

Candles in beakers investigation

This resource accompanies the article **Understanding the hypothesis**, part of the Teaching science skills series, from *Education in Chemistry* which can be viewed at: rsc.li/3iIfXug

A set of slides and a student worksheet are available from rsc.li/3Hj3IWP

Learning objectives

- 1 Make predictions using your scientific knowledge and use them to form a hypothesis.
- 2 Plan an appropriate investigation to test your predictions.

Slides 1– 6 address LO1. Slides 7–11 move on to LO2, as learners plan and evaluate data from an example experiment. The follow-up task (slide 12) can be used to check understanding of LO1.

Introduction

Experiments ‘to show’ can be frustrating for learners if they already know what the experiment will show. The approach here is to change the experiment into one where they will not know what happens.

Learners have to use critical thinking to evaluate the alternative suggestions in the concept cartoon. They are then asked to formulate a hypothesis based on their own ideas about what will happen. They will need experimental data in order to test their prediction.

As learners are asked to plan an investigation to test their hypothesis they are prompted to think about what makes a fair test and how to get reliable data.

How to use the resource

This could be used to follow on from a class investigation into the effect of beaker size on the length of time the candle burnt. The slides can be used to guide a class discussion, in combination with or as an alternative to the worksheets. Give learners time to read the concept cartoon and consider their own ideas, then discuss and work towards agreeing on a hypothesis to test.

Alternatively, learners can work through the worksheet in groups, or independently as a homework task.

If the learners plan and carry out their own investigations this will be an activity for a whole lesson or even two. Otherwise all or part can be used as an activity at the start or end of a lesson.

There is an opportunity to evaluate some real experimental data (this might motivate learners to carry out the experiment to obtain better evidence). Learners are then asked to briefly think about the difficulties of showing only slight effects in results, as in medical research.

The follow-up task asks learners to use creative skills to produce their own concept cartoons. You can show learners more examples of concept cartoons from our collection rsc.li/3ZYTE7p.

Differentiation

This activity was created to be challenging, requiring learners to use critical thinking. By structuring as a class discussion you can use the guidance below to offer prompts or ask questions to help guide learners needing more support. Alternatively, asking learners to work in small groups for some parts of the activity will give them a chance to support one another. More confident learners could complete the worksheet independently.

Answers/discussion guidance

Concept cartoon

The only unreasonable statement in the cartoon is the suggestion that the wax would run out. If you think the experimental results (shown later in slide 9) are reliable, then the carbon dioxide argument gains credibility.

Planning your own investigation

Learners should include consideration of how to make it a fair test and make the results reliable.

Fair test

- The wick needs to be in a similar state each time (new candles need to burn for a little while).
- The volume inside the beaker must be the same. If you are going to cut down a candle then the cut pieces must be put inside the beaker. If you are going to support the candle at different heights, then the supports must be inside the beaker for all tests.
- The air needs to be fresh each time.
- Carbon dioxide can dissolve in water, so the beaker should be dry each time.

Reliability

- Any difference in the time is likely to be small so the experiment needs to be repeated many times to get a reliable result. This will be illustrated with the

example experimental data offered, but learners should be suggesting repeats even if they don't yet realise that the time difference will be very small.

Evaluation

1. Any of the following points are valid:
 - The data shows that further repeats are necessary to be sure of a conclusion.
 - It also shows that there is quite a lot of variation in the repeated results.
 - The impact of candle length on the time that the candle burns is, at most, small.
 - The data suggests that a more extensive investigation might show that the shorter candle went out quickest.
2. A scientist would want much clearer evidence before publishing. The experiment needs to be repeated many more times.
3. In medical research large numbers of people (a large sample group) are included to reduce the effect of randomness in disease.

Acknowledgements

This resource was originally written by Tim Jolliff as part of our *Chemistry for the gifted and talented* collection. It has been updated and made more accessible.