Which sodium salt is which?

Time

1–1.5 h.

Curriculum links

Tests for sulfur dioxide. Sulfur chemistry – students can find much of this in text books.

Group size

2–4.

Materials and equipment

Materials per group

1 g of each of the following:
- sodium metabisulfite (NaHSO₃) (harmful if swallowed, causes serious eye damage, contact with acids liberates toxic gas)
- sodium sulfate (Na₂SO₄.10H₂O) (no significant hazard)
- sodium peroxodisulfate (Na₂S₂O₈) (Skin/respiratory sensitiser, skin/eye/respiratory irritant, harmful if swallowed)
- sodium sulfite (Na₂SO₃.7H₂O) (harmful if swallowed, causes serious eye damage, contact with acids liberates toxic gas)
- sodium thiosulfate (Na₂S₂O₃.5H₂O) (No significant hazard)
- 2 mol dm⁻³ hydrochloric acid (No significant hazard)
- acidified potassium dichromate(VI) solution (1% solution in 1 M sulphuric acid) (Carcinogen, mutagen, reproductive toxin, harmful if inhaled, skin/eye irritant)
- 0.5 mol dm⁻³ potassium iodide solution (No significant hazard)
- 0.5 mol dm⁻³ iron(III) chloride solution (Corrosive to skin/eyes, harmful if swallowed, hazardous to the aquatic environment)
- 0.2 mol dm⁻³ iodine in aqueous potassium iodide (No significant hazard but will stain skin and clothing)
- 0.1 mol dm⁻³ silver nitrate solution (Skin/eye irritant)
- 2 mol dm⁻³ sodium hydroxide solution (corrosive to skin and eyes)
- 3% hydrogen peroxide solution (No significant hazard)
- deionised water
- litmus paper
- strips of filter paper
- safety goggles
- protective gloves.

Equipment per group

- 10 test-tubes
- test-tube rack
- test-tube holders
- Bunsen burner
- wood splints
- spatula
- wash bottle of deionised water
- dropping pipettes
- safety goggles.
Safety

Eye protection must be worn.

Some of the tests produce sulphur dioxide (corrosive, toxic - asthmatics are especially sensitive so it should only be handled in a fume cupboard).

Warming with dilute HCl produces chlorine (toxic if inhaled) this too should be carried out in a fume cupboard or on a very small scale. Do not inhale the gas.

Disposal: Silver solutions should be kept for recycling/ disposal. The other test tube reactions can be washed to waste with plenty of water.

Risk assessment

It is the responsibility of the teacher to carry out a suitable risk assessment.

This is an open-ended problem solving activity, so the guidance given here is necessarily incomplete. Teachers need to be particularly vigilant, and a higher degree of supervision is needed than in activities which have more closed outcomes. Students must be encouraged to take a responsible attitude towards safety, both their own and that of others. In planning an activity students should always include safety as a factor to be considered. Plans should be checked by the teacher before implementing them.

You must always comply with your employer’s procedures and in some cases may decide that a particular activity is inappropriate in your situation. Further information on Health and Safety should be obtained from reputable sources such as CLEAPSS [http://science.cleapss.org.uk/] in England, Wales and Northern Ireland and, in Scotland, SSERC [https://www.sserc.org.uk/].

Commentary

Students should be encouraged to predict the reactions of the salts and then draw up a systematic plan for the experiment. The following scheme is set out in the Independent learning project for advanced chemistry. It identifies all of the sulfur oxo-anions except the metabisulfite.

<table>
<thead>
<tr>
<th>Test</th>
<th>Na₂SO₃</th>
<th>Na₂SO₄</th>
<th>Na₂S₂O₃</th>
<th>Na₂S₂O₈</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Add silver nitrate solution</td>
<td>Initial white ppt. dissolved on shaking. With more AgNO₃ a dense white ppt remained.</td>
<td>No reaction at first, then a faint white ppt. appeared.</td>
<td>Initial white ppt. dissolved on shaking. With more AgNO₃ the ppt. remained and turned yellow, brown and black.</td>
<td>Blackish ppt. formed slowly.</td>
</tr>
<tr>
<td>3. Add iodine solution (in aqueous)</td>
<td>The brown colour was immediately discharged. (Iodine reduced.)</td>
<td>No visible reaction.</td>
<td>The brown colour was immediately discharged. (Iodide reduced.)</td>
<td>The brown colour become darker. (Iodide oxidised.)</td>
</tr>
</tbody>
</table>
### A procedure for distinguishing between sulfites and metabisulfites is given in Vogel² as follows:

Aqueous sulfite shows an alkaline reaction with litmus paper, because of hydrolysis:

$$\text{SO}_3^{2-}(aq) + \text{H}_2\text{O}(l) \rightarrow \text{HSO}_3^-(aq) + \text{OH}^-(aq)$$

while aqueous metabisulfite is neutral. On adding a neutral solution of dilute hydrogen peroxide to aqueous sulfite, sulfate ions are formed and the solution becomes neutral:

$$\text{SO}_3^{2-}(aq) + \text{H}_2\text{O}_2(aq) \rightarrow \text{SO}_4^{2-}(aq) + \text{H}_2\text{O}(l)$$

with aqueous metabisulfite hydrogen peroxide yields hydrogen ions with the same test:

$$\text{HSO}_3^-(aq) + \text{H}_2\text{O}_2(aq) \rightarrow \text{SO}_4^{2-}(aq) + \text{H}^+(aq) + \text{H}_2\text{O}(l)$$

and the solution shows a definite acid reaction.

### References


### Credits

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*Health & safety checked May 2018*

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