The Periodic Table – solubility of sulphates and carbonates of Groups 1 and 2

Topic
Periodic Table – Groups 1 and 2.

Timing
20 min.

Apparatus (per group)
- One student worksheet
- One clear plastic sheet (eg ohp sheet).

Chemicals (per group)
Solutions contained in plastic pipettes, see ‘Apparatus and techniques for microscale chemistry’ handout.
- Magnesium nitrate 0.5 mol dm\(^{-3}\)
- Calcium nitrate 0.5 mol dm\(^{-3}\)
- Strontium nitrate 0.5 mol dm\(^{-3}\)
- Barium nitrate 0.2 mol dm\(^{-3}\)
- Lithium bromide 1 mol dm\(^{-3}\)
- Sodium chloride 0.5 mol dm\(^{-3}\)
- Potassium bromide 0.2 mol dm\(^{-3}\)
- Sodium carbonate 0.5 mol dm\(^{-3}\)
- Sodium sulphate 0.5 mol dm\(^{-3}\).

Observations
There should be no precipitates in Group 1, indicating that all Group 1 carbonates and sulphates are soluble.

For Group 2, magnesium sulphate is soluble while strontium and barium sulphates are insoluble. Calcium sulphate is particularly interesting because although it is only sparingly soluble its solubility is much higher than is expected from the solubility product. This is due to ion pairing of the calcium and sulphate ions in aqueous solution. No precipitate will be seen.

The concepts of solubility product and ion pairing may be too complex for most pre-16 students.

Tips
Students might think that the Group 1 part of this experiment is rather dull. However, they can be told that chemistry experiments that seem to produce no visual results may nevertheless still produce useful information!

Students should also observe that all the precipitates are white not coloured. The accompanying solubility data will be useful.

**Solubility data**

Solubility in grams per 100 cm$^3$ of water at 20 °C (except where indicated with a superscript).

<table>
<thead>
<tr>
<th></th>
<th>Carbonate</th>
<th>Hydroxide</th>
<th>Sulphate</th>
<th>Fluoride</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnesium</strong></td>
<td>0.0106</td>
<td>0.0009</td>
<td>73.8</td>
<td>0.0076$^{28}$</td>
</tr>
<tr>
<td><strong>Calcium</strong></td>
<td>0.0014</td>
<td>0.185</td>
<td>0.209</td>
<td>0.0016$^{18}$</td>
</tr>
<tr>
<td><strong>Strontium</strong></td>
<td>0.0011</td>
<td>0.41</td>
<td>0.0113</td>
<td>0.012$^{27}$</td>
</tr>
<tr>
<td><strong>Barium</strong></td>
<td>0.002</td>
<td>5.6</td>
<td>0.00022</td>
<td>0.12$^{25}$</td>
</tr>
</tbody>
</table>

(Source: *CRC handbook of chemistry and physics*, 74th edn. 1993–4.)

**Health & Safety**

Students must wear eye protection.

Magnesium nitrate, 0.5 mol dm$^{-3}$ MgNO$_3$.6H$_2$O (aq), Calcium nitrate, 0.5 mol dm$^{-3}$ Ca(NO$_3$)$_2$.4H$_2$O (aq), Strontium nitrate, 0.5 mol dm$^{-3}$ Sr(NO$_3$)$_2$.4H$_2$O (aq) and Barium nitrate, 0.2 mol dm$^{-3}$ Ba(NO$_3$)$_2$ are skin/eye irritants.

Sodium sulphate, 0.5 mol dm$^{-3}$ Na$_2$SO$_4$(aq), Sodium chloride, 0.5 mol dm$^{-3}$ NaCl (aq), Lithium bromide, 1 mol dm$^{-3}$ LiBr (aq) and Potassium bromide, 0.2 mol dm$^{-3}$ KBr (aq) are low hazard.

Sodium carbonate, 0.5 mol dm$^{-3}$ Na$_2$CO$_3$.10H$_2$O is a skin/eye irritant.

**Credits**

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*Health & safety checked May 2018*

Page last updated August 2018