

9.2 Periodicity of chemical properties of Period 3

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

KEY WORDS oxidation number 氧化数 • oxide 氧化物 • amphoteric 两性 • chlorides 氯化物
• hydrolysis 水解

Objective

Build the skills to answer exam questions on the **chemical properties of Period 3** — reactions with oxygen, chlorine and water, the **oxides** 氧化物 and **chlorides** 氯化物, **amphoteric** 两性 behaviour, and **hydrolysis** 水解.

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 Worked examples

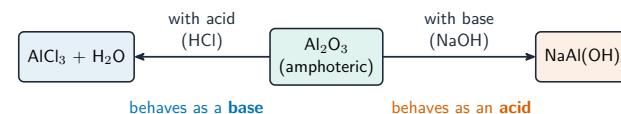
■ Oxides: acid–base trend

Na_2O	MgO	Al_2O_3	P_4O_{10}	SO_3
basic		amphoteric	acidic	
pH ≈ 14		pH ≈ 7		pH ≈ 0

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

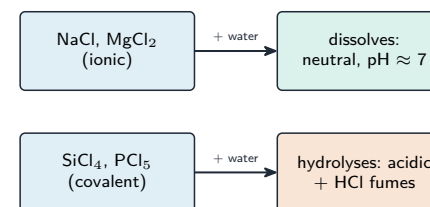
Oxides change from basic (metals) $\rightarrow$ amphoteric (Al_2O_3) $\rightarrow$ acidic (non-metals)

Na_2O , MgO are **basic** ($\text{Na}_2\text{O} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$, pH 13–14). P_4O_{10} , SO_3 are **acidic** ($\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$, pH 0–1). The oxidation number rises across ($\text{Na}_2\text{O} +1 \dots \text{SO}_3 +6$) = 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 $\text{SiCl}_4/\text{PCl}_5$ hydrolyse to an acidic solution + HCl

E.g. $\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$.

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

2.1 $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$.

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) $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$; pH 0–1.

(b) amphoteric = reacts with both acids and bases; $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$.

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.