1 Quicklime, which is calcium oxide, is made by heating limestone in a furnace.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

The reaction does not come to equilibrium.

(a) Suggest why the conversion to calcium oxide is complete.

..... [1]

(b) Calcium hydroxide, slaked lime, is made from calcium oxide.

Write an equation for this reaction.

..... [2]

(c) Calculate the maximum mass of calcium oxide which could be made from 12.5 tonnes of calcium carbonate. 1 tonne = 1×10^6 g.

.....

.....

..... [2]

(d) Limestone is used in agriculture to reduce the acidity of soil and for the desulfurisation offlue gases in power stations.

(i) Most crops thrive in soils whose pH is close to 7. Calcium carbonate, which is insoluble in water, and calcium oxide, which is slightly soluble in water, are both used to reduce the acidity of soils.

Suggest **two** advantages of using calcium carbonate for this purpose.

1.....

2..... [2]

(ii) Explain the chemistry of desulfurisation of fluegases.

.....

.....

.....

..... [3]

(iii) Give **one** other use of calcium carbonate.

..... [1]

[Total: 11]

2 A small piece of marble, $CaCO_3$, was added to 5.0 cm^3 of hydrochloric acid, concentration 1.0 mol / dm^3, at 25 °C. The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm^3 of different solutions of acids. The acid was in excess in all of the experiments.

Typical results are given in the table.

experiment	temperature / °C	acid solution	time / min
1	25	hydrochloric acid 1.0 mol / dm^3	3
2	25	hydrochloric acid 0.5 mol / dm^3	7
3	25	ethanoic acid 1.0 mol / dm^3	10
4	15	hydrochloric acid 1.0 mol / dm^3	8

(a) (i) Explain why it is important that the pieces of marble are the same size and the same shape.

.....

.....

..... [2]

(ii) How would you know when the reaction had stopped?

..... [1]

(b) The equation for the reaction in experiment 1 is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Complete the following ionic equation.

$$CaCO_3(s) + 2H^+(aq) \rightarrow \text{.....} + \text{.....} + \text{.....}$$

[1]

(c) (i) Explain why the reaction in experiment 1 is faster than the reaction in experiment 2.

.....

..... [1]

(ii) The acids used for experiment 1 and experiment 3 have the same concentration. Explain why experiment 3 is slower than experiment 1.

.....

.....

..... [2]

(iii) Explain in terms of collisions between reacting particles why experiment 4 is slower than experiment 1.

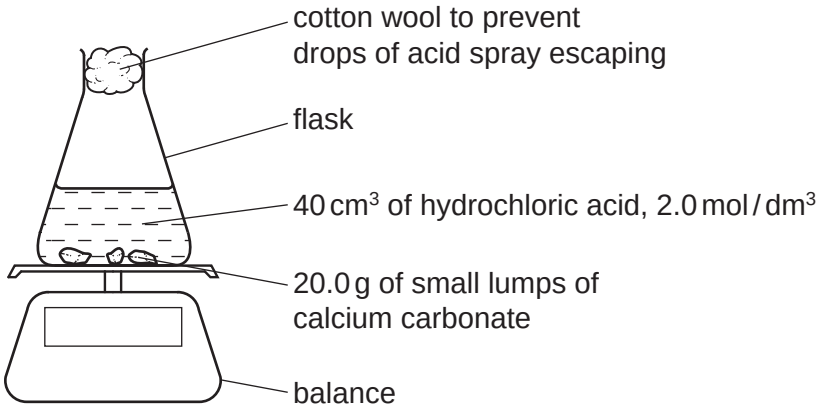
.....

.....

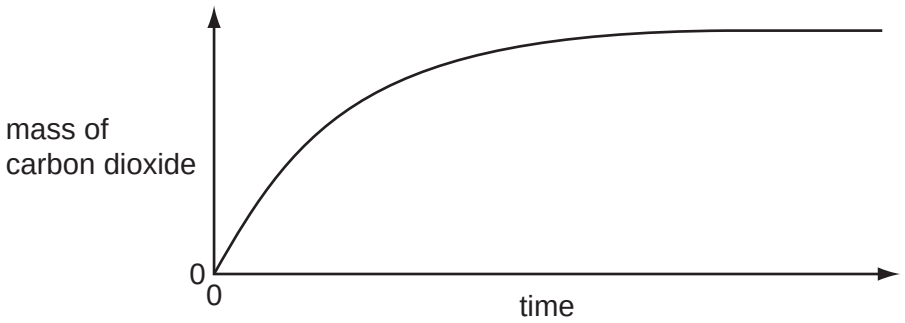
..... [3]

[Total: 10]

3 20.0 g of small lumps of calcium carbonate and 40 cm^3 of hydrochloric acid, concentration 2.0 mol / dm^3, were placed in a flask on a top pan balance. The mass of the flask and contents was recorded every minute.



The mass of carbon dioxide given off was plotted against time.



$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

In all the experiments mentioned in this question, the calcium carbonate was in excess.

(a) Explain how you could determine the mass of carbon dioxide given off in the first five minutes.

..... [1]

(ii) Label the graph **F** where the reaction rate is the fastest, **S** where it is slowing down and **0** where the rate is zero. [2]

(iii) Explain how the shape of the graph shows where the rate is fastest, where it is slowing down and where the rate is zero.

.....

.....

..... [2]

(b) Sketch on the same graph, the line which would have been obtained if 20.0 g of small lumps of calcium carbonate and 80 cm^3 of hydrochloric acid, concentration 1.0 mol / dm^3, had been used. [2]

(c) Explain in terms of collisions between reacting particles each of the following.

(i) The reaction rate would be slower if 20.0 g of larger lumps of calcium carbonate and 40 cm^3 of hydrochloric acid, concentration 2.0 mol / dm^3, were used.

.....

.....

..... [2]

(ii) The reaction rate would be faster if the experiment was carried out at a higher temperature.

.....

.....

..... [2]

(d) Calculate the maximum mass of carbon dioxide given off when 20.0 g of small lumps of calcium carbonate react with 40 cm^3 of hydrochloric acid, concentration 2.0 mol / dm^3.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

number of moles of HCl used =

mass of carbon dioxide = ... g [4]

[Total: 15]

4 Lead is an excellent roofingmaterial.Itismalleableandresistanttocorrosion.Leadrapidly becomes coated with basic lead carbonate which protects it from further corrosion.

(a) Lead has a typical metallic structure which is a lattice of lead ions surrounded by a 'sea' of mobile electrons. This structure is held together by attractive forces called a metallic bond.

(i) Explain why there are attractive forces in a metallic structure.

.....

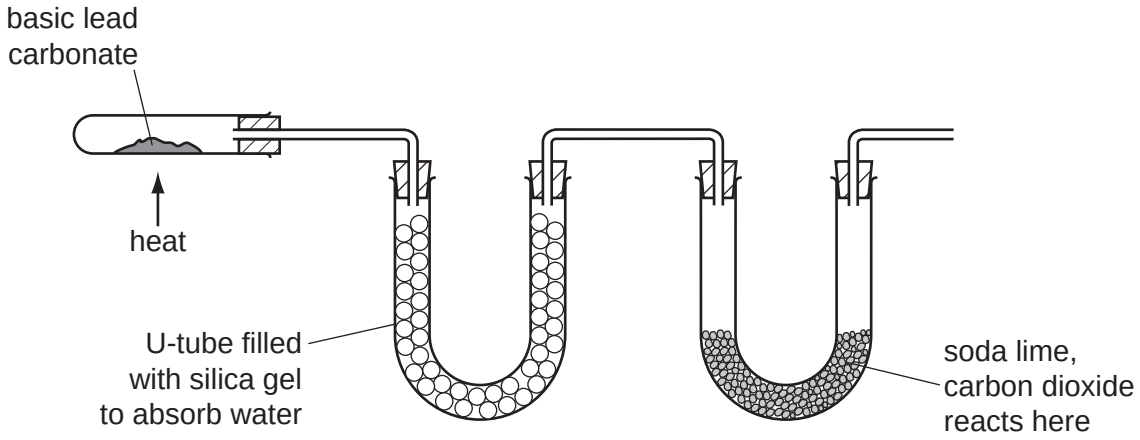
..... [2]

(ii) Explain why a metal, such as lead, is malleable.

.....

..... [2]

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink.
Suggest a reason.

..... [1]

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

.....

..... [2]

(iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]

(c) Basic lead(II) carbonate has a formula of the type $xPbCO_3.yPb(OH)_2$ where x and y are whole numbers.
Determine x and y from the following information.

$$PbCO_3 \rightarrow PbO + CO_2$$

$$Pb(OH)_2 \rightarrow PbO + H_2O$$

When heated, the basic lead(II) carbonate gave 2.112 g of carbon dioxide and 0.432 g of water.

Mass of one mole of CO_2 = 44 g
Mass of one mole of H_2O = 18 g

Number of moles of CO_2 formed = ... [1]

Number of moles of H_2O formed = ... [1]

x = ... and y = ...

Formula of basic lead(II) carbonate is ..... [1]

[Total: 12]