Flame tests (the wooden splint method)

Introduction

The method described in this experiment is intended for students to carry out and avoids the need for the use of concentrated hydrochloric acid. It also avoids the cost and contamination problems associated with the use of nichrome or platinum wires. A circus arrangement for the procedure would make classroom management much easier than if every group of students have to collect and test all the solutions at their own workstation. The time taken will depend on the number of tests to be carried out, but 30 minutes should be sufficient.

Equipment

Apparatus

- Eye protection
- Bunsen burners
- Heat-resistant mat(s)
- Boiling tube racks
- Boiling tubes
- Wooden splints

Chemicals

- Distilled water

A selection from solutions of the following salts

- Lithium chloride solution, 0.5 mol dm^{-3}
- Sodium chloride, 0.5 mol dm^{-3}
- Potassium chloride, 0.5 mol dm^{-3}
- Rubidium chloride, 0.5 mol dm^{-3}
- Caesium chloride, 0.5 mol dm^{-3}
- Calcium chloride, 0.5 mol dm^{-3}
- Strontium chloride, 0.5 mol dm^{-3}
- Barium chloride, 0.1 mol dm^{-3}
- Copper chloride, 0.5 mol dm^{-3}

Health, safety and technical notes

- Read our standard health and safety guidance here https://rsc.li/3Djq0yY
- Always wear eye protection.
- Lithium chloride, sodium chloride, potassium chloride, rubidium chloride, caesium chloride, calcium chloride, and barium chloride are all of low hazard.
- Strontium chloride can cause eye damage.
- Copper chloride can be harmful, and dangerous to the environment.
- See CLEAPSS Hazard HC047b for more information on chlorides.

Procedure

1. Well before the lesson in which they are to be used, thoroughly soak a supply of wooden splints in distilled water.
2. Sets of boiling tubes should be up to half-filled with the solutions of the salts.
3. Each ‘station’ around the laboratory should then consist of a boiling tube containing one of the above solutions, held in a test tube rack. Each should be labelled with the name and symbol of the metal ion present, plus appropriate hazard warnings. There

should also be as many pre-soaked splints as there are working groups. These should be immersed in the solution.

4. Students hold a soaked splint in a blue Bunsen flame to reveal the flame colour. It is important not to let the splint start to burn too vigorously. Bunsen burners could be clamped at an angle if desired: this helps avoid contamination caused by dripping onto the mouth of the burner (but care is need in the direction of the flame).
5. A container (such as a beaker half filled with water) for the disposal of used splints will be needed at each workstation.
6. One station could be set up with distilled water as a control and another with a solution labelled as 'unknown' if wanted.

Notes

- Watch this experiment in our practical video identifying ions here https://rsc.li/3Df0Am3
- Lead salts are best avoided. They carry an extra risk, and the flame test result is not that impressive.
- The chlorides of metals give the best results, but other salts, such as sulfates, also work. Nitrates are best avoided in order to avoid production of toxic nitrogen oxides.
- Potassium iodide and lithium iodide can be used instead of the chlorides. As a general rule, chlorides are usually suggested, since they tend to be more volatile and more readily available. These two are in fact a little more volatile than the chloride, and potassium iodide is certainly likely to be available.
- Teachers have traditionally used nichrome wire for carrying out flame tests. The main problems with this method are: - the need to use concentrated hydrochloric acid (corrosive, respiratory irritant). This presents considerable hazard that often deters teachers from using the procedure with students, the problem of contamination of wires which are then difficult to clean, the cost of regularly renewing wires.