Collins

DRAFT

# AQA GCSE (9-1)
# Chemistry

## Teacher Pack

## Advance draft material for the 2016 specifications

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# How the lesson plans work

Every chapter and every lesson plan follows the same structure.

## Chapter introductions

- give an overview of the of the content and skills covered in the chapter
- help in assessing prior learning and identifying misconceptions
- list the overarching learning objectives to help medium-term planning.

## Learning objectives and outcomes

- **Learning objectives** for each topic are listed and also shared with students in the Student Book for short-term planning.
- **Learning outcomes** at three levels are listed, and it is shown which learning activities contribute to achieving each outcome.
- **Skills development** show how the lesson will develop aspects of working scientifically.

## Resources needed and digital resources

These give an overview of all the resources needed for a lesson. Every lesson has an associated differentiated worksheet to support written work. Practical sheets are provided to give support for planning, carrying out and analysing practical work. Technician's notes are provided to explain the materials and setup and help with planning. These can be downloaded from the Collins website at www.collins.co.uk/GCSEscience.

## Key vocabulary

This is highlighted throughout to support literacy.

## Teaching sequence

The lesson plans all use the same learning sequence. This is based on the idea that learning develops in stages during a lesson and that different parts of the lesson have different functions. In addition to the learning cycles, the lesson plans all have three levels of differentiation: low, standard and high.

- **Engage** This section draws students in to thinking about the ideas, and includes possible starter activities. Here students encounter ideas that will make them want to find out more.
- **Challenge and develop** Students meet something that will challenge their existing understanding. It might be questions, ideas, demonstrations or experiments that make them realise the inadequacy of a simpler explanation.
- **Explain** Students are encouraged to develop a good explanation and supported in capturing ideas in words or graphically. Differentiation ideas are given for students making less or more than expected progress.
- **Consolidate and apply** Students realise how the new learning is to be consolidated and applied, including real-world applications. Again, differentiation ideas are given for students making different levels of progress.
- **Extend** Addresses how the ideas of the topic can be extended to stretch students able to progress further.
- **Plenary suggestions** Varied activities help in gauging student progress.
- **Answers** All answers to worksheet questions are provided.

# Atomic structure and the periodic table: Introduction

**When and how to use these pages**

This unit: builds on ideas that the atom is the building block of matter. It underpins every other chapter.

## Overview of the unit

In this unit, pupils will learn about the structure of atoms and use a range of different models to describe both the atoms themselves and the physical and chemical properties of the elements and compounds they form. They will also explore how atomic models developed as new data have become available and how the periodic table was constructed. In the process they will learn how testing predictions can support or refute new scientific ideas.

Pupils will carry out experiments, describe practical procedures, select techniques for a particular purpose and explain their choices. They will also make and record observations, describe patterns in data and use data to make predictions.

The unit offers a number of opportunities for the pupils to use mathematics. They visualise and represent two-dimensional (2D) and 3D forms; use ratios to write simple formulae; substitute numerical values into chemical equations to balance them; use prefixes and powers of ten to describe the sizes of atoms and their components; translate data between graphical and numerical form; plot variables against each other to describe trends and relationships; and interpolate and extrapolate graphs to make predictions.

## Obstacles to learning

Atoms and their sizes are an abstract concept and hard to visualise. The use of models and analogies may help some pupils to recognise that they are very small, that most of their volume is made up of empty space and that they bond together to make 3D structures. The use of physical models and diagrams will also help pupils to classify substances as elements, compounds and mixtures; their particles as atoms, ions or molecules; and their structures as atomic, molecular or crystalline. Particle pictures and physical models will also help pupils who struggle to use ratios to determine formulae and balance chemical equations.

## Practicals in this unit

In this unit pupils will do the following practical work:

- Separate a mixture of copper powder and sodium chloride using filtration and evaporation.
- Burn strips of magnesium ribbon and observe the traces of magnesium oxide produced.
- Make space-filling models of the molecules in a selection of elements and compounds.
- Model the electron arrangements in atoms.
- Model the arrangement of elements in the periodic table.
- Test a range of metal and non-metal oxides in water with universal indicator solution.
- Model the changes in electron arrangements when atoms react to form ions.

| | **Lesson title** | **Overarching objectives** |
|---|---|---|
| 1 | Elements, compounds and mixtures | Classify substances as elements, compounds or mixtures. |
| 2 | Writing formulae and equations | Use symbols to represent elements and compounds. |
| 3 | Modelling the atom | Model atoms as positive nuclei surrounded by negative electrons. |
| 4 | Changing ideas about atoms | Describe how ideas about atoms changed as new evidence became available. |
| 5 | Comparing small particles | Use formulas to distinguish between elements and compounds. |
| 6 | Relating charges and masses | Describe the similarities and differences between protons, neutrons and electrons. |
| 7 | Numbers of sub-atomic particles | Use atomic numbers and mass numbers to determine the numbers of sub-atomic particles in atoms. |
| 8 | Electronic structure and the periodic table | Describe the arrangement of electrons in shells or energy levels. |
| 9 | Developing the periodic table | Describe how Mendeleev developed the periodic table. |
| 10 | Comparing metals and non-metals | Describe the physical and chemical differences between metals and non-metals. |
| 11 | Metals and non-metals | Distinguish metals from non-metals using their position in the periodic table and ability to form positive ions. |
| 12 | Exploring Group 0 | Explain their lack of reactivity and trends in their physical properties. |
| 13 | Exploring Group 1 | Describe their high reactivity and trends in their chemical properties. |
| 14 | Group 7 elements | Describe their high reactivity and trends in their physical and chemical properties. |
| 15 | Reaction trends and predictions | Explain trends in reactivity in Groups 1 and 7 and changes across a period. |
| 16 | Transition metals | Describe similarities and differences between transition metals and contrast them with those of Group 1 elements. |
| 17 | Key concept: The outer electrons | |
| 18 | Practical: Separating substances | |
| 19 | Using maths skills in science | |

# Atomic structure and the periodic table: Lesson 1

## Lesson overview

### Learning objectives

- Review the differences between elements, compounds and mixtures.
- Separate a mixture.
- Compare separation techniques.

### Learning outcomes

- Recognise examples of elements, compounds and mixtures. [O1]
- Link separation techniques to differences in physical properties. [O2]
- Suggest ways of separating different mixtures. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 2.2 Describe a practical procedure.
- WS 2.3 Select a technique for a particular purpose and explain why.

**Resources needed** Equipment as listed in the Technician's notes; Worksheets 1.1.1 and 1.1.2; Practical sheet 1.1.1; Technician's notes 1.1.1.

**Key vocabulary** element, compound, mixture, separation, filtration, crystallisation, simple distillation, fractional distillation, chromatography, physical processes, chemical reactions.

## Teaching and learning

### Engage

- **Display** 12 kg of barbecue charcoal and **identify** it as the average mass of the element carbon in a 15-year-old girl. **Introduce** the idea that we get carbon into our bodies by eating it. [O1]
- **Ask** for examples of foods that contain carbon and **discuss** the fact that that the element carbon cannot be seen because it is chemically joined with other elements in compounds. Bread could be toasted to make the compounds (carbohydrates and proteins) in it react and leave a layer of carbon on its surface. [O1]
- **Remind** pupils that table salt is sodium chloride – a compound of sodium and chlorine – and **display** a model of its structure. **Contrast** this with a model of the element copper to emphasise the difference. Add the element copper to the salt to **make** a mixture. [O2]

### Challenge and develop

- Low demand: Give out Practical sheet 1.1.1. Pupils work in pairs to **separate** copper from sodium chloride. [O3]
- Standard demand: Make the apparatus listed in the Technician's guide available and **challenge** pupils to **separate** the mixture of copper and sodium chloride. Pupils work in pairs or threes to complete the task. [O3]
- High demand: **Challenge** pupils to select the apparatus they need to **separate** a mixture of copper and sodium chloride. Pupils work in pairs or threes to complete the task. [O3]

### Explain

- Low demand: Pupils **complete** the questions on Practical sheet 1.1.1. [O3]
- Standard demand: Pupils **describe** how they separated copper and sodium chloride. [O3]
- High demand: Pupils use diagrams to **explain** how their method worked. [O3]

### Consolidate and apply

- All pupils can be asked to **read** 'Mixtures' in the Pupil Book and **complete** Worksheet 1.1.1. [O2]
- **Spokesperson**. Groups prepare answers to the questions on Worksheet 1.1.2 and appoint a spokesperson to present their explanations. Different groups can be selected to explain each technique, with others invited to offer additional points they haven't covered. [O3]

### Extend

Ask pupils able to progress further to:

- **Find** an image of a simple solar still and **identify** its advantages and disadvantages compared with the laboratory distillation apparatus illustrated in the Pupil Book. [O2]

### Plenary suggestion

Learning triangle. Ask pupils to draw a large triangle with a smaller inverted triangle that just fits inside it (so they have four triangles). In the outer three ask them to write about this lesson: something they've seen; something they've done; something they've discussed. Then add in the central triangle: something they've learned.

## Answers to Practical sheet 1.1.1

Predictions: 1, sodium chloride; 2, copper; 3, sodium chloride.

Evaluation: 1, they are both soluble; 2, sodium chloride is soluble but copper is insoluble; 3, No.

## Answers to Worksheet 1.1.1

Successful separations: 1, d,h,o; 2, e,f,l; 3, a,g,m; 4, b,j,n; 5, c,i,k.

## Answers to Worksheet 1.1.2

Which method?

1. Filtration: filter funnel, filter paper, conical flask; the solution passes through holes in the filter paper, but the silver chloride particles are too big to pass through them

2. Chromatography: to separate or identify the colourings in foods

3. Using crystallisation: as water evaporates the solution becomes too concentrated for the copper sulfate to remain dissolved

4. Fractional distillation; ethanol evaporates more easily than water because it has a lower boiling point.

# Atomic structure and the periodic table: Lesson 2

## Lesson overview

### Learning objectives

- Learn the symbols of the first 20 elements.
- Use symbols to describe elements and compounds.
- Use formulae to write equations.

### Learning outcomes

- Recognise elements and compounds of the first 20 elements from their formulae. [O1]
- Write formulae correctly using elements from Groups 1, 2, 6 and 7. [O2]
- Write equations for simple reactions. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 2.4 Carry out experiments appropriately.
- WS 4.1 Use scientific terminology.

**Maths focus** Use ratios.

**Resources needed** Equipment as listed in the Technician's notes; a periodic table for each pupil; a large wall-mounted periodic table; a printed copy of each slide in Presentation 1.2.1 displayed on a notice board visible to the pupils; Worksheets 1.2.1, 1.2.2 and 1.2.3; Practical sheet 1.2.1; Technician's notes 1.2.1.

**Digital resources** Presentation 1.2.1 'Name that compound'.

**Key vocabulary** balanced, compound, equation, formula, symbol.

## Teaching and learning

### Engage

- **Display** unlabelled samples of magnesium powder and calcium oxide. **Ask** pupils to deduce which is an element and which is a compound. [O1, O2 and O3]
- **Present** the formula of each sample and **discuss** how symbols can make it easier to identify elements and compounds. Make sure every pupil has a periodic table. [O1, O2 and O3]

### Challenge and develop

- Low demand: Give out Practical sheet 1.2.1. Pupils work in pairs to **burn** a sample of magnesium ribbon and **answer** the questions. [O1 and O2]
- Standard and high demand: Challenge pupils to **burn magnesium** and **describe** the product formed using words and symbols. **CARE!** Pupils must hold the magnesium with tongs at arm's length and must not look directly at the flame. [O1 and O2]
- Low demand: **Ask** pupils to **read** 'Elements and compounds' from spread 1.2 of the pupil book and **complete** questions 1 and 2. [O1]
- All pupils: **Introduce** the idea that each compound has a set formula and this contains the symbols of the elements that reacted to make it. Pupils **complete** the quiz on Presentation 1.2.1 to practice identifying symbols. [O1 and O2]
- Standard and high demand: **Spokesperson.** Challenge groups to identify patterns in the formulae of the compounds in Presentation 1.2 and ask each group in turn to offer one new point until every group 'passes'.

### Explain

- Low demand: **Read** 'Formulae' from spread 1.2 of the pupil book. Then **complete** questions 3 and 4 from the pupil book and part 1 of Worksheet 1.2.1. [O1 and O2]
- Standard and high demand: **Read** 'Formulae' from spread 1.2 of the pupil book. Then **complete** questions 3 and 4 from the pupil book and part 1 of Worksheet 1.2.2. [O1 and O2]

### Consolidate and apply

- Low demand: Pupils **construct** the formulas and equations on Worksheets 1.2.1 and 1.2.2. [O2 and O3]
- Standard and high demand: Pupils **construct** the formulas and equations on Worksheet 1.2.3. [O2 and O3]

### Extend

Ask pupils able to progress further to:

- **Devise** a help sheet to support pupils who don't know how to balance equations. [O3]

### Plenary suggestion

The big ideas. Ask pupils to write down three things they learned about writing equations. Then ask them to share their facts in groups and compile a master list, with the most important facts at the top.

## Answers to Practical sheet 1.2.1

Evaluation: 1, any two differences between Mg and $O_2$; 2, magnesium oxide; 3, A; 4. B; 5. D; 6, magnesium + oxygen → magnesium oxide; 7, the oxygen atoms are bonded/joined together.

## Answers to Worksheet 1.2.1

Find the formula: a, CaO; b, $CaCl_2$; c, NaF; d, BeS; e, $BeF_2$; f, LiF; g, MgS; h, KCl; I, $MgF_2$; j, $Li_2O$; k, $Na_2O$; l, $Li_2S$.

## Answers to Worksheet 1.2.2

Line up the symbols … then balance the equation: a, $2Ca + O_2 \rightarrow 2CaO$; b, $Ca + Cl_2 \rightarrow CaCl_2$; c, $2Na + F_2 \rightarrow 2NaF$; d, $Be + S \rightarrow BeS$; e, $Be + F_2 \rightarrow BeF_2$; f, $2Li + F_2 \rightarrow 2LiF$; g, $Mg + S \rightarrow MgS$; h, $2K + Cl_2 \rightarrow 2KCl$; I, $Mg + F_2 \rightarrow MgF_2$; j, $4Li + O_2 \rightarrow 2Li_2O$; k, $4Na + O_2 \rightarrow 2Na_2O$; l, $2Li + S \rightarrow Li_2S$.

## Answers to Worksheet 1.2.3

1. Find the formula: a, CaO; b, $CaCl_2$; c, NaF; d, BeS; e, $BeF_2$; f, LiF; g, MgS; h, KCl; I, $MgF_2$; j, $Li_2O$; k, $Na_2O$; l, $Li_2S$.
2. Line up the symbols … then balance the equation: a, $2Ca + O_2 \rightarrow 2CaO$; b, $Ca + Cl_2 \rightarrow CaCl_2$; c, $2Na + F_2 \rightarrow 2NaF$; d, $Be + S \rightarrow BeS$; e, $Be + F_2 \rightarrow BeF_2$; f, $2Li + F_2 \rightarrow 2LiF$; g, $Mg + S \rightarrow MgS$; h, $2K + Cl_2 \rightarrow 2KCl$; I, $Mg + F_2 \rightarrow MgF_2$; j, $4Li + O_2 \rightarrow 2Li_2O$; k, $4Na + O_2 \rightarrow 2Na_2O$; l, $2Li + S \rightarrow Li_2S$.

# Atomic structure and the periodic table: Lesson 3

## Lesson overview

### Learning objectives

- Explore the structure of atoms.
- Consider the sizes of atoms.
- Explore the way atomic radius changes with position in the periodic table.

### Learning outcomes

- Describe atoms as positive nuclei surrounded by shells of negative electrons. [O1]
- Recognise that the nucleus is very small but contains most of an atom's mass. [O2]
- Describe trends in atomic radius down a group and across a period. [O3]

### Skills development

- WS 1.2 Recognise, draw and interpret models of atoms.
- WS 3.5 Describe trends in graphical data.
- WS 4.4 Use prefixes and powers of ten to compare sizes of atoms.

**Maths focus** Use prefixes and powers of ten; plot two variables from data.

**Resources needed** Model atom as described in the Technician's notes; periodic tables; graph paper; Technician's notes 1.3.1.

**Digital resources** Presentation 1.3.1 'Helium'; Graph plotter 1.3.1.

**Key vocabulary** charge, electron, nucleus, electron shell.

## Teaching and learning

### Engage

- **Use** Presentation 1.3.1 'Helium' to **introduce** helium as a gas made of individual atoms.
- **Ideas hothouse**. **Ask** pupils to work in pairs and list things they know or can deduce about helium atoms. Then **ask** the pairs to join together into fours and then six–eights to come up with an agreed list of points. Ask one person from each group to report back to the class and collate their ideas. [O1]
- **Explain** that although we can draw atoms as solid spheres or circles, real atoms are mostly empty space.

### Challenge and develop

- **Read** 'Atoms' and 'More on atoms' in the pupil book. [O1 and O2]
- **Introduce** the model atom described in the Technician's notes and highlight the small positive nucleus, the 'shell' of negative electrons represented by the hoop and the empty space between the two where there is nothing at all. [O1 and O2]
- **Pairs to fours.** Pupils work in pairs to **list** ways in which the model helium atom is the same as a real atom and ways in which it is different. Then they join with another pair to explain and compare ideas and agree on three main points. [O1 and O2]
- **Survey** pupil's ideas and **bring out** the idea that both the real and the model atoms contain a central positive nucleus surrounded by a shell of negative electrons. However, real atoms are spherical and if a real helium atom was magnified to give it a diameter of 1 m, its nucleus would only be about 0.1 mm in diameter – too small for us to see it on the model. Also, the model has air between the nucleus and the electrons but in real atoms that space is completely empty. [O1 and O2]
- **Use** a video clip to **review** the sizes of atoms. [Google search string:] Just How Small Is an Atom? – Jonathan Bergmann. [O2]

### Explain

- Low demand: Pupils **complete** Worksheet 1.3.1. [O1 and O2]
- Standard and high demand: Pupils **draw** a labelled diagram of a helium atom and list differences between their drawing and a real atom. [O1 and O2]

### Consolidate and apply

- Draw pupil's attention to the table of atomic radii in the pupil book. [O3]
- Low demand: Pupils use Graph Plotter 1.3.1 to **complete** questions 4 and 5 from the pupil book. [O3]
- Standard and high demand: Pupils use graph paper to **complete** questions 4 and 5 from the pupil book. [O3]

### Extend

Ask pupils able to progress further to:

- **Use** the patterns they investigated to **predict** which element has the largest atoms and which has the smallest. Then use the internet to check their predictions. [O3]

### Plenary suggestion

What do I know? Ask pupils to each write down one thing about atoms they are sure of, one thing they are unsure of and one thing they need to know more about.

## Answers to Worksheet 1.3.1

Atoms:

1. The following parts should be labelled: positive nucleus, negative electrons, and empty space.

2. Any two differences from the following list: real helium atoms are spherical rather than flat, the nucleus is much smaller in a real atom, there is nothing between the nucleus and the electron shell in a real helium atom.

# Atomic structure and the periodic table: Lesson 4

## Lesson overview

### Learning objectives

- Learn how models of the atom changed as scientists gathered more data.
- Consider the data Rutherford and Marsden collected.
- Link their data to our model of the atom.

### Learning outcomes

- Describe how and why the atomic model has changed over time. [O1]
- Describe the difference between the plum-pudding model of the atom and the nuclear model of the atom. [O2]
- Describe why the new evidence from the scattering experiment led to a change in the atomic model. [O3]

### Skills development

- WS 1.1 Explain why new data led to changes in a model.
- WS 1.2 Match features of a model to data from experiments.
- WS 1.3 Explain why the data needed to answer scientific questions may be incomplete.

**Resources needed** Equipment as listed in the Technician's notes; Worksheets 1.4.1, 1.4.2 and 1.4.3; Technician's notes 1.4.1.

**Digital resources** Presentation 1.4.1 'Name that model'.

**Key vocabulary** electron shell, Ernest Rutherford, Geiger and Marsden experiment, J. J. Thomson, James Chadwick, John Dalton, Neils Bohr.

## Teaching and learning

### Engage

- **Display** the three atomic models described in the Technician's notes. **Explain** that we started with Dalton's atomic model, but the model had to be changed whenever scientists found evidence that didn't fit the model they were using. [O1]

### Challenge and develop

- Give out Worksheet 1.4.1. Pupils work in pairs to **cut-out** the cards. Then **read** spread 1.4 in the pupil book to **find out** when each scientist worked and **arrange** the cards in chronological order. [O1]
- Low demand: Pairs **stick** the cards in chronological order onto an A3 sheet, and then **draw** each scientist's atomic model below their card. [O1]
- Standard and higher demand: Pairs use the cards and information from spread 1.4 in the pupil book to **create** a timeline showing each scientist's contribution to the development of the atomic model. [O1]

### Explain

- Low and standard demand: **Display** Thomson's plum pudding model and the Rutherford-Bohr nuclear atom. Challenge pupils to **find** two things that are the same about them and two things that are different. [O2]
- **Demonstrate** Geiger and Marsden's scattering experiment by throwing model alpha particles at the Rutherford-Bohr atomic model. Most will pass straight through as Rutherford expected but any that hit the positive nucleus will bounce back. Rutherford found this amazing. His calculations showed that a bounce back would only be possible if almost the entire mass of the atom was squashed into a tiny nucleus. There must be a vast empty space between this nucleus and the electrons. [O3]

- **Show** a video to reinforce the significance of the scattering experiment [Google search string:] New Syllabus 2.1 Aim: Rutherford's gold foil experiment. [O3]
- Standard demand: **Complete** Worksheet 1.4.2. [O3]
- High demand: **Snowball**. **Display** Thomson's plum-pudding model and the Rutherford–Bohr nuclear atom. Challenge pupils to **describe** why the new evidence from Geiger and Marsden's scattering experiment led to a change in the atomic model. Individuals could explore the question briefly, and then discuss their ideas in pairs and fours before they summarise them in writing. [O3]

### Consolidate and apply

- **Show** a video to reinforce the steps in the development of ideas about the atom [Google search string:] The 2,400-year search for the atom. [O1–O3]
- Low demand: **Complete** Worksheet 1.4.3. [O1 and O2]
- Standard and high demand: **Pairs to fours**. Pupils work together in pairs to decide which scientist made the biggest contribution to our understanding of atoms and why. Each pair then joins up with another pair to explain and compare ideas and they elect a spokesperson to feedback to the rest of the class. [O2 and O3]

### Extend

Ask pupils able to progress further to:

- **Find** out more about Geiger and Marsden's scattering experiment and **suggest** why it could not have been done 100 years earlier. [O1]

### Plenary suggestion

Run Presentation 1.4.1 'Name that model' as a whole class quiz.

## Answers to Worksheet 1.4.1

Developing the atomic model.The correct order is: 1, Democritus, 400 BCE; 2, Dalton, 1803; 3, Thomson, 189; 4, Geiger and Marsden, 1909; 5, Rutherford, 1911; 6, Bohr, 1913.

## Answers to Worksheet 1.4.2

Geiger and Marsden's scattering experiment: 1, The gold foil only has a few layers of atoms and most of an atom's volume is empty space; 2, The tiny positive nuclei in the gold atoms were repelling the positively charged alpha particles and causing them to change course; 3, The positive charge would be spread too thinly to repel the alpha particles.

## Answers to Worksheet 1.4.3

Changing ideas: 1, Dalton, Thomson, Rutherford, Bohr; 2, Thomson; 3, Dalton; 4, Bohr; 5, Thomson; 6, Rutherford and Bohr.

# Atomic structure and the periodic table: Lesson 5

## Lesson overview

### Learning objectives

- Compare the formulae of elements and compounds.
- Find out why some elements and compounds form molecules.
- Compare the sizes of molecules.

### Learning outcomes

- Use formulae to distinguish between elements and compounds. [O1]
- Recognise that molecules form when atoms share electrons. [O2]
- Recognise that metals do not share electrons or form molecules. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 1.2 Recognise, draw and interpret diagrams.
- WS 2.4 Carry out experiments appropriately.

**Resources needed** Equipment as listed in the Technician's notes; Practical sheet 1.5.1; Worksheet 1.5.1; Technician's notes 1.5.1.

**Digital resources** Presentation 1.5.1 'Molecules'.

**Key vocabulary** compound, element, molecule.

## Teaching and learning

### Engage

- **Display** slide 1 of Presentation 1.5.1 'Molecules' to prompt pairs to **discuss** what they know about molecules. Slides 2–4 can be used to **clarify** pupil's ideas and emphasise that we are using Dalton's model of the atom today because it makes it easier to see how atoms join to make molecules. [O1 and O3]

### Challenge and develop

- All pupils: Give out Practical sheet 1.5.1. Pupils work in pairs to **make** models of molecules. [O3]

### Explain

- Low demand: **Read** 'Atoms and molecules' from spread 1.5 of the pupil book and **complete** questions 1 and 2. [O1]
- Standard and high demand: **Use** slide 5 of Presentation 1.5.1 'Molecules' to challenge pairs to **identify** how many other atoms can each atom can join on to and then use this information to make predictions. [O2]
- High demand: **Use** slide 6 of Presentation 1.5 'Molecules' to challenge pairs to **identify** a link between an atom's position in the periodic table and the number of other atoms it can join on to. [O2]

### Consolidate and apply

- All pupils: **Sort** the cards from Worksheet 1.5.1 into two groups. [O2 and O3]
- Low demand: Pairs **list** the substances in each group and **describe** what is the same about them. [O1]
- Standard and high demand: **Challenge** pupils to use the examples on the cards to **explain** in as much detail as possible what decides whether an element or compound is made of molecules. **Snowball**. Individuals

explore the question briefly; then suggest ideas quickly in pairs, then double up to fours, appoint a spokesperson and formulate an agreed explanation. [O2 and O3]

### Extend

Ask pupils able to progress further to:

- **Research** carbon compounds. Does carbon always form four bonds? Which other elements does it usually bond with? [O1]

### Plenary suggestion

What do I know? Ask pupils to write down one thing about the molecules they are sure of, one thing they are unsure of and one thing they need to know more about. Ask them to work in groups of five–six to agree on group lists. Then take feedback from other groups and agree as a class what they are confident about, what they are less sure of and what things they want to know more about.

## Answers to Worksheet 1.5.1

Comparing compounds: Pupils should divide the cards into molecular substances containing only non-metals – ethanoic acid, oxygen, water and chlorine – and metal compounds.

# Atomic structure and the periodic table: Lesson 6

## Lesson overview

### Learning objectives

- Compare protons, neutrons and electrons.
- Find out why atoms are neutral.
- Relate the number of charged particles in atoms to their position in the periodic table.

### Learning outcomes

- Use a periodic table to find the number of protons or electrons in an atom. [O1]
- Explain why atoms are neutral. [O2]
- Recall the relative masses and charges of protons, neutrons and electrons. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 1.2 Recognise, draw and interpret diagrams.
- WS 3.5 Recognise patterns in data.

**Maths focus** Subtracting negative numbers.

**Resources needed** Periodic tables; equipment as listed in the Technician's notes; Worksheet 1.6.1; Technician's notes 1.6.1.

**Digital resources** Presentation 1.6.1 'One of these is not like the others'.

**Key vocabulary** atomic number, electron, neutral, neutron, proton, symbol

## Teaching and learning

### Engage

- **Display** the Rutherford–Bohr model of a helium atom used in Lesson 1.4. Point out the two positive charges in the nucleus and the two electrons in a shell around the outside. Challenge pupils to suggest what makes atoms of hydrogen different from helium atoms. [O1]

### Challenge and develop

- **Use** red ball pond balls to **model** the two protons that make up the positive nucleus in helium. Then use two green balls to model the rest of helium's nucleus – two neutrons – and two blue balls to model its two electrons. Stress that these models are not very realistic. Real protons and neutrons have 20,000 times more mass than electrons. [O2]
- **Use** a video clip to **review** the structure of helium [Google search string:] BBC Bitesize – GCSE chemistry – Atomic structure. [O1, O2 and O3]
- **Emphasise** that different elements have different numbers of subatomic particles. The number of protons is crucial. Atoms with the same number of protons always belong to the same element. Hydrogen has only one proton so it only needs one electron to balance the charge on its nucleus. [O1 and O2]

### Explain

- Low demand: **Read** 'Structure of atoms' and 'Masses and charges' from spread 1.6 in the pupil book and answer questions 1–4. [O1, O2 and O3]
- Standard and high demand: **Complete** questions 1–4 of Worksheet 1.6.1. [O1, O2 and O3]

### Consolidate and apply

- **Use** the Rutherford–Bohr model to **introduce** the idea that the nucleus never changes during a chemical reaction. However, metallic elements lose electrons when their atoms react to form compounds – making their atoms become charged. [O2]
- **Use** model protons and electrons to **show** how losing one electron leaves a lithium atom with an overall positive charge. This new charged particle is called an ion. [O2]
- Pupils **complete** question 5 from Worksheet 1.6.1. [O2]

### Extend

Ask pupils able to progress further to:

- **Describe** any patterns they spotted in the table in question 5 from Worksheet 1.6.1.

### Plenary suggestion

One of these is not like the others. Use Presentation 1.6.1 to display three particles and ask groups to say why one of them is not like the others. Encourage pupils to find as many possible answers as they can.

## Answers to Worksheet 1.6.1

Inside atoms: 1, Protons in the centre, electrons in the top left section and neutrons in the midle on the right. 2, They have different numbers of protons (neutrons and electrons). 3, Electrons (and protons). 4, The atomic number shows the number of protons, which is the same as the number of electrons in a neutral atom. 5, Table as shown below.

| | Atomic number | Protons | Electrons | Charge |
|---|---|---|---|---|
| Li atom | 3 | 3 | 3 | 0 |
| Li ion | 3 | 3 | 2 | +1 |
| Be atom | 4 | 4 | 4 | 0 |
| Be ion | 4 | 4 | 2 | +2 |
| Na atom | 11 | 11 | 11 | 0 |
| Na ion | 11 | 11 | 10 | +1 |
| Mg atom | 12 | 12 | 12 | 0 |
| Mg ion | 12 | 12 | 10 | +2 |
| Al atom | 13 | 13 | 13 | 0 |
| Al ion | 13 | 13 | 10 | +3 |

# Atomic structure and the periodic table: Lesson 7

## Lesson overview

### Learning objectives

- Find out what the periodic table tells us about each element's atoms.
- Learn what isotopes are.
- Use symbols to represent isotopes.

### Learning outcomes

- Use atomic numbers and mass numbers to find the number of sub-atomic particles in an atom. [O1]
- Explain what isotopes are and how they differ. [O2]
- Use symbols to represent isotopes. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 1.2 Recognise, draw and interpret diagrams.
- WS 4.1 Use scientific definitions.

**Resources needed** Periodic tables, equipment as listed in the Technician's notes; Worksheets 1.7.1 and 1.7.2.

**Digital resources** Presentation 1.7.1 'Isotopes'.

**Key vocabulary** atomic mass, isotope, neutrons, protons.

## Teaching and learning

### Engage

- **Display** slide 1 of Presentation 1.7.1 'Isotopes' to prompt pairs to **discuss** what they know about atoms and isotopes. Slides 2–4 can be used to clarify pupil's ideas. [O2]

### Challenge and develop

- **Display** slide 5 of Presentation 1.7.1 'Isotopes' and **demonstrate** how to calculate numbers of neutrons from mass and atomic numbers. [O1]
- **Use** a video clip to **review** how to use atomic numbers and mass numbers to find the number of sub-atomic particles in an atom [Google search string:] BBC Bitesize – GCSE chemistry – How mass and atomic numbers explain atomic structure. (Avoid the isotopes video in the same series as its description of isotopes could cause misconceptions). [O1]

### Explain

- Low and standard demand: Pupils use Worksheet 1.7.1 to **calculate** the number of neutrons in atoms. [O1]
- High demand: Pupils use the 'Neutrons' section of Worksheet 1.7.2 to **compare** the neutron:proton ratio in a range of atoms. [O1]

### Consolidate and apply

- **Display** slide 5 of Presentation 1.7 'Isotopes' and **introduce** the term 'isotopes' to describe atoms of the same element with different numbers of neutrons. [O2]
- Low demand: **Read** 'Isotopes' from spread 1.7 in the pupil book; **write** the formula of each isotope of hydrogen, and draw a diagram of its atom. [O2 and O3]

- Standard demand: **Read** 'Isotopes' from spread 1.7 in the pupil book and **answer** questions 3–5.[O2 and O3]
- High demand: Pupils use the 'Isotopes' section of Worksheet 1.7.2 to **practice** using symbols to represent isotopes. [O3]

### Extend

Ask pupils able to progress further to:

- Some elements only have radioactive isotopes. **Find out** which elements these are.

### Plenary suggestion

The big ideas: Ask pupils to **write** down three things they know about atoms, and then move into groups to **compile** a master list with the most important at the top. The most important one can then be shared with the rest of the class.

## Answers to Worksheet 1.7.1

Neutrons: Table completed as shown below.

| Atom | Symbol | Mass number | Atomic number | Neutrons |
|---|---|---|---|---|
| Hydrogen | **H** | 1 | **1** | **0** |
| Helium | **He** | 4 | **2** | **2** |
| Lithium | **Li** | 7 | **3** | **4** |
| Beryllium | **Be** | 9 | **4** | **5** |
| Boron | **B** | 11 | **5** | **6** |
| Carbon | **C** | 12 | **6** | **6** |
| Nitrogen | **N** | 14 | **7** | **7** |
| Oxygen | **O** | 16 | **8** | **8** |
| Fluorine | **F** | 19 | **9** | **10** |
| Neon | **Ne** | 20 | **10** | **10** |
| Sodium | **Na** | 23 | **11** | **12** |
| Magnesium | **Mg** | 24 | **12** | **12** |
| Aluminium | **Al** | 27 | **13** | **14** |
| Silicon | **Si** | 28 | **14** | **14** |
| Phosphorus | **P** | 31 | **15** | **16** |
| Sulfur | **S** | 32 | **16** | **16** |
| Chlorine | **Cl** | 35 | **17** | **18** |
| Argon | **Ar** | 40 | **18** | **22** |
| Potassium | **K** | 39 | **19** | **20** |
| Calcium | **Ca** | 40 | **20** | **20** |

## Answers to Worksheet 1.7.2

Neutrons:

1. Li, Be, B, F, Na, Al, P, Cl, Ar, K
2. Only H

Isotopes:

1. $^{32}_{16}S$ $^{35}_{17}Cl$ $^{40}_{18}Ar$ $^{39}_{19}K$ $^{40}_{20}Ca$
2. carbon-12, six protons, six electrons, six neutrons; carbon-13, six protons, six electrons, seven neutrons; carbon-14, six protons, six electrons, eight neutrons

# Atomic structure and the periodic table: Lesson 8

## Lesson overview

### Learning objectives

- Find out how electrons are arranged in atoms.
- Use diagrams and symbols to show which energy levels they occupy.
- Relate each element's electron configuration to its position in the periodic table.

### Learning outcomes

- Represent the electronic structures of the first 20 elements. [O1]
- Recognise that elements in the same group have similar chemical properties. [O2]
- Relate the number of electrons in the outer shell (highest energy level) to an element's group number. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 1.2 Recognise, draw and interpret diagrams.
- WS 1.2 Make predictions based on a model.

**Resources needed** Equipment as listed in the Technician's notes; individual periodic tables; a large wall-mounted periodic table; Worksheets 1.8.1, 1.8.2 and 1.8.3; Technician's notes 1.8.1.

**Digital resources** Presentation 1.8.1 'Name that atom'.

**Key vocabulary** electronic structure, electron shells, energy levels.

## Teaching and learning

### Engage

- **Display** the Rutherford–Bohr model of a helium atom used in Lesson 1.4 with two positive charges in the nucleus and two electrons in a shell around the outside. **Explain** that we need to improve the model to describe atoms bigger than helium because only two electrons will fit in this shell. [O1]

### Challenge and develop

- Low and standard demand: Give each pair a copy of Worksheet 1.8.2 and a set of model electrons. **Demonstrate** how these can be used to **model** the electron arrangements in atoms and point out the link between the shell being filled and the element's period. Then choose elements from 1 to 20 at random until pupils are confident that they can lay out the appropriate electronic structures. [O1]
- High demand: **Pairs to fours**. Pairs sort the cards from Worksheet 1.8.1 into groups of four. They show the name, symbol, group number and electron configurations of five different atoms. **Challenge** pairs to describe the connections between an atom's position in the periodic table and the way their electrons are arranged. Then link pairs into fours to compare ideas and appoint a spokesperson to feedback to the class. [O1 and O3]

### Explain

- Low and standard demand: **Read** 'The 'build-up' of electrons' from spread 1.8 in the pupil book and **answer** questions 1 and 2. [O1]
- High demand: Pupils **explain** how they can deduce an atoms electronic structure from its position in the periodic table. [O1 and O3]

### Consolidate and apply

- **Use** a video clip to **review** the arrangement of electrons in atoms. [Google search string:] BBC Bitesize – GCSE chemistry – The arrangement of electrons in the periodic table. [O1, O2 and O3]
- Low and standard demand: **Read** 'Electron patterns and groups' and 'Maximum numbers' from spread 1.8 in the pupil book and **answer** questions 3–6. Worksheet 1.8.3 supports question 6. [O1, O2 and O3]
- High demand: Pupils **choose** elements in Period 3 from Groups 1, 7 and 8 and draw out their electronic structures. [O1 and O3]

### Extend

Ask pupils able to progress further to:

- **Research** the absorption and emission spectra produced when electrons move between energy levels.

### Plenary suggestion

Pupils complete the quiz on Presentation 1.8.1 'Name that atom' to practice using electronic structures to identify elements. [O1]

## Answers to Worksheet 1.8.1

Atoms and electrons: the number of electron shells occupied indicates the period; the number of electrons in the outer shell corresponds to the group number; the first shell holds up to two electrons and the others hold up to eight.

# Atomic structure and the periodic table: Lesson 9

## Lesson overview

### Learning objectives

- Find out how the periodic table has changed over the years.
- Explore Mendeleev's role in its development.
- Consider the accuracy of Mendeleev's predictions.

### Learning outcomes

- Describe the main steps in the development of the periodic table. [O1]
- Explain why the periodic table has changed throughout the years. [O2]
- Describe and explain how testing a prediction can support or refute a new scientific idea. [O3]

### Skills development

- WS 1.2 Match features of the periodic table to data and observations.
- WS 1.2 Make predictions based on the periodic table.
- WS 1.2 Recall Mendeleev's predictions and explain why they boosted support for his periodic table.

**Resources needed** Periodic tables; equipment as listed in the Technician's notes; Worksheets 1.9.1 and 1.9.2; Technician's notes 1.9.1.

**Digital resources** Presentation 1.9.1 'Mendeleev'.

**Key vocabulary** periodicity, predictions, properties.

## Teaching and learning

### Engage

- Scientists are coming up with new ideas all the time. **Ask** groups to **suggest** how we can tell whether their ideas are correct. [O3]

### Challenge and develop

- Give out sets of cards cut from Worksheet 1.9.1 and use Presentation 1.9.1 'Mendeleev' to **guide** pupils through the main steps in the development of the periodic table. [O1 and O2]
- Use a video clip to **review** Mendeleev's work [Google search string:] Mendeleev's dream video – BIG QUESTIONS Mendeleev's dream. [O1, O2 and O3]

### Explain

- Low and standard demand: Use spread 1.9 in the Pupil Book to **draw** a timeline for the development of the periodic table. Then **answer** questions 1–4. [O1 and O2]
- Standard and high demand: **Explain** why the periodic table has changed throughout the years. [O2]

### Consolidate and apply

- Use a video clip to **review** and extend pupil's understanding of Mendeleev's contribution. [Google search string:] The genius of Mendeleev's periodic table. [O1, O2 and O3]
- Standard and high demand: Complete Worksheet 1.9.2. [O3]

### Extend

Ask pupils able to progress further to:

- **Explain** why the discovery of isotopes made it possible to show why an element order based on atomic weights was not always correct.

### Plenary suggestion

Ask pupils to draw a large triangle with a smaller inverted triangle that just fits inside it (so they have four triangles). In the outer three ask them to write: something they've seen; something they've done; something they've discussed. Then add in the central triangle: something they've learned.

## Answers to Worksheet 1.9.2

Changing scientific ideas: 1, The results did not match predictions based on the model. 2, Germanium's properties matched Mendeleev's predictions. 3, The elements in each group have the same number of outer electrons. 4, Ar and K or Te and I or Hs and Mt. 5, Atomic number or proton number.

# Atomic structure and the periodic table: Lesson 10

## Lesson overview

### Learning objectives

- Review the physical properties of metals and non-metals.
- Compare oxides of metals and non-metals.
- Make predictions about unknown metals and non-metals.

### Learning outcomes

- Use physical properties to distinguish between metals and non-metals. [O1]
- Use the pH of solutions of their oxides to distinguish between metals and non-metals. [O2]
- Explain the differences between metals and non-metals on the basis of their characteristic physical and chemical properties. [O3]

### Skills development

- WS 2.3 Carry out experiments appropriately.
- WS 2.6 Make and record observations.
- WS 3.5 Use data to make predictions.

**Resources needed** Equipment as listed in the Technician's notes; Practical sheet 1.10.1; Worksheet 1.10.1; Technician's notes 1.10.1.

**Digital resources** Presentation 1.10.1 'Metal or non-metal'; Presentation 1.10.2 'One of these is not like the others'.

**Key vocabulary** electrical conductor, lustrous, tensile strength, thermal conductivity.

## Teaching and learning

### Engage

- **Display** a large unlabelled lump of graphite (or display slide 1 of Presentation 1.10.1 'Metal or non-metal' if no graphite is available). **Suggest** that it could be a metal because it is slightly lustrous (shiny). **Ask** groups to suggest tests you could do to support or refute the idea that an element is a metal, and what results you would expect. [O1]

### Challenge and develop

- Low and standard demand: Pupils **use** the examples on slide 2 of Presentation 1.10.1 'Metal or non-metal' to **practice** using physical properties to distinguish between metals and non-metals. [O1]
- Higher demand: **Use** a video clip to **explore** the atomic structure of metals and explain why they are both malleable and strong [Google search string:] BBC Bitesize – GCSE chemistry – The atomic structure of metals. [O1]
- **Present** the main properties of graphite using slide 3 of Presentation 1.10.1 'Metal or non-metal' and **confirm** that it is a non-metal despite having some metallic properties. [O1]

### Explain

- Low and standard demand: Pupils **read** 'Physical properties' from spread 1.10 in the pupil book and complete 'Metal vs non-metal 1' from Worksheet 1.10.1. [O1]
- High demand: **Pair talk**. Pupils **rank** the physical properties of metals and non-metals in order of the usefulness in distinguishing which group an element belongs to. [O3]

### Consolidate and apply

- Low demand: Give out Practical sheet 1.10.1. Pupils work in pairs to **compare** the pH values of metal and non-metal oxides that have been mixed with water. [O2]
- Standard and high demand: Make the apparatus listed in the Technician's guide available and **challenge** pairs to find a difference between the pH values of metal and non-metal oxides that have been mixed with water. [O2]
- Low and standard demand: Pupils **read** 'Chemical properties' from spread 1.10 in the pupil book and complete 'Metal vs non-metal 2' from Worksheet 1.10.1. [O1]
- High demand: Pupils **read** 'Chemical properties' from spread 1.10 in the pupil book and compare and contrast the chemical properties of metals and non-metals. [O3]

### Extend

Ask pupils able to progress further to:

- **Find** out what is meant when an element is called a 'metalloid' element and list the elements in Periods 1–4 that are usually classified as metalloids.

### Plenary suggestion

One of these is not like the others. Use Presentation 1.10.2 to display three elements or compounds and ask groups to say why one of them is not like the others. Encourage pupils to find as many possible answers as they can but don't allow the use of metal or non-metal in their answers.

## Answers to Worksheet 1.10.1

Metal vs non-metal 1: Table as shown below

| Physical property | Metal | Non-metal |
|---|---|---|
| Lustrous | YES | NO |
| Hard | YES | NO |
| Density | HIGH | LOW |
| Tensile strength | HIGH | LOW |
| Melting or boiling point | HIGH | LOW |
| Conductor of heat | YES | NO |
| Conductor of electricity | YES | NO |

. Metal vs non-metal 2: Table as shown below.

| Chemical property | Metal | Non-metal |
|---|---|---|
| Most react with oxygen | YES | YES |
| Most react with acid | YES | NO |
| Their oxides are acidic | NO | YES |
| Their oxides are basic | YES | NO |

# Atomic structure and the periodic table: Lesson 11

## Lesson overview

### Learning objectives

- Explore the links between electron configurations of elements and their properties.
- Find out what happens to the outer electrons when metals react.
- Draw diagrams to show how ions form.

### Learning outcomes

- Relate the electron configurations of metals and non-metals to their position in the periodic table. [O1]
- Describe how metal atoms form ions when they react with non-metals. [O2]
- Explain how the reactions of elements are related to the arrangement of electrons in their atoms. [O3]

### Skills development

- WS 1.2 Recognise, draw and interpret diagrams.
- WS 3.5 Recognise and describe patterns in data.
- WS 4.1 Use scientific vocabulary, terminology and definitions.

**Resources needed** Equipment as listed in the Technician's notes; Worksheets 1.11.1 and 1.11.2; Technician's notes 1.11.1.

**Key vocabulary** ions, atomic structure, metalloids

## Teaching and learning

### Engage

- **Point out** element number 34 – selenium. **Ask** pupils whether it's a metal or a non-metal and how we can tell. [O1]
- **Ask** pupils to **draw** in a metal–non-metal dividing line between Be and B, Al and Si, Ge and As, Sb and Te, and Po and At. [O1]

### Challenge and develop

- **Use** a video clip to **demonstrate** the reaction between sodium and chlorine. [Google search string:] Practical chemistry videos: reaction of sodium and chlorine. Then **use** a model to **show** the structure of the sodium chloride produced.
- Low and standard demand: **Pairs to fours**. Give each pair a copy of Worksheet 1.8.2 and a set of model electrons. Ask alternate groups to produce the electron arrangements in sodium and chlorine, and then join another pair with the other atoms. **Explain** that when sodium reacts with chlorine its outer electron is transferred to the non-metal and fills the gap in its outer shell (highest energy level). This converts both atoms into charged ions which attract each other to form a crystal. [O1 and O2]
- High demand: **Pairs to fours**. **Explain** that when sodium reacts with chlorine its outer electron is transferred to the non-metal and fills the gap in its outer shell (highest energy level). **Challenge** pairs to explain why this makes sodium chloride form a regular crystal structure. They should then join with another group to compare ideas. [O1 and O2]

### Explain

- Low and standard demand: Pupils **complete** Worksheet 1.11.1. [O1–O3]
- High demand: Pupils **explain** how atoms of sodium and chlorine are changed when they react with each other. [O1 and O2]

### Consolidate and apply

- **Use** a video clip to **review** the formation of ions. [Google search string:] BBC Bitesize – GCSE chemistry – Ionic compounds and the periodic table. [O1–O3]
- **Ask** pupils to **annotate** their periodic table to show the charges on the ions formed by elements in Groups 1–3 and 5–7. [O3]
- Low and standard demand: Pupils **read** spread 1.11 in the pupil book and **answer** questions 1–4. [O1–O3]
- High demand: Pupils read spread 1.11 in the Pupil Book and explain how the reactions of elements are related to the arrangement of electrons in their atoms. [O3]

### Extend

Ask pupils able to progress further to:

- **Complete** Worksheet 1.11.2 Dot and cross diagrams. [O2]

### Plenary suggestion

Ask pupils to draw a large triangle with a smaller inverted triangle that just fits inside it (so they have four triangles). In the outer three ask them to write: something they've seen; something they've done; something they've discussed. Then add in the central triangle: something they've learned.

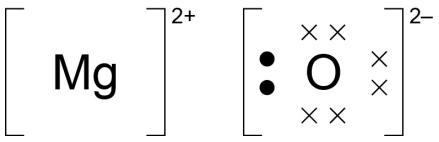
## Answers to Worksheet 1.11.1

Ions: 1. $Na^+$, $Mg^{2+}$, $Al^{3+}$; 2, $O^{2-}$, $F^-$; 3 a, $Li^+$; b, $Cl^-$; c, $Ca^{2+}$; d, $S^{2-}$; e, $Br^-$; f, $K^+$.

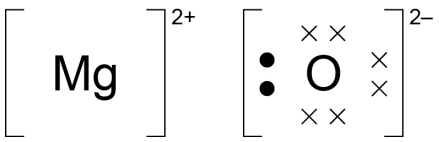
## Answers to Worksheet 1.11.2

Dot and cross diagrams:

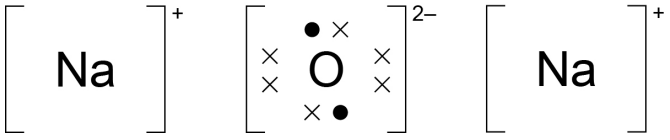
1.



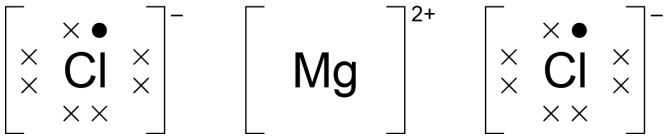

2.




3.




4.



# Atomic structure and the periodic table: Lesson 12

## Lesson overview

### Learning objectives

- Explore the properties of noble gases.
- Find out how the mass of their atoms affects their boiling points.
- Relate their chemical properties to their electronic structures.

### Learning outcomes

- Describe the properties of noble gases. [O1]
- Predict and explain the trends of the boiling points of the noble gases (going down the group). [O2]
- Explain how properties of the elements in Group 0 depend on their electron configurations. [O3]

### Skills development

- WS 1.2 Match features of a model to data from observations.
- WS 3.5 Recognise and describe patterns in data.
- WS 4.1 Use scientific vocabulary, terminology and definitions

**Maths focus** Plot two variables from data using negative numbers.

**Resources needed** Internet access; graph paper; Worksheet 1.12.1.

**Digital resources** Graph plotter 1.12.1; Presentation 1.12.1 ‘Group 0’; Presentation 1.12.2 ‘Argon’

**Key vocabulary** elements, helium, neon, argon, density, unreactive.

## Teaching and learning

### Engage

- **Display** Presentation 1.12.1 ‘Group 0’ to prompt small-group discussion about the elements in Group 0. [O2]

### Challenge and develop

- **Use** a video clip to **give** an overview of the physical properties of these elements. [Google search string:] Noble gases Open University video.
- **Jigsaw**. **Challenge** pupils to **find** an important use for each element and **describe** the properties that use depends on. **Divide** the class into groups of up to six and **allocate** a different Group 8 element to each pupil. They should regroup into ‘expert’ groups to research their element and then share their findings with their home group. [O1]

### Explain

- **Explain** that although Group 0 are all unreactive they show trends in their properties that make them more useful for different jobs. Draw attention to the table of boiling points on spread 1.12 of the pupil book and the atomic masses listed in the periodic table. [O2]
- Low demand: Pairs use Graph Plotter 1.12.1 to **display** the relationship between atomic mass and the boiling points of Group 0 elements. Then they **describe** the pattern in the graph. [O2]
- Standard and high demand: Pupils **display** the relationship between atomic mass and the boiling points of Group 0 elements using graph paper. Then they **describe** the pattern in the graph. [O2]
- Pupils **read** ‘Patterns in Group 0’ from spread 1.12 in the pupil book and **answer** questions 1 and 2. [O2]

### Consolidate and apply

- **Display** Presentation 1.12.1 'Argon' and **ask** what is the same about the electronic structures of the elements in Group 0 and whether this could explain their lack of reactivity. [O3]
- Low demand: Pupils **complete** Worksheet 1.12.1. [O3]
- Standard and high demand: Pupils **read** 'Why do elements in Group 0 exist as single atoms?' from spread 1.12 in the pupil book and **answer** questions 3 and 4. [O3]

### Extend

Ask pupils able to progress further to:

- **Find** the relationship between the density of Group 0 elements and their atomic masses.

### Plenary suggestion

Ideas hothouse. Display Presentation 1.12.2 'Group 0' again and prompt pairs to **discuss** their conclusion. Then ask pairs to join up to make groups of six and agree a response to feedback to the rest of the class.

## Answers to Worksheet 1.12.1

The Group 0 elements: 1, They all have full outer shells. 2, Helium's outer shell can only hold two electrons. 3, They have no spare outer electrons to give away and there are no gaps in their outer shells to fill.

# Atomic structure and the periodic table: Lesson 13

## Lesson overview

### Learning objectives

- Explore the properties of Group 1 metals.
- Compare their reactivity.
- Relate their reactivity to their electronic structures.

### Learning outcomes

- Explain why Group 1 metals are known as the alkali metals. [O1]
- Use the trends down the group to make predictions. [O2]
- Relate the properties of alkali metals to their electron configurations. [O3]

### Skills development

- WS 2.4 Identify the main hazards associated with Group 1 metals.
- WS 2.6 Make and record observations.
- WS 4.1 Use scientific vocabulary, terminology and definitions.

**Maths focus** Interpolate and extrapolate graphs.

**Resources needed** Equipment as listed in the Technician's notes; Worksheets 1.13.1, 1.13.2 and 1.13.3; Technician's notes 1.13.1.

**Digital resources** Presentation 1.13.1 'Ions'.

**Key vocabulary** alkali, density, indicator, ion, reactivity, stable electronic structure.

## Teaching and learning

### Engage

- **Show** the bottles of Group 1 metals (Technician's notes 1.13.1) and elicit pupils' ideas about why they are stored under oil and why the pieces being used are so small. [O1]

### Challenge and develop

- **Demonstrate** the reactions of lithium, sodium and potassium with water following the method detailed in Technician's notes 1.13.1. Emphasise the similarities between them, the way they become softer and less dense going down the group and the way their reactivity increases going down the group. [O1]
- **Follow up** the demonstration with a video clip so pupils can see close-ups of the metals and their reactions with water. [Google search string:] Alkali metals in water, accurate! [O1]

### Explain

- Low demand: Pupils **read** 'Properties of Group 1 elements' and 'Reaction trends of alkali metals' from spread 1.13 in the pupil book and **answer** questions 1–5. [O1]
- Standard and high demand: Pupils **record** the similarities and differences between the reactions of lithium, sodium and potassium with water. [O1]

### Consolidate and apply

- Low and standard demand: Pupils **use** the trends down the group to **make** predictions using Worksheets 1.13.1. and 1.13.2. [O2]

- High demand: Pupils **use** the trends in melting point down the group to **make** predictions using Worksheet 1.13.2. [O2]
- High demand: **Point out** francium at the bottom of Group 1. **Explain** that it is very rare and all its isotopes are radioactive, so it is nearly impossible to study. Ask pupils to **predict** how it reacts with water and justify their predictions with evidence from reactions they have seen. [O2]
- **Display** Presentation 1.13.1 'Ions' and **discuss** the similarity between the electronic structures of lithium and sodium. [O3]
- Low and standard demand: Pupils **complete** Worksheet 1.13.3. [O3]
- High demand: **Ask** pairs or small groups to **explain** how the electronic structures of these elements make them have similar chemical properties. [O3]

### Extend

Ask pupils able to progress further to:

- **Research** the reactions of beryllium, magnesium and calcium with water, **compare** them with Group 1 elements and **describe** any similarities and differences you notice.

### Plenary suggestion

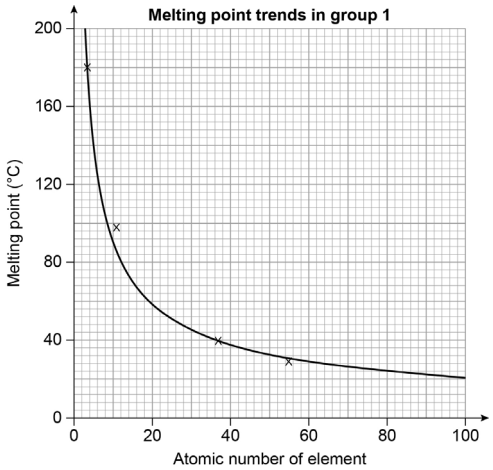
Ask pupils to draw a large triangle with a smaller inverted triangle that just fits inside it (so they have four triangles). In the outer three ask them to write: something they've seen; something they've done; something they've discussed. Then add in the central triangle: something they've learned.

## Answers to Worksheet 1.13.1

Trends in Group 1: 1, They will react more violently with water than with potassium, because the reactivity of Group 1 metals increases going down the group; 2, $2Li + 2H_2O \rightarrow 2LiOH + H_2$, $2K + 2H_2O \rightarrow 2KOH + H_2$, $2Rb + 2H_2O \rightarrow 2RbOH + H_2$; 3, Caesium hydroxide + hydrogen; 4, The hydroxides react with water to make alkaline solutions.

## Answers to Worksheet 1.13.2

Using graphs to make predictions:




Potassium, melting point: 55–65°C; francium: melting point, 26–30°C.

## Answers to Worksheet 1.13.3

Achieving a stable electronic structure: 1, They both have one electron in their outer shell; 2, 2,8,8,1; 3, One of the positive charges in the nucleus is no longer cancelled out; 4, $Na^+$; $K^+$.

# Atomic structure and the periodic table: Lesson 14

## Lesson overview

### Learning objectives

- Explain why Group 7 non-metals are known as halogens.
- Compare their reactivity.
- Relate their reactivity to their electronic structures.

### Learning outcomes

- Recall that fluorine, chlorine, bromine and iodine are non-metals called halogens. [O1]
- Use the trends down the group to make predictions. [O2]
- Construct balanced symbol equations for the reactions. [O3]

### Skills development

- WS 2.4 Carry out experiments appropriately.
- WS 2.6 Make and record observations.
- WS 4.1 Use scientific vocabulary, terminology and definitions.

**Resources needed** Equipment as listed in the Technician's notes; Worksheets 1.14.1, 1.14.2 and 1.14.3; Technician's notes 1.14.1 and 1.14.2.

**Digital resources** Presentation 1.14.1 'Halogens'.

**Key vocabulary** bromine, chlorine, halogen, iodine.

## Teaching and learning

### Engage

- **Read** lines 9–14 of the Wilfred Owen poem *Dulce et Decorum Est* and ask pupils what gas the author is referring to. Stress that the gas is toxic at high concentrations, but only kills bacteria at the concentrations found in swimming pools. [O1]

### Challenge and develop

- **Demonstrate** the appearance of chlorine, bromine and iodine following the guidance in the Technician's notes 1.14.1 or show images of the elements. Stress that at room temperature bromine is a very volatile liquid rather than a gas, and iodine is a grey solid that sublimes to form a purple vapour when warmed. [O1]
- **Demonstrate** the reaction between sodium and chlorine, or show a video of it. Stress that every Group 1 element reacts with every Group 7 element and all the compounds formed this way are salts. That's why the group are called halogens – which means 'salt-producing'. [O1]

### Explain

- Low and standard demand: Using Worksheet 1.14.1, pupils **practice** writing equations for similar reactions to the one they have witnessed. [O3]
- High demand: Ask pupils to **read** 'The halogens' from spread 1.14 in the pupil book and **answer** question 1. [O3]
- High demand: Pupils could **choose** pairs of elements from Groups 1 and 7 that will react in a similar way to sodium and bromine and **write** symbol equations to **describe** their reactions. [O3]

### Consolidate and apply

- **Display** Presentation 1.14.1 'Halogens' and **discuss** the trends in their colours and states as their atoms get bigger going down the group. [O2]
- Low and standard demand: Pupils **practice** using a graph with negative axes to make predictions by completing Worksheet 1.14.2. [O2]
- High demand: Ask pupils to **read** 'Group 7 trends' from spread 1.14 in the pupil book and **answer** questions 2–4. [O2]
- **Demonstrate** the reaction between chlorine water and potassium bromide and **prompt** groups to come up with a hypothesis to explain the colour change. Use the term 'displacement' to describe this sort of reaction. [O2]
- **Show** pupils a solution of iodine and **ask** them which halogen is dissolved in the water. **Explain** that iodine molecules are purple but they form brown solutions. Ask them to **predict** what will happen if chlorine water is added to potassium iodide. **Demonstrate** this reaction using Technician's notes 1.14.2 and add hexane to the products to support the conclusion that iodine has been displaced by revealing its purple colour. [O2]
- **Check** pupils' understanding by asking them to **predict** what will happen when bromine is added to potassium chloride. Pupils could **complete** Worksheet 1.14.3 to practice writing equations for this sort of reaction. [O3]

### Extend

Ask pupils able to progress further to:

- The compounds halogens make with Group 1 metals are all white crystalline solids. **Research** some of the molecular compounds the halogens make with other non-metals and **describe** their properties.

### Plenary suggestion

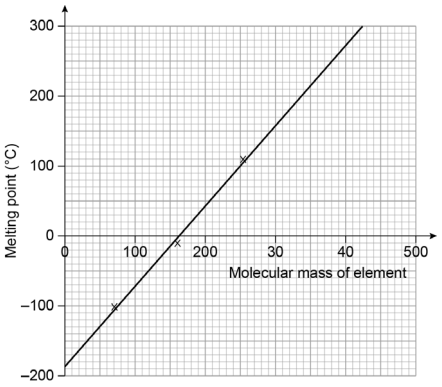
Name a halogen and challenge groups to list five things they know about it.

## Answers to Worksheet 1.14.1

Making compounds: 1, lithium + iodine → lithium iodide, potassium + bromine → potassium bromide; 2, $2Na + Cl_2 \rightarrow 2NaCl$; 3, $2Na + Br_2 \rightarrow 2NaBr$, $2K + Cl_2 \rightarrow 2KCl$, $2K + I_2 \rightarrow 2KI$, $2Na + At_2 \rightarrow 2KAt$, $2Cs + I_2 \rightarrow 2CsI$, $2Li + Br_2 \rightarrow 2LiBr$; 4, White crystals that will dissolve.

## Answers to Worksheet 1.14.2

Using graphs to make predictions:




Estimated melting point of astatine, 290–300°C.

## Answers to Worksheet 1.14.3

Displacement: 1, Chlorine, pale green; potassium iodide and chloride, colourless; iodine, brown solution; 2, Displacement; 3, pairs b and c; 4, $Br_2 + 2KI \rightarrow I_2 + 2KBr$, $I_2 + 2KAt \rightarrow At_2 + 2KI$, $Cl_2 + 2NaI \rightarrow I_2 + 2NaCl$, $F_2 + 2NaBr \rightarrow Br_2 + 2NaF$, $F_2 + 2KCl \rightarrow Cl_2 + 2KF$.

# Atomic structure and the periodic table: Lesson 15

## Lesson overview

### Learning objectives

- Review the patterns in the periodic table.
- Compare the trends in Group 1 and Group 7.
- Relate these trends to the way atoms form ions.

### Learning outcomes

- Predict the reactions of elements with water, dilute acid or oxygen from their position in the periodic table. [O1]
- Explain why the trends down the group in Group 1 and in Group 7 are different. [O2]
- Explain the changes across a period. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 1.2 Make predictions based on a model.
- WS 3.5 Recognise and describe patterns or trends.

**Resources needed** Large wall-mounted periodic table; individual periodic tables; Worksheet 1.15.1.

**Digital resources** Presentation 1.15.1 'Explaining reactivity'.

**Key vocabulary** electron arrangement, reactivity, trend.

## Teaching and learning

### Engage

- **Ask** pupils to **predict** which Group 1 metal and Group 7 non-metal would react together most violently. If francium is suggested, explain that because all its isotopes are radioactive, and decay very rapidly, it is impossible to get enough of the element to do the experiment with. [O1]
- **Show** a video clip to **demonstrate** the reaction between fluorine with caesium. [Google search string:] Reacting fluorine with caesium – First Time on Camera. **Remind** pupils that we can **predict** how an element will react by looking at its position in the periodic table because the element's position reflects its electronic structure. [O1]

### Challenge and develop

- **Display** slide 1 of Presentation 1.15 'Explaining reactivity' and **discuss** the differences between the electronic structures of lithium and sodium and how that affects how easily they lose their outer electrons. Then **compare** fluorine and chlorine using slide 2 to explain why smaller non-metal atoms are more reactive. [O2]
- **Use** a video clip to **summarise** the trends in the reactivity of the elements in Group 1 and Group 7. [Google search string:] Bitesize – GCSE Chemistry – Reactivity of Group 1 and 7 elements. [O2]

### Explain

- Low demand: Pupils **complete** the questions on Worksheet 1.15.1. [O2]
- Standard and high demand: **Ask** pupils to **read** 'Opposite trends' and 'Trends across' from spread 1.15 in the pupil book and **answer** questions 2–4. [O2 and O3]
- High demand: Pupils **use** diagrams to **explain** how the size of their atoms affects the reactivity of the elements in Group 1 and Group 7. [O2]

### Consolidate and apply

- **Use** a video clip to **review** the trend in properties across a period from Group 1 to Group 3 and from Group 6 to Group 8. [Google search string:] Science in Focus Periodic Table Blind Date. [O3]
- High demand: **Use** slide 3 of Presentation 1.15.1 'Explaining reactivity' to **summarise** the trends in atomic radiuses across Periods 1–4 of the periodic table. Group 2 metals are generally less reactive than Group 1 elements. **Ask** small groups to come up with two possible explanations for this. They should spot that the outer electrons are closer to the nucleus in Group 2 elements and that two electrons need to be lost to form an ion, rather than one. [O3]

### Extend

**Ask** pupils able to progress further to:

- **Create** a costume design and script for an element from Group 1 or 7 that will be appearing on the next episode of 'Periodic Table Blind Date'. [O1]

### Plenary suggestion

Display the names of elements from Groups 1, 7 and 0, and challenge small groups to list as many things about each element as they can in 30 seconds.

## Answers to Worksheet 1.15.1

Explaining trends in reactivity: 1, They lose their outer electrons; 2, Sodium's because it is further from the nucleus; 3, Potassium's outer electron is even further from the nucleus; 4, They attract an electron into their outer shell; 5, Chlorine; 6, Its outer shell is closer to the nucleus so it attracts electrons more strongly.

# Atomic structure and the periodic table: Lesson 16

## Lesson overview

### Learning objectives

- Compare the properties of transition metals with those of Group 1 metals.
- Explore the uses of transition metals.
- Find out why they can form compounds with different colours.

### Learning outcomes

- Describe the properties of transition metals. [O1]
- Relate these properties to their uses. [O2]
- Describe the ions that transition metals form. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 2.6 Make and record observations.
- WS 3.5 Recognise and describe patterns.

**Resources needed** Equipment as listed in the Technician's notes; Worksheet 1.16.1; Technician's notes 1.16.1.

**Digital resources** Presentation 1.16.1 'Transition metals'.

**Key vocabulary** catalyst, chromium, cobalt, manganese, nickel, transition element.

## Teaching and learning

### Engage

- **Display** a range of unlabelled coloured transition metal compounds and elicit pupils' ideas about what they have in common. [O1]
- **Contrast** coloured transition metal compounds with the white compounds formed by Group 1 elements. [O1]
- **Use** the cannon-fire audio experiment to **demonstrate** the catalytic activity of a manganese compound, following the instructions on Technician's notes 1.16.1. [O1]

### Challenge and develop

- **Display** slide 1 of Presentation 1.16.1 'Transition metals' and give groups a minute to **suggest** as many differences as possible between the physical properties of Group 1 metals and those of transition metals. [O1]
- **Use** the Royal Society of Chemistry Periodic Table [Google search string:] rsc periodic-table trends, to **compare** visually the densities and melting points of Group 1 and transition metals. [O1]

### Explain

- **Explain** that like any group of elements the transition metals share properties but are not identical. Pupils **complete** Worksheet 1.16.1 to **link** the properties of transition metals to their common uses. [O1 and O2]
- Low demand: Pupils **choose** one example of a catalyst from spread 1.16 in the pupil book and **record** the name of the transition metal and the process it speeds up. [O2]
- Standard and high demand: **Ask** pupils to **research** the Haber process and the conversion of vegetable oils into margarine. For each process they should find: the name of the catalyst used, the reaction it speeds up and why the reaction is important. [O2]

### Consolidate and apply

- **Display** slide 2 of Presentation 1.16.1 'Transition metals' and explain that the roman numerals in a compound's name show which ion is present. [O3]
- Low and standard demand: Pupils **practice** writing formulas for ions using slide 3 of Presentation 1.16.1 'Transition metals'. [O3]
- High demand: Pupils **read** 'Ions and coloured compounds' from spread 1.16 in the pupil book and **answer** questions 2–4. [O3]

### Extend

Ask pupils able to progress further to:

- **Find** out what ions elements 21–30 can form. Should zinc and scandium be called transition metals? [O3]

### Plenary suggestion

Silent animation. Show pupils a video of the cobalt-catalysed reaction between tartrate and hydrogen peroxide. [Google search string:] cobalt magic video. Ask groups to deduce what is happening using what they know about the compounds of transition metals like cobalt. Cobalt(II) ions are pink in solution. They catalyse the reaction and in the process are changed into green cobalt(III) and then back to pink cobalt(II) ions.

## Answers to Worksheet 1.16.1

Transition metal properties: chromium, F; manganese, G; iron, A; cobalt, D; nickel, B; copper, E; osmium, C.

# Atomic structure and the periodic table: Lesson 17

## Lesson overview

### Learning objectives

- Review the patterns in the periodic table
- Compare the trends in Group 1 and Group 7.
- Relate these trends to the number of outer electrons and the sizes of atoms.

### Learning outcomes

- Predict the reactivity of elements from their position in the periodic table. [O1]
- Predict whether a compound will contain molecules or ions. [O2]
- Explain why the trends down the group in Group 1 and in Group 7 are different. [O3]

### Skills development

- WS 1.2 Use models in explanations.
- WS 1.2 Make predictions based on a model.
- WS 3.5 Recognise and describe patterns or trends.

**Resources needed** Periodic tables, equipment as listed in the Technician's notes; Worksheet 1.17.1; Technician's notes 1.17.1.

**Digital resources** Presentation 1.17.1 'Outer electrons'.

**Key vocabulary** outer shell electrons.

## Teaching and learning

### Engage

- **Challenge** groups to list as many things as possible that they can tell about an element from its position in the periodic table. [O1, O2 and O3]

### Challenge and develop

- Low and standard demand: **Ask** pairs to **sort** cards cut from Worksheet 1.17.1 into stable and unstable atoms based on their electron configurations. They should recognize that only He, Ne and Ar are stable because these have full outer shells. [O1]
- Low and standard demand: **Display** slide 1 of Presentation 1.17.1 'Outer electrons' and **ask** pairs to **divide** the reactive elements into those that definitely transfer outer electrons to other atoms to form positive ions, those that definitely do not, and those they are not sure about. They should appreciate that the metals in Groups 1 and 2 transfer their outer electrons to other atoms when they react and form positive ions. Although boron and aluminium can form ions in solution, their small size makes it difficult for them to transfer electrons to other atoms. [O1 and O2]
- Low and standard demand: **Check** that pupils appreciate that reactive elements that don't form positive ions can form molecules, and the most reactive non-metals can also accept electrons to form negative ions. [O1 and O2]
- High demand: **Display** slide 2 of Presentation 1.17.1 'Outer electrons' and **ask** pairs to **copy** the diagram and then **use** the electron configuration cards to **place** the first 18 elements in the correct groups. [O1 and O2]

### Explain

- Low and standard demand: Pupils **copy** the diagram on slide 2 of Presentation 1.17.1 'Outer electrons' and use their electron configuration cards to **find** an example for each group. [O2]

- High demand: **Ask** pairs to **explain** how an element's outer electrons determine whether ions or molecules form when it reacts. Use sodium chloride and silicon chloride as examples. [O2]

### Consolidate and apply

- **Use** a video clip to **remind** pupils of the trends in reactivity in Groups 1 and 7. [Google search string:] Science Bank Patterns of Reactivity. [O3]
- **Pairs to fours**. **Ask** pairs of pupils to use the electron configuration cards to explain why reactivity increases as you go down Group 1, and as you go up Group 7. Pairs should then join up into groups of four to compare ideas and agree on an explanation. The symbols on these cards reflect the sizes of the atoms to prompt pupils to consider the distance between the outer electrons and the nucleus. [O3]
- If appropriate, reuse a video clip from Lesson 1.15 to summarise the reasons for the trends in the reactivity of Group 1 and Group 7 elements. [Google search string:] Bitesize – GCSE Chemistry – Reactivity of Group 1 and 7 elements. [O2]

### Extend

**Ask** pupils able to progress further to:

- **Research** boron and aluminium. Do they form ions or molecules when they react? [O3]

### Plenary suggestion

What do I know? Ask pupils to write one thing about the outer electrons they are sure of, one thing they are unsure of and one thing they need to know more about. Then let groups of five–six pupils formulate group lists to feed back to the rest of the class.

# Atomic structure and the periodic table: Lesson 18

## Lesson overview

### Learning objectives

- Separate a salt from a mixture.
- Carry out a flame test to identify the metal in the salt.
- Make a precipitate to identify the non-metal in the salt.

### Learning outcomes

- Safely use a range of apparatus. [O1]
- Separate mixtures. [O2]
- Identify Group 1 and Group 7 ions in a compound. [O3]

### Skills development

- WS 2.2 Describe a practical technique for a specific purpose.
- WS 2.3 Select apparatus for a specific purpose.
- WS 2.4 Identify the main hazards in a practical context and suggest how to reduce the risk of harm.

**Resources needed** Equipment as listed in the Technician's notes; Practical sheet 1.18.1; Technician's notes 1.18.1.

**Digital resources** Presentation 1.18.1 'Separating Substances'; Presentation 1.18.2 'Which apparatus?'

**Key vocabulary** filtration, distillation, evaporation, crystallisation, flame test.

## Teaching and learning

### Engage

- **Use** slide 1 of Presentation 1.18.1 'Separating Substances' to set the challenge and slide 2 to **focus** pupils' attention on the first part of the task. [O1, O2 and O3]

### Challenge and develop

- Stress that each group must **write** an outline plan before they start step 1 of Practical sheet 1.18.1. Their plans should **list** the techniques they will use, **highlight** any hazards involved and **record** the steps they will take to minimise the risks. They may find it helpful to review work from Lesson 1.1. [O1]
- Slide 3 of Presentation 1.18.1 'Separating Substances' can be used to **focus** pupils' attention on the precautions they may need to take. [O1]

### Explain

- **Check** each group's plans before they begin the practical work. A suitable plan would involve decanting the liquids from the solids, using a separating funnel to remove the oil, filtering the aqueous layer if necessary and evaporating the solvent to leave the salt. If groups suggest using distillation to remove the alcohol from the salt solution, they could be shown the apparatus used for fractional distillation but advised that this is only required when one of the liquids needs to be collected. In this case the solvents could simply be evaporated to leave the salt. [O2]
- Pupils should appreciate that evaporating solvents other than water with a Bunsen burner is potentially hazardous. **Advise** them that their mixture has had the ethanol removed. [O1 and O2]

### Consolidate and apply

- **Remind** pupils that all the Group 1 metals form white compounds that look very similar, but each metal ion gives a different colour in a Bunsen flame. Then **demonstrate** how to carry out a flame test. [O3]
- **Explain** that all the Group 7 elements form white compounds with group 1 metals and these all look very similar, but each non-metal ion forms a different precipitate with silver ions**.** Then **demonstrate** how to dissolve a little of their salt in distilled water and add two drops of silver nitrate to form a precipitate. [O2]
- **Point out** the known Group 1 salts and halides that pupils can test for comparison. To avoid cross-contamination have one of each set up in an accessible part of the room, as detailed in Technician's notes 1.18.1, for pupils to use when they need them.
- Low and standard demand: Pupils **use** Practical Sheet 1.18.1 to structure the identification of their salts. [O2 and O3]
- High demand: Pupils **confirm** the identity of their salts and describe the evidence they used. [O2 and O3]

### Extend

**Ask** pupils able to progress further to:

- **Test** tap water for the presence of group 1 metal halides. [O2 and O3]

### Plenary suggestion

Which apparatus. Display Presentation 1.18.2 'Which apparatus?' and ask groups to list the apparatus they would need for each separation.

# Using maths skills in science: Lesson 19

## Lesson overview

### Learning objectives

- Use numbers in standard form to compare sizes.
- Use numbers in standard form in calculations.

### Learning outcomes

- Recognise numbers written in standard form. [O1]
- Convert decimals to standard form and vice versa. [O2]
- Use standard form to make estimates. [O3]

### Skills development

- WS 4.2 Recognise the importance of scientific quantities.
- WS 4.4 Use powers of 10 for orders of magnitude.

**Maths focus** Recognise and use numbers in decimal and standard form.

**Resources needed** Equipment as listed in the Technician's notes; Worksheet 1.19.1; Technician's notes 1.19.1.

**Digital resources** Presentation 1.19.1 'Powers of 10'.

**Key vocabulary** standard form, decimal point, significant figure.

## Teaching and learning

### Engage

- **Ask** pairs to **sort** cards cut from Worksheet 1.19.1 into sets of three. Check that pupils recognise that the long numbers are decimals and the powers of 10 are the same numbers written in standard form. [O1, O2 and O3]

### Challenge and develop

- **Use** a video clip to **show** the powers of 10 between the sizes of the largest and smallest objects in the universe. [Google search string:] Powers of Ten™ (1977). [O1]
- **Use** Presentation 1.19.1 'Powers of 10' to **show** how digits move one place to the left of the decimal point each time they are multiplied by 10, and one place to the right of the decimal point when they are divided by 10. [O1 and O2]
- Low demand: Pairs **arrange** the sets of cards used at the start of the lesson so that each decimal number covers the number in standard form. Then they take turns to **convert** each decimal into standard form. They could then turn the decimal card over and **convert** the numbers they have written in standard form back to decimals. [O2]
- Standard and high demand: **Ask** pupils to **read** spread topic 1.19 of the pupil book and answer questions 1–4. [O2]

### Explain

- **Pair talk**. Pupils explain how to convert numbers from decimals to standard form and vice versa. [O2]

### Consolidate and apply

- **Remind** pupils how to multiply and divide numbers written in standard form. [O3]

- Low and standard demand: Pupils **complete** questions 1–5 from the pupil book. [O3]
- High demand: Pupils **complete** question 6 from the pupil book. [O3]

### Extend

**Ask** pupils able to progress further to:

- **Research** Avogadro's number. [Google search string:] The History of Avogadro's Number with Bill Bryson. [O1]

### Plenary suggestion

Ask groups to create an outline for a short version of the 'Powers of 10' video for use in primary schools. It should only cover sizes from $10^2$ m. to $10^{-2}$ m. What images would they choose for each scene?

## Answers to Worksheet 1.19

The correct sets are: AHN; BJL; CGO; DIK; EFM.

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