Popping good chemistry

The investigation is a fun way for learners to explore a neutralisation reaction and develop working scientifically skills. Use in a lesson, science club or as a Science Week activity. Download classroom slides, plus a version of the experiment for primary aged learners, from rsc.li/3ZLzbFi.

Learning objectives – understanding

1 Describe chemical reactions as the rearrangement of atoms.

2 Represent chemical reactions using formulas and equations.

Success criteria

1 I can describe chemical reactions as the rearrangement of atoms.

2 I can represent chemical reactions using formulas and equations.

Learning objectives – skills

1 Make predictions, observations and measurements.

2 Identify variables and how to make an experiment fair.

3 Identify patterns and make conclusions from results.

4 Evaluate the reliability of methods and suggest improvements.

Success criteria

1 I can make predictions using scientific knowledge and understanding.

2 I can identify dependent and independent variables and can state how to make an experiment fair.

3 I can make and record observations and measurements.

4 I can identify patterns and make a conclusion from my results.

5 I can evaluate the reliability of methods and suggest possible improvements.

Slides 5–8 provide some information about how effervescent tablets work and relate this to the 'understanding' learning objectives and success criteria. The jigsaw activity on slide 9 provides assessment evidence and you can scaffold it for different learners, as described later.

Slides 10–12 relate to the 'skills' learning objectives and success criteria and direct learners in planning and executing their investigation. You can focus on a few of these learning objectives as time may not allow your learners to develop them all in one session.

Introduction

This investigation shows how carbon dioxide gas, produced here from the chemical reaction between sodium hydrogencarbonate (commonly known as bicarbonate of soda) and citric acid, causes the pressure inside a sealed tube to increase, making the lid pop off.

Both sodium hydrogencarbonate and citric acid are solids in the tablet and are not free to react to form carbon dioxide until the tablet is dissolved in water. Once dissolved, it is the gas produced in the reaction that creates the bubbles of carbon dioxide that learners can observe.

This is a neutralisation reaction and can be described by the following word and chemical equations:

sodium hydrogencarbonate + citric acid → sodium citrate + water + carbon dioxide

$$3NaHCO_3 + C_6H_8O_7 \rightarrow Na_3C_6H_5O_7 + 3H_2O + 3CO_2$$

Vitamin C is needed to make collagen for healthy skin, hair and bones. It also helps us to absorb iron and aids in wound healing. There are claims that it boosts our immune system. Our bodies can't make vitamin C, so we must get it from the food we eat. Citrus fruits, like oranges, red peppers and broccoli are examples of foods high in vitamin C.

People who aren't eating a balanced diet may take vitamin pills or tablets to make sure they get enough vitamins. A fizzy tablet can be a good way to take extra vitamins because after the reaction, vitamin C is dissolved in the water and can be absorbed by the body more quickly.

Scaffolding

Equation jigsaw

Learners can complete this activity in a few different ways. Ask learners to write the word equation or chemical equation in their notes or mini whiteboards. This is the least scaffolded way.

Or ask learners to cut and stick the chemical formula for each component underneath the chemical names in the word equation. This would generate the chemical equation.

Give more support by asking learners to cut out each of the word equation components and stick them into their notes, similar to creating a jigsaw.

Investigation

The experimental method is presented as a traditional list of instructions (slide 13) and as integrated instructions (slide 14). Integrated instructions use clear numbering, arrows and simple pictograms to remove unnecessary information. This reduces cognitive load and can make the investigation more accessible to different learners. You can print the integrated instructions and allow learners to annotate and tick off

the steps that they complete. Read more about integrated instructions at rsc.li/47bIKi5 .

Slide 15 shows a skeleton table of results. You can pre-populate the table headings with the dependent variable (e.g. time (seconds)) and/or their chosen independent variable to increase the support given to learners.

You can also scaffold the conclusion for different learners as required.

Practical experiment notes

Read our standard health and safety guidance (rsc.li/3zyJLkx) and carry out a risk assessment before running any live practical.

Equipment (per group)

- Safety glasses or goggles
- Empty vitamin C tube
- Minimum 2 vitamin C tablets (more to allow for repeats)
- 1 boiling tube holder
- 1 measuring cylinder
- 1 timer or stopwatch
- Water
- Spillage tray and paper towels

Safety and hazards

Use slide 11 to discuss hazards and control measures with learners. The lid pops off suddenly and it is important to ensure that all learners wear eye protection. Remind learners not to look directly down at the tubes once the reaction has started and not to point them directly at anyone. If a lid does not pop off within the expected time, learners should let you know and you can carefully remove the lid.

Remind learners never to eat or drink anything in a science lab. The solution is an irritant if in contact with eyes – tell learners to wash their hands after the practical.

Tips

- The vitamin C tubes may topple over after the lids pop off so carry out the experiment in a tray or washing up bowl to minimise mess.
- Most vitamin C tubes include silica gel balls in the cap sealed with a cardboard disc. Once wet these can dislodge, therefore it's a good idea to remove them beforehand.

Resources

You can buy vitamin C tubes relatively cheaply from large supermarkets, pharmacies and pound shops. These tubes can be washed, dried and used a few times.

Evaluation questions

1. Did your conclusion match your prediction?
2. How did you ensure your results were reliable?
3. How could you have improved your experiment?

Questions for discussion

1. How do you know a gas is produced?
   Carbon dioxide gas is produced causing the pressure inside the sealed tube to increase, making the lid pop off.
2. What would happen if you repeated the experiment, using one whole tablet that was crushed up?
   A powdered tablet would have a larger surface area and so the reaction should be faster.
3. Would all effervescent tablets react in the same way?
   Effervescent tablets for headaches have a different active ingredient but they will react in the same way if they contain sodium hydrogencarbonate and citric acid.
4. What would happen if you repeated the experiment but used a translucent or transparent plastic container like Tupperware?
   This is a good way for learners to see that bubbles of carbon dioxide gas are produced during the reaction.

Extension activity

Extend this investigation by collecting and measuring the volume of gas produced. Repeat the experiment but instead of putting the lid on, use a balloon secured with an elastic band. Alternatively, perform the reaction in a side arm test tube and collect the gas in a gas syringe or by the downward displacement of water.

Follow up activity

Why not get learners to make an academic-style poster to share their investigation with others and practise their communication skills? Download from rsc.li/3FWp45U.

Additional information

This resource was originally developed by Declan McGeown, who worked at Royal Society of Chemistry from 2015 to 2022. It encapsulates his passion for getting learners excited about a subject he loved and is published in his memory. Beth Anderson, Alex Farrer and Helen Scally adapted, tested and reviewed the materials.