

Topic 11 – Periodicity Revision Notes

1) Trends across period 3

- Across period 3, nuclear charge increases and shielding remains constant
- There is increased attraction between the nucleus and the outer shell electrons so atomic radius decreases, first ionisation energy increases (apart from dips to Al and S)
- When covalently bonded, there is increased attraction between the nucleus and the shared pair electrons so electronegativity increases
- Na, Mg and Al have metallic bonding. Si is giant covalent. P₄, S₈ and Cl₂ are simple molecular. Ar is simple atomic

2) Reactions of period 3 elements

a) Reactions of Period 3 elements with water

Equation	Observations	Redox
$2\text{Na(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2\text{(g)}$	Effervescence Yellow flame	Na from 0 to +1, oxidation H from +1 to 0, reduction
$\text{Mg(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Mg(OH)}_2\text{(aq)} + \text{H}_2\text{(g)}$	Fine bubbles Slow reaction	Mg from 0 to +2, oxidation H from +1 to 0, reduction

- Magnesium reacts rapidly with steam



b) Reactions of Period 3 elements with oxygen

Equation	Observations	Redox
$4\text{Na(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{Na}_2\text{O(s)}$	White solid produced	Na from 0 to +1, oxidation O from 0 to -2, reduction
$2\text{Mg(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{MgO(s)}$	Bright white flame White solid produced	Mg from 0 to +2, oxidation O from 0 to -2, reduction
$4\text{Al(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{Al}_2\text{O}_3\text{(s)}$	White solid produced	Al from 0 to +3, oxidation O from 0 to -2, reduction
$\text{Si(s)} + \text{O}_2\text{(g)} \rightarrow \text{SiO}_2\text{(s)}$		Si from 0 to +4, oxidation O from 0 to -2, reduction
$\text{P}_4\text{(s)} + 5\text{O}_2\text{(g)} \rightarrow \text{P}_4\text{O}_{10}\text{(s)}$		P from 0 to +5, oxidation O from 0 to -2, reduction
$\text{S(s)} + \text{O}_2\text{(g)} \rightarrow \text{SO}_2\text{(g)}$	Blue flame Pungent/choking gas produced	S from 0 to +4, oxidation O from 0 to -2, reduction

3) Reactions of Period 3 oxides

a) Structure and bonding of oxides

- Na₂O, MgO are giant ionic – high melting and boiling points due to strong attraction between oppositely charged ions
- Al₂O₃ is ionic with covalent character - high melting and boiling points due to strong attraction between oppositely charged ions
- SiO₂ is giant covalent – very high melting and boiling points as there are many strong covalent bonds to break
- P₄O₁₀ and SO₃ are simple molecular – low melting and boiling points due to weak VdW forces between molecules

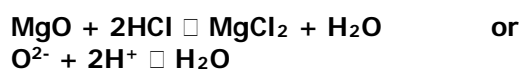
b) Reactions with water

Equation	Observations	Notes
Na ₂ O(s) + H ₂ O(l) → 2NaOH(aq)	Dissolves readily	Alkaline solution, pH 14 Oxide ions react with water to form OH⁻
MgO(s) + H ₂ O(l) → Mg(OH) ₂ (aq)	Sparingly soluble	Alkaline solution, pH 10 Oxide ions react with water to form OH⁻
Al ₂ O ₃ (s) + H ₂ O(l) → No reaction	Al ₂ O ₃ doesn't dissolve Lattice enthalpy is too high	Al ₂ O ₃ is amphoteric
SiO ₂ (s) + H ₂ O(l) → No reaction		
P ₄ O ₁₀ (s) + 6H ₂ O(l) → 4H ₃ PO ₄ (aq)		Acidic solution, pH 0
SO ₂ (g) + H ₂ O(l) → H ₂ SO ₃ (aq)		Acidic solution, pH 3
SO ₃ (g) + H ₂ O(l) → H ₂ SO ₄ (aq)		Acidic solution, pH 0

- Giant ionic oxides produce alkaline solutions
- Al₂O₃ and SiO₂ are insoluble
- Simple molecular oxides produce acidic solutions
- The trend across the Period is from ionic to covalent oxides and from alkaline to acidic solutions

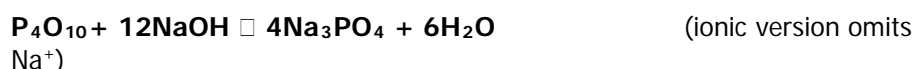
c) Reactions with acids and bases

- Alkaline oxides react with acids e.g.



This would also apply to amphoteric Al₂O₃ when acting as a base

- Acidic oxides react with bases e.g.



- (Amphoteric) aluminium oxide reacting as an acid

