** rather than an s-orbital. This p-orbital is further from the nucleus

- slightly screened by the 3s-orbital
- which more than compensates for the increase in nuclear charge.

DECREASE BETWEEN P AND S

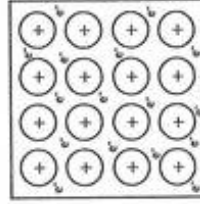
The dip between P and S is because the additional electron in S **shares an orbital** with another electron. The two electrons repel each other, so it is easier (takes less energy) to ionise.

MELTING POINT

The melting points of the Period 3 elements are a result of their structure and bonding.

METALLIC ELEMENTS

Na, Mg and Al contain metallic bonding. Metallic bonding is strong because there are many strong attractions between positive ions and negative electrons. The melting points of these elements are high.



The ions in the metallic bonding increase in charge across Period 3: 1+ in Na, 2+ in Mg and 3+ in Al.

The 'sea' of electrons also becomes more highly charged across the period. The metallic bonding is, therefore, stronger in Al than in Na, so there is a higher melting point.

GIANT COVALENT

Si has a giant covalent structure. Each Si atom forms four covalent bonds to other Si atoms.



Giant covalent lattices have multiple strong covalent bonds, which require a lot of energy to break. Si has a very high melting point.

COVALENT MOLECULES

P, S, Cl and Ar are small covalent molecules with different numbers of atoms.



The larger molecules have more electrons, so have stronger van der Waals forces between molecules and, therefore, require a higher temperature to melt.