



GCSE Chemistry

Atom Economy and Percentage Yield

Question Paper

Time available: 55 minutes

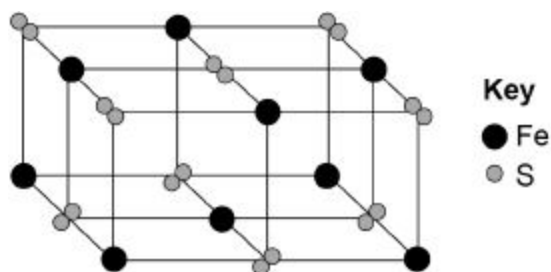
Marks available: 51 marks

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1. This question is about metals and metal compounds.

(a) Iron pyrites is an ionic compound.

The diagram below shows a structure for iron pyrites.



Determine the formula of iron pyrites.

Use the diagram above.

(1)

(b) An atom of iron is represented as ${}_{26}^{56}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(c) Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

1. _____

2. _____

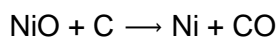
(2)

Nickel is extracted from nickel oxide by reduction with carbon.

(d) Explain why carbon can be used to extract nickel from nickel oxide.

(2)

(e) An equation for the reaction is:



Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

Percentage atom economy = _____ %

(3)

(Total 11 marks)

2.

A scientist produces zinc iodide (ZnI_2).

This is the method used.

1. Weigh 0.500 g of iodine.
 2. Dissolve the iodine in ethanol.
 3. Add an excess of zinc.
 4. Stir the mixture until there is no further change.
 5. Filter off the excess zinc.
 6. Evaporate off the ethanol.
- (a) Ethanol is flammable.

Suggest how the scientist could carry out **Step 6** safely.

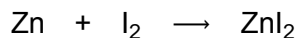
(1)

- (b) Explain why the scientist adds excess zinc rather than excess iodine.

(3)

(c) Calculate the minimum mass of zinc that needs to be added to 0.500 g of iodine so that the iodine fully reacts.

The equation for the reaction is:



Relative atomic masses (M_r): Zn = 65 I = 127

Minimum mass of zinc = _____ g

(3)

A different scientist makes zinc iodide by the same method.

The scientist obtains 12.5 g of zinc iodide.

The percentage yield in this reaction is 92.0%.

(d) What is the maximum theoretical mass of zinc iodide produced in this reaction?

Maximum theoretical mass = _____ g

(3)

(e) Suggest **one** reason why the percentage yield in this reaction is **not** 100%.

(1)

(f) The scientist makes a solution of zinc iodide with a concentration of 0.100 mol / dm^3

Calculate the mass of zinc iodide (ZnI_2) required to make 250 cm^3 of this solution.

Relative atomic masses (A_r): Zn = 65 I = 127

Mass = _____ g

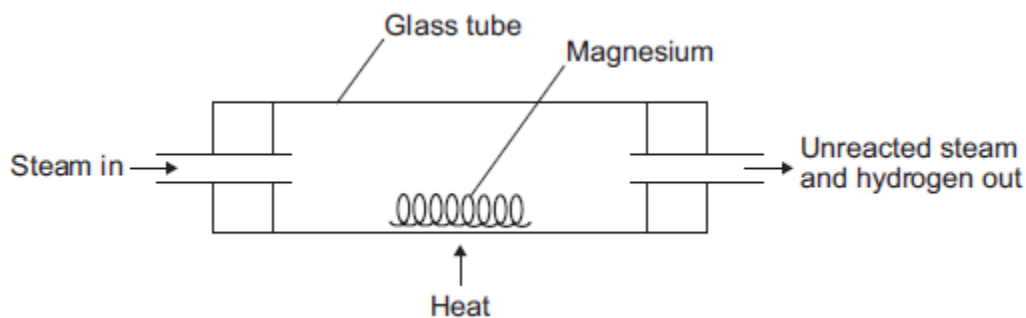
(3)

(Total 14 marks)

3.

Magnesium reacts with steam to produce hydrogen gas and magnesium oxide.

A teacher demonstrated the reaction to a class. The figure below shows the apparatus the teacher used.



(a) (i) The hydrogen produced was collected.

Describe how to test the gas to show that it is hydrogen.

Test _____

Result _____

(2)

(ii) Explain why the magnesium has to be heated to start the reaction.

(2)

(b) The equation for the reaction is:



(i) The teacher used 1.00 g of magnesium.

Use the equation to calculate the maximum mass of magnesium oxide produced.

Give your answer to three significant figures.

Relative atomic masses (A_r): O = 16; Mg = 24

Maximum mass = _____ g

(3)

(ii) The teacher's demonstration produced 1.50 g of magnesium oxide.

Use your answer from part (b)(i) to calculate the percentage yield.

If you could not answer part (b)(i), use 1.82 g as the maximum mass of magnesium oxide. This is **not** the answer to part (b)(i).

Percentage yield = _____ %

(2)

(iii) Give **one** reason why the percentage yield is less than 100%.

(1)

(Total 10 marks)

4.

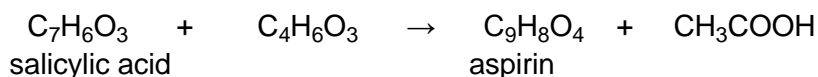
Aspirin tablets have important medical uses.



A student carried out an experiment to make aspirin. The method is given below.

1. Weigh 2.00 g of salicylic acid.
2. Add 4 cm³ of ethanoic anhydride (an excess).
3. Add 5 drops of concentrated sulfuric acid.
4. Warm the mixture for 15 minutes.
5. Add ice cold water to remove the excess ethanoic anhydride.
6. Cool the mixture until a precipitate of aspirin is formed.
7. Collect the precipitate and wash it with cold water.
8. The precipitate of aspirin is dried and weighed.

(a) The equation for this reaction is shown below.



Calculate the maximum mass of aspirin that could be made from 2.00 g of salicylic acid.

The relative formula mass (M_r) of salicylic acid, $\text{C}_7\text{H}_6\text{O}_3$, is 138

The relative formula mass (M_r) of aspirin, $\text{C}_9\text{H}_8\text{O}_4$, is 180

Maximum mass of aspirin = _____ g

(2)

(b) The student made 1.10 g of aspirin from 2.00 g of salicylic acid.

Calculate the percentage yield of aspirin for this experiment.

(If you did not answer part (a), assume that the maximum mass of aspirin that can be made from 2.00 g of salicylic acid is 2.50 g. This is **not** the correct answer to part (a).)

Percentage yield of aspirin = _____ %

(2)

(c) Suggest **one** possible reason why this method does **not** give the maximum amount of aspirin.

(1)

(d) Concentrated sulfuric acid is a catalyst in this reaction.

Suggest how the use of a catalyst might reduce costs in the industrial production of aspirin.

(1)

(Total 6 marks)

5.

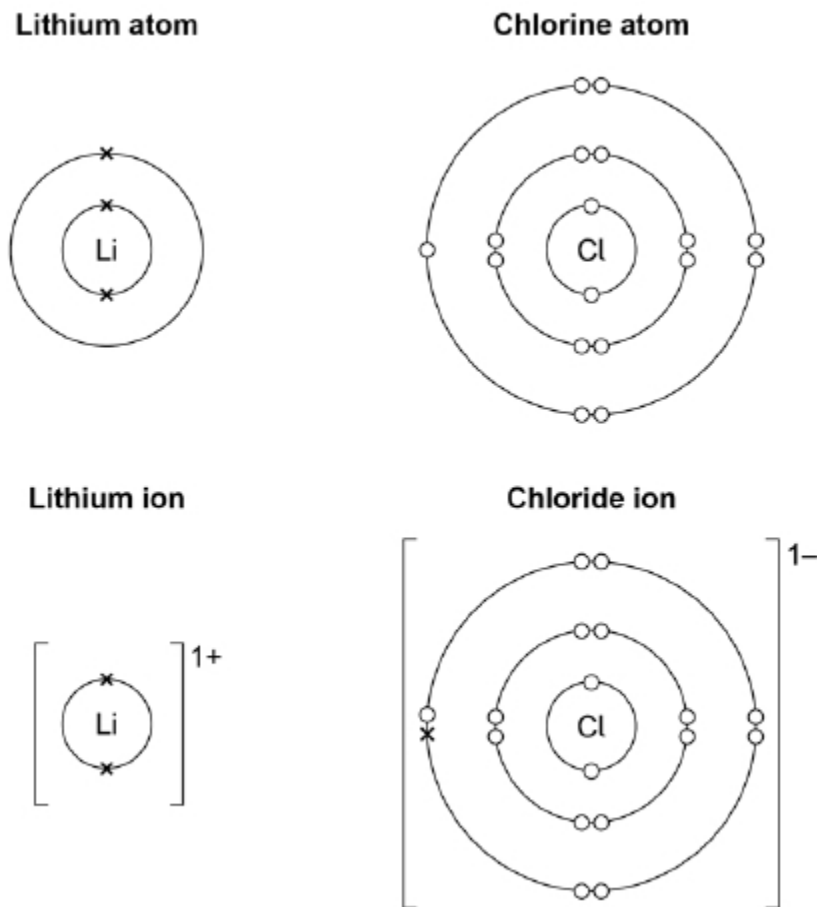
This question is about metal compounds.

(a) Lithium reacts with chlorine to produce lithium chloride.

When lithium atoms and chlorine atoms react to produce lithium chloride, lithium ions and chloride ions are formed.

The diagram shows the electronic structures of the atoms and ions.

The symbols **o** and **x** are used to represent electrons.

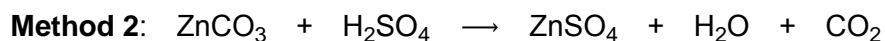


Describe what happens when a lithium atom reacts with a chlorine atom.

Answer in terms of electrons.

Zinc sulfate can be made by two methods.

The equations for the two methods are:



(b) Calculate the percentage atom economy for making zinc sulfate in **Method 1**.

Use the equation:

percentage atom economy =

$$\frac{\text{relative formula mass of ZnSO}_4}{\text{relative formula mass of ZnO} + \text{relative formula mass of H}_2\text{SO}_4} \times 100$$

Give your answer to 3 significant figures.

Relative formula masses (M_r): $\text{ZnO} = 81$ $\text{H}_2\text{SO}_4 = 98$ $\text{ZnSO}_4 = 161$

Percentage atom economy = _____ %

(3)

(c) **Method 1** gives a higher percentage atom economy for making zinc sulfate than **Method 2**.

Give a reason why it is important to use a reaction with a high atom economy.

(1)

(d) A student uses 50 cm^3 of a zinc sulfate solution of 80 g/dm^3

What mass of zinc sulfate is dissolved in 50 cm^3 of this zinc sulfate solution?

Mass = _____ g

(2)

(Total 10 marks)