

Fight fire! Fill up with foam

This resource accompanies the article **Chemicals that play with fire** in *Education in Chemistry* which can be viewed at: rsc.li/44gGuU2. Using this resource, your learners will plan and carry out their own investigation into the reagents that produce carbon dioxide foam.

Learning objectives

- 1 Plan an investigation to identify the reagent that produces the largest quantity of carbon dioxide foam.
- 2 Record the investigation results and make a conclusion.
- 3 Design a 'foam launcher' suitable for delivering the foam to a fire.

Success criteria: learners react a suitable combination of the reagents available to safely produce a good quantity of foam containing carbon dioxide.

Planning

Time	60 minutes – this time can be split into: <ul style="list-style-type: none"> • 20 min – setting the scene and planning time • 30 min – practical work • 10 min – making a conclusion Optional homework: <ul style="list-style-type: none"> • 10 min – answering questions • 20 min – designing a 'foam launcher'
Group size	2–3
Curriculum links	Combustion, reactions of acids and bases, planning and carrying out an investigation.

Suggested lesson plan

Start the lesson with the **Fire stopper** demonstration (rsc.li/3OXdpHR) to show learners how carbon dioxide extinguishes fire by smothering the flames and preventing further oxygen from reaching the fire.

Introduce the task using the student sheet and slides for guidance. Show the learners the equipment and reagents that they will be testing.

The task then falls into three stages: **plan**, **experiment** and **make conclusions**.

Prior to starting any experiments, ensure learners have a clear plan to investigate which extra reagent produces the largest volume of carbon dioxide foam. Learners will need to choose an order in which to add reagents to the reaction container.

Note: ensure that learners know to keep this order the same for each test, so they are only changing the extra reagent in each experiment.

As learners discuss their plans, circulate to support and scaffold discussions. Ensure learners have drawn a suitable table to record their results. Confirm that learners are aware of the reagent hazard warnings and have included safety precautions in their plans. Prior to learners starting any practical work, risk assess their plans.

In the planning stage, learners will apply their understanding of practical skills to a new situation, which learners often find demanding. Use the additional **investigation support sheet** for learners requiring a scaffolded method, results table and conclusion.

Once learners have completed their investigation, introduce the questions and challenge. If time does not allow, these sections could be set for homework.

Setting up the experiment

Refer to the **technician notes** for the equipment list, safety notes and preparation and disposal advice.

[Read our standard health and safety guidance](#) and carry out a risk assessment before running any live practical.

Example results

Extra reagent: washing detergent powder

The table below provides example results of changing the order of reagent addition. Although results will differ based on the brand used, the highest volume of foam was produced when the washing detergent powder was added to the reaction container first.

Added first	Added second	Added last	Volume of foam produced (cm ³)
Sulfuric acid	Sodium hydrogen carbonate	Washing detergent powder	250
Sodium hydrogen carbonate	Sulfuric acid	Washing detergent powder	250
Sulfuric acid	Washing detergent powder	Sodium hydrogen carbonate	600
Sodium hydrogen carbonate	Washing detergent powder	Sulfuric acid	600
Washing detergent powder	Sulfuric acid	Sodium hydrogen carbonate	700
Washing detergent powder	Sodium hydrogen carbonate	Sulfuric acid	650



The image shows an example of the volume of foam produced when washing powder detergent is added to the measuring cylinder first, followed by sodium hydrogen carbonate with sulfuric acid added last.

Extra reagent: washing up liquid solution

In these results, a 1:5 dilution washing up liquid solution (1 part washing up liquid mixed with 5 parts water) was tested. A higher volume of foam may be produced by diluting the washing up liquid solution more. The results will differ based on the brand used, so make sure to test before running a live practical.

Added first	Added second	Added last	Volume of foam produced (cm ³)
Sulfuric acid	Sodium hydrogen carbonate	Washing up liquid	200
Sodium hydrogen carbonate	Sulfuric acid	Washing up liquid	400
Sulfuric acid	Washing up liquid	Sodium hydrogen carbonate	250
Sodium hydrogen carbonate	Washing up liquid	Sulfuric acid	400
Washing up liquid	Sulfuric acid	Sodium hydrogen carbonate	300
Washing up liquid	Sodium hydrogen carbonate	Sulfuric acid	450

Extra reagent: water

With water as the extra reagent, the reaction will fizz but no foam should be produced (depending on how well learners have rinsed their reaction containers).

Assessment

You can assess learner performance in several different ways. At the end of the session, a fun way to assess success would be to ask groups to set up and run their best reagent combinations to identify which one produced the most foam.

Alternatively, learners could submit a full report, written independently or using the scaffolded investigation support sheet provided.

Also, if time allows, ask each group to deliver a presentation in which they present their 'foam launchers' to a panel of industry experts.

Answers

- (a) D. CO_2

(b) Acid + metal hydrogen carbonate \rightarrow salt + water + carbon dioxide

(c) C. Limewater turns cloudy when the gas is bubbled through it.
- (a) Heat and fuel

(b) i. Water removes heat.

ii. The fire break removes the fuel (the wood).

iii. The blanket smothers the flame and prevents further oxygen from reaching the fire.