1 Two white powders, **A** and **B**, known to be Group 2 carbonates, are investigated.

(a) (i) The presence of the carbonate ion is usually confirmed using a simple test carried out in two stages at room temperature. Describe this test and its results.

(2)

Test .....

.....

Results .....

.....

.....

(ii) Using barium carbonate as your example, write the equation for each of the stages of the carbonate test. Include state symbols in both equations.

(3)

First equation (test)

Second equation (result)

(b) When a flame test is carried out on the two powders, **A** gives no colour and **B** gives a yellow-red flame.

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

(3)

(ii) Give the **formulae** of the metal ions in **A** and **B**.

(2)

A ..... **B** .....

*(iii) Explain the origin of the flame colour.

(3)

(iv) Suggest why compound **A** produces no flame colour.

(1)

*(c) When Group 2 metal carbonates are heated strongly, they decompose forming the metal oxide and carbon dioxide.

Explain why the thermal stability of the metal carbonates increases as the group is descended.

(3)

(Total for Question = 17 marks)

2 This is a question about Group 2 elements and their compounds.

*(a) Explain why the first ionization energy of calcium (590 kJ mol^{-1}) is greater than that of strontium (550 kJ mol^{-1}).

(2)

(b) (i) Describe how you would carry out a flame test on a sample of a Group 2 metal salt.

(2)

(ii) What result of the flame test would confirm the presence of a barium salt?

(1)

*(iii) Explain, in terms of electronic transitions, how the result of the flame test arises.

(3)

(c) Barium reacts with water to form a clear, colourless solution.

(i) Give the name or formula of the barium compound formed.

(1)

.....

(ii) State **another** observation that would be made when barium reacts with water.

(1)

.....

.....

(d) Barium reacts with chlorine gas to form barium chloride as shown in the equation below.

$$Ba(s) + Cl_2(g) \rightarrow BaCl_2(s)$$

(i) Use the changes in oxidation numbers to show that this is a redox reaction.

(2)

.....

.....

.....

(ii) Write the ionic equation for the reaction between barium chloride solution and dilute sulfuric acid. Include state symbols in the equation.

(2)

(iii) The reaction in (d)(ii) is used to test for sulfate ions.

Why is dilute hydrochloric acid added with the barium chloride solution in this test?

(1)

.....

.....

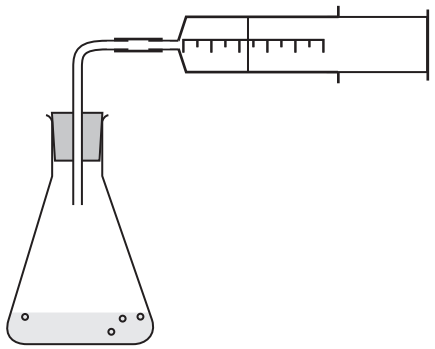
.....

(e) Magnesium carbonate, $MgCO_3$, readily reacts with hydrochloric acid.

(i) Write the equation for this reaction. State symbols are not required.

(1)

*(ii) The rate of the reaction between powdered magnesium carbonate and dilute hydrochloric acid was monitored using the experimental apparatus shown below.



State two factors that would **decrease** the rate of this reaction, other than by changing the reaction temperature.

Explain how these two factors decrease the reaction rate.

(4)

Factor 1 .....

Explanation 1 .....

.....

.....

.....

Factor 2 .....

Explanation 2 .....

.....

.....

.....

(f) Suggest why pressure has little or no effect on the rate of the reaction of magnesium oxide and hydrochloric acid, the equation for which is given below.

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$$

(1)

.....

.....

(Total for Question = 21 marks)

3 This question is about some reactions of halogens and halide ions.

(a) (i) When chlorine is added to a solution containing bromide or iodide ions, a colour change occurs. What solvent would you add to the mixture to confirm the identity of the halogen produced?

(1)

(ii) Give the result for the test with this solvent in a reaction in which bromine is produced.

(1)

(b) (i) Solid potassium bromide and potassium iodide can be distinguished by their reactions with concentrated sulfuric acid.

Potassium bromide reacts with concentrated sulfuric acid initially to produce hydrogen bromide. This reacts further, as shown below, to produce a sharp smelling gas and a brown fuming liquid.

$$2HBr(g) + H_2SO_4(l) \rightarrow SO_2(g) + Br_2(l) + 2H_2O(l)$$

Show, by use of oxidation numbers for sulfur, that the sulfuric acid has been reduced.

(2)

(ii) State TWO observations, which would differ from those with potassium bromide, when potassium iodide reacts with concentrated sulfuric acid.

(2)

(iii) One product of the reaction with potassium iodide is hydrogen sulfide, H_2S. How does this show that iodide ions are more powerful reducing agents than bromide ions?

(1)

(c) In areas where the natural concentration of fluoride ions in rocks is low, some water authorities add fluoride to the water supply to improve the dental health of children. An alternative would be to supply free fluoride tablets.

Give ONE reason why it could be considered more ethical to supply free fluoride tablets rather than to add fluoride compounds to the water supply.

(1)

(Total for Question = 8 marks)