Q1.

This question is about magnesium and its compounds.

(a) State **one** observation when magnesium reacts with steam.

Give an equation, including state symbols, for this reaction.

Observation _____

_____

Equation

_____

(2)

(b) Describe the bonding in magnesium.

_____

_____

_____

_____

(2)

(c) Explain, in terms of structure and bonding, why magnesium chloride has a high melting point.

_____

_____

_____

_____

_____

_____

(3)

(d) Give **one** medical use for magnesium hydroxide.

_____

_____

(1)

(Total 8 marks)

Q2.

What is a use for barium sulfate?

A In agriculture to act as a fertiliser ⬭

B In agriculture to neutralise acidic soil ⬭

C In medicine to produce an X-ray image ⬭

D In medicine as an antacid to treat indigestion ⬭

(Total 1 mark)

Q3.

This question is about Group 2 elements and their compounds.

(a) Explain why the melting point of magnesium is higher than the melting point of sodium.

_____

_____

_____

_____

_____

_____

(2)

(b) Give an equation to show how magnesium is used as the reducing agent in the extraction of titanium.

Explain, in terms of oxidation states, why magnesium is the reducing agent.

Equation

_____

Explanation

_____

_____

_____

_____

_____

(2)

(c) State what is observed when dilute aqueous sodium hydroxide is added to separate solutions of magnesium chloride and barium chloride.

Observation with magnesium chloride _____

_____

Observation with barium chloride _____

_____

(2)

(Total 6 marks)

Q4.

This question is about the reactions of magnesium and its compounds.

(a) Magnesium is used in one of the stages in the extraction of titanium.

Give an equation for the reaction between titanium(IV) chloride and magnesium.
State the role of magnesium in this reaction.

Equation

_____

Role of magnesium

_____

(2)

(b) A mixture of magnesium oxide and magnesium hydroxide has a mass of 3200 mg

This mixture is reacted with carbon dioxide to form magnesium carbonate and water. The mass of water produced is 210 mg

$$Mg(OH)_2 + CO_2 \rightarrow MgCO_3 + H_2O$$

$$MgO + CO_2 \rightarrow MgCO_3$$

Calculate the percentage by mass of magnesium oxide in this mixture.

% of magnesium oxide _____

(4)

(Total 6 marks)

Q5.

Which property would you expect the element radium, Ra, to possess?

A It forms a soluble sulfate. ⬭

B It does not react with water. ⬭

C It is a good conductor of electricity. ⬭

D It forms a covalent fluoride. ⬭

(Total 1 mark)

Q6.

Which statement is **not** correct?

A Strontium has a lower first ionisation energy than calcium. ⬭

B Strontium has a larger ionic radius than calcium. ⬭

C Strontium reacts less vigorously with water than calcium. ⬭

D Strontium hydroxide is more soluble in water than calcium hydroxide. ⬭

(Total 1 mark)

Q7.

Which property of the Group 2 elements, Ca to Ba, increases with increasing atomic number?

A Atomic Radius ⬭

B Electronegativity ⬭

C First ionisation energy ⬭

D Melting Point ⬭

(Total 1 mark)

Q8.

What is the correct observation when barium metal is added to an excess of water?

A Forms a colourless solution only ⬭

B Forms a colourless solution and effervesces ⬭

C Forms a white precipitate only ⬭

D Forms a white precipitate and effervesces ⬭

(Total 1 mark)

Q9.

An aqueous solution of a salt gives a white precipitate when mixed with aqueous silver nitrate and when mixed with dilute sulfuric acid.

Which could be the formula of the salt?

A $BaCl_2$ ⬭

B $(NH_4)_2SO_4$ ⬭

C KCl ⬭

D $Sr(NO_3)_2$ ⬭

(Total 1 mark)

Q10.

Which substance is used to reduce titanium(IV) chloride in the extraction of titanium metal?

A Magnesium ⬭

B Manganese ⬭

C Vanadium ⬭

D Zinc ⬭

(Total 1 mark)

Q11.

Which statement about barium sulfate is correct?

A It is soluble in water at a temperature of 100 °C. ⬭

B It is used in medicine because it does not dissolve in body fluids. ⬭

C It is a pale yellow solid. ⬭

D It reacts with acidified barium chloride solution. ⬭

(Total 1 mark)

Q12.

Which compound is used to treat the symptoms of indigestion?

A MgO ⬭

B $Mg(OH)_2$ ⬭

C CaO ⬭

D $Ca(OH)_2$ ⬭

(Total 1 mark)

Q13.

This question is about s-block metals.

(a) Give the full electron configuration for the calcium ion, Ca^{2+}

_____

(1)

(b) Explain why the second ionisation energy of calcium is lower than the second ionisation energy of potassium.

_____

_____

_____

_____

_____

(2)

(c) Identify the s-block metal that has the highest first ionisation energy.

_____

(1)

(d) Give the formula of the hydroxide of the element in Group 2, from Mg to Ba, that is least soluble in water.

_____

(1)

(e) A student added 6 cm^3 of 0.25 mol dm^{-3} barium chloride solution to 8 cm^3 of 0.15 mol dm^{-3} sodium sulfate solution.
The student filtered off the precipitate and collected the filtrate.

Give an ionic equation for the formation of the precipitate.
Show by calculation which reagent is in excess.
Calculate the total volume of the other reagent which should be used by the student so that the filtrate contains only one solute.

Ionic equation

_____

Reagent in excess

_____

Total volume of other reagent _____

_____

_____

_____

_____

(3)

(f) A sample of strontium has a relative atomic mass of 87.7 and consists of three isotopes, ^{86}Sr, ^{87}Sr and ^{88}Sr
In this sample, the ratio of abundances of the isotopes ^{86}Sr :^{87}Sr is 1:1

State why the isotopes of strontium have identical chemical properties.
Calculate the percentage abundance of the ^{88}Sr isotope in this sample.

Why isotopes of strontium have identical chemical properties

_____

_____

_____

Percentage abundance of ^{88}Sr _____ %

(4)

(g) A time of flight (TOF) mass spectrum was obtained for a sample of barium that contains the isotopes ^{136}Ba, ^{137}Ba and ^{138}Ba

The sample of barium was ionised by electron impact.

Identify the ion with the longest time of flight.

_____

(1)

(h) A $^{137}Ba^{+}$ ion travels through the flight tube of a TOF mass spectrometer with a kinetic energy of 3.65×10^{-16} J
This ion takes 2.71×10^{-5} s to reach the detector.

$KE = \frac{1}{2}mv^2$ where m = mass (kg) and v = speed (m s^{-1})

The Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1}

Calculate the length of the flight tube in metres.

Give your answer to the appropriate number of significant figures.

Length of flight tube _____ m

(5)

(Total 18 marks)

Q14.

Which products are formed when magnesium reacts with steam?

A Magnesium hydroxide and hydrogen ⬭

B Magnesium hydroxide and oxygen ⬭

C Magnesium oxide and hydrogen ⬭

D Magnesium oxide and oxygen ⬭

(Total 1 mark)

Q15.

This question is about ion testing.

(a) Describe how a student could distinguish between aqueous solutions of potassium nitrate, KNO_3, and potassium sulfate, K_2SO_4, using one simple test-tube reaction.

Reagent

_____

Observation with $KNO_3(aq)$ _____

_____

Observation with $K_2SO_4(aq)$ _____

_____

(3)

(b) Describe how a student could distinguish between aqueous solutions of magnesium chloride, $MgCl_2$, and aluminium chloride, $AlCl_3$, using **one** simple test-tube reaction.

Reagent

_____

Observation with $MgCl_2(aq)$ _____

_____

Observation with $AlCl_3(aq)$ _____

_____

(3)

(Total 6 marks)

Q16.

A sample of strontium ore is known to contain strontium oxide, strontium carbonate and some inert impurities. To determine the mass of strontium carbonate present, a student weighed a sample of the solid ore and then heated it in a crucible for 5 minutes. The sample was allowed to cool and then reweighed. This heating, cooling and reweighing was carried out three times.

The results are set out in the table.

Mass of crucible / g	9.85
Mass of crucible and ore sample / g	16.11
Mass of crucible and sample after first heating / g	14.66
Mass of crucible and sample after second heating / g	14.58
Mass of crucible and sample after third heating / g	14.58

(a) When strontium carbonate is heated it decomposes according to the following equation.

$$SrCO_3 \longrightarrow SrO + CO_2$$

Give a reason why the mass of the solid sample changed during the experiment.

_____

_____

_____

(1)

(b) Use the data in the table to calculate the mass of strontium carbonate in the original ore sample. Give your answer to an appropriate precision.

Mass of strontium carbonate = ___ g

(5)

(c) Each balance reading has an uncertainty of ±5.00 mg.

Calculate the percentage error in the initial mass of ore used.

Percentage error = _____ %

(1)

(d) The mass of inert impurities in the sample was 347 mg.

Deduce the mass of SrO in the sample and justify any assumption made in calculating your answer.
(If you have been unable to answer part **(b)**, assume the mass of strontium carbonate was 4.85 g. This is **not** the correct answer.)

Mass of SrO = _____

_____

_____

(2)

(e) Strontium metal can be extracted by heating strontium oxide with aluminium metal.

In this reaction, strontium vapour and solid aluminium oxide are formed.

Write an equation for the reaction and state the role of the aluminium in the process.
Explain why strontium forms a vapour but aluminium oxide is formed as a solid.

Equation

_____

Role of aluminium _____

_____

Explanation _____

_____

_____

_____

_____

_____

_____

(5)

(Total 14 marks)

Q17.

This question is about the chemistry of some Group 2 elements.

(a) Write an equation for the reaction of calcium with water at 25 °C and predict a possible value for the pH of the solution formed.

Equation

_____

pH

_____

(2)

(b) State the trend in solubility, in water, of the Group 2 sulfates from magnesium to barium.

_____

(1)

(c) State the trend in solubility, in water, of the Group 2 sulfates from magnesium to barium.

Reagent

_____

Equation

_____

(2)

(d) Explain why the melting point of calcium sulfate is high.

_____

_____

_____

_____

_____

_____

_____

(2)

(Total 7 marks)