Testing salts for anions and cations

Topic
Qualitative analysis.

Timing
1–2 hours.

Description
Students attempt to identify the anions and cations present in a salt by a combination of tests.

Apparatus and equipment (per group)
- Test-tubes.

Chemicals (per group)
Access to:
- Full range indicator paper
- Ammonia solution 2 mol dm$^{-3}$ (Causes eye damage)*
- Sodium hydroxide solution 0.4 mol dm$^{-3}$ (Skin/eye Irritant)
- Hydrochloric acid solution 0.4 mol dm$^{-3}$
- Barium chloride solution 0.1 mol dm$^{-3}$ (Harmful)
- Limewater solution 0.02 mol dm$^{-3}$
- Nitric acid 0.4 mol dm$^{-3}$ (Skin/eye Irritant)
- Silver nitrate solution 0.1 mol dm$^{-3}$
- Unknown substances labelled A, B, C …each might contain one of the following anions and one of the following cations:
  Anions - OH$^-$, SO$_4^{2-}$, CO$_3^{2-}$, Cl$^-$, Br$^-$, I$^-$, NO$_3^-$
  Cations - H$^+$, Ca$^{2+}$, Cu$^{2+}$, Fe$^{3+}$, Fe$^{2+}$, NH$_4^+$

A sensible selection might be:
copper chloride (Toxic if swallowed, Causes skin irritation and eye damage), potassium carbonate (Harmful if swallowed, skin/eye irritant), potassium iodide (skin/eye irritant), copper(II) sulfate (Harmful if swallowed, skin/eye/respiratory irritant), iron(III) chloride (Harmful if swallowed, Skin Irritant, causes serious eye damage), iron(II) sulfate (Harmful if swallowed, skin/eye irritant), lead nitrate (Reproductive toxin, causes serious eye damage, harmful if swallowed or inhaled, possible carcinogen and skin sensitiser).

Extension – for flame tests
Nichrome wire loops attached to wooden handles (cleaned before lesson in concentrated hydrochloric acid).
Safety

Pupils wear goggles (BS EN 166 3). * If the ammonia is reduced to 1.5 mol dm^{-3} or less then ordinary eye protection will suffice

When preparing solutions:

Ammonia solution is corrosive, causing burns, and gives off ammonia vapour which irritates the eyes, lungs and respiratory system. Prepare dilute solutions in a fume cupboard

Sodium hydroxide is corrosive, causing burns and is extremely dangerous to the eyes.

Hydrochloric acid is corrosive, causing burns. It also gives off choking fumes – prepare dilute solutions in a fume cupboard.

Barium chloride is harmful by inhalation and Toxic if swallowed.

Nitric acid is corrosive, causing burns. It also gives off toxic fumes – prepare dilute solutions in a fume cupboard.

Silver nitrate is corrosive to skin and eyes and an oxidising agent. The 0.1 mol dm^{-3} solution is of Low hazard.

Teaching tips

Test-tubes should be washed initially. Thorough washing to prevent contamination is important.

Flame tests

It is probably inadvisable to use concentrated hydrochloric acid to produce volatile chlorides at this level. This procedure should be effective as long as sodium, which produces a persistent yellow colour, is not given as an unknown.


This experiment is probably suitable for able 15/16 year old students in this format. Teachers may wish to adapt this for less able students and or spread the work over 2 or 3 lessons.

Background theory

A knowledge of precipitation reactions is helpful as is pre-knowledge of the chemistry of the tests. Otherwise, the students should test known substances to ensure they know what is a positive result.

Credits

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Health & safety checked January 2018
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