

Investigating the rate of reaction between hydrogen peroxide and iodide ions

Background

In aqueous acid solution hydrogen peroxide reacts with iodide ions to produce iodine.



The iodine can be detected by its colour. The detection of the iodine can be enhanced by the addition of starch solution. The concentrations of each of the reactants can be varied and the time it takes to produce a fixed amount of iodine can be measured.

One way of measuring the rate is to time how long it takes to produce a certain amount of iodine.

This can be done by adding a fixed amount of sodium thiosulphate to the reaction mixture, which will react with a fixed amount of iodine.



When the sodium thiosulphate has been used up the iodine/starch colour will suddenly appear in solution. From the amount of thiosulphate added the amount of iodine produced can be calculated.

Practical Techniques

You will need to find out about how to make up accurate solutions. You may need to find out about colorimetry and the use of pH meters.

Where to start

Plan a series of experiments to investigate the effect of changing the concentrations of the reactants on the rate of the reaction. You will be able to find the order of reaction for each reactant and hence the rate equation for the reaction.

Possible Investigations

- Investigate the reaction at different temperatures to determine the effect of temperature on the rate and hence determine the activation enthalpy for the reaction.

- Investigate the effect of ammonium molybdate (1g dm^{-3}) on the reaction - what is its catalytic effect? Vary the temperature and find the activation enthalpy for this reaction.
- Investigate a different technique for monitoring the rate of the reaction – possibilities are – colorimetry, conductivity or pH. You will not need to include the sodium thiosulphate solution with these methods.

Sources of Information

- Hill G. C. and Holman J., (2001), *Chemistry in Context Laboratory Manual (Fifth Edition)*, Nelson Thornes
- Woods G., Hydrogen Peroxide, *Chemistry Review*, September 1996
- Denby D., Clock Reactions, *Chemistry Review*, November 1996
- Thorpe A., Colorimetry, *Chemistry Review*, February 2003
- Thorpe A., Assessing the risks in practical work, *Chemistry Review*, September 2000
- Ellis P.R., The White Knight's Experiment, *Education in Chemistry*, September 1996, Vol 33, No5
- <http://users.erols.com/merosen/kinetics.htm>
- Thorpe A, Experimental error and error analysis: just how good are those results, *Chemistry Review*, November 2001
- Thorpe A., Making a standard solution, *Chemistry Review*, November 2002

Teachers' Notes

General

This investigation is based around a very familiar experiment that can be found in most practical chemistry books. It is sometimes known as the “iodine clock” reaction. The practical techniques are fairly straightforward and students of all abilities should be able to carry out the experiments successfully. If more demanding manipulative skills are required then students should investigate the other techniques (e.g. colorimetric) that are suggested.

Chemical Principles

Reaction Kinetics.

Essential Equipment

Burettes, pipettes

Essential Chemicals

Hydrogen peroxide, potassium iodide, sulphuric acid, sodium thiosulphate, starch.

Safety

No risk assessment has been given. It is essential that students prepare a detailed risk assessment before they start. Teachers must be satisfied that this is suitable for the proposed investigation.

Starter Experiment - Investigating the rate of reaction between hydrogen peroxide and iodide ions

Here is a suggested method to investigate the effect of varying the concentration of iodide ions.

Prepare the following solutions

- Hydrogen peroxide 0.25 mol dm^{-3}
- Potassium iodide 0.5 mol dm^{-3}
- Sulphuric acid 0.05 mol dm^{-3}
- Sodium thiosulphate 0.01 mol dm^{-3}
- Starch solution 4 g dm^{-3}

You will need to think about how much of each solution to prepare. This will depend on how much of each solution is used in each experiment and how many experiments you do (including any repeats).

Use pipettes and /or burettes to put the following solutions into a small beaker.

Expt	Sulphuric acid (cm^3)	Starch (cm^3)	Potassium iodide (cm^3)	Water (cm^3)	Sodium thiosulphate (cm^3)
1	25	1	1	4	1
2	25	1	2	3	1
3	25	1	3	2	1
4	25	1	4	1	1
5	25	1	5	0	1

When you are ready to start you should add 1 cm^3 of hydrogen peroxide solution to the beaker and start timing. You need to record the time it takes to produce the iodine/starch colour.

The rate of the reaction can be determined by the reciprocal of time (because a constant amount of iodine is produced in each reaction) and a graph of the concentration of the variable under test against $1/t$ can be plotted. This graph can be used to determine the order of the reaction.