Unit 7E Acids and alkalis

About the unit

In this unit pupils:
- learn about acids and alkalis as classes of chemicals with distinct properties and uses
- use indicators to classify solutions as acidic, alkaline or neutral
- use the pH scale to compare the acidity and alkalinity of different solutions
- begin to explore neutralisation

In scientific enquiry pupils:
- recognise hazards and use information sources to assess risks associated with acids and alkalis
- make and present qualitative observations
- interpret qualitative observations, making comparisons and identifying simple patterns
- investigate the effectiveness of different antacids, controlling appropriate variables

This unit is expected to take approximately 7 hours.

Where the unit fits in

This unit uses ideas developed in the key stage 2 programme of study. It builds on unit 6C 'More about dissolving' and unit 6D 'Reversible and irreversible changes' in the key stage 2 scheme of work.

This unit introduces pupils to chemicals, reactions and practical techniques which are likely to be new to them, through using a range of acids and alkalis encountered in familiar and laboratory contexts. It lays the foundation for work on reactions of acids in unit 9E 'Reactions of metals and metal compounds' and work on carbonate rocks in unit 8G 'Rocks and weathering' and unit 8H 'The rock cycle'.

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will: obtain and present qualitative results in a way which helps to show patterns; describe how to deal with hazards relating to acids and alkalis; suggest how to investigate a question about antacids, planning and making a fair comparison

some pupils will not have made so much progress and will: obtain and present qualitative results; describe some hazards of acids and alkalis; explain how they made a fair comparison in their investigation into antacids

some pupils will have progressed further and will: explain how their conclusions match the evidence obtained and suggest ways in which the data collected could be improved

in terms of materials and their properties

most pupils will: name some common acids and alkalis and classify solutions as acidic, alkaline or neutral, using indicators and pH values; describe what happens to the pH of a solution when it is neutralised; describe some everyday uses of acids, alkalis and neutralisation

some pupils will not have made so much progress and will: name some common acids and alkalis; state some everyday uses of acids and alkalis and classify solutions using indicators

some pupils will have progressed further and will: explain how a neutral solution can be obtained and relate the pH value of an acid or alkali to its hazards and corrosiveness

Prior learning

It is helpful if pupils:
- know that solids can dissolve and form solutions
- have experience of mixing materials and seeing that new materials are formed as a result of a reaction

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:
- work with acids and alkalis
- plan their own investigations into antacids

Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:
- names of laboratory acids and alkalis, *eg hydrochloric acid*, *sodium hydroxide*
- names of classes of chemical, *eg acid, alkali*
- words with different meanings in scientific and everyday contexts, *eg indicator, solution, neutral, react, equation*
- words with similar but distinct meanings, *eg harmful, corrosive, caustic*
- words and phrases relating to scientific enquiry, eg *hazard, risk, pH range, evaluate, strength of evidence*

Through the activities pupils could:
- ask questions to gain clarification and further information, *eg why, how, what then*
- find information, *eg using contents, index, glossary, key words, hotlinks*

Resources

Resources include:
- household acids and alkalis (not bleaches), together with containers
- Hazcards and transport hazard warnings identifying hazards associated with acids and alkalis
- range of plant material from which indicator dyes can be extracted, *eg red cabbage, blackcurrants*
- pH sensor linked to a computer
- advertisements for products, *eg for skin and hair care,* which refer to pH
- indigestion remedies
- reference sources, including ICT sources, providing information about domestic and everyday uses/problems relating to acids and alkalis

Out-of-school learning

Pupils could:
- use the internet to search for information, using key words about uses and hazards of acids and alkalis
- observe hazard signs on transport vehicles and in public places

1	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What are acids and alkalis like and where do we use them?				
	• that many household materials are acids and are not hazardous	• Elicit pupils' ideas about acids by asking them to work in pairs or small groups to suggest words they would use to describe an acid and examples of where acids are used. • Show pupils a range of household acids that can be safely handled, *eg vinegar, fruit juices,* and ask them to explore and describe the appearance and smell of these. If appropriate, pupils could be asked to taste drops of the solutions that are food products. Provide packaging or labels from additional household materials (that do not have hazard warnings) and ask pupils to find the names of acids contained in them. • Ask pupils to compare what they found with the ideas they had about acids, and to highlight differences.	• identify some acids, *eg vinegar, lemon juice* • identify some everyday uses of acids, *eg in foods, medicines, cleaning materials*	• This activity could be used to reinforce the idea that not all colourless liquids are water. Pupils are likely to have worked with liquids other than water at key stage 2. ⚠ **Safety** – eye protection should be used when working with acids and alkalis. Teachers should follow school procedures for dealing with spills and splashes – scrupulous hygiene must be observed in all tasting activities
	• to recognise and interpret common hazard signs • to select key ideas from written material • how to deal with acids or alkalis if they are spilt or splashed on the skin • that adding water to an acid or alkali solution dilutes it and makes it less hazardous	• Provide pupils with containers for household and laboratory acids and alkalis with hazard warning labels, student safety sheets, Hazcards and information about hazard symbols and ask them to describe the distinctions between them and why the materials they used in the previous activity did not have hazard labels. Ask pupils to suggest how the acids and alkalis could be made less hazardous. • Consider hazard warning signs used when acids and alkalis are transported by road. • Ask pupils to suggest why different acids and alkalis are labelled differently and to suggest safety procedures for working with acids and alkalis. Agree a common set of procedures, which should include use of eye protection.	• identify hazard symbols for harmful, irritant and corrosive substances • describe how to work safely with acids and alkalis and what to do if a spill occurs • explain that if water is added to an acid or alkali it dilutes it and the solution becomes less hazardous	• In the next activity, acids are distinguished from alkalis using indicators. • CLEAPSS produces Hazcards and student safety sheets. • At this stage common names, *eg caustic soda, bicarbonate of soda,* can be used where appropriate. • Adding water to concentrated sulphuric acid is hazardous because the reaction is highly exothermic. Concentrated sulphuric acid should be diluted by adding the acid to water. • It may be helpful to point out that sulfur is the internationally accepted spelling. ⚠ **Safety** – containers should be sealed or empty

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
How can acids and alkalis be identified and distinguished from each other?			
• to devise a table to show results effectively and to identify patterns in these • that acids and alkalis can change the colours of some dyes and that this can be used to classify them • the names of some common laboratory acids and alkalis • to classify solutions as acidic or alkaline, using indicators	• Establish, by quick questioning, that pupils recall key ideas about safety. • Provide pupils with solutions of dyes extracted from plant material, *eg red cabbage, raw beetroot, blackcurrant, litmus,* and ask them to explore and record the effect of adding household and laboratory acids and alkalis to the dyes. • Compare the results with different dyes and establish, by comparing results from the class, that there are two classes of solution and that the dyes can indicate which is which. Introduce the terms 'indicator' and 'alkali'. • Provide pupils with a range of acidic and alkaline solutions and indicators and ask them to use the indicators to identify and record whether the solutions are acidic or alkaline.	• present their results in a way which helps them identify patterns • recognise that solutions of dyes which show one colour in acids and another in alkalis are called indicators • recall the names of some common laboratory acids and alkalis • use their record of results to identify which solutions are acidic and which are alkaline	• Pupils could extract the dyes from plant materials themselves if they are familiar with the techniques required. ⚠ **Safety** – avoid the use of bleach, drain cleaner or descaler. 0.4 mol dm^{-3} laboratory acids and alkalis can be used for this activity. None are hazardous although some are irritants, and eye protection is needed. In general, alkalis are more hazardous to skin and eyes than acids of a similar concentration
Is there a range of acidity and alkalinity?			
• that universal indicator gives a range of colours in acidic and alkaline solutions • that pH numbers indicate how acidic or alkaline a solution is • that neutral solutions are pH7, acidic solutions below 7 and alkaline solutions above 7	• Demonstrate the use of universal indicator paper or solution to obtain a pH number for a few solutions previously tested. Ask pupils to explore the range of pH of solutions previously tested (including some neutral solutions) and to see if they can relate them to earlier work on hazard labels.	• identify the pH of a given solution from an appropriate colour chart • classify the solution as strongly or weakly acidic or alkaline, or neutral • relate their classification to the use of the acid or alkali and associated hazards	• Full-range universal indicator pH0–14 should be used for this activity. • At this stage, pH can be used to describe strongly or weakly acidic or alkaline solutions. It is not necessary to discuss the difference between weak and strong, and dilute and concentrated, although the appropriate terms should be used. • Extension: pupils could be asked to predict the effect on pH of making an acid more dilute or more concentrated and how this would affect its corrosiveness. ⚠ **Safety** – 0.4 mol dm^{-3} solutions can be used for this activity. None are hazardous, although some are irritant and eye protection is needed

3	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
What happens when an acid is added to an alkali?				
	• that acids and alkalis are used in a range of everyday situations • how to find information, *eg using contents, index, glossary, key words, hotlinks* • to select and note appropriate information about uses and effects of acids and alkali	• Ask pupils to use a range of reference sources including advertisements to find information about the use of acids and alkalis in a range of everyday situations, *eg hair and skin care, treatment of stings and bites, treatment of indigestion, food preservation, treatment of soil.* Ask them to find out how living things use acids, *eg ants, nettles, humans in digestion.* Agree with pupils key words they need to use and remind them how to use an index, glossary or search facility. Ask them to identify and note key points about the range of pH used and potential harmful effects, and to explain these to other pupils either orally or by contributing to an information folder.	• identify uses of acids and alkalis and the benefits and potential hazards of these • communicate clearly key points about a particular use of acids or alkalis	• Advertisements for skin-care and hair-care products could be used to introduce this activity. • Most pupils will need to be guided towards suitable sources of information, *eg websites such as www.miamisci.org*. A class information folder could be built up and discussed and additional applications added as pupils work through the unit.
	• that when an acid is added to an alkali, it lowers the pH • that a neutral solution can be obtained by adding an acid to an alkali	• Ask pupils to explore what happens to the pH when a solution of an acid is added drop by drop to a solution of an alkali. Challenge pupils to predict what will happen if more acid is added, or if alkali is added to an acid, and test their predictions using a pH monitor and datalogger.	• describe that when an acid is added to an alkali, the pH of the mixture falls and vice versa • explain how to obtain a neutral solution • find information in reference books, on CD-ROMs, or from databases	• ICT: pH logging using ICT could be used to record changes and generate a graph. • Teachers may wish to emphasise that acidity and alkalinity are measured on a continuous scale. • Extension: pupils could be asked to describe what computer-generated graphs show about the way pH changes as more alkali is added. • Extension: pupils could be asked to investigate changes in temperature during neutralisation and be introduced to the idea that a chemical reaction is taking place. ⚠ **Safety** – 0.4 mol dm^{-3} solutions of acid and alkali can be used. These may be irritant, so eye protection is needed
Checking progress				
	• to summarise key ideas about acids, alkalis and neutralisation	• Help pupils to work in groups to produce questions about acids, alkalis and neutralisation, which will help clarify their thoughts. Pupils ask others to answer or find the answers to their questions. Use all the questions and answers and, together with the pupils, agree a summary of key ideas.	• identify key questions about acids and alkalis • use correct scientific terminology in answering questions	• Later activities in this unit offer the opportunity for consolidation of key ideas for pupils who need this. • Extension: pupils could also be asked to explore whether mass is conserved as neutralisation takes place. This idea is covered more fully in unit 9H 'Using chemistry'.

Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
Where is neutralisation important?			
• how to frame a question that can be investigated • how to use preliminary work to help decide what to measure or to observe • to choose appropriate techniques and equipment • to compare their investigative method and evidence collected with those of others • to work with others in summarising information and evaluating a product	• Remind pupils of earlier work about acid in the stomach. Show pupils a range of packages and leaflets for some common antacid indigestion remedies and ask them to identify how the remedies are intended to work and to suggest what sort of solution would work and be safe to take. • Ask them to suggest ways in which one remedy might be more effective than others and how they might investigate their suggestions. • Encourage a range of different investigations, *eg Does one tablet of each antacid neutralise the same amount of acid? Do the antacids neutralise acid equally quickly?* Ask pupils to write a brief account of their suggestions, results and what they found out, to share with other groups in the class. Encourage pupils to question each other about what they did and what they found out. • Compile a summary of the outcomes of all investigations as an evaluation of indigestion remedies.	• decide on a suitable question to investigate and suitable techniques for doing so • summarise what they have found out • demonstrate understanding of the strength of evidence through the questions they ask • use the evidence collected to evaluate an indigestion remedy	• This activity offers pupils the opportunity to see how work carried out by different groups can be evaluated and synthesised. • It is possible to simulate different antacids by mixing bicarbonate of soda and salt in varying proportions. • It may be helpful to review words used on commercial products, *eg antacid*, and compare them with scientific terms, *eg alkali,* as pupils may be confused by the change in terminology. • As an alternative, pupils could be asked to investigate differences in the acid content of a range of soft drinks. ⚠ **Safety** – teachers should check pupils' plans for health and safety before practical work begins
Reviewing work			
• to relate ideas about acids and alkalis to each other	• Help pupils to bring together their knowledge about acids and alkalis by asking them to produce a concept map using terms encountered, *eg acid, alkali, strongly acidic, weakly acidic, weakly alkaline, strongly alkaline, neutral, indicator, universal indicator, colour change, corrosive, sour.* Ask pupils to comment on others' maps and additional connections, explaining those shown.	• identify relationships between key ideas • explain why connections were made	• A concept map shows connections between different ideas in a particular topic and is a useful source of information about pupils' understanding. Many pupils will be familiar with making concept maps from their work in primary science. Some pupils will require help, *eg a range of terms could be written on a large sheet of paper and pupils asked to draw lines between those they think are linked, and to write a phrase or sentence on the lines explaining why they have linked those terms.*