7F
Answers

7F Acids and alkalis

7Fa Hazards

Student Book

1: 7Fa Chemistry in the home (Student Book)

L4 **1** *Students' own answers*
L4 **2** They might spill it on their skin or drink it.
L5 **3** Keep bleach locked away in a cupboard or use dilute bleach.
L6 **4** **a** so you know the harm that the substance can cause and how to reduce the chances of that harm happening before you use the substance
b Young children cannot read; they may mistake a substance for something else.

2: 7Fa Hazards (Student Book)

L4 **1** **a** by adding water **b** It is a mixture as water has been added to dilute it.
L4 **2** *Students' own answers*, e.g. hydrochloric acid is used in the laboratory, ethanoic acid is used in everyday life
L4 **3** **a** two of: metal, stonework, skin L5
b plastic or glass
L5 **4** A corrosive chemical will damage the skin. An irritant will not usually cause serious injury but can cause the skin to become red.
L4 **5** sour
L5 **6** **a** citric acid or phosphoric acid **b** They do not cause damage.
L6 **7** **a** dangerous to the environment, toxic, flammable
b caution
L7 **8** less volume to transport so transport costs are less

3: 7Fa Controlling risk (Student Book)

L4–6 **1**

Hazard	Risk	Precaution to reduce risk
Unattended lit Bunsen burner	this could set fire to someone's hair or jacket.	Never leave a lit Bunsen burner unattended.
Bottle of a flammable liquid beside lit Bunsen burner	the heat could make the liquid catch fire.	Remove the bottle of flammable liquid and store it safely.
Student heating test tube while not wearing safety glasses	boiling liquid could spurt out of the test tube onto the student's face.	Wear safety goggles (and point test tubes away from people).
Student eating food beside bottles of chemicals	the student could eat something toxic.	Do not eat or drink in the laboratory.
Student heating beaker and fumes billowing out	fumes could be dangerous to all in the laboratory.	Carry out the experiment in a fume cupboard.
Bags left in corridors	a student could trip over the bags and fall.	Keep all corridors and working areas clear.

L5 **2** **a** concentrated sulfuric acid
b It can destroy certain substances such as metal, stonework and skin.
c the hazard label on the bottle
L6 **d** Diluting it with water would reduce the risk.
L6 **3** **a** Toxic gases are formed.
b Carry out the experiment in a fume cupboard.
L6 **4** **a** It could cause burns as temperatures reach over 100 °C.
b Leave to cool for 20 minutes.

Activity Pack

7Fa-1 Hazardous or safe?

L5 Quick-light: flammable
Drain-clear: corrosive
Pest-gone: danger to environment
Super-clean: caution (irritant)
Home-fresh: explosive
Germs-away: toxic

7Fa-2 Comparing acids 1

L5 **1** *Students' own answers* depending on acids selected
L5 **2** *Students' own answers* depending on acids selected
L5 **3** It fizzed the least/slowest.

7Fa-3 Comparing acids 2

Students need to create a table with a row for each acid and a column for each concentration.
Students should see bubbles forming on the marble chips with each acid and at each concentration except perhaps with the most diluted acid. Ensure that students note the similarities and differences in their observations.
L4 **1** Most hazardous produces most bubbles/fastest/most vigorous. Least hazardous, the least/slowest.

L5 **2** Adding water makes the acids less hazardous as they react more slowly.
L5 **3** Some acids are corrosive (react away substances), others are irritants (will sting).
L6 **4** Most hazardous: safety goggles, rubber gloves, protective clothing, Corrosive warning symbols, special containers.
Least hazardous: safety goggles, Caution warning.

7Fa-4 Hazard symbols
L5 Match symbol to description and example:
Corrosive – concentrated sulfuric acid
Caution – dilute sulfuric acid
Flammable – petrol
Toxic – cyanide

7Fa-5 Hazard under control
L5–6 The Pipeclear! label should show the Corrosive symbol prominently and explain that Pipeclear! can attack/wear away materials, burn skin and severely damage eyes. If spilt it should be diluted with cold water (adding a weak base like baking soda would be better but hasn't been covered yet) and mopped up while wearing rubber gloves, shoes, safety goggles. If the product is used as suggested (poured from the bottle straight down the pipes) then the chance of coming to harm is small so the risk is low.
The diluted version label should show the Caution symbol and explain that the product can irritate skin and eyes. It should explain that the product contains water diluting the hazardous material (students will probably not understand the concept of concentration).

7Fa-6 The Hazchem code
L5 **1** **a** Corrosive
L7 **b** B (a fog means a fine spray mist of water)
L7 **2** **a** True, the V in the code for P shows this.
b False, for P full protective clothing is recommended.
c True, for P the code says 'dilute'. It is safe to wash dilute sulfuric acid down the drain.
d False. There is no E in the code for sulfuric acid so evacuation is not needed.
L7 **3** **a** Use a fog and full protective clothing, dilute the methanol but evacuate the area. (NB methanol is flammable and toxic.)
b Use a fog and full protective clothing , contain the phosphorus and evacuate the area. (NB phosphorus is flammable and burns to form corrosive and toxic smoke.)
L7 **4** For those who know the code, single letters stand for a lot of information. It can be displayed clearly and is easily read (from a distance). It does not cause unnecessary concern to members of the public. The full safety instructions would have to be in small print and difficult to read quickly.

7Fa-7 Acids and hazards
L4 **1** any six examples: any named fizzy drink, yogurt, milk, vinegar, lemon juice, pickles, any citrus fruit, blackcurrants, cheese, acid drops (or similar sweets), etc.
L5 **2** corrosive
L5 **3** from left to right: Caution (irritant), Flammable, Explosive, Toxic
L5 **4** Wear safety goggles, rubber gloves and protective clothing; dilute the substance with water; mop it up and dispose of it.

7Fa-8 Nitric acid hazards
L5 **1** **a** E **b** B **c** no hazard **d** F **e** A **f** C **g** D
L5 **2** **a** By diluting the concentrated nitric acid with water (it is usually done by adding the acid to water).
L5 **b** Wear safety goggles, rubber gloves and protective clothing; do it in a fume cupboard; use a drip tray to catch any spillages.
L6 **c i** Concentrated nitric acid is more hazardous than dilute so must be kept away from where it may cause harm.
ii There is a low chance/probability of people being harmed by concentrated nitric acid if it is kept securely out of people's reach and there is little chance of people being seriously harmed by the dilute nitric acid.

7Fa-9 Hazchem in action
L6 The report should include the following points:
Risks: Petrol is flammable, people are at risk of being burned (and asphyxiated or poisoned by smoke).
Phosphoric acid is corrosive and people could suffer from chemical burns.
There could be a violent reaction if both substances are mixed or contact other chemicals.
L7 When dealing with the petrol tanker the fire service will be: spreading foam; wearing breathing apparatus.
They will be trying to contain leaking petrol to stop it contaminating the environment and they will be evacuating people from the scene.
For the phosphoric acid lorry they will: wear full protective clothing; use a fog or fine spray mist of water to dilute the acid.

7Fb Indicators

Student Book

1: 7Fb Indicators (Student Book)
L3 **1** red cabbage and litmus
L4 **2** **a** red **b** red
L4 **3** It is alkaline.
L4–5 **4** by filtration (including students' own diagrams)

L3 **5** A – acid; B – neutral; C – neutral; D – acid; E – neutral; F – alkaline

L5 **6** **a i** red **ii** yellow

L6 **b** No, neutral solutions do not change the colours of indicators.

L6–7 **7** No, she would need to show that the purple berries changed colour in different types of solution and check that it was red in other known alkalis.

Activity Pack

7Fb-1 Indicators, acids and alkalis

L4 Turn litmus solution red: sulfuric acid, vinegar, citric acid, lemon juice, hydrochloric acid, yogurt.

Turn litmus solution blue: toothpaste, sodium hydroxide, soap, baking soda, bleach, oven cleaner.

Do not affect litmus: salt, sugar, alcohol.

7Fb-4 Evaluating indicators

L5 **1** **a** red **b** blue **c** purple

L5 **2** Litmus is purple in a neutral solution.

L6 **3** Purple is the colour produced by mixing red and blue.

7Fb-5 Indicator colours

L5 **1** **a** indicator **b** red, alkali

L5 **2** sodium hydroxide – blue, salt – purple, sulfuric acid – red, soap – blue, vinegar – red, bleach – blue, citric acid – red, sugar – purple, pure water – purple, limewater – blue

L6 **3** It is an alkali.

7Fb-6 Colourful hazards

L5 **1** Answer depends on indicator chosen but could be: the distinctiveness of the colours, the association of particular colours with acids and alkalis.

L5 **2** Depends on the indicator. Some indicators show a mixture of the colours in neutral solutions (e.g. litmus), others show either the acid colour (phenolphthalein) or the alkali colour (methyl orange). Explanations could include that neutral is halfway between acid and alkali or a mixture/combination of the two.

L5 **3** *Students' own opinions*. They may point out that many acidic or alkaline substances are harmless so don't need warnings.

7Fb-7 Sort the labels

L6 **A** citric acid **B** battery acid (sulfuric acid) **C** drain cleaner (sodium hydroxide) **D** baking soda (sodium hydrogen carbonate) **E** vinegar (ethanoic acid)

7Fb-8 Robert Boyle's indicator

L5 **1** It has a sharp/sour taste. It turns litmus paper red.

L5 **2** They feel slippery like soap. They turn litmus paper blue.

L5 **3** The dye acted as an indicator and some substances were acids and some alkalis.

L4 **4** **a** He found that these coloured substances turned one colour in acids and another colour in alkalis.

L4 **b** Indicators could be used to identify which substances were acids or alkalis.

L5 **c** He suggested that acids had a sharp taste because they were made up of tiny particles with spikes. Alkalis, however, were made up of soft slippery balls. When acids reacted with alkalis the acid spikes stuck into alkali balls.

L5 **5** He could have added the solution of violets to known acids and known alkalis and noted the colours.

L5 **6** Other people could use it to repeat his experiments and check his results. They could use his conclusions to investigate new substances and they could test his ideas to see if they were correct. Or, it spread his results and ideas around so that other people began to study chemistry in a similar way.

L6 **7** When the solutions were mixed they made a neutral solution.

L5 **7Fb-9 Indicators at home**

1 good examples: red cabbage, beetroot, tea, blackcurrant, onion skins, etc.

2 acids – vinegar (preferably clear vinegar), lemon juice in water, lemonade

alkalis – detergent, baking soda in water (not baking powder), washing powder

3 Method should be logical and show the chosen indicator being added to the examples of acids and alkalis chosen.

Conclusions:

1 *Students' own opinions* based on the evidence collected.

2 See answer to question 1 above.

3 Not all coloured substances act as indicators. They have the same colour in acid or alkali.

7Fb-10 Comparing indicators

L5 **1** Daffodil – it is the same colour in all the test substances.

L5 **2**

Indicator	Acid	Neutral	Alkali
litmus	red	purple	blue
red cabbage	red	purple	blue-green
phenolphthalein	colourless	colourless	purple
onion skins	colourless	colourless	yellow

L6 **3** **a** Litmus and red cabbage. They have a distinctive colour in acidic solutions (the others do not).

b Litmus and red cabbage. These are the only indicators that have a different colour for neutral solutions.

L6 **4** Soap appears as neutral with phenolphthalein and onion skins and as an alkali with litmus and red cabbage. Sodium hydroxide and ammonia appear as an alkali with all four indicators. This suggests that sodium hydroxide and ammonia are more alkaline than soap.
Also red cabbage turns a different colour in soap (blue-green) than in sodium hydroxide and ammonia (blue).
L6 **5** Purple is a mixture of/halfway between the blue colour seen in alkali and the red colour seen in acids. Neutral is between acid and alkali.
L6 **6** *Students' own opinions*. Likely to choose litmus or red cabbage because of their distinctive colours in acid, neutral and alkaline solutions. Reasons should match the choice.

7Fc Acidity and alkalinity

Student Book

1: 7Fc Acidity and alkalinity (Student Book)
L4 **1** **a** pH 4–5 **b** acid **c** not very acidic
L4–5 **2**

Name of chemical	Colour of universal indicator	Acid, alkali or neutral	pH
hydrochloric acid	red	very acidic	1 or 2
pure water	green	neutral	7
sodium hydroxide	blue/purple	alkaline	10–14
carbon dioxide solution	orange	not very acidic	4–5

L4 **3** **a** 2 **b** 9 **c** 4 **d** 8
L5–6 **4** The hazard rating increases the lower the pH of the acid and the higher the pH of the alkali.
L5–6 **5** The pH would go up as washing soda is alkaline.
L5–7 **6** **a** probably not, as it is close to the pH of rainwater
b pH of river water at different places (above and below factory)
L5–7 **7** benefit – looks good; drawback – damages hair

2: 7Fc Writing titles (Student Book)
L4 **1** **a** lipstick **b** Red27 **c** Tina and Sandra
L5 **2** **a** Colour-changing is the special property of this lipstick.
b 'fashion-conscious girls'
c temperature, pH; 'turns different shades of pink depending on the temperature and pH of your lips'
L5 **3** **a** top climate scientists
b global warming forecasts

L5 **4** *Students' own answers* (must reflect the pH scale or its use)
L5 **5** **a** It could describe any number of test tubes and their contents.
b key words: common solutions, testing, universal indicator, colour, red, yellow, blue, purple, acids and alkalis
c e.g. testing common solutions with universal indicator
L5 **6** how the pH depends on the type of fizzy drink

Activity Pack

7Fc-1 Indicator rainbow
L5 **1** *Students' own answers* – check colouring is correct
L5 **2** **A** – acidic, red; **B** – neutral, green; **C** – alkaline, blue
L5 **3** stomach acid – pH 1 – red; soap – pH 10 – green/blue; pure water – pH 7 – green

7Fc-3 pH colours and numbers
L6 **1** Using two methods to measure pH means that one method can check that the other is correct, thus improving the reliability of the data.
L6 **2** *Students' own opinions*. Reasons should match the choice e.g. pH meter gives a more precise measurement but it has to be calibrated and checked regularly, and it doesn't contaminate the solution. Universal indicator is quick and simple to use but less precise and contaminates the solution. (Students will not use the term 'precise' or 'contaminates' but may offer explanations covered by these terms).
L6 **3** *Students' own answers*.

7Fc-4 pH indicators
L5 **1** Check that students have recorded the colours of their indicator over the pH range tested.
L6 **2** Students will probably find that their mixture does not differentiate between pH numbers across part (or all) of their chosen range.
L6 **3** The report should include an aim, a description of the work done, results and conclusions.

7Fc-5 Using pH
L5 **D** Universal *indicator* is used to work out the pH *number* of solutions. If the pH is less than *7* the solution is an acid; if it is over 7 it is an *alkali* and if it is equal to 7 it is a *neutral* solution.
F Check that the correct colours are used for each box.
Acids: vinegar, fizzy drinks, stomach acid, rainwater, lemon juice, milk.
Alkalis: toothpaste, washing powder, oven cleaner, soap, hair dye, sea water, baking soda.
Neutral: pure water, salt water, sugar solution.

pH	0	1	2	3	4	5	6	7
colour	yellow	yellow-green	yellow-green	green	blue-green	blue	blue	blue

7Fc-7, 4

L6 7Fc-6 pH applications

2 Examples of the keywords and pH in each box are:

Box 1: changes in pH; seawater; carbon dioxide in the air increases

Box 2: hairdressers; shampoo pH 9; skin pH 5.5; citric acid pH 3; hair dyes pH 11

Box 3: pH of drinks; mineral water pH 8; milk pH 6.5; yogurt pH 4.5; lemonade pH 5; most acidic cola pH 3; phosphoric acid; beer pH 4

Box 4: coal; power stations; sulfuric acid; lakes pH 2; chalk streams pH 7.5; peaty streams pH 6

Box 5: cleaning metals; sulfuric acid pH 1 cleans iron and steel; pH 7 for cleaning aluminium; alloys clean with pH 12

Box 6: soil pH; crops pH 5.5; potatoes pH 5.5; sugar beet pH 8

7Fc-7 Inventing indicators

L6 1 a methyl red (red below pH 4, yellow above pH 6.5)

b bromothymol blue (yellow below pH 6, blue above pH 7.5)

c thymol blue (yellow below pH 8, blue above pH 9.5) and phenolphthalein (colourless below pH 8, red above pH 10)

L7 2 Only a little thymol blue is needed to produce an intense/bright colour.

L6 3 between pH 4 and 10 (none of the indicators changes colour below pH 4 or above pH 10).

L7 4 e.g. using methyl violet and bromocresol green (see table at top of page)

Other mixtures may be used. Check that the colours of the mixtures match the pH ranges of each indicator.

L7 5 From students' own research. pH meters are important as they give an accurate, precise and continuous reading without having to add any substances to the sample. Beckman was a physical chemist who had an interest designing measuring instruments. He founded Beckman Instruments.

7Fc-8 The pH test

L5 1 A false; **B** true; **C** true; **D** false; **E** true.

L5 2 A Experiment 7, dilute sulfuric acid turned the indicator red, not blue.

B Experiment 3, vinegar turned the indicator orange, which is the sign it is an acid.

C Experiments 1, 5, 9 and 11 had no effect on the indicator paper.

D Experiments 2, 8, 10 and 12 were solutions that did not turn the indicator red, orange or yellow.

E Only substances that are solutions or are wet (e.g. toothpaste) changed the colour of the indicator.

L5 3 Test more substances that are known to be acids or alkalis; add water to crystals and other dry substances to see if the indicator changes colour.

L5 4 Dilute sulfuric acid. It made the indicator change to red, the other acids only turned it orange.

L5 5 Washing soda has the higher pH because it makes the indicator turn more blue.

7Fc-9 A day of pH

Check that students star the most acidic and alkaline substances they recorded.

7Fc-10 pH colour changes

L7 1 a yellow **b** yellow **c** blue

L7 2

pH number	Colour of methyl orange	Colour of thymol blue	Colour of a mixture of the two indicators
3	red	yellow	orange
7	yellow	yellow	yellow
10	yellow	blue	green

L7 3 a yellow **b** yellow **c** purple

L7 4 a The mixture would produce different colours across the range of pH numbers.

b 4 (red, orange, green, brown)

c See table at bottom of page.

L7 5 A mixture can show whether a solution is more or less acidic or alkaline.

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
colour	red					orange			green		black/brown				

7Fc-10, 4c

7Fd Neutralisation

Student Book

1: 7Fd Neutralisation (Student Book)

L4 **1** **a** below 7 **b** above 7
L4 **2** **a** cauliflower and mushrooms **b** leeks
L4 **3** **a** more acid L5 **b** The indicator colour is red.
L5 **4** **a** that the pH is 1 (or 2) **b** 12 (to 14)
L4 **5** **a** 7 **b** The indicator turns green.
L5 **6** **A** sodium hydroxide; **B** hydrochloric acid; **C** water, sodium chloride; **D** hydrochloric acid, sodium hydroxide; **E** sodium chloride, water
L6 **7** **a** lithium chloride; water **b** sodium hydroxide; water
L6 **8** ammonium hydroxide (ammonia) + sulfuric acid
L5–6 **9** neutralise with alkali and/or dilute with water

Activity Pack

7Fd-1 Neutralisation

L5 **1** Set 1: test tube 1 = red; test tube 2 = blue.
Set 2: test tube 1 = red; test tube 2 = blue.
Set 3: test tube 1 = purple; test tube 2 = blue.
Set 4: test tube 1 = blue.
L5 **2** **a** alkali **b** neutralisation (or chemical)
c reactants **d** neutralised, acid **e** neutralisation
f products

7Fd-2 Acids and alkalis react

L5 **1** The indicator on the test tube changes colour.
L5 **2** 5 cm^3 (may be 4–6 cm^3)
L5 **3** sodium chloride, water
L5 **4** New substances have been formed.

7Fd-3 Making salts

Part 1:
1 10 cm^3 (probably between 9 and 11 cm^3)
L6 **2** The hydrochloric acid was neutralised by the sodium hydroxide solution.
Part 2:
L6 **1** a white solid, sodium chloride (common salt)
L6 **2** hydrochloric acid + sodium hydroxide → sodium chloride + water

7Fd-4 Changing pH

L5 **1** The pH should have risen by less than one unit.
Conclusions
L5–6 **2** graph – check axes and plotting of points (on this occasion it does not matter if the line is drawn as a ‘join the dots’ or a smooth curve).
L5 **3** should be around 20 cm^3 (i.e. between 18 and 22 cm^3)
L5 **4** sodium chloride and water
L6 **5** hydrochloric acid + sodium hydroxide → sodium chloride + water
L5 **6** It is an S shape with a rapid change of pH between about 18 and 22 cm^3.
L6–7 **7** Neutralising. When diluting, the acid remains in the solution. When alkali is added, a salt is formed which is neutral.
L6–7 **8** Add an alkali to neutralise the acid.

L6 7Fd-5 Neutralisation equations

1 hydrochloric acid + lithium hydroxide → lithium chloride + water
ethanoic acid + sodium hydroxide → sodium ethanoate + water
citric acid + potassium hydroxide → potassium citrate + water
nitric acid + ammonium hydroxide → ammonium nitrate + water
sulfuric acid + calcium hydroxide → calcium sulfate + water
2 **a** Neutralising nitric acid with ammonium hydroxide.
nitric acid + ammonium hydroxide → ammonium nitrate + water
b Makes the water neutral so animals and plants can live.
sulfuric acid + calcium hydroxide → calcium sulfate + water
c Makes the soil neutral so that crops can grow.
nitric acid + calcium hydroxide → calcium nitrate + water
d Neutralising citric acid with potassium hydroxide.
citric acid + potassium hydroxide → potassium citrate + water

7Fd-6 Using neutralisation

L5 **1** an alkali
L5 **2** **a** vinegar
L5 **b** It is an acid.
L5 **3** **a** *physical*, should be chemical
L5 **b** *adjudicator*, should be indicator
L5 **c** *hydroxide*, should be sulfate
L5 **d** *reactants*, should be products
L5 **4** *Students’ own answers* e.g. use of neutralisation in farming, medicine (indigestion), food, toiletries, etc.

7Fd-7 Changing soil pH

L5 **1** **a** 5
L5 **b** 7
L5 **2** neutralisation
L5 **3** underline *nitric acid* and *calcium hydroxide*, circle *calcium nitrate* and *water*
L5 **4** new substances

7Fd-8 Sorting word equations

L5–6 **1** A product of the reaction of an acid and alkali:

A product of the reaction of an acid and alkali:	salt	(last)
Substances that react with acids.	alkalis	(all I ask)
The pH when all of an acid and alkali react.	seven	(evens)
The salts formed by sulfuric acid.	sulfates	(use flats)
It happens to an acid when alkali is added.	neutralised	(late side run)
Shows when an acid and alkali have reacted.	indicator	(A dirt coin)

L6 **2** **a** potassium chloride
b sulfuric acid, water
c sodium hydroxide (or oxide)
d hydrochloric acid, calcium hydroxide (or oxide)

L6 **3** Letter should suggest that the soil is too acidic and must be neutralised by adding an alkali such as calcium hydroxide (lime).

7Fd-9 pH changes

Dilution

L5 **1** 1 cm^3 of the acid is diluted into 100 cm^3, then 1% of this first solution is put into the second and final solution. 1% of 1 is 0.01 cm^3. Another way to look at this is that the first solution contains 1cm^3 of acid. 1/100th of this acid is put into the second and final solution: 1 ÷ 100 = 0.01, so there is 0.1 cm^3 in the final solution.

L5 **2** A very large volume of water is needed to raise the pH of the acid to 5 so it is not very effective (100 x 100 = 10000 cm^3 or 10 litres for every 1 cm^3 of pH 1 acid)

Neutralisation

L7 **1** Check the title, axes and the points plotted are correct. The line may be drawn as a smooth curve or 'join the dots'.

L7 **2** It is an S curve with a rapid change of pH close to 10 cm^3 of alkali.

L6 **3** The sodium hydroxide neutralises the hydrochloric acid.

L5 **4** new substances are formed

L6 **5** hydrochloric acid + sodium hydroxide → sodium chloride + water

L7 **6** **a** sodium chloride, water and unreacted hydrochloric acid
b sodium chloride and water
c sodium chloride, water and unreacted sodium hydroxide

L7 **7** 10 cm^3. This is the amount needed to make the solution neutral/pH 7.

L7 **8** Yes – because much less of the sodium hydroxide is needed to make the acid safe than pure water.

No – If too much sodium hydroxide is added it becomes alkaline, which is also hazardous. (Students may note that adding an alkali of lower pH would be safe and effective.)

7Fd-10 Balancing pH

L7 **1** At first the pH does not change. The pH falls rapidly when between 8 and 12 cm^3 of acid is added. After this, the pH remains constant as more acid is added.

L7 **2** The shampoo is neutral at pH 7. Reading from the graph, 10 cm^3 of acid was needed to neutralise the shampoo.

L7 **3** If she doesn't use enough acid the pH remains high and if she uses too much the pH goes too low.

L6 **4** Citric acid is not as acidic/has a higher pH than hydrochloric acid so is safer to use in a shampoo.

L6 **5** nitric acid, potassium hydroxide (or oxide)

L6 **6** nitric acid + potassium hydroxide → potassium nitrate + water

L7 **7** They should carry out experiments to measure how much potassium hydroxide is needed to neutralise a sample of nitric acid (or vice versa).

7Fe Neutralisation in daily life

Student Book

1: 7Fe Neutralisation in daily life (Student Book)

L4 **1** **a** a base or an alkali **b** above 7

L4 **2** a neutralisation reaction

L5 **3** It would make the stomach too alkaline.

L5 **4** to neutralise acids in the mouth

L6 **5** aluminium hydroxide + hydrochloric acid → aluminium chloride + water

L6 **6** Wasp stings are alkaline so it was thought that treating them with an acid like vinegar would neutralise them. Bee stings are acidic so it was thought that treating them with an alkali like bicarbonate (of soda) would neutralise them.

L6 **7** because the acid he is using is corrosive

L6 **8** calcium hydroxide + sulfuric acid → calcium sulfate + water

L4–7 **9** Take a measured volume of hydrochloric acid in a beaker. Add universal indicator. Add an indigestion tablet and stir to dissolve. Continue adding indigestion tablets until neutralised. Repeat this exactly with other tablets. The one that requires the least number of tablets to neutralise the acid is the best indigestion tablet.

2: 7Fe Danger at home (Student Book)

L6 **1** (i) flammable (ii) corrosive (iii) dangerous for the environment (iv) harmful

L5 **2** *Students' own answers*, e.g. **A** vinegar; **B** bleach; **C** methylated spirits; **D** drain cleaner

L4 **3** **a** Add universal indicator paper or liquid;

you can tell the pH from the colour of the paper or solution.
L5 **b** pH numbers below 7 are acidic, pH 7 is neutral, pH above 7 is alkaline
L6 **4 a** Heat was given out.
L4 **b** neutralisation
L5 **c** sulfuric acid + sodium hydroxide → sodium sulfate + water
L6 **5** *Student's own safety information leaflets*

Activity Pack

L5 7Fe-1 Using acids and bases
1 Problem: Indigestion means there is too much hydrochloric acid in the stomach.
Solution: Indigestion remedies contain magnesium hydroxide, a base.
2 Problem: Burning fuels makes acid gases.
Solution: Lime (calcium oxide) is a base that is mixed with the gases.
3 Problem: Food leaves acids in the mouth which cause tooth decay.
Solution: Toothpaste contains aluminium hydroxide, a base.
4 Problem: Steel becomes coated with rust (iron oxide), a base.
Solution: Rust repair kits contain sulfuric acid.

L5 7Fe-2 Indigestion 1
1 Tubes with Antac, Magplus and Superbase.
2 Probably both Magplus and Superbase (the others may remain cloudy if the mixture is not stirred sufficiently or the volume of acid was less than $10 cm^3$).
3 *Students' own opinions*. Antac is probably the best as it neutralises the acid and has the least amount of magnesium hydroxide left over.

L6 7Fe-3 Indigestion 2
1 The pH of the acid will rise when just enough antacid has been added to neutralise it.
2 a *Students' own opinions* based on evidence collected. Superbase should turn out to be the most effective as it contains the highest proportion of base.
b The 'best' antacid neutralises the most acid.
3 Repeat measurements. Other improvements will depend on how effective the student's own method was.

7Fe-4 Making crystals
L6 **1** sulfuric acid
L6 **2** sulfuric acid + copper (II) oxide → copper (II) sulfate + water (the (II) may be omitted)

Part 1
L5 **3** There is a change of colour.
L6 **4** Some copper (II) oxide powder remains unreacted.
L6 **5** universal indicator, litmus paper or pH meter
L6–7 **6** copper (II) sulfate, water and (unreacted) copper (II) oxide

Part 2
L7 **7** Filter the mixture and collect the filtrate. Filter funnel, filter paper, beaker.
L7 **8** The solution will be clear.
L7 **9** Heat the solution to evaporate the solvent (water). Evaporating dish, Bunsen burner.

L7 7Fe-5 Useful salts
Suggestions:
Ammonium nitrate: mix nitric acid and ammonium hydroxide (ammonia) solution until neutral, measured by pH meter. Evaporate the water.
Iron sulfate: add solid iron oxide (or hydroxide) to sulfuric acid until in excess, filter and evaporate the water.
Both these methods have problems in practice, e.g. ammonium nitrate is explosive, iron sulfate decomposes on heating, but these difficulties can be ignored here.
Safety: acids and ammonium hydroxide may be corrosive at the concentrations used. Students should suggest standard safety precautions.
Word equations:
nitric acid + ammonium hydroxide → ammonium nitrate + water
sulfuric acid + iron oxide or hydroxide → iron sulfate + water

7Fe-6 Healthy teeth
L6 **1 a** C **b** B **c** A
L5–7 **2** The advert should emphasise the benefits of the aluminium hydroxide in neutralising acids to prevent decay and cavities.
L5–7 **3** e.g. indigestion remedies, treating rust, treating waste gases from power stations, neutralising acid soils

L5–6 7Fe-7 Acids and bases
1 iron
2 base
3 purple
4 reactant
5 product
6 indicator
7 alkali
8 chloride
9 salt
10 seven
Hidden word: neutralise

7Fe-8 Investigating indigestion

L5 **1** They all suggest using an indicator which changes colour when the base neutralises/reacts with the acid.

L6 **2** The remedy reacts with/neutralises the acid forming a salt and water.

L6 **3** The volume/amount of acid.

L6 **4** **a** The pH after the remedy had been reacted with the acid.

b The volume of acid required to neutralise the remedy.

L6 **5** **a** They both add one reactant to the other until the mixture is neutral/pH 7.

b Conrad adds the acid to the remedy, Amy does the reverse. Conrad adds the reactant in smaller quantities.

L6 **6** Amy's is better because she adds the remedy a little at a time and records when the mixture is neutral. Byron's experiment only tells if a fixed quantity of remedy will neutralise the acid. So Amy collects more evidence.

L6 **7** He measures the mass of remedy used.
He adds the acid in small, precisely measured amounts.
He says he will repeat the tests and take an average.
Accept any other valid response.

7Fe-9 Sulfuric acid

L5 **1** It has a low pH or, a pH less than 2, or it is a corrosive acid.

L5 **a** rust/iron oxide, calcium hydroxide

L5 **b** An alkali is a base that is dissolved in water.

L6 **2** **a** iron sulfate + water

b sulfuric acid + calcium hydroxide → calcium sulfate + water

L5 **3** An acid reacts with a base to form a (neutral) salt and water.

L6 **4** e.g. antacids as cure for indigestion – neutralise excess acid.
Lime added to acidic soil – neutralise acid to allow crops to grow.
Toothpaste – neutralises acids that cause tooth decay.

7Fe-10 Acids, bases and salts

L7 **1** **a** sulfuric acid + potassium hydroxide → potassium sulfate + water
Method: use an indicator that changes colour rapidly around pH 7. Potassium hydroxide is an alkali and neutralises the acid, producing potassium sulfate solution. Evaporate the solution to recover the potassium sulfate.

b hydrochloric acid + magnesium hydroxide → magnesium chloride + water
Method: magnesium hydroxide is a base that neutralises an acid but is insoluble. Some solid magnesium hydroxide will be left over when the acid has been neutralised. Filter off the magnesium hydroxide, then evaporate the solution to recover the magnesium chloride.

c nitric acid + iron oxide → iron nitrate + water
Method: iron oxide is a base that neutralises an acid but is insoluble. Some solid iron oxide will be left over when the acid has been neutralised. Filter off the iron oxide, then evaporate the solution to recover the iron nitrate.

L6 **2** **a** sulfuric acid + iron oxide → iron sulfate + water
Iron oxide is a base that neutralises sulfuric acid, forming a soluble salt that washes away.

b Sodium hydroxide is an alkali that forms a solution with a high pH that is corrosive/harmful. Magnesium hydroxide is an insoluble base which neutralises the acid but does not itself cause harm.

c sulfuric acid + calcium hydroxide → calcium sulfate + water
nitric acid + calcium hydroxide → calcium nitrate + water
Calcium hydroxide is a base that neutralises the acids.

d Aluminium hydroxide is a base that neutralises the acids that would attack teeth. Aluminium hydroxide is not soluble so it neutralises the acid whilst you are cleaning your teeth but does not cause harm.