Your notes

GCSE Chemistry: revision notes

Yield and atom economy

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Percentage yield

- The **yield** is the amount of product made. Even though no atoms are gained or lost, it is not always possible to get the mass you calculate.
- **Percentage yield** = (mass of product actually made ÷ maximum theoretical mass of product) × 100.
- Reasons the **yield** is less than 100%: the reaction may be reversible and not go to completion; some product may be lost when it is separated from the reaction mixture; some reactants may react in unexpected ways (side reactions).

Theoretical yield (Higher)

- The maximum theoretical mass of product is calculated from the balanced equation, using moles.
- Example: 10 g of $CaCO_3$ (0.1 mol) can make at most 0.1 mol of CaO, which is 0.1 × 56 = 5.6 g.

Atom economy

- **Atom economy** is a measure of the amount of starting materials that end up as useful products.
- **Atom economy** = (Mr of desired product from the equation ÷ sum of Mr of all reactants) × 100.
- Reactions with only one product have an **atom economy** of 100%.
- A high **atom economy** is important for **sustainable development** and for economic reasons: less waste, fewer resources used, and less cost.

Choosing a reaction pathway

- Chemists consider the **atom economy**, the **yield**, the rate of reaction, the position of equilibrium (for **reversible reactions**), and whether by-products are useful.
- Example: $CaCO_3 \rightarrow CaO + CO_2$ has an **atom economy** of $(56 \div 100) \times 100 = 56\%$, unless a use is found for the carbon dioxide.

Worked examples

A reaction could make 12 g of product, but only 9 g is made. Find the percentage yield.

Use percentage yield = actual ÷ theoretical × 100. **9 ÷ 12 × 100**

Answer: 75%

Find the atom economy for making calcium oxide: $CaCO_3 \rightarrow CaO + CO_2$ (Mr: $CaCO_3 = 100$, $CaO = 56$)

Use atom economy = Mr of the useful product ÷ total Mr of the reactants × 100. **56 ÷ 100 × 100**

Answer: 56%

Key terms

Yield	The amount of product obtained from a reaction.
Percentage yield	The actual mass of product as a percentage of the maximum theoretical mass.
Theoretical yield	The maximum mass of product that could be made, calculated from the equation.
Atom economy	The percentage of the mass of reactants that ends up in the desired product.
By-product	An unwanted product of a reaction.
Reversible reaction	A reaction in which the products can react to reform the reactants.
Sustainable development	Meeting the needs of people today without harming the ability of future generations to meet theirs.

Quick questions

Cover the answers and test yourself: remembering is what makes it stick.

1. A reaction could make 8.0 g of product, but only 6.0 g is made. What is the percentage yield?
2. Why might the percentage yield be less than 100%?
3. What is the atom economy of a reaction with only one product?

Your notes

4. What is the formula for atom economy?
5. Why is a high atom economy important?
6. $CaCO_3$ (Mr 100) → CaO (Mr 56) + CO_2 (Mr 44). What is the atom economy for making CaO?
7. What is a by-product?
8. A theoretical yield is 20 g and the percentage yield is 60%. What mass was made?

Answers

1. 75%
2. Some product is lost when it is separated
3. 100%
4. Mr of desired product ÷ total Mr of reactants × 100
5. It means less waste and uses resources efficiently
6. 56%
7. An unwanted product of a reaction
8. 12 g

What to do next

Practise 10 questions on this topic

Try 7 exam questions, with mark schemes

Read the lesson, one step at a time

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