

# The ups and downs of chemistry

## - Your task

Design and make a device (with final dimensions NOT exceeding 15 cm × 15 cm × 15 cm) which will sink in water, and then after a reasonable length of time, rise to the surface. As far as possible, the device is to be constructed from 'junk' materials.

- The final device must be loaded with chemicals, and be ready to start the experiment when told. You cannot do anything to the device, eg add anything to it (or to the water) once it is in the tank.
- There must be no connection between the device and the surface, once it has sunk.

Based on a Suggestion by Sussex SATRO.

## Time

It is suggested that either:-

an entire morning be devoted to the problem (eg on the last day of term), which would allow 2 hours for practical activities and 30 minutes for judging

or

the problem be given to the class as a homework exercise 2 weeks or so before the judging. Judging could then take place in a normal double science lesson, allowing 45 minutes for repair and final adjustments, and 30 minutes for judging.

(The exercise is better as a pre-set problem for younger students.)

## Group size

3–4.

## Equipment & materials

Eye protection.

Items from the 'junk' list, for example thin-necked plastic lemonade bottles, yoghurt pots, plastic 'specimen' containers with lids, plastic bags, balloons, scissors (see 'In search of solutions' additional handout ) - to encourage creativity.

Test tank, containing water to a depth of 20 cm.

Judges will require a stopclock and a 30 cm ruler plus marker pen.

### General

Corks to fit yoghurt pots, plastic beakers (100 cm<sup>3</sup>), stopclocks, 10g masses, rubber bands, rubber tubing (1 metre), sticky tape or masking tape, string, plastic buckets for 'test runs'.

For students who have studied neutralisation reactions, 0.5 mol dm<sup>-3</sup> hydrochloric acid, marble chips and tartaric acid could also be included.

Selection of chemicals: Salt, sugar, tartaric acid, marble chips, hydrochloric acid (2 mol dm<sup>-3</sup>), 'Alka Seltzer' tablets, Andrews' liver salts, or a mixture of solid sodium hydrogencarbonate/citric acid (1 teaspoon of sodium hydrogencarbonate to 3 teaspoons of citric acid).

Access to water.

### Per group

Identical teaspoons (can be plastic). A 30 cm ruler.

## Health & Safety notes

This is an open-ended problem solving activity, so the guidance given here is necessarily incomplete. Teachers need to be particularly vigilant, and a higher degree of supervision is needed than in activities which have more closed outcomes. Students must be encouraged to take a responsible attitude towards safety, both their own and that of others. In planning an activity students should always include safety as a factor to be considered. Plans should be checked by the teacher before implementing them.

You must always comply with your employer's procedures and in some cases may decide that a particular activity is inappropriate in your situation. Further information on Health and Safety should be obtained from reputable sources such as CLEAPSS [<http://science.cleapss.org.uk>] in England, Wales and Northern Ireland and, in Scotland, SSERC [<https://www.sserc.org.uk>].

Citric acid is an eye irritant. Wear eye protection. All other reagents mentioned are of low hazard.

It is the responsibility of the teacher to carry out a suitable risk assessment.

## Curriculum links

Solubility. Reaction of weak 'solid' acids with sodium hydrogencarbonate in the presence of water.

## Possible approaches

Generating a gas which causes a container to become buoyant; weighting a container with soluble material and allowing water to dissolve it so that the container then rises to the surface. (The sinking or floating/rising aspects could be investigated separately.)

## Evaluation of solution

These are suggestions only:

- 1 Students should not do anything to the device, eg add something to it (or to the water) once it is in the tank. Also, there must be no connection between the device and the surface, once it has sunk.
- 2 The final device must be loaded with chemicals, and be ready to start the experiment when the judge says so.
- 3 When placed on water the device should float for at least 5 seconds. Then when left it should sink until it is at least 5 cm under the surface of the water. It must stay at least 5 cm under water for any reasonable length of time, but must then rise to the surface where it should remain afloat again for another 5 seconds.
- 4 Judges should be looking for simplicity, reliability, elegance and humour.

## Extension work

Increasing the complexity of the behaviour required in terms of time limits and depth limits. Extend to actual lifting of a submerged object.

## Credits

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*Health & safety checked May 2018*

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