

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.

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..... [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.

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least soluble most soluble
explanation
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..... [4]

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

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..... [1]

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

Explain your answer.

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..... [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.

$K_{\text{sp}} =$ [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

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..... [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**.

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..... [3]

[Total: 7]