7H
Atoms, elements and compounds

This unit uses the context of resources from the Earth and atmosphere to introduce ideas about the make-up of matter. It expands on particle theory and explains the differences between atoms, and molecules, elements and compounds. It looks at the symbols and formulae for elements and compounds. The involvement of chemical reactions in the formation and decomposition of compounds is also covered. It links these with the more abstract ideas of particle models, naming compounds and word equations.

Recommended teaching time for unit: 7.5–10 hours

Topic 7Ha contains additional work on scientific skills (recording and presenting data in tables, charts and graphs). Topic 7Hc provides an opportunity to look at how material in this unit is used by people working in the mining industry, with a focus on STEM skills (Critical analysis and evaluation and use of maths). You may wish to spend additional time on these topics, should you feel that your students would benefit from these skills development opportunities.

From primary most students will be able to:

- compare and group materials together, according to whether they are solids, liquids or gases
- observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C)
- demonstrate that dissolving, mixing and changes of state are reversible changes
- compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal) and response to magnets
- explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

From previous units, most students will be able to:

- identify different kinds of mixtures, including solutions, and describe ways of separating mixtures (7E)
- describe the difference between chemical and physical changes, and recognise neutralisation as a type of chemical reaction (7F)
- recognise differences between solids, liquids and gases, in terms of ease of flow and maintenance of shape and volume (7G)
- describe the properties of the different states of matter in terms of particle kinetics, including gas pressure and diffusion (7G).

Topic 7Ha reviews chemical and physical change and introduces basic definitions of atoms, molecules, elements, compounds and mixtures. There is also a Working Scientifically spread that looks at the different ways in which data is presented, depending upon the type of variables.

Topic 7Hb investigates elements and provides some examples with their symbols. The periodic table is introduced as a special list of all known elements.

Topic 7Hc uses the properties of elements to classify them into metals and non-metals. It also looks at how the properties of substances are linked to their uses. There is an opportunity to find out about STEM and the skills associated with jobs in the mining industry (with a focus on critical analysis and evaluation, and use of maths).

Topic 7Hd looks at the formation of compounds from elements and the difference in properties between elements and compounds. It also introduces ideas about naming simple compounds.

Topic 7He reviews chemical reactions and applies them to thermal decomposition reactions. It also extends ideas about naming compounds and further develops the idea of word equations from Unit 7F.

Curriculum coverage

This unit covers the following:

- the concept of a pure substance
- mixtures, including dissolving
- air as a mixture (its components and some of their uses)
- the simple (Dalton) atomic model
- the Periodic Table; metals and non-metals
- differences between atoms, elements and compounds
- chemical symbols and formulae for elements and compounds
- combustion, thermal decomposition, oxidation and displacement reactions
- the varying physical and chemical properties of different elements
- the composition of the Earth
- minerals and ores
- the difference between chemical and physical changes
- atoms and molecules as particles.

This unit also has a focus on the following aspects of Working Scientifically/Scientific Enquiry:

- interpret, use and draw tables, bar charts, pie charts, scatter graphs and line graphs
- classify data as: quantitative, qualitative, discrete/discontinuous, continuous
- choose appropriate ways to present different types of data.

STEM skills

This unit explores these STEM skills and how they are used:

- critical analysis and evaluation (checking that you have enough good-quality data from which to draw a conclusion)
- use of maths (percentages, and using percentages to make fair comparisons).

Cross-disciplinary opportunities

7Ha – Physics – physical changes and ideas about atoms and molecules

7Hc – Physics – the physical properties of metals and non-metals

Cross-curricular opportunities

7Ha – Geography – composition of the atmosphere
7Ha – History – changes in the atmosphere, both natural and human-made
7Ha – Maths – data handling
7Hb – Geography – composition of the Earth, mining and the consumption of resources
7He – Geography – the importance of limestone
7He – History – the use of metals during the Bronze and Iron Ages

Maths skills

- qualitative and quantitative data
- the use of: tables; line graphs; scatter graphs; pie charts; and bar charts.

7H Background information

7Ha Our material world/Sorting resource data/ The air we breathe

This topic gives an introduction to the particles that make up matter, providing basic definitions of atoms, molecules, elements and compounds. Air, a natural resource, is used to illustrate these ideas. The table below shows the % content of gases (by volume) in dry air. Only the four most abundant gases are considered in this topic.

Gases in air	% content
nitrogen (N_2)	78.084
oxygen (O_2)	20.946
argon (Ar)	0.9340
carbon dioxide (CO_2)	0.0397
neon (Ne)	0.001818
helium (He)	0.000524
methane (CH_4)	0.000179
krypton (Kr)	0.000114
hydrogen (H_2)	0.000055
nitrous oxide (N_2O)	0.0000325
carbon monoxide (CO)	0.00001
xenon (Xe)	0.000009

Mixtures are much more common than pure substances. Air, soil, sea water and most rocks are mixtures. Air is a mixture that is fairly consistent throughout the world.

The Greek philosopher Democritus (460–370 BCE) was the first person to consider matter in terms of tiny particles. He reasoned, 'If you break a piece of matter in half, and then break it in half again, and so on eventually you will get the smallest possible bit of matter which cannot be divided anymore.' He called these indivisible particles 'atoms'. Many other philosophers disagreed and the idea then disappeared for 2000 years.

In this topic the atom is regarded as a tiny indivisible sphere. The atoms of an element are treated as identical, with different elements containing different kinds of atoms. Atomic structure is not covered in this topic and isotopes are only introduced in GCSE/IG. There are 98 natural elements. In this unit we describe elements as simple substances that contain only one kind of atom and cannot be broken down into anything simpler.

A molecule is introduced as a small group of atoms joined together. The idea that a molecule has a particular size and consists of a specific number of atoms is mentioned, but not stressed. This will be considered in more detail following discussion on lattices, macromolecules, polymers and so on. The ancient Greeks believed that all matter was made up of four elements: earth, water, air and fire. This idea was supported by Aristotle, who also thought that these elements were a combination of the opposites: hot and cold and wet and dry.

In this unit we describe elements as simple substances that cannot be broken down into anything simpler as they contain the one kind of atom. We should add that elements cannot be broken down 'by chemical means', as the transmutation of elements is possible in nuclear reactions. However, this is usually classified as nuclear physics rather than chemistry.

Compounds are introduced as substances that contain two or more types of atom (two or more elements) joined together. The forces of attraction which hold atoms together are called 'bonds'. No attempt is made to explain bonds or intramolecular forces in this unit.

This topic introduces some difficult concepts. To help students to appreciate the differences between atoms, molecules, elements and compounds, the use of particle models is recommended throughout this unit.

7Hb Earth's elements

Robert Boyle came up with the modern concept of elements in 1661: he assumed that elements really were 'elementary'; it therefore followed that atoms were the smallest possible particles. The discovery of sub-atomic particles (notably the proton and the electron) about 100 years ago meant that the definitions had to be modified. We would now say that the distinguishing feature of an atom of an element is the number of protons in the nucleus. At this stage, the atoms of any particular element are treated as identical.

This topic introduces elements by looking at the elemental constituents of the Earth's crust and atmosphere. Students should be given the opportunity to become familiar with the periodic table as a special list of elements, with their names and symbols (a copy is provided at the back of the Student Book). Topic 7Hc requires students to identify where metals and non-metals are found in the periodic table, but no additional information on the structure of the table is needed at this stage.

The names and symbols for chemical elements are officially standardised by the IUPAC (International Union of Pure and Applied Chemistry). Many of the

symbols fit the English name of the element. Others, however, have their roots in Latin or other modern European languages (for example, the symbol Na for sodium comes from the Latin 'Natrium'), reflecting the multicultural nature of science.

7Hc Metals and non-metals/Obtaining metals
Metals are a class of substance that every Year 7 student will recognise but will find hard to define. The *Shorter Oxford Dictionary* defines a metal by reference to copper, silver and tin, suggesting that the metallic lustre is the most constant feature. In this topic students will classify metals and non-metals more scientifically according to their physical properties. Chemical properties of metals and non-metals are not dealt with here.

The Student Book uses the following range of properties to describe 'metals': high melting point solids; strong and flexible; malleable; shiny (when polished); good conductors of heat and good conductors of electricity.

The properties used to describe 'non-metals' include: low melting point gases, liquids and solids; brittle when solid; not shiny; poor conductors of heat and poor conductors of electricity. Perhaps the most useful property at this stage is the conduction of electricity – all metals are good conductors of electricity, with all non-metals (excepting graphite) being poor conductors. There are other exceptions to the rules: mercury is a liquid at room temperature, iodine crystals are shiny and so on. The metals and non-metals in the periodic table are separated by a zig-zag line, with the metals to the left and the non-metals to the right.

7Hd Making compounds
This topic deals with the reaction of elements to form simple two-element compounds. As an example, the Student Book details the formation of iron sulfide.

An introduction to the role played by energy in reactions should be discussed. In most spontaneous reactions, energy is released in the form of heat. Some input of energy is needed to start the reaction off, however; for example, a mixture of iron and sulfur needs to be heated but once the reaction has got going, the heat source can be removed. The role of energy in reactions is revisited in more detail in later units, and thermochemical terms such as 'exothermic' and 'endothermic' should not be used.

The fact that some compounds such as iron sulfide form a lattice structure composed of billions of atoms, rather than forming molecules, is mentioned in the Student Book. It is not necessary, however, to stress the different types of structures that atoms can form. Matter can be classified in different ways, depending on the structure its atoms form. For example, we could split matter up into four groups: single atoms, discrete molecules, large molecules of varying size and lattice structures. The single atoms would be the noble gases. The discrete molecules would include covalently bonded elements and compounds such as oxygen, nitrogen and carbon dioxide. The large molecules of varying size would include natural and man-made polymers. The lattices would include ionic, metallic and covalent lattices. At this stage it is not necessary to stress the different types of structure. These ideas will evolve as the students learn more about matter, structure and bonding.

This topic shows how simple compounds can be named using the IUPAC rules. Compounds containing two elements are named by stating the name of the metal, for example 'iron', followed by the name of the non-metal with the ending changed to '-ide', e.g. 'sulfide' to give iron sulfide.

Electronegativity is a measure of the attraction that an element's atoms have for the electrons in a bond. These are calculated values and several are available. The most commonly used are Pauling's electronegativity values. In general the least electronegative element is the one furthest left/down in the periodic table. The most electronegative element is the one furthest right/up in the periodic table.

In some compounds the oxidation state is added to the name, such as copper(II) oxide, where the (II) is the oxidation state and refers to the charge (or apparent charge) on the metal ion. In others, the names include a prefix to indicate the proportions of the elements (for example, sulfur dioxide and sulfur trioxide for SO_2 and SO_3).

Note that the formation of all compounds depends on the formation of bonds between the atoms of the reacting elements. The nature of all chemical bonding is based on the electrostatic forces of attraction between the positive protons in the nucleus of one atom and the negative electrons of another atom. Explanations of chemical bonding are not necessary at this stage.

7He Chemical reactions/Problems with elements
The first articles used by humans would have been based on natural materials – stone, wood and natural fibres derived from plants shaped to suit their purpose. Later we would learn how to make new materials by chemical reactions, and so we would start to exploit the elemental resources from the Earth's crust.

This topic reviews the nature of chemical reactions and the signs which indicate that a chemical change has occurred.

The topic explains how to name compounds containing three different elements, where one of these elements is oxygen. The rules are the same as for two-element compounds except that the ending changes to '-ate', such as sodium sulfate (Na_2SO_4).

Thermal decomposition and the role energy plays in these reactions should be discussed. Unlike reactions involving the formation of compounds where heat is often given out, the decomposition of compounds often needs an input of energy. Heat is not only needed to start the reaction, but is required to keep

the reaction going. Unreactive metals, such as gold and silver, are found naturally as the 'uncombined' element. However, other metals, such as copper and tin, need to be extracted from their ores. These metals are obtained by the thermal decomposition of their metal oxides or carbonates by heating with wood or charcoal.

Copper and tin are among the easiest metals to extract from their ores. They can be produced by smelting the ores with wood or charcoal. Thus bronze, an alloy of copper and tin, was one of the first metals to be produced and used on a large scale. Note that, in general, mixtures of metals have different properties from the pure metals. They often tend to be harder and can have other improved properties.

Iron ore is more plentiful than copper ore, but the temperatures required to extract iron from its ore are much higher and therefore it requires more sophisticated technology. The first types of iron were produced about 1000 BCE and thus the Iron Age began.

The terms 'reactants' and 'products' are also introduced, and students are also given opportunities to write word equations for simple reactions.

7Ha
The air we breathe

Objectives

Developing:

1. Describe the difference between a mixture and a pure substance.
2. State that all matter is made up of tiny particles called atoms.
3. Interpret particle models of atoms, molecules, elements, compounds and mixtures, and explain the meaning of each term.

Securing:

4. Explain, in terms of atoms and particles, how air is a mixture of elements, compounds, atoms and molecules.
5. Represent atoms, molecules of elements and simple compounds using a model.

Exceeding:

Exceeding objectives are designed to broaden students' skills and knowledge beyond what is required, often introducing a higher level of challenge.

6. Recall that atoms can be joined together by bonds and that bonds affect the shape of a molecule.

Focused Working Scientifically/Scientific Enquiry objectives

1. Interpret, use and draw tables, bar charts, pie charts, scatter graphs and line graphs.
2. Classify data as: quantitative, qualitative, discrete/discontinuous, continuous.
3. Choose appropriate ways to present different types of data.

The scientific skills focused on in this topic are some of those students generally have most difficulty with, and are skills common to all curricula. They are further developed and reinforced in the main content pages. Other scientific skills are introduced and developed within the main content pages.

Student materials

Topic notes

- Students are unlikely at this stage to have encountered pie charts, line graphs and scatter graphs in maths so the concepts may need to be introduced for the first time. The Skills Sheets can provide support with this.
- It is important that teachers review all materials that they intend to use with students before use, to ensure suitability.
- It is envisaged that in the course of studying the chemistry component of this topic, students will use one Starter idea, Explaining 1, one further Exploring or Explaining idea, and one of the plenaries. Additional activities can be added as time allows.

STARTERS

1: Quick Quiz

BA

Use the 7H Quick Quiz for baseline assessment. Students can use the 7H Quick Quiz Answer Sheet to record their answers. Use either the whole Quick Quiz (which can be revisited at the end of the unit) or simply the Quick Quiz questions which relate to this topic. These questions can be revisited formatively in a plenary for this topic. See the ASP for more information about Quick Quizzes.

Course resources
ASP: 7H Quick Quiz; 7H Quick Quiz Answer Sheet.

2: Particles

BA

Get students to think back to Unit 7G work on the arrangements of particles in solids, liquids and gases. Ask them to draw the particle arrangements in a solid, liquid and gas, or present them with three different diagrams and ask which is which. Ask students questions about the particles to ascertain any previous knowledge about atoms, molecules, elements or compounds. Possible questions include: Are the particles the same in each state? Are the particles in a liquid the same as or different from the particles in a gas?

3: Terms of matter

BA

Write the following words: atom, chemical change, compound, element, matter, molecule, mixture, physical change, pure. Ask students to make up a table containing these words, adding a definition of what they think each word means with examples and an illustration where possible. Collect in word sheets from each student and revisit lists formatively in Plenary 4.

4: About purity

BA

Students draw up a table on a piece of paper with two columns, one headed 'pure' and the other 'mixture'/'impure'. Ask the students, individually or in groups, to think about the meaning of the words in the headings and then list as many words or phrases connected with the headings as possible.

Possible associated terms for pure could be: clean, wholesome, nice, alone, good for you, not mixed, 100%, genuine, natural, regular, nothing else.

Possible associated terms for mixture/impure could be: nasty, unclean, not alone, poisonous, mixed, polluted, dirty, assorted, various, lots of things, not one thing.

The students' answers could be displayed to allow everyone to see them. Use the results to initiate a discussion about the meaning of the words 'pure' and 'impure', when referring to matter.

Students should be given time to amend their own table using ideas from the class discussion. They should make any changes in a different colour so it is clear to them where there may be gaps in their knowledge.

EXPLORING TASKS

1: Investigating air

WS

This practical can be used to carry out a Working Scientifically investigation. A set of descriptions to assign developing, securing or exceeding to the work is provided in the ASP. Even if this is not formally assessed, the descriptions could be used for students to mark each others' work and to provide formative feedback to each other.

Start by placing a burning candle under a beaker, discuss what happens and why it happens. Talk about the idea that air contains oxygen and that oxygen is needed for and is used up by burning. Then discuss possible questions that could be investigated, along with suitable variables and methods for investigations with the class.

Developing: Students look at instructions on Worksheet 7Ha-2.

Securing: Students look at Worksheet 7Ha-3 for more aspects on planning and evaluation.

Exceeding: Students carry out the investigation given in the first part of Worksheet 7Ha-3, up to and including the apparatus list. Students then have the opportunity to do all the planning of the method for the investigation.

Rather than each group repeating the experiment several times with different-sized beakers you may wish to give each group a different size of beaker and then use the results of all groups to draw the scatter graph.

Get students to write a short paragraph stating what they have learned about air.

Take care to keep flammable materials away from the flame. Wear eye protection.

Course resources
AP: Worksheets 7Ha-2; 7Ha-3.
ASP: 7H WS Investigations.

Equipment (per group)
Individual eye protection, tea light/candle, different-sized beakers (200 cm^3, 300 cm^3, 400 cm^3, 500 cm^3), heat-resistant mat, stop clock, lighter.

2: Toy plastic brick mixtures

WS

Use different-coloured toy plastic bricks for students to build up representations of different types of matter. Each group makes one of: a pure solid element; an almost pure/impure solid element; a solid compound; a gas element; a gas compound; a mixture of gas elements; a mixture of gas compounds; a mixture of gas elements and compounds. Include substances composed of atoms but also those made up of molecules. Place each representation at a numbered 'station' next to its 'state of matter' label around the room. Students could be asked to go round each station and decide whether the models represent the kind of matter at each station accurately. Rough paper should be provided for them to make notes explaining how the model works or does not work. If help is needed, write a list of appropriate words and phrases to be used on the board.

Groups could be allowed to use feedback from others to amend their models, which could be left on display for the duration of the topic

Alternatively, models could be made up by technicians to represent the different types of solid. Note there should only be a tiny amount of the impurity in the impure solid and the impurities could be several different colours.

Equipment
Plastic construction bricks.

3: Research a gas

Worksheet 7Ha-5 describes a research task to find information on one or more of the gases in air. A list of information to find out for each gas is suggested. Skills Sheets RC 1 and RC 4 can be used to help with researching and reporting skills.

Use the bullet points in the brief for this task as criteria for students to peer review each others' reports. Students could provide oral feedback to each other in pairs or small groups, after which they should be given an opportunity to apply the feedback to improve their reports. These resources could then be saved into a shared network area for students to use as a resource when they revise.

Course resources
AP: Skills Sheets RC 1; RC 4. Worksheet 7Ha-5.

Equipment
Internet/library access.

4: About the gases in air

WS

Worksheet 7Ha-9 gives students further practice at drawing bar charts and pie charts, and thinking about the options available when presenting data. Skills Sheets PD 3 and PD 7 may be useful.

Extend this activity by asking students to write questions that can be answered using the graphs they have drawn in this activity. The rest of their group just has to say which graph is better for answering the question – 'either', 'bar chart is better' or 'pie chart is better'. Challenge students to write a sentence about when bar charts are more useful than pie charts and vice versa, using the information in the Student Book spread 7Ha Sorting resource data.

Course resources
AP: Skills Sheets PD 3; PD 7. Worksheet 7Ha-9.

5: Displaying data

BA **WS**

Tell students about a series of investigations that could be done about air and ask them to sketch the type of chart or graph that they would draw for each. Students should be encouraged to add labels to the axes to show which variable goes where. Then ask students at random to say which graph they have drawn for each investigation and ask them to justify their choices. Go through each investigation, establishing that scatter graphs are to show relationships between quantities, line graphs generally show how something changes over time, bar charts are for comparing things and are often best for using when one variable is in words, and pie charts are useful for showing the part of a whole each thing contributes. Refer to the **AL** presentation *Presenting data* to reinforce these ideas. Note that it may be the first time that some students have encountered these charts and graphs.

A – Investigation to see if there is a link between the height of the wick of a candle under a jar, and the length of time it burns for (scatter graph).

B – Investigation to find out how much of each gas is in breathed-out air (pie chart).

C – Investigation to find out which of these is a favourite gas in the class – oxygen, nitrogen, carbon dioxide, argon (bar chart).

D – Investigation to find out how the amount of oxygen in the air changes over the course of a day (line graph).

E – Investigation to find the order of precise amounts of the different gases in the air (table).

Exceeding: Ask students to think of a title for a scientific investigation, a description of the data that would be collected and a description/sketch of how best to display the data. For example, 'What is the average daily temperature each month in one year?' would require a daily temperature taken at the same time and in the same place each day (data). The data would be displayed as a bar chart showing the average temperature for each month of the year – months on horizontal axis, temperature values on vertical axis.

The **AL** presentation *Presenting data* shows a series of slides with examples of different types of data that can be displayed in different ways: tables, bar charts, pie charts, scatter graphs and line graphs. Match these to the examples that students have produced.

Course resources
AL: Presentation *Presenting data*.

6: A new look at materials

FA

Set up a display of different materials for students to look at. You may wish to display the materials somewhere where students can be observed. Ask them how the materials might be sorted. Their suggestions might include: solids, liquids and gases, metals and non-metals, natural and manufactured, elements and compounds, mixtures and pure substances.

Ask students to classify the materials as elements, mixtures or compounds and to say how they made

their choice for each of the substances. In groups, students should discuss which of the substances are easiest and hardest to classify and why. Students should list which substances they feel least confident about, paying attention to these as they go through the unit.

Extend this activity by asking students to re-classify the substances using one of the other systems of classification identified at the start of the activity.

The correct hazard warning symbols should be on the containers. Mercury (toxic), chlorine (toxic) and bromine (very toxic and corrosive) should be stored in strong, sealed containers. If there are doubts about the capability of the class to examine these samples without damaging the containers, do not use these substances.

Equipment
Individual eye protection. A display of samples of various materials, each labelled with the name and hazard symbol, heat-resistant mat. Possible materials: sulfur, copper, mercury, chlorine, bromine, oxygen, iron, carbon, aluminium, nitrogen, carbon dioxide, wood, polythene (or other plastic), glass, pure water, sea water, air, salt.

EXPLAINING TASKS

1: 7Ha Our material world (Student Book)

BA

This unit starts by reviewing some ideas about matter, and chemical and physical change. This acts as an introduction to the topics in this unit, which are used to build an understanding of chemical reactions and different types of chemical reactions. Questions 1, 2 and 3 can be used for baseline assessment for the topic. The **AL** interactive *Chemical and physical change* helps students to revise the chemical and physical changes in the context of the world around us.

Course resources
AL: Interactive *Chemical and physical change*.

2: 7Ha Sorting resource data (Student Book)

FA

These two pages ask students to think about different ways of sorting and presenting data, including the use of tables, bar charts, pie charts and scatter graphs. Questions 1 and 2 can be used for formative assessment.

The **AL** spreadsheet *Data sort* contains further examples of different types of data which can be displayed in different ways.

Students can represent information to check understanding, for example making a concept map or table to illustrate different graphs and their uses. Skills Sheets PD 2, PD 3, PD 6 and PD 7 may be useful for this activity.

Note that the percentages in figure C do not add up to 100% because of rounding.

Course resources
AP: Skills Sheets PD 2; PD 3; PD 6; PD 7.
AL: Spreadsheet *Data sort*.

3: 7Ha The air we breathe (Student Book)

FA

This spread looks at the different types of particles in air to introduce atoms and molecules, elements and compounds. Worksheet 7Ha-1 is the Access Sheet. Questions 1 and 2 can be used as baseline assessment. Question 6 can be used for formative assessment with students working in groups to answer the question. See the ASP Introduction for ideas on how to run the feedback and action components for this formative assessment. This also contains mini-plenary ideas.

The **AL** interactive *Our atmosphere* shows the arrangement of particles in air and how they can be classified. Ask students to think about how well the activity acts as a model of particles in air. This could be done by asking students to write down one good point and one poor point about the animation and share these ideas in their groups. Groups can then submit their agreed good and poor points to a class discussion, which will help to reveal understanding and misconceptions about the science involved. Ask students to think about how well the animation acts as a model of particles in air. This could be done by asking students to write down one good point and one poor point about the animation and share these ideas in their groups. Groups can then submit their agreed good and poor points to a class discussion, which will help to reveal understanding and misconceptions about the science involved.

The AL interactive *Particles in elements, compounds and mixtures* asks students to label images of substances to identify the types of particles they contain.

Course resources
AP: Worksheet 7Ha-1.
AL: Interactives *Our atmosphere*; *Particles in elements, compounds and mixtures*.

4: Elements, compounds and mixtures
Display a variety of space-filling models showing elements, mixtures and compounds. Explain to students that the representation of elements and compounds in this way is a model, and one that provides a good way of showing the differences between elements and compounds. Explain to students what to look for when deciding whether something is an element or a compound. You can extend this by asking students to pick appropriate terms to describe models as you display them (e.g. pure, mixture, atoms, molecules, element and compound).

Equipment
A variety of space-filling models showing elements, mixtures and compounds.

5: Atoms, molecules, elements and compounds
Give students the opportunity to recognise and draw a variety of different types of substance including: pure substances, and mixtures containing elements and compounds, including atoms and molecules.

Developing: Students use Worksheet 7Ha-4 to help them recognise the nature of a substance using particle diagrams.

Securing: Students use Worksheet 7Ha-6 to construct particle diagrams containing atoms, molecules, elements and compounds.

Exceeding: Students use Worksheet 7Ha-8 to practise drawing particle diagrams containing atoms, molecules, elements and compounds.

All students (whether working on Developing, Securing or Exceeding objectives) will have to develop a system for making sure that their different atoms look different. Their systems can be looked at in Starter 2 in the next topic.

Course resources
AP: Worksheets 7Ha-4; 7Ha-6; 7Ha-8.

PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

1: Quick Check WS
FA WS
Assessment: The 7Ha Quick Check WS sheet provides a set of simple questions about drawing and using different types of chart.

Feedback: Ask students to confer with one another in order to check their work. Any disagreements should be settled by the teacher. Then review the answers to the questions with the class.

Action: Students note where they were wrong and describe what they have to do in order to be able to get the answers right if they were given a similar sheet in the future

Course resources
ASP: 7Ha Quick Check WS.

2: Thinking about mixtures
FA
Use the following thinking skills questions to explore common mixtures.

Plus, Minus, Interesting: Tap water should come with a list of the substances in it, like bottled water does. (Possible answers: **Plus** – we would all know exactly what we were drinking; **Minus** – a list of chemicals might put some people off drinking the water; **Interesting** – does tap water contain any minerals that are good for you? You can get information about what is in your tap water from the local water company.)

Plus, Minus, Interesting: The sea should be pure water. (Possible answers: **Plus** – we would be able to drink it; **Minus** – we would not be able to get sea salt for cooking; **Interesting** – what would happen to all the salt? The amount of salt in sea water from different seas is not the same.)

Consider All Possibilities: A sample of air contains more carbon dioxide than usual. (Possible answers: it is air that has been breathed out by someone; something has been burnt in the air; the test was inaccurate.)

Odd One Out: nitrogen, oxygen, carbon dioxide. (Possible answers: carbon dioxide is a compound and the other two are elements.)

Odd One Out: tap water, sea water, mineral water. (Possible answers: tap water is manufactured and

the other two are natural; sea water is the only one we cannot drink as it contains large quantities of sodium chloride.)

The AL presentation *7Ha Thinking skills* accompanies this exercise.

Feedback: Students answer the thinking skills questions in groups, giving each other feedback to arrive at a shared response.

Action: Ask students to write down their group's best answer and consider why they think this is the best. Carry out the same process for the weakest answers, with students writing down how they need to improve. These reflections could benefit from categorising the areas of strength or weakness, e.g. 'did not understand the science ideas'; 'did not read the question properly'; 'did not make enough separate points'. Ask a spokesperson from a number of groups to read out their best answer and why they think it is good. Identify any ideas that are missing and share them with the class. Share weaknesses in groups' answers in a similar way. List the most common areas needing improvement for the class and make these a focus in future activity. If understanding is poor then revise the concepts using the Student Book.

Course resources
AL: Presentation *7Ha Thinking skills*.

3: Quick Check

FA

Assessment: The 7Ha Quick Check sheet provides a set of statements that can be applied to elements, mixtures or compounds. Students must identify which term should be applied to each statement.

Feedback: A completed grid should be supplied for students to check each others' answers.

Action: Students should then be given an opportunity to make corrections. Any disagreements or problems should be discussed with the class and individual students during and after the corrections.

Course resources
ASP: 7Ha Quick Check.

4: Terms of matter

FA

Return the student sheets from Starter 3 with their definitions of the terms: chemical change, compound, element, matter, molecule, mixture, physical change and pure. Working in groups the students amend their definitions. Students should then compare their definitions with the word sheet. If students made a concept map at the start of the unit, these can be revised to incorporate new ideas and examples.

Equipment
Students' word sheets from Starter 3.

5: Questions for scientists

FA

Ask students to prepare two questions that they would like to ask about matter. Each question must be based around one of the key words from this topic: change, compound, element, matter, molecule, mixture, physical change and pure.

Then ask students to gather into groups of four or five and share their ideas. Each group should discuss the questions and agree on a list of four questions. These questions should be submitted to the class, and questions that are similar should be combined.

Ask students to vote on which are their favourite questions. If one question gets more than half the votes, pick it, and let everyone have another vote. Otherwise count up the votes for each question and pick the top four to put to a scientist. There are various ways you could do this (e.g. on 'Ask a scientist' sites on the Internet, on general question and answer sites, on Twitter). Compare the answers you get from the different sites. Ask students to suggest which of the answers they think carry the most weight, giving their reasons.

HOMEWORK TASKS

1: Types of matter
Worksheet 7Ha-7 provides practice in recognising the difference between atoms and molecules, and elements and compounds based on particle diagrams. It also asks questions about the difference between elements, compounds and mixtures.

Course resources
AP: Worksheet 7Ha-7.

2: Substances in air
Worksheet 7Ha-8 provides practice in drawing atoms and molecules found in air. It also asks questions about recognising compounds and the differences between pure substances and mixtures.

Course resources
AP: Worksheet 7Ha-8.

3: Concept maps
Worksheet 7Ha-10 asks students to complete a concept map on the classification of matter, which should include information on atoms, molecules, elements and compounds. It also contains some more challenging questions on molecules. Students will have to develop a system for making sure that their different atoms look different. Their systems can be looked at in Starter 2 in the next topic.

Course resources
AP: Worksheet 7Ha-10.

7Hb
Earth's elements

Objectives
Developing:

1. Recall that different materials have different properties.
2. Recognise some symbols for common elements.
3. Relate the uses of different elements to their properties (including gaseous elements in the air).

Securing:

4. Explain the advantages of recycling metals.
5. Explain why internationally agreed symbols and conventions are useful in science communication.

Exceeding:

Exceeding objectives are designed to broaden students' skills and knowledge beyond what is required, often introducing a higher level of challenge.

6. Explain how new evidence has changed ideas about elements.

Student materials

Topic notes

- Information about the number of elements can be found in the Background information for this topic.
- The periodic table is dealt with in greater detail in Year 8.
- It is important that teachers review all materials that they intend to use with students before use, to ensure suitability.
- It is envisaged that in the course of studying the chemistry component of this topic, students will use one Starter idea, Explaining 1, one further Exploring or Explaining idea, and one of the plenaries. Additional activities can be added as time allows.

STARTERS

1: The beginning of elements

BA

Ask students to list all they know about elements and compounds, including examples of each. Then ask what the students hope to learn about elements in this topic. If there are any questions they could be noted and reviewed later in the Explaining Tasks. The **AL** interactive *The elements in the Earth* can be used by students to investigate methods for extracting natural elements from the Earth and information about the elements themselves (finite resources and so on).

Course resources
AL: Interactive *The elements in the Earth*.

2: Symbols

BA

Stress to students the importance of symbols around us. Get students to suggest some everyday symbols, prompting them (for example) to think about symbols on keyboards or MP3 players or video games. Tell students that elements can also be represented by symbols. The **AL** presentation *Symbols for elements* shows Dalton's symbols for the elements (also found on the Student Book spread 7Hb Earth's elements). If students have completed Homework 2 or Homework 3 from the last topic, ask them to describe how they have shown different atoms. Compare their ideas with Dalton's and then use the **AL** presentation *Periodic table*. Establish that symbols are useful because they take less time to write and can be understood by people all over the world, who do not necessarily speak a certain language.

Course resources
AL: Presentations *Periodic table*; *Symbols for elements*.

3: Element or not?

BA

Give students a list of materials encountered in Topic 7Ha (e.g. sulfur, copper, mercury, chlorine, bromine, oxygen, iron, carbon, aluminium, nitrogen, carbon dioxide, wood, polythene (or other plastic), glass, pure water, sea water, air, salt) and ask them to sort the list into two groups: elements and other substances. This could be achieved by arranging sticky notes with the names of the substances on them. Ask students to recall the definition of an element and discuss how an element might be different from a non-element in terms of particles. Get some students to show their ideas on the board. Discuss any questions.

EXPLORING TASKS

1: About elements

BA

Ask students to find out about specific elements, using secondary sources such as the Internet and data books. Give them about five elements each and ask them to write down one question about each and information like: its symbol, state at room temperature, % abundance in the Earth's crust, appearance, where it is found, its uses and any other useful or interesting information. Ask students to research and present information addressing these questions on a sheet of A4 paper so that the sheets can be put together for a class display of the periodic table. There are many suitable websites for this kind of research.

Equipment
Internet/library access, paper, coloured pencils.

2: Elements' symbols

Issue students with a basic periodic table with names and symbols (Skills Sheet SC 5) and ask them to colour in the symbols that match the letters of each element's name. Ask students why some elements need to have a two-letter symbol and why some do not use the first two letters of their name. Extend this activity by asking students to find out how some other element symbols were chosen (e.g. W, Au, Ag, Pb, Cu) and annotate their periodic table with this information.

The **AL** presentation *Symbols for elements* can be used as a quick-fire quiz on the symbols for common elements (with a range of photographs of elements, names and symbols given). Encourage students to make notes of areas that they need to review.

Course resources
AP: Skills Sheet SC 5.
AL: Presentation *Symbols for elements*.

Equipment
Coloured pencils, Internet/library access.

3: Elements bingo

This can be used as a fun activity that can also develop students' skills in information retrieval and reinforce some of the key ideas introduced during the topic. Differentiation is achieved by the degree of teacher input. The bingo cards provided on Worksheet 7Hb-2 are a simplified version of the periodic table. The teacher acts as caller. The students should have access to a simple periodic table (see Skills Sheet SC 5).

Developing: Students could be told the name of an element and its chemical symbol, which they then cross off on their cards if they have it.

Securing: The teacher reads out the name only, with some clues as to where the element is located in the periodic table. This can then reinforce ideas about the positions of metals and non-metals in the table. Students then have to look up the symbol on the periodic table (see Skills Sheet SC 5) before crossing it off.

Exceeding: The teacher gives some background information, key properties and/or clues as to the location of the element in the table. Students have to work out the name of the element and then look up the symbol. Students could highlight the elements and groups that they know in an outline of the periodic table. This can be added to as they discover more about elements and their properties.

Course resources
AP: Skills Sheet SC 5; Worksheet 7Hb-2.

4: Recycling phones

Ask students to find out what metals are in their mobile phones.

Developing: Students should find out how much the metals in their phones are worth. They should then write a statement about the benefits of recycling phones. This could take the form of a paper poster or online advert.

Securing: Students should also find out why each of the metals is used.

Equipment
Internet/library access.

5: The components of air

Ask students to do some research to find out some uses for the six most common gases in the atmosphere (see Background information). Students should present their findings as an ordered table, which should include the names of the gases, their percentages in the air and one use for each.

EXPLAINING TASKS

Get students to look at the 'class questions' about the unit, if these were agreed in Starter 1. After carrying out the explaining tasks, they should identify which have been answered for them and which they are still unsure about.

1: 7Hb Earth's elements (Student Book)

FA

Questions 1 and 2 can be used for baseline assessment, and Questions 7 and 8 for formative assessment for this topic.

The topic looks at the elements found on Earth and how the Earth's crust is our source of all the elements we use for living.

Worksheet 7Hb-1 is the Access Sheet.

Developing: Students use copies of the periodic table to write clues for the crossword on Worksheet 7Hb-3 using sentence starters 'An element with the symbol ...' or 'The symbol for …'.

Securing: Encourage students to work in groups and use secondary sources of information to look up facts about the elements on Worksheet 7Hb-3 in order to write clues.

Exceeding: Students can use Worksheet 7Hb-4 to extend their knowledge and understanding of elements' names and symbols.

Course resources
AP: Worksheets 7Hb-1; 7Hb-3; 7Hb-4.

2: Molecules of elements and compounds

WS

Use molecular model kits to demonstrate the distinction between atoms and molecules, and between molecules of elements and compounds. Ask students to write down some definitions of these terms and to explain the distinctions.

Equipment
Molecular model kits.

3: Elements in use

Show the class some large samples of elements from the store cupboard. Tell them their names, and ask students to find their symbols. Then, for the elements, discuss their properties and how the property is linked to a use. Some possible examples are: copper (Cu, malleable (bendy), used for roofs and posts); lead (Pb, dense (heavy), used for flashings and as a weight for divers and fishing); carbon (graphite, C, soft and breaks away, used in pencil leads); mercury (Hg, liquid metal, used in thermometers); sulfur (S, burns easily, used in matches).

Equipment
Large-sized samples of different elements.

4: Looking at elements

Show students some displays of elements in sealed containers. Suitable examples would cover a range of structural types and uses. Describe the properties of each element and link these properties to uses.

Securing: For each element, show students a diagram of how its atoms are arranged, reinforcing the idea that there are many different ways in which atoms can be arranged and these can be modelled.

Exceeding: Make links between some of the atomic arrangements and the properties of the elements.

Possible elements to use: sulfur (S_8 molecules, powder can be used as a pesticide); copper (lattice structure, roofing material); oxygen (diatomic molecules, oxygen supplies in hospitals); phosphorus (P_4 molecules, used to be used in matches but is poisonous); mercury (closely packed atoms able to move over each other, used in thermometers); iron (lattice structure, bridges, steel supports); and zinc (lattice structure, roofing).

This could be concluded by considering some of the properties and uses of the elements.

Equipment
Samples of elements in sealed containers, e.g. sulfur, copper, oxygen, phosphorus, mercury, iodine, iron and zinc (use a substitute for phosphorus, if included, or something that looks like it and is kept under water like the real thing).

PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

1: Quick Check

FA

Assessment: The 7Hb Quick Check sheet contains a series of statements about elements. Students have to agree or disagree with the statements. It also includes some questions on element symbols and uses of metals.

Feedback: Students should work in pairs to check their work. They should take each statement that they think is wrong, and explain why it is wrong.

Action: Students then review the answers to the questions with the class. They should note where they were wrong and write explanations for the corrections.

Course resources
ASP: 7Hb Quick Check.

2: Thinking about the Earth's elements
Plus, Minus, Interesting: There should only be 10 elements. (Possible answers: **Plus** – simpler to learn the elements' properties; **Minus** – you would not get the variety of compounds we have now; **Interesting** – could we still make the complex molecules needed for life? Between 2000 and 2010, scientists created five new elements.)

Consider All Possibilities: A substance contains the atoms of three different elements. (Possible answers: it is a mixture of three separate elements; a mixture of one element and one compound; a single compound.)

Odd One Out: iron, silicon, carbon dioxide. (Possible answers: iron, as it is the only metal; carbon dioxide, as it is the only compound – the others are elements; carbon dioxide, as it is the only gas.)

Plus, Minus, Interesting: All elements should have the same abundance in the Earth's crust. (Possible answers: **Plus** – there would be a plentiful supply of all elements and none of our sources would run out; **Minus** – there may be more poisonous compounds formed, or the soil may not support plant life, or some reactive elements may remove oxygen from the air; **Interesting** – what would the rocks and soil on Earth look like?)

Odd One Out: lead, phosphorus, potassium. (Possible answers: potassium's symbol does not have a P in it; lead does not begin with a P; phosphorus is non-metal; potassium is on the left-hand side of the periodic table.)

Odd One Out: gold, aluminium, potassium. (Possible answers: gold can be found in its native state; potassium only has one letter in its symbol; gold is used in jewellery.)

Plus, Minus, Interesting: We should recycle mobile phones. (Possible answers: **Plus** – we would need to mine less of the valuable metals used to make phones; **Minus** – it takes some effort to get people to recycle their phones, if we use less of the metals there may be fewer jobs for miners; **Interesting** – how much are the metals in a mobile phone worth? There is up to £2-worth of gold in many mobile phones.)

What Was The Question: iron. (Possible answers: Name an element that is cheap and strong. Name an element used to make bridges. Name an element that has been known for thousands of years.)

The (AL) presentation *7Hb Thinking skills* contains the answers to these questions.

Feedback: Students answer the thinking skills questions in groups, giving each other feedback to arrive at a shared response.

Action: Ask students to write down their group's best answer and consider why they think this is the best. Carry out the same process for the weakest answers, with students writing down how they need to improve. These reflections could benefit from categorising the areas of strength or weakness, e.g. 'did not understand the science ideas'; 'did not read the question properly'; 'did not make enough separate points'. Ask a spokesperson from each of a number of groups to read out their best answer and to say why they think it is good. Identify any ideas that are missing and share them with the class. Share weaknesses in groups' answers in a similar way. List the most common areas needing improvement for the class and make these a focus in future activities. If understanding is poor then revise the concepts using Student Book spread 7Hb Earth's elements.

Course resources
AL: Presentation *7Hb Thinking skills*.

3: Elements quiz
(FA)
Assessment: Ask students to make up a quiz sheet about elements, their properties and symbols (with model answers on a separate sheet). These could be done in the same format as the Quick Quiz (i.e. multiple choice, which will make any marking of correct/incorrect answers easier).

Developing: Students will be assisted if they have access to a periodic table (such as Skills Sheet SC 5).

Feedback: The students should then swap their quiz sheets with other students, for them to answer.

Action: Any disputed answers, and questions, should be brought to a class discussion.

Course resources
AP: Skills Sheet SC 5.

4: Element disappearance
(FA)
Students play in pairs, taking turns to identify the name and symbol of an unknown element. Make this a simple game with only nine guesses.

Draw an image of a person on the board with nine strokes (e.g. two arms, two legs, stick body, head, two eyes and a smiley face). For each wrong letter

guess, remove one component of the person. The game is over when the last component is removed.

Developing: Students will be assisted if they have access to a periodic table (such as Skills Sheet SC 5).

Course resources
AP: Skills Sheet SC 5.

HOMEWORK TASKS

1: Names and symbols
Worksheet 7Hb-5 contains a wordsearch and questions on the elements, which involve the students using the periodic table.

Course resources
AP: Worksheet 7Hb-5.

2: Silicon and germanium
Worksheet 7Hb-6 contains questions on the elements, their discovery, properties, uses and symbols.

Course resources
AP: Worksheet 7Hb-6.

3: Thinking about elements
Worksheet 7Hb-7 provides more challenging activities on the make-up of matter, by considering different ideas about elements.

Course resources
AP: Worksheet 7Hb-7.

7Hc
Metals and non-metals

Objectives
Developing:

1. Identify some common materials as being metals or not.
2. Describe common physical properties of metal and non-metal elements (electrical/thermal conductivity, state, shininess).
3. Relate the uses of different elements to their properties (includes magnetism).

Securing:

4. Describe further physical properties of metal and non-metal elements (malleability, ductility, brittleness).
5. Use evidence to classify unfamiliar materials as being metal elements, metallic, non-metal elements, non-metallic.

Exceeding:

Exceeding objectives are designed to broaden students' skills and knowledge beyond what is required, often introducing a higher level of challenge.

6. Interpret experimental evidence to identify elements.

Student materials

Topic notes

- It is important that teachers review all materials that they intend to use with students before use, to ensure suitability.
- It is envisaged that in the course of studying the chemistry component of this topic, students will use one Starter idea, Explaining 1, one further Exploring or Explaining idea, and one of the plenaries. Additional activities can be added as time allows.

STARTERS

1: Uses of metals

BA

Introduce a display of different metals to the class and ask students to match each metal with a possible use. Could also have objects made of the same metals to show the different uses before or after class discussion. Then challenge students to explain why they have made those matches. At this stage it may just be 'because our pans at home are aluminium' rather than linking with actual properties. But the Starter will get students used to thinking about metals and properties and teachers may gain some insight into what their students know about metals already.

Equipment
A display of different metals and metal objects: copper and electrical wire, aluminium and other metal cooking pots, mercury and thermometer, zinc and nail, tin and tin can, iron and car part, etc.

2: Ideas about metals

BA

It can be expected that all students are familiar with the word 'metal', and will be bringing to the topic some prior knowledge of what metallic properties are. Start with a collection of objects on a tray – ask students to identify those that are metals. Ask students the criteria that they use to judge whether something is a metal. Note these down and revisit them at the end of the topic. The obvious visible indicators, such as the shiny appearance, are likely to be known from general knowledge, or work at primary.

Equipment
A variety of objects containing a number of different metals and non-metals.

3: What is the can made of?

BA

Show students two similar cans (one made of steel and one made of aluminium) and ask what they are made of (answer: metal). Expand by asking what properties metals have in common. You could write the statement 'All metals are …' on the board and ask students to list possible properties (such as conduction of heat and electricity, and some might suggest magnetism). Finally, ask students how they know which can is which and then demonstrate using a magnet that they are indeed different. Ask students to consider how this property can be useful when recycling metals. This could then lead naturally on to the practical work in Exploring 3.

Equipment
Steel can, aluminium can, magnet.

EXPLORING TASKS

1: What is a metal?

WS

Students carry out three tests to examine the thermal conduction, electrical conduction and density of metals. These tests draw on ideas introduced in earlier units.

Developing: Students use Worksheet 7Hc-2 to provide a structured approach to the three properties tested.

Securing: Students use the more open-ended approach of Worksheet 7Hc-3 to help plan an investigation to classify substances as metals or substances that are not metals using three properties.

Check students' plans before the practical work starts.

Get students to make a summary table of the materials tested, showing all the properties investigated in these experiments.

Care with hot water for test 1 (do not heat above 60 °C).

Course resources
AP: Worksheets 7Hc-2; 7Hc-3.

Equipment
Individual eye protection.
Test (1): 250-cm^3 beaker, access to kettle, rods of iron, copper, plastic, wood, glass and aluminium.
Test (2): Circuit board or equivalent, cell, connecting wires, bulb, crocodile clips, samples as for Test (1).
Test (3): Blocks/cubes of materials as listed in Test (1) (*which must have equal dimensions)*, access to balance.

2: Magnetic materials

The AL animation *Magnetic materials* shows a 'virtual demonstration' in which eight metallic elements can be 'tested' to see if they are magnetic or not. In each case, ask students to locate the metal in the periodic table and predict whether or not it is magnetic. Collect the class votes before carrying out the test.

If students produced an annotated periodic table in the previous topic, get them to add annotations of properties of the metals they have explored in this topic, e.g. conductivity, weight and magnetism.

Course resources
AL: Animation *Magnetic materials*.

3: Practical: sorting metals

WS

Review Starter 3 and discuss why it is important to be able to separate waste metals, and how the magnetic property of certain metals could be used to separate them, pointing out that magnets are made of magnetic metals. Show students the apparatus and ask them to work in groups to devise a set-up to separate the ball bearings and glass marbles.

Students then use a ramp and magnet system to design a simple materials sorter. In the real world context, magnets would be used to separate iron from other metals. If ball bearings of non-ferrous metals can be obtained, this would be a more realistic set-up. In practice, it is likely that a separation of steel ball bearings from glass marbles is a more practical option. Tell students that you are using this arrangement to model the behaviour in a genuine recycling facility.

Students may need varying amounts of help for this task. Ask them to produce a plan on paper before they attempt the practical. This would involve a trial and error method. The students should be encouraged to experiment with varying the magnet position and position of the marbles on the ramp to provide a reliable separation that will collect the different marbles in the two 'bins'. The class evaluation of the practical should include a discussion of all the variables involved and possible problems in real-life recycling plants.

Care should be taken to avoid the marbles going on the floor.

Equipment (per group)
Ramps, magnets (ceramic magnets will probably be best), two plastic pots (e.g. small ice cream containers), metre ruler, ball bearings, glass marbles of roughly similar size to ball bearings.

4: Properties and uses

Worksheet 7Hc-4 involves students in thinking about properties and the classification of elements and how properties are linked to uses. This task can lead on from the activity in Starter 3.

Developing: Students complete the worksheet.

Securing: Ask students to make their own versions of Question 2, using research if needed. Students swap their questions with one another to complete.

Course resources
AP: Worksheet 7Hc-4.

5: Classifying elements
Ask students to work in groups to discuss ways in which they think they could classify elements (e.g. solids, liquids and gases). Then ask them to complete Worksheet 7Hc-5, which challenges them to think about different ways of classifying elements, and use the periodic table to record information about different elements. At the end, encourage students to write statements to say how their ideas about classifying elements have changed as a result of doing this activity.

Course resources
AP: Worksheet 7Hc-5.

6: Investigating properties
Students work in groups to research the properties and uses of a group of linked elements (e.g. they are all common metals, they are all used in hospitals) in order to produce a joint presentation. Each group should decide what information they are going to research and how they are going to present it. The final presentation could be a joint booklet, information poster or Microsoft® PowerPoint presentation. Worksheet 7Hc-6 provides guidance on the style and content for their presentations.

Extend this activity by asking students to summarise new knowledge gained about the properties of metals and non-metals during their research. Using the outline periodic table is one way, annotating information on the groups or individual elements.

Course resources
AP: Worksheet 7Hc-6.

Equipment
Internet/library access.

7: Linking properties to uses
The (AL) interactive *Properties of metals* is a linking exercise that shows some of the uses of metals linked to their properties. Ask students to come up in turn, and drag one of the names into a space on the chart, or move one of the existing names if they think it is in the wrong place. When a consensus has been reached, check answers and explain any corrections that need to be made.

Course resources
AL: Interactive *Properties of metals*.

8: Extracting metals
At the end of the STEM spread 7Hc Obtaining metals, there is an activity in which students do some simple data analysis.

Start by going through the first question with students, identifying the data that they have been given in the activity box and comparing it with the roles and processes shown in diagram A in the Student Book spread 7Hc Obtaining metals.

Students should then show that the copper will be sold for less than the cost of production.

EXPLAINING TASKS

1: 7Hc Metals and non-metals (Student Book)
(FA)
Questions 1 and 2 can be used for baseline assessment, and Questions 7 and 8 for formative assessment, for the topic. This topic looks at the different properties of metals and non-metals and links properties to uses.

Worksheet 7Hc-1 is the Access Sheet.

These questions should be marked with written feedback, or students could check their answers against model answers. Students should be asked to make corrections to their responses in a different colour, then reflect on what they did well and where they need to improve.

The (AL) presentation *Metals and non-metals* contains pictures of different elements. Students are asked to look at each element, discuss its properties and then decide if it is a metal or non-metal.

Course resources
AP: Worksheet 7Hc-1.
AL: Presentation *Metals and non-metals.*

2: 7Hc Obtaining metals (Student Book)
This spread in the Student Book looks at some jobs in the mining industry, and the skills and training needed. There is a particular focus on critical analysis and evaluation (checking that you have enough good-quality data from which to draw a conclusion) and using percentages to make fair comparisons.

Before starting the spread, ask students what a percentage is and why we use percentages. Make

sure that all students realise that percentages are fractions of 100, and they are often used to make fair comparisons between things. Ask students for some everyday examples of where percentages are used to make comparisons (e.g. discounts when buying items).

For students that still struggle with percentages, Skills Sheet MS 2 *Percentages* may help.

Course resources
AP: Skills Sheet MS 2 *Percentages*.

3: Linking properties to uses

WS

Demonstrate some of the other properties of metals. In each case, link the property of the metal with a use.

Malleability: Using a rod of lead, a heavy hammer and an anvil, show how lead can be beaten into shape. Lead is beaten into shapes when used for roofing.

Flexibility: Use sheets of copper or tin, and a spring to illustrate flexibility.

Ductility: A useful property of metals is that they can be drawn into thin wires. Illustrate this property by having some examples of metal wires: copper, steel, etc. The term 'ductile' will be met further on in Unit 8G.

A safety screen and eye protection are needed for the malleability demonstration.

Equipment
Eye protection, safety screen, rods of lead, anvil, heavy hammer, sheets of copper or tin, steel springs.

PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

1: Quick Check

FA

Assessment: The 7Hc Quick Check sheet contains a series of statements about metals and non-metals that are all wrong in some way. Students have to explain why each statement is wrong.

Feedback: For each statement, ask for volunteers to explain what is wrong with the false statements. You could also ask students to hold up red/amber/green cards or smiley faces to show how confident they are in their answers.

Action: Note any areas where there were difficulties and go over each after checking answers. The sections of card should then be used to create a poster display on the properties of metals and non-metals. The class should agree which statements should be used in the posters. Any students with difficulties in this area should copy the final lists of properties from the posters.

Course resources
ASP: 7Hc Quick Check.

2: Thinking about metals and non-metals

FA

Use the following thinking skills questions as a plenary.

Plus, Minus, Interesting: Metal X is very flexible. (Possible answers: **Plus** – it can be made easily into complex shapes; **Minus** – the shapes may not hold; **Interesting** – are there other metals like this? Gallium is very flexible but will melt in your hand.)

Plus, Minus, Interesting: Gold is used for electrical connections. (Possible answers: **Plus** – it is a very good conductor of electricity; **Minus** – it is very expensive; **Interesting** – there is up to £2-worth of gold in many new mobile phones. Are there any metals that conduct electricity better than gold?)

Odd One Out: steel, aluminium, copper. (Possible answers: copper is red-brown in colour; steel rusts; steel is not an element).

Odd One Out: potassium, mercury, sulfur. (Possible answers: sulfur is a non-metal; mercury is a liquid; sulfur does not conduct electricity; sulfur does not conduct heat; sulfur is yellow.)

What Was The Question: It is a non-metallic mixture. (Possible questions: How could you describe air? How could you describe sea water? Why doesn't air conduct electricity?)

What Was The Question: It conducts electricity. (Possible questions: Suggest one property of metal Y. Why can't solid X be sulfur? Why is copper used for electrical wiring?)

What Was The Question: The right-hand side of the periodic table. (Possible questions: Where on

the periodic table are non-metals found? Where on the periodic table are you less likely to find metals? Where on the periodic table is chlorine found? Where on the periodic table are elements that are gases found?)

The AL presentation *7Hc Thinking skills* can be used to help with these questions.

Course resources
AL: Presentation *7Hc Thinking skills*.

3: Poster plenary

FA

Ask students to summarise the properties of metals and non-metals as a poster display showing examples of metals and non-metals, along with important properties and how those properties are related to the uses of the elements. Students may be able to download images from the Internet, but note that these may be under copyright.

Students could peer review the posters against criteria agreed in a brief for the posters before they start. Groups could produce their own brief or there could be a class brief. The criteria might include aspects of properties, uses, similarity to other materials, periodic table and recycling potential.

HOMEWORK TASKS

1: Metal or non-metal 1
Worksheet 7Hc-7 asks students to complete a list of properties of metals and non-metals (some first letters have been included). They then relate the use of some metals to their properties.

Course resources
AP: Worksheet 7Hc-7.

2: Metal or non-metal 2
Worksheet 7Hc-9 includes more challenging questions on the properties of metals and non-metals, relating their use to their properties.

Course resources
AP: Worksheet 7Hc-9.

3: Metal or non-metal 3
Worksheet 7Hc-10 asks students to use information on the properties of 10 elements to classify them as metals or non-metals. It also includes some challenging questions on identifying elements by their properties.

Course resources
AP: Worksheet 7Hc-10.

7Hd
Making compounds

Objectives
Developing:

1. Describe how elements can combine to form compounds in a chemical reaction, and some observations that a chemical reaction occurs.
2. Describe the changes in properties between a compound and its constituent elements.
3. Explain the differences between atoms, molecules, elements and compounds (including interpreting and using particle models).

Securing:

4. Name simple compounds formed from two elements.
5. Represent atoms, molecules of elements and simple compounds using a model.
6. Recall that metals are extracted from minerals found in rocky ores.

Exceeding:

Exceeding objectives are designed to broaden students' skills and knowledge beyond what is required, often introducing a higher level of challenge.

7. Write simple chemical formulae from molecular structures.

Student materials

Topic notes

- It is important that teachers review all materials that they intend to use with students before use, to ensure suitability.
- It is envisaged that in the course of studying the chemistry component of this topic, students will use one Starter idea, Explaining 1, one further Exploring or Explaining idea, and one of the plenaries. Additional activities can be added as time allows.

STARTERS

Students should review the class questions created at the start of the unit, ticking off any that they are now confident with and highlighting those relevant to this next topic.

1: Element or not?

BA

This is a 'quick-fire' Starter for reviewing elements and compounds. The **AL** interactive *Element or compound?* asks students to suggest which substances are elements and which are compounds. A quieter version of this activity could involve the use of red and green cards. Students hold up a green card for an element and a red card for a compound (not element). This activity could also be revisited as a plenary. Identify those photographs that cause difficulties and discuss them at the end in more detail. Ask individual students to voluntarily explain how they can tell if the example is an element or not. Other students should be encouraged to add any further thoughts.

Course resources
AL: Interactive *Element or compound?*

Equipment
Class set of red and green cards.

2: Ideas about elements and compounds

BA

Ask students to work together in pairs to agree a definition of element or compound, together with an example. They must not use the words 'element' or 'compound' in their definitions. Then ask a student at random to stand up and read out their definition. Ask another student to say whether the definition is one for an element or one for a compound. Definitions could include particle diagrams as part of their explanation. Correct any misconceptions and then repeat the questioning for a few more rounds.

3: Missing words and definitions

BA

Cut up the words and definitions from the Word Sheets for Topics 7Ha, 7Hb and 7Hc to make up sets for group work. Then remove one word and one definition from each set. Ask students to work together to match the words with the correct definitions and to write down the missing words and a definition for the missing definition.

Course resources
ASP: 7H Word Sheets.

EXPLORING TASKS

1: Iron and sulfur

WS

Students can make a compound from the two elements iron and sulfur. This experiment is shown in the Student Book and so you may wish to get

students to do the experiment before they look at the book.

Developing: Students follow instructions on Worksheet 7Hd-2, which also provides guidance on recording and considering results.

Securing: Students use Worksheet 7Hd-3 to plan their investigation.

A mixture of iron and sulfur, about 0.2 g, can be heated gently in an ignition tube. This should be pre-filled before the lesson. Once the reaction has started the tube should be removed from the flame, and the red glow will continue to spread through the tube, indicating that a reaction is taking place.

To remove the iron sulfide it will almost certainly be necessary to break the tube – for this reason the use of small ignition tubes is recommended. To remove the iron sulfide from the tube, wrap the tube in a cloth or rag and break the glass with a pestle or hammer. Use tongs to pick up the pieces of iron sulfide. This should be carried out by the teacher only.

Alternatively, the reaction could be carried out on a larger scale as a teacher demonstration (using a maximum of 2 g of mixture). There is some risk of the sulfur catching fire to form the toxic gas sulfur dioxide. This risk is reduced if excess iron is used. A mineral wool plug in the mouth of the tube will also reduce the risk of sulfur vapour escaping and igniting to form sulfur dioxide. The stoichiometric ratio of iron to sulfur is 1:1 in terms of atoms, or 56:32 in terms of mass. The exact ratio by mass will therefore be 7:4; a 2:1 mixture of iron to sulfur will therefore contain a small excess of iron.

Students are asked to test iron filings, sulfur and iron sulfide for magnetism and flotation. It is a good idea to use bought samples of iron sulfide for these tests. The iron sulfide formed from the students' practical is likely to be attracted to the magnet (due to the excess iron in the mixture, iron sulfide is not magnetic).

Students could be asked to test the substances with dilute acid. Iron sulfide should release the gas hydrogen sulfide. This gas has a strong and distinctive smell. Iron filings should give off the gas hydrogen but if the iron filings contain even minute quantities of iron sulfide then a 'false positive' will be obtained (that is, the smell of hydrogen sulfide). For these reasons, this test has not been included on the worksheets, and teachers are recommended to try out the test in advance with the iron filings that they have in stock to judge whether it is worth adding this test to the magnetism and flotation tests.

Hydrogen sulfide is very toxic and extremely flammable. Although the quantities involved are likely to be small, this reaction should be carried out in a fume cupboard. The human nose can detect hydrogen sulfide in very low concentrations. Eye protection should be worn when heating the iron and sulfur and when breaking the glass. Broken glass should be placed in the broken glass bin.

Course resources
AP: Worksheets 7Hd-2; 7Hd-3.

Equipment (per group)
Individual eye protection, test tubes, test-tube rack, one small test tube (ignition tube), ignition tube holder, Bunsen burner, mineral wool, magnet, iron, sulfur, mixture of iron and sulfur (2:1 mixture of iron to sulfur by mass), heatproof mat, cloth or rag, pestle or hammer, tongs.

2: Making compounds

WS

Worksheet 7Hd-4 allows students to practise their basic understanding of the changes that occur when a compound is formed.

Course resources
AP: Worksheet 7Hd-4.

Equipment
Coloured pencils.

3: Another compound

WS

Worksheet 7Hd-5 can be used to improve students' understanding of the changes that occur during the formation of compounds, the difference between elements and compounds and how simple compounds are named. The worksheet considers the changes involved in the formation of a compound that will be unfamiliar to the students.

Students can compare their answers to these sheets in small groups, annotating their own answers with any revisions. Where there is disagreement about any answer they should note this for a plenary discussion.

Course resources
AP: Worksheet 7Hd-5.

Equipment
Coloured pencils.

4: Hydrogen explosions

WS

The AL video *Explosions with hydrogen 1* shows the explosion of a hydrogen balloon with a voice-over describing the chemical reactions involved and the part energy plays in the reaction.

The AL animation *Hydrogen explosion* shows what happens during the explosion at a molecular level. Ask the students to watch the animation before telling them that some students in another class have missed this work. Tell them that their task is to create a flowchart with illustrations to explain what the animation showed. Students should compare their flowcharts to see if they missed any stages or detail, improving them after discussions in their group.

Course resources
AL: Animation *Hydrogen explosion*. Video *Explosions with hydrogen 1*.

5: Research

WS

Ask the students to use books or the Internet to find information on some common compounds.

Developing: Students find names of some common compounds and the names of the elements they are made from, together with differences between the properties of compounds and their constituent elements.

Securing: Students find uses for the elements and the compound.

In their groups, students should agree a brief for the format of the product of the research. For example, this could be a book, with chapters and sub-headings, illustrations, an index and a front cover. This encourages students to think about the key ideas to present, and gives them scope to be creative. Peer review of the books can be carried out between groups. The books should be judged against the criteria agreed at the start of the activity, and could include presentation, interesting communication techniques, scientific accuracy and accuracy of the text.

Equipment
Internet/library access.

6: Particles in elements, mixtures and compounds

Ask students to draw some, or all, of the following as particle diagrams: an element made up of atoms; a mixture of elements as atoms; an element made up of two-atom molecules; a mixture element made up of two-atom molecules; a compound containing two elements; a mixture of compounds. Initiate a discussion, in small groups or with the whole class, about elements, compounds and mixtures, the nature of pure and impure substances and how particle diagrams can be used to represent different substances.

7: An introduction to chemical formulae

WS

Worksheet 7Hd-6 challenges more able students by introducing simple formulae derived from molecular structures. Students could work independently and then compare and discuss their answers.

Extend this activity by asking students to write out what they would say to the class in order to teach everyone about how formulae are written out and derived from looking at molecular structures.

Course resources
AP: Worksheet 7Hd-6.

Equipment
Coloured pencils.

EXPLAINING TASKS

1: 7Hd Making compounds (Student Book)

FA

Questions 1 and 2 can be used for formative assessment for the topic. This topic looks at the changes which occur in the formation of compounds including the energy needed to start a reaction and the temperature changes that take place during many chemical reactions.

Worksheet 7Hd-1 is the Access Sheet.

Students should note the areas where they are least confident, and write a question that they must aim to answer during this topic.

Course resources
AP: Worksheet 7Hd-1.

2: Making compounds

WS

These experiments are intended as teacher demonstrations only. Some or all of these demonstrations can be used as a way of showing

that a compound can be very different from the elements that make it up, as well as a way of engaging students' interest.

Demonstration 1: Demonstrate the reactions that take place when copper and magnesium are heated in the air.

Eye protection should be worn by the demonstrator and audience for all these demonstrations. Warn students not to stare directly at the flame; they should look through a narrow gap between their fingers.

Equipment
Eye protection, copper foil, magnesium ribbon (2 cm long), Bunsen burner, tongs, heatproof mat.

Demonstration 2: The reaction of iron with chlorine can be demonstrated by heating some wire wool on the end of a deflagrating spoon. Once the wool starts sparking or glowing, it should be placed into a gas jar of chlorine (toxic). Dense brown fumes of iron(III) chloride are formed as the iron burns in the chlorine.

Chlorine is toxic. This reaction should be carried out in a fume cupboard. Eye protection should be worn by the demonstrator and audience.

Equipment
Eye protection, gas jar of chlorine, deflagrating spoon, iron wool, heatproof mat, Bunsen burner.

Demonstration 3: The reaction of aluminium and iodine can take place at room temperature, and is catalysed by the presence of water. Mix 0.5 g of aluminium powder (highly flammable) and 2 g of iodine crystals (corrosive) together on a heatproof mat. Add about five drops of water with a little detergent, and leave the reaction mixture to stand. After an induction period of 1–2 minutes, a vigorous reaction takes place. The heat generated by the reaction is usually sufficient to vaporise some of the iodine, and clouds of purple vapour (harmful) are produced.

This reaction must be carried out in a fume cupboard. Hazardous fumes of iodine are likely to be released. Iodine is harmful and crystallises painfully on the eye. Eye protection should be worn by the demonstrator and audience.

Equipment
Eye protection, aluminium powder, iodine (solid), water with a little detergent in it, heatproof mat.

If students have access to phones or digital cameras, get them to produce short video clips or a sequence of photos with voice-over describing and explaining what is happening in the reactions. They could then write a series of questions for other students to answer while watching their presentation.

3: Chemical and physical change
WS
Find some video or still imagery of different sorts of changes (e.g. downloaded from video or still image storage sites on the Internet). Examples could include rust, combustion, cooking and glow sticks (for chemical reactions) and boiling, condensation and freezing (for physical changes). Go through each piece of footage/image, and ask students to decide whether it shows a chemical reaction or a physical change, before giving the correct answer and an explanation as to why it is correct.

PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

1: Quick Check
FA
Assessment: The 7Hd Quick Check sheet contains a series of activities on the formation of iron sulfide.

Feedback: Students work in groups of three or four to check their work. Then each group writes a list of facts about what they have learned about the formation of compounds in this topic. The 'fact sheets' should then be passed around the groups so that any mistakes can be corrected and any

missing facts can be added. When completed the 'fact sheets' should be displayed on the wall for a final check.

Action: Where understanding remains weak, use the Student Book or Explaining 3 to reinforce learning about the nature of chemical reactions and correct misconceptions.

Course resources
ASP: 7Hd Quick Check.

2: Thinking about elements and compounds

FA

Assessment: Students discuss the answers to the questions in groups.

Odd One Out: glass, aluminium, brass. (Possible answers: glass is the only one that is not a metal; glass is the only one that is transparent; aluminium is the only element.)

Odd One Out: sodium, chlorine, salt (sodium chloride). (Possible answers: salt is a compound made from the other two; chlorine is a gas at room temperature – the others are solids.)

Odd One Out: oxygen, hydrogen, water. (Possible answers: water is the only liquid; water is the only one that is not an element; pure hydrogen does not occur (in significant amounts) in our air; hydrogen is the only one that does not contain oxygen atoms; oxygen is the only one that does not contain (two) hydrogen atoms.)

Plus, Minus, Interesting: All compounds should be made up of only two different elements. (Possible answers: **Plus** – makes the study of compounds easier; **Minus** – how would we replace the compounds with more than two elements that will disappear? **Interesting** – what compounds would be left and what would our Earth look like? There are no known compounds of helium.)

The (AL) presentation *7Hd Thinking skills* contains answers to these questions. Once students have completed these activities, they should get into small groups to design a dichotomous key to tell whether a chemical is an element or not, and a metal or a non-metal. Agree two materials in each category (element metal, element non-metal, etc.) for groups to check that each others' keys work.

Feedback: Groups feed back to each other about whether the keys work or don't work, then discuss how they can be improved

Action: Groups revise and write down their keys for 'element or not', and 'metal or non-metal', so that they work with all the chosen materials.

Course resources
AL: Presentation *7Hd Thinking skills*.

3: In the hot seat

FA

Assessment: Working in groups, ask students to think up four questions using their study of Topic 7Hd. They should then decide the order for their questions and who is going to ask them. Finally each group then selects one person, at random, to take the 'hot seat'. Ask one of these students to take a seat at the front of the class, dim the lights and illuminate the hot seat with a lamp or torch. (Or you could use yourself in the hot seat.) Start a stop clock to count down 1 minute, then each group gets the chance to ask one question in turn.

Feedback: After each answer has been given, the group asking the question holds up a card to indicate if the answer was 'correct' or 'incorrect'. At the end of one minute, count up the score.

Action: After each contestant has finished, give an opportunity for the groups asking the question to give the correct answer for any that were thought to be incorrect. Discuss any problems with any of these answers and any questions that were ambiguous. If there is time, allow a student from each group to be in the hot seat. Note any similar questions that continue to cause problems for a later review.

4: Chemical keys

FA

Students work in small groups to design a dichotomous key to tell whether a chemical is an element or not, and a metal or a non-metal. Students then swap their keys with other groups to be 'road-tested'.

5: Making compounds

FA

There are many videos available on Internet video storage sites that show compounds being made from two elements with an obvious release of energy (e.g. sodium + chlorine, iron + sulfur, iron + fluorine).

Show a selection of videos with the sound muted. For each video ask the students to write a voice-over explaining how you can tell that a reaction is occurring and what the reactants and products are.

HOMEWORK TASKS

1: Elements, mixtures and compounds 1
Worksheet 7Hd-7 involves identifying elements, mixtures and compounds using particle diagrams and naming them. It moves on to evidence of a chemical reaction occurring.

Course resources
AP: Worksheet 7Hd-7.

2: Elements, mixtures and compounds 2
Worksheet 7Hd-8 contains questions which involve applying knowledge to identify elements and compounds. It then moves on to identifying evidence of a chemical reaction occurring and drawing particle diagrams to represent a mixture.

Course resources
AP: Worksheet 7Hd-8.

3: Elements, compounds and mixtures 3
Worksheet 7Hd-9 provides more challenging activities based around the composition of air, including what chemical formulae tell us and drawing particle diagrams.

Course resources
AP: Worksheet 7Hd-9.

7He
Chemical reactions

Objectives
Developing:

1. Recall some observations that indicate a chemical reaction, and describe differences between chemical reactions and physical changes.
2. Use word equations (including identifying reactants and products).
3. Identify thermal decomposition reactions, their reactants and products (including the test for carbon dioxide).

Securing:

4. Model simple reactions using word equations.
5. Describe what happens during thermal decomposition of a metal carbonate.
6. Name compounds that contain two elements plus oxygen.

Exceeding:

Exceeding objectives are designed to broaden students' skills and knowledge beyond what is required, often introducing a higher level of challenge.

7. Apply knowledge of thermal decomposition in carbonates to other compounds.

Student materials

Topic notes

- It is important that teachers review all materials that they intend to use with students before use, to ensure suitability.
- It is envisaged that in the course of studying the chemistry component of this topic, students will use one Starter idea, Explaining 1, one further Exploring or Explaining idea, and one of the plenaries. Additional activities can be added as time allows.

STARTERS

1: Different changes
BA **WS**
To quickly show the difference between a chemical and a physical change and how one is easier to reverse than the other, demonstrate burning a match and bending a match (use long matches, and do not break them). Then demonstrate folding a piece of cotton or wool fabric and burning it.

After the demonstration ask students to describe the difference between the changes, which should lead to ideas about chemical changes usually being more difficult to reverse and physical changes often being easy to reverse. Ask students to suggest further examples of chemical reactions and physical changes.

Equipment (for demonstration)
Long matches, heatproof mat, piece of cotton or wool fabric, retort stand and clamp (to hold fabric in place).

2: Making links
BA **WS**
Making links is a simple quick way of getting students thinking about the content of the topic. Working individually or in groups students use sets of words and phrases to make sentences about the topic. Give each group/student the following sets of words/phrases and ask them to make the link between them.

a nail – rusting – chemical reaction
an egg – goes white and hardens – chemical reaction
a candle – burning – chemical reaction
ice – water – physical change
water – evaporating – physical change
copper sulfate – clear blue solution – physical change
reactants – products – word equation

Challenge students to use the words/phrases to create full sentences using appropriate conjunctions. Ask selected students to read out their answers and correct misconceptions as they arise.

Equipment
Sets of words and phrases linked to Topic 7He to be handed out on pieces of paper to groups/students.

3: Physical and chemical change
BA **WS**
Remind students of the criteria for deciding whether or not a chemical reaction has occurred (colour change, evolution of gas, energy change). Students should have encountered reversible and

irreversible changes (mixing and changes of state) at primary and will have studied dissolving in Unit 7E. Remind students of what the terms 'reversible' and 'irreversible' mean. Then show students the following demonstrations and ask them which changes are physical changes, which are chemical reactions, which are reversible and which are irreversible. Ask students to explain how they made their decisions.

For teacher demonstration only:

- Lead nitrate solution mixed with potassium iodide solution will give a vivid yellow precipitate of lead iodide.
- Filtering lead iodide to get a clear solution.
- Pieces of zinc placed into a beaker of dilute hydrochloric acid will show some fizzing, due to hydrogen gas being given off.
- Ice melting.
- Displacement reaction between a large iron nail in copper sulfate solution which will form copper brown copper metal on the nail.
- Evaporating salt solution to obtain salt.
- Dissolving sugar in warm water.
- Adding 2 mol dm^{-3} hydrochloric acid solution to 2 mol dm^{-3} sodium hydroxide solution and measuring the temperature rise.

Lead nitrate solution and lead iodide are toxic. Hydrogen gas is flammable. Solid copper sulfate is harmful. Demonstrator and students should all wear eye protection.

Equipment (for demonstration)
Eye protection, 0.5 mol dm^{-3} lead nitration solution, 0.5 mol dm^{-3} potassium iodide solution, zinc granules, 2 mol dm^{-3} hydrochloric acid, 2 mol dm^{-3} sodium hydroxide solution, 0.5 mol dm^{-3} copper sulfate solution, iron nail, salt solution, sugar, warm water, boiling tubes and rack or conical flasks, filter paper, filter funnel, thermometer (0–100 °C), spatula, heatproof mat, Bunsen burner, ice cubes.

4: Thinking about changes

BA

Use some Odd One Out thinking skills questions to get students to think about different types of changes. Some examples are given below.

Odd One Out: dissolving salt in water, burning gas on a cooker, frying an egg. (Possible answers: dissolving salt in water, as no new substance is formed and it is reversed easily; frying an egg, as this needs energy to be supplied to keep the change going.)

Odd One Out: grinding sand into small grains, mixing sand and salt, letting a mixture of sand, cement and water set. (Possible answers: letting a mixture of sand, cement and water set, as a new substance is formed and it is not reversed easily; mixing sand and salt, as a mixture is formed but no chemical reaction occurs; grinding sand into small grains, as only one substance is involved.)

Odd One Out: using a magnet to attract iron filings, iron railings rusting, melting iron. (Possible answers: iron railings rusting, as a new substance is formed and it is not reversed easily; melting iron, as this involves a change of state.)

Odd One Out: wax dripping down a candle, the candle burning and producing light, soot particles sticking to a glass and making it dirty. (Possible answers: the candle burning and producing light, as a new substance is formed and it is not reversed easily; soot particles sticking to a glass and making it dirty, as this is the only change where the product is a solid.)

Plus, Minus, Interesting: Only physical reactions could take place. (Possible answers: **Plus** – unwanted reactions like rusting would not happen; **Minus** – photosynthesis could not take place, we could only use the substances found on Earth as they are, could not cook; **Interesting** – would our new technology work without man-made materials? We might have to rely on wind power for our cars, which might look something like the Ventomobile.)

The activity could be repeated at the end of the topic to see if the students have altered their ideas about change.

EXPLORING TASKS

1: Signs of a reaction

WS

Students should be asked to carry out, in test tubes, some chemical reactions in which visible changes occur. Students could be reminded of the criteria for deciding whether a reaction has occurred (change in colour, release of a gas, a solid forming, heat). They should be reminded that they are looking for evidence that new materials have been made using chemical reactions. They could use digital cameras or their phones to record before and after images which they then paste into a table with five columns: name of chemical(s), appearance before, appearance after, description of what has happened in the reaction, name of product(s).

Developing: Students follow instructions on Worksheet 7He-2 and use Worksheet 7He-3 for recording results.

Securing: Students use Worksheet 7He-2 to plan their investigations and make up their own tables to record results.

Exceeding: Challenge students to find out the word equations for some of the reactions.

Likely outcomes:

1. Sugar will melt (physical change) and start to darken (chemical change). If heating is excessive, the sugar will decompose to black carbon and steam will be given off.
2. Initially a pale blue gelatinous precipitate (copper(II) hydroxide) will form. With excess ammonia, the precipitate will redissolve to give a dark blue solution containing a complex copper/ammonia ion.
3. Fizzing will occur as carbon dioxide is given off. A solution of magnesium chloride is formed. Temperature will probably fall slightly.
4. Blue/green precipitate of iron(II) carbonate will form – together with some iron(II) hydroxide.
5. No reaction will occur, unless you get the tube hot enough to melt the salt.
6. Copper sulfate turns from white to blue. Some of the copper sulfate will dissolve. There is a temperature rise.

Copper sulfate solid is harmful. Eye protection must be worn.

Course resources
AP: Worksheets 7He-2; 7He-3.

Equipment (per group)
Individual eye protection, test-tube rack, test tubes, Bunsen burner, heatproof mat, thermometer; access to: sugar (sucrose), copper sulfate solution (0.4 mol dm^{-3}), dilute hydrochloric acid (0.4 mol dm^{-3}), ammonia solution (0.4 mol dm^{-3}), magnesium carbonate (solid), iron chloride solution (0.2 mol dm^{-3}), sodium carbonate solution (0.4 mol dm^{-3}) , salt (solid), anhydrous copper sulfate (solid).

2: Chemical reactions

WS

The **AL** video *Chemical reactions* shows clips of different chemical reactions. There are eight clips altogether, numbered 1–8. It is not important what the reactions are, but for the record:

1. magnesium + oxygen
2. sodium + chlorine
3. sodium chloride + silver nitrate
4. potassium chromate(VI) + lead(I) nitrate
5. ammonium chloride + ammonium nitrate + zinc dust
6. heating hydrated copper(II) sulfate
7. zinc + hydrochloric acid
8. sulfuric acid + sucrose.

Pause the video as each asset finishes and ask students to say or write down what evidence there was in the clip that a chemical reaction had occurred.

Alternatively, agree the signs of chemical reactions ahead of watching the video. Write these on the board and number them. Students suggest which number is being shown or suggest new evidence of a reaction.

Course resources
AL: Video *Chemical reactions*.

3: Household reactions

WS

For further examples of chemical and physical change the students can carry out the following set of experiments using mainly household chemicals to decide whether there is no reaction, a reversible or an irreversible change. They should also state whether a change is physical or chemical, including their reasons.

Students will require some guidance for all these tests. This could be done by producing a simple instruction card for each experiment. The practical could be carried out using the 'stations' technique.

Suitable experiments are:

1. lemon juice added to bicarbonate of soda (chemical reaction, irreversible)
2. baking powder and water (chemical reaction, irreversible)
3. a small amount of plaster of Paris and water (chemical reaction, irreversible)
4. heat zinc oxide and allow to cool (physical, colour change, reverses on cooling)
5. iron wool placed in copper sulfate solution (chemical reaction, irreversible)
6. drop of water added to anhydrous copper sulfate then heated (physical, colour change, reverses on heating).

Students should now be able to build up a categorisation of chemical reactions – needing or not needing energy to start them off, reversible or not, undergo physical and chemical change or just chemical change, etc. Students should be encouraged to make their own categorisations.

Anhydrous copper sulfate is harmful. Plaster substitutes can get very hot. Plaster of Paris must be disposed of via a hazardous waste contractor, not in the bin – see Hazcard 19B – 2013 edition.

Equipment (for each station)
Individual eye protection.
For each station:

1. test-tube rack with test tubes, bicarbonate of soda, lemon juice, spatula
2. test-tube rack with test tubes, baking soda, water, spatula
3. plaster of Paris, plastic beaker, water, spatula
4. test-tube rack with test tubes, zinc oxide (solid), test-tube holder, Bunsen burner, heatproof mat
5. test-tube rack with test tubes, iron wool (or filings), copper sulfate solution (0.5 mol dm^{-3})
6. test-tube rack with test tubes, test-tube holder, water, dropper, anhydrous copper sulfate (solid), Bunsen burner, heatproof mat.

Note: plaster of Paris is $CaSO_4 \cdot \frac{1}{2}H_2O$. Some substitutes used for model making are not genuine plaster of Paris.

4: Thermal decomposition

WS

This practical investigation considers the ease of thermal decomposition of a number of metal carbonates.

Developing: Students follow instructions on Worksheet 7He-4, which also provides guidance on recording results.

Securing: Students are given the Aim and Apparatus list from Worksheet 7He-4 to plan their investigation.

Calcium carbonate is very difficult to break down in the heat of a Bunsen burner (about 800 °C). The order for the other carbonates is: copper carbonate will break down the easiest, then lead carbonate, then magnesium carbonate (requires strong heating to break down) and then calcium carbonate.

Make sure that you wear eye protection for all these experiments. **Be careful to remove the tube from the limewater when you stop heating to avoid suck-back.**

Course resources
AP: Worksheet 7He-4.

Equipment
Individual eye protection, Bunsen burner, heatproof mat, clamp and stand, four test tubes, delivery tube, collecting tube (e.g. boiling tube), copper carbonate powder, lead carbonate powder, magnesium carbonate powder, calcium carbonate powder, limewater.

5: Matching Q & A

Worksheet 7He-5 involves a cut-out matching exercise, on questions and answers, about this topic.

Course resources
AP: Worksheet 7He-5.

6: Word equations

Worksheet 7He-6 includes a number of descriptions of reactions, which the students can translate into word equations for more practice.

Get students to summarise how a word equation for a chemical reaction works by producing a generic equation ('equation kit'); for example, reactant substance A (plus sign) reactant substance B (arrow) product substance C (and possibly other product substances).

Course resources
AP: Worksheet 7He-6.

EXPLAINING TASKS

1: 7He Chemical reactions (Student Book)

FA

Questions 1 and 2 can be used for formative assessment for the topic.

These pages in the Student Book look at chemical reactions in general and thermal decomposition reactions in particular. Worksheet 7He-1 is the Access Sheet.

Remind students of their work on gases in the air, and that carbon dioxide is one of those gases. Remind students that carbon dioxide is produced by respiration in cells, and demonstrate the test for carbon dioxide by blowing out through a straw in a tube of limewater. Point out the change from clear and colourless to a white milky suspension, and ensure that students understand that this is a test for carbon dioxide.

Having covered the material on these pages, hold a class discussion about the common errors in this topic or areas for improvement. This could involve students adding notes to their own work, annotating to say how each aspect could be improved.

Course resources
AP: Worksheet 7He-1.

Blow gently into the tube to avoid splashes. Do not suck. Wear eye protection.

Equipment
Clean/new/sterile drinking straw, test tube, limewater, eye protection.

2: 7He Problems with elements (Student Book) **WS**

The final page of the unit asks the students to think about some of the advantages and disadvantages of having a source of valuable elements in your country.

The **AL** presentation *Mining issues* shows some of the consequences of having large-scale mining operations in a country. Students can explore the positive and negative issues around mining. In small groups, students should discuss the consequences and decide if they are advantages or disadvantages for the local population. Get students to sketch an additional character for the concept cartoon within the presentation who gives an overall summary comment/balanced view of the discussion.

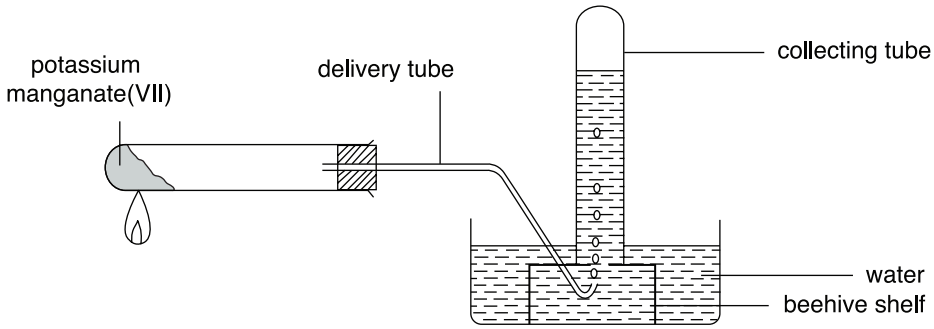
Course resources
AL: Presentation *Mining issues*.

3: Thermal decomposition reactions

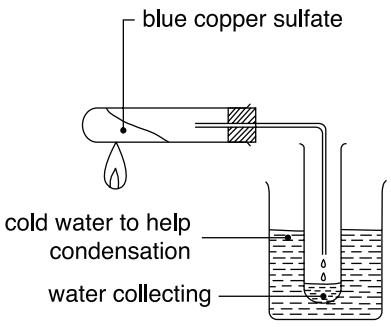
There are a number of different reactions that you can use to demonstrate thermal decomposition.

The thermal decomposition of a metal carbonate can be demonstrated by following the method on Worksheet 7He-4.

Potassium permanganate (or potassium manganate(VII)) decomposes on heating to produce a 'black powder' (a mixture of potassium manganate and manganese(IV)) and oxygen. This can be demonstrated using the apparatus shown below. You could also show students the test for oxygen (relighting a glowing splint) but the important point here is that students see that a single compound breaks down into more than one other substance when heated.



Hydrated (blue) copper sulfate also shows thermal decomposition, and breaks down into water (the 'water of crystallisation') and anhydrous (white copper sulfate). This reaction (unlike the others listed here) is reversible. It is usefully demonstrated using the apparatus shown below.



Wear eye protection.

Remove the delivery tube from the limewater when heating is fininshed (to avoid suck-back).

Potassium manganate(VII) is oxidising, harmful if swallowed and stains skin and clothing. It is also very toxic to aquatic life, with long-lasting effects. Avoid raising dust. Wash hands after demonstration.

Course resources
AP: Worksheet 7He-4.

Equipment

For metal carbonates: eye protection, Bunsen burner, heat-resistant mat, clamp and stand, test/boiling tube, delivery tube and bung, metal carbonate powder (e.g. copper, lead, zinc or calcium carbonate), limewater.

For potassium permanganate (potassium manganate(VII)): eye protection, Bunsen burner, heat-resistant mat, clamp and stand, 2 x test tubes/boiling tubes, delivery tube and bung, potassium manganate(VII) crystals, water trough, beehive shelf.

For hydrated copper sulfate: eye protection, Bunsen burner, heat-resistant mat, clamp and stand, 2 x test tubes/boiling tubes, delivery tube and bung, beaker of cold water, hydrated copper sulfate crystals.

4: Word equations 2

Using some of the simpler chemical reactions you have used in earlier sections introduce the terms for reactants and products and explain how reactions can be described by using word equations. Reactions such as magnesium and oxygen or copper and chlorine can be demonstrated again or examples can be found in the **AL** presentation *Word equations.* The presentation shows animated descriptions of chemical reactions and explains how word equations can be written. The **AL** interactive *More word equations* can also be used here.

Course resources
AL: Interactive *More word equations*.
Presentation *Word equations*.

5: Limestone to lime

WS

Show students one or more videos (e.g. from an Internet video storage site) showing how limestone is converted into quicklime (calcium oxide) and how this is used in cement. The **AL** animation *A decomposition reaction* shows a series of slides, with accompanying word equations explaining how quicklime (calcium oxide) can be made from limestone (calcium carbonate) in the laboratory. Ask students to watch the video and the presentation and take notes. They should then write a short summary report on how limestone is changed into lime in industry and the laboratory. The report should contain a description of the process with illustrations and word equations.

Course resources
AL: Animation *A decomposition reaction*.

6: Concentrated sulfuric acid and sugar

WS

A demonstration of the dehydration effect is the decomposition of sugars using concentrated sulfuric acid. The reaction is sufficiently exothermic to melt the sugar and convert some of the water formed into steam. Along with the formation of carbon dioxide and sulfur dioxide through oxidation, this results in the formation of a solid 'foam' of carbon, which rises up out of the beaker. This allows discussion of the chemical and physical changes that occur. In addition, this is a spectacular example of a chemical reaction that does not need heat energy to be supplied to start it off; compare this with reactions that need to be heated to get them started.

Enough concentrated sulfuric acid needs to be added to saturate the sugar and if a narrow beaker is used the 'foam' of carbon will grow well above the top of the beaker.

This reaction must be carried out in a fume cupboard, as quantities of sulfur dioxide and carbon monoxide may also be formed in side reactions. Concentrated sulfuric acid is corrosive. Wear eye protection or a face shield, and chemical-resistant gloves. Do not touch the carbon mass formed unless gloves are worn. For disposal, plunge the beaker and carbon into an excess of water when cool. The carbon can then be disposed of with normal refuse.

Equipment (for demonstration)
Eye protection, chemical-resistant gloves, concentrated sulfuric acid (corrosive), sugar (granulated or caster sugar), beaker or jam jar, glass rod.

PLENARIES

Most plenaries can be used for formative assessment. Suggested assessment, feedback and action strands of formative assessment can all be modified. See the ASP for further information and ideas on formative assessment.

1: Quick Check

FA

Assessment: The 7He Quick Check sheet contains a crossword with a series of question clues related to the thermal decomposition reactions introduced in this topic.

Feedback: Students work in pairs to check their answers. If they get an answer wrong or there is disagreement they should agree a correct answer or get clarification from the teacher on what those answers should be.

Action: The students should write out a list of 'facts to revise', based on the questions they found difficult to answer in the Quick Check. They should be instructed to use their own words in their notes and not just copy the clues and their answers.

Course resources
ASP: 7He Quick Check.

2: Thinking about chemical reactions
FA
Assessment: Students should think up answers to the following thinking skills.

Plus, Minus, Interesting: All chemical reactions should give out heat. (Possible answers: **Plus** – we would always have enough energy; **Minus** – the everyday reactions which always happen could make our planet overheat; **Interesting** – do most reactions give out heat or take in heat as they occur? The reaction in glow sticks transfers energy by light rather than by heating.)

Consider All Possibilities: A substance is heated and a gas is given off. (Possible answers: the substance has evaporated; the substance has decomposed, giving off a gas; the substance has reacted with another substance, producing a gas; the substance is burning.)

Odd One Out: calcium oxide, calcium carbonate, carbon dioxide. (Possible answers: carbon dioxide, as it is the only gas; calcium carbonate, as it is the reactant – the others are products; calcium oxide, as it does not contain carbon.)

Feedback: Students work in groups to discuss the questions and their answers. Then ask which questions they found the most difficult.

Action: Ask students to list the main learning points from the topic that they could use to answer the questions they found most difficult. Could also challenge students to design a different thinking skills question and a set of answers on the topics they found most difficult.

The (AL) presentation *7He Thinking skills* can be used to support this task.

Course resources
AL: Presentation *7He Thinking skills*.

3: Concept map
FA
Assessment: Worksheet 7He-7 asks students to create a concept map about chemical reactions, using given labels. Ask students to work in pairs to complete their concept maps. The Summary Sheets could be used by some students if required.

Feedback: Students create a gallery by pinning their completed concept maps on the wall. All students then take a 'gallery walk', reading their colleagues' answers and noting any points of disagreement where they arise. This should also give the teacher an opportunity to note any problem areas to be discussed with the class.

Action: Students who are still having difficulty with some of the ideas of the topic can redo their concept map but referring to the gallery and the Summary Sheets for help.

Course resources
AP: Worksheet 7He-7.
ASP: 7H Summary Sheets.

Equipment
Scissors, glue.

4: Quick Quiz revisited
Revisit the 7H Quick Quiz to test students' knowledge of the content of this unit. Students could fill in their answers on the 7H Quick Quiz Answer Sheet. Encourage students to identify areas for themselves that are still weak and decide how they are going to remedy this. For example, ask students why they found certain questions more difficult. They can categorise their issues as, for example: 'do not understand the science'; 'did not read the question properly'.

Extend this activity by challenging students to design Quick Quiz questions on the subjects that they still find difficult. The additional questions could be tried out in groups.

Course resources
ASP: 7H Quick Quiz; 7H Quick Quiz Answer Sheet.

5: End of Unit Test
Use either or both of the End of Unit Tests. A Mark Scheme is given in the ASP. Encourage students to identify areas that are still weak and to formulate plans to strengthen those areas. Summary Sheets are provided to help students with revision.

Extend this activity by getting students to produce questions on areas where they need further

clarification. Spread these out around the room. Other students then choose one question to attempt to answer – writing this on the same piece of paper. Students then return to their original question and comment on how well they think the answer provided helps them.

Course resources
ASP: End of Unit Test Standard (S); End of Unit Test Higher (H); 7H Mark Scheme; 7H Summary Sheets.

6: Progression Check
Students should circle the stars next to each statement on the 7H Progression Check to record what they feel they know, and how certain they are of it. Encourage students to plan how to do further work on the things about which they remain unsure.

Course resources
ASP: 7H Progression Check.

7: Open-ended Assessment Task
Students complete the 7H Open-ended Assessment Task sheet, which challenges students to prepare a scientific report to help government ministers attending an international conference on material resources from our Earth to understand the science behind elements, mixtures and compounds. The instructions for the task are on the 7H Assess Yourself! sheet.

You can assess this activity by using the 7H Open-ended Assessment Task sheet or students can rate their own performance by using the 7H Assess Yourself! sheet (see the ASP).

Course resources
ASP: 7H Assess Yourself!, 7H Open-ended Assessment Task.

HOMEWORK TASKS

1: Compound experiments
Worksheet 7He-8 reviews two of the important chemical changes, the formation and decomposition of compounds, which are introduced in this unit.

Course resources
AP: Worksheet 7He-8.

2: Compound properties
Worksheet 7He-9 gives students the opportunity to consider the changes involved in thermal decomposition reactions, how compounds are named and word equations for chemical changes.

Course resources
AP: Worksheet 7He-9.

3: Planning an experiment
Worksheet 7He-10 allows students the opportunity to plan an investigation concerning a decomposition reaction.

Course resources
AP: Worksheet 7He-10.