

Unit 7F Simple chemical reactions

About the unit

In this unit pupils:

- are introduced to the idea that chemical change results in new substances that are different from the ones from which they were made
- explore some simple chemical reactions of acids in which a gas is made
- explore burning as a chemical reaction involving a gas, air or oxygen
- identify hydrogen and carbon dioxide as substances made during some of these reactions
- work with gases to understand that gases are real materials
- begin to use word equations as shorthand descriptions of reactions

In scientific enquiry pupils:

- learn techniques for testing for gases, using laboratory equipment effectively and taking action to control risks
- present observations in ways which enable patterns to be seen
- make generalisations from observations
- suggest and evaluate explanations of observations
- investigate the role of air in the burning of a candle

This unit is expected to take approximately 7 hours.

Where the unit fits in

This unit uses ideas developed in the key stage 2 programme of study. It builds on ideas introduced in unit 5C 'Gases around us' and unit 6D 'Reversible and irreversible changes' in the key stage 2 scheme of work.

This unit relates closely to unit 7E 'Acids and alkalis' and these can be used together as an introductory unit in year 7, in which pupils use equipment and techniques they may not have encountered in key stage 2.

An approach to teaching about energy is included in the *Teacher's guide* and in the 'About the unit' section of unit 7I 'Energy resources'.

Unit 9E 'Reactions of metals and metal compounds' and unit 9F 'Patterns of reactivity' include further work on the reactions of acids and on burning as a chemical change. Unit 9H 'Using chemistry' includes work on the conservation of mass in chemical reactions, including burning.

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will: obtain and present qualitative results, identifying patterns in these; work safely with acids and when burning materials; suggest how to test an idea about burning, obtaining results which can be represented as a line graph

some pupils will not have made so much progress and will: obtain and present qualitative results, describe some hazards of acids and of burning; work safely with acids and when burning materials; test an idea about burning and present results

some pupils will have progressed further and will: evaluate how well ideas about burning match the data collected

in terms of materials and their properties

most pupils will: identify that some new materials are formed during a chemical reaction and generalise that hydrogen is formed when acids react with metals, carbon dioxide when acids react with carbonates, and oxides when materials burn; describe tests for carbon dioxide and hydrogen and describe burning as a reaction with oxygen

some pupils will not have made so much progress and will: identify some products of chemical reactions and state that oxygen or air is needed for burning

some pupils will have progressed further and will: predict that carbon dioxide and water will be made when a hydrocarbon burns and use word equations to represent reactions in which materials burn

Prior learning

It is helpful if pupils:

- know that there are many gases
- have explored changes in which new materials are formed and which cannot easily be reversed
- have used the pH scale as a measure of acidity and alkalinity

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:

- work with acids
- observe materials burning in oxygen
- burn liquid fuels
- plan their own investigation into burning a candle

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

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:

- names of gases, *eg hydrogen, oxygen, carbon dioxide, methane*
- names of other elements and compounds, *eg carbon, zinc, calcium carbonate*
- words and phrases describing chemical reactions, *eg reactant, product, word equation*
- words and phrases relating to scientific enquiry, *eg line graph, generalisation, evaluate*

Through the activities pupils could:

- collaborate with others to share information and ideas, and solve problems
- group sentences into coherent paragraphs with subheadings as appropriate

Resources

Resources include:

- corroded metals
- building materials including carbonate rocks, *eg chalk, marble*
- carbonated water
- computer and software to produce information leaflet
- cards on which are written words, phrases and statements about chemical reactions

Out-of-school learning

Pupils could:

- visit a fire station open day to hear talks and see fire-prevention displays
- consider how burning is used in celebrations, *eg candles, bonfires, fireworks*

What is a chemical reaction?

- to make and interpret observations
- Provide pairs of pupils with everyday materials which react chemically when they are mixed, *eg lemon juice and bicarbonate of soda, baking powder and water, plaster of Paris and water*. Ask pupils to mix them and make as many observations as they can. Ask pupils to decide and give their reasons for whether a new material has been made. Explain that in each case a chemical reaction has taken place and that in this unit they will find out more about other chemical reactions and what new substances are made.
- describe changes, *eg it bubbled, it felt warm*
- generalise that when bubbles are formed a gas is released and this is a new material
- In key stage 2 many pupils will have explored changes in which new materials are made (unit 6D 'Reversible and irreversible changes') but are less likely to have classified the changes as chemical reactions.

How do acids react with metals?

- how to carry out a test for hydrogen
- that acids can be corrosive
- that acids react with some metals to produce new substances, including hydrogen
- Remind pupils of earlier descriptions of acids as corrosive and show some examples of corroded metals. Establish through a quick class experiment that when an acid is added to a metal, *eg zinc, magnesium*, bubbles are made.
- Demonstrate an appropriate method for testing the gas produced and explain that a gas behaving in this way is hydrogen.
- describe and carry out the lighted splint test for hydrogen
- generalise that when an acid is added to many metals, hydrogen is produced and the metal disappears or becomes smaller
- relate the disappearance of the metal to the idea of corrosion
- In key stage 2, pupils are likely to have seen reactions of acids producing a gas (unit 6D 'Reversible and irreversible changes') and have encountered common gases (unit 5C 'Gases around us'). However, they will not have tested or identified gases produced.
- It may be helpful to introduce the terms 'reactant' and 'product'.
- ⚠ **Safety** – eye protection should be used. 0.4 mol dm^{-3} acid is suitable. Acids are not necessarily corrosive and most of those encountered by pupils will not be
- to record relevant observations
- to identify and describe patterns in qualitative data
- to identify results which do not appear to fit the pattern
- Ask pupils to investigate what happens when a range of acids is added to a range of metals and to record and make generalisations from their results.
- Bring together pupils' results and establish that in most cases a new material, hydrogen, is made, showing that there was a chemical reaction between the acid and the metal.
- use a table to present observations in a way which enables patterns to be seen
- identify metal(s), *eg copper*, which do not react with acids to produce hydrogen
- conclude that when hydrogen was made a chemical reaction had taken place
- At this stage, it is sufficient for many pupils to identify that acids react with many metals to produce hydrogen. Some teachers may wish to take this further, either by considering what other products are obtained or by considering patterns in reactivity. This is more fully covered in unit 9F 'Patterns of reactivity'.

Pupils should learn:

Pupils:

How do acids react with carbonates?

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| <ul style="list-style-type: none"> • how to carry out a test for carbon dioxide • to produce new substances, including carbon dioxide • to identify and describe patterns in qualitative data • to generalise from their observations | <ul style="list-style-type: none"> • Ask pupils what the 'fizz' in bottled water is. Identify the gas as carbon dioxide and demonstrate how to collect carbon dioxide and test for it using lime water. • Provide pupils with samples of carbonate, possibly including rocks, <i>eg chalk</i>, building materials, <i>eg marble</i>, household materials, <i>eg baking powder</i>, <i>carbonate indigestion remedies</i>, and ask them to investigate the effect of adding a range of acids to these and to record and make generalisations from their results. Establish that in each case a chemical reaction took place and draw out the idea that chemical reactions are important. | <ul style="list-style-type: none"> • carry out and describe the lime water test for carbon dioxide • generalise that when an acid is added to a carbonate, carbon dioxide is made • use a table to present observations in a way which enables patterns to be seen • conclude that the production of carbon dioxide is evidence of a chemical reaction | <ul style="list-style-type: none"> • It may be helpful to emphasise that the colourless gas (carbon dioxide) collected in this activity is a different material and behaves differently from the gas collected in the previous activity. • The effects of acid rain on carbonate building materials are covered in unit 8G 'Rocks and weathering'. <p>! Safety</p> <ul style="list-style-type: none"> – eye protection should be worn when lime water is in use – eye protection should be used. 0.4 mol dm⁻³ acid is suitable |
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What new substances are made when materials burn in air or oxygen?

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| <ul style="list-style-type: none"> • that burning requires oxygen • that new substances, usually oxides, are formed when materials burn • to use appropriate scientific terminology and conventions • how to carry out combustion reactions safely • to identify and note key points • to group sentences into coherent paragraphs with subheadings as appropriate | <ul style="list-style-type: none"> • Demonstrate burning some elements in air and then in oxygen. Emphasise the hazards of burning materials in oxygen. Use secondary sources to illustrate more hazardous reactions. Show pupils how to burn materials safely in oxygen. Ask pupils to describe what they see and point out to them that in each case the new material is an oxide and that a chemical reaction has taken place. • Introduce the idea of word equations for simple combustion reactions and ask pupils to sort cards showing reactants and products to produce word equations. • Ask pupils to use secondary sources to find information about fire prevention and firefighting and to produce information sheets, <i>eg for use in the home</i>, explaining key principles. | <ul style="list-style-type: none"> • describe, <i>eg through producing word equations</i>, burning as a reaction in which a material reacts with oxygen to produce an oxide • name the products of some reactions • explain precautions that need to be taken when burning materials and why more care is needed if materials are burnt in oxygen • identify key points about fire safety • express key points clearly in a structured way | <ul style="list-style-type: none"> • In key stage 2, pupils will have considered burning as an irreversible change (unit 6D 'Reversible and irreversible changes'). However, they are unlikely to have considered it in terms of combination with oxygen. • Some teachers may wish to test the pH of the oxide produced and to demonstrate that the product of burning carbon turns lime water cloudy. • At this stage word equations are used as shorthand. Teachers may wish to postpone their introduction for some pupils. Units 8E, 8F, 9E, 9F, 9G and 9H deal more fully with equations. • This activity could be ICT-based. <p>! Safety – eye protection should be worn by teachers and pupils, who should be seated 2m away. Employer's risk assessments on the use of elements such as sulfur, phosphorus and magnesium should be consulted</p> |
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Pupils should learn:

Pupils:

Checking progress

- that new materials are made during chemical reactions
- that the products of a reaction can be deduced from the reactants
- Provide pupils with a series of cards showing words or phrases about the chemical reactions, *eg reactant, product, metal, acid, carbonate, oxide, carbon dioxide, hydrogen, oxygen*, and ask them to group them into three sets to describe the three types of chemical reaction covered in the unit. Help them to use the words or phrases to make generalisations about the three types of reaction.
- identify a product of each type of reaction
- make generalisations about the products of each type of reaction

What is produced when fuels burn?

- that fuels are substances that release energy when they burn
- that fossil fuels are rich in compounds containing carbon
- that burning fossil fuels results in the production of carbon dioxide
- that natural gas is called methane, and carbon dioxide and water are produced when it burns
- Elicit pupils' ideas about fuels by asking them what they understand by the term and what examples they can give of fuels. Explain that fossil fuels are rich in carbon and ask pupils to suggest what might be formed when they burn.
- Demonstrate that carbon dioxide (and water) is produced when methane burns. If possible, extend the demonstration by using other fuels containing hydrogen and carbon, *eg wax, ethanol, wood*. Discuss with pupils whether it is likely that carbon dioxide and water could be turned back into fuel.
- Help pupils make a summary of information about burning fossil fuels.
- name a range of fuels and explain the meaning of the term 'fuel'
- generalise that carbon dioxide is produced when carbon-containing fuels burn
- summarise burning of methane in a word equation
- The formation of fossil fuels and burning of fuels to release energy is covered in unit 7I 'Energy resources'. In this unit teachers may wish to concentrate on identifying the products of burning.
- Pupils often think that energy, like gas, is a material and has mass.
- Environmental effects of burning fossil fuels are covered later in unit 9G 'Environmental chemistry'.



Safety – employer's risk assessments on the use of fuels should be followed. Eye protection should be worn. Small quantities of fuels should be used and storage bottles kept well away from where the fuels are burnt

Pupils should learn:

Pupils:

What is needed for things to burn?

- that part of the air is used up during burning
- to suggest and evaluate explanations
- to suggest how to test an idea
- to produce a line graph from results and to draw conclusions from these
- to collaborate with others to share information and ideas, and to solve problems
- Show pupils the effect of putting a large glass container over a lighted candle floating on a trough of water and ask questions to help them explain what happens, eg
 - *What was in the large container?*
 - *Why did the candle go out?*
 - *Why didn't it go out immediately?*
 - *Why did the water rise up the container?*
 - *What is made when a wax candle burns?*
 - *What happens to this?*
- Ask pupils in groups to work out explanations. Help them to evaluate their explanations through questioning and establish that part of the air was used up and that the candle could not continue to burn. Link back to earlier work on comparing burning in air and oxygen.
- Extend by asking pupils to investigate the idea that the candle goes out when part of the air is used up. Help them to turn this into a question that can be tested and to devise a way of getting results from which a graph can be plotted.

- explain that the candle goes out when oxygen is used up
- suggest and evaluate ideas about why the water rose up the container
- generalise that the less oxygen there is the sooner the candle would go out and suggest a way of testing this
- draw a line graph of results; describe what it shows, relating this to the oxygen available for burning
- contribute usefully to group work

- This activity provides an opportunity for pupils to suggest their own ideas and to think critically about these and the ideas of others. Teachers may wish to go into detail with some pupils about factors such as expansion of air on heating and solubility of carbon dioxide, but it is not necessary to do so.
- Extension: pupils could be asked to find out about earlier work on burning and oxygen by scientists, eg *Lavoisier*, *Priestley*.



Safety – use candles that are short and difficult to knock over and ensure they are set in a firm base. Teachers should check pupils' plans for health and safety before practical work begins

Reviewing work

- to identify key points about reactions of acids with metals, acids with carbonates and burning
- to group points together to make a summary
- Provide pupils with a series of statements, or ask them to make their own, about the areas covered in the unit. Ask them to work together to choose the most helpful statements for a summary and to group those chosen into four or five main sections. Ask pupils to explain why they chose or rejected particular statements and agree an overall summary with them.
- identify statements which are helpful to a summary
- combine statements into a summary
- give reasons for choosing or rejecting particular statements