

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

18 Caesium and barium are in Period 6 of the Periodic Table.

Which row is correct?

	the larger ionic radius	the higher melting point
A	Ba^{2+}	barium
B	Ba^{2+}	caesium
C	Cs^+	barium
D	Cs^+	caesium

2 The Period 3 elements show trends in physical and chemical properties across the period.

(a) Fig. 2.1 shows the variation in atomic and ionic radii of the Period 3 elements Na to Cl.

The ionic radius of Si is **not** shown.

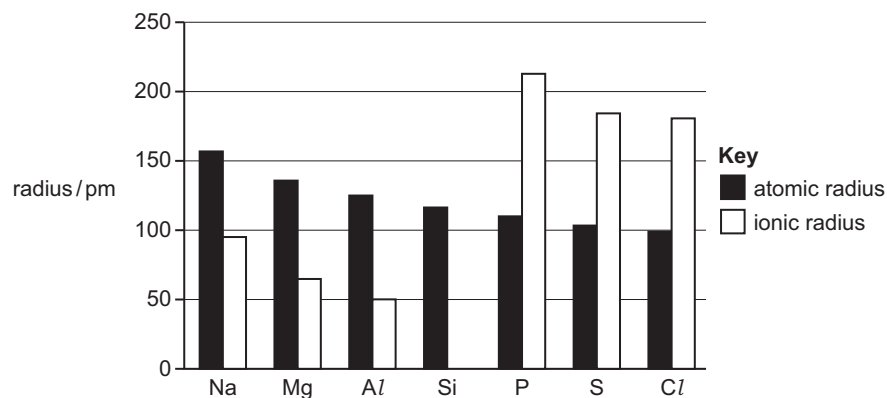


Fig. 2.1

(i) Explain the trend shown in the atomic radii of the Period 3 elements Na to Cl.

.....

 [2]

(ii) Explain why there is a large difference in the ionic radii of Al and P.

.....

 [2]

(b) Table 2.1 gives some information about some of the Period 3 oxides.

Row B gives the pH of the solution that forms when the Period 3 oxide is added to water.

Table 2.1

	formula of Period 3 oxide	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₃
A	oxidation number of Period 3 element			+3			
B	pH of solution			—	—		

(i) Complete Table 2.1. [2]

(ii) State why there is no data given in row B for Al₂O₃ and SiO₂.

..... [1]

(c) (i) Write an equation for the reaction of Na₂O with dilute hydrochloric acid.

..... [1]

(ii) Construct an equation for the reaction of Al₂O₃ with a base to form NaAlO₂.

..... [1]

(d) Group 2 nitrates decompose on heating to form oxides.

(i) State the trend in thermal stability of the Group 2 nitrates down the group.

..... [1]

(ii) Identify the other products of the thermal decomposition of Group 2 nitrates.

..... [1]

[Total: 11]

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]

1 (a) Solutions of Group 2 hydrogencarbonates, $\text{M}(\text{HCO}_3)_2$, 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.

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

- (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]