

Week 19

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

A-Level Chemistry

Name: _____ Score: _____

1. 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
2. Heating a Group 2 carbonate produces:
 - ☐ the metal oxide and carbon dioxide
 - ☐ the metal and oxygen
 - ☐ the hydroxide and hydrogen
 - ☐ nitrogen dioxide only
3. A Group 2 metal reacting with water forms:
 - ☐ a hydroxide and hydrogen gas
 - ☐ an oxide and oxygen
 - ☐ a chloride and hydrogen
 - ☐ a carbonate
4. 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
5. The oxides and hydroxides of Group 2 metals are:
 - ☐ basic
 - ☐ acidic
 - ☐ amphoteric
 - ☐ neutral
6. 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

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. $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{H}_2$; 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 (Ba(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. $2\text{Ca(NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$ (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

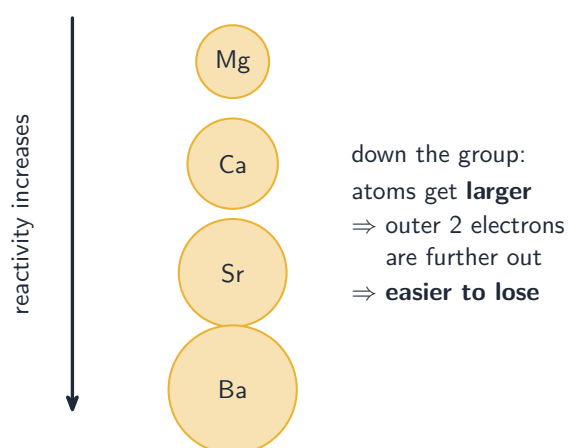
Build the skills to answer exam questions on the **Group 2 metals** 第二族金属 — their reactions, **thermal decomposition** 热分解 and **thermal stability** 热稳定性, and **solubility** 溶解度 trends.

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



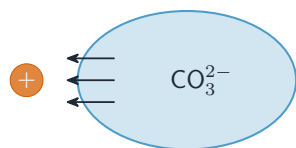
Reactivity increases down Group 2: larger atoms lose their two outer electrons more easily

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

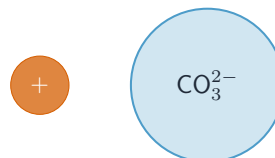
■ Thermal decomposition and stability

small Mg^{2+} : high polarising power



distorts the ion
⇒ **decomposes easily**

large Ba^{2+} : low polarising power



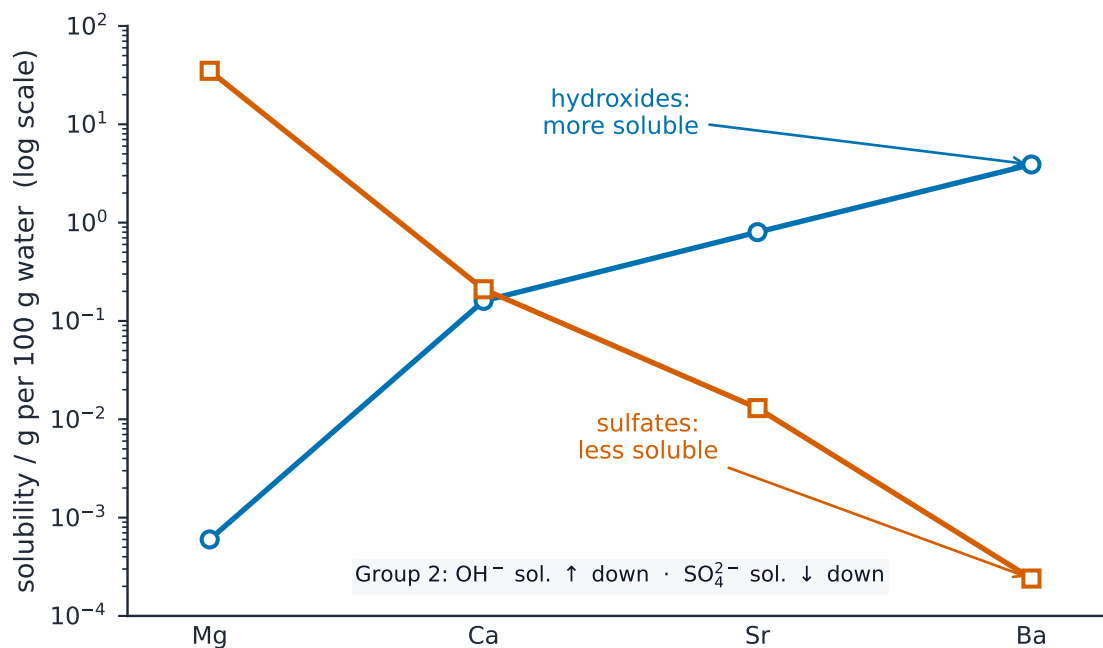
barely distorted
⇒ **thermally stable**

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



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

2.1 $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$.

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.

3.3 (a) $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$.

(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.

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** $\text{Ba}(\text{NO}_3)_2$

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-}

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]