

Q1.(a) Nickel is a metal with a high melting point.

(i) State the block in the Periodic Table that contains nickel.

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(1)

(ii) Explain, in terms of its structure and bonding, why nickel has a high melting point.

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(2)

(iii) Draw a labelled diagram to show the arrangement of particles in a crystal of nickel.
In your answer, include at least six particles of each type.

(2)

(iv) Explain why nickel is ductile (can be stretched into wires).

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(1)

(b) Nickel forms the compound nickel(II) chloride (NiCl_2).

(i) Give the full electron configuration of the Ni²⁺ ion.

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(1)

(ii) Balance the following equation to show how anhydrous nickel(II) chloride can be obtained from the hydrated salt using SOCl₂. Identify **one** substance that could react with both gaseous products.



Substance

(2)

(Total 9 marks)

Q2. This question is about some Period 3 elements and their oxides.

(a) Describe what you would observe when, in the absence of air, magnesium is heated strongly with water vapour at temperatures above 373 K. Write an equation for the reaction that occurs.

Observations

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Equation

(3)

(b) Explain why magnesium has a higher melting point than sodium.

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(Extra space)

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(2)

- (c) State the structure of, and bonding in, silicon dioxide.
Other than a high melting point, give **two** physical properties of silicon dioxide that are characteristic of its structure and bonding.

Structure

Bonding.....

Physical property 1.....

Physical property 2.....

(4)

- (d) Give the formula of the species in a sample of solid phosphorus(V) oxide.
State the structure of, and describe fully the bonding in, this oxide.

Formula

Structure

Bonding.....

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(4)

- (e) Sulfur(IV) oxide reacts with water to form a solution containing ions.

Write an equation for this reaction.

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(1)

- (f) Write an equation for the reaction between the acidic oxide, phosphorus(V) oxide, and the basic oxide, magnesium oxide.

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(1)

(Total 15 marks)

Q3. Group 2 metals and their compounds are used commercially in a variety of processes and applications.

(a) State a use of magnesium hydroxide in medicine.

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(1)

(b) Calcium carbonate is an insoluble solid that can be used in a reaction to lower the acidity of the water in a lake.

Explain why the rate of this reaction decreases when the temperature of the water in the lake falls.

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(3)

(c) Strontium metal is used in the manufacture of alloys.

(i) Explain why strontium has a higher melting point than barium.

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(2)

(ii) Write an equation for the reaction of strontium with water.

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(1)

(d) Magnesium can be used in the extraction of titanium.

(i) Write an equation for the reaction of magnesium with titanium(IV) chloride.

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(1)

(ii) The excess of magnesium used in this extraction can be removed by reacting it with dilute sulfuric acid to form magnesium sulfate.

Use your knowledge of Group 2 sulfates to explain why the magnesium sulfate formed is easy to separate from the titanium.

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(1)

(Total 9 marks)

Q4. There are several types of crystal structure and bonding shown by elements and compounds.

(a) (i) Name the type of bonding in the element sodium.

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(1)

(ii) Use your knowledge of structure and bonding to draw a diagram that shows how the particles are arranged in a crystal of sodium. You should identify the particles and show a minimum of six particles in a two-dimensional diagram.

(2)

(b) Sodium reacts with chlorine to form sodium chloride.

(i) Name the type of bonding in sodium chloride.

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(1)

(ii) Explain why the melting point of sodium chloride is high.

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(Extra space)

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(2)

(c) The table below shows the melting points of some sodium halides.

	NaCl	NaBr	NaI
Melting point /K	1074	1020	920

Suggest why the melting point of sodium iodide is lower than the melting point of sodium bromide.

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(1)

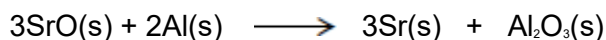
(Total 7 marks)

Q5. Group 2 metals and their compounds are used commercially in a variety of processes.

- (a) Strontium is extracted from strontium oxide (SrO) by heating a mixture of powdered strontium oxide and powdered aluminium.

Consider these standard enthalpies of formation.

	SrO(s)	Al ₂ O ₃ (s)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	- 590	- 1669



Use these data and the equation to calculate the standard enthalpy change for this extraction of strontium.

The use of powdered strontium oxide and powdered aluminium increases the surface area of the reactants.

Suggest **one** reason why this increases the reaction rate.

Suggest **one** major reason why this method of extracting strontium is expensive.

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(5)

- (b) Explain why calcium has a higher melting point than strontium.

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(2)

- (c) Magnesium is used in fireworks. It reacts rapidly with oxygen, burning with a bright white light. Magnesium reacts slowly with cold water.

Write an equation for the reaction of magnesium with oxygen.

Write an equation for the reaction of magnesium with cold water.

Give a medical use for the magnesium compound formed in the reaction of magnesium with cold water.

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(3)

(Total 10 marks)

Q6. Group 2 elements and their compounds have a wide range of uses.

- (a) For parts (a)(i) to (a)(iii), draw a ring around the correct answer to complete each sentence.

decreases.

(i) From $\text{Mg}(\text{OH})_2$ to $\text{Ba}(\text{OH})_2$, the solubility in water

increases.
stays the same.

(1)

(ii) From Mg to Ba, the first ionisation energy

decreases.
increases.
stays the same.

(1)

(iii) From Mg to Ba, the atomic radius

decreases.
increases.
stays the same.

(1)

(b) Explain why calcium has a higher melting point than strontium.

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(Extra space)
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(2)

(c) Acidified barium chloride solution is used as a reagent to test for sulfate ions.

(i) State why sulfuric acid should **not** be used to acidify the barium chloride.

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(1)

- (ii) Write the **simplest ionic** equation for the reaction that occurs when acidified barium chloride solution is added to a solution containing sulfate ions.

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(1)

(Total 7 marks)