



AQA Chemistry Unit 3 Lesson 8: Atom Economy and Percentage Yield

Learning Objective:

To explore percentage yield and atom economy.

Success Criteria:

- To calculate the percentage yield and atom economy of a reaction.
- To calculate the theoretical yield of a chemical reaction.
- To explain why a reaction pathway is chosen to produce a specific product.

Context:

This is lesson 8 in a series of lessons that covers the topic of KS4 quantitative chemistry with a focus on percentage yield and atom economy. This lesson is only suitable for those students on the separate science course. You can teach this lesson as a stand-alone lesson or use it to form the wider unit of work on quantitative chemistry. The choice is yours!

Resources

calculators
dice
two potatoes
potato peeler
knife
mini-whiteboards

Starter

Provide students with the [Quantitative Chemistry Revision Game](#). Individually or in pairs, students take it in turns to roll a dice. The numbers that their dice land on indicate the question that the student must answer. Students should write their working and answers on the corresponding answer sheet. You may choose to allow students to self- or peer-assess.

Main Activities

Atom Economy:

Introduce to students the concept of atom economy. In a chemical reaction, no atoms are lost or gained. However, not all reactants end up as the desired product. Instead, they form by-products, something that is produced as a waste product. The amount of starting materials that end up as useful products during a chemical reaction is called the atom economy. For economic reasons and sustainable development, it makes sense to use reactions with a high atom economy. Use the analogy of potatoes. One child turns their potato into wedges while the other child peels their potato and turns it into fries. Discuss with students that the method with the least steps would be most economical. You may wish to use potatoes and visually represent the analogy to the class.

How to Calculate Atom Economy:

Discuss with students how to calculate the atom economy using the equation. Give the example of the thermal decomposition of limestone and ask students to independently calculate the atom economy of the reaction. You may choose to do this activity on mini-whiteboards so that students can reveal their answer. A one-minute time has been included on the slide to support with this activity.

Percentage Yield:

Introduce to students the concept of percentage yield. The percentage yield is a measure of how much product is made in a chemical reaction. In a chemical reaction, the maximum mass of a product that can be made is called the theoretical yield. The theoretical yield can be calculated from the balanced symbol equation, the mass and relative formula mass of the limiting reactant, and the relative formula mass of the product. In a chemical reaction, no atoms are gained or lost. However, it is not always possible to obtain the calculated amount of product. Very few reactions result in a yield of 100%.

How to Calculate Percentage Yield:

Discuss with students how to calculate percentage yield using the equation. Give the example of the thermal decomposition of limestone and ask students to independently calculate the percentage yield of the reaction. You may choose to do this activity on mini-whiteboards so that students can reveal their answer. A one-minute time has been included on the slide to support with this activity.

Atom Economy and Percentage Yield:

Provide students with the differentiated [Atom Economy and Percentage Yield Worksheets](#). Use this opportunity to allow students to self- or peer-assess their work once completed.

Reaction Pathways:

Explain to students that, in some cases, there are multiple ways of making a particular substance. Give the example of ethanol which can be made through fermentation of yeast or by hydration of ethene. A reaction pathway demonstrates a series of reactions that are needed to produce a product from a set of raw materials. The reaction pathway that is chosen is dependent on several factors: the percentage yield, atom economy, usefulness of the waste products, position of the equilibrium and reaction rate. Provide students with the [Reaction Pathways Worksheet](#) and ask them to evaluate the two processes of making ethanol. You may choose to allow students to self- or peer-assess their answer.

Plenary

True or False:

Students are provided with five statements and asked to decide which are true and which are false. This activity may be done on mini-whiteboards.