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| Simple Chemical Reactions |
| Neutralisation of strong and weak acids |

**Introduction**

CfE Advanced Higher

Inorganic & Physical Chemistry

This is a straightforward neutralisation reaction which is followed by pH (using an indicator) and by following the change in conductivity.

**You will need**

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| Conductivity flask | AC power supply and leads |
| 0.1 mol l-1 hydrochloric acid | 0.1 mol l-1 ethanoic acid |
| 0.1 mol l-1 sodium hydroxide | Full range indicator\* |
| 25 cm3 measuring cylinder | 3 cm3 Pasteur pipette |

\* if full range indicator is not available, use universal.

You could also use a pH meter rather than (or as well as) the indicator.

**To do**

1. Set up the conductivity flask
2. Add 25 cm3 of sodium hydroxide solution to it.
3. Add a few drops of indicator and record the pH and the conductivity.
4. Using the Pasteur pipette, add 3 cm3 of hydrochloric acid to the vessel and stir. Record the pH and the conductivity reading
5. Continue adding 3 cm3 amounts of acid, recording pH and conductivity, until you have added 40 cm3.
6. Rinse out the flask and repeat the experiment, this time using ethanoic acid instead of hydrochloric.

**What is happening?**

The addition of 3 cm3 of 0.1 mol l-1 sodium hydroxide to 10 cm3 of 0.1 mol l-1 hydrochloric acid reduces the concentration of H+ ions from 0.1 mol l-1 to a little over 0.05 mol l-1 (some of the HCl has been neutralised and the volume of the solution has increased). pH is logarithmic, so it rises from 1 to about 1.3.

After 18 cm3 of sodium hydroxide have been added, the concentration of the remaining H+ ions is still significant (just over 0.005 mol l-1; pH 2.3). The pH of hydrochloric acid hardly changes until an excess of alkali has been added.

The addition of alkali to 0.1 mol l-1 ethanoic acid removes the few H+ ions present in the solution but more ethanoic acid molecules dissociate to replace them. The pH in this case rises steadily until all the acid has been neutralised.

Conductivity changes in tandem with the reaction.

The initial conductivity of the NaOH is due mainly to the OH- ions (as they are significantly more mobile than the Na+ ions.

As the HCl neutralises the NaOH, the conductivity drops as there are fewer OH- ions. The addition of Cl- ions does not compensate.

At the point of neutralisation, the conductivity reaches a minimum as the only conductors are sodium and chloride ions.

On continuing to add acid, however, the conductivity rises rapidly: more rapidly than it fell as H+ ions are much more mobile than OH- ions.

With the ethanoic acid, the first part of the graph is similar as OH- ions are becoming less concentrated.

After neutralisation, however, the increase in conductivity is much slower as only a fraction of the excess acid is dissociated to produce H+ ions.

**Safety**

At these concentrations, the two acids are not of any significant hazard.

**It is the responsibility of teachers doing this demonstration to carry out an appropriate risk assessment.**