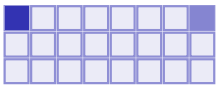
Chemical Periodicity

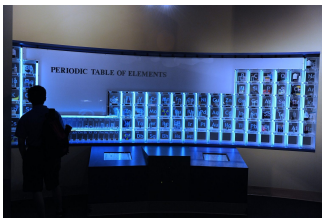
A-Level Chemistry ▪ Topic 9

A-Level Chemistry



What we will cover

1. Atomic radius
2. Melting point & structure
3. Oxidation numbers
4. Oxides: acid–base
5. Amphoteric Al_2O_3
6. Chlorides with water



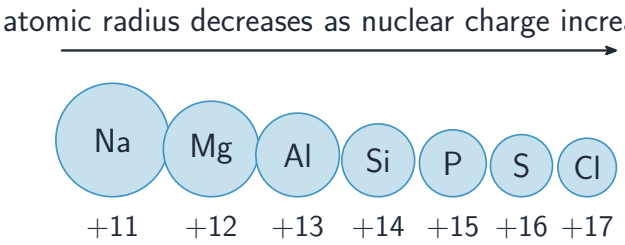
properties repeat in periods

1 Physical properties

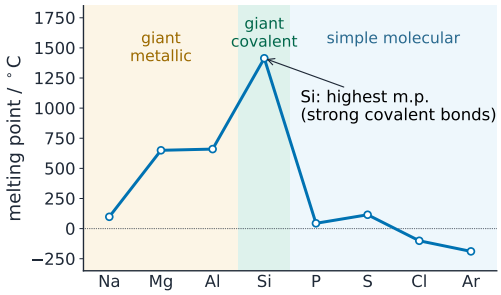
Atomic radius across Period 3

Periodicity 周期性: properties repeat across each **period** 周期.

> **Atomic radius** 原子半径 decreases across Period 3 – the rising **nuclear charge** 核电荷 pulls the same outer shell inwards.



Melting point and structure



Melting point peaks at silicon:

- Na, Mg, Al – **giant metallic** 金属晶体, conduct
- Si – **giant covalent** 原子晶体, highest m.p.
- P, S, Cl, Ar – **simple molecular** 分子晶体, low m.p.

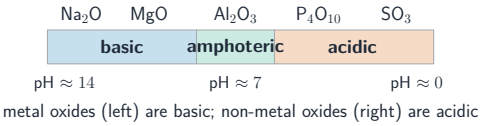
2 Chemical properties

Oxidation numbers

Na_2O	MgO	Al_2O_3	P_4O_{10}	SO_3
$+1$	$+2$	$+3$	$+5$	$+6$

The **oxidation number** 氧化数 rises across the period – it equals the **valence** 价层 electrons used in bonding. The chlorides show the same $+1$ to $+5$ rise.

Oxides: acid–base behaviour



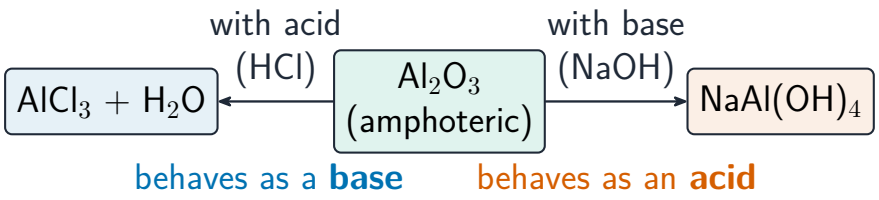
metal oxides (left) are basic; non-metal oxides (right) are acidic

The oxides change across the period:

- metal oxides (Na, Mg) – basic
- Al_2O_3 – **amphoteric** 两性
- non-metal oxides (P, S) – acidic

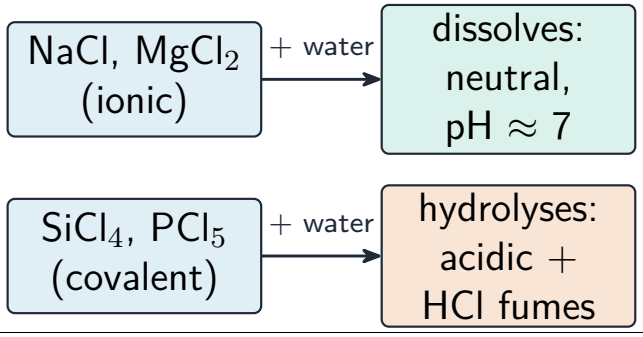
Amphoteric aluminium oxide

Aluminium oxide 氧化铝 is **amphoteric** 两性 – it reacts with both acids and bases. With acid it behaves as a base; with base it behaves as an acid.



Chlorides with water

- ionic chlorides (NaCl, $MgCl_2$) just dissolve – near-neutral
- covalent chlorides ($SiCl_4$, PCl_5) **hydrolyse** 水解 – acidic + HCl fumes



3 Recap

Worked example – melting points across Period 3

Explain why the melting point rises Na → Al, peaks at Si, then falls sharply at P.

- Na, Mg, Al: giant metallic. Charge goes $+1 \to +3$ and more electrons delocalise, so attraction grows.
- Si: giant covalent. Many strong covalent bonds must break ⇒ the peak.
- P: simple molecular (P_4). Only weak **induced-dipole forces** 诱导偶极力 break.
- So the drop is giant → simple, not a change in bond strength.

Melting point follows the structure, not the atom. Giant (metallic or covalent) ⇒ high; simple molecular ⇒ low.

Topic 9 – key takeaways

1 Radius

decreases across the period

2 Melting point

peaks at silicon (giant covalent)

3 Oxides

basic → amphoteric → acidic

4 Chlorides

ionic dissolve; covalent hydrolyse

Check yourself

1. Which Period 3 element has the highest melting point?
2. Which oxide is amphoteric?
3. Is Na_2O acidic or basic?
4. What do covalent chlorides do in water?

Answers **1.** silicon **2.** Al_2O_3 **3.** basic **4.** hydrolyse to an acidic solution