9.2 Periodicity of chemical properties of Period 3

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

KEY WORDS oxidation number • oxide • amphoteric • chlorides • hydrolysis

Objective

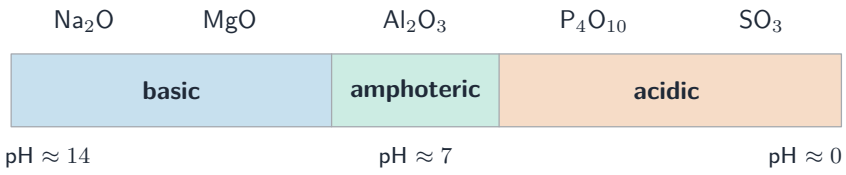
Build the skills to answer exam questions on the **chemical properties of Period 3** – reactions with oxygen, chlorine and water, the **oxides** and **chlorides**, **amphoteric** behaviour, and **hydrolysis**.

You must be able to:

- write equations for the reactions with oxygen, chlorine and water
- explain the acid–base behaviour of the oxides (including amphoteric Al_2O_3)
- explain the reactions of the chlorides with water and the pH obtained

1 Key knowledge and worked examples

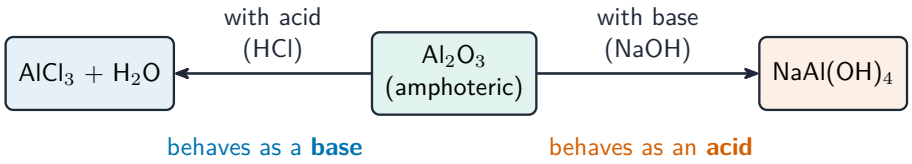
Oxides: acid–base trend



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

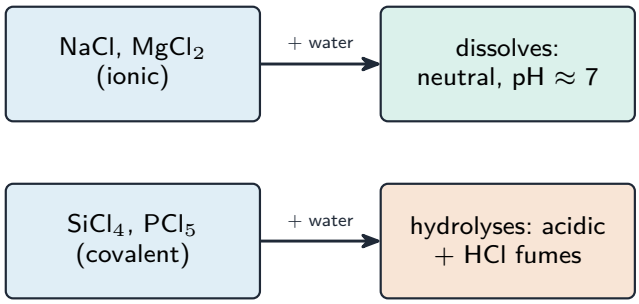
Oxides change from basic (metals) → amphoteric (Al_2O_3) → acidic (non-metals)

Na_2O, MgO are **basic** ($Na_2O + H_2O \rightarrow 2NaOH$, pH 13–14). P_4O_{10}, SO_3 are **acidic** ($SO_3 + H_2O \rightarrow H_2SO_4$, pH 0–1). The oxidation number rises across (Na_2O +1 … SO_3 +6) = the outer-shell electrons used.



Al_2O_3 is amphoteric – it reacts with both acids and bases

- **Chlorides with water**



Ionic $NaCl/MgCl_2$ just dissolve (neutral); covalent $SiCl_4/PCl_5$ hydrolyse to an acidic solution + HCl

E.g. $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$.

2 Practice

2.1 Write the equation for the reaction of sodium with water. [1]

2.2 State the acid–base nature of (a) MgO and (b) SO_3. [2]

3 Exam-style questions

3.1 Which Period 3 oxide is amphoteric? [1]

☐ **A** Na_2O
B MgO
C Al_2O_3
D SO_3

3.2 When PCl_5 is added to water, the solution formed is: [1]

- ☐ **A** strongly alkaline
- **B** neutral
- **C** acidic, with HCl fumes
- **D** unchanged (no reaction)

3.3 (a) Write an equation for the reaction of sulfur trioxide, SO_3, with water, and state the approximate pH. [2]

(b) Explain what is meant by Al_2O_3 being **amphoteric**, and write an equation for its reaction with hydrochloric acid. [3]

3.4 Explain why sodium chloride dissolves to give a neutral solution but silicon(IV) chloride gives an acidic solution. [3]

Solutions

Each answer shows the steps, then the **result**.

2.1

- $2Na + 2H_2O \rightarrow 2NaOH + H_2$

2.2

(a)

- basic

(b)

- (strongly) acidic

3.1 C

- Al_2O_3 is amphoteric

3.2 C

- PCl_5 hydrolyses to an acidic solution and HCl fumes

3.3

(a)

- $SO_3 + H_2O \rightarrow H_2SO_4$; pH 0–1

(b)

- amphoteric = reacts with both acids and bases; $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

3.4

- NaCl is ionic, so it just dissolves to give ions and a neutral solution; $SiCl_4$ is covalent and is hydrolysed by water, releasing HCl which makes the solution acidic