

RELATIVE FORMULA MASS, ATOM ECONOMY & PERCENTAGE YIELD 2

Q1. Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.



Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2 .

(a) Calculate the relative formula mass (M_r) of SnF_2 .

Relative atomic masses: $\text{F} = 19$; $\text{Sn} = 119$

(2 marks)

(b) Calculate the percentage by mass of fluorine in SnF_2 .

(2 marks)

(c) A tube of toothpaste contains 1.2 g of SnF₂.

Calculate the mass of fluorine in this tube of toothpaste.

(1 mark)

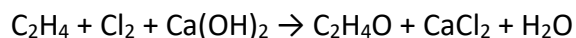
Q2. Epoxyethane has the formula C₂H₄O. It is used to make antifreeze and some types of plastic.

When choosing a method of making a chemical, it is important to consider:

- the percentage yield
- the atom economy

Epoxyethane can be made from ethene by two different methods. The overall equation for each method is shown below.

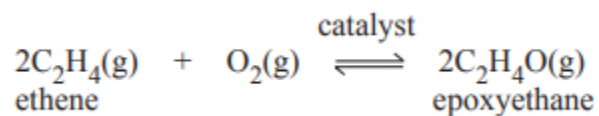
Method 1



Ethene

epoxyethane

Method 2



(a) The table gives the relative formula masses (*M_r*) of the reactants and products for Method 1.

Formula of reactant or product	Relative formula mass (<i>M_r</i>)
H ₂ O	18
C ₂ H ₄	28
C ₂ H ₄ O	44
Cl ₂	71
Ca(OH) ₂	74
CaCl ₂	111

The percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{Total } M_r \text{ of all reactants added together}} \times 100\%$$

The percentage atom economy for **Method 2** is 100%.

Calculate the percentage atom economy for Method 1.

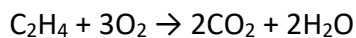
(2 marks)

(b) Method 2 has the higher atom economy.

Suggest why this is an advantage.

(2 marks)

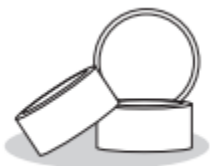
(c) One problem with Method 2 is that ethene can also react with oxygen to make carbon dioxide and water.



How might this reaction affect the percentage yield of epoxyethane?

(1 mark)

Q3. Calcium hypochlorite tablets are added to water in some swimming pools to kill microorganisms.



The formula of calcium hypochlorite is CaCl_2O_2 .

(i) Calculate the relative formula mass (M_r) of calcium hypochlorite.

Relative atomic masses: O = 16; Cl = 35.5; Ca = 40.

(2 marks)

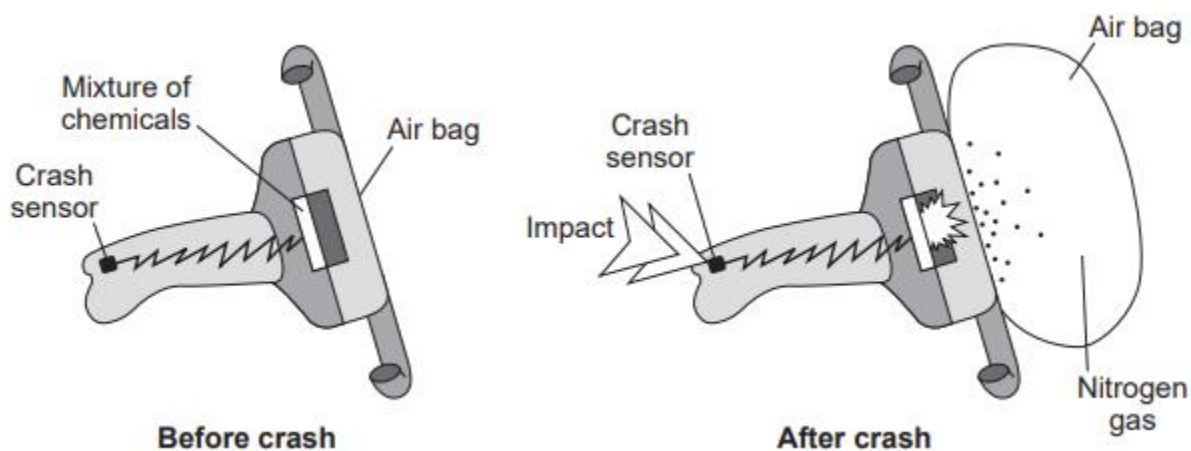
(ii) Calculate the percentage by mass of chlorine in calcium hypochlorite.

(2 marks)

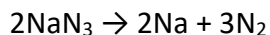
(iii) Calculate the mass of chlorine in a 20 g tablet of calcium hypochlorite.

(1 mark)

Q4. Air bags are used to protect the passengers in a car during an accident. When the crash sensor detects an impact it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.



The mixture of chemicals contains sodium azide (NaN_3) which decomposes on heating to form sodium and nitrogen.



A typical air bag contains 130 g of sodium azide.

Calculate the mass of nitrogen that would be produced when 130 g of sodium azide decomposes.

Relative atomic masses (A_r): N = 14; Na = 23

(3 marks)

Q5. Iron chloride has the formula FeCl_3

Relative atomic masses (A_r): Cl = 35.5; Fe = 56.

(i) Calculate the relative formula mass (M_r) of iron chloride (FeCl_3).

(2 marks)

(ii) Calculate the percentage of iron in iron chloride (FeCl_3).

(2 marks)

Q6. The formula of sodium chloride is NaCl

(i) Calculate the relative formula mass of sodium chloride.

Relative atomic masses: Na = 23; Cl = 35.5

(1 mark)

(ii) Draw a ring around the correct answer to complete the sentence.

The relative formula mass of a substance, in grams, is one

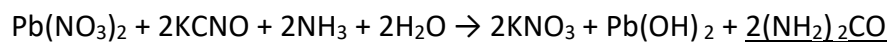
ion
isotope
mole

 of the substance.

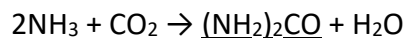
(1 mark)

Q7. The equations below show two methods of making urea.

Method 1 (Old method)



Method 2 (The modern industrial method)



(the formula of urea has been underlined)

Method 2 has a higher atom economy than method 1.

Use information from the equations to explain why.

(2 marks)

Q8. Ammonia is used to make the fertiliser ammonium nitrate.

(a) Calculate the relative formula mass (M_r) of ammonium nitrate, NH_4NO_3

Relative atomic masses (A_r): H = 1; N = 14; O = 16

(2 marks)

(b) Another fertiliser is potassium nitrate, KNO_3 .

The relative formula mass (M_r) of potassium nitrate is 101.

Relative atomic masses (A_r): N = 14; O = 16; K = 39

The table shows the percentage by mass of potassium and nitrogen in four fertilisers, **A**, **B**, **C** and **D**.

Fertiliser	Percentage by mass of potassium (%)	Percentage by mass of nitrogen (%)
A	12.45	25.21
B	19.91	24.12
C	38.61	13.86
D	24.89	9.25

Which fertiliser, **A**, **B**, **C** or **D** is potassium nitrate?

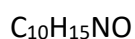
You must show your working to gain full marks.

(2 marks)

Q9.

(i) Athletes sometimes take drugs because the drugs improve their performance. One of these drugs is ephedrine.

Ephedrine has the formula:



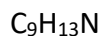
Find the relative molecular mass of Ephedrine.

Show clearly how you work out your answer.

Relative atomic masses: H = 1; C = 12; N = 14; O = 16.

(2 marks)

(ii) Another drug is amphetamine which has the formula:



The relative molecular mass (M_r) of amphetamine is 135.

Calculate the percentage by mass of nitrogen in amphetamine.

Relative atomic mass: N = 14

(2 marks)

Q10. A company made magnesium using this reaction.



(i) Calculate the mass of magnesium oxide needed to produce 1.2 tonnes of magnesium.

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

(3 marks)

(ii) The company calculated that they would produce 1.2 tonnes of magnesium, but only 0.9 tonnes was produced. Calculate the percentage yield.

(1 mark)

(iii) Give one reason why the calculated yield of magnesium might not be obtained

(1 mark)

Total marks (39)