1 (a) Calcium oxide is manufactured by heating calcium carbonate.

The waste product of this process is carbon dioxide.

(i) Calculate the relative formula mass of carbon dioxide, CO_2.
(Relative atomic masses: C = 12, O = 16)

(1)

.....

.....

relative formula mass = ...

(ii) The equation for the reaction is

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

Calculate the maximum mass of calcium oxide that can be obtained by heating 25 tonnes of calcium carbonate.
(Relative atomic masses: C = 12, O = 16, Ca = 40)

(3)

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mass calcium oxide = ... tonnes

(b) (i) State what is meant by **theoretical yield**.

(1)

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(ii) Explain why the actual yield for a reaction is usually less than the theoretical yield for the reaction.

(2)

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(c) Many industrial processes produce waste products.

Suggest reasons why manufacturers try to find uses for these waste products.

(2)

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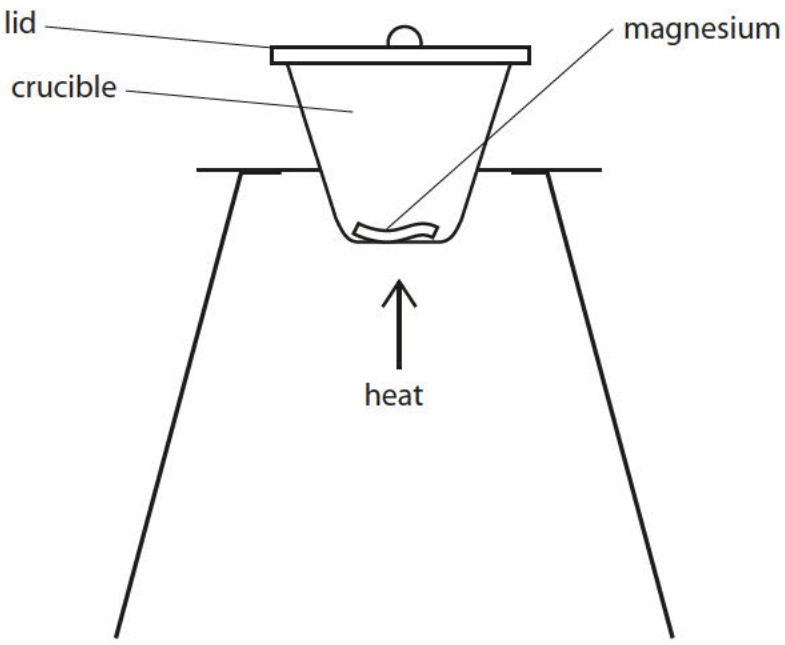
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(Total for Question 1 = 9 marks)

2 The diagram shows a piece of magnesium ribbon being heated.



During the heating, the magnesium reacts with oxygen from the air.
The lid of the crucible was raised slightly from time to time.
Magnesium oxide was formed as a white powder.
The experiment was repeated with different masses of magnesium.

The table shows the mass of magnesium used and the mass of the magnesium oxide formed in each experiment.

experiment	mass of magnesium used /g	mass of magnesium oxide formed /g	mass of oxygen in magnesium oxide /g
1	0.10	0.16	0.06
2	0.15	0.24	0.09
3	0.25	0.40	0.15
4	0.30	0.48	0.18
5	0.35	0.49	0.14
6	0.50	0.80	0.30

(a) Suggest why the lid had to be raised from time to time during the experiment.

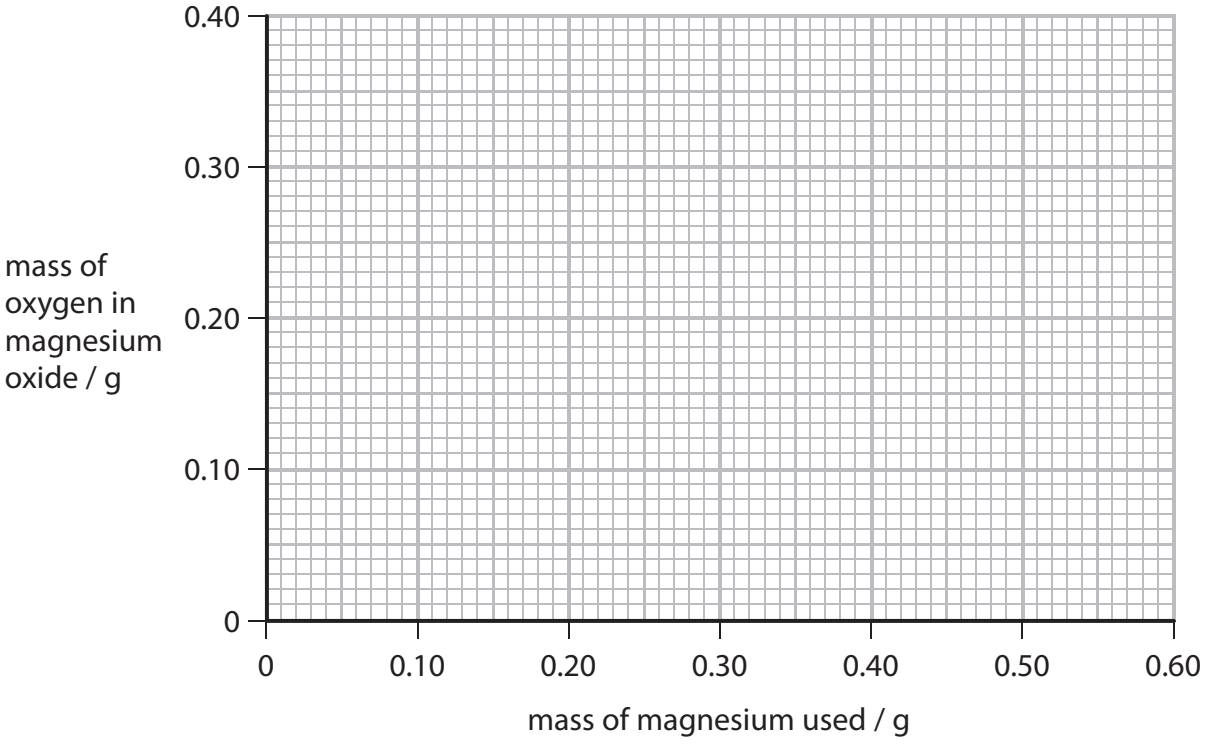
(1)

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(b) (i) On the grid provided, draw a graph of the mass of oxygen in magnesium oxide against the mass of magnesium used.

(3)



(ii) The result of experiment 5 is anomalous.
The masses were all measured accurately.

Suggest what might have caused this anomalous result.

(1)

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.....

(c) Write the balanced equation for the reaction of magnesium with oxygen to form magnesium oxide.

(3)

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(d) An oxide of lead was analysed.
0.414 g of lead was combined with 0.064 g of oxygen in this oxide.

Calculate the empirical formula of this lead oxide.

(relative atomic masses: O = 16, Pb = 207)

(3)

empirical formula .....

(Total for Question 2 = 11 marks)

3 (a) A compound of iron and chlorine was formed by reacting 2.80 g of iron with 3.55 g of chlorine.

Calculate the empirical formula of the compound.
(relative atomic masses: Cl = 35.5, Fe = 56.0)

(3)

empirical formula .....

(b) Sodium reacts with chlorine to form sodium chloride.

$$2Na + Cl_2 \rightarrow 2NaCl$$

Calculate the maximum mass of sodium chloride that could be formed by reacting 9.20 g of sodium with excess chlorine.
(relative atomic masses: Na = 23.0, Cl = 35.5)

(3)

mass of sodium chloride ..... g

*(c) Chlorine, bromine and iodine are in group 7 of the periodic table.

The order of reactivity of these three elements can be shown by carrying out displacement experiments.

You are provided with

potassium bromide solution

potassium chloride solution

potassium iodide solution

bromine solution

chlorine solution

iodine solution

Describe how these solutions could be used to carry out experiments to show the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.
You may use equations if you wish.

(6)

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(Total for Question 3 = 12 marks)

4 In industry sodium carbonate is made from sodium chloride solution and calcium carbonate in the Solvay Process.

(a) Describe the test to show that calcium carbonate contains carbonate ions.

(3)

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(b) Another product of the Solvay Process is calcium chloride.

Calculate the relative formula mass of calcium chloride, $CaCl_2$.
(Relative atomic masses: Ca = 40; Cl = 35.5)

(1)

.....

relative formula mass = ...

(c) The overall equation for the Solvay Process is

$$2NaCl + CaCO_3 \rightarrow Na_2CO_3 + CaCl_2$$

Calculate the maximum mass of sodium carbonate that could be formed by reacting 40 kg of calcium carbonate with an excess of sodium chloride solution.
(Relative formula masses: $CaCO_3$ = 100; Na_2CO_3 = 106)

(2)

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mass of sodium carbonate = ... kg

(d) Sodium carbonate was made in a laboratory experiment.
The theoretical yield of the experiment was 15.0 g.
The actual yield of the experiment was 10.4 g.

(i) Calculate the percentage yield of sodium carbonate in this experiment.

(2)

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.....

.....

.....

percentage yield = ...

(ii) Suggest **two** reasons why the actual yield was less than the theoretical yield.

(2)

reason 1 .....

.....

reason 2 .....

.....

(Total for Question 4 = 10 marks)