

## An icebreaker for thermodynamics

### Education in Chemistry

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## Technician notes

### Kit

- 60 cm<sup>3</sup> plastic syringe
- Syringe cap (ideally a LuerLOK system)
- 15 cm latex or silicone tubing to fit syringe nozzle
- Spotting tile
- Screw-top cap for a glass sample vial, with diameter less than the internal diameter of the syringe.
- 2x 250 cm<sup>3</sup> beakers
- 100 cm<sup>3</sup> of 1 M NaOH (corrosive)
- 3 cm<sup>3</sup> Fresh household bleach, NaOCl (corrosive)
- 1 ml 6 M HCl (irritant)
- Glass Pasteur pipette
- Medium test tube (15 mm x 180 mm)
- 5 cm<sup>3</sup> 100 vol hydrogen peroxide, H<sub>2</sub>O<sub>2</sub>, (corrosive, causes serious eye damage)
- Approx. 1.2 g sodium hydroxide, NaOH (corrosive)

## Preparation

### Preparing chlorine

This is a method of making about 60 ml of chlorine in a syringe. It demonstrates a useful technique which can be used for many other gases. Wear splash-proof goggles and work in a fume cupboard near a large waste beaker or sink. Measure out 3 cm<sup>3</sup> of the bleach into the dips in a spotting tile, approx. 100 cm<sup>3</sup> 1 M NaOH into a 250 cm<sup>3</sup> beaker for neutralising the reactants following the preparation of the gas, and approx. 100 cm<sup>3</sup> of water into another beaker for washing. Ensure the plunger moves smoothly within the syringe.

Remove the plunger from the syringe, and drop the vial cap in, open end up. Load 1 cm<sup>3</sup> of 6 M HCl into the vial cap and float it in the water. Keeping the syringe upright with the nozzle held over the sink, lower the vial cap to the base of the syringe, without spilling its contents, by the evacuating water.

Keeping the syringe upright, replace the plunger for the syringe, and depress it until stopped by the vial cap. Draw up the bleach carefully to avoid sucking in air as well, and close the nozzle of the syringe with the syringe cap. Inverting and gently shaking the syringe will cause the liquids to mix; approx. 55 cm<sup>3</sup> of chlorine gas will be produced within 30 seconds. Keep the nozzle facing up. You may need to assist the plunger in slowly moving back if the pressure of the gas is too low.

Once the syringe has reached the desired 60 cm<sup>3</sup> mark, with the nozzle still held upwards, apply a small backwards pressure on the plunger to avoid spitting, and remove the syringe cap. Rotate the syringe 180° over the beaker of sodium hydroxide and discharge the liquid. Immediately draw up approx. 5 cm<sup>3</sup> of water from the washing beaker. Cap and invert the syringe (nozzle up) and shake to wash any remaining reactants from the walls. Remove the cap, and invert once again (nozzle down) to flush out the liquid only before capping to complete the procedure.

### Assembling the apparatus

Dissolve approx. 1.2 g of sodium hydroxide in 5 cm<sup>3</sup> water. Add this to a medium-sized test tube held in a clamp stand. Insert a 15 cm-length piece of tubing into the wide end of a Pasteur pipette and place by the gas syringe. Have the 5 cm<sup>3</sup> of hydrogen peroxide and a wash bottle of water standing by.

### **In front of the class**

Add the hydrogen peroxide to the test tube. Sometimes it can begin to decompose before the chlorine is added – this reaction can be quenched with a little water from a wash bottle. Remove the cap from the syringe and fit the tubing/pipette to the nozzle. Turn off the lights in the room – a student by the switch can assist with this. Lower the nozzle of the pipette into the alkaline hydrogen peroxide and slowly bubble the chlorine gas through the solution. The stunning, vibrant red chemiluminescence of singlet oxygen is observed.