Questions

Q1.

A white solid was thought to be barium carbonate. A student suggested that the presence of the carbonate ion could be tested for by adding a small amount of sulfuric acid.

Explain whether or not this suggestion is valid.

(2)

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(Total for question = 2 marks)

Q2.

This question is about the elements in Group 2 of the Periodic Table.

Explain how the trend in the reactivity of the Group 2 elements is determined by their electronic configurations.

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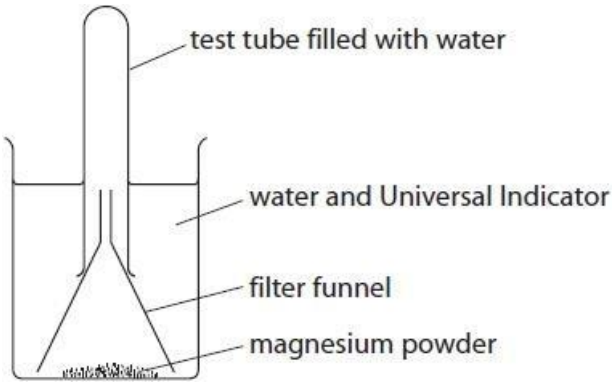
(Total for question = 3 marks)

Q3.

This question is about the elements in Group 2 of the Periodic Table.

Magnesium powder is added to a beaker of water containing a few drops of Universal Indicator.

The apparatus is set up as shown and allowed to stand for a few days.



State **two** changes that will be **seen** after a few days.

(2)

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(Total for question = 2 marks)

Q4.

A group of students design and carry out experiments to deduce the formulae of two salts, **X** and **Y**.

X contains one cation and one anion.
Y contains water of crystallisation.

(a)(i) A flame test is carried out on **X**.

Describe how to carry out a flame test.

(3)

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(ii) The colour of the flame is yellow.

Give the **formula** of the metal ion present in salt **X**.

(1)

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(b) A sample of **X** is placed in a test tube and dissolved in deionised water. The solution is acidified with hydrochloric acid and barium chloride solution is added.

A white precipitate forms.

(i) Give the **formula** of the anion present in **X**.

(1)

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(ii) Deduce the **formula** of **X**, using your answers to (ii) and (iii).

(1)

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(Total for question = 6 marks)

Q5.

This question is about tests for ions.

A student wrote the following answer to a question about the processes that can give rise to a flame colour during a flame test of an inorganic compound.

"When an inorganic compound is heated, energy is emitted as ions move up energy levels. Electrons return to lower energy levels and release energy as light which is always in the visible region of the electromagnetic spectrum."

Identify **three** errors in this account. Include in your answers a correct word or phrase that should be used instead.

(3)

First error

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Correct word or phrase

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Second error

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Correct word or phrase

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Third error

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Correct word or phrase

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(Total for question = 3 marks)

Q6.

Explain whether magnesium carbonate is more or less thermally stable than barium carbonate.

(3)

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(Total for question = 3 marks)

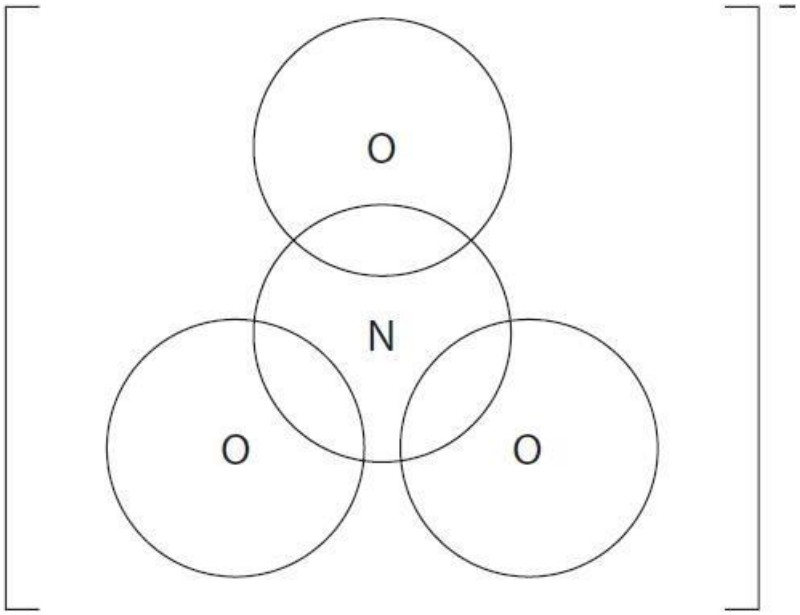
Q7.

This question is about s-block elements and some of their compounds.

The s-block nitrates undergo thermal decomposition.

(i) Draw a dot-and-cross diagram for the nitrate(V) ion, NO_3^-, showing outer electrons only.

(1)



(ii) Write an equation for the thermal decomposition of lithium nitrate.

State symbols are **not** required.

(1)

(iii) The equation for the thermal decomposition of sodium nitrate is different from that for lithium nitrate.

$$NaNO_3(s) \rightarrow NaNO_2(s) + \tfrac{1}{2}O_2(g)$$

The gas produced is collected in a gas syringe.
Calculate the theoretical volume of gas, in **cm^3**, that could be collected at 298 K and 101 kPa by the decomposition of 0.500 g of pure sodium nitrate. Give your answer to 2 significant figures.
[$pV = nRT$, $R = 8.31$ J mol^{-1} K^{-1}]

(4)

(iv) State one reason why the experimental gas volume may differ from the calculated theoretical volume.

Assume that no gas escapes and measurements have been made accurately.

(1)

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(Total for question = 7 marks)

Q8.

This question is about s-block elements and some of their compounds.

A textbook states, 'The thermal stability of Group 1 carbonates is generally higher than the thermal stability of Group 2 carbonates in the same period'.

Explain why Group 1 carbonates are more thermally stable than Group 2 carbonates.

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(Total for question = 3 marks)

Q9.

The labels on four colourless solutions had fallen off in storage. It was known that the solutions were:

hydrochloric acid	magnesium sulfate
potassium chloride	sodium carbonate

In order to identify each solution, a number of tests were carried out.

(a) Solutions can be sprayed into a flame to produce a flame colour identical to that seen in the more conventional method with a solid on a nichrome wire.

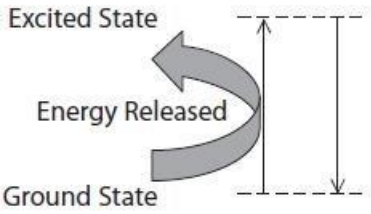
Which solution would produce a lilac flame?

(1)

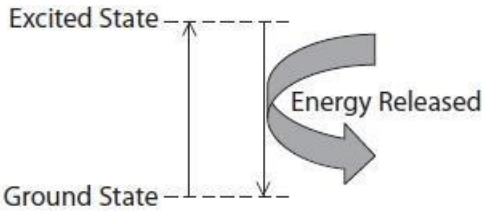
- ☒ **A** hydrochloric acid
- ☒ **B** magnesium sulfate
- ☒ **C** potassium chloride
- ☒ **D** sodium carbonate

(b) Which of the following diagrams best illustrates the electronic transitions that take place during a flame test?

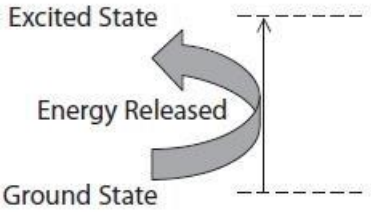
(1)



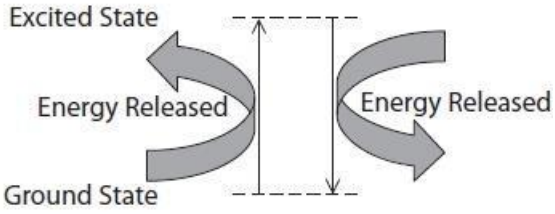
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(c) Which solution produces a white precipitate with acidified barium chloride solution?

(1)

- ☒ **A** hydrochloric acid
- ☒ **B** magnesium sulfate
- ☒ **C** potassium chloride
- ☒ **D** sodium carbonate

(d) Two of the solutions produce the same result on the addition of dilute nitric acid followed by silver nitrate solution.

State the observation with this test and the **two** solutions that give this result.

(2)

Observation

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Solutions

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(e) The hydrochloric acid and the sodium carbonate solution react together. State an observation you would make and write the **ionic** equation for the reaction. State symbols are not required.

(2)

Observation

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Ionic equation

(Total for question = 7 marks)

Q10.

This question is about trends within Group 2 of the Periodic Table.

Describe, with the aid of a labelled diagram, how you would compare the thermal stability of two different Group 2 nitrates using simple laboratory equipment.

Your answer **must** include **one** safety precaution (excluding the use of gloves, laboratory coat
and eye protection).

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(Total for question = 4 marks)

Q11.

A solid, white, water-soluble compound was thought to be magnesium bromide.
A student carried out tests to confirm the identity of both ions present.

A flame test was carried out to test for the cation.

(i) Describe how a flame test is carried out.

(3)

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(ii) Explain the origin of flame test colours.

(4)

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(iii) Give a reason why the magnesium ion does not produce a flame colour.

(1)

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(iv) Give a reason why the lack of a flame colour is not a positive test for the magnesium ion.

(1)

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(Total for question = 9 marks)

Q12.

Some metal carbonates also undergo thermal decomposition.

(i) Draw a diagram of the apparatus that could be used to compare the ease of thermal decomposition of lithium carbonate, Li_2CO_3, and magnesium carbonate, $MgCO_3$.

(2)

(ii) State **one** way in which you would ensure a fair test.

(1)

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(iii) State how data obtained in this experiment could be used to make a comparison.

(1)

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(Total for question = 4 marks)

Q13.

Explain why magnesium nitrate, $Mg(NO_3)_2$ decomposes more readily on heating than potassium nitrate, KNO_3.

(4)

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(Total for question = 4 marks)

Q14.

The presence of some ions in compounds can be identified using a Bunsen burner flame.

A flame test on a white powder gave a lilac flame colour. Dilute hydrochloric acid was added to a second sample of the same powder in a boiling tube and the gas produced bubbled into limewater. The limewater turned cloudy.

Give a possible **formula** for the white powder.

(2)

(Total for question = 2 marks)

Q15.

Malachite is a green mineral with the formula $Cu_2CO_3(OH)_2$. It has a molar mass of 221 g mol^{-1}.

(i) Describe how you would carry out a flame test on a sample of powdered malachite.

(3)

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(ii) When the atoms of some elements are heated, they produce a characteristic flame colour. For example, the copper in malachite gives a blue-green colour. Explain how atoms of different elements can produce different characteristic flame colours when heated.

(4)

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(Total for question = 7 marks)

Q16.

This question is about flame tests for Group 1 and 2 metal ions.

(i) State the colour of the flame produced by separate samples of potassium and strontium ions.

(1)

Potassium ions
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Strontium ions
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(ii) Give a reason why carrying out a flame test on a mixture of potassium chloride and strontium chloride does not
clearly show that two different metal ions are present.

(1)

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(Total for question = 2 marks)

Q17.

This question is about flame tests for Group 1 and 2 metal ions.

In the first stage of the flame test, the nichrome wire is dipped into concentrated hydrochloric acid and then heated in a Bunsen flame.

In the second stage, this nichrome wire is dipped into fresh hydrochloric acid and then into the metal salt to be tested before being reheated in the Bunsen flame.

(i) Give **two** reasons why the wire is made of nichrome and not iron.

(2)

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(ii) Give a reason why the wire is dipped into acid and then heated in the first stage.

(1)

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(iii) State why **fresh** concentrated hydrochloric acid is used in the second stage of the flame test.

(1)

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(iv) State why **hydrochloric acid** is used in the second stage of the flame test.

(1)

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(Total for question = 5 marks)

Q18.

This question is about the chemistry of hydrated magnesium nitrate, $Mg(NO_3)_2.xH_2O$.

Group 2 nitrates decompose when heated.

(i) State **two** observations you would see when hydrated magnesium nitrate is heated.

(2)

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(ii) Explain the trend in thermal stability of Group 2 nitrates.

(3)

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(Total for question = 5 marks)

Q19.

The presence of some ions in compounds can be identified using a Bunsen burner flame.

(i) Some metal ions give characteristic colours in a flame test.

Describe how to carry out a flame test on an unknown solid.

(2)

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(ii) Which of the following ions does **not** give a red flame?

(1)

☒ **A** barium

☒ **B** calcium

☒ **C** lithium

☒ **D** strontium

(iii) Some anions can also be identified by heating in a Bunsen burner flame. A compound heated in a test tube in a Bunsen burner flame gave off a brown gas and caused a glowing splint to relight. The formula of the ion responsible is

(1)

☐ **A** Br^-

☐ **B** NO_2^-

☐ **C** NO_3^-

☐ **D** O^{2-}

(Total for question = 4 marks)

Q20.

An inorganic salt **A** contains one cation and one anion.
The results of two tests on salt **A** are shown in the table.

Test	Observation
Add aqueous sodium hydroxide to solid **A**. Warm the mixture. Test any gas evolved with damp red litmus paper.	A gas was evolved. The gas turned red litmus paper blue.
Add dilute nitric acid followed by aqueous silver nitrate to an aqueous solution of **A**.	A cream precipitate formed.

Deduce the **name** of salt **A**.

(2)

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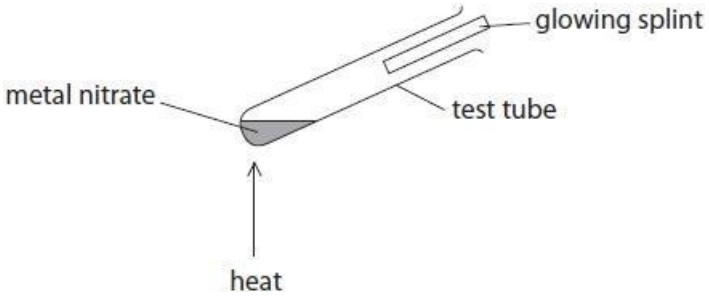
(Total for question = 2 marks)

Q21.

Thermal decomposition is the breaking down of a substance by heat.

An experiment was carried out to investigate the thermal decomposition of a metal nitrate using the apparatus shown.



(i) The glowing splint is used as a test for one of the gases given off in this experiment. Identify this gas and the positive result of the test.

(1)

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(ii) Give the name and appearance of the other gas given off in this experiment when a Group 2 nitrate is heated.

(1)

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(iii) Write the equation for the decomposition if the Group 1 compound, sodium nitrate, was used in this experiment.
State symbols are not required.

(1)

(iv) Describe the apparatus that would be used to compare the decomposition of metal carbonates. Include how the rate of decomposition would be compared

(2)

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(Total for question = 5 marks)

Q22.

This question is about the thermal stability of Group 1 and Group 2 nitrates and carbonates.

Calcium carbonate is thermally decomposed during the manufacture of cement.

(i) Write an equation, including state symbols, for the thermal decomposition of calcium carbonate.

(1)

(ii) Name all the types of bond present in calcium carbonate.

(1)

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(iii) Give a reason, in terms of the bonding, why a high decomposition temperature is required.

(1)

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(Total for question = 3 marks)

Q23.

Colour is often used in chemistry to identify substances.

Compare and contrast the origin of the colour of a copper(II) complex with the origin of the colour of the copper(II) ion in a flame test.

You do not need to state any specific colours.

(6)

(Total for question = 6 marks)