**Beaker contents**

Copper carbonate is gradually added to a beaker containing sulfuric acid.

Copper sulfate solution is formed.

A picture containing object

Description automatically generated

* 1. Complete the table below to show what the beaker contains at each stage of the experiment.
  2. Describe how the pH changes during the reaction. The pH of the sulfuric acid is 1.

|  |  |  |  |
| --- | --- | --- | --- |
| **Substance** | **Stage 1** | **Stage 2** | **Stage 3** |
| sulfuric acid |  |  |  |
| copper carbonate |  |  |  |
| copper sulfate solution |  |  |  |
| water |  |  |  |

*Chemistry > Big idea CCR: Chemical reactions > Topic CCR4: Acids and alkalis > Key concept CCR4.1: Neutralisation*

|  |
| --- |
| **Response activity** |
| **Beaker contents** |

**Overview**

|  |  |
| --- | --- |
| Learning objective: | A salt is formed from a neutralisation reaction between an acid and a base. |
| Observable learning outcome: | Predict the pH at the end of a reaction between an acid and an insoluble base. |
| Activity type: | Clarifying |
| Key words: | acid, solution, pH |

This activity can help develop students’ understanding by addressing the misunderstandings revealed by the following diagnostic question:

* Final pH

**What does the research say?**

Driver (1994) refers to research (Hand and Treagust, 1989) that found that a third of students taking part in the study regarded the reaction of acids with either metals or calcium carbonate as examples of ‘acids eating something away’. Other research (Sheppard, 2006) found that some students considered neutralisation to be the physical mixing of an acid and base with no named products.

This type of misunderstanding could lead to confusion for students in terms of predicting the final pH of a neutralisation reaction.

Test questions used by researchers (Demircioğlu, et al. 2005) found that students had misunderstandings about the pH of salts. Some thought that all salt solutions had a pH of 7 whilst others thought that salt solutions do not have a pH at all. The former misunderstanding was thought to arise from students being introduced first to the formation of salts from strong and acids and bases. Salts do not always have to have a pH of 7, for example if the salts have been formed from reaction a strong acid (or base) with a weak base (or acid).

Even if students do correctly predict the final pH to be 7 this may not necessarily be for the correct reasons. For example, Hand and Treagust (1989) also found that some students considered neutralisation to be the breakdown of an acid. This would predict a final pH of 7 but not for scientifically correct reasons.

**Ways to use this activity**

This activity gives students the opportunity to clarify their thinking through discussion. To support this, students should answer the question in pairs or small groups.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome, through a whole class clarification or redirection part way through the activity.

*Differentiation*

If some students are working with a teaching assistant, then a list of prompt questions for the teaching assistant could help to make this activity more purposeful.

**Expected answers**

1a

|  |  |  |  |
| --- | --- | --- | --- |
| **Substance** | **Stage 1** | **Stage 2** | **Stage 3** |
| sulfuric acid | ✓ | ✓ | X |
| copper carbonate | X | X | ✓ |
| copper sulfate solution | X | ✓ | ✓ |
| water | ✓ | ✓ | ✓ |

b The pH at the start will be pH1 because the beaker contains sulfuric acid. As more copper carbonate is added it reacts with sulfuric acid so that the amount of sulfuric acid decreases. This means that the pH will increase until, at the end of the reaction no sulfuric acid is left. The pH at the end will be pH 7.

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden and Alistair Moore (UYSEG)

**References**

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Hand, B. and Treagust, D. F. (1989). Application of a conceptual conflict teaching strategy to enhance student learning of acids and bases. *Research in Science Education,* 19**,** 133-144.

Sheppard, K. (2006). High school students' understanding of titrations and related acid-base phenomena. *Chemistry Education Research and Practice,* 7(1)**,** 32-45.