**Reactant and product pH**

Hydrochloric acid reacts with sodium hydroxide forming sodium chloride and water.

The chemical equation is: HCl(aq) + NaOH(aq) → NaCl(aq) +H2O(l)

The diagram below shows what is in each test tube.

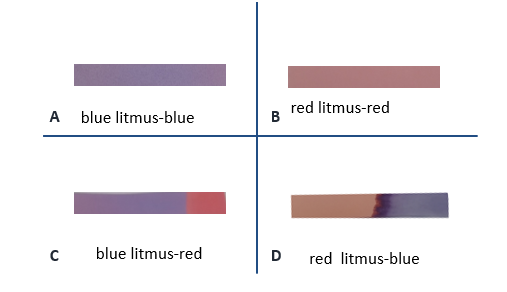
A close up of a logo

Description automatically generated

hydrochloric sodium sodium chloride

acid hydroxide solution

1. Which litmus test results would you expect for each of the following?
   1. hydrochloric acid
   2. sodium hydroxide
   3. sodium chloride solution



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

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| --- |
| **Response activity** |
| **Reactant and product pH** |

**Overview**

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| --- | --- |
| Learning objective: | A salt is formed from a neutralisation reaction between an acid and a base. |
| Observable learning outcome: | Suggest evidence than an acid has reacted with an alkali. |
| Activity type: | application and practice |
| Key words: | acid, alkali, litmus, solution |

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

* Reaction evidence

**What does the research say?**

Research (Sheppard, 2006) found that students taking part in the study confidently described neutralisation as ‘some form of interaction between an acid and base’. About a third of the students described the process as the physical mixing of an acid with a base rather than recognising that a chemical reaction was taking place. Alternative ideas about what takes place during neutralisation fell into categories of Andersson’s classification of misunderstandings about chemical reactions (Andersson, 1990) such a ‘modification’ where the original substance keeps its identity but changes its properties (in this case pH).

Another paper (Schmidt, 1995) notes that historically neutralisation used to be defined as the reaction between an acid and a base which then ‘consume’ each other (from the Latin ‘neuter’ meaning neither of the two). However according to more modern definitions, the products of neutralisation do not necessarily have a pH of 7 (for example if reacting a weak base with a strong acid or vice versa). It should be noted that neutralisation reactions that are likely to be first encountered by students in the laboratory are usually between strong acids (hydrochloric, sulfuric or nitric) and strong bases (sodium hydroxide or potassium hydroxide) and therefore the products will have a pH of 7.

Responses to test items showed that students were influenced by the term ‘neutralisation’ in the question and interpreted it as its original meaning.

This activity therefore focuses on the formation of a new product with different properties (pH) rather than the terminology associated with this type of reaction.

**Ways to use this activity**

This activity gives students the opportunity to practise applying their understanding and 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.

Asking students to share their answer is a useful check. After a group has fed back, it might be helpful to model an even better answer. You could do this, for example, by asking another group to add to, or clarify, the first observation. Then ask another group to sum up the important part of the observation, and so on.

*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 B and C

b A and D

c A and B

**Acknowledgments**

Developed by Helen Harden (UYSEG).

Images: Helen Harden and Alistair Moore (UYSEG)

**References**

Andersson, B. (1990). Pupils' conceptions of matter and its transformations (age 12-16). *Studies in Science Education,* 18**,** 53-85.

Schmidt, Hans-Jürgen (1995). Students' misconceptions- looking for a pattern. *Science Education,* 81**,** 123-135.

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