

Week 15

A-Level Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

Topic 10 quiz	2
Exercise sheet 10.1	5
Past-paper questions 10.1	10

10. Group 2

Starter Quiz · 课前小测

A-Level Chemistry

Name: _____ Score: _____

- Reactivity increases down Group 2 because:
 - ☐ the atoms get larger and lose their outer electrons more easily
 - ☐ the atoms get smaller
 - ☐ the nuclear charge falls
 - ☐ they gain electrons
- Heating a Group 2 carbonate produces:
 - ☐ the metal oxide and carbon dioxide
 - ☐ the metal and oxygen
 - ☐ the hydroxide and hydrogen
 - ☐ nitrogen dioxide only
- A Group 2 metal reacting with water forms:
 - ☐ a hydroxide and hydrogen gas
 - ☐ an oxide and oxygen
 - ☐ a chloride and hydrogen
 - ☐ a carbonate
- Thermal stability of the carbonates increases down Group 2 because:
 - ☐ a larger metal ion polarises the carbonate ion less, so it is harder to break apart
 - ☐ the metal ion gets smaller
 - ☐ the carbonate ion gets larger
 - ☐ the temperature falls
- The oxides and hydroxides of Group 2 metals are:
 - ☐ basic
 - ☐ acidic
 - ☐ amphoteric
 - ☐ neutral
- Group 2 metals form ions with a 2+ charge.
 - ☐ True ☐ False

7. Group 2 carbonates become more thermally stable down the group.

☐ True ☐ False

8. Down Group 2:

- ☐ hydroxide solubility increases, while sulfate solubility decreases
- ☐ both increase
- ☐ both decrease
- ☐ hydroxide solubility decreases, sulfate increases

9. A Group 2 carbonate reacting with a dilute acid produces:

- ☐ a salt, water and carbon dioxide
- ☐ a hydroxide and hydrogen
- ☐ an oxide only
- ☐ nitrogen dioxide

10. Heating a Group 2 nitrate produces:

- ☐ the oxide, brown nitrogen dioxide and oxygen
- ☐ the metal and nitrogen
- ☐ only the oxide
- ☐ the carbonate

10. Group 2

A-Level Chemistry

1. **the atoms get larger and lose their outer electrons more easily**

Larger atoms hold their two outer electrons less tightly, so they are lost more readily.

2. **the metal oxide and carbon dioxide**

Thermal decomposition: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$.

3. **a hydroxide and hydrogen gas**

e.g. $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$; the reaction gets faster down the group.

4. **a larger metal ion polarises the carbonate ion less, so it is harder to break apart**

A big cation distorts the carbonate ion less, so more energy (a higher temperature) is needed to decompose it.

5. **basic**

They are basic — they react with water and neutralise acids.

6. **True**

They lose their two outer electrons.

7. **True**

Larger cations polarise the carbonate less.

8. **hydroxide solubility increases, while sulfate solubility decreases**

Hydroxides become more soluble ($\text{Ba}(\text{OH})_2$ soluble); sulfates become less soluble (BaSO_4 insoluble).

9. **a salt, water and carbon dioxide**

e.g. $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$.

10. **the oxide, brown nitrogen dioxide and oxygen**

e.g. $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$ (brown NO_2 gas is given off).

10.1 Group 2 metals, magnesium to barium

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS thermal stability 热稳定性 • thermal decomposition 热分解 • solubility 溶解度
• group 族 • oxide 氧化物

Objective

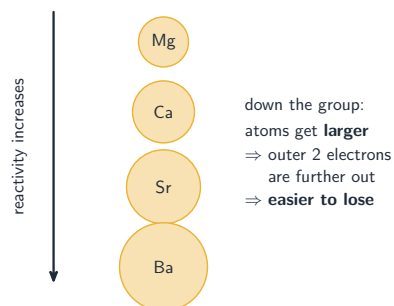
Build the skills to answer exam questions on the **Group 2 metals** 第二族金属 — their reactions, **thermal decomposition** 热分解 and **thermal stability** 热稳定性, and **solubility** 溶解度 trends.

You must be able to:

- write equations for the reactions with oxygen, water and dilute acids
- describe the thermal decomposition of the carbonates and nitrates and the stability trend
- state the solubility trends of the hydroxides and sulfates

1 Worked examples

■ Reactivity and reactions



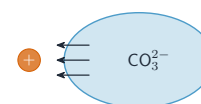
Reactivity increases down Group 2: larger atoms lose their two outer electrons more easily

- **oxygen:** $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$.
- **water:** $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$ (faster down the group).

- **acid:** $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$.

■ Thermal decomposition and stability

small Mg^{2+} :
high polarising power



distorts the ion
=> **decomposes easily**

large Ba^{2+} :
low polarising power

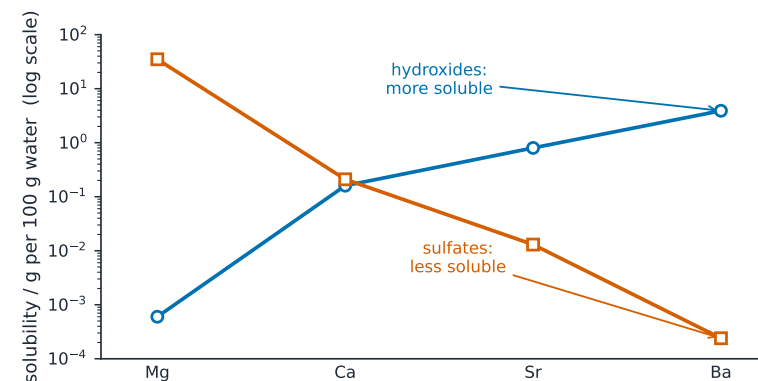


barely distorted
=> **thermally stable**

A small cation polarises the carbonate more, weakening it — so stability rises down the group

Carbonates → oxide + CO_2 ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$); nitrates → oxide + NO_2 + O_2 .
Thermal stability increases down the group (a larger ion polarises less).

■ Solubility



Group 2: OH^- sol. ↑ down • SO_4^{2-} sol. ↓ down

Down Group 2: hydroxides become more soluble; sulfates become less soluble

2 Practice

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

2.2 State the trend in reactivity down Group 2 and why. [2]

3 Exam-style questions

3.1 Which carbonate is the **most** thermally stable? [1]

- A MgCO_3
- B CaCO_3
- C SrCO_3
- D BaCO_3

3.2 Down Group 2, the solubility of the sulfates: [1]

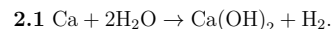
- A increases
- B decreases
- C stays the same
- D first rises then falls

3.3 (a) Write the equation for the thermal decomposition of calcium nitrate. [2]

(b) Explain why barium carbonate is more thermally stable than magnesium carbonate.[3]

3.4 Describe and explain the trend in reactivity of the Group 2 metals with water. [2]

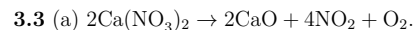
Solutions



2.2 reactivity increases down the group; the atoms are larger, so the two outer electrons are lost more easily.

3.1 D. Thermal stability increases down the group, so BaCO_3 is most stable.

3.2 B. Sulfate solubility decreases down Group 2.



(b) the Ba^{2+} ion is larger (lower charge density) than Mg^{2+} ; it polarises/distorts the carbonate ion less; so the C–O bonds are weakened less and a higher temperature is needed to decompose it.

3.4 reactivity increases down the group; larger atoms hold their outer electrons less tightly, so they react faster with water.

Name:

A-Level Chemistry: **w25 11**

19 The trends seen in Group 2 can be used to predict the properties of radium and its compounds.

Which statement is correct?

- A** Radium has the highest second ionisation energy of the elements in Group 2.
- B** Radium hydroxide is the least soluble of the hydroxides of the elements in Group 2.
- C** Radium carbonate has the lowest thermal stability of the carbonates of the elements in Group 2.
- D** Radium reacts faster with water than the other elements in Group 2.

20 Equal masses of CaCO_3 , $\text{Ca}(\text{NO}_3)_2$, BaCO_3 and $\text{Ba}(\text{NO}_3)_2$ are thermally decomposed. The volume of gas produced in each experiment is measured under the same conditions.

Which compound will produce the greatest volume of gas?

- A** CaCO_3 **B** $\text{Ca}(\text{NO}_3)_2$ **C** BaCO_3 **D** $\text{Ba}(\text{NO}_3)_2$

A-Level Chemistry: **w25 12**

19 When heated, magnesium nitrate decomposes.

Which equation for the thermal decomposition of magnesium nitrate is correct?

- A** $\text{Mg}(\text{NO}_3)_2 \rightarrow \text{MgO} + \text{NO}_2 + \text{NO} + \text{O}_2$
- B** $2\text{Mg}(\text{NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO} + 3\text{O}_2$
- C** $2\text{Mg}(\text{NO}_3)_2 \rightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2$
- D** $3\text{Mg}(\text{NO}_3)_2 \rightarrow \text{Mg}_2\text{N}_3 + \text{MgO} + 3\text{NO} + 7\text{O}_2$

20 R is the aqueous solution of an ionic compound.

- A white precipitate is formed when R is added to $\text{Sr}(\text{NO}_3)_2(\text{aq})$.
- No visible reaction is seen when R is added to dilute $\text{HNO}_3(\text{aq})$.

What is the anion present in compound R?

- A** Cl^- **B** SO_4^{2-} **C** HCO_3^- **D** CO_3^{2-}

A-Level Chemistry: **w25 14**

19 Magnesium nitrate, $\text{Mg}(\text{NO}_3)_2$, will decompose when heated to give a white solid and a mixture of gases. One of the gases released is oxygen.

29.7 g of anhydrous magnesium nitrate is heated until no further reaction takes place.

Which mass of oxygen is produced?

- A** 3.2 g **B** 6.4 g **C** 12.8 g **D** 19.2 g

20 Which row shows the trends in the named properties going down the Group 2 nitrates?

	thermal stability	volume of gas produced, measured at room conditions, when 1.0 g of anhydrous solid nitrate is thermally decomposed
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

1 (a) Solutions of Group 2 hydrogencarbonates, $M(\text{HCO}_3)_2$, decompose on heating to give the corresponding metal carbonate, carbon dioxide and water.

(i) Write an equation for the decomposition of strontium hydrogencarbonate, $\text{Sr}(\text{HCO}_3)_2$.

..... [1]

(ii) The thermal stability of Group 2 carbonates increases down the group.

Explain this trend.

.....

 [2]

(b) The hydroxides and fluorides of Group 2 elements show similar trends in solubility.

Describe the trend in the solubility of the fluorides of calcium, strontium and barium.

Explain your answer.

.....
 least soluble most soluble
 explanation

 [4]

(c) (i) Define enthalpy change of hydration, ΔH_{hyd} .

.....

 [1]

(ii) State the main factors that affect the magnitude of enthalpy change of hydration.

Explain your answer.

.....

 [2]

(d) Table 1.1 shows various energy changes.

Table 1.1

energy change	value / kJ mol^{-1}
lattice energy of MgF_2	–2957
enthalpy change of hydration, ΔH_{hyd} , of Mg^{2+}	–1926
enthalpy change of hydration, ΔH_{hyd} , of F^-	–505

Use data from Table 1.1 to calculate the enthalpy change of solution, ΔH_{sol} , for $\text{MgF}_2(\text{s})$.

It may be helpful to draw a labelled energy cycle. Show your working.

ΔH_{sol} of $\text{MgF}_2(\text{s}) = \dots\dots\dots \text{kJ mol}^{-1}$ [2]

(e) Mercury(I) fluoride, Hg_2F_2 , is sparingly soluble in water.

The cation in Hg_2F_2 exists as the diatomic ion Hg_2^{2+} with a covalent Hg–Hg bond.

(i) Write the expression for the solubility product, K_{sp} , of Hg_2F_2 . Include the units.

$K_{\text{sp}} =$
 units [2]

(ii) The solubility of Hg_2F_2 is $9.20 \times 10^{-3} \text{ mol dm}^{-3}$ at 298 K.

Calculate the value of K_{sp} of Hg_2F_2 at 298 K.

$K_{\text{sp}} = \dots\dots\dots$ [1]

[Total: 15]

1 Magnesium nitrate, $\text{Mg}(\text{NO}_3)_2$, and strontium nitrate, $\text{Sr}(\text{NO}_3)_2$, both decompose when heated to form the metal oxide and a mixture of gases.

(a) Write an equation for the thermal decomposition of $\text{Mg}(\text{NO}_3)_2$.

..... [1]

(b) State which of $\text{Mg}(\text{NO}_3)_2$ or $\text{Sr}(\text{NO}_3)_2$ decomposes at a lower temperature.

Explain your answer.

compound that decomposes at a lower temperature

explanation

.....

.....

.....

.....

[2]

(c) Magnesium oxide, MgO , and strontium oxide, SrO , both react with dilute sulfuric acid.

MgO forms a soluble salt, **A**.

SrO forms an insoluble salt, **B**.

(i) Identify the products formed when MgO reacts with dilute sulfuric acid.

..... [1]

(ii) Explain why **A** is more soluble than **B**.

.....

.....

.....

.....

.....

..... [3]

[Total: 7]