

# Which bleach is the best buy?

You are the scientist working for a consumer magazine. This month they are investigating chlorine-containing bleaches; they want to find out which bleach is the best buy.

(NB Chlorine is the active chemical in bleach.)

## - Your task

Determine how much available chlorine is present in four different bleaches, and which bleach is the best buy.

- Each bleach has already been diluted 50 times by water.

Based on a suggestion by S. Robilliard.

## Time

90 minutes.

## Group size

4.

## Equipment & materials

Eye protection.

### General

Burettes, funnels, volumetric flasks (available but not visible). Conical flasks and white tiles. Pipettes and safety fillers. Indicator paper (as a distractor).

Solutions of four different brands of chlorine-containing bleach (diluted 50 times by water). **NB** Environmental friendly bleaches do not contain chlorine.

### Per group

Sodium thiosulphate solution ( $0.1 \text{ mol dm}^{-3}$ ) ..... –  $80 \text{ cm}^3$

10 % potassium iodide solution ..... –  $80 \text{ cm}^3$

Dilute sulfuric acid (below  $1.52 \text{ mol dm}^{-3}$ ), starch solution as indicator.

## 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>].

Household bleach solutions (containing sodium chlorate(I) / sodium hypochlorite) sold for the domestic market is probably corrosive, typically they contain about 5% sodium chlorate(I). Even quite dilute

bleach is irritant if more than 0.15 Mol dm<sup>-3</sup> NaOCl. Eye protection is essential, and should be goggles to BSEN 166 3 (not safety spectacles) when preparing the diluted solutions.

Bleaches can release toxic chlorine gas. Undiluted solutions should be used in a well-ventilated laboratory and pupils with asthma should keep away from them.

Some bleaches also contain detergents and thickening agents, which may cause excessive frothing in this experiment.

Sulfuric acid, dilute H<sub>2</sub>SO<sub>4</sub>(aq), is a skin/eye irritant between 0.5 and 1.52 mol dm<sup>-3</sup>. Above that it is corrosive. Below, it is of low hazard.

Sodium thiosulfate, 0.1 M Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> is of low hazard. Potassium iodide is an eye irritant. A 10% solution is also an eye irritant but any concentration lower than that is of no significant hazard.

**Disposal:** Diluted bleach solutions are of low hazard, but for anything more than very small quantities of bleach, 'neutralise' with iron II salts or sodium thiosulphate and then wash to waste.

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

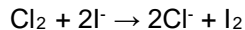
## Curriculum links

Redox reactions. Industrial technology. Chlorine.

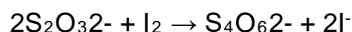
## Possible approaches

To find the amount of chlorine in each bleach:-

The bleach solutions are mixed with potassium iodide and then acidified. The chlorine present in the bleach oxidises iodide to iodine (*ie* chlorine is above iodine in the reactivity series):-



The iodine produced is then reduced quantitatively by sodium thiosulphate



Thus by adding iodide ions to the bleach and titrating it against sodium thiosulphate it is possible to determine the amount of available chlorine present in the bleach.

The molar ratio Cl<sub>2</sub> : I<sub>2</sub> : S<sub>2</sub>O<sub>3</sub><sup>2-</sup> = 1 : 1 : 2

**TITRATION:** 25 cm<sup>3</sup> of bleach in conical flask. Add **(i)** 10 cm<sup>3</sup> of KI solution, **(ii)** 20 cm<sup>3</sup> dilute sulphuric acid (both in excess). Titrate with sodium thiosulphate solution (0.1 mol dm<sup>-3</sup>) using starch as the indicator (added near the endpoint which is colourless). This procedure uses approximately 10 cm<sup>3</sup> of sodium thiosulphate – the accuracy of the burette readings can be increased by using more dilute solutions of sodium thiosulphate.

You should not give students cost/size of bottle (see data table) – unless asked for. Experiment could be used initially as an assessed practical (*ie* for design purposes where students have to suggest own methods). A couple of lessons later students could carry out their experiment and then present their results for assessment. Credit could be given for accuracy, consistency and treatment of results.

## Evaluation of solution

This experiment has been used as an A-level assessed practical (planning stage). Suggest credit is given for:-

- 1 Clarity of instructions.
- 2 Identifying a relevant reaction.
- 3 Choosing appropriate reagents for the reaction.

- 4 Suggesting appropriate quantities/concentrations of reagents.
- 5 Selecting appropriate apparatus.
- 6 Awareness of any variables that may need controlling.
- 7 Suggesting a way of controlling these variables.
- 8 Anticipating any hazards that may be encountered.
- 9 Suggesting ways of avoiding hazards by taking precautions.

After students carry out their experiment, credit could be given for example, for accuracy, consistency and treatment of results under the following headings: Method and explanation. Each titration. Calculation. 'Best buy' value.

Exercise enables considerable discussion regarding consumer choice and advertising.

## Suggested write-up

Students write a report for the "Consumer Watch-dog" magazine, explaining their methods and results, and finally which bleach is the best buy!

### Data table

Bleach	Cost per bottle	Size of bottle
eg Domestos	65 p	739 cm <sup>3</sup>
Vortex		
Parazone		
Sainsbury's		

### Extension work

Test viscosity ('staying power'), test 'bleaching power' on, eg ink. Discuss/investigate/report on environmental problems due to bleaches. Compare the bleaching power of chlorine and non-chlorine containing bleaches (**NB** Environmental friendly bleaches contain hydrogen peroxide as the oxidising agent that still liberates iodine).

### Credits

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*Health & safety checked May 2018*

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