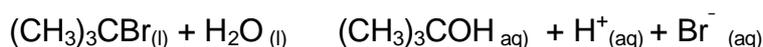


Investigating the rate of hydrolysis of organic halogen compounds

Background

Organic halogen compounds react with water to produce an alcohol, halide ions and hydrogen ions. This is an example of a hydrolysis reaction.

For example – 2-bromo 2-methylpropane



The rate of this reaction can be followed by measuring the amount of hydrogen ions or bromide ions produced in a given time. This can be carried out by sampling the reaction mixture and carrying out an appropriate titration.

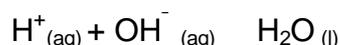
Practical Techniques

You will need to find out how to make accurate solutions and volumetric analysis (titration).

Where to start

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

This can be done by stopping the reaction and titrating the remaining solution with sodium hydroxide. The hydroxide ions will react with the hydrogen ions that have been produced.



From the amount of hydroxide added the amount of hydrogen ions produced can be calculated. The extent of the reaction can therefore be determined.

Another method might be to add silver ions to the compound dissolved in ethanol and time how long it takes for the silver bromide precipitate to form. This could be by marking a cross on a piece of paper and timing how long it takes to obscure the cross.

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 a different technique for monitoring the rate of the reaction – possibilities are – conductivity or pH. You will not need to include the stop the reaction with these methods. You could make use of data logging equipment.
- Investigate the rate of reaction of other organic halogen compounds - you can change the halogen atom or the carbon skeleton– what affect does this have on the comparative rates of hydrolysis?

Sources of information

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Teachers' Notes

General

practical chemistry books. The practical techniques are quite complicated and students will need to be well organised and fairly competent in order to carry technique.

Chemical Principles

Burettes, pipettes, water bath.

Essential Chemicals

2- bromo 2-methylpropane (or chloro or iodo compounds), ethanol, sodium hydroxide, methyl red indicator

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.

Experiment Starter Sheet – Investigating the hydrolysis of organic halogen compounds

Here is a suggested method to investigate the rate of the reaction.

Prepare the following solutions

- 2- bromo 2-methylpropane
- Ethanol/water mixture 4:1 vol/vol
- Sodium hydroxide 0.05 mol dm^{-3}
- Methyl red indicator

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).

1. Place 100 cm^3 of the ethanol/water mixture into a 250 cm^3 conical flask. Place a stopper in the reaction vessel. You may like to place this in a water bath to regulate the temperature. This is the reaction mixture.
2. Place of 20 cm^3 (new portions) of the ethanol/water mixture into six separate 100 cm^3 conical flasks. Add five drops of indicator to each flask. Place each flask in an ice bath.
3. Place the sodium hydroxide solution in a burette.
4. Place 1 cm^3 of the 2- bromo 2-methylpropane into the reaction mixture as quickly as possible, mix well and start timing.
5. After two minutes remove a 10 cm^3 sample and place into one of the cooled 100 cm^3 flasks. This will slow down/stop the reaction. Then, with the flask still in the ice bath, titrate immediately with the sodium hydroxide solution. Stop when the indicator turns from red to orange.
6. Repeat the sampling and titration at intervals of 5, 10, 20, 30 and 45 minutes.
7. Finally, after another 20 minutes, titrate the remaining mixture in the reaction vessel.

The concentration of the 2- bromo 2-methylpropane will reduce as the reaction proceeds. A graph can be plotted of the concentration of 2- bromo 2-methylpropane against time. The gradient of tangents drawn on the curve can be used to determine the rate of the reaction at a given concentration.