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| Chemical Demonstrations |
| Universal Indicator Rainbow |

**Introduction**

This reaction can be applied to curriculum for excellence.

SCN 3-19a

*Through experimentation, I can identify indicators of chemical reactions having occurred ...*

CfE Higher – Chemistry in Society

*Oxidising or reducing agents*

Universal Indicator is a full-range indicator and the pH is shown by a range of different colours. The acid colours are shades of red, orange and yellow (pH 1–6). Neutral is green (pH 7) and the alkali colours are dark greens, blues and purples (pH 8–14).

In this demonstration, a measuring cylinder is filled with very dilute HCl containing indicator. A saturated solution of sodium carbonate is poured down the side and establishes a density gradient which is also a pH gradient.

**You will need**

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| **For Cylinder version** |  |
| *250 cm3 measuring cylinder* | *0.1M HCl about 125 cm3* |
| *Water* | *Universal indicator* |
| *Saturated Na2CO3 solution (about 30 cm3 .* |  |

**To do**

1. Half fill the measuring cylinder with 0.1 M HCl.
2. Add enough universal indicator to give a good colour
3. Top up with fresh water – this should mix the indicator. If not, stir/shake/invert to mic.
4. Tilt the measuring cylinder and gently pour the sodium carbonate solution down the side. As the sodium carbonate is more dense, it will sink to the bottom and produce the purple/blue colour while a rainbow will appear above it.

**Comments**

A white background is useful to show the colours.

If the diameter of the tube is too wide, then mixing will occur too quickly and not all the colours will be seen using the first method.

The second method can also usefully tie in to reinforcing the concept of liquid density.

**What is happening?**

The neutralisation reaction between the acid and the alkali is:

acid + alkali → salt + water

hydrochloric acid + sodium hydroxide → sodium chloride + water

in this case, as we have a carbonate, CO2 is produced as well.

HCl(aq) + Na2CO3(aq) → NaCl(aq) + CO2 + H2O(l)

As the acid is very dilute, only a small amount of carbon dioxide is produced and this simply dissolves in the water. A more concentrated acid will result in effervescence that will disturb the pH gradient. All the other ions remain in solution as spectator ions.

The simplest neutralisation reaction may be written as:

H+ (aq) + OH- (aq) → H2O(l)

pH is a measure of the concentration of hydrogen ions. It is calculated using the formula

pH = -log10[H+]

**Safety**

The sodium carbonate solution is irritant. It is advisable to wear eye protection.

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