Heating Group 1 metals in air and in chlorine

This demonstration could follow on from work on the properties of the Group 1 metals and their reaction with water.

It is recommended that you always practise demonstrations before carrying them out in front of a class.

Equipment required

- 3 clean, dry bricks with at least 1 flat surface each
- Chlorine generator (see below) – dropping funnel, conical flask and delivery tube
- 3 gas jars with lids
- Bunsen burner
- Scalpel
- Filter paper
- Indicator paper.

Chemicals

- Lithium, sodium and potassium (Highly flammable and corrosive)
- Potassium manganate(VII) (Oxidising agent, harmful)
- Concentrated hydrochloric acid (Corrosive).

Chlorine

You will need to fill three gas jars with chlorine. This can be done using a chlorine generator and must be carried out in a fume cupboard, although the rest of the demonstration can be carried out on a bench if the room is well ventilated.

To make a chlorine generator, place a couple of spatulas of potassium manganate(VII) in a conical flask. Attach a delivery tube and a dropping funnel containing concentrated hydrochloric acid (see Figure 1).

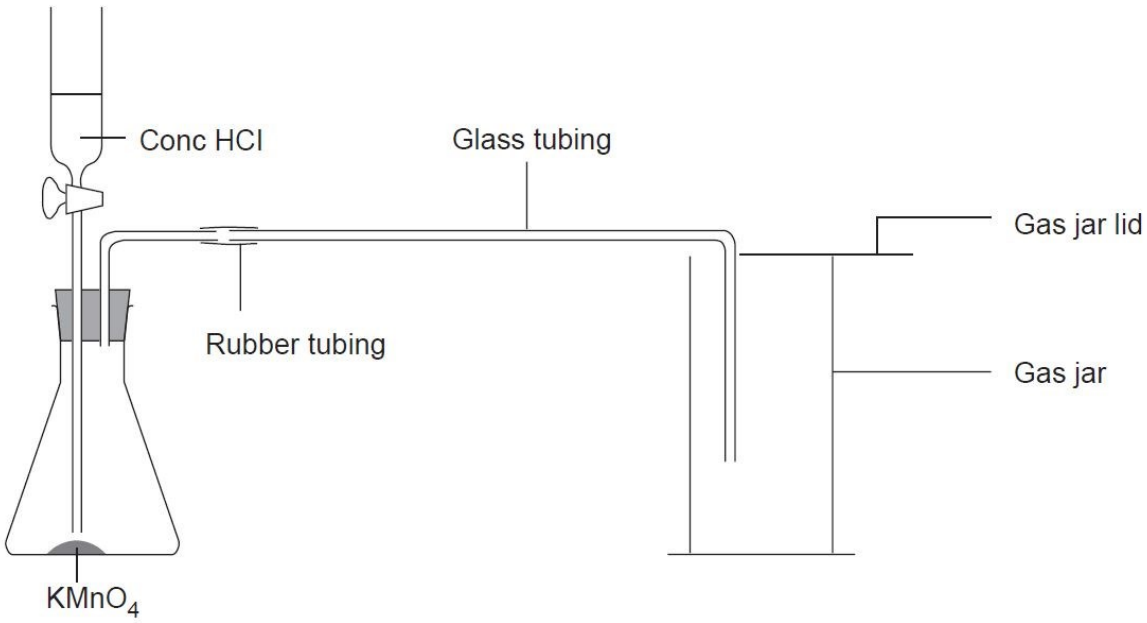

Figure 1 Chlorine generator

Check carefully that the acid is hydrochloric acid. Explosions have occurred through use of the wrong acid. Allow the acid to drip slowly onto the potassium manganate(VII) and collect

the gas by downward delivery. The gas jar will appear green when enough gas has been collected. When the gas jar has been filled, seal the lid on using a little Vaseline®. Have three filled gas jars ready prior to the demonstration.

An alternative method for making chlorine is to react sodium chlorate(I) with hydrochloric acid. See CLEAPSS Hazcards 22 and 89 for more details.

Health and safety

- Wear eye protection during both the demonstration and the chlorine generation.
- Read our standard health and safety guidance at https://rsc.li/3R4uLod
- Some chlorine will escape during the demonstration but it should be safe to carry out the experiment in a well-ventilated laboratory.
- The gas jars should be filled with chlorine in a fume cupboard beforehand.
- Your employer's risk assessment should be consulted before carrying out this activity.
- It is covered by model (general) risk assessments widely adopted for use in UK schools such as those provided by CLEAPSS, SSERC, ASE and DfES. Bear in mind, however, that these may need some modification to suit local conditions.

Heating in air

Start with lithium. Cut a small cube of the metal with an edge of about 3 mm. Blot off any oil using filter paper and place the cube onto the flat surface of a brick. It is no longer recommended to remove oil by dissolving in hexane as this has caused a number of fires.

Heat the sample from above using the hottest part of a roaring Bunsen flame (just beyond the blue cone). Once the metal is on fire, remove the Bunsen flame and you should be able to observe the classic red colour of a lithium flame. (You may initially see a yellow flame, but this is the result of any remaining oil burning.)

Test the residue with damp indicator paper to show that it is an alkali.

Repeat for sodium and potassium.

The expected pattern of reactivity – *ie* increasing from lithium to potassium – may be difficult to observe as it is often hard to see the potassium burning in the absence of the Bunsen flame. This may well be because the potassium reacts faster than the other metals so an oxide coating can form almost as soon as you begin to heat it.

$4Li(s) + O_2(g) \rightarrow 2\ Li_2O(s)$

Sodium and potassium produce a mixture of oxides, peroxides and superoxides.

Heating in chlorine

Again, begin by cutting a small cube of metal with an edge of about 3 mm and blotting off any excess oil. Place the sample on a clean, dry brick.

Check that the mouths of the gas jars containing the chlorine are narrower than the brick to reduce the amount of escaping gas. Make sure you can see a distinct green colour in the jars – if not, there is not enough chlorine present for the demonstration to be successful.

Heat the piece of metal from above using the Bunsen burner as for the **Heating in air** demonstration. When the metal is burning, take away the Bunsen burner, invert one of the gas jars, remove the lid and immediately place the jar over the burning metal. It may be helpful to have a second pair of hands to do this. The metal will continue to burn, producing fumes of white chloride. This method avoids the production of $FeCl_3$, which can occur when the experiment is done on a combustion spoon.

Repeat for the other two metals.

Again, the trend in reactivity is harder to see than in the reaction of the metals in water.

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

and similarly for sodium and potassium.

References

For details of how to demonstrate the reaction of Group 1 metals in water, see:
T. Lister, *Classic Chemistry Demonstrations*, London: Royal Society of Chemistry, 1995.

See also:
Safer Chemicals, Safer Reactions, Uxbridge: CLEAPSS School Science Service, 2003.

This document is provided on the CLEAPSS Science Publications CDROM, which is updated annually.