

Using equations to find masses and yields

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

When baking soda meets vinegar, the fizzing stops when one reactant has run out. This lab measures the carbon dioxide lost for different masses of baking soda, so you can see the limiting reactant appear in the data and use it to find the concentration of the vinegar.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-7, GCSE C3

Aim

To show that the mass of carbon dioxide released stops rising once the acid is used up, and to use the plateau to find the concentration of vinegar.

Equipment

- Top-pan balance (2 decimal places)
- 100 cm³ conical flask and cotton wool
- 25.0 cm³ measuring cylinder or pipette
- Vinegar (ethanoic acid solution)
- Sodium hydrogencarbonate (baking soda), weighed into six small pots
- Spatula, stopwatch

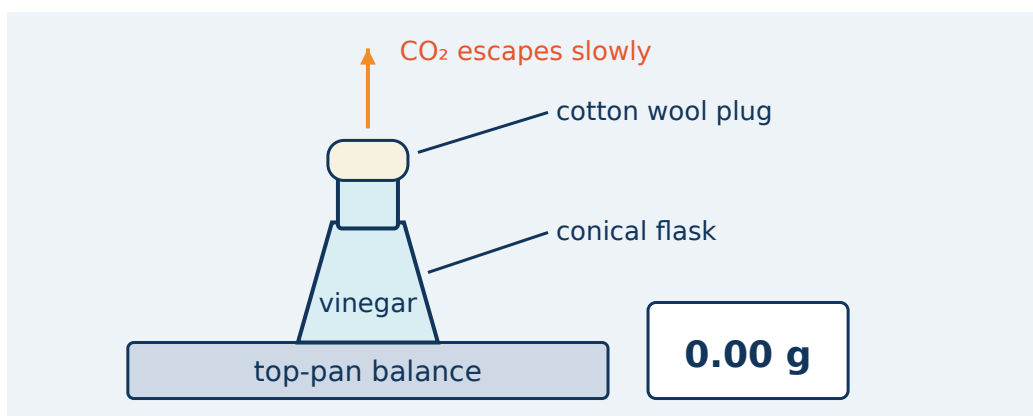
Safety

Safety

Wear safety goggles. Add the powder slowly to avoid froth overflowing. Wipe spills at once. Never seal the flask: carbon dioxide must be able to escape.

Method

1. Measure 25.0 cm³ of vinegar into the conical flask and plug it loosely with cotton wool.
2. Place the flask and one pot of baking soda on the balance and record the total mass.
3. Tip the powder into the flask, replace the plug and wait until the fizzing stops.
4. Record the final mass of flask, pot and contents. The mass loss is the carbon dioxide released.
5. Repeat with fresh vinegar and each of the six masses of baking soda.



Mass is read before and after the reaction.

Results

Sample data for $\text{NaHCO}_3 + \text{CH}_3\text{COOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2$ (Ar: Na = 23, H = 1, C = 12, O = 16):

Trial	Mass of NaHCO_3 (g)	Mass lost (g)
1	0.42	0.21
2	0.84	0.43
3	1.26	0.65
4	1.68	0.86
5	2.10	0.87
6	2.52	0.87

Analysis questions

Question 1 Plot the graph

Plot mass lost (y) against mass of NaHCO_3 (x) and describe its two parts.

Question 2 Find the turning point

Estimate the mass of NaHCO_3 at the point where the line becomes horizontal.

Question 3 Explain the plateau

Explain why trials 5 and 6 lose the same mass as trial 4.

Question 4 Moles of carbon dioxide

Calculate the moles of CO_2 released at the plateau (M of $\text{CO}_2 = 44 \text{ g/mol}$).

Question 5 Concentration of the vinegar

The ratio acid : CO₂ is 1 : 1. Calculate the concentration of ethanoic acid in the 25.0 cm³ sample.

Question 6 Percentage yield of CO₂

The expected plateau for 0.80 mol/dm³ acid is 0.88 g. Calculate the percentage yield.

Question 7 Sources of error

State one reason why the mass lost could be a little too small and one reason it could be too large.

Question 8 Improve the lab

Suggest two changes that would make the plateau easier to locate.