

THE ROYAL
SOCIETY OF
CHEMISTRY

Carbon dioxide is widely used in fire extinguishers (coloured black to distinguish them from water-containing extinguishers which are red). Because carbon dioxide is heavier than air it smothers and extinguishes fires by preventing further oxygen from reaching the source of the flames.

However, one of the difficulties in putting out big oil fires in the open air is that the wind blows away the carbon dioxide gas, allowing oxygen to reach the fire, keeping it burning. Ideally, we should apply the carbon dioxide not as a gas but as a blanket of thick foam.

Your task

Make as much foam as possible (measured in a very large container) using:

- 1 Any combination of the 3 liquids (you are allowed a maximum volume of 20 cm³ of each).
- 2 Any combination of the 3 solids (in this case you are allowed a maximum of 6 spatula fulls of each solid).

These can be mixed in any order, but must not be shaken or stirred.



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Time	70 minutes.
Group size	2–3.
Equipment & materials	Eye protection.

General

Large measuring cylinders (500, 1000 cm³) or empty 1 litre plastic lemonade bottles with tops cut off, pestles and mortars, spatulas. Sodium hydrogencarbonate, sulphuric acid (2 mol dm⁻³), aluminium sulphate, washing up liquid, washing powder, water, food colouring – optional (see possible approaches below).

Safety notes See page 11.

Curriculum links Colloids. Combustion and Firefighting. Carbon dioxide.

Possible approaches A foam is a colloidal system in which a gas is dispersed in a liquid. Construction of a table to record results would be useful and aid systematic working. The foam is formed when a sodium hydrogencarbonate solution is mixed with a solution containing a detergent and aluminium sulphate (or any weak acid). Carbon dioxide gas is produced which is trapped by the detergent.

Trialled with a group of mixed ability second years, students were not given washing powder, just liquid detergent, to reduce variables. 500 cm³ measuring cylinders were fine for most students, but one or two needed to use the litre measuring cylinders. (It might be possible to use 500 cm³ beakers but they would really be too wide.) The foam makes it very difficult to read the calibrations on the measuring cylinder – colouring the mixture might help. Students were good at keeping a record of the amounts they used – which has to be quoted for their ‘best’ result to count. The greatest volume of foam was 800 cm³.

- ☛ **NB** Conkers make wonderful foam! Boil conkers up with water: peel conkers, mash them up, put in 250 cm³ beaker a third full of water. Boil for 5/10 minutes. DECANT SOLUTION. To make the froth: add sodium hydrogencarbonate (approximately a dessert spoon) and aluminium sulphate (sufficient acidity).
- ☛ Frothing agent obtained is the same as that found in shaving foams and fire extinguishers (a C₁₀ alcohol).

