

Popping good chemistry

In this investigation, learners explore changing materials, irreversible changes and gases around us. Use in a lesson, science club or as a Science Week activity. Download classroom slides, plus a version of the experiment for learners aged 11–14 years, from rsc.li/3ZLzbFi.

Age group: 9–11 years

Learning objectives

Understanding

- I can describe an irreversible change.
- I know that an irreversible change produces new materials.
- I understand that some solids dissolve.

Enquiry skills

- I can make and test predictions.
- I can make observations, take measurements and record my results.
- I understand what 'variables' are.
- I can suggest how to improve my investigation.

Background science

This investigation shows how carbon dioxide gas, produced here from the chemical reaction between sodium hydrogencarbonate (commonly bicarbonate of soda) and citric acid, causes the pressure inside a sealed tube to increase, making the cap pop off. Both sodium hydrogencarbonate and citric acid are solids in the tablet and are not free to react 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 reaction can be described using a word equation, although this is not required for learners at this level:

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

This is an irreversible change as new materials are formed and cannot be changed back into the tablets.

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.

Prior learning

Make sure learners understand the properties of solids, liquids and gases.

Learners may have previously investigated reversible changes by dissolving salt in water and know you can get the salt and water back through evaporation and condensation. Make it clear that this is different because a reaction is taking place after the tablet dissolves.

Check that learners have some knowledge of fair testing and the effect of changing variables.

Useful vocabulary

You may wish to hide the definitions and examples on the PowerPoint slide and discuss learners' ideas first. Choose which vocabulary you want to explore.

Dissolve – some substances dissolve when mixed with water or other liquids. The substance doesn't disappear but breaks down into tiny particles and spreads out.

Effervescent – a reaction that produces bubbles of gas.

Irreversible change – a chemical change where new materials are formed.

Gas – a state of matter where particles have high energy and can move around freely in all directions. Gases can change their shape and spread out.

Reversible change – a change where no new materials are created and the original material can be recovered. For example: melting, evaporating, freezing, dissolving and mixing.

Variable – something that is observed or measured in a science experiment.

Vitamin – found in foods in very small amounts as part of a healthy diet.

Equipment

- Safety glasses
- Empty vitamin C tube
- 2 x vitamin C tablets per group (more to allow for repeats)
- Water
- Measuring cylinder or jug
- Timer or stopwatch
- Spillage tray and paper towels



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Safety

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

Use the safety slide to talk over the risks and safety precautions. Because the lid pops off suddenly, get learners to wear safety glasses if they are conducting the investigation themselves. Emphasise the importance of general science safety rules, such as ensuring that no chemicals go near learners' mouths and that they wash their hands after the practical work is complete.

Remind learners not to look directly down at the tubes once the reaction has started and not to point them at anyone. If a lid does not pop off within the expected time then the learner should let you know and you can carefully remove the lid when it is safe to do so.

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. If you have access to boiling tube racks (from a nearby secondary school) then this is a useful way to keep the tubes upright. Pencil holders also work.

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.

To keep everyone safe during the investigation, make sure that everyone has all the equipment they need before any reactions start. Depending on your class, you can choose to complete the investigation in small groups with extra adult supervision.

Step-by-step instructions

1. Show learners what happens when you put one tablet in a glass of water.
2. Ask learners to make a prediction about what might happen when you put a tablet inside the tube with some water and the lid on. Use the prompts on slide 5.
3. Make sure learners understand the safety rules (slide 6).
4. Pass out the equipment to each group. Check that learners know how to use stopwatches and measuring cylinders correctly.
5. Fill the empty tube with water, then pour it into a measuring cylinder or jug. Write down the volume and calculate half. This is the amount of water you need for each repeat. Note: for learners not confident calculating half or to speed up the preparation you can specify to use 30 ml of water.
6. Measure out the water and carefully pour into the tube.
7. Break one of the tablets in half, so that you can run the investigation with half a tablet and one tablet.
8. Get your timer ready. Work with a partner to make sure you start the timer as soon as the tablet is added.
9. Place half a vitamin tablet into the tube and put the cap back on as quickly as you can. Start the timer.
10. The reaction will start, forming bubbles of carbon dioxide and other new materials.
11. Wait until the lid pops off and stop your timer.
12. Record the result.
13. Repeat the experiment again with one whole tablet.
14. Your results will be more reliable if you do more repeats.

Resources

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

If possible, borrow safety goggles and/or test tube racks from a neighbouring secondary school.

Question prompts

1. How do you know a gas is produced?
Carbon dioxide gas is produced causing the pressure inside a sealed tube to increase, making the lid pop off.
2. How do you know this is an irreversible change?
A new material (carbon dioxide) is produced. This is an irreversible reaction because we cannot put the carbon dioxide back into the vitamin tablet.
3. If you repeated the experiment, what variables could you change and investigate? For example, could the amount of water affect the time taken for the lid to pop off?
If you use less water, there will be more space in the tube for the gas, so it will take longer for the lid to pop off. Other variables that you could investigate include temperature of the water, brand of tablet, flavour of tablet.
4. 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.
5. Can you think of any other chemical reactions that produce carbon dioxide?
Some other reactions of acids and alkalis release carbon dioxide, for example citric acid and bicarbonate of soda in sherbet sweets. Learners may have also made model volcanos erupt with bicarbonate of soda and vinegar, which also produces carbon dioxide. Burning fossil fuels and respiration (breathing) also release carbon dioxide.

FAQs

1. Do 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 bicarbonate of soda and citric acid.
2. Why does the reaction only happen when we add water to the tube?
The tablet is a solid. It is only when the bicarbonate of soda and citric acid dissolve in water that they are free to react together to make carbon dioxide gas.
3. 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.
4. What might happen if you used warm water instead of cold water?
Chemical reactions happen more quickly when the temperature is higher, so be ready to stand back before the lid pops off!

5. What might happen if you used more than two crushed up tablets?
Chemical reactions happen more quickly when the reactants are powdered, so the lid will pop off more quickly. Definitely an investigation to take outdoors!

More investigations to try

The creation of carbon dioxide using similar ingredients is also used in these investigations: Bath bombs (rsc.li/3hCBqnW), Freaky hand (rsc.li/3wCxjww), Fire extinguisher (rsc.li/3ejZSs7) and Lava lamp (rsc.li/3ehzJKJ).

You may also be interested in exploring the global experiment Measuring vitamin C in food (rsc.li/47Wpoys).

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.