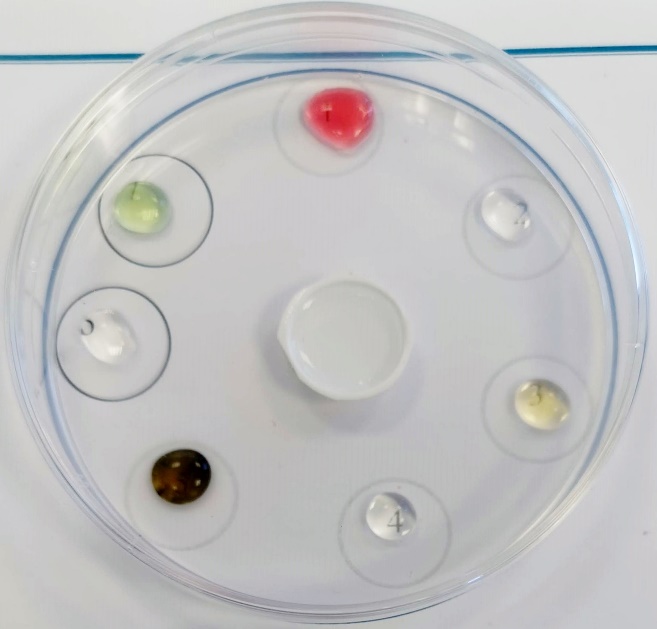
A picture containing vector graphics

Description automatically generated

|  |
| --- |
| Microscale Chemistry |
| The chemistry of sulphur dioxide |

****

**A simple method for investigating the reactions of ammonia. Using a technique which can be applied to many other reactions.**

**CfE Level 3**

Through experimentation, I can identify indicators of chemical reactions having occurred. I can describe ways of controlling the rate of reactions and can relate my findings to the world around me.

SCN 3-19a

**National 5** – Chemistry in Society

Fertilisers

**Introduction**

Sulphur dioxide dissolves in water readily to produce an acidic solution (of sulphurous acid, HSO3). It is unusual as an acidic gas in that it can act as either a reducing agent or an oxidising agent.

**Health & Safety**

* Wear eye protection.
* Sulphur dioxide gas is toxic and corrosive – work in a well-ventilated area

If all the sulphur dioxide were to be released, which it isn’t due to high solubility in solutions and the containment, each dish would release 15 cm3 of gas.

While harmful if sniffed directly, when dispersed in the room, it would take 6 or more to breach the Workplace Exposure Limit.

So as long no one, or very few, open their Petri dishes at the end of the experiment – except in a fume cupboard, there is no significant hazard.

**Each pupil will need**

|  |  |
| --- | --- |
| 2 x petri dishes | Laminated reaction sheet – or non-laminated inside a plastic wallet. |
| Sodium sulphite solution (1.6g in 10 cm3) | 1mol l-1 hydrochloric acid |
| Universal indicator solution (or paper, damp) | Potassium manganate(VII) (0.001 mol l-1) |
| Blue food dye (diluted) | Iodine solution |
| Potassium iodide 0.1 mol l-1 | Potassium iodide/iodate(V) 0.1 mol l-1 |
| Ammonium vanadate solution 0.1 mol l-1 | Hydrogen peroxide (20 vol) |
| Small watch glass or ‘blister’ from tablet pack | 1 cm3 Pasteur pipettes |

**Instructions**

1. If not already laminated, place the reaction sheet in a plastic wallet/folder.
2. Place two 9 cm diameter Petri dishes on the thick (blue) circles on the sheet. Remove the lid.
3. Place 2-3 drops of the test solutions/papers in the Petri dishes in the numbered positions, **1 – 7**, as described below.

*(one of the dishes is the control to allow you to see the colour changes more clearly)*

* 1. Universal indicator solution – or a damp piece of indicator paper - 1-2 cm
  2. Potassium manganate(VII) (0.001 mol l-1)
  3. Blue food dye, dilute
  4. Iodine solution
  5. Potassium iodide, 0.1 mol l-1
  6. Potassium iodide / potassium iodate(V), 0.1 mol l-1 of each (mixed)
  7. Ammonium vanadate solution 0.2 mol l-1

1. Place an empty ‘reaction vessel’ (eg, small watch glass) in the ‘RV’ circle in the upper petri dish.
2. To generate the sulphur dioxide gas

Put 5 drops of sulphite solution in the reaction vessel (gas generator). Add approximately 5 drops of 1 mol l-1 hydrochloric acid solution to the reaction vessel. **Immediately place the lid on the Petri dish**.

1. Watch carefully and record your observations over the next 5-10 minutes *(eg, take photographs).*
2. Explain as much of the chemistry going on in the Petri dish as you can.

**Disposal**: put petri dish in a bowl of water, without opening it. All the gas will dissolve in the water. Wash solution to waste with cold running water.

**TIP**

If you place the control petri dish upside-down: put the drops in the lid and then put the ‘base’ on top, you get less ingress of SO2 leaking from the experimental dish next to it and changing the colour of the indicator.

**Results and explanation**

Adding acid to the sodium sulphite released sulphur dioxide.

2 HCl + Na2SO3 → SO2 + 2 NaCl + H2O

1. Universal indicator – goes red

SO2 + H2O → H2SO3 (H2SO3 ⮀ H+ + HSO3-)

1. Potassium manganate(VII) (0.001 mol l-1) goes from purple to colourless

The sulphur dioxide is reduced by KMnO4

5 SO2 + 2 MnO4- + 2 H2O → 2 Mn2+ + 5 SO42- + 4 H+

1. The blue food dye goes from blue to colourless

This is due to the dye molecule being reduced to its reduced form which is colourless.

1. Iodine solution goes from yellow to colourless

I2 + SO2 + 2H2O → 2HI + H2SO4

1. Potassium iodide solution – no change
2. Potassium iodide/iodate solution goes from clear (possibly pale yellow)to dark red as the acid facilitates the iodate reaction with iodide to produce elemental iodine.

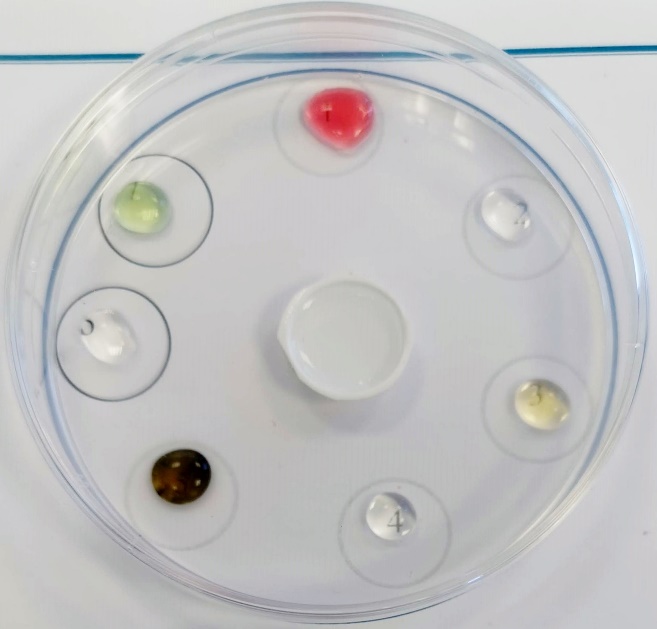
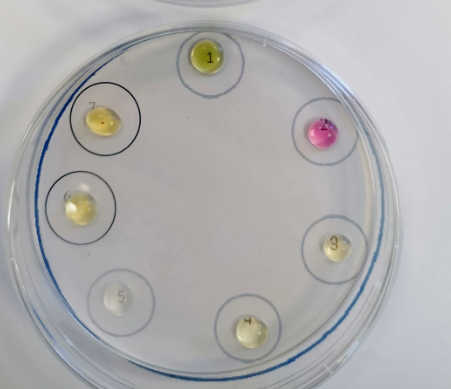
IO3− + 5 I− + 6 H+ → 3 I2 + 3 H2O

*Although the iodine is theoretically reduced by the SO2, in reality this process is too slow to remove the iodine quickly enough.*

1. Ammonium vanadate changes from yellow to green and then blue

SO2 reduces the vanadium from V5+ (yellow) to V4+ (blue). The green colour is a physical effect due to the mixing of yellow and blue.

**Sample results**

****Before After

**Extensions / alternatives**

Bromine water – this can be used as well as or instead of iodine – it too is decolorised by the sulphur dioxide.

Potassium dichromate (instead or as well as the vanadate) – the yellow/orange dichromate(VI) is reduced by the SO2 to green Cr(III)

|  |  |
| --- | --- |
| Experiment  Control | **Sulphur dioxide chemistry** |
| **Wear eye protection. Work in a well-ventilated lab.**   * If not already laminated, place this sheet in a plastic wallet/folder. * Place 2 x 9 cm diameter Petri dishes on the two blue circles (left). Remove lids. * Place 2 – 3 drops of the test solutions/papers in **both** Petri dishes in the numbered positions, **1 to 7** as described below.  1. Universal indicator solution 2. Potassium permanganate. 3. Blue dye. 4. Iodine solution 5. Potassium iodide, 0.1 M 6. Potassium iodide / potassium iodate(V) 0.1 M 7. Ammonium metavanadate solutions 0.2 M  * Place an empty ‘reaction vessel’ (eg,) in the ‘RV’ circle. * To generate sulphur dioxide gas (TOXIC): place 5 drops of sodium (or potassium) sulphite IV to the gas generator). Add approximately 5 drops) of 1.0 M hydrochloric acid to the reaction vessel. **Immediately place the lid on the Petri dish**. * Watch carefully and record your observations over the next 5-10 minutes (eg, *take photographs*). * Explain as much of the chemistry going on in the Petri dish as you can. * **Disposal**: put petri dish in a bowl of water. Wash solution to waste with cold running water. |