1 (a) Define the term **relative isotopic mass**.

(2)

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(b) Naturally occurring chlorine contains 75.53% of ^{35}Cl and 24.47% of ^{37}Cl.

(i) Calculate the relative atomic mass of chlorine to **four** significant figures.

(2)

(ii) Two of the peaks in the mass spectrum of chlorine, Cl_2, are at *m/e* 70 and 74. Identify the species giving rise to these peaks.

(2)

70 .....

74 .....

(iii) What is the *m/e* value of the other peak that you would expect to see in this region of the mass spectrum and the identity of the species giving rise to it?

(2)

Value .....

Species .....

(Total for Question 8 marks)

2 Sodium burns in oxygen to give a pale yellow solid **X**.

(a) (i) 1.73 g of sodium reacts with 1.20 g of oxygen.

Calculate the empirical formula of **X**.

(2)

(ii) The molar mass of **X** is 78 g mol ^{1}. Give the molecular formula of **X**.

(1)

(iii) Write the equation, including state symbols, for the reaction of sodium with oxygen to produce **X**.

(2)

(iv) Calculate the volume of oxygen in dm^3 (at room temperature and pressure) which reacts with 1.73 g of sodium. (The molar volume of any gas at room temperature and pressure is 24 dm^3 mol ^{1}.)

(2)

(v) Calculate the number of oxygen **molecules** that react with 1.73 g of sodium. (The Avogadro constant 6.02×10^{23} mol ^{1}.)

(1)

(b) If sodium is burnt in **air**, compound **X** is not the only product. Suggest why this is so.

(1)

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(Total for Question 9 marks)

3 An organic compound **X** contains carbon, hydrogen, oxygen and nitrogen.

0.132 g of **X** is burned completely in oxygen to produce 0.072 g of water, 0.176 g of carbon dioxide and 24.0 cm^3 of nitrogen.

[Molar volume of nitrogen under the conditions of the experiment 24 000 cm^3 mol^{-1}]

(a) Calculate the empirical formula of compound **X**.

(5)

(b) The molar mass of **X** is 132 g mol^{-1}. Deduce the molecular formula for **X**. Show how you arrived at your answer.

(1)

(c) When **X** is refluxed with concentrated hydrochloric acid for several hours, cooled and neutralized, there is only one organic product, **Y**, which has the molecular formula $C_2H_5O_2N$.

One mole of **Y** will react with either one mole of hydrochloric acid or one mole of sodium hydroxide solution.

When **Y** is sprayed with a solution of ninhydrin and heated, a purple colour is observed.

(i) Use **all** the information above to deduce the functional groups present in **Y** and to classify the type of compound it is. Justify your answer.

(3)

(ii) Deduce the displayed formula **Y** and give its name.

(2)

(iii) Hence give the structural formula **X**.

(1)

(Total for Question 12 marks)

4 0.400 g of magnesium ribbon reacted with exactly 22.2 cm^3 of hydrochloric acid of concentration 1.50 mol dm^{-3}.

400 cm^3 of hydrogen gas was formed, the volume being measured at room temperature and pressure.

In the calculations that follow, use the following molar masses:

Mg	24.0 g mol^{-1}
Cl	35.5 g mol^{-1}

(a) Calculate the amount (in moles) of magnesium used.

(1)

(b) Calculate the amount (in moles) of hydrochloric acid used.

(1)

(c) Calculate the amount (in moles) of hydrogen produced.

[Molar volume of any gas at room temperature and pressure 24 000 cm^3 mol^{-1}]

(1)

(d) Show that the calculated amounts of magnesium, hydrochloric acid and hydrogen are consistent with the following equation for the reaction

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

(1)

(e) Calculate the maximum mass of magnesium chloride that would be formed in this reaction. Give your answer to **three** significant figures.

(3)

(Total for Question 7 marks)