GCSE Chemistry

The Sweet Factory

Instructions and answers for teachers

These instructions should accompany the OCR resource **'The Sweet Factory'** ***activity*** *which supports OCR GCSE Chemistry.*


GCSE Chemistry
Lesson Element

GCSE Chemistry

The Sweet Factory

Task 1

1) Measure the mass of your envelope with your sweets in.

Mass of envelope and sweets: g

This mass is your **theoretical mass** as you expect all the sweets to be good enough to eat!

So what is the **actual mass?** g

2) Open your envelope and measure the mass of one sweet. g

This mass is your **actual mass** for one sweet, so what is your total **percentage yield?**

3) Work out your percentage yield:

Percentage yield = Actual mass / Theoretical mass x 100

= x 100

= %

OCR

The Activity:

This resource comprises of 2 tasks.

Learning Outcomes:

- To calculate percentage yield when given masses of reactants and products
- To understand the difference between actual and theoretical yield and why these are different
- To relate their modelling activity to chemical reactions in industry and undertake related calculations

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Associated materials:

'The Sweet Factory' Lesson Element learner activity sheet.

Introduction

This is an activity to use when delivering content on percentage mass and looking at atom economy. The activity is largely kinaesthetic and is intended for lower ability learners who find handling equations a challenge. Percentage yield allows learners to see clearly that the yield is linked to how much product is actually obtained compared to how much is expected.

Prior knowledge and skills for this activity include familiarity with the terms reactant and product, to have covered material about percentage mass in compounds and have the ability to calculate percentages. Common learner misconceptions and difficulties include misuse of the equation when carrying out divisions, and so ending up with percentage yields higher than 100% and not realising this is not possible and differentiating between waste and desired products in reactions. Learners with poor numeracy skills might find calculating percentages difficult. It is important to make sure that they are familiar with how to calculate them before they move on to the main task.

Notes for teachers

Activity 1

The activity can be undertaken with learners working in pairs, though larger groups can be used. Each group are in charge of quality control of the output of a sweet shop. It is their job to check random samples of sweets before they are sold.

Each group will have a small envelope with some boiled sweets in. Unknown to the learners, prior to the activity some of the boiled sweets will have been unwrapped. It will be the learners' job to calculate the yield of sweets that have been wrapped properly.

Apparatus (per group):

- One envelope
- Ten wrapped boiled sweets. To add challenge some could be unwrapped (refer to the notes below)
- A calculator
- A bag of sweets for the teacher demonstration
- A single unbagged sweet
- One top pan balance (per class).

Activity:

1. Demonstrate to learners how to calculate percentages. Simple questions can be initially asked, such as asking learners to calculate the percentage of boys/girls in the classroom.
2. With one of the envelopes of sweets, ask learners how they would be able to guess the number of sweets in the bag without opening it. If they find this difficult, show them a loose sweet and explain to them that they can measure the mass of one sweet, and then the whole bag and calculate the number of sweets.
3. Ask why the number of sweets calculated is inaccurate. Learners should be able to explain that the mass included the weight of the bag and any wrapping, as well as assuming that all the sweets were the same size/shape. This should be used to introduce the concepts of **theoretical mass** – how much they were expecting, and **actual mass** – how much they actually obtained. These masses should then be used to calculate **percentage yield**.
4. Learners are given an envelope and based on what has been demonstrated they should measure the theoretical mass for their packet. They then need to measure the actual mass by either measuring the total mass of unwrapped sweets or the empty packet and wrappings if the balance is sensitive enough.
5. Those learners who have a bag of mixed wrapped and unwrapped sweets can be told that any that were unwrapped cannot be sold so must be classed as waste products. They then need to try to calculate the actual percentage yield of their packet of sweets.
6. Learners should be asked to explain why this method never allows for 100% yield. This is because this method includes the mass of the envelope in the expected mass. Learners can be asked to discuss how this might be applied to foods they buy. For example does a packet of crisps contain 30g of potato?

Supporting information

Good laboratory practice should be applied by learners regarding the eating of the sweets.

Ensure that you have knowledge of the implications of waste in industrial processes. It is important to any chemical company that waste is kept to a minimum, and as much of the reactants produce a usable product as possible. It is important that you are able to translate the activity to real examples that are provided on the student task sheet but others that you may want to discuss are:

- The Haber process – in particular unreacted products are recycled back into the reactor to reduce waste.
  - $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
  - Much of the reactants (85%) do not react at all when making ammonia. To keep a high yield, the ammonia is liquefied, then the unreacted hydrogen and nitrogen is recycled back into the reactor.
- The blast furnace – heat is recycled back into the furnace, slag that is generated is now sold as a building material.
  - Reaction involves the reduction of Fe_2O_3 by carbon. $CaCO_3$ is used in the furnace to react with minerals from the iron ore. This produces molten slag.
- The contact process – the sulphur dioxide in this process is a waste product obtained from the extraction of copper from $CuFeS_2$ (Chalcopyrite, a common copper ore).
  - SO_2, a by-product of the process, is reacted with O_2 to make SO_3. This is then reacted further to make H_2SO_4, which is then sold.

These could be provided as a research task for learners as an extension activity.

Task 2 Question Time!

The activity sheet contains questions that the learners can now apply their knowledge to and practise calculations.

1) You were expecting to obtain 200g of sticky toffee from your machine. Unfortunately the toffee was so sticky you could only get out 170g. What was the percentage yield?

170 ÷ 200 = 0.85

0.85 x 100 = 75%

2) You were expecting to make 45 litres of fizzy orange drink. During the process some of the water evaporated and you only managed to get 30 litres. What was the percentage yield

30 ÷ 45 = 0.67

0.67 x 100 = 67%

3) When planning to make some lemon sherbet, you know that when you filter it the percentage yield is 75%. You want to make 50 kg of lemon sherbet. How much should you start with?

50 ÷ (75 ÷ 100) = 67kg

Percentage yield can be used for many chemical reactions, not just for making sweets! Don't worry – the calculation is the same.

4) When extracting titanium, batches of titanium chloride are used. The amount of titanium expected is 1000kg. In one reaction, the titanium chloride doesn't fully react and only 880kg is made. What is the percentage yield?

880 ÷ 1000 = 0.880

0.880 x 100 = 88.0%

5) The reaction to make aspirin is broken down into many stages. Reactants have to be heated up and evaporated, then cooled again. The remaining product has to be filtered, then purified by dissolving in ethanol.

Why is the yield for aspirin rarely higher than 60%? How could it be improved?

Idea that reactants are lost at each stage of the reaction. Yield could be increased by reducing losses by evaporation (condensing unreacted reactants), filtration (ensuring as much is collected from filter paper as possible) and making sure all of the reactant is dissolved.