25: Clock Reactions

CORROSIVE
sulphuric acid

IRRITANT
hydrogen peroxide

- **Intermediate/high level**
- **30-60 mins to set up and time rates of reaction**
- **30-60 mins to develop the trick**

Requirements

stop clock
5 x 600 cm^3 beakers
5 x 250 cm^3 beakers
100 cm^3 measuring cylinders
5 stirring rods

eye protection

stock solutions of : solution A: sodium thiosulphate solution, $Na_2S_2O_3$ (0.2 mol dm^{-3})
solution B: potassium iodide solution, KI (1.0 mol dm^{-3})
solution C: starch solution 1%
solution D: a mixture of: sulphuric acid, H_2SO_4 (0.2 mol dm^{-3})
and hydrogen peroxide, H_2O_2 (0.09 mol dm^{-3})

Method

Make up the stock solutions and label the volumetric flasks clearly.

SOLUTION A: SODIUM THIOSULPHATE SOLUTION
Dissolve 49.6 g of $Na_2S_2O_3.5H_2O$ in 600 cm^3 distilled water. Make the volume up to 1 dm^3 with more distilled water. This solution will start to decompose after a few days so you should make it up fresh.

SOLUTION B: POTASSIUM IODIDE
Dissolve 166 g of KI in 800 cm^3 of distilled water. Make the volume up to 1 dm^3 with distilled water.

SOLUTION C: STARCH SOLUTION
Bring 500 cm^3 of distilled water to the boil in a 1 dm^3 beaker.
In a clean beaker make a slurry of 10 g of starch in 20 cm^3 of distilled water.
Pour the slurry into the boiling water and boil for 5 minutes.
Place 450 g of ice or 450 cm^3 of very cold water in a 2 dm^3 beaker and pour the hot starch mixture into the 2 dm^3 beaker.
After the ice has melted, dilute the mixture to 1 dm^3. This solution should be made up fresh.

SOLUTION D: HYDROGEN PEROXIDE / SULPHURIC ACID SOLUTION
Add 100 cm^3 of 2.0 mol dm^{-3} sulphuric acid (corrosive) to a 1 dm^3 beaker and add 500 cm^3 of distilled water to this.
Add 100 cm^3 of 20 vol hydrogen peroxide solution (irritant) to the 1 dm^3 beaker.
Dilute the solution to 1 dm^3 by adding distilled water. (This solution is now 0.2 mol dm^{-3} H_2SO_4 and ~0.09 mol dm^{-3} H_2O_2 and is low hazard.)

See the pupils' sheet for the rest of the procedure.

Chemical background

The initial concentration of thiosulphate ions is varied and the clock period rate is varied. The sudden change from colourless to deep blue can be explained with the following sequence of equations:

In an acidic solution, iodide ions are oxidized by the peroxide to triodide ions:

$$\text{(i)}\ 3I^-(aq) + H_2O_2(aq) + 2H^+(aq) \longrightarrow I_3^-(aq) + 2H_2O(l)$$

The triodide ions are reduced back to iodide ions by the thiosulphate ions:

$$\text{(ii)}\ I_3^-(aq) + 2S_2O_3^{2-}(aq) \longrightarrow 3I^-(aq) + S_4O_6^{2-}(aq)$$

When all the thiosulphate ions have been used by the second reaction, triodide ions react with starch to from the blue starch-iodide complex.