

Investigating the effect of fluoride ions on the rate of a reaction

Background

Eggshells can react with acids to produce carbon dioxide gas. It has been found that fluoride ions can slow down this reaction (Parkin, 1998). It is thought that this reaction is similar to the reaction between tooth enamel and acids and the protective action of fluoride ions. This investigation is based around the kinetics of the reaction and the factors affecting it.

Practical Techniques

You will need to find out how to make accurate solutions.

Where to start

You need to collect some eggshell and soak it in sodium fluoride solution of various concentrations. You then need to react the treated eggshell with dilute ethanoic acid and measure the rate of reaction. You can do this by measuring the time it takes to produce carbon dioxide gas.

The article by Christopher Parkin in the School Science Review (March 1998) gives details of apparatus that can be used.

Possible Investigations

- Vary the concentration of the fluoride ions to investigate their effect on the rate of the reaction.
- Investigate the reaction at different temperatures to determine the effect of temperature on the rate and hence determine the activation enthalpy for the reaction. You can do this with and without the fluoride ions.
- Investigate the effect of other ions on the rate of the reaction
- Investigate a different technique for monitoring the rate of the reaction – possibilities could be –, pH, conductivity or mass– you could link these instruments to a computer if it is available.

Sources of Information

- Parkin C (1998) Do fluoride ions protect teeth? *School Science Review* Vol 53 (288) p.110
- The Chemistry Video Consortium and The Royal Society of Chemistry (2000) *Practical Chemistry for Schools and Colleges* CD ROM
- Thorpe A, Making a standard solution, *Chemistry Review*, November 2002
- Lindsey D, Measuring pH, *Chemistry Review*, September 1998
- Ferguson M., Volumetric Analysis. *Chemistry Review*, September 1996
- <http://users.erols.com/merosen/kinetics.htm>
- Thorpe A., Assessing the risks in practical work, *Chemistry Review*, September 2000
- Thorpe A., Experimental error and error analysis: just how good are those results, *Chemistry Review*, November 2001

Teachers' Notes

General

This investigation is based the article by Christopher Parkin in the School Science Review and students need to consult this article.

The practical techniques are initially very tricky as the rate of reaction is slow but students should be able to obtain results fairly quickly once the apparatus is set up and working. Time needs to be allowed for soaking the eggshells.

The modified apparatus suggested in the article does work and teachers may wish to ask technicians to help construct this. I found that I could not prepare the range of concentrations suggested in the article, as the sodium fluoride would not dissolve easily.

You could try the experiment with actual teeth if you can get hold of them.

Chemical Principles

Acids, reaction kinetics, solubility.

Essential Equipment

Burettes, pipettes.

Essential Chemicals

Ethanoic acid, sodium fluoride, eggshells.

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.