Some reactions of sulfur dioxide – teacher notes

Topic
Gases

Timing
20 minutes.

Apparatus
- Eye protection
- Student worksheet
- Clear plastic sheet (eg OHP sheet)
- Plastic Petri dish (base + lid), 9 cm
- Plastic pipette
- Scissors

Chemicals
Solutions should be contained in plastic pipettes. See the accompanying guidance on apparatus and techniques for microscale chemistry, which includes instructions for preparing a variety of solutions here https://rsc.li/3SG8VG3

- Hydrochloric acid, 1 mol m^{-3}
- Potassium iodide, 0.2 mol dm^{-3}
- Potassium iodate(V), 0.1 mol dm^{-3}
- Potassium manganate(VII), 0.01 mol dm^{-3}
- Full-range indicator solution diluted 1:1 with deionised water
- Sulfuric acid, 1 mol dm^{-3}
- Sodium sulfite powder

Method
Sodium sulfite + hydrochloric acid generates sulfur dioxide:
$Na_2SO_3(s) + 2HCl(aq) \rightarrow 2NaCl(s) + SO_2(g) + H_2O(l)$

Results
The iodide/iodate mixture turns black due to liberation of iodine:
$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(g) + 3H_2O(l)$

If sufficient sulfur dioxide is produced and the solution contains excess acid, the potassium manganate(VII) solution is decolorised:
$8H^+(aq) + 5e^- + MnO_4^-(aq) \rightarrow Mn^{2+}(aq) + 4H_2O(l)$

However, with less sulfur dioxide and therefore less acid, the brown manganese(IV) oxide is formed:
$4H^+(aq) + MnO_4^-(aq) + 3e^- \rightarrow MnO_2(s) + 2H_2O(l)$

Full-range indicator turns from green to yellow, indicating that sulfur dioxide is an acidic gas.

Health, safety and technical notes

- Read our standard health and safety guidance here https://rsc.li/3eeAKq4
- Students must wear eye protection.
- Sulfur dioxide is toxic and is a particular problem for asthmatics. Only use a very small amount of sulfite and acid to keep the sulfur dioxide production to a minimum. A risk-assessment should include any individual sensitivities (see CLEAPSS Hazcard HC097).
- Hydrochloric acid 1 mol m^{-3}, potassium iodide 0.2 mol dm^{-3}, potassium iodate(V) 0.1 mol dm^{-3} and potassium manganate(VII) 0.01 mol dm^{-3} are all of low hazard (see CLEAPSS Hazcards HC047a, HC047b, HC080, HC081).
- Sulfuric acid 1 mol dm^{-3} is a skin/eye irritant (see CLEAPSS Hazcard HC098a).
- Sodium sulfite powder is a skin, eye and respiratory irritant. Depending on its formulation, full range indicator can still be flammable when diluted 1:1 with water. Keep away from sources of ignition (see CLEAPSS Hazcard HC092).