*Chemistry > Big idea CCR: Chemical reactions > Topic CCR4: Acids and alkalis*

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| **Key concept (age 11-14)** |
| **CCR4.1: Neutralisation** |

**What’s the big idea?**

A big idea in chemistry is that during a chemical reaction, atoms are rearranged resulting in the formation of a new substance or substances.

**How does this key concept develop understanding of the big idea?**

This key concept helps to develop the big idea by using understanding of chemical reactions to explain the change in pH when an acid reacts with a base.

****The conceptual progression starts by checking understanding of more familiar observations of acid reactions. It then supports the development of understanding of the reaction between an acid and a metal carbonate in order to enable understanding of the end point of a neutralisation reaction between a strong acid and a strong alkali.

**Using the progression toolkit to support student learning**

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.

**Progression toolkit: Neutralisation**

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| **Learning focus** | A salt is formed from a neutralisation reaction between an acid and a base. | | | | |
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| **As students’ conceptual understanding progresses they can:** | **C o n c e p t u a l p r o g r e s s I o n** | | | | |
| Explain the appearance of bubbles when bicarbonate of soda reacts with vinegar.  **P** | Explain what happens when an acid appears to ‘eat away’ a material.  **P** | Suggest evidence than an acid has reacted with an alkali. | Predict the pH at the end of a reaction between an acid and an insoluble base. | Describe the end point of a reaction between a strong acid and a strong alkali.  **B** |
|  |  |  |  |  |  |
| **Diagnostic questions** | Vinegar fizz | Damaged marble | Reaction evidence | Final pH | End point |
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| **Response**  **activities** | Carbon dioxide possibility | Describing reactions | Reactant and product pH | Beaker contents | Changing pH |

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| Key: | | | |
| **P** | Prior understanding from earlier stages of learning | **B** | Bridge to later stages of learning |

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| **Vinegar fizz** | **Damaged marble** | **Reaction evidence** | **Final pH** | **End point** |
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| Confidence grid | Simple multiple choice | Confidence grid | Confidence grid | Confidence grid |
| **Carbon dioxide possibility** | **Describing reactions** | **Reactant and product pH** | **Beaker contents** | **Changing pH** |
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| Application and practice | Clarifying | Application and practice | Clarifying | Clarifying |

**What’s the science story?**

Acids and alkalis are solutions commonly used in chemical reactions, including the making of salts. Litmus indicator can be used to identify whether a solution as an acid or alkali. Universal indicator or a pH meter provide information on the pH of the solution. Measurement of pH may be used to determine the end point of a neutralisation reaction between a strong acid and a strong alkali.

**What does the research say?**

A key misunderstanding of students is that ‘acids eat material away’. Driver (1994) summarises research (Hand and Treagust, 1989) that found that even after further teaching about one third of students studied still perceived the reaction between calcium carbonate and an acid as the ‘acid eating the calcium carbonate away’ rather than as a chemical reaction.

This is consistent with more generalised research by Andersson (1990) which found five different categories of answer used by students in explaining chemical reactions. Only one of these, that substances combine or split to form new substances, is scientifically correct. The misconception that calcium carbonate is ‘eaten away’ by an acid could be categorised as explaining the reaction through the ‘disappearance’ of a reactant.

For this reason, the conceptual progression starts with two more familiar reactions of acids. The focus is on checking that the students understand that a chemical reaction is taking place. The appearance of bubbles may be explained as the formation of a new substance in the gas state. The apparent disappearance of the marble may be explained by the formation of a new, soluble, product.

A key misconception of older students is that neutralisation always produces a neutral solution. Schmidt (1995) analysed responses to test items and found that students were influenced by the term ‘neutralisation’ in its original more historic meaning (the reaction between an acid and base in which they ‘consume’ each other, from the Latin ‘neuter’ meaning neither of the two) rather than thinking more carefully about the reaction between ions or equilibrium reactions.

Another research paper (Demircioğlu et al., 2005) found that students also had misunderstandings about the pH of salts with some students thinking that all salts are neutral and others that salt solutions had no pH at all.

The conceptual progression therefore encourages students to think about the pH of the salt solution formed rather than simply linking the term neutralisation with a pH of 7 with no other chemical understanding.

**Guidance notes**

This key concept intentionally limits examples of neutralisation to the reaction between a strong acid (e.g. hydrochloric acid) and a strong base (sodium hydroxide). An alkali is a soluble base. Strong acids and strong bases are fully ionised in solution meaning that the reaction equal amounts (in moles) of hydrochloric acid and sodium hydroxide solution will result in the formation of a neutral solution of the salt, sodium chloride.

It should be noted that a neutralisation reaction does not necessarily produce a neutral solution. For example, the reaction between a weak acid (ethanoic acid) and a strong base (sodium hydroxide) produces a solution of sodium ethanoate which is alkaline.

Similarly, the reaction between a strong acid (hydrochloric) and a weak base (ammonia) produces ammonium chloride which is acidic.

For this reason, the key concept emphasises the formation of a neutral salt through complete reaction of the acid and base.

**References**

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