Neutralisation – ‘curing acidity’

Class practical

This simple experiment allows students to follow the **pH** and **temperature changes** when an **acidic** solution (**vinegar**) is gradually **neutralised** by the addition of **slaked lime** (**calcium hydroxide**) and limestone (**calcium carbonate**). The experiment can be used to explore the issues involved in the control of **soil pH** in agriculture.

Lesson organisation

The practical work involved is straightforward if the students understand the need for methodical care, and follow the instructions accordingly.

The activity is, perhaps, best suited to more thoughtful students who will appreciate the need for a sequence of repetitive steps to be carried out with care and attention to detail, in order to establish a clear result.

Apparatus	Chemicals
Eye protection ***Each group of students will require:*** **Beaker (100 cm^3)** **Measuring cylinder (25 cm^3)** **Spotting tile (white plastic, 12 cavities)** **Glass rod** **Stirring thermometer (-10C - 110C) or electronic temperature probe (Note 1)** **Spatula** **Universal indicator paper (full range, pH 1-14) (Note 2)** **Universal indicator pH colour chart (full range pH 1-14)**	Calcium hydroxide powder (IRRITANT) Calcium carbonate powder Vinegar, 20-30 cm^3 Distilled (or deionised) water, in wash bottles **Refer to Health & Safety and Technical notes section below for additional information.**

Health &Safety and Technical notes

Read our standard health &safety guidance

Wear eye protection throughout.

Calcium hydroxide powder, $Ca(OH)_2(s)$, (IRRITANT) - see CLEAPSS Hazcard. Each group of students will need a small container (e.g. small beaker or watch glass) of at least 6 spatula measures of calcium hydroxide powder (also labelled as ‘slaked lime’ and IRRITANT).

Calcium carbonate powder, $CaCO_3(s)$ - see CLEAPSS Hazcard. Each group of students will need a small container (e.g. small beaker or watch glass) of at least 6 spatula measures of calcium carbonate powder (also labelled as ‘ground limestone’).

Vinegar (dilute ethanoic acid), $CH_3COOH(aq)$ - see CLEAPSS Hazcard. Distilled (colourless) malt vinegar is required, as the colouring in ordinary malt vinegar would obscure the indicator colours. The concentration of the vinegar should be checked before the lesson, and adjusted if necessary, to ensure that the addition of 6 successive spatula measures of slaked lime

produces a clear sequence of pH changes, and no further change between the final two spatula measures. The vinegar can be provided in a small (labelled) beaker.

1 Stirring thermometers should be able to indicate clearly a rise of about 4C from room temperature. If electronic temperature probes are used instead, they may need to be clamped while students stir the solution with the glass rods.

2 Indicator paper is expensive, so it would make sense to pre-cut the paper into smaller test pieces. Each group of students will need 12 pieces to fit into the cavities in the spotting tile.

Procedure

a Place a piece of Universal indicator paper in each of the hollows on the spotting tile.

b Measure 10 cm^3 of vinegar into the beaker and add 10 cm^3 of water. Stir to mix. Record the temperature of this vinegar solution.

c Use the glass rod to take a drop of the vinegar solution and place it onto the first piece of indicator paper on the spotting tile. Compare the colour with the indicator chart and record the pH.

d Add a spatula measure of 'slaked lime' to the vinegar solution and stir steadily for 10 seconds. Record the new temperature of the solution. Take a drop of the solution and place on the second piece of indicator paper on the spotting tile. Make sure you do not transfer solid particles of slaked lime. Record the pH found.

e Repeat the procedure five more times, with one more spatula measure of slaked lime each time, for five more pieces of indicator paper. Record the temperature of the solution and the pH each time.

f Rinse out the beaker, glass rod and thermometer. Repeat steps **a – e** using ground limestone instead of slaked lime.

Teaching notes

The intention of this experiment is to reinforce the idea that pH changes steadily over the pH range as an acid, such as the ethanoic (acetic) acid in vinegar, is neutralised by an alkali such as slaked lime. Indeed, the pH will end up on the alkaline side when excess alkali is added.

The first part, using slaked lime, should take about 20-30 minutes, while the second part should not add more than 15 minutes of practical work.

The measurement of the temperature rise is intended solely as an introduction to the idea of energy changes accompanying chemical changes. In this case, the temperature rise (about 4C) is not large enough for most students to notice without the use of a thermometer or temperature probe.

The evolution of gas (carbon dioxide) with ground limestone should be noticeable (fizzing). At this time, this is probably best just noted as an interesting event and need not be followed up until later.

The other difference from slaked lime is more important here: whereas slaked lime takes the pH across to a moderately alkaline value (pH about 10 may be expected), ground limestone should take the pH change only as far as about 7 (roughly neutral). This should be checked before the lesson, in case any impurities in the 'ground limestone' might lead to an alkaline result.

The use of lime in agriculture has of course more complex reasons than just a matter of adjusting pH. But at this stage, it is the adjustment of the pH of soil that is the target idea. Slaked lime has a more rapid effect on soil pH, but care may be needed not to add too much and make the soil too alkaline. However ground limestone, although slower in its effect, will only take the pH to neutral, and any surplus added will simply help to retain the pH around neutral for some time afterwards.

Health &Safety checked, 2016

Credits

This Practical Chemistry resource was developed by the Nuffield Foundation and the Royal Society of Chemistry.

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