Q1.

This question is about the elements in Group 2.

(a) Explain why the third ionisation energy of beryllium is **much** higher than the second ionisation energy of beryllium.

_____

_____

_____

_____

_____

_____

(3)

(b) Magnesium reacts slowly with cold water but rapidly with steam.

Compare these reactions, in terms of the products formed.
You should identify one similarity in, and one difference between, these reactions.

Similarity _____

_____

Difference _____

_____

(2)

(c) The reaction of calcium with water is a redox reaction.

Explain, in terms of oxidation states, why this reaction involves both oxidation and reduction.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q2.

A student is provided with separate unlabelled samples of four different solutions for analysis.

The four solutions are known to be ammonium nitrate, potassium sulfate, sodium carbonate and magnesium nitrate, but the student does not know which sample is which.

Outline a series of test-tube reactions that the student can use to identify each of these solutions.

Include:

- the expected observations
- ionic equations for any reactions.

(Total 6 marks)

Q3.

This question is about an experiment to determine the solubility of strontium hydroxide in water at 20 °C

Strontium hydroxide is slightly soluble in water. Strontium hydroxide solution reacts in a similar way to calcium hydroxide solution.

- Some solid strontium hydroxide is added to approximately 1 dm^3 of distilled water in a stoppered flask.
- The mixture is kept at 20 °C. Every day, the mixture is checked. If no solid is present in the flask, more solid strontium hydroxide is added.
- On the day when no more solid needs to be added, the flask is opened and the mixture is filtered into another flask and stoppered.
- A 25.0 cm^3 sample of the filtrate is transferred to a conical flask with a pipette and a few drops of indicator added.
- This sample is titrated with 0.100 mol dm^{-3} hydrochloric acid.
- The titration is repeated several times with further samples of the filtrate. The results are shown in the below table in part (e).

(a) Suggest why the solution is kept until no more solid needs to be added.

_____

_____

(1)

(b) Suggest why it is important to remove the undissolved strontium hydroxide before the titration.

_____

_____

(1)

(c) After the filtration, the solution is stored in a stoppered flask.

Suggest a reason for stoppering the flask.

_____

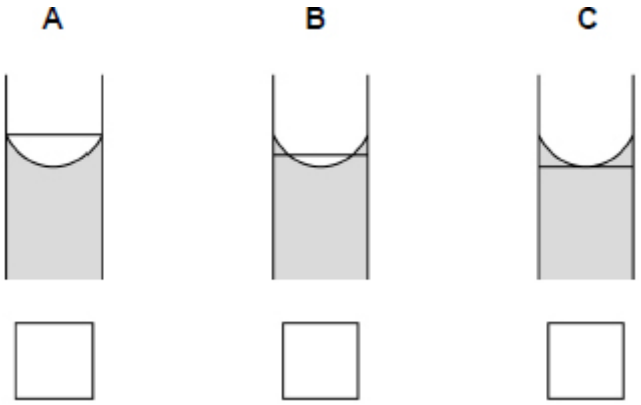
_____

(1)

(d) The diagrams in the figure below show the part of a pipette with the graduation line.

Which diagram identifies the pipette that is correctly filled?

Tick (✓) **one** box.



(1)

(e) Solubility can be quoted as 'g of solute per 100 cm^3 of solution'.

The table below shows the results of the titrations between strontium hydroxide and hydrochloric acid. These can be used to determine the solubility of strontium hydroxide.

Titration	**Rough**	**1**	**2**	**3**
Final burette reading / cm^3	34.40	38.00	41.05	37.00
Initial burette reading / cm^3	0.00	5.55	8.05	4.60
Titre / cm^3	34.40	32.45	33.00	32.40

Give the equation for the reaction between strontium hydroxide and hydrochloric acid.
Use the results in the above table to calculate the mean titre.

Use the mean titre to calculate the solubility of strontium hydroxide, in g per 100 cm^3 of solution, at 20 °C

Equation

_____

Mean titre _____ cm^3

Solubility of strontium hydroxide _____ g per 100 cm^3 solution

(6)

(Total 10 marks)

Q4.

This question is about the elements in Group 2.

(a) Describe the structure and bonding in magnesium.

_____

_____

_____

_____

(2)

(b) State the trend in the atomic radius of the elements down Group 2 from Mg to Ba

Give a reason for this trend.

Trend _____

Reason _____

_____

_____

(2)

(c) Give an equation, including state symbols, for the reaction of magnesium with steam.

State **two** observations for this reaction.

Equation

_____

Observation 1 _____

Observation 2 _____

(3)

(d) The sulfates of the elements in Group 2 from Mg to Ba have different solubilities.

State the formula of the least soluble of these sulfates.

Give a use for this sulfate.

Formula _____

Use _____

(2)

(e) A sample of strontium is made up of only three isotopes: ^{86}Sr, ^{87}Sr and ^{88}Sr
This sample contains 83.00% by mass of ^{88}Sr
This sample of strontium has A_r = 87.73

Calculate the percentage abundance of each of the other two isotopes in this sample.

% abundance ^{87}Sr = _____

% abundance ^{86}Sr = _____

(4)

(f) $Mg(OH)_2$ is used as an antacid to treat indigestion.
A student does an experiment to determine the percentage by mass of $Mg(OH)_2$ in an indigestion tablet.

40.0 cm^3 of 0.200 mol dm^{-3} HCl (an excess) is added to 0.200 g of a powdered tablet.
The mixture is swirled thoroughly.
All of the $Mg(OH)_2$ reacts with HCl as shown.

$$Mg(OH)_2 + 2\ HCl \rightarrow MgCl_2 + 2\ H_2O$$

The amount of HCl remaining after this reaction is determined by titration with 0.100 mol dm^{-3} NaOH

29.25 cm^3 of 0.100 mol dm^{-3} NaOH are needed.

Calculate the percentage by mass of $Mg(OH)_2$ in the indigestion tablet.

Percentage by mass _____

(6)

(Total 19 marks)

Q5.

This question is about ionisation energies of Group 2 elements.

(a) Explain why the first ionisation energy of the Group 2 elements decreases down the group.

_____

_____

_____

_____

_____

(2)

(b) Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of magnesium is measured.

_____

(1)

(c) Explain why the third ionisation energy of magnesium is much higher than the second ionisation energy of magnesium.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q6.

A student does two test-tube reactions on four colourless solutions (**A**, **B**, **C** and **D**).

The table below shows the student's observations.

Solution	**Test 1** Add $Na_2CO_3(s)$	**Test 2** Add acidified $AgNO_3(aq)$
A	Effervescence	No visible change
B	Effervescence	White precipitate
C	No visible change	No visible change
D	No visible change	Very pale yellow precipitate

(a) Identify the gas formed in **Test 1**.

Describe a further test to confirm the identity of this gas.

Identity of gas _____

Test

_____

_____

(2)

(b) Explain how the observations from **Test 1** and **Test 2** can be used to show that solution **B** contains hydrochloric acid.

_____

_____

_____

_____

(2)

(c) Describe a series of tests that the student can use to show that solution **C** contains ammonium sulfate.

(4)

(d) The student does an additional experiment to show that solution **D** contains a mixture of halide ions. One of the halide ions is chloride.

Method:

Step 1 Add an excess of $AgNO_3(aq)$ to 10.0 cm^3 of solution **D**.
Step 2 Filter, wash, dry and weigh the precipitate.
Step 3 Add an excess of dilute ammonia to the dry precipitate.
Step 4 Filter, wash, dry and weigh the solid that remains.

Explain how the masses recorded during this experiment can be used to show that solution **D** contains a mixture of halide ions.

(2)

(Total 10 marks)