### Where this unit fits in

**This unit builds on:**
unit 6C More about dissolving and unit 6D Reversible and irreversible changes.

**The concepts in this unit are:**
acids and alkalis, indicators, the pH scale, a first look at neutralisation.

**This unit leads onto:**
unit 9E Reactions of metals and metal compounds, and work on carbonate rocks in unit 8F Rocks and weathering and unit 8H The rock cycle.

### Prior learning

To make good progress, pupils starting this unit need to:
- 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.

### Expectations from the QCA Scheme of Work

At the end of this unit …

**… most pupils will …**
- obtain and present qualitative results in a way that 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 …**
- 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 have progressed further and will …**
- name some common acids and alkalis
- state some everyday uses of acids and alkalis
- classify solutions using indicators.

**in terms of scientific enquiry** NC Programme of Study Sc1 1b; 2a, c, d, e, f, g, i, j, l, m, p

- obtain and present qualitative results
- describe some hazards of acids and alkalis
- explain how they made a fair comparison in their investigation into antacids.

**in terms of materials and their properties** NC Programme of Study Sc3 3d, e, f

- explain how a neutral solution can be obtained
- relate the pH value of an acid or alkali to its hazards and corrosiveness.

### Suggested lesson allocation (see individual lesson planning guides)

<table>
<thead>
<tr>
<th>Direct route</th>
<th>E1 Acids, bases, alkalis</th>
<th>E2 How acidic?</th>
<th>E3 Taking away acidity</th>
<th>E4 Problem soil: Think about compensation</th>
<th>Review and assess progress (distributed appropriately)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra lessons (not in pupil book)</td>
<td>E1 Acids, bases, alkalis. Might need more than one lesson if both activities are done.</td>
<td>E3 Investigate: How well do antacids work?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Misconceptions

Some common misconceptions that should be addressed are:
- all colourless liquids are water
- all acids are hazardous
- all indicators give the same colour changes
- litmus paper and pH paper are the same thing
- dilute and concentrated mean the same as weak and strong.

### Health and safety

(see activity notes to inform risk assessment)

In this unit, pupils should wear eye protection when working with acids and alkalis. Teachers should follow school procedures for dealing with spills and splashes.
Learning objectives

i Acids can taste sour and may be corrosive, harmful or irritant. They are used in everyday situations.

ii Bases are the opposite of acids and cancel out acidity.

iii An alkali is a soluble base. Alkalis may be corrosive, harmful or irritant. They are used in everyday situations.

iv A neutral solution is neither acidic nor alkaline.

v Indicators turn different colours with acidic, alkaline and neutral solutions.

vi It is important to work safely with acids and alkalis and know what to do if a spillage occurs.

vii Begin to relate conclusions to scientific knowledge and understanding. (Framework YTO Sc1 7g part)

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objectives see above</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook E1</td>
<td>i, ii, iii and iv</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>20 min</td>
<td>R/G</td>
</tr>
</tbody>
</table>

Activity E1a Practical

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objectives see above</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity E1b Practical</td>
<td>vi and vii</td>
<td>Using plant extracts as indicators Pupils explore effects of adding household and lab acids and alkalis to different plant extracts.</td>
<td>20 min</td>
<td>✓</td>
</tr>
</tbody>
</table>

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils provide their own definitions for key words.</td>
<td>Whole-class discussion of responses from Activity E1a.</td>
<td>Working in pairs, pupils summarise and present the results of their research from Activity E1b.</td>
<td>Hazard symbols matching game.</td>
<td>Pupils brainstorm a list of possible acids and alkalis used in the home and in leisure.</td>
</tr>
</tbody>
</table>

Learning outcomes

<table>
<thead>
<tr>
<th>Most pupils will ...</th>
<th>Some pupils, making less progress will ...</th>
<th>Some pupils, making more progress will ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify hazard symbols for harmful, irritant and corrosive substances</td>
<td>Identify hazard symbols for harmful, irritant and corrosive substances</td>
<td>describe a range of uses of acids and alkalis in everyday situations</td>
</tr>
<tr>
<td>explain that bases cancel out acidity, bases that dissolve in water are called alkalis and a solution that is neither acidic nor alkaline is neutral</td>
<td>explain that bases cancel out acidity, bases that dissolve in water are called alkalis and a solution that is neither acidic nor alkaline is neutral</td>
<td>use a wider range of indicators and begin to appreciate how different indicators might be used in certain situations.</td>
</tr>
<tr>
<td>work safely with acids and alkalis and know what to do if a spillage occurs</td>
<td>work safely with acids and alkalis and know what to do if a spillage occurs</td>
<td></td>
</tr>
<tr>
<td>explain how indicators may be used to identify acidic, alkaline and neutral solutions.</td>
<td>explain how indicators may be used to identify acidic, alkaline and neutral solutions.</td>
<td></td>
</tr>
<tr>
<td>use indicators to classify acidic, alkaline and neutral solutions.</td>
<td>use indicators to classify acidic, alkaline and neutral solutions.</td>
<td></td>
</tr>
</tbody>
</table>

Key words

acid, concentrated, dilute, corrosive, toxic, harmful, irritant, bases, alkalis, neutral, indicator, litmus

Out-of-lesson learning

Homework E1. Textbook E1 end-of-spread questions
Identify products in the home that contain acids and bases
Look out for hazard signs on transport vehicles
Learning objectives

i. Universal indicator gives a range of colours in acidic and alkaline solutions.
ii. pH numbers indicate how acidic or alkaline a solution is.
iii. Neutral solutions are pH7, acidic solutions below 7 and alkaline solutions above 7.

Scientific enquiry

iv. Make, present and interpret qualitative observations, making comparisons and identifying simple patterns.
v. Begin to relate conclusions to scientific knowledge and understanding. (Framework YTO Sc1 7g part)

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objectives see above</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook E2</td>
<td>i, ii and iii</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>20 min</td>
<td>R/G</td>
</tr>
<tr>
<td>Activity E2a Practical</td>
<td>iv and v</td>
<td>Pupils test solutions of household substances with pH paper and examine the packaging for hazard warnings that accompany strongly acidic and strongly alkaline substances.</td>
<td>25 min</td>
<td>✓ ✓</td>
</tr>
</tbody>
</table>

Suggested alternative main activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objectives</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook E2</td>
<td>i, ii and iii</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>20 min</td>
<td>R/G</td>
</tr>
<tr>
<td>Activity E2a Practical</td>
<td>iv and v</td>
<td>Pupils test solutions of household substances with pH paper and examine the packaging for hazard warnings that accompany strongly acidic and strongly alkaline substances.</td>
<td>25 min</td>
<td>✓ ✓</td>
</tr>
</tbody>
</table>

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review learning</td>
<td>Quick quiz of pH values and colours.</td>
<td>Pupils suggest what action they would take to deal with an acidic liquid that has been spilled onto a busy road following an accident.</td>
</tr>
<tr>
<td>Sharing responses</td>
<td>Whole-class discussion of advantage of universal indicator compared to litmus.</td>
<td></td>
</tr>
<tr>
<td>Group feedback</td>
<td>In groups, pupils share their findings from Activity E2a.</td>
<td></td>
</tr>
<tr>
<td>Word game</td>
<td>Present pupils with a true/false quiz.</td>
<td></td>
</tr>
</tbody>
</table>

Learning outcomes

Most pupils will …

- Identify the pH of a given solution from an appropriate colour chart
- Classify the solution as strongly or weakly acidic or alkaline, or neutral
- Begin to use the terms ‘weak or strong’ and ‘dilute or concentrated’ correctly.

Some pupils, making less progress will …

- Identify the pH of a given solution from an appropriate colour chart
- Classify the solution as strongly or weakly acidic or alkaline, or neutral.

Some pupils, making more progress will …

- Relate the classification of strongly or weakly acidic or alkaline, or neutral solutions to their use and associated hazards.

Key words
universal indicator, pH scale

Out-of-lesson learning
Homework E2
Textbook E2 end-of-spread questions
Test household items with pH paper
Collect advertisements for hair and skin care products that mention pH
Learning objectives

i. When an acid is added to an alkali, it lowers the pH.
ii. A neutral solution can be obtained by adding an acid to an alkali.
iii. Everyday uses of neutralisation.

Scientific enquiry

iv. Begin to relate conclusions to scientific knowledge and understanding. (Framework YTO Sc1 7g part)

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objective see above</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook E3</td>
<td>i, ii and iii</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>20 min</td>
<td>R/G G R S</td>
</tr>
<tr>
<td>Activity E3a</td>
<td></td>
<td>Adding an acid to an alkali. Pupils explore what happens to the pH when a solution of an acid is added drop by drop to a solution of an alkali.</td>
<td>25 min</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Activity E3b ICT</td>
<td>iv</td>
<td>Using a datalogger to check pH changes as an acid is added to an alkali.</td>
<td>25 min</td>
<td>✓</td>
</tr>
</tbody>
</table>

Suggested alternative main activities

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils describe the process of neutralisation.</td>
<td>Whole-class discussion of responses to Activity E3a.</td>
<td>Group brainstorming of examples of neutralisation in real life.</td>
<td>Check progress by playing bingo with the key words in the unit so far.</td>
<td>Pupils revise and consolidate knowledge from the unit.</td>
</tr>
</tbody>
</table>

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook E3</td>
<td>i, ii and iii. Pupils find out how the pH changes as an acid is added to an alkali.</td>
<td>20 min</td>
<td>R/G G R S</td>
</tr>
<tr>
<td>Activity E3b</td>
<td>Adding an acid to an alkali. Pupils explore what happens to the pH when a solution of an acid is added drop by drop to a solution of an alkali.</td>
<td>25 min</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>ICT</td>
<td>Using a datalogger to check pH changes as an acid is added to an alkali.</td>
<td>25 min</td>
<td>✓</td>
</tr>
</tbody>
</table>

Learning outcomes

<table>
<thead>
<tr>
<th>Most pupils will ...</th>
<th>Some pupils, making less progress will ...</th>
<th>Some pupils, making more progress will ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>describe that when an acid is added to alkali, the pH of the mixture falls and vice versa</td>
<td>describe that when an acid is added to alkali, the pH of the mixture falls and vice versa</td>
<td>explain a wider range of everyday applications of neutralisation and appreciate that it is a chemical reaction</td>
</tr>
<tr>
<td>explain how to get a neutral solution and give a range of everyday applications of this reaction.</td>
<td>explain how to get a neutral solution and give a range of everyday applications of this reaction.</td>
<td>apply their knowledge of neutralisation to describe what computer generated pH graphs show.</td>
</tr>
</tbody>
</table>

Key words
neutralisation, lime

Out-of-lesson learning
Homework E3
Textbook E3 end-of-spread questions
Internet search about everyday uses of acids and alkalis

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Lesson planning guide

Investigate: How well do antacids work?

Learning objectives
i Plan and carry out an investigation into how well antacid remedies work, controlling appropriate variables.

Scientific enquiry
ii Use scientific knowledge to decide how ideas and questions can be tested; make predictions of possible outcomes. (Framework YTO Sc1 7b)
iii Select (extension only) and use (extension and core) appropriate equipment, including ICT to collect measurements and identify and control variables. (Framework YTO Sc1 7c, d, e)
iv Present results in charts/graph form and analyse them by comparing with secondary source data. (Framework YTO Sc1 7f)
v Evaluate the sample size in the light of comparison with the secondary source data and discuss whether increasing the sample size would have strengthened the conclusion. (Framework YTO Sc1 7g, h)

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Setting the context</th>
<th>Introduce the apparatus</th>
<th>Safety</th>
<th>Brainstorming (1)</th>
<th>Brainstorming (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class discussion about why the stomach makes acid.</td>
<td>Demo of neutralisation of hydrochloric acid by an antacid.</td>
<td>Pupils discuss what the hazards are for the investigation.</td>
<td>The variables and what factors to keep constant.</td>
<td>How they will record their data and how they will present their findings.</td>
</tr>
</tbody>
</table>

Investigation

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objectives see above</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity E3c Paper</td>
<td>i, ii and iii</td>
<td>How well do antacids work? Planning Pupils plan an investigation to compare how quickly different brands of antacid work.</td>
<td>15 min</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Activity E3d Practical</td>
<td>iv</td>
<td>How well do antacids work? Obtaining evidence Pupils carry out the investigation they have planned in Activity E3c.</td>
<td>20 min</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Activity E3e Paper</td>
<td>v</td>
<td>How well do antacids work? Considering and evaluating evidence Pupils consider and evaluate the evidence they have collected.</td>
<td>15 min</td>
<td>✓ ✓ ✓</td>
</tr>
</tbody>
</table>

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Group feedback</th>
<th>Analysing</th>
<th>Evaluating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-led review of factors/variables.</td>
<td>In groups, pupils share their findings about the effectiveness of the indigestion remedies.</td>
<td>Teacher-led discussion of which brand would give faster relief.</td>
<td>Teacher-led discussion on whether the investigation was a fair test.</td>
</tr>
</tbody>
</table>

Learning outcomes

<table>
<thead>
<tr>
<th>Most pupils will …</th>
<th>Some pupils, making less progress will …</th>
<th>Some pupils, making more progress will …</th>
</tr>
</thead>
<tbody>
<tr>
<td>• obtain and present qualitative results in a way that helps to show patterns</td>
<td>• obtain and present qualitative results</td>
<td>• explain their conclusions match the evidence obtained</td>
</tr>
<tr>
<td>• suggest how to investigate a question about antacids</td>
<td>• explain how they made a fair comparison in their investigation into antacids</td>
<td>• suggest ways in which the data collected could be improved</td>
</tr>
<tr>
<td>• planning and making a fair comparison.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key words
antacid, indigestion, datalogging, pH sensor
## Lesson planning guide

### Problem soil – Think about compensation

**Learning objectives**

1. The particle concept of neutralisation through a soil neutralisation scenario.
2. The idea of dilution by illustrating that if you add more water you must compensate by adding more base or use more of the solution.
3. To resolve any cognitive conflict arising from thinking about diluting something to make it go further.

*The structure of this lesson is based around the CASE approach. The starter activities give concrete preparation. The main activities move away from the concrete towards a challenging situation, where pupils need to think. The extended plenary gives pupils time to discuss what they have learnt, to negotiate a method to commit to paper and express their ideas verbally to the rest of the class.*

**Scientific enquiry**

4. Begin to relate conclusions to scientific knowledge and understanding. (Framework YTO 7g part)

<table>
<thead>
<tr>
<th>Suggested alternative starter activities (5–10 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bridging to the unit</strong></td>
</tr>
<tr>
<td>Demo of the effects of dilution.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Suggested alternative plenary activities (5–10 minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group feedback</strong></td>
</tr>
<tr>
<td>In pairs, pupils explain how compensation and dilution work.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning outcomes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Most pupils will ...</th>
<th>Some pupils, making less progress will ...</th>
<th>Some pupils, making more progress will ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>• describe the particle concept of neutralisation through a soil neutralisation scenario and begin to understand the idea of dilution by illustrating that if you add more water you must compensate by adding more base or use more of the solution.</td>
<td>• begin to describe neutralisation in terms of the particles and sate that if you add more water you must compensate by adding more base or use more of the solution. • have the opportunity to begin to resolve any cognitive conflict arising from thinking about diluting something to make it go further.</td>
<td>• begin to apply their knowledge of dilution to a range of numerical examples.</td>
</tr>
</tbody>
</table>

**Key words**

- sample, compensate

**Out-of-lesson learning**

- Textbook E4 end-of-spread questions
**Acids, bases, alkalis**

### Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Introduce the unit</th>
<th>Share learning objectives</th>
<th>Brainstorming</th>
<th>Problem solving</th>
<th>Capture interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit map for Acids and alkalis.</td>
<td>● Find out about acids, bases and alkalis. ● List common materials that are acids or alkalis. ● Be able to test a solution to find out whether it is an acid. (Sc1)</td>
<td>Words associated with dissolving.</td>
<td>Pupils consider whether all colourless liquids are water and how they can tell this.</td>
<td>Show video clips of uses of acids and alkalis. <em>Catalyst Interactive Presentations 1</em></td>
</tr>
</tbody>
</table>

### Introduce the unit

- **Either** draw the outline of the unit map on the board then ask pupils to give you words to add, saying where to add them. Suggest some words yourself when necessary to keep pupils on the right track.

- **Or** give out the unit map and ask pupils to work in groups deciding how to add the listed words to the diagram. Then go through it on the board as each group gives suggestions.

### Share learning objectives

- Ask pupils to write a list of FAQs they would put on a website telling people about acids, bases and alkalis. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

### Brainstorming

- Ask pupils to work in groups of three or four to brainstorm words that they associate with dissolving, and then to write a definition for each word.

- Groups report back their words and definitions. Choose from these to make up a master list for pupils to copy.

### Problem solving

- Show pupils five containers, each containing a colourless, transparent liquid.

- Ask pupils to work in pairs to answer the questions opposite. Pairs then report back their ideas. Expect or elicit ideas such as boiling points, chemical tests, pouring onto plants or rocks, evaporating to dryness, but *not* tasting.

### Capture interest

- Show video clips of the uses of acids and alkalis at home, in the car (battery) and in industry. Focus on dispelling the common misconception that all acids are dangerous by mentioning that we eat some acids, e.g. vinegar, and that many are very useful to us.

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This worksheet may have been altered from the original on the CD-ROM.
Copy the unit map and use these words to help you complete it. You may add words of your own too.

**Acids and alkalis**

**Indicators**

**Neutralisation**

What are acids? What are alkalis?
Recap last lesson

- Show on an OHT the list of substances found in or around the home. Ask pupils to divide them into two lists, acids and alkalis. Ask for ideas around the class to build up an ‘agreed’ pair of lists. Pupils may ask ‘How can you tell?'; they will find out in this unit.

Share learning objectives

- Ask pupils to write a list of FAQs they would put on a website telling people how to find out how acidic or alkaline a solution is. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

Brainstorming

- Show pupils the list of acids and their uses on OHT, and ask them to discuss in pairs how they could put them in order of how acidic/how strong they are. Each pair then goes on to list the acids in order.
- Ask for ideas around the class and put the ‘agreed’ order on the board. Ask what ideas they used, e.g. ‘more/less sour’ and ‘more/less harmful/corrosive’.
- Tell pupils that they will be learning how to measure accurately how strong acids are.

Problem solving

- Ask pupils to work individually or in pairs to design a poster about safety with acids and alkalis. They could just list their ideas, or draw a quick sketch.
- Refer back to the corrosive and toxic hazard symbols if these do not feature in pupils’ posters.

Capture interest

- Have three labelled beakers containing 100 cm³ of hydrochloric acid of different concentrations. To each add a small strip of magnesium ribbon. Let pupils see the difference in the rate of reaction. Discuss the effects of the different strengths of acid.

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Recap last lesson</th>
<th>Share learning objectives</th>
<th>Brainstorming</th>
<th>Problem solving</th>
<th>Capture interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils classify substances listed on an OHT as acids or alkalis.</td>
<td>● Find out how to test whether a solution is weakly or strongly acidic or alkaline. ● Be able to use universal indicator to test acids and alkalis. (Sc1)</td>
<td>How acidic is an acid?</td>
<td>Pupils design a safety poster.</td>
<td>Demo of different concentrations of acid.</td>
</tr>
</tbody>
</table>

Recap last lesson

- Pupil sheet

(Eye drops are acidic; ant and bee stings are acidic; wasp stings are alkaline.)

Brainstorming

- Pupil sheet

Capture interest

- Technician sheet
Recap last lesson

- eye drops
- vinegar
- oven cleaner
- pickled onions
- household floor cleaner
- lemons
- washing powder
- car battery liquid
- wasp sting
- bee sting
- ant bite


**Brainstorming**

- sulphuric acid  
  *used in car batteries*

- boric acid  
  *used in eye drops*

- ethanoic acid (acetic acid)  
  *used in vinegar*

- citric acid  
  *found in lemons, and used in foods*

- methanoic acid (formic acid)  
  *found in ant bites*
How acidic?

Capture interest

*Technician sheet*

- Set up three labelled beakers containing 100 cm³ of hydrochloric acid of different concentrations:
  - bench acid (1 mol/dm³);
  - one-tenth bench acid (10 cm³ of acid and 90 cm³ of water);
  - one-hundredth bench acid (1 cm³ of acid and 99 cm³ of water).

- Cut three 5 cm strips of magnesium ribbon cleaned with abrasive paper.
Taking away acidity

Recap last lesson

- As they enter the room, hand each pupil the pupil sheet with a table to be completed.
- Allow 2 minutes to complete the activity, then ask for answers around the class. Correct any misconceptions.

Share learning objectives

- Ask pupils to write a list of FAQs they would put on a website telling people what happens when acids and bases are mixed. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

Brainstorming

- Write the lists opposite on the board.
- Point out that dock leaves contain alkali, sodium hydrogencarbonate is alkaline in solution and vinegar is acidic.
- Ask pupils what each treatment is doing (the alkali and acid are cancelling out). Take care not to mention neutralisation yet, as this is introduced in the lesson.

Problem solving

- Show two containers of colourless transparent liquids. Explain that you are going to mix them, and ask pupils how they might tell whether a chemical reaction has taken place. Allow pairs a few minutes to come up with ideas, and then report back.
- Mix the two liquids. The white precipitate shows that a new substance has been formed, and therefore a chemical reaction has taken place.
- Ask pupils what you might now do to turn the milky liquid back into two clear liquids. Emphasise that this cannot easily be done.

Capture interest

- Show pupils litmus in test tubes of acid and alkali.
- Measure 150 cm³ of dilute hydrochloric acid into a beaker with a magnetic stirrer. Add litmus. Add dilute sodium hydroxide solution from a second beaker a little at a time, allowing it to mix. Continue until the indicator changes colour.
- Ask for ideas as to what has happened to the acid. Be careful not to pre-empt the lesson.

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Recap last lesson</th>
<th>Share learning objectives</th>
<th>Brainstorming</th>
<th>Problem solving</th>
<th>Capture interest</th>
</tr>
</thead>
</table>
| Pupils answer questions about acids and alkalis. | ● Find out what happens when acids and bases are mixed together.  
● Be able to name a use of neutralisation.  
● Be able to describe how the pH changes as an acid is added to an alkali. (Sc1) | How do you stop a sting hurting? | Demo of how you can tell whether a new substance is made. | Demo of neutralisation. |
## Taking away acidity

### Recap last lesson

Five solutions were tested with universal indicator. The table shows the results. Complete the table.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Colour of universal indicator</th>
<th>Acid or alkali?</th>
<th>pH</th>
<th>Liquid</th>
<th>Use of liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>yellow</td>
<td></td>
<td>5</td>
<td>boric acid</td>
<td>eye drops</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>sulphuric acid</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>purple</td>
<td>sodium hydroxide</td>
<td></td>
<td></td>
<td>oven cleaner</td>
</tr>
<tr>
<td>D</td>
<td>red</td>
<td>ethanoic acid</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>greenish blue</td>
<td>magnesium hydroxide</td>
<td>9</td>
<td></td>
<td>indigestion remedy</td>
</tr>
</tbody>
</table>

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This worksheet may have been altered from the original on the CD-ROM.
Taking away acidity

Problem solving

Technician sheet

- Prepare two solutions, each one 200 cm$^3$ of normal bench concentration in a 400 cm$^3$ beaker. Use either sodium chloride and silver nitrate solutions, or sodium sulphate and barium nitrate solutions.

Capture interest

Technician sheet

Supply the following for a demonstration:

- two test tubes and a rack
- a magnetic stirrer set up with a 400 cm$^3$ beaker
- a bottle of dilute (1 mol/dm$^3$) hydrochloric acid and a 200 cm$^3$ measuring cylinder
- a bottle of dilute (1 mol/dm$^3$) sodium hydroxide solution, and a second 400 cm$^3$ beaker
- a bottle of liquid litmus indicator.
Investigate: How well do antacids work?

**Suggested alternative starter activities (5–10 minutes)**

<table>
<thead>
<tr>
<th>Setting the context</th>
<th>Introduce the apparatus</th>
<th>Safety</th>
<th>Brainstorming (1)</th>
<th>Brainstorming (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class discussion about why the stomach makes acid.</td>
<td>Demo of neutralisation of hydrochloric acid by an antacid.</td>
<td>Pupils discuss what the hazards are for the investigation.</td>
<td>The variables and what factors to keep constant.</td>
<td>How they will record their data and how they will present their findings.</td>
</tr>
</tbody>
</table>

**Setting the context**
- Ask for ideas about why the stomach makes acid. Explain that it makes acid to help with the digestion of food. Sometimes the stomach makes too much acid, and this causes indigestion. Cures for indigestion include tablets that neutralise the acid.

**Introduce the apparatus**
- Demonstrate how one brand of antacid reacts with dilute hydrochloric acid, as detailed in Activity E3cde.
- Add one tablet, stir the mixture and allow pupils to observe it until the reaction ceases.
- Add another tablet and allow pupils to see that the reaction is continuing. Do not add further antacid.

**Safety**
- Ask pupils to write down as many safety hazards as they can think of for this investigation.
- Ask pupils to discuss these hazards in pairs, and to suggest how they can be minimised. Collect ideas from groups during class discussion.
- Write a list of essential safety procedures on the board for pupils to include in their writing up.

**Brainstorming (1)**
- Ask pupils to discuss in groups what the variables are in investigating what number of indigestion tablets is the most effective.
- During a class discussion, ask individual pupils to suggest which variables are input and outcome variables and which variables should be kept constant.

**Brainstorming (2)**
- First ask pupils to work in pairs to design a ‘data capture’ sheet to use during the investigation.
- Then they decide how they will present their findings in a report of the investigation.
Problem soil – Think about

**Bridging to the unit**

- Have a solution of potassium manganate(VII), a measuring cylinder and several beakers each containing 100 cm³ of water at the front of the class. Add 10 cm³ of the solution to the first beaker of water and stir. Ask pupils to note the change in colour intensity. Add 10 cm³ of this diluted solution to the second beaker and stir. Keep repeating until the solution is very pale pink, asking pupils to note their observations.

- Discuss how the solution is being diluted. Carry out a simple calculation of how much the original solution has been diluted in each beaker.

**Setting the context**

- Carry out the procedure described on the teacher sheet and show pupils the colour of the first tube before and after adding the universal indicator. Compare the tube with the colour chart to determine the pH.

- Show the second tube containing only water as a control. Explain that this control shows that the acidic or alkaline substances have come from the soil, not the water.

**Concrete preparation (1)**

- Give each pupil a copy of the pupil sheet about solutions of acid. Allow them a few minutes to complete the work.

- Ask individual pupils to give their answers.

- Use class discussion to correct misconceptions and work through the correct answers. Avoid the words ‘strong’ and ‘weak’ when referring to concentrations – instead use the terms ‘more concentrated’ and ‘less concentrated’, to avoid confusion with strong and weak acids and alkalis.

**Concrete preparation (2)**

- Give each pupil a copy of the pupil sheet about acidic soil on a farm. Allow them a few minutes to complete the work.

- Ask individual pupils for their answers. Use these to frame a class discussion.
Problem soil

Bridging to the unit

Technician sheet

Supply the following for a demonstration:

● a bottle of potassium manganate(VII) solution of a concentration that is very dark purple in colour

● a stirring rod

● a 10 cm³ and a 100 cm³ measuring cylinder

● six 250 cm³ beakers.
Problem soil

Setting the context

Teacher sheet

1. Half fill a centrifuge tube with dry soil.
2. Add water to the tube until it is three-quarters full.
3. Shake the tube well for 30 seconds.
4. Centrifuge the tube (wear eye protection).
5. Add water to a second tube until it is three-quarters full. This will be a control to check for contamination and confirm that any acidic or alkaline substances have come from the soil and not the water.
6. Add 3 drops of universal indicator solution to each tube. Any acidic or alkaline substances that have dissolved in the water from the soil will change the colour of the indicator.
7. Find out the pH of the soil from the colour chart. (Wash hands afterwards.)

Technician sheet

Supply the following for a demonstration:

- two centrifuge tubes
- universal indicator solution and colour chart
- a dry soil sample (e.g. from the school grounds)
- access to a centrifuge.

Wear eye protection.
Wash hands afterwards.
Concrete preparation (1)

Solutions of an acid may contain different amounts of that acid dissolved in water. So one acid solution may be more or less concentrated than another solution.

Look carefully at this table showing how different solutions of the same acid have been made.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Mass of acid used in g</th>
<th>Volume of solution made in cm³</th>
<th>Concentration in g/100 cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>E</td>
<td>300</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>500</td>
<td>10</td>
</tr>
</tbody>
</table>

1. Complete the table by filling in the empty boxes.

2. List the solutions in order of concentration, starting with the least concentrated.
Concrete preparation (2)

If soil is too acidic, most plants will not grow well in it. This is a problem for farmers who need their crops to grow well.

One way to cure acidity in the soil is to put lime on it. Lime is the common name for calcium hydroxide. This is a solid that dissolves only a little in water.

Try to think of the best answers to the following questions.

1. What sort of reaction is there between the acid in the soil and the lime the farmer spreads on a field?

2. How will the farmer know how much lime to spread on the field?

3. Why would using too much lime be a problem for the farmer?

4. How will the farmer know when there is enough lime on the field?
Make your own indicator

Running the activity

Pupils work in groups of two or three. They are given the method for the activity and prompted to consider the evidence.

If there is time, try making indicators out of other plants (e.g. red cabbage, blackcurrants) and comparing them to find out which is best.

Pupils may need help with filtering if they haven’t done it before. They may also need ‘filtrate’ explaining.

Here are some possible demonstrations using other indicators:

- Try the invisible ink trick. Paint your message onto a large piece of filter paper using 1% phenolphthalein solution. Spray with dilute sodium hydroxide solution to show up your message.

- Turn ‘water’ into ‘wine’. Half fill a 100 cm$^3$ beaker with phenolphthalein indicator. Put one drop of dilute sodium hydroxide solution in a 100 cm$^3$ beaker. Put two drops of dilute hydrochloric acid into a third beaker. Tell them that the liquid in the first beaker is water and that you are going to turn it into wine. Pour the liquid into the second beaker. It will turn red! Tell the class that you will now change the wine back to water. Pour the liquid into the third beaker. Watch it turn back to colourless!

Other relevant material

Skill sheet 12: Lighting a Bunsen burner
Skill sheet 13: Heating substances

Expected outcomes

Beetroot indicator is pink in acidic solutions and yellow in alkaline solutions.

Pitfalls

Make sure pupils obtain a sufficiently concentrated extract.

Safety notes

Eye protection should be worn.
Remind pupils to take care with knives.
Take care with corrosive substances.

Answers

1. pink
2. yellow
Make your own indicator

Other relevant material
Skill sheet 12: Lighting a Bunsen burner
Skill sheet 13: Heating substances

Equipment
For each group:
- a cooked beetroot (not pickled)
- a knife to cut the beetroot
- a white tile
- a heatproof mat
- a Bunsen burner
- a tripod and gauze
- a 250 cm$^3$ beaker
- a 250 cm$^3$ conical flask

For the class (optional teacher demonstrations):
- a large piece of filter paper
- 1% phenolphthalein solution
- a paintbrush
- a spray container
- sodium hydroxide solution, 2 mol/dm$^3$ [CORROSIVE]
- three 100 cm$^3$ beakers
- a dropping pipette
- dilute hydrochloric acid (1 mol/dm$^3$) [IRRITANT]

Tips
Have a few ‘unknown’ acidic and alkaline solutions for pupils to test if they finish early.

For your information

Running the activity
Pupils work in groups of two or three. They are given the method for the activity and prompted to consider the evidence.

If there is time, try making indicators out of other plants (e.g. red cabbage, blackcurrants) and comparing them to find out which is best.

Here are some possible demonstrations using other indicators:
- Try the invisible ink trick. Paint your message onto a large piece of filter paper using 1% phenolphthalein solution. Spray with dilute sodium hydroxide solution to show up your message.
- Turn ‘water’ into ‘wine’. Half fill a 100 cm$^3$ beaker with phenolphthalein indicator. Put one drop of dilute sodium hydroxide solution in a 100 cm$^3$ beaker. Put two drops of dilute hydrochloric acid into a third beaker. Tell them that the liquid in the first beaker is water and that you are going to turn it into wine. Pour the liquid into the second beaker. It will turn red! Tell the class that you will now change the wine back to water. Pour the liquid into the third beaker. Watch it turn back to colourless!
**Expected outcomes**
Beetroot indicator is pink in acidic solutions and yellow in alkaline solutions.

**Pitfalls**
Make sure pupils obtain a sufficiently concentrated extract.

**Safety notes**
Eye protection should be worn.
Remind pupils to take care with knives.
Take care with corrosive substances.
Make your own indicator

An indicator changes colour if a substance is acidic or alkaline. You are going to make an indicator solution out of beetroot.

Obtaining evidence

1. Cut a small, cooked beetroot into small pieces.
2. Half fill a beaker with water. Add the beetroot.
3. Set up the Bunsen burner, tripod, gauze and heatproof mat.
4. Boil the beetroot until the water is red.
5. Leave the apparatus to cool.
6. Set up a conical flask, filter paper and funnel.
7. Filter the beetroot and water. The filtrate is your indicator.
8. Add a few drops of the indicator to some lemon juice in a test tube. Lemon juice is acidic.
9. Add a few drops of the indicator to some soap solution a test tube. Soap solution is alkaline.

Considering the evidence

1. What colour is beetroot indicator in acidic solutions?
2. What colour is beetroot indicator in alkaline solutions?
Using plant extracts as indicators

Running the activity
Pupils work in groups of two or three. They are given the method for the activity. Demonstrate the test procedure, emphasising the need for only one or two drops of each solution to prevent overflowing.

Pupils design their own results table and look for patterns in their results; help may be given if necessary.

Provide the various acids, alkalis and plant extracts in labelled beakers with dropping pipettes set out so that all pupils have access to them. Pupils need to know (from experience, discussion, or the labels) which are acids and which are alkalis. They could be encouraged to try to sort the substances into acids and alkalis themselves, from the names and prior experience. However, help can be given if necessary. If resources allow, each bench could have its own set. Pupils have the opportunity to work out a pattern for themselves.

Expected outcomes
Each plant extract turns one colour in acid and another in alkali. Pupils may not know at the start which of the substances are acidic and which are alkaline, but they should be able to work this out from their results.

Pitfalls
Beware of pupils mixing or contaminating the test solutions and dropping pipettes. If too much solution is used on the tile it will overflow and cause contamination.

Safety notes
Eye protection should be worn. The main hazard is that a pupil could deliberately or accidentally squirt one of the solutions from a dropping pipette. If this is likely to be a problem then replace the dropping pipettes with glass tubes (dip the tube in the solution, put a finger over the end, transfer to the tile and remove the finger).

In general, alkalis are more hazardous to skin and eyes than acids of a similar concentration.

Answers
① Pupils should note that each plant extract turns one colour in acid and another in alkali.
② The actual colours depend on the plant extracts used.
Using plant extracts as indicators

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical</td>
<td>Pupils test various household and laboratory acids and alkalis with different plant extracts to identify a pattern.</td>
</tr>
</tbody>
</table>

Equipment

For each group:

- a spotting tile (dimple tile)
- access to a range of plant extracts in labelled beakers with dropping pipettes (the dyes will need to be extracted from the plant material ready for the lesson), for example:
  
<table>
<thead>
<tr>
<th>Plant Extract</th>
<th>Beaker Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>red cabbage</td>
<td>blackcurrant</td>
</tr>
<tr>
<td>raw beetroot</td>
<td>litmus</td>
</tr>
</tbody>
</table>

- access to a range of household and laboratory acids and alkalis (maximum strength 0.4 mol/dm³), for example:

<table>
<thead>
<tr>
<th>Acid/Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid</td>
</tr>
<tr>
<td>sulphuric acid</td>
</tr>
<tr>
<td>nitric acid</td>
</tr>
<tr>
<td>lemon juice</td>
</tr>
<tr>
<td>vinegar</td>
</tr>
<tr>
<td>lemonade</td>
</tr>
<tr>
<td>sodium hydrogencarbonate</td>
</tr>
<tr>
<td>calcium hydroxide solution</td>
</tr>
<tr>
<td>ammonia solution</td>
</tr>
<tr>
<td>sodium hydroxide solution</td>
</tr>
</tbody>
</table>

For your information

Running the activity

Pupils work in groups of two or three. They are given the method for the activity. Demonstrate the test procedure, emphasising the need for only one or two drops of each solution to prevent overflowing.

Pupils design their own results table and look for patterns in their results; help may be given if necessary.

Provide the various acids, alkalis and plant extracts in labelled beakers with dropping pipettes set out so that all pupils have access to them. Pupils need to know (from experience, discussion, or the labels) which are acids and which are alkalis. They could be encouraged to try to sort the substances into acids and alkalis themselves, from the names and prior experience. However, help can be given if necessary. If resources allow, each bench could have its own set. Pupils have the opportunity to work out a pattern for themselves.

Expected outcomes

Each plant extract turns one colour in acid and another in alkali. Pupils may not know at the start which of the substances are acidic and which are alkaline, but they should be able to work this out from their results.

Pitfalls

Beware of pupils mixing or contaminating the test solutions and dropping pipettes. If too much solution is used on the tile it will overflow and cause contamination.

Safety notes

Eye protection should be worn. The main hazard is that a pupil could deliberately or accidentally squirt one of the solutions from a dropping pipette. If this is likely to be a problem then replace the dropping pipettes with glass tubes (dip the tube in the solution, put a finger over the end, transfer to the tile and remove the finger).

In general, alkalis are more hazardous to skin and eyes than acids of a similar concentration.
You are going to test various household and laboratory acids and alkalis with different plant extracts.

Planning
1. Look at the range of acids and alkalis that are available to you, and the different plant extracts.
2. Design a results table so that you can record the colour of each acid or alkali with each plant extract.

Obtaining evidence

3. Put a drop of the solution to be tested on a spotting tile.
4. Add a drop of the plant extract.
5. Record the colour in your results table.
6. Repeat for the other solutions and the other plant extracts.

Considering the evidence

1. Can you see any patterns in your results?
2. For each plant extract, write down its colour in acid and in alkali.

Wear eye protection.
Take care with acids and alkalis.
Dip and check

Running the activity
Pupils work in groups of two or three.

Core: Pupils are given a method for the activity and prompted to record and consider the evidence.

Help: Pupils follow the method given on the Core sheet, then use the Help sheet to record their results. A clean piece of paper is required for question 1.

Other relevant material
Skill sheet 10: Hazard symbols

Expected outcomes
Pupils will identify strongly and weakly acidic and alkaline substances, and neutral substances. They will examine the packaging of household substances for hazard warnings that accompany strongly acidic and alkaline substances.

Pitfalls
Beware of pupils mixing or contaminating the test solutions.

Safety notes
Eye protection should be worn.
Remind pupils about the risks of handling hazardous substances and procedures for dealing with spills.

Answers
Core:
① They are all strongly acidic or strongly alkaline.
② Avoid spills and contact with the skin. Wash it off if you get it on yourself.
③ Wash it off and tell the teacher.

Help:
① Individual answers.
**Dip and check**

**Other relevant material**

**Skill sheet 10: Hazard symbols**

**Equipment**

For each group:
- a range of household substances with various pHs (e.g. bleach, washing up liquid, soap, oven cleaner, vinegar, lemon juice, etc.) Each should be mixed with or dissolved in a beaker of water for testing. The original packaging should be displayed and the beakers labelled to match the packaging.
- a glass rod for each beaker
- a book of pH paper

**Tips**

Use a clean glass rod for each test.

**For your information**

**Running the activity**

Pupils work in groups of two or three.

*Core:* Pupils are given a method for the activity and prompted to record and consider the evidence.

*Help:* Pupils follow the method given on the Core sheet, then use the Help sheet to record their results. A clean piece of paper is required for question 1.

**Expected outcomes**

Pupils will identify strongly and weakly acidic and alkaline substances, and neutral substances. They will examine the packaging of household substances for hazard warnings that accompany strongly acidic and alkaline substances.

**Pitfalls**

Beware of pupils mixing or contaminating the test solutions.

**Safety notes**

Eye protection should be worn.

Remind pupils about the risks of handling hazardous substances and procedures for dealing with spills.
You are going to test some solutions of household substances with universal indicator paper. This will tell you whether they are weakly or strongly acidic, weakly or strongly alkaline, or neutral solutions. Each substance has been added to a beaker of water.

**Obtaining evidence**

1. Dip a glass rod into your first test solution.
2. Touch the pH paper with the glass rod and record its colour.
3. Use the colour chart to decide on the pH.

**Presenting the results**

4. Make a table for your results like the one below.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Colour</th>
<th>pH</th>
<th>Weakly acidic</th>
<th>Strongly acidic</th>
<th>Weakly alkaline</th>
<th>Strongly alkaline</th>
<th>Neutral</th>
<th>Hazard warning</th>
</tr>
</thead>
</table>

5. Decide whether this substance is weakly or strongly acidic, weakly or strongly alkaline, or neutral. Record your results in the table.

6. Look at the packaging for the substance. Is it corrosive, irritant, toxic or harmful? Record this in the last column of your table.

7. Repeat steps 1 to 6 with each substance. Use a fresh piece of pH paper for each test.

**Considering the evidence**

1. Do the substances with hazard warnings have anything in common?
2. What safety precautions should you take when handling hazardous acidic and alkaline substances in the home?
3. What should you do if you accidentally spill an acidic or alkaline substance in class?
Presenting the results

4 Record your results in the table. Lemon juice has been done for you.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Colour</th>
<th>pH</th>
<th>Weakly acidic</th>
<th>Strongly acidic</th>
<th>Weakly alkaline</th>
<th>Strongly alkaline</th>
<th>Neutral</th>
<th>Hazard warning</th>
</tr>
</thead>
<tbody>
<tr>
<td>lemon juice</td>
<td>orange</td>
<td>3</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 Look at the packaging to see if there are any hazard labels. If any substances are corrosive, irritant, toxic or harmful, write this in the table.

Considering the evidence

1 Use your results to write a sentence about each substance like this:

The colour of universal indicator paper with lemon juice is orange. The pH is 3, so lemon juice is weakly acidic.
**Adding an acid to an alkali**

**Running the activity**

Pupils work in groups of two or three. Demonstrate the procedure first. Pupils measure out an excess of acid and 20 cm³ of alkali. Watch for contamination – there is a separate measuring cylinder and dropping pipette for each solution. Put the indicator in the alkali (so it goes blue – easy to check as you go round) and add acid using a dropping pipette in quantities of 0.5–1 cm³ until the mixture is neutral.

Have some strips of pH paper in your pocket as you go round for testing the contents of beakers.

*Core:* Pupils are given a method for the activity and prompted to predict, record, and consider the evidence.

*Help:* Pupils follow the same method but there are spaces to record their predictions, results and conclusions on the sheet.

**Expected outcomes**

When an acid is added to an alkali, it neutralises it and the pH of the mixture falls.

**Pitfalls**

The pH changes from alkaline to acidic very suddenly and it is easy to miss the neutral point.

Watch for contamination – there is a separate measuring cylinder and dropping pipette for each solution.

Watch for pupils trying to neutralise acid with acid or alkali with alkali!

**Safety notes**

Eye protection should be worn. The concentrations used here are not rated more hazardous than ‘irritant’.

Beware of dropping pipettes being used to squirt liquid.

**Answers**

*Core:*

1. The pH of the alkali at the start will be high / 11–14 because alkalis have high pH numbers.
2. As the hydrochloric acid is added the pH will fall / the solution will become neutral / the pH will be 7.
3. If more acid is added the pH will fall even lower / below pH 7 because the solution is becoming more acidic / has gone past the neutral point.
4. If alkali is added to acid, the pH will start low and get higher.
5. The pH falls / the solution becomes neutral / the pH is 7.
6. The pH falls even lower / the pH changes from 7 to 1 / the solution becomes completely acidic.
7. Check whether pupils’ results agree with their predictions.

*Help:* Correct words are as follows:

1. high
2. lower
3. neutral
4. Check whether pupils’ results agree with their predictions.
Adding an acid to an alkali

**Equipment**

For each group:
- universal indicator colour chart
- universal indicator solution
- two 100 cm³ beakers
- two 50 cm³ measuring cylinders
- two dropping pipettes
- a stirring rod
- 100 cm³ of hydrochloric acid, 0.4 mol/dm³
- 100 cm³ of sodium hydroxide solution, 0.4 mol/dm³

**For your information**

**Running the activity**

Pupils work in groups of two or three. Demonstrate the procedure first. Pupils measure out an excess of acid and 20 cm³ of alkali. Watch for contamination – there is a separate measuring cylinder and dropping pipette for each solution. Put the indicator in the alkali (so it goes blue – easy to check as you go round) and add acid using a dropping pipette in quantities of 0.5–1 cm³ until the mixture is neutral.

Have some strips of UI paper in your pocket as you go round for testing the contents of beakers.

*Core:* Pupils are given a method for the activity and prompted to predict, record, and consider the evidence.

*Help:* Pupils follow the same method but there are spaces to record their predictions, results and conclusions on the sheet.

**Expected outcomes**

When an acid is added to an alkali, it neutralises it and the pH of the mixture falls.

**Pitfalls**

The pH changes from alkaline to acidic very suddenly and it is easy to miss the neutral point.

Watch for contamination – there is a separate measuring cylinder and dropping pipette for each solution.

Watch for pupils trying to neutralise acid with acid or alkali with alkali!

**Safety notes**

Eye protection should be worn. The concentrations used here are not rated more hazardous than ‘irritant’.

Beware of dropping pipettes being used to squirt liquid.
Adding an acid to an alkali

You are going to add an acid to an alkali a little at a time and observe what happens to the pH.

Predicting
1. What do you think the pH of the alkali will be at the start? Explain your answer.
2. What do you think will happen to the pH as you add the acid a little at a time? Explain your answer.
3. What do you think will happen if even more acid is added? Explain your answer.
4. What will happen if alkali is added to acid? Explain your answer.

Obtaining evidence
1. Copy the table below:

<table>
<thead>
<tr>
<th></th>
<th>Colour</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium hydroxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>solution at start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>solution after adding some acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>solution after adding more acid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Measure 40 cm³ of hydrochloric acid. Put it in a beaker.
3. Measure 20 cm³ of sodium hydroxide solution. Put it in a beaker.
4. Add 5 drops of universal indicator (UI) solution to the sodium hydroxide solution in the beaker.
5. Record the colour. Look up the pH on the colour chart. Write the pH in the table.
6. Use a dropper to add hydrochloric acid to the sodium hydroxide solution a little at a time and stir gently to make sure they are mixed.
7. Check the colour of the indicator. If the colour has changed, record the new colour and pH in your table.
8. Repeat steps 6 and 7 until the colour stops changing.

Considering the evidence
5. Look at your results table. What happens to the pH as a little hydrochloric acid is added to sodium hydroxide solution?
6. What happens to the pH as more acid is added to the alkali?
7. Were your predictions correct?

Wear eye protection. Take care with acids and alkalis.
Adding an acid to an alkali

You are going to add an acid to an alkali a little at a time and observe the pH.

Predicting

1. Complete the following predictions by crossing out the wrong words.

   I think the pH of the sodium hydroxide solution at the start will be high/low because sodium hydroxide solution is an alkali.

   If more acid is added I think the pH will get higher/lower because the solution is becoming more acidic.

Obtaining evidence

Use this table to record your results as you follow the instructions below.

<table>
<thead>
<tr>
<th></th>
<th>Colour</th>
<th>pH</th>
<th>Acidic, neutral or alkaline</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium hydroxide solution at start</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>solution after adding some acid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>solution after adding more acid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Measure 40 cm³ of hydrochloric acid into a beaker.
3. Measure 20 cm³ of sodium hydroxide solution into a beaker.
4. Add 5 drops of universal indicator solution to the sodium hydroxide solution.
5. Record the colour. Look up the pH on the colour chart and record it.
6. Use a dropper to add hydrochloric acid to the sodium hydroxide solution a little at a time and stir gently to mix.
7. Check the colour of the indicator. If it has changed, record the new colour and pH in your table.
8. Repeat steps 6 and 7 until the colour stops changing.
9. For each pH in your table, fill in the last column.

Considering the evidence

10. Use your results table to help you complete these sentences.

   If the right amount of hydrochloric acid is added to sodium hydroxide solution, the acid cancels out the alkali and the solution becomes ...................... .

   My results agree/disagree with my prediction because: ..............................................................
Using a datalogger to check pH changes

Running the activity
This activity can be used as small-group extension work or could be done as a demonstration.
The activity is carried out with a pH sensor and datalogger to give a graphical output of pH against time.

ICT opportunities
Pupils use a datalogger.

Expected outcomes
Pupils will obtain a printout of a graph showing pH against time. The pH does not change steadily as pupils might expect, but within a very narrow time band.

Pitfalls
Watch for contamination – use a separate measuring cylinder and dropping pipette for each solution.
Make sure that the magnetic stirrer does not knock against the pH sensor too vigorously.
Check that the datalogger is operating.

Safety notes
Pupils should wear eye protection. Beware of dropping pipettes being used to squirt liquid.

Answers
① high / 11–14
② It will get lower as the acid neutralises the alkali.
③ It will get even lower / the solution will become acidic / pH 1–3.
④ The pH will start low and get higher.
⑤ ⑥ Answers are derived from pupils’ graphs.
⑦ Individual answers.
Using a datalogger to check pH changes

**Equipment**

For each group:
- a 250 cm³ beaker
- a 100 cm³ measuring cylinder
- a 50 cm³ measuring cylinder
- a 100 cm³ dropping funnel
- a magnetic stirrer
- a retort stand and clamp
- a pH sensor
- a datalogger with printer
- 100 cm³ of hydrochloric acid, 0.4 mol/dm³
- 100 cm³ of sodium hydroxide solution, 0.4 mol/dm³

**For your information**

**Running the activity**

This activity can be used as small-group extension work or could be done as a demonstration.

The activity is carried out with a pH sensor and datalogger to give a graphical output of pH against time.

**Expected outcomes**

Pupils will obtain a printout of a graph showing pH against time. The pH does not change steadily as pupils might expect, but within a very narrow time band.

**Pitfalls**

Watch for contamination – use a separate measuring cylinder and dropping pipette for each solution.

Make sure that the magnetic stirrer does not knock against the pH sensor too vigorously.

Check that the datalogger is operating.

**Safety notes**

Pupils should wear eye protection. Beware of dropping pipettes being used to squirt liquid.
Using a datalogger to check pH changes

You are going to add hydrochloric acid to sodium hydroxide solution drop by drop and record the pH using a datalogger.

**Predicting**

1. What do you think the pH of the alkali will be at the start? Explain your answer.
2. What do you think will happen to the pH as you add the acid drop by drop? Explain your answer.
3. What do you think will happen if even more acid is added? Explain your answer.
4. What will happen if alkali is added to acid? Explain your answer.

**Obtaining evidence**

1. Measure 75 cm$^3$ of hydrochloric acid. Put it in a dropping funnel.
2. Measure 50 cm$^3$ of sodium hydroxide solution. Put it in a narrow 250 cm$^3$ beaker.
3. Stand the beaker on a magnetic stirring plate and put the stirrer in the beaker. Start the stirrer.
4. Clamp the pH sensor so that it is in the liquid.
5. Arrange the dropping funnel so that it can drip into the beaker.
6. Start the datalogger.
7. Open the funnel tap slightly so that the hydrochloric acid drips into the sodium hydroxide solution, approximately one drop every second. Count the drops in 30 seconds.
8. Continue adding the acid until the pH stops changing (about pH 1 or 2).
9. Stop adding the acid, and turn off the stirrer and datalogger.

**Presenting the results**

10. Print out the graph of the data collected by the datalogger.

**Considering the evidence**

11. On your graph, mark the point at which the mixture was exactly neutral.

5. How long did it take for the mixture to go from alkaline to neutral?
6. How long did it take for the mixture to go from pH 14 to pH 1?
7. Write a paragraph comparing your predictions with your results of how the pH changes as the acid runs into the alkali.
Investigate: How well do antacids work?

**Running the activity**

The investigation is in three parts with three separate pupil sheets at Core and Help level: planning the investigation (E3c), obtaining evidence (E3d) and considering and evaluating evidence (E3e). The Extension sheet covers all three parts.

**Core, Help:** In Activity E3c pupils are shown some proprietary brands of antacid and told that they neutralise excess acid in the stomach. Pupils come up with a plan to find out which brand works the most quickly. They are encouraged to think about fair tests. Pupils also make a prediction about which antacid will work the fastest.

The plan, prediction and results table must be checked by the teacher before pupils work in small groups to carry out their plan in Activity E3d.

In Activity E3e pupils consider the evidence and evaluate their investigation as prompted by the questions on the pupil sheet. Provide comparative prices for the different antacids to enable pupils to compare which is the best in terms of price and speed of neutralisation of the antacids.

The Help sheet provides extra support in the form of a structured format for pupils to record on the sheet.

**Extension:** Pupils plan and carry out an experiment, then write a report. They consider which brand is the best buy, and how their investigation could be improved.

**Other relevant material**

- **Skill sheet 20:** Writing frame: Planning an investigation
- **Skill sheet 21:** Writing frame: Reporting an investigation

For Activity E3e pupils will need the results from their practical work in Activity E3d.

**ICT opportunities**

A pH sensor and datalogger are used for the Extension activity.

**Expected outcomes**

Pupils should produce a plan to time how long it takes for each antacid to neutralise a fixed quantity of acid. From reading the packets they should predict that the antacid with the greatest amount of alkali in each dose will neutralise the acid the fastest.

Pupils will carry out their plan and work out which antacid acts the most quickly. They will have thought about fair testing. They will find out whether their prediction was correct.

**Pitfalls**

Some pre-testing of brands of indigestion remedies will be needed to check the times for the experiments. It is suggested that 0.1 mol/dm$^3$ hydrochloric acid is used. For reasons of economy, it might be a good idea to package your own ‘indigestion powder’ using sodium hydrogen carbonate. If this is done, the
different powders should be labelled with the amount of alkali in them and pupils told how much to add each time.

Glass pH sensors are very delicate and should be handled with great care. Plastic-bodied sensors are more robust but have a shorter shelf life.

**Safety notes**

Eye protection should be worn. Even though 0.1 mol/dm$^3$ hydrochloric acid poses almost no hazard, remind pupils about the risks of handling acids. Pupils should not eat the antacid tablets.

**Answers**

Plans should include the following steps:

Pupils check the universal indicator colour chart to find the colour for pH 7. When the solution in the beaker reaches this colour, they will stop the stopwatch.

Pupils add one antacid tablet to a measured amount of acid, or use the recommended dose if the antacid is a powder. As soon as the antacid enters the acid they start the stopwatch and stir very carefully with a stirring rod.

If the pH has not reached 7 when the first tablet (or powder) has dissolved, more antacid should be added.

They stop the stopwatch when the indicator colour shows that the pH has reached 7 (neutral) and record the time taken by this antacid in their table.

The procedure is repeated for the other brands of antacids.

**Activity E3e Core:**

1. Pupils should choose the antacid that neutralised the acid in the shortest time. They should explain that it contains more alkali and therefore neutralised the acid fastest. The difference between powder and tablet form and how fast they dissolve should be considered.

2. The investigation would not be a fair test if tablets are of different sizes or brands have different recommended doses. One antacid may have been in tablet form and one powder.

3. Pupils need to consider the cost of the antacid preparations as well as how fast they work.

4. Use the same masses of antacids; take surface area into account.

**Activity E3e Help:** Missing words are as follows:

- indigestion, show, neutralises, green

**Activity E3e Extension:**

1. Yes, because it’s quick and accurate. (Give credit for sensible answers.)

2. The investigation would not be a fair test if tablets are of different sizes or brands have different recommended doses. One antacid may have been in tablet form and one a powder.

3. For example: compare powders with other powders and tablets of equal size; weigh the antacids.

4. For example: find out the exact concentration and volume of stomach acid likely to be present and use that to test more brands; find out the minimum dose required to neutralise a fixed volume of acid at a certain concentration.
**Investigate: How well do antacids work?**

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper, practical</td>
<td>Pupils plan and carry out an investigation to compare how quickly different brands of antacid work. Pupils analyse the results from their investigation, conclude which antacid worked the most quickly and evaluate the investigation.</td>
<td>Core, Help, Extension</td>
</tr>
</tbody>
</table>

**Other relevant material**

- **Skill sheet 20: Writing frame: Planning an investigation**
- **Skill sheet 21: Writing frame: Reporting an investigation**

For Activity E3e pupils will need the results from their practical work in Activity E3d.

**Equipment**

Equipment may vary slightly according to the method chosen by pupils in their plans.

For each group:
- four 250 cm³ beakers
- a 100 cm³ measuring cylinder
- a stirring rod
- hydrochloric acid, 0.1 mol/dm³, labelled ‘stomach acid’
- four different brands of antacid
- a stopwatch
- universal indicator solution
- a universal indicator colour chart

Additional for Extension:
- a datalogger with printer (optional)
- a pH sensor (two, if available)
- a retort stand and clamp (depending on type of sensor)
- a plastic stirring rod

**For your information**

**Running the activity**

The investigation is in three parts with three separate pupil sheets at Core and Help level: planning the investigation (E3c), obtaining evidence (E3d) and considering and evaluating evidence (E3e). The Extension sheet covers all three parts.

*Core, Help:* In Activity E3c pupils are shown some proprietary brands of antacid and told that they neutralise excess acid in the stomach. Pupils come up with a plan to find out which brand works the most quickly. They are encouraged to think about fair tests. Pupils also make a prediction about which antacid will work the fastest.

The plan, prediction and results table must be checked by the teacher before pupils work in small groups to carry out their plan in Activity E3d.

In Activity E3e pupils consider the evidence and evaluate their investigation as prompted by the questions on the pupil sheet. Provide comparative prices for the different antacids to enable pupils to compare which is the best in terms of price and speed of neutralisation of the antacids.
Investigate: How well do antacids work?  
(continued)

The Help sheet provides extra support in the form of a structured format for pupils to record on the sheet.

*Extension:* Pupils plan and carry out an experiment, then write a report. They consider which brand is the best buy, and how their investigation could be improved.

**ICT opportunities**
A pH sensor and datalogger are used for the Extension activity.

**Expected outcomes**
Pupils should produce a plan to time how long it takes for each antacid to neutralise a fixed quantity of acid. From reading the packets they should predict that the antacid with the greatest amount of alkali in each dose will neutralise the acid the fastest.

Pupils will carry out their plan and work out which antacid acts the most quickly. They will have thought about fair testing. They will find out whether their prediction was correct.

**Pitfalls**
Some pre-testing of brands of indigestion remedies will be needed to check the times for the experiments. It is suggested that 0.1 mol/dm³ hydrochloric acid is used. For reasons of economy, it might be a good idea to package your own ‘indigestion powder’ using sodium hydrogencarbonate. If this is done, the different powders should be labelled with the amount of alkali in them and pupils told how much to add each time.

Glass pH sensors are very delicate and should be handled with great care. Plastic-bodied sensors are more robust but have a shorter shelf life.

**Safety notes**
Eye protection should be worn. Even though 0.1 mol/dm³ hydrochloric acid poses almost no hazard, remind pupils about the risks of handling acids. Pupils should not eat the antacid tablets.
Investigate: How well do antacids work?

Antacids (indigestion remedies) help to relieve acid indigestion by neutralising stomach acid. The adverts say how quickly some antacids work. Do some antacids really work faster than others? You are going to plan an investigation to compare how quickly different brands of antacid work.

Equipment

- four beakers
- a stirring rod
- a stopwatch
- a solution of ‘stomach acid’
- four different brands of antacid
- a measuring cylinder
- universal indicator solution
- a universal indicator chart

Planning

1. What is the aim of your investigation? Write down the question you are trying to answer.

2. Read the information on the antacid packets. How could you test the antacids in the lab instead of using stomach acid? Discuss your ideas.

3. How will you know when the antacid has neutralised the acid? How will you measure how long the neutralisation takes? Discuss your ideas.

4. Work out whether anything other than the type of antacid may affect your results. If so, these are variables and you must include in your plan some way to keep them the same to make it a fair test.

5. Decide what equipment you will need to use and make a list.

6. Decide how you will set up your equipment. Draw a labelled diagram.

7. Think about how to make your results reliable. How many readings will you take? Write down your decisions.

8. Finish your plan. Make sure it says:
   - what you are going to change (the input or independent variable)
   - what you are going to measure or observe (the outcome or dependent variable)
   - what you will keep the same to try to make it a fair test
   - the number of measurements you will take
   - whether you will repeat the measurements, and why
   - how you will keep your investigation safe – take safety precautions.

9. Check your plan with your teacher. Before you begin to collect evidence, draw a table for your results with a heading for each column. If you are doing repeat readings, leave room to calculate averages.

Predicting

10. Predict which brand will be the most effective cure. You will need to read the information on the packaging to help you with this.
    *Hint: the stronger antacids will have the most alkali, but you might expect a powder antacid to work faster than a tablet.*

11. Use your scientific knowledge to explain your prediction.
Antacids help to relieve acid indigestion by neutralising stomach acid. The adverts say how quickly some antacids work. Do some antacids really work faster than others? You are going to plan an investigation to compare how quickly different brands of antacid work.

Equipment
- four beakers
- a measuring cylinder
- a stirring rod
- a solution of ‘stomach acid’
- four different brands of antacid
- a stopwatch
- universal indicator solution
- a universal indicator chart
- a solution of ‘stomach acid’

Planning and predicting
1. Read the information on the antacid packets. The alkali in them neutralises stomach acid. Think about these questions:
   - How could you test the antacid in the lab instead of using stomach acid?
   - How will you know when the antacid has neutralised the acid? (Hint: an indicator shows when a change from acid to neutral happens.)
   - How will you measure how long it takes?
2. Discuss each point below in your group. Fill in the gaps as you go.

Aim: The question we want to answer is ...................................................................................................................................................................

Input variable: we will change the ...................................................................................................................................................................

Outcome variable: we will measure ...................................................................................................................................................................

We will measure it by ..................................................................................................................................................................................

Fair test: we will keep these variables the same (make a list) ..........................................................................................................................................................................................

Equipment we will need: Make a list. The list above will give you some ideas. ..........................................................................................................................................................................................

Reliable results: We will repeat each measurement ........................................ times.

Predicting: We think the antacid that will work the quickest is ........................................
We think this because .................................................................................................................................................................

(Hint: read the information on the packets. The strongest antacids will work the quickest. The strongest antacids have the most alkali in them. If a tablet and a powder antacid have similar amounts of alkali, then you might expect the powder to work quickest as it dissolves faster.)

3. Check your plan with your teacher.
Investigate: How well do antacids work?

You are going to carry out the investigation you planned in Activity E3c to find out whether some antacids really work faster than others.

**Obtaining evidence**

1. Set up your equipment as you planned it in Activity E3c.
2. Carry out your plan to measure how long it takes for each antacid to neutralise the acid solution.
   - Use the dose suggested on the packet.
   - Add another tablet or dose until the reaction has finished.
     (If the mixture fizzes or you are using universal indicator and it stays red, orange or yellow, add another tablet or dose.)

**Presenting the results**

3. Write your results in the table you prepared. Your table might look like this:

<table>
<thead>
<tr>
<th>Antacid</th>
<th>Number of doses</th>
<th>Time taken to neutralise acid solution (1)</th>
<th>Time (2)</th>
<th>Time (3)</th>
<th>Average $\frac{1 + 2 + 3}{3}$</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>
Investigate: How well do antacids work?

You are going to carry out the investigation you planned in Activity E3c to find out whether some antacids really work faster than others.

**Equipment**
- four beakers
- a measuring cylinder
- a stirring rod
- a solution of ‘stomach acid’
- four different brands of antacid
- a stopwatch
- universal indicator (UI) solution
- a universal indicator chart

**Obtaining evidence**

1. Set up the apparatus as shown in the diagram.
2. Check the colour chart to find the colour for pH 7. When the solution in the beaker reaches this colour you will stop the stopwatch.
3. If the pH has not reached 7 when the first tablet (or dose) has dissolved, quickly add another tablet or dose of antacid.
4. Record the time taken by this antacid in your table.
5. Repeat for the other brands of antacid.

**Presenting the results**

6. Record your results in a table like this.

<table>
<thead>
<tr>
<th>Antacid</th>
<th>Number of doses</th>
<th>Time taken to neutralise acid solution (1)</th>
<th>Time (2)</th>
<th>Time (3)</th>
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</tbody>
</table>
Investigate: How well do antacids work?

You are going to analyse the results from your investigation, conclude which antacid worked the most quickly and evaluate the investigation.

Considering the evidence

1. Which brand of antacid would give the fastest relief from indigestion? Explain your answer.
2. Was the investigation a fair test?
3. Which brand of antacid is the better buy? Explain your answer.

Evaluating

4. How could you improve the investigation to make it a fair test?
Investigate: How well do antacids work?

You are going to analyse the results from your investigation, conclude which antacid worked the most quickly and evaluate the investigation.

Considering the evidence

1. Complete these sentences using the words below.

   Too much stomach acid causes ...................................... .

   Universal indicator can be used to ...................................... when an antacid ...................................... stomach acid because it changes to ...................................... in a neutral solution.

   Look at your results table. Which brand of antacid would give fastest relief from indigestion? Explain your answer.

2. Was the investigation a fair test?
**Investigate: How well do antacids work?**

You are a scientist working for a pharmaceutical company that produces antacids for the relief of acid indigestion. You have decided to use a pH sensor to compare how quickly different brands of antacid work.

**Equipment**
- four beakers
- a measuring cylinder
- a plastic stirrer
- a solution of ‘stomach acid’
- pH sensors
- a datalogger
- four brands of antacid

**Planning and predicting**
1 Design an investigation to compare how quickly four brands of antacid work. You can use two pH sensors at once.
2 Ask your teacher to check your plan.
3 Predict which brand will be the most effective cure. You will need to read the information on the packaging. Explain your prediction fully.

**Obtaining evidence**
4 Carry out your plan.
5 Print out or sketch the graph from the datalogger. Label your graph to show when neutralisation took place.
6 Repeat the investigation with the other brands of antacid.

**Considering the evidence**
7 Write a report, using your results to support your conclusions. Include calculations to decide which brand is the best buy.

**Evaluating**
1 Do you think that datalogging was the best technique to use for this investigation? Give your reasons.
2 Do you think that your investigation was a fair test?
3 What improvements could you make to your investigation?
4 Can you think of any further investigations you could do to help you decide which is the best brand of antacid?
E1

Acids, bases, alkalis

**Review learning**

- In pairs, ask pupils to write definitions in their own words of the key words listed.
- Take feedback from pairs. Summarise on the board. Identify the importance of using scientific vocabulary.

**Sharing responses**

- Pupils compare colour changes obtained with beetroot in acids and alkalis.
- Discuss whether the change is consistent across all groups and whether beetroot is reliable for detecting the presence of acids and alkalis.
- Ask pupils to suggest why there is variation in the strength of colour seen for different groups.

**Group feedback**

- Ask a pair of pupils to present to the class their results on OHT/PowerPoint. Other pairs confirm or challenge the data.
- If data is challenged, ask pupils to suggest why the data may be unreliable. Use the questions as prompts.

**Word game**

- In groups, pupils discuss which hazard to match with which symbol and example. Time how quickly the group can match up all the items.

**Looking ahead**

- Pupils brainstorm alone for one minute to come up with examples of acids and alkalis used in the home or leisure. They compare notes with another pupil and refine their list.
- Suggest uses such as hairdressing, marking out football pitches, acid etching which they may not know about and show photos of these.

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**Suggested alternative plenary activities (5–10 minutes)**

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils provide their own definitions for key words.</td>
<td>Whole-class discussion of responses from Activity E1a.</td>
<td>Working in pairs, pupils summarise and present the results of their research from Activity E1b.</td>
<td>Hazard symbols matching game.</td>
<td>Pupils brainstorm a list of possible acids and alkalis used in the home and in leisure.</td>
</tr>
</tbody>
</table>

**Key words**

Indicator, hazard, acid, alkali.

**Questions**

- Is it because they put the data in the wrong place?
- Is it due to procedural error, i.e. they used too much and it overflowed?
- Could something have contaminated the dropper pipette?
- Are there any drawbacks with these indicators?
- Which indicator would they choose to help them test further liquids and why?

➔ Pupil sheet

➔ Interactive Presentations for Catalyst 1
## Word game

Work in your group to decide which hazard matches which symbol and example. Draw lines between the ones that match.

<table>
<thead>
<tr>
<th>Hazard name</th>
<th>Hazard symbol</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosive</td>
<td><img src="image" alt="Corrosive symbol" /></td>
<td>Mercury metal, pesticides such as DDT</td>
</tr>
<tr>
<td>Flammable</td>
<td><img src="image" alt="Flammable symbol" /></td>
<td>Sulphuric acid found in car batteries</td>
</tr>
<tr>
<td>Irritant</td>
<td><img src="image" alt="Irritant symbol" /></td>
<td>Petrol</td>
</tr>
<tr>
<td>Toxic</td>
<td><img src="image" alt="Toxic symbol" /></td>
<td>Oven cleaner</td>
</tr>
</tbody>
</table>
**Suggested alternative plenary activities** (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick quiz of pH values and colours.</td>
<td>Whole-class discussion of advantage of universal indicator compared to litmus.</td>
<td>In groups, pupils share their findings from Activity E2a.</td>
<td>Present pupils with a true/false quiz.</td>
<td>Pupils suggest what action they would take to deal with an acidic liquid that has been spilled onto a busy road following an accident.</td>
</tr>
</tbody>
</table>

**Review learning**
- Give a pH value and ask pupils to write the corresponding colour change from a pH chart.

**Sharing responses**
- Ask pupils to discuss in pairs what they think are the advantages of using universal indicator compared with litmus. Use the questions as prompts.
- Take feedback from specific pairs and ask other pairs if their results agree/disagree. Explore any disagreements.
- Ask pairs to describe the colours of the universal indicator they would now associate with acids and with alkalis.
- Compare the language they are using to describe the colours of the universal indicator, e.g. red, deep red, and bright red. Explain why it is important to use the same descriptions.

**Group feedback**
- Ask specific pairs to give their responses to the questions, based on their findings from the activity.
- Ask other pairs if they agree or disagree. What suggestions do they have?

**Word game**
- Read out the statements on the Teacher sheet and let pupils work in pairs or alone to decide if the statements are true or false.

**Looking ahead**
- The question can be set for individuals to consider and suggest answers to. They then share responses with other pupils. Make it clear they may not know the answer and need to suggest their ideas and predictions.
- Suggestions can be summarised and recorded in pupils’ books to reconsider after further lessons.

**Questions**
- What information would they expect litmus to provide in this activity that the universal indicator also provides?
- What information would the litmus not be able to provide? Does this matter? Why?

**Teacher sheet**

**Questions**
- Do the substances with hazard warnings have anything in common?
- What should you do if you accidentally spill an acidic or alkaline substance in class?
- What safety precautions should you take when handling hazardous acidic and alkaline substances in the home?

**Question**
What action would you take to deal with an acid spillage on a busy road following an accident?
## Word game

<table>
<thead>
<tr>
<th>Statement</th>
<th>True/False</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinegar is an example of an alkali.</td>
<td>F</td>
</tr>
<tr>
<td>Tea contains tannic acid.</td>
<td>T</td>
</tr>
<tr>
<td>Coke is an alkali.</td>
<td>F</td>
</tr>
<tr>
<td>Water is the only liquid that is neutral.</td>
<td>F</td>
</tr>
<tr>
<td>Tooth decay is caused by bacteria that release acid in the mouth.</td>
<td>T</td>
</tr>
<tr>
<td>Sodium hydroxide will produce a pH value between 1 and 6.</td>
<td>F</td>
</tr>
<tr>
<td>Hydrochloric acid is an example of a concentrated acid.</td>
<td>T</td>
</tr>
<tr>
<td>You can dilute an acid by adding water to it.</td>
<td>T</td>
</tr>
<tr>
<td>You should treat an acid spill by adding alkali.</td>
<td>F</td>
</tr>
<tr>
<td>Lactic acid is an acid found in yoghurt.</td>
<td>T</td>
</tr>
<tr>
<td>Vitamin C is an example of an acid.</td>
<td>T</td>
</tr>
<tr>
<td>You can treat wasp stings with vinegar.</td>
<td>T</td>
</tr>
<tr>
<td>Litmus is an indicator made from plants.</td>
<td>T</td>
</tr>
</tbody>
</table>
Review learning

- Pupils work in pairs to describe the process of neutralisation. They can present their ideas as a role-play, as a cartoon strip, flow chart or as a sequence of sentences.
- Make sure they include how the UI provides evidence that changes are occurring.

Sharing responses

- Ask pupils to recall the sequence of colours they observed as the process took place.
- Ask pupils to suggest what is difficult and what is easy about carrying out neutralisation.
- Ask pupils to suggest why acid or alkali spills tend to get treated with lots of water rather than trying to neutralise them?

Group feedback

- Pupils work in pairs to suggest a maximum of three examples of neutralisation in everyday life.
- Pupils then make a group of four and refine their list.
- Take feedback from groups and summarise on the board.

Word game

- Pupils select nine words from the list to write into their bingo grid.
- Read out definitions from the Teacher sheet in any order. Pupils match these to their chosen words. The game is over when a pupil can strike out a line.
- The pupil has to recall the definitions as they read out each word back to the class to check their winning line.

Looking back

- Pupils revise and consolidate knowledge from the unit. They can use the Unit map, Pupil check list, or the Test yourself questions.
Taking away acidity

Word game

Bingo!

Choose nine words from the list below and write them in the empty table.

Cross out each word when you hear the teacher read out its definition.  

Shout ‘BINGO!’ when you have crossed out a line of three words on the card.  

The line can be across, down or diagonally.

<table>
<thead>
<tr>
<th>acid</th>
<th>pH 8–14</th>
<th>universal indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>base</td>
<td>pH 1–6</td>
<td>corrosive</td>
</tr>
<tr>
<td>alkali</td>
<td>neutral</td>
<td>litmus</td>
</tr>
<tr>
<td>neutralisation</td>
<td>hydrochloric acid</td>
<td>pH 7</td>
</tr>
</tbody>
</table>

\[\text{Table}\]
Taking away acidity

Word game

Read out the definitions below in any order.

1. A substance that turns litmus red. [Acid]
2. A substance that has a pH value between 8 and 14. [Alkali]
3. A word that describes a substance that can attack skin, metals and stone statues. [Corrosive]
4. The acid present in the stomach. [Hydrochloric acid]
5. A substance used to compare different acids. [Universal indicator]
6. The pH range for acids. [pH 1–6]
7. The pH range for oven cleaner. [pH 8–14]
8. A word that describes substances that are neither acid nor alkali. [Neutral]
9. An indicator made from plants. [Litmus]
10. The process that removes acidity. [Neutralisation]
11. The opposite of an acid. [Base]
12. The pH value for water. [pH 7]
Investigate: How well do antacids work?

**Suggested alternative plenary activities** (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Group feedback</th>
<th>Analysing</th>
<th>Evaluating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-led review of factors/variables.</td>
<td>In groups, pupils share their findings about the effectiveness of the indigestion remedies.</td>
<td>Teacher-led discussion of which brand would give faster relief.</td>
<td>Teacher-led discussion on whether the investigation was a fair test.</td>
</tr>
</tbody>
</table>

**Review learning**

- Pupils identify the variables in the investigation.
- Pupils say what values they chose for the things they were going to keep the same and for independent variables.

**Group feedback**

- Pupils work in pairs to use the data they have collected to decide on a response to this question.
- Ask them to discuss if there is a relationship between the amount of antacid in the cure and the time taken for the acid to be neutralised. Ask them to suggest something from their data to justify their response.

**Analysing**

- Ask each pair/group to present their data so it can be compared with data from other groups.
- Discuss whether or not the values are exactly the same and if not, why not.
- Ask if pupils can see a pattern in the data. Ask other groups to support or challenge the original suggestion.
- Ask pupils to recommend which brand would give faster relief and use their ideas of particles to explain why.

**Evaluating**

- Ask pupils what strategies they used to make sure it was a fair test.
- Ask pupils to suggest if any variation in the data from all the groups could be caused by their method and procedures. Help them to identify which parts of the method could have resulted in errors.
- Ask pupils to suggest what they might do differently to make it a fairer test next time and to get better results.
**Problem soil – Think about**

**Suggested alternative plenary activities (5–10 minutes)**

<table>
<thead>
<tr>
<th>Group feedback</th>
<th>Bridging to other topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>In pairs, pupils explain how compensation and dilution work.</td>
<td>Pupils think about examples of compensation in life.</td>
</tr>
</tbody>
</table>

**Group feedback**

- In pairs, pupils explain to each other how compensation and dilution work.
- The key point is that they understand that as one variable increases, the other variable decreases. This is a common relationship in science.
- They explain why the farmer’s idea did not work.

**Bridging to other topics**

- Pupils work in groups to come up with examples of when compensation can be useful in other contexts. Examples are: making up orange squash, using washing powder, making up wallpaper paste, making jelly, making instant whip or custard.

- Remind pupils of some examples of compensation that they may have come across already and some to come. They may have met some examples from KS2:
  - the effect of distance on shadow length.

Pupils will use compensation in future units:
- 9L the beam balance and moments
- 9J the effect of distance on gravitational force.
Acids, bases, alkalis

1. Use the words on the right to fill in the gaps.

   a. Some acids, like vinegar and ............................................, taste .............................................

   b. Bases are the ............................................ of acids.

   c. Bases that dissolve in water are called .............................................

   d. Water is ............................................ . This means it is neither an acid nor an alkali.

   e. Something that is different colours in an acid and an alkali is called an .............................................

2. Match the word to its hazard symbol. Then match the hazard symbol to its meaning.

   - **corrosive**
     - Eats away skin and metal and other materials.

   - **irritant**
     - Can make my skin red or blistered.

   - **harmful**
     - Can make me ill if I swallow it, breathe it in or get it on my skin.
3 Litmus is an indicator.
Litmus is red in acids, blue in alkalis and purple in neutral solutions.

a Use this information to fill in the table.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Colour of litmus indicator</th>
<th>Acid, alkali or neutral?</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium hydroxide</td>
<td>blue</td>
<td></td>
</tr>
<tr>
<td>sodium hydrogencarbonate</td>
<td></td>
<td>alkali</td>
</tr>
<tr>
<td>water</td>
<td>purple</td>
<td></td>
</tr>
<tr>
<td>lemon juice</td>
<td>red</td>
<td>acid</td>
</tr>
<tr>
<td>battery acid</td>
<td>blue</td>
<td></td>
</tr>
<tr>
<td>oven cleaner</td>
<td>blue</td>
<td></td>
</tr>
</tbody>
</table>

b In the table, colour in the substances the colour litmus turns with them.
1. This is a pH scale for universal indicator.

<table>
<thead>
<tr>
<th>pH</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>red</td>
</tr>
<tr>
<td>1</td>
<td>orange</td>
</tr>
<tr>
<td>7</td>
<td>yellow</td>
</tr>
<tr>
<td>10</td>
<td>green</td>
</tr>
<tr>
<td>14</td>
<td>blue</td>
</tr>
<tr>
<td>14</td>
<td>purple</td>
</tr>
</tbody>
</table>

- **Strongly acidic**
- **Weakly acidic**
- **Neutral**
- **Weakly alkaline**
- **Strongly alkaline**

a. Write in the missing numbers.

b. Use these words to fill in the gaps.

- weakly
- strongly
- acidic
- alkaline
- neutral

C. If you have time, colour in the pH scale.
How acidic? (continued)

2 Use this information to answer the questions.

- **a** Which substance has a pH of 1?
- **b** Which is the strongest alkali?
- **c** Name a weak acid.
- **d** Name a weak alkali.
- **e** Name a neutral substance.
- **f** Colour each substance the colour it would turn universal indicator.

- **hydrochloric acid** (pH = 1)
- **vinaigre** (pH = 4)
- **baking soda** (pH = 9)
- **sodium hydroxide** (pH = 14)
- **water** (pH = 7)
Taking away acidity

1 Use these words to fill in the gaps.

- Bases ............................................ acids. This means they ............................................ each other out.

- Indigestion medicines contain ............................................ or bases to neutralise stomach acid.

2 We use neutralisation every day. Which of these use neutralisation? Tick the boxes.

- Adding lime to acidic soil so plants grow well.
- Lighting a candle.
- Dissolving sugar in water.
- Cleaning your teeth.
- Taking an indigestion tablet.
- Making a cup of tea.

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This worksheet may have been altered from the original on the CD-ROM.
3. a Match the pHs to the substances.

- Washing soda is a weak alkali. \( \text{pH} = 5 \)
- Hydrochloric acid is a strong acid. \( \text{pH} = 12 \)
- Water is neutral. \( \text{pH} = 7 \)
- Orange juice is a weak acid. \( \text{pH} = 14 \)
- Sodium hydroxide turns universal indicator purple. \( \text{pH} = 14 \)

b Name a substance which you could use to neutralise washing soda. ..............................................................

c I will know when the solution is neutral because its colour will be ...
- ... yellow
- ... blue
- ... green.

d If I add orange juice to a beaker of sodium hydroxide, the pH will ...
- ... go up
- ... go down
- ... stay the same.
Problem soil

1 Plants grow best if the soil has a pH of 6 to 7.
   Farmer James tests his soil to find out its pH.

a The instructions for his soil test kit are all mixed up!
   Write numbers in the boxes to put them in order.

b Farmer James follows the instructions. The universal indicator turns orange. Circle the pH of the soil.

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

To grow plants well, what should Farmer James do?

add some alkali
leave it alone
add some acid

Tick the box.
2 Look at this picture of Farmer James’s soil.

Here are three solutions that he could add to his soil to neutralise (cancel out) the acid.

a How many acid particles are there in the soil? ............

b How many base particles are there in:

   solution A? ............

   solution B? ............

   solution C? ............

c Which solution should Farmer James add to his soil to exactly neutralise the acid? ............

d Why should he add this solution?

Because it has the same number of base particles as acid particles.  
Because it has more base particles than acid particles.  
Because it has fewer base particles than acid particles.
E1 Acids, bases, alkalis

1a lemon juice, sour  
bcalkalis d neutral e indicator

corrosive – second hazard symbol – Eats away skin and metal and other materials.
Irritant – fifth hazard symbol – Can make my skin red or blistered.
Harmful – fourth hazard symbol – Can make me ill if I swallow it, breathe it in or get it on my skin.

2 Correctly coloured substances.

E2 How acidic?

1a and b

correctly coloured in.

2a hydrochloric acid  
b sodium hydroxide  
c vinegar  
d baking soda  
e water  
f correctly coloured.

E3 Taking away acidity

1a neutralise, cancel  
b alkalis

2 The following should be ticked – Adding lime to acidic soil so plants grow well. Cleaning your teeth. Taking an indigestion tablet.

3a Washing soda is a weak alkali – pH = 12.
Hydrochloric acid is a strong acid – pH = 1.
Water is neutral – pH = 7.
Orange juice is a weak acid – pH = 5.
Sodium hydroxide turns universal indicator purple – pH = 14.

b Hydrochloric acid or orange juice.

c green  
d go down

E4 Problem soil

1a correct numbers are 3, 1, 2, 4.

b pH is 5

c add some alkali

2a 10  
b i 16  
ii 4  
iii 10  
c C

d Because it has the same number of base particles as acid particles.
HELP

1 The Catalyst Chemical Company uses hazard labels on its chemical bottles. The glue was useless and they all fell off. Look at the information about each chemical shown below.

Here are the three hazard labels that fell off.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Symbol A, B or C?</th>
</tr>
</thead>
<tbody>
<tr>
<td>dilute hydrochloric acid</td>
<td></td>
</tr>
<tr>
<td>dilute phenol solution</td>
<td></td>
</tr>
<tr>
<td>sodium hydroxide pellets</td>
<td></td>
</tr>
</tbody>
</table>

2 The substances listed below are either acids or alkalis. For each substance, write down whether it is an acid or an alkali.

   a oven cleaner
   b lemon juice
   c car battery solution
   d sodium hydroxide solution
   e a cola drink

3 Copy and complete the following sentence about what indicators do. Indicators are useful because they …
4 Litmus is a common indicator. You can have either blue litmus or red litmus. When you add an alkali to red litmus, it turns blue. When you add an acid to blue litmus, it turns red.

Copy and complete this table to show what happens when you add different substances to litmus. The first row has been done for you.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Effect on blue litmus</th>
<th>Effect on red litmus</th>
<th>Acid or alkali?</th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium carbonate solution</td>
<td>stays blue</td>
<td>turns blue</td>
<td>alkali</td>
</tr>
<tr>
<td>vinegar</td>
<td>turns red</td>
<td>stays red</td>
<td></td>
</tr>
<tr>
<td>potassium hydroxide solution</td>
<td>stays blue</td>
<td>alkali</td>
<td></td>
</tr>
<tr>
<td>stomach contents</td>
<td>turns red</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 Your clumsy friend has spilt a bottle of dilute hydrochloric acid (irritant) on the bench and it is dripping onto the floor.

a What must you do straight away to make people aware of the problem?

b How should the spillage be made safe?

c i Suppose some of the acid got onto your hand. What would you do?
   ii Why would this be necessary?

d Why must you wear safety spectacles when handling dilute hydrochloric acid?

EXTENSION

6a Compare and contrast the terms ‘base’ and ‘alkali’.

The table gives some information about bee stings, wasp stings and antidotes. Read it carefully.

b What would be the best substance to rub onto a wasp sting?

c Explain why your substance would ease the pain of the sting.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>bee sting</td>
<td>contains an acidic irritant</td>
</tr>
<tr>
<td>wasp sting</td>
<td>contains an alkaline irritant</td>
</tr>
<tr>
<td>vinegar</td>
<td>a weak acid</td>
</tr>
<tr>
<td>baking soda</td>
<td>a weak alkali when dissolved</td>
</tr>
</tbody>
</table>
How acidic?

HELP

1 Write out each pH number along with its correct description.

- **pH 5**: weak acid
- **pH 1**: strong acid
- **pH 7**: neutral
- **pH 13**: strong alkali
- **pH 9**: weak alkali

2 Copy and complete the table. Use the pH numbers and colours from the lists below to fill in the gaps. Use each number or colour only once.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Description</th>
<th>pH number</th>
<th>Colour of universal indicator paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid</td>
<td>strong acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>boric acid</td>
<td>weak acid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sodium hydroxide</td>
<td>strong alkali</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sodium hydrogencarbonate</td>
<td>weak alkali</td>
<td></td>
<td></td>
</tr>
<tr>
<td>distilled water</td>
<td>neutral</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**pH numbers**

- 1
- 5
- 7
- 9
- 14

**Colours**

- purple
- red
- yellow
- greenish blue
- green
How acidic? (continued)

CORE

3 For each solution, choose its most likely pH value from the list in the box.

- orange juice (medium strength acid)
- baking powder (weak alkali)
- paint stripper (very strong alkali)
- car battery acid (very strong acid)
- water (neutral)

4 Some of the sentences below have a mistake in them. If the sentence is correct, write ‘true’. If it has a mistake, rewrite it, correcting the error. Do not change the underlined part.

- Neutral substances have a pH of 6.
- Weak acids have a pH of less than 3.
- Strong acids have low pH values.
- High pH values mean weak alkalis.
- A solution of pH 5 is a weak acid.

EXTENSION

5 You will need these words for this question.

Example: Sulphuric acid is a strong acid.

- Sulphuric acid solution has a pH of 1.
- Ammonia solution has a pH of 11.
- A bottle of potassium hydroxide solution contained a lot of potassium hydroxide dissolved in a small amount of water.
- Some hair shampoos have a pH of 7.
- Rainwater consists mostly of water with only a small amount of added chemicals, and has a pH of 5.6. (Hint: use two key words.)
Taking away acidity

HELP

1 Copy and complete these sentences, choosing from the words below.

If you add a ...................................... to an acid, you take away the acidity.

The pH ...................................... and you get a ...................................... solution.

2 a The sentences below describe how to get a neutral solution, starting from sodium hydroxide solution. They are in the wrong order. Rewrite them in the correct order.

A When the solution becomes green, stop adding acid.
B Put 10 cm\(^3\) of sodium hydroxide solution into a small conical flask.
C Add drops of hydrochloric acid to the flask from a dropper, counting the drops.
D Write down the number of drops of acid added.
E Gently swirl the flask after each drop of acid.
F Add a few drops of universal indicator solution so that it just goes purple.

b Copy and complete these sentences.

i The name of this type of chemical reaction is …

ii The colour of the neutral solution is …

CORE

3 a In question 2, why is it important to count the number of drops?

b How would you use this procedure to get a neutral solution that is not coloured?
Taking away acidity (continued)

4  a  i  ‘Tum-eaze’ is a medicine for acid indigestion. Suggest the pH of stomach contents.
ii  If ‘Tum-eaze’ neutralises excess stomach acid, what sort of substance must it contain?
iii  What will happen to the amount of acid in the stomach contents after taking ‘Tum-eaze’?

b  Most plants grow best in soil that is just alkaline. In Derbyshire, some of the soil is quite acidic. Farmers spread lime on their fields. Explain why this helps their crops to grow better.

EXTENSION

5  You will need a sheet of graph paper for this question.

A pupil put 50 cm³ of alkali into a flask and added a little universal indicator solution. She added acid from a measuring cylinder, in 10 cm³ amounts. After each addition of acid, she matched the colour of the liquid in the flask against a colour chart and estimated the pH of the solution in the flask. She made sure everything in the flask was well mixed before she matched the colour.

Here are her results from just one attempt.

<table>
<thead>
<tr>
<th>Volume of acid added in cm³</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH of solution in the flask</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>7.5</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

a  Plot the results on a graph, putting pH on the vertical axis. Draw in a best-fit curve.

b  What had happened to the alkali after 40 cm³ of acid had been added?

c  What was the colour of the indicator in the flask:
   i  after 50 cm³ of acid had been added?
   ii  before any acid had been added?

d  Describe what you think would happen to the graph if the pupil kept on adding acid until she had put in a total of 100 cm³.

e  Can the pupil state, with total certainty, the volume of acid she needs to exactly neutralise 50 cm³ of the alkali? Explain your answer.

f  What should she do to help her be more certain?
### HELP

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dilute hydrochloric acid <strong>C</strong>, dilute phenol solution <strong>A</strong>, sodium hydroxide pellets <strong>B</strong>&lt;br&gt;One mark each.</td>
<td>3</td>
</tr>
<tr>
<td>2 <strong>a</strong></td>
<td>Alkali</td>
<td>1</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Acid</td>
<td>1</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>Acid</td>
<td>1</td>
</tr>
<tr>
<td><strong>d</strong></td>
<td>Alkali</td>
<td>1</td>
</tr>
<tr>
<td><strong>e</strong></td>
<td>Acid</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Indicators are useful because they change colour, showing whether a solution is an acid or an alkali.&lt;br&gt;Underscores show answers; other text copied by pupils. Accept equivalent answers.</td>
<td>1, 1</td>
</tr>
</tbody>
</table>

**Total for Help** 10

### CORE

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Vinegar: turns red, stays red, <strong>acid</strong>&lt;br&gt;Potassium hydroxide solution: stays blue, <strong>turns blue</strong>, alkali&lt;br&gt;Stomach contents: turns red, <strong>stays red</strong>, <strong>acid</strong>&lt;br&gt;Underscores show answers; other text copied by pupils.</td>
<td>1, 1</td>
</tr>
<tr>
<td>5 <strong>a</strong></td>
<td>Tell your teacher</td>
<td>1</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Award two marks for describing your departmental procedure as taught.</td>
<td>2</td>
</tr>
<tr>
<td><strong>c</strong> i</td>
<td>Rinse in lots of cold running water</td>
<td>1</td>
</tr>
<tr>
<td><strong>ii</strong></td>
<td>It removes the irritant or prevents the acid causing irritation.</td>
<td>1</td>
</tr>
<tr>
<td><strong>d</strong></td>
<td>Eyes are more delicate than skin so splashing an irritant into your eye could damage it.</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total for Core** 10

### EXTENSION

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 <strong>a</strong></td>
<td>A base is a substance that cancels an acid.&lt;br&gt;An alkali is a base that is soluble.</td>
<td>1</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Vinegar</td>
<td>1</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>Vinegar is an acid, so it cancels out the alkali in the sting.&lt;br&gt;The alkali will no longer irritate the skin.</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total for Extension** 5
## HELP

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH 1 strong acid</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pH 5 weak acid</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pH 7 neutral</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pH 9 weak alkali</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>pH 13 strong alkali</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Hydrochloric acid: strong acid, 1, red</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Boric acid: weak acid, 5, yellow</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sodium hydroxide: strong alkali, 14, purple</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sodium hydrogencarbonate: weak alkali, 9, greenish blue</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Distilled water: neutral, 7, green</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Underscores show answers; other text copied by pupils.</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Total for Help 10**

## CORE

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Neutral substances have a pH of 7</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Weak acids have a pH of less than 7 or between 3 and 7 or more than 3.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Accept suitable alternatives.</em></td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>True</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>High pH values mean strong alkalis.</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>True</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Underscores show answers; other text copied by pupils.</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Total for Core 10**

## EXTENSION

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Ammonia solution is a weak alkali or is weakly alkaline.</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>The potassium hydroxide solution is a concentrated solution.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Accept: … is a strong alkali.</em></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Some hair shampoos are neutral.</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>Rainwater is a dilute solution, and is a weak acid.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><em>Accept equivalent answers.</em></td>
<td></td>
</tr>
</tbody>
</table>

**Total for Extension 5**
### HELP

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>If you add a base to an acid, you take away the acidity. The pH rises and you get a neutral solution. Underscores show answers; other text copied by pupils.</td>
<td>3</td>
</tr>
</tbody>
</table>
| 2a | The correct order is:  
B Put 10 cm³ of sodium hydroxide solution into a small conical flask.  
F Add a few drops of universal indicator solution so that it just goes purple.  
C Add drops of hydrochloric acid to the flask from a dropper, counting the drops.  
E Gently swirl the flask after each drop of acid.  
A When the solution becomes green, stop adding acid.  
D Write down the number of drops of acid added.  
One mark for B somewhere before F; one mark for F somewhere before C; one mark for C somewhere before E; one mark for E somewhere before A; One mark for A somewhere before D; | 5 |
| b | The name of this type of chemical reaction is neutralisation.  
ii | The colour of the neutral solution is green. | 1 |

**Total for Help** 10

### EXTENSION

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a</td>
<td>Award one mark for sensible scales, one mark for accurate plots and one mark for a good best-fit line.</td>
<td>3</td>
</tr>
<tr>
<td>b</td>
<td>It had been neutralised.</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>Green</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>Purple</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>It would stay horizontal for a while, then fall to a low pH or pH 1.</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>No, because there are not enough results or because the indicator stayed green even though more acid was added. Accept equivalent answers or suitable alternatives.</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>Repeat the procedure to check volumes. Accept: use a different indicator.</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total for Extension** 10
1. Draw lines to match each hazard warning symbol to its meaning.

- [ ] can make you ill if you swallow it, breathe it in or absorb it through your skin
- [ ] may cause red or blistered skin
- [ ] attacks and destroys living tissue including eyes and skin

2. Litmus solution turns pink in acids and blue in alkalis. Complete the table by writing in the colour of litmus in each solution. The first one has been done for you.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Colour of litmus</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid</td>
<td>pink</td>
</tr>
<tr>
<td>sodium hydroxide</td>
<td></td>
</tr>
<tr>
<td>citric acid</td>
<td></td>
</tr>
<tr>
<td>ammonia solution</td>
<td></td>
</tr>
<tr>
<td>phosphoric acid</td>
<td></td>
</tr>
<tr>
<td>water</td>
<td></td>
</tr>
</tbody>
</table>

3. Complete the table using the words below.

- [ ] neutral
- [ ] pH 1
- [ ] pH 9
- [ ] light green
- [ ] purple
- [ ] weak acid
- [ ] strong alkali
- [ ] weak alkali
- [ ] strong acid

<table>
<thead>
<tr>
<th>Substance</th>
<th>Strength and type</th>
<th>pH</th>
<th>Colour of universal indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid</td>
<td>strong acid</td>
<td></td>
<td>red</td>
</tr>
<tr>
<td>boric acid</td>
<td></td>
<td>pH 5</td>
<td>yellow</td>
</tr>
<tr>
<td>sodium hydroxide</td>
<td></td>
<td>pH 14</td>
<td></td>
</tr>
<tr>
<td>sodium hydrogencarbonate</td>
<td>weak alkali</td>
<td></td>
<td>dark green</td>
</tr>
<tr>
<td>distilled water</td>
<td></td>
<td>pH 7</td>
<td></td>
</tr>
</tbody>
</table>
4 Write true or false for each statement about acids and alkalis.

Acids have pH numbers less than 7. .........................

Some alkalis have pH numbers greater than 9. ..................

A neutral solution has a pH anywhere between 5 and 9. ..................

pH 7 means neutral. .........................

The lower the number, the stronger the acid. ..................

The lower the number, the stronger the alkali. ..................  

5 You find an unlabelled bottle on the bench. When you test the liquid in the bottle with universal indicator, you find that it has a pH of 5. Which of the following is true? Underline the true statement.

A The liquid is an alkali.

B The liquid is a weak acid.

C The liquid is sodium hydroxide solution.

D The liquid is hazardous.

6 Complete these sentences by crossing out the wrong words.

Acids turn universal indicator red/green/blue, and have a sharp/sweet/blunt taste.

Some alkalis are described as acidic/corrosive/alkaline because they can burn living tissue.

Alkalis turn universal indicator red/green/dark green if they are weak/strong/neutral.

When acids and alkalis are mixed together, they add up/cancel out/disappear.

The word scientists use to describe this is evaporation/condensation/neutralisation.
7 Complete the crossword.

Across
1 To cancel out an acid and alkali
4 Substance with a sour taste
6 These fruit are acidic
7 Is hydrochloric acid an alkali?
8 A common one of 3 down

Down
1 Not an acid or an alkali – pH 7!
2 These can be corrosive!
3 These show what is an acid and what is an alkali
5 Farmers put this on acidic soil

8 Which group of pH numbers would all indicate the presence of acids? Circle the correct letter.

A  1, 3, 5
B  1, 5, 7
C  7, 9, 11
D  9, 11, 13
Acids and alkalis

1. Draw lines to match each hazard warning symbol to its meaning.

- Can make you ill if you swallow it, breathe it in or absorb it through your skin
- May cause red or blistered skin
- Attacks and destroys living tissue including eyes and skin

2. Litmus solution turns pink in acids and blue in alkalis. Complete the table by writing in the colour of litmus in each solution. The first one has been done for you.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Colour of litmus</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid</td>
<td>pink</td>
</tr>
<tr>
<td>sodium hydroxide</td>
<td>blue</td>
</tr>
<tr>
<td>citric acid</td>
<td>pink</td>
</tr>
<tr>
<td>ammonia solution</td>
<td>blue</td>
</tr>
<tr>
<td>phosphoric acid</td>
<td>pink</td>
</tr>
<tr>
<td>water</td>
<td>light green / no change</td>
</tr>
</tbody>
</table>

3. Complete the table using the words below.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Strength and type</th>
<th>pH</th>
<th>Colour of universal indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>hydrochloric acid</td>
<td>strong acid</td>
<td>pH 1</td>
<td>red</td>
</tr>
<tr>
<td>boric acid</td>
<td>weak acid</td>
<td>pH 5</td>
<td>yellow</td>
</tr>
<tr>
<td>sodium hydroxide</td>
<td>strong alkali</td>
<td>pH 14</td>
<td>purple</td>
</tr>
<tr>
<td>sodium hydrogencarbonate</td>
<td>weak alkali</td>
<td>pH 9</td>
<td>dark green</td>
</tr>
<tr>
<td>distilled water</td>
<td>neutral</td>
<td>pH 7</td>
<td>light green</td>
</tr>
</tbody>
</table>
4 Write true or false for each statement about acids and alkalis.

Acids have pH numbers less than 7. ......................  \textbf{true} \\
Some alkalis have pH numbers greater than 9. ......................  \textbf{true} \\
A neutral solution has a pH anywhere between 5 and 9. ......................  \textbf{false} \\
pH 7 means neutral. ......................  \textbf{true} \\
The lower the number, the stronger the acid. ......................  \textbf{true} \\
The lower the number, the stronger the alkali. ......................  \textbf{false} \\

5 You find an unlabelled bottle on the bench. When you test the liquid in the bottle with universal indicator, you find that it has a pH of 5. Which of the following is true? Underline the true statement.

\begin{itemize}
    \item[A] The liquid is an alkali.
    \item[B] The liquid is a weak acid.
    \item[C] The liquid is sodium hydroxide solution.
    \item[D] The liquid is hazardous.
\end{itemize}

6 Complete these sentences by crossing out the wrong words.

Acids turn universal indicator \textbf{red}/green/blue, and have a sharp/sweet/blunt taste.

Some alkalis are described as \textbf{acidic}/corrosive/alkaline because they can burn living tissue.

Alkalis turn universal indicator \textbf{red}/green/dark green if they are weak/strong/neutral.

When acids and alkalis are mixed together, they \textbf{add-up}/cancel out/disappear.

The word scientists use to describe this is \textbf{evaporation}/condensation/neutralisation.
Acids and alkalis (continued)

7 Complete the crossword.

Across
1 To cancel out an acid and alkali
4 Substance with a sour taste
6 These fruit are acidic
7 Is hydrochloric acid an alkali?
8 A common one of 3 down

Down
1 Not an acid or an alkali – pH 7!
2 These can be corrosive!
3 These show what is an acid and what is an alkali
5 Farmers put this on acidic soil

8 Which group of pH numbers would all indicate the presence of acids? Circle the correct letter.

A 1, 3, 5
B 1, 5, 7
C 7, 9, 11
D 9, 11, 13
1 Read the passage opposite.

a Name an acid in the paragraph. 1 mark
b Name an alkali in the paragraph. 1 mark

2 a Look at the list opposite. Name one acid and one alkali in the list that you might find in the school laboratory. 2 marks
b Name one other acid. 1 mark

3 a Copy the sentence below that describes what this symbol means.

● can make you ill if swallowed, breathed in or absorbed through the skin
● may cause reddening or blistering of the skin
● attacks and destroys living tissue including eyes and skin

b Choose one of the substances below that could have this symbol. 1 mark

c Look at the diagram below. List the letters in order, most hazardous substance first. 2 marks

d If you spill acid on your skin, why should you rinse it with water? 1 mark
Shaheen has three colourless solutions labelled X, Y and Z.

a When she puts universal indicator into solution X, it turns red. When she puts it into solution Y, it turns purple. Copy out the correct statement.

- X and Y are both strong acids.
- X is a strong acid; Y is a strong alkali.
- X is a weak acid; Y is a weak alkali.
- X and Y are both weak alkalis.

b Shaheen now puts universal indicator into solution Z and it turns light green. What does this tell her about the solution?

c Suggest what solution Z might be.

d Below is a pH scale with some values marked in. Copy the scale and mark Shaheen’s three solutions where you think they would be on it.

If you have a stomach ache, this is often caused by acid indigestion.

a What causes acid indigestion?

b You can buy indigestion remedies to cure this. What sort of substance do many of them contain?

c Explain how an indigestion remedy can cure acid indigestion.

d Nettle stings contain formic acid. Many people say that rubbing a dock leaf on a nettle sting will cure it. What test would you carry out on a dock leaf to see if this could be true?
6 a Andrew has finished an experiment. Write two things shown in the picture that are safety hazards.

2 marks

b Andrew wants to know which cures indigestion faster, indigestion tablets or powders. He prepares these three samples to test.

- sample A: tablets ground into a fine powder
- sample B: tablets broken up into small lumps
- sample C: whole tablets

He will add acid to each sample in turn, and then start his timer.

To make this a fair test, explain what he must check each time for:

i the acid 1 mark

ii the indigestion tablets. 1 mark

c What should Andrew always wear for his own safety? 1 mark
Acids and alkalis

1 a Choose one of the substances below that could have this symbol.

[Diagram showing symbols]

- a weak acid
- a strong acid
- a weak alkali
- a strong alkali

1 mark

b Look at the diagram below. List the letters in order, most hazardous substance first.

[A, B, C diagrams]

2 marks

c If you spill acid on your skin, why should you rinse it with water? 1 mark

2 Shaheen has three colourless solutions labelled X, Y and Z.

a When she puts universal indicator into solution X, it turns red. When she puts it into solution Y, it turns purple. Copy out the correct statement.

- X and Y are both strong acids.
- X is a strong acid; Y is a strong alkali.
- X is a weak acid; Y is a weak alkali.
- X and Y are both weak alkalis.

1 mark

b Shaheen now puts universal indicator into solution Z and it turns light green. What does this tell her about the solution? 1 mark

c Suggest what solution Z might be. 1 mark

d Below is a pH scale with some values marked in. Copy the scale and mark Shaheen’s three solutions where you think they would be on it. 3 marks
3 If you have a stomach ache, this is often caused by acid indigestion.

a What causes acid indigestion?  

b You can buy indigestion remedies to cure this. What sort of substance do many of them contain?  

c Explain how an indigestion remedy can cure acid indigestion.  

d Nettle stings contain formic acid. Many people say that rubbing a dock leaf on a nettle sting will cure it. What test would you carry out on a dock leaf to see if this could be true?  

4 The graph shows how the pH of sodium hydroxide solution changes as hydrochloric acid is slowly added to it.

a How much hydrochloric acid has been added when the solution becomes neutral?  

b Explain why the pH of the mixture changes as it does.  

5 Two pupils carried out an experiment to investigate temperature changes during neutralisation. They slowly added acid to an alkali and recorded the temperature after adding each 5 cm³ of acid. The table shows their results.

a Draw a line graph of the students’ results.  

b Describe what happens to the temperature during the experiment.  

b Mark on your graph the point where you think the neutralisation had finished.  

<table>
<thead>
<tr>
<th>Acid added in cm³</th>
<th>Temperature in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
</tr>
</tbody>
</table>
Andrew wants to know which cures indigestion faster, indigestion tablets or powders. He prepares these three samples to test.

- **sample A**: tablets ground into a fine powder
- **sample B**: tablets broken up into small lumps
- **sample C**: whole tablets

He will add acid to each sample in turn, and then start his timer. To make this a fair test, explain what he must check each time for:

1. the acid  
2. the indigestion tablets.

b) What should Andrew always wear for his own safety?  

When Andrew adds the acid to the samples, fizzing happens. How will he know when to stop timing each experiment?  

c) When Andrew adds the acid to the samples, fizzing happens. How will he know when to stop timing each experiment?  

He finds that sample A reacts the fastest. What should Andrew do now to make sure his results are reliable?
## Acids and alkalis

**End of unit test mark scheme**

**Green (NC Tier 2–5)**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 a</strong></td>
<td>Orange juice</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Soap or soap and water</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>2 a</strong></td>
<td>Acid: hydrochloric acid</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Alkali: sodium hydroxide solution</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Accept any other acid</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>3 a</strong></td>
<td>Attacks and destroys living tissue including eyes and skin</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>A strong acid or a strong alkali</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>C, A, B. <em>One mark for C first; one mark for A before B.</em></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>d</strong></td>
<td>Water stops the acid corroding the skin by washing it away or diluting it or making the acid weaker.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>4 a</strong></td>
<td>X is a strong acid; Y is a strong alkali.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>It is neutral.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>Any neutral liquid, e.g. water.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>d</strong></td>
<td>X at pH1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Y at pH13</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Z at pH7</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>5 a</strong></td>
<td>Too much or excess stomach acid. <em>Do not accept ‘stomach acid’.</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Antacid or alkali or base or carbonate</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>It neutralises or cancels out or uses up excess acid</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>d</strong></td>
<td>Extract the juice from a dock leaf and test it to see if it is an alkali or if it neutralises an acid or do a pH test <em>Accept equivalent answers.</em></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>6 a</strong></td>
<td>Two from: spilled acid; acid bottle without a stopper; Bunsen burner alight or hot tripod</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>b i</strong></td>
<td>Use the same volume each time.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>ii</strong></td>
<td>Use the same mass each time.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>Eye protection or goggles or safety specs</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

**Scores in the range of:**

<table>
<thead>
<tr>
<th>NC Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>4–7</td>
</tr>
<tr>
<td>8–13</td>
</tr>
<tr>
<td>14–17</td>
</tr>
<tr>
<td>18–25</td>
</tr>
</tbody>
</table>
## Acids and alkalis

### Question 1
- **a** A weak acid or a weak alkali
- **b** C, A, B. One mark for C first; one mark for A before B.
- **c** Water stops the acid corroding the skin by washing it away or diluting it or making the acid weaker

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a</td>
<td>A weak acid or a weak alkali</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>C, A, B. One mark for C first; one mark for A before B.</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c</td>
<td>Water stops the acid corroding the skin by washing it away or diluting it or making the acid weaker</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

### Question 2
- **a** X is a strong acid; Y is a strong alkali.
- **b** It is neutral.
- **c** Any neutral liquid, e.g. water
- **d** X at pH1
- **d** Y at pH13
- **d** Z at pH7

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 a</td>
<td>X is a strong acid; Y is a strong alkali.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>It is neutral.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>Any neutral liquid, e.g. water</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>X at pH1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Y at pH13</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Z at pH7</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

### Question 3
- **a** Too much or excess stomach acid. Do not accept ‘stomach acid’.
- **b** Antacid or alkali or base or carbonate
- **c** It neutralises or cancels out or uses up excess acid
- **d** Extract the juice from a dock leaf and test it to see if it is an alkali or if it neutralises an acid or do a pH test Accept equivalent answers.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 a</td>
<td>Too much or excess stomach acid. Do not accept ‘stomach acid’.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>Antacid or alkali or base or carbonate</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>It neutralises or cancels out or uses up excess acid</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>d</td>
<td>Extract the juice from a dock leaf and test it to see if it is an alkali or if it neutralises an acid or do a pH test Accept equivalent answers.</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

### Question 4
- **a** 42 cm$^2$. Accept answers in the range 40–45, with units.
- **b** The pH stays at 14 while there is excess alkali, then falls quickly to 7 as the alkali is neutralised, and then to 1 as the excess of acid is established. Accept equivalent answers.
- **c** Extract the juice from a dock leaf and test it to see if it is an alkali or if it neutralises an acid or do a pH test Accept equivalent answers.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 a</td>
<td>42 cm$^2$. Accept answers in the range 40–45, with units.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>b</td>
<td>The pH stays at 14 while there is excess alkali, then falls quickly to 7 as the alkali is neutralised, and then to 1 as the excess of acid is established. Accept equivalent answers.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>c</td>
<td>Extract the juice from a dock leaf and test it to see if it is an alkali or if it neutralises an acid or do a pH test Accept equivalent answers.</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

### Question 5
- **a** One mark for appropriate scales (0–30 cm$^3$ on x-axis, 0–30 °C on y-axis) one mark for points and line correct.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 a</td>
<td>One mark for appropriate scales (0–30 cm$^3$ on x-axis, 0–30 °C on y-axis) one mark for points and line correct.</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

### Question 6
- **a** i Use the same volume each time.
- **a** ii Use the same mass each time.
- **b** Eye protection or goggles or safety specs
- **c** When there are no more bubbles or the tablet or powder has all reacted or dissolved or gone
- **d** Repeat the experiment

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 a i</td>
<td>Use the same volume each time.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>a ii</td>
<td>Use the same mass each time.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>Eye protection or goggles or safety specs</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>When there are no more bubbles or the tablet or powder has all reacted or dissolved or gone</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>d</td>
<td>Repeat the experiment.</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
Acids and alkalis (continued)

<table>
<thead>
<tr>
<th>Scores in the range of:</th>
<th>NC Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>4–9</td>
<td>3</td>
</tr>
<tr>
<td>10–14</td>
<td>4</td>
</tr>
<tr>
<td>15–18</td>
<td>5</td>
</tr>
<tr>
<td>19–25</td>
<td>6</td>
</tr>
</tbody>
</table>
### Acids and alkalis

<table>
<thead>
<tr>
<th>Learning outcomes</th>
<th>I can do this very well</th>
<th>I can do this quite well</th>
<th>I need to do more work on this</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can recognise the corrosive symbol on chemicals and household products.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe how to deal safely with an acid or alkali spill.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can test a solution to find out whether it is an acid.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can name at least one common laboratory acid and alkali.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can list common materials that are acids or alkalis.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use pH values to classify solutions as acidic, alkaline or neutral.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can make predictions about neutralisation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe what neutralisation is.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can name at least one everyday use of neutralisation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can explain what dilution is and how compensation works with solutions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use my ideas of particles to explain what happens in neutralisation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use data to decide which antacids are the fastest acting.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe and carry out a fair test to compare antacids.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe the relationship between the amount of antacid and the time it takes to neutralise an acid.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word</td>
<td>Definition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>acid</td>
<td>A solution that has a pH lower than 7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>alkali</td>
<td>A solution that contains a lot of dissolved solute is concentrated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>base</td>
<td>A solution that does not contain much dissolved solute is dilute.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>compensate</td>
<td>Substances that may destroy living tissues on contact are corrosive.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>concentrated</td>
<td>Toxic means poisonous. Substances that may cause serious health risks and even death if inhaled, taken internally or absorbed through the skin are toxic.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>corrosive</td>
<td>Harmful substances may have a health risk similar to but less serious than toxic substances.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dilute</td>
<td>Substances that can cause redness or blistering in contact with the skin are irritant.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>harmful</td>
<td>A substance that reacts with an acid and neutralises it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>indicator</td>
<td>A base that dissolves in water, forming a solution with a pH greater than 7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>irritant</td>
<td>A substance that is neither acidic nor alkaline, with a pH of 7, is neutral.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lime</td>
<td>An indicator made from lichens. Acids turn blue litmus red. Alkalis turn red litmus blue.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>litmus</td>
<td>An indicator that has a range of colours showing the strength of acidity or alkalinity on the pH scale.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neutral</td>
<td>A number scale used to measure the strength of acidity and alkalinity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neutralisation</td>
<td>The chemical reaction that takes place when an acid reacts with a base.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH scale</td>
<td>A basic substance containing calcium oxide, or other calcium compounds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sample</td>
<td>A small part of something, used to represent the whole.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>toxic</td>
<td>Make up for a change by balancing things out.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>universal indicator</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Acids and alkalis

acid
alkali
base
compensate
concentrated
corrosive
dilute
harmful
indicator

irritant
lime
neutral
neutralisation
pH scale
sample
toxic
universal indicator
E1 Acids, bases, alkalis

Green

a Irritant
b Tannic acid, citric acid, lactic acid, ascorbic acid, phosphoric acid.
c An alkali is a base which will dissolve in water.
d Indicator
1 a Acid in food can give it a sour taste.
b Some acids are dangerous because they are corrosive.
c Bases are the opposite of acids.
d Indicators are coloured substances.
e Many of them are made from plants.
2 a red
b blue
3 a, b, c Labels drawn correctly as on previous page.

Red

a When they are attacked.
b Tannic acid, citric acid, lactic acid, ascorbic acid, phosphoric acid, acetic acid, etc.
c All alkalis are bases, which are opposite to acids. Some bases do not dissolve in water, but those that do are called alkalis.
1 Battery acid is very strong and corrosive but the acid in cola is not very strong and is not corrosive.
2 Ryan was right. There are acids in some foods and they are not corrosive.
3 Indicators are substances which can be used to tell whether solutions are acidic, neutral or alkaline.
4 Phenolphthalein

E2 How acidic?

Green

a When it is necessary to know the different strengths of acids or alkalis.
b It is a mixture of indicators, each of which turns colour at a different strength.
c Universal indicator.
d How acid or how alkaline a solution is.
e Neutral

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Colour with pH</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>indigestion medicine</td>
<td>9</td>
<td>weakly alkaline</td>
</tr>
<tr>
<td>tea</td>
<td>5</td>
<td>weakly acidic</td>
</tr>
<tr>
<td>salt water</td>
<td>8</td>
<td>weakly alkaline</td>
</tr>
<tr>
<td>rainwater</td>
<td>6</td>
<td>weakly acidic</td>
</tr>
<tr>
<td>soap</td>
<td>10</td>
<td>alkaline</td>
</tr>
<tr>
<td>lemon juice</td>
<td>3</td>
<td>acid</td>
</tr>
</tbody>
</table>

2 pH 9
3 Orange

E3 Taking away acidity

Green

a The base will take away the acidity of the vinegar.
b Neutralisation
c Too much acid in the stomach.
d By taking antacids which contain an alkali or base in them.
e Many plants do not grow well in an acidic soil.
f Dig in lime.
1 A base is the opposite of an acid. A base will react with an acid, taking away its acidity. This change is called neutralisation.
2 Cola is acidic and would irritate her stomach which already suffered from acid indigestion.
3 Stomach acid is a weak acid.
4 Add an acid to neutralise it.

Red

a Vinegar, citrus fruits, tea, yoghurt, vitamin C, any other suitable, slightly acidic substance found in the home.
b The rivers would become contaminated. Plants and animals which live in it would die.
1 When alkalis are added to acids, the solution becomes neutral.
2 Bubbles
3 Cola is acidic and would irritate her stomach which already suffered from acid indigestion.
4 This is not a good idea. Since fruits are acidic, fruit-flavoured toothpaste would make your mouth acidic. It is acids which attack the enamel on teeth.
5 Dig in lime. Afterwards, take a sample of soil and add it to some water in a beaker and swirl it around, mixing it well. Then add a drop of universal indicator to see if neutralisation has occurred.

6 By bubbling carbon dioxide through it. Carbonic acid is formed by doing this and the acid neutralises the alkalis.

E4 Problem soil

Green

a No. Sarah should take several samples from different parts of the field.
b Yes.
c Only half the soil.
d 100 litres, or all of it
e Spreading weedkiller, food preparation – making coffee, salting food, etc.

1 Individual answers
2 Individual answers

Red

a Not very. Sarah should take several samples from different parts of the field.
b Yes. He will only be able to neutralise half the amount of soil.
c 12
d 40

1 The solution will be diluted.
2 You'll have to use all of the solution on that soil.
3 Individual answers, containing the idea that every acid particle must be matched by a base particle, no matter how spread out they are.
4 All of it.
5 Individual answers, but must contain the principle that a cheaper alternative will probably not contain as many base particles or will contain bases that are not as strong as the ‘Superbase’ brand.