Get set... demonstrate
Running inspiring science demos

Iodine Clock

An eye-catching colour change demonstration in which a colourless solution suddenly changes to a dark-blue after an amount of time. It is known as the "iodine clock" as the colour change doesn't happen straight away. The demonstration is particularly well-suited as an introduction to reaction rates and kinetics.

About these notes

These notes have been designed to accompany the film "Iodine Clock demonstration - Get set...demonstrate for Demo Day 2014", as part of the Get Set Demonstrate series of video guides. They are not a standalone guide to performing this demonstration. The aim is to encourage as many teachers as possible to try a new demonstration for National Science and Engineering Week. See www.getsetdemo.com for more information.

Equipment

2 large conical flasks marked "A" and "B"
Several 250 ml beakers
Stirring rod
Stopclock/timer
Safety screen used as white background
Few sheets of white paper
Balance
Eye protection
Volumetric flasks
Measuring cylinders (2 x 100 cm^3)

Chemicals

2dm^3 deionised/distilled water

For solution A

0.2g soluble starch
4.1g anhydrous sodium ethanoate (sodium acetate) - see CLEAPSS Hazcard 38A
50g potassium iodide - see CLEAPSS Hazcard 47B
9.4g sodium thiosulfate-5-water - see CLEAPSS Hazcard 95C

For solution B

30 cm^3 glacial (concentrated) ethanoic acid (CORROSIVE) - see CLEAPSS Hazcard 38A
500 cm^3 hydrogen peroxide solution, 20 'vol' (IRRITANT) - see CLEAPSS Hazcard 50

Making the solutions

Solutions **A** and **B** should be made up before the demonstration. The solutions will keep overnight, but best results are obtained if the solutions are made up on the day.

1. Make a paste of 0.2 g of soluble starch with a few drops of water in a beaker. Pour onto this approximately 100 cm^3 of boiling water and stir.

2. Pour the resulting solution into a 1 dm^3 beaker and dilute to around 800 cm^3.

3. Add 4.1 g of sodium ethanoate, 50 g of potassium iodide and 9.4 g of sodium thiosulfate. Stir until all the solids have dissolved and allow to cool to room temperature.

4. Pour the mixture into a 1 dm^3 volumetric flask and make up to 1 dm^3 with water. Label this flask **solution A**.

5. In a 1 dm^3 volumetric flask mix 500 cm^3 of 20 volume hydrogen peroxide with 30 cm^3 of glacial ethanoic acid and dilute to 1 dm^3 with water. This flask should be labelled **solution B**.

Both solutions are colourless although solution **A** will be slightly cloudy.

Demonstration procedure

1. Measure 100 cm^3 of solution A and pour it into an empty 250 ml beaker.
2. Measure 100 cm^3 of solution B in a separate (clean) 100 cm^3 measuring cylinder.
3. Position the beaker containing solution **A** against a white or light coloured surface. Add solution **B** to the 250 ml beaker and give it a good mix with a stirring rod.
4. Leave the mixture to stand. After about 20 seconds at room temperature the mixture will suddenly turn dark blue.

The appearance of the blue colour may be timed; a pupil could start and stop the timer.

Safety notes

- The acid will react slowly with sodium thiosulfate and produce a cloudy suspension of sulfur and release sulfur dioxide which is TOXIC (see CLEAPSS Hazcard 97). To avoid this the acid and sodium thiosulfate are separated in solutions A and B.
- Ethanoic acid is corrosive and you should refer to CLEAPSS Hazcard 38A.
- Hydrogen peroxide solution, 20 'vol' is an irritant and you should refer to CLEAPSS Hazcard 50.

Teaching notes

In the main reaction the hydrogen peroxide oxidises iodide ions to iodine. This is quite slow and is the rate determining step in this demonstration (useful stimulus for advanced discussions):

$$H_2O_{2(aq)} + 2I^-_{(aq)} + 2H^+_{(aq)} \rightarrow I_{2(aq)} + 2H_2O_{(l)}$$

As soon as any iodine is formed, it reacts with the thiosulfate and turns back into iodide ions by this fast reaction:

$$2S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$$

Therefore, there is no colour change as long as there is thiosulfate present in the solution. However, once all the thiosulfate is used up, the free iodine remains in solution and reacts with the starch to form the familiar blue-black complex.

The ethanoic acid/sodium ethanoate is added to buffer the pH.

The time for the blue colour to appear can be adjusted by diluting the hydrogen peroxide solution, as in the video. Alternatively, varying the amount of thiosulfate in solution A will also change the time for the blue colour to appear.

It may help if students are already familiar with the reaction between iodine and starch.

To enable pupils to see the colour change easily, you can use a sheet of white paper attached to a safety screen (or similar) behind the beaker. Alternatively, if you are "lucky" enough to have an old overhead projector in your department, you could place the beaker onto the projector, which will illuminate it from underneath.

Note that hydrogen peroxide is capable of oxidising thiosulfate ions to tetrathionate ions but the reaction is too slow to affect this demonstration.

References

Hazcards 38A, 47B, 50, 95C.
CLEAPSS recipe book, sheet 29 - further clock reaction recipes
CLEAPSS Guide L195 'Safer chemicals, safer reactions', section 13 - useful information about how to carry out rates experiments involving acid/thiosulfate mixtures more safely.
Nuffield Foundation Practical Chemistry instructions
http://www.nuffieldfoundation.org/practical-chemistry/iodine-clock-reaction