Halogen displacement reactions

Equipment (per group)

- 1 dimple tray
- 1 dropping pipette in each beaker bottle of distilled water
- A set of halogen water dropper bottles or access to larger stopper bottles kept in a fume cupboard. Less than 2 ml of each solution will be needed.
- Access to potassium chloride, potassium bromide and potassium iodide solution and droppers. Less than 2 ml of each solution will be needed.

Safety equipment: safety spectacles

Preparation

You will need to make up the solutions below. Ideally these solutions should be put into small dropper bottle, enough for each group to have one set. Otherwise make up approximately 100 cm^3 and place in a stopper bottle.

- Chlorine water 0.1%–0.3% (w/v)
- Bromine water 0.1% (w/v)
- Iodine solution 0.1 mol dm^{-3}
- Potassium chloride solution 0.1 mol dm^{-3}
- Potassium bromide solution 0.1 mol dm^{-3}
- Potassium iodide solution 0.1 mol dm^{-3}

The sodium salts can be used if the potassium salts are not available. The concentration of the potassium iodide solution should be adjusted so that it gives a light brown solution on addition of chlorine water. If the reagents are too concentrated, a black precipitate of iodine often results instead of a brown solution.

Chlorine water needs to be freshly prepared and bromine water needs to be checked prior to the practical as concentration decreases over time.

Equipment set-up and tips

Dimple tray can be placed in a bucket of water at the end of the practical.

Use dropper bottles to reduce the release of toxic vapours.

Safety

Read our standard health & safety guidance and carry out a risk assessment before running any live practical.

Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

Chemical supplied for the practical	Preparation
Chlorine water - 0.1-0.3% (w/v) Cl_2 (aq) Currently not classified as hazardous but chlorine gas (toxic) readily diffuses from these solutions.	There are different ways to make to make chlorine water. Check CLEAPSS/ SSERC. The preferred methods are using sodium chlorate(I) solution and sodium dichloroisocyanurate.
Bromine water - 0.1% (w/v) Br_2 (aq) Currently not classified as hazardous but inhalation of bromine vapour acts as a respiratory irritant.	Bromine liquid Br_2 (l) MW = 160.00 g mol^{-1} **DANGER** Causes severe skin burns and eye damage Very toxic to aquatic organisms Inhalation of bromine vapour acts as a respiratory irritant.
Iodine solution - 0.1 mol dm^{-3} (prepared in 0.5 mol dm^{-3} potassium iodide solution) I_2 (aq) Currently not classified as hazardous.	Iodine solid I_2 (aq) MW = 253,80 g mol^{-1} **WARNING** Harmful (skin, inhalation) Very toxic to aquatic life Potassium iodide solid KI (s) MW = 166.00g mol^{-1} Not usually classified as hazardous
Potassium chloride solution - 0.1 mol dm^{-3} KCl (aq) Not usually classified as hazardous.	Potassium chloride solid KCl (s) MW = 74.55 g mol^{-1} Not usually classified as hazardous
Potassium bromide solution - 0.1 mol dm^{-3} KBr (aq) Not usually classified as hazardous.	Potassium bromide solid KBr (s) MW = 119.00g mol^{-1} Not usually classified as hazardous
Potassium iodide solution - 0.1 mol dm^{-3} KI (aq) Not usually classified as hazardous.	Potassium iodide solid KI (s) MW = 166.00g mol^{-1} Not usually classified as hazardous

WARN STUDENTS NOT TO INHALE CHLORINE AND BROMINE WATER.

Do not work on your own if halogen solutions have to be prepared.

- Bromine is acutely toxic by inhalation; take great care when using bromine and wear splash proof goggles or a face shield and gloves and work in a fume cupboard. Always make sure there is someone in the room with you in case of emergency. If using a bromine ampoule, follow guidance from CLEAPSS or SSERC on how to open it. It's best to prepare quantity required only or the quantity that you might need over two weeks as bromine will be lost by diffusion, the solution will look paler and the concentration will decrease. However, this is not always possible if you use a bromine ampoule and you might want to prepare a higher concentration (e.g. 0.3%) and dilute the necessary volume to 0.1%. The remaining 0.3% solution can be tried and diluted accordingly at a later date. Any bromine water that has not been used should be decanted into a screw-top glass bottle for storage.
- Chlorine gas is acutely toxic by inhalation and may have delayed effects; chlorine gas readily diffuses from chlorine water. Wear splash proof goggles or a face shield and gloves and work in a fume cupboard. Do not attempt to make chlorine water without supervision for the first time. Some technicians use chlorine tablets (eg Milton) as a source for chlorine water as it safer. You should then check the ingredients on the packaging to check how much chlorine is available and take into account any other chemical present in the tablet to check that they are not going to react. You will need to try the prepared chlorine solution.
- Potassium iodide turns yellow when stored. Make up solutions as normal and then add 1–2 crystals of sodium thiosulfate-5-water to remove any colour.

Disposal

Place large buckets of water in the laboratory where the students will be able to put their dimple trays. They can be rinsed and the water can be poured down a foul-water drain.

Potassium chloride, potassium bromide and potassium iodide solutions can be kept for another practical. Store potassium iodide solution in a dark bottle.

Iodine solution: concentration decreases with storage; dilute solutions are particularly affected. Store in screw-top glass bottles. Plastic bottles (and caps) become discoloured. Dilute down to at least 0.04 mol dm^{-3} using 1 mol dm^{-3} sodium thiosulfate solutions and pour down a foul-water drain.

Bromine water: use small quantities and work in a fume cupboard. Add slowly to 1 mol dm^{-3} sodium carbonate solution. Heat may be produced. The resulting solution should be tested for alkalinity with any acid/base indicator and, when just alkaline, poured down a foul-water drain with further dilution.

Chlorine water: can be diluted and poured down a foul-water drain. Work in a fume cupboard or in a well ventilated room.