Qualification Accredited

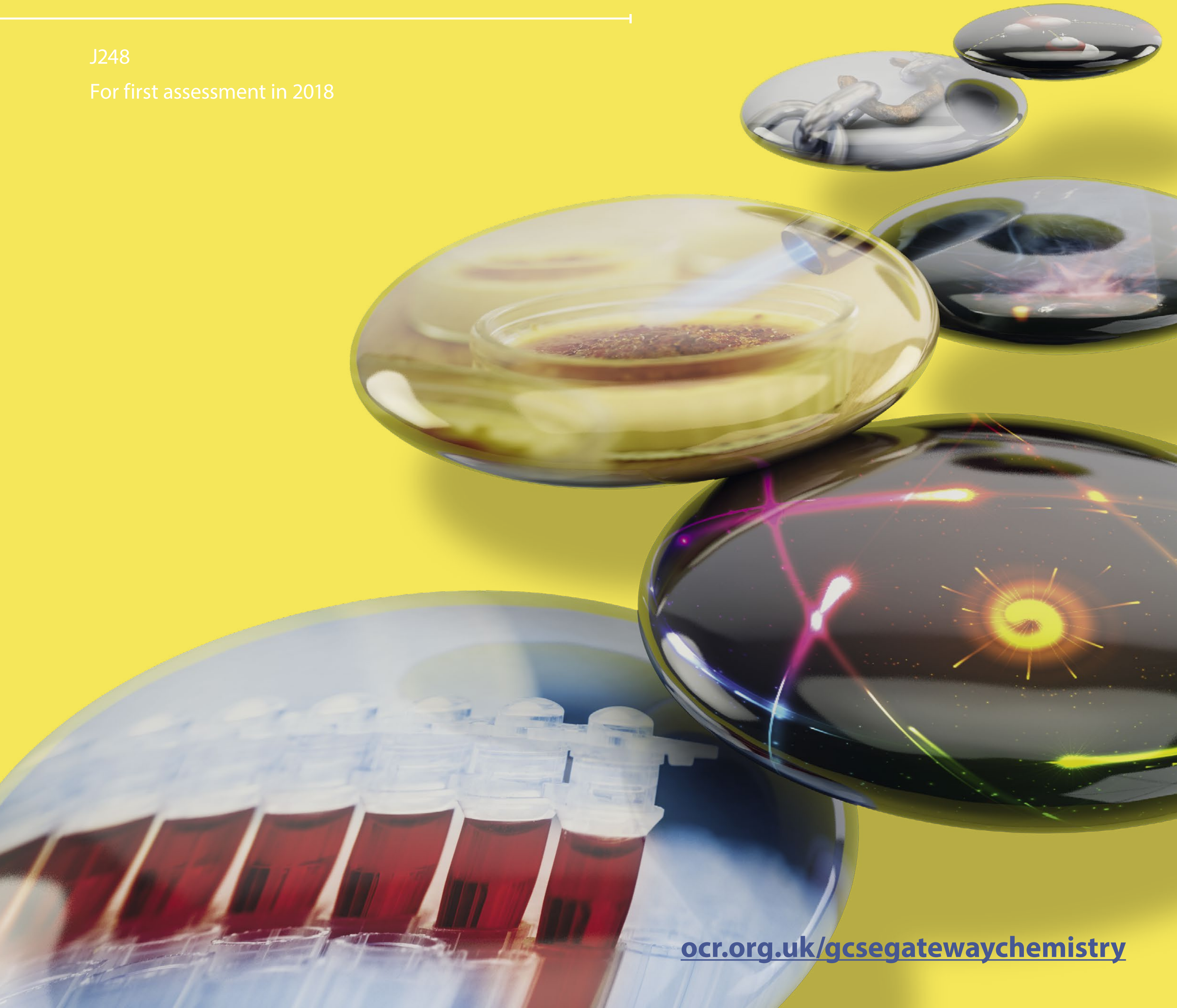
Oxford Cambridge and RSA

GCSE (9-1)
Specification

GATEWAY SCIENCE CHEMISTRY A

J248

For first assessment in 2018



ocr.org.uk/gcsegatewaychemistry

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OCR is an exempt charity.

We will inform centres about any changes to the specifications. We will also publish changes on our website. The latest version of our specifications will always be those on our website (**ocr.org.uk**) and these may differ from printed versions.

Contents

Support and Guidance

Introducing a new specification brings challenges for implementation and teaching, but it also opens up new opportunities. Our aim is to help you at every stage. We are working hard with teachers and other experts to bring you a package of practical support, resources and training.

Subject Specialists

OCR Subject Specialists provide information and support to centres including specification and non-exam assessment advice, updates on resource developments and a range of training opportunities.

Our Subject Specialists work with subject communities through a range of networks to ensure the sharing of ideas and expertise supporting teachers and students alike. They work with developers to help produce our specifications and the resources needed to support these qualifications during their development.

You can contact our Chemistry A Subject Specialists for specialist advice, guidance and support:

01223 553998
ChemistryA@OCR.org.uk
@OCR_ChemistryA

Teaching and learning resources

Our resources are designed to provide you with a range of teaching activities and suggestions that enable you to select the best activity, approach or context to support your teaching style and your particular students. The resources are a body of knowledge that will grow throughout the lifetime of the specification, they include:

- Delivery Guides
- Transition Guides
- Topic Exploration Packs
- Lesson Elements.

We also work with a number of leading publishers who publish textbooks and resources for our specifications. For more information on our publishing partners and their resources visit: ocr.org.uk/qualifications/gcse-and-a-level-reform/publishing-partners

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Our improved Professional Development Programme fulfils a range of needs through course selection, preparation for teaching, delivery and assessment. Whether you want to come to face-to-face events, look at our new digital training or search for training materials, you can find what you're looking for all in one place at the CPD Hub: cpdhub.ocr.org.uk

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We run training events throughout the academic year that are designed to help prepare you for first teaching and support every stage of your delivery of the new qualifications.

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Enabling you to build, mark and assess tests from OCR exam questions and produce a complete mock GCSE or A Level exam. Find out more at **ocr.org.uk/examcreator**

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Assess students' progress under formal examination conditions with question papers downloaded from a secure location, well-presented, easy-to-interpret mark schemes and commentary on marking and sample answers.

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These guides cover topics that could be relevant to a range of qualifications, for example communication, legislation and research.

Download the guides at **ocr.org.uk/skillsguides**

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Our free online results analysis service helps you review the performance of individual students or your whole cohort. For more details, please refer to **ocr.org.uk/activeresults**

1 Why choose an OCR GCSE (9–1) in Chemistry A (Gateway Science)?

1a. Why choose an OCR qualification?

Choose OCR and you've got the reassurance that you're working with one of the UK's leading exam boards. Our new OCR GCSE (9–1) in Chemistry A (Gateway Science) course has been developed in consultation with teachers, employers and Higher Education (HE) to provide learners with a qualification that's relevant to them and meets their needs.

We're part of the Cambridge Assessment Group, Europe's largest assessment agency and a department of the University of Cambridge. Cambridge Assessment plays a leading role in developing and delivering assessments throughout the world, operating in over 150 countries.

We work with a range of education providers, including schools, colleges, workplaces and other institutions in both the public and private sectors. Over 13 000 centres choose our A Levels, GCSEs and vocational qualifications including Cambridge Nationals and Cambridge Technicals.

Our Specifications

We believe in developing specifications that help you bring the subject to life and inspire your learners to achieve more.

We've created teacher-friendly specifications based on extensive research and engagement with the teaching community. They're designed to be straightforward and accessible so that you can tailor the delivery of the course to suit your needs. We aim to encourage learners to become responsible for their own learning, confident in discussing ideas, innovative and engaged.

We provide a range of support services designed to help you at every stage, from preparation through to the delivery of our specifications. This includes:

- A wide range of high-quality creative resources including:
  - Delivery Guides
  - Transition Guides
  - Topic Exploration Packs
  - Lesson Elements
  - . . . and much more.
- Access to subject specialists to support you through the transition and throughout the lifetime of the specification.
- CPD/Training for teachers to introduce the qualifications and prepare you for first teaching.
- Active Results – our free results analysis service to help you review the performance of individual learners or whole schools.
- ExamCreator – our new online past papers service that enables you to build your own test papers from past OCR exam questions.

All GCSE (9–1) qualifications offered by OCR are accredited by Ofqual, the Regulator for qualifications offered in England. The accreditation number for OCR's GCSE (9–1) in Chemistry A (Gateway Science) is QN601/8663/X.

1

1b. Why choose an OCR GCSE (9–1) in Chemistry A (Gateway Science)?

We appreciate that one size doesn't fit all so we offer two suites of qualifications in each science:

Chemistry A (Gateway Science) – Provides a flexible approach to teaching. The specification is divided into topics, each covering different key concepts of chemistry. Teaching of practical skills is integrated with the theoretical topics and they are assessed through the written papers.

Chemistry B (Twenty First Century Science) – Learners study chemistry using a narrative-based approach. Ideas are introduced within relevant and interesting settings which help learners to anchor their conceptual knowledge of the range of topics required at GCSE level. Practical skills are embedded within the specification and learners are expected to carry out practical work in preparation for a written examination that will specifically test these skills.

All of our specifications have been developed with subject and teaching experts. We have worked in close consultation with teachers and other stakeholders with the aim of including up-to-date relevant content within a framework that is interesting to teach and easy to administer within all centres.

Our new GCSE (9–1) in Chemistry A (Gateway Science) specification builds on our existing popular course. We've based the redevelopment of our GCSE sciences on an understanding of what works well in centres large and small. We've undertaken a significant amount of consultation through our science forums (which include representatives from learned societies, HE, teaching and industry) and through focus groups with teachers.

The content is clear and logically laid out for both existing centres and those new to OCR, with assessment models that are straightforward to administer. We have worked closely with teachers to provide high quality support materials to guide you through the new qualifications.

Aims and learning outcomes

GCSE study in the sciences provides the foundation for understanding the material world. Scientific understanding is changing our lives and is vital to world's future prosperity, and all learners should be taught essential aspects of the knowledge, methods, process and uses of science. They should be helped to appreciate how the complex and diverse phenomena of the natural world can be described in terms of a small number of key ideas relating to the sciences which are both inter-linked, and are of universal application.

These key ideas include:

- the use of conceptual models and theories to make sense of the observed diversity of natural phenomena
- the assumption that every effect has one or more cause
- that change is driven by differences between different objects and systems when they interact
- that many such interactions occur over a distance and over time without direct contact
- that science progresses through a cycle of hypothesis, practical experimentation, observation, theory development and review
- that quantitative analysis is a central element both of many theories and of scientific methods of inquiry.

OCR's GCSE (9–1) in Chemistry A (Gateway Science) will encourage learners to:

- develop scientific knowledge and conceptual understanding of chemistry
- develop understanding of the nature, processes and methods of science, through different types of scientific enquiries that help them to answer scientific questions about the world around them
- develop and learn to apply observational, practical, modelling, enquiry and problem-solving skills, both in the laboratory, in the field and in other learning environments
- develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions, both qualitatively and quantitatively.

1

1c. What are the key features of this specification?

Our GCSE (9–1) in Chemistry A (Gateway Science) specification is designed with a concept-led approach and provides a flexible way of teaching. The specification:

- is laid out clearly in a series of teaching topics with guidance included where required to provide further advice on delivery
- is co-teachable with the GCSE (9–1) in Combined Science A (Gateway Science)
- embeds practical requirements within the teaching topics
- identifies opportunities for carrying out practical activities that enhance learners' understanding of chemistry theory and practical skills
- highlights opportunities for the introduction of key mathematical requirements (see Appendix 5e and the To include column for each topic) into your teaching
- identifies, within the Working scientifically column, how the skills, knowledge and understanding of working scientifically (WS) can be incorporated within teaching.

1d. How do I find out more information?

Whether new to our specifications, or continuing on from our legacy offerings, you can find more information on our webpages at www.ocr.org.uk

Visit our subject pages to find out more about the assessment package and resources available to support your teaching. The science team also release a termly newsletter *Science Spotlight* (despatched to centres and available from our subject pages).

If you are not already a registered OCR centre then you can find out more information on the benefits of becoming one at: www.ocr.org.uk

If you are not yet an approved centre and would like to become one go to: www.ocr.org.uk

Want to find out more?

You can contact the Science Subject Specialists:

E-mail:
ScienceGCSE@ocr.org.uk

Telephone:
01223 553998

Join our Science Community: http://social.ocr.org.uk/

Check what CPD events are available:
www.cpdhub.ocr.org.uk

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2 The specification overview

2a. OCR's GCSE (9–1) in Chemistry A (Gateway Science) (J248)

Learners are entered for either Foundation Tier (Paper 1 and Paper 2) **or** Higher Tier (Paper 3 and Paper 4) to be awarded the OCR GCSE (9–1) in Chemistry A (Gateway Science).

2

Content Overview	Assessment Overview	
Foundation Tier, grades 5 to 1		
Content is split into six teaching topics C1-C6 and a practical activity skills topic C7: • Topic C1: Particles • Topic C2: Elements, compounds and mixtures • Topic C3: Chemical reactions • Topic C4: Predicting and identifying reactions and products • Topic C5: Monitoring and controlling chemical reactions • Topic C6: Global challenges Paper 1 assesses content from Topics C1–C3 and C7. Paper 2 assesses content from Topics C4–C6 and C7, with assumed knowledge of Topics C1–C3.	Paper 1 J248/01 90 marks 1 hour 45 minutes Written paper	**50%** of total GCSE
	Paper 2 J248/02 90 marks 1 hour 45 minutes Written paper	**50%** of total GCSE
Higher Tier, grades 9 to 4		
Content is split into six teaching topics C1-C6 and a practical activity skills topic C7: • Topic C1: Particles • Topic C2: Elements, compounds and mixtures • Topic C3: Chemical reactions • Topic C4: Predicting and identifying reactions and products • Topic C5: Monitoring and controlling chemical reactions • Topic C6: Global challenges Paper 3 assesses content from Topics C1–C3 and C7. Paper 4 assesses content from Topics C4–C6 and C7, with assumed knowledge of Topics C1–C3.	Paper 3 J248/03 90 marks 1 hour 45 minutes Written paper	**50%** of total GCSE
	Paper 4 J248/04 90 marks 1 hour 45 minutes Written paper	**50%** of total GCSE

J248/02 and J248/04 include synoptic assessment.

2b. Content of GCSE (9–1) in Chemistry A (Gateway Science) (J248)

The GCSE (9–1) in Chemistry A (Gateway Science) specification content is specified in section 2c It is divided into six teaching topics C1-C6 and a practical activity skills topic C7.

Learning at GCSE (9–1) in Chemistry A (Gateway Science) is described in the tables that follow:

Overview of the content layout

Topic C1: Topic title

C1.1 sub-topic

Summary
A short overview of the sub-topic that will be assessed in the examinations.

Underlying knowledge and understanding
Underlying knowledge and understanding learners should be familiar with linked to the sub-topic.

Common misconceptions
Common misconceptions students often have associated with this topic.

Tiering
A brief summary of the tiering of the sub-topic.

Reference	Mathematical learning outcomes	Mathematical skills (See appendix 5e)
OCRs mathematics reference code	This column defines the areas of mathematics that will need to be taught specifically within the context of this sub-topic. Questions in the examination will assess these learning outcomes within the context of the topic.	Mathematical skill code as indicated in Appendix 5e

Topic content			Opportunities to cover: Items that are contained within these columns are intended as a starting point for lesson planning.		Practical suggestions (See topic C7)
Learning outcomes		**To include**	**Maths** (See appendix 5e)	**Working scientifically** (See appendix 5d)	
Spec. reference number ☑	Column specifies the subject content that will be assessed in the examinations. This symbol indicates content that is found only in the chemistry separate science qualification	This column is included to provide further/specific advice on delivery of the learning outcome.	Mathematical skills will be assessed throughout the examination. This column highlights the mathematical skills that could be taught alongside the topic content.	Working scientifically will be assessed throughout the examination. This column highlights the working scientifically skills that could be taught alongside the topic content.	The compulsory Practical Activity Groups or PAGs are indicated in the table in Topic C7. Activities in this column can be used to supplement the PAGs using topic appropriate experiments

2

Chemistry key ideas

Chemistry is the science of the composition, structure, properties and reactions of matter, understood in terms of atoms, atomic particles and the way they are arranged and link together. It is concerned with the synthesis, formulation, analysis and characteristic properties of substances and materials of all kinds.

Learners should be helped to appreciate the achievements of chemistry in showing how the complex and diverse phenomena of both the natural and man-made worlds can be described in terms of a small number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below. These ideas include:

- matter is composed of tiny particles called atoms and there are about 100 different naturally occurring types of atoms called elements
- elements show periodic relationships in their chemical and physical properties these periodic properties can be explained in terms of the atomic structure of the elements
- atoms bond by either transferring electrons from one atom to another or by sharing electrons
- the shapes of molecules (groups of atoms bonded together) and the way giant structures are arranged is of great importance in terms of the way they behave
- there are barriers to reaction so reactions occur at different rates
- chemical reactions take place in only three different ways:
  - proton transfer
  - electron transfer
  - electron sharing
- energy is conserved in chemical reactions so can therefore be neither created or destroyed.

Summary of content for GCSE (9–1) in Chemistry A (Gateway Science)

Topic C1: Particles	Topic C2: Elements, compounds and mixtures	Topic C3: Chemical reactions
C1.1 The particle model C1.2 Atomic structure	C2.1 Purity and separating mixtures C2.2 Bonding C2.3 Properties of materials	C3.1 Introducing chemical reactions C3.2 Energetics C3.3 Types of chemical reactions C3.4 Electrolysis
Topic C4: Predicting and identifying reactions and products	**Topic C5: Monitoring and controlling chemical reactions**	**Topic C6: Global challenges**
C4.1 Predicting chemical reactions C4.2 Identifying the products of chemical reactions	C5.1 Monitoring chemical reactions C5.2 Controlling reactions C5.3 Equilibria	C6.1 Improving processes and products C6.2 Organic chemistry C6.3 Interpreting and interacting with earth systems

Topic 7 is a practical-based topic which provides learners with the necessary skills to undertake the 15% practical content in the examinations.

2c. Content of topics C1 to C6

Topic C1: Particles

C1.1 The particle model

Summary
This short section introduces the particle model and its explanation of different states of matter. A simple particle model can be used to represent the arrangement of particles in the different states of matter and to explain observations during changes in state. It does not, however, explain why different materials have different properties. This explanation is that the particles themselves and how they are held together must be different in some way. Elements are substances that are made up of only one type of atom and atoms of different elements can combine to make compounds.

Underlying knowledge and understanding
Learners should be familiar with the different states of matter and their properties. They should also be familiar with changes of state in terms of the particle model. Learners should have sufficient grounding in the particle model to be able to apply it to unfamiliar materials and contexts.

Common misconceptions
Learners commonly intuitively adhere to the idea that matter is continuous. For example, they believe that the space between gas particles is filled or non-existent, or that particles expand when they are heated. The notion that empty space exists between particles is problematic because this lacks supporting sensory evidence. They also show difficulty understanding the concept of changes in state being reversible; this should be addressed during the teaching of this topic.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM1.1i	represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon	M5b

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		**To include**	**Maths**	**Working scientifically**	
C1.1a	describe the main features of the particle model in terms of states of matter and change of state		M5b	WS1.1a, WS1.1b	
C1.1b	explain in terms of the particle model the distinction between physical changes and chemical changes				
C1.1c	**explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres (e.g. like bowling balls)**	**that it does not take into account the forces of attraction between particles, the size of particles and the space between them**	M5b	WS1.1c	Observations of change of state with comparison to chemical changes.

2

C1.2 Atomic structure

Summary

An atom is the smallest component of an element that gives an element its property. These properties can be explained by models of atomic structure. Current models suggest that atoms are made of smaller sub-atomic particles called protons, neutrons and electrons. They suggest that atoms are composed of a nucleus surrounded by electrons. The nucleus is composed of neutrons and protons. Atoms of each element have the same number of protons as electrons. Atoms of different elements have different numbers of protons. Atoms of the same element will have the same number of protons but may have different numbers of neutrons.

Underlying knowledge and understanding

Learners should be familiar with the simple (Dalton) atomic model.

Common misconceptions

Learners commonly have difficulty understanding the concept of isotopes due to the fact they think that neutral atoms have the same number of protons and neutrons. They also find it difficult to distinguish between the properties of atoms and molecules. Another common misconception is that a positive ion gains protons or a negative ion loses protons i.e. that there is a change in the nucleus of the atom rather than a change in the number of electrons.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM1.2i	relate size and scale of atoms to objects in the physical world	M4a
CM1.2ii ☑	estimate size and scale of atoms and nanoparticles	M1c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C1.2a	describe how and why the atomic model has changed over time	the models of Dalton, Thomson, Rutherford, Bohr, Geiger and Marsden		WS1.1a, WS1.1i, WS1.2b	Timeline of the atomic model.
C1.2b	describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus			WS1.4a	
C1.2c	recall the typical size (order of magnitude) of atoms and small molecules	the concept that typical atomic radii and bond length are in the order of 10^{-10}m	M1c, M4a	WS1.1c, WS1.4b, WS1.4c, WS1.4d, WS1.4e, WS1.4f	
C1.2d	recall relative charges and approximate relative masses of protons, neutrons and electrons			WS1.4a, WS1.4b, WS1.4c	
C1.2e	calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number of isotopes	definitions of an ion, atomic number, mass number and an isotope, also the standard notation to represent these		WS1.3c, WS1.4b	

Topic C2: Elements, compounds and mixtures

C2.1 Purity and separating mixtures

Summary

In chemical terms elements and compounds are pure substances and mixtures are impure substances. Chemically pure substances can be identified using melting point. Many useful materials that we use today are mixtures. There are many methods of separating mixtures including filtration, crystallisation, distillation and chromatographic techniques.

Underlying knowledge and understanding

Learners should be familiar with the concept of pure substances. They should have met simple separation techniques of mixtures. The identification of pure substances in terms of melting point, boiling point and chromatography will also have been met before.

Common misconceptions

Learners commonly misuse the word pure and confuse it with natural substances or a substance that has not been tampered with. They think that when a substance dissolves that the solution is pure and not a mixture.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM2.1i	arithmetic computation, ratio, percentage and multistep calculations permeates quantitative chemistry	M1a, M1c, M1d
CM2.1ii	provide answers to an appropriate number of significant figures	M2a
CM2.1iii	change the subject of a mathematical equation	M3b, M3c
CM2.1iv	arithmetic computation and ratio when determining empirical formulae, balancing equations	M3b, M3c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C2.1a	explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term 'pure'			WS1.4a	Purification of compounds. (PAG C4, PAG C7)
C2.1b	use melting point data to distinguish pure from impure substances		M1a, M1c, M1d, M2a		Measurement of melting point.
C2.1c	calculate relative formula masses of species separately and in a balanced chemical equation	the definition of relative atomic mass, relative molecular mass and relative formula mass	M3b, M3c	WS1.3c, WS1.4c	
C2.1d	deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa		M3b, M3c	WS1.1b, WS1.4a	
C2.1e	explain that many useful materials are formulations of mixtures	alloys			
C2.1f	describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation	knowledge of the techniques of filtration, crystallisation, simple distillation and fractional distillation		WS1.2b, WS1.2c, WS2a, WS2b	Separation of mixtures and purification of compounds. (PAG C4, PAG C7) Distillation of mixtures (PAG C4)
C2.1g	describe the techniques of paper and thin layer chromatography			WS1.2b, WS1.2c, WS1.4a, WS2a, WS2b	Thin layer chromatography. (PAG C3)
C2.1h	recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases	identification of the mobile and stationary phases		WS1.4a	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C2.1i	interpret chromatograms, including measuring R_f values	the recall and the use of the formula	M3b, M3c	WS1.3c, WS1.4a	
C2.1j	suggest suitable purification techniques given information about the substances involved				
C2.1k	suggest chromatographic methods for distinguishing pure from impure substances	paper, thin layer (TLC) and gas chromatography		WS1.4a	Using chromatography to identify mixtures of dyes in an unknown ink. (PAG C3)

C2.2 Bonding

Summary

A simple electron energy level model can be used to explain the basic chemical properties of elements. When chemical reactions occur, they can be explained in terms of losing, gaining or sharing of electrons. The ability of an atom to lose, gain or share electrons depends on its atomic structure. Atoms that lose electrons will bond with atoms that gain electrons. Electrons will be transferred between the atoms to form a positive ion and a negative ion. These ions attract one another in what is known as an ionic bond. Atoms that share electrons can bond with other atoms that share electrons to form a molecule. Atoms in these molecules are held together by covalent bonds.

Underlying knowledge and understanding

Learners should be familiar with the simple (Dalton) atomic model.

Common misconceptions

Learners do not always appreciate that the nucleus of an atom does not change when an electron is lost, gained or shared. They also find it difficult to predict the numbers of atoms that must bond in order to achieve a stable outer level of electrons. Learners think that chemical bonds are physical things made of matter. They also think that pairs of ions such as Na^+ and Cl^- are molecules. They do not have an awareness of the 3D nature of bonding and therefore the shape of molecules.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM2.2i ☑	estimate size and scale of atoms and nanoparticles	M1c
CM2.2ii	represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon	M5b
CM2.2iii	translate information between diagrammatic and numerical forms	M4a

Topic content			Opportunities to cover:		
Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C2.2a	describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties	physical properties, formation of ions and common reactions, e.g. with oxygen to form oxides		WS1.3f, WS1.4a	
C2.2b	explain how the atomic structure of metals and non-metals relates to their position in the periodic table				
C2.2c	explain how the position of an element in the periodic table is related to the arrangement of electrons in its atoms and hence to its atomic number	group number and period number	M1c	WS1.4a	
C2.2d	describe and compare the nature and arrangement of chemical bonds in: i. ionic compounds ii. simple molecules iii. giant covalent structures iv. polymers v. metals		M5b, M4a	WS1.4a	Make ball and stick models of molecules.
C2.2e	explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons			WS1.4a	
C2.2f	construct dot and cross diagrams for simple covalent and binary ionic substances		M4a	WS1.4a	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C2.2g	describe the limitations of particular representations and models to include dot and cross diagrams, ball and stick models and two- and three-dimensional representations		M5b	WS1.1c	
C2.2h	explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number			WS1.1b, WS1.3f, WS1.4a	
C2.2i	explain in terms of atomic number how Mendeleev's arrangement was refined into the modern periodic table			WS1.1a, WS1.4a	

C2.3 Properties of materials

Summary
This section explores the physical properties of elements and compounds and how the nature of their bonding is a factor in their properties.

Underlying knowledge and understanding
Learners will know the difference between an atom, element and compound.

Common misconceptions
Learners commonly have a limited understanding of chemical reactions, for example substances may explode, burn, contract, expand or change state.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM2.3i	represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon	M5b
CM2.3ii ☑	relate size and scale of atoms to objects in the physical world	M4a
CM2.3iii ☑	estimate size and scale of atoms and nanoparticles	M1d
CM2.3iv ☑	interpret, order and calculate with numbers written in standard form when dealing with nanoparticles	M1b
CM2.3v ☑	use ratios when considering relative sizes and surface area to volume comparisons	M1c
CM2.3vi ☑	calculate surface areas and volumes of cubes	M5c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C2.3a	recall that carbon can form four covalent bonds			WS1.4a	
C2.3b	explain that the vast array of natural and synthetic organic compounds occur due to the ability of carbon to form families of similar compounds, chains and rings				
C2.3c	explain the properties of diamond, graphite, fullerenes and graphene in terms of their structures and bonding		M5b	WS1.4a	
C2.3d	use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur			WS1.2a, WS1.3f, WS1.4a, WS1.4c	
C2.3e	use data to predict states of substances under given conditions	data such as temperature and how this may be linked to changes of state			
C2.3f	explain how the bulk properties of materials (ionic compounds; simple molecules; giant covalent structures; polymers and metals) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged	recognition that the atoms themselves do not have the bulk properties of these materials		WS1.4a	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C2.3g ☑	compare 'nano' dimensions to typical dimensions of atoms and molecules		M4a, M1d, M1b	WS1.4c, WS1.4d	
C2.3h ☑	describe the surface area to volume relationship for different-sized particles and describe how this affects properties		M1c	WS1.4c	Dissolving tablets. (PAG C8)
C2.3i ☑	describe how the properties of nanoparticulate materials are related to their uses		M5c	WS1.1c, WS1.1e, WS1.3c, WS1.4a	
C2.3j ☑	explain the possible risks associated with some nanoparticulate materials			WS1.1d, WS1.1f, WS1.1h, WS1.1i WS1.4a	

Topic C3: Chemical reactions

C3.1 Introducing chemical reactions

Summary

A chemical equation represents, in symbolic terms, the overall change in a chemical reaction. New materials are formed through chemical reactions but mass will be conserved. This can be explained by a model involving the rearrangement of atoms. Avogadro gave us a system of measuring the amount of a substance in moles.

Underlying knowledge and understanding

Learners should be familiar with chemical symbols and formulae for elements and compounds. They should also be familiar with representing chemical reactions using formulae. Learners will have knowledge of conservation of mass, changes of state and chemical reactions.

Common misconceptions

Although learners may have met the conservation of mass they still tend to refer to chemical reactions as losing mass. They understand that mass is conserved but not the number or species of atoms. They may think that the original substance vanishes 'completely and forever' in a chemical reaction.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM3.1i	arithmetic computation and ratio when determining empirical formulae, balancing equations	M1a, M1c
CM3.1ii	**calculations with numbers written in standard form when using the Avogadro constant**	**M1b**
CM3.1iii	provide answers to an appropriate number of significant figures	M2a
CM3.1iv	convert units where appropriate **particularly from mass to moles**	M1c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		**To include**	**Maths**	**Working scientifically**	
C3.1a	use chemical symbols to write the formulae of elements and simple covalent and ionic compounds		M1a, M1c	WS1.4a	
C3.1b	use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations **and half equations**		M1a, M1c	WS1.4c	
C3.1c	use the names and symbols of common elements from a supplied periodic table to write formulae and balanced chemical equations where appropriate	the first 20 elements, Groups 1, 7, and 0 and other common elements included within the specification			
C3.1d	use the formula of common ions to deduce the formula of a compound		M1a, M1c		
C3.1e	**construct balanced ionic equations**		M1a, M1c		
C3.1f	describe the physical states of products and reactants using state symbols (s, l, g and aq)				
C3.1g	**recall and use the definitions of the Avogadro constant (in standard form) and of the mole**	**the calculation of the mass of one atom/molecule**	M1b, M1c	WS1.4b, WS1.4c, WS1.4d, WS1.4f	
C3.1h	**explain how the mass of a given substance is related to the amount of that substance in moles and vice versa**		M1c, M2a	WS1.4b, WS1.4c	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C3.1i	recall and use the law of conservation of mass			WS1.4c	
C3.1j	explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model			WS1.1b, WS1.4c	
C3.1k	**deduce the stoichiometry of an equation from the masses of reactants and products and explain the effect of a limiting quantity of a reactant**		M1c	WS1.3c, WS1.4c, WS1.4d, WS1.4f	
C3.1l	**use a balanced equation to calculate masses of reactants or products**		M1c	WS1.3c, WS1.4c	

C3.2 Energetics

Summary

Chemical reactions are accompanied by an energy change. A simple model involving the breaking and making of chemical bonds can be used to interpret and calculate the energy change.

Underlying knowledge and understanding

Learners should be familiar with exothermic and endothermic chemical reactions.

Common misconceptions

Learners commonly have the idea that energy is lost or used up. They do not grasp the idea that energy is transferred. Learners also wrongly think that energy is released when bonds break and do not link this release of energy with the formation of bonds. They also may think for example that a candle burning is endothermic because heat is needed to initiate the reaction.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM3.2i	interpretation of charts and graphs when dealing with reaction profiles	M4a
CM3.2ii	arithmetic computation when calculating energy changes	M1a

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		**To include**	**Maths**	**Working scientifically**	
C3.2a	distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings			WS1.4c	Measuring the temperature change in reactions. (PAG C8)
C3.2b	draw and label a reaction profile for an exothermic and an endothermic reaction	activation energy, energy change, reactants and products	M4a	WS1.3b, WS1.3c, WS1.3d, WS1.3e, WS1.3g, WS1.3h, WS1.4c	
C3.2c	explain activation energy as the energy needed for a reaction to occur			WS1.4c	
C3.2d	**calculate energy changes in a chemical reaction by considering bond making and bond breaking energies**		M1a	WS1.3c, WS1.4c	

C3.3 Types of chemical reactions

Summary

Chemical reactions can be classified according to changes at the atomic and molecular level. Examples of these include reduction, oxidation and neutralisation reactions.

Underlying knowledge and understanding

Learners should be familiar with combustion, thermal decomposition, oxidation and displacement reactions. They will be familiar with defining acids and alkalis in terms of neutralisation reactions. Learners will have met reactions of acids with alkalis to produce a salt and water and reactions of acids with metals to produce a salt and hydrogen.

Common misconceptions

Learners commonly intuitively adhere to the idea that hydrogen ions in an acid are still part of the molecule, not free in the solution. They tend to have little understanding of pH, for example, they tend to think that alkalis are less corrosive than acids. Learners also may think that the strength of acids and bases and concentration mean the same thing.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM3.3i	arithmetic computation, ratio, percentage and multistep calculations permeates quantitative chemistry	M1a, M1c, M1d

Topic content		Opportunities to cover:		Practical suggestions
Learning outcomes	**To include**	**Maths**	**Working scientifically**	
C3.3a explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced	the concept of oxidising agent and reducing agent		WS1.4a	
C3.3b explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced			WS1.4a	
C3.3c recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions			WS1.4a	
C3.3d describe neutralisation as acid reacting with alkali or a base to form a salt plus water			WS1.4a	Production of pure dry sample of salt. (PAG C7)
C3.3e recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water			WS1.4a	
C3.3f recall that carbonates and some metals react with acids and write balanced equations predicting products from given reactants			WS1.4a	
C3.3g use and explain the terms dilute and concentrated (amount of substance) and weak and strong (degree of ionisation) in relation to acids	**ratio of amount of acid to volume of solution**	M1a, M1c, M1d	WS1.4a	
C3.3h recall that relative acidity and alkalinity are measured by pH			WS1.4a	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C3.3i	**describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH (whole numbers only)**	**pH of titration curves**		WS1.4a	Neutralisation reactions. (PAG C6)
C3.3j	**recall that as hydrogen ion concentration increases by a factor of ten the pH value of a solution decreases by a factor of one**		M1a, M1c, M1d	WS1.4a	
C3.3k	describe techniques and apparatus used to measure pH				Determining pH of unknown solutions. (PAG C6) Use of pH probes. (PAG C6)

C3.4 Electrolysis

Summary
Decomposition of a liquid during the conduction of electricity is a chemical reaction called electrolysis. This section explores the electrolysis of various molten ionic liquids and aqueous ionic solutions.

Underlying knowledge and understanding
Learners should be familiar with ionic solutions and solids.

Common misconceptions
A common misconception is that ionic solutions conduct because of the movement of electrons. Another common misconception is that ionic solids do not conduct electricity because electrons cannot move.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM3.4i	arithmetic computation and ratio when determining empirical formulae, balancing equations	M1a, M1c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C3.4a	recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes	the terms cations and anions		WS1.4a	
C3.4b	predict the products of electrolysis of binary ionic compounds in the molten state	compounds such as $NaCl$	M1a, M1c	WS1.2a, WS1.2b, WS1.2c, WS1.4a, WS2a, WS2b	
C3.4c	describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present	the electrolysis of aqueous $NaCl$ and $CuSO_4$ using inert electrodes	M1a, M1c	WS1.4a	Electrolysis of sodium chloride solution. (PAG C2) Electrolysis of copper sulfate solution. (PAG C2)
C3.4d	describe electrolysis in terms of the ions present and reactions at the electrodes		M1a, M1c		
C3.4e	describe the technique of electrolysis using inert and non-inert electrodes				

Topic C4: Predicting and identifying reactions and products

C4.1 Predicting chemical reactions

Summary
Models of how substances react and the different types of chemical reactions that can occur enable us to predict the likelihood and outcome of a chemical reaction. The current periodic table was developed based on observations of the similarities and differences in the properties of elements. The way that the periodic table is arranged into groups and periods reveals the trends and patterns in the behaviour of the elements. The model of atomic structure provides an explanation for trends and patterns in the properties of elements. The arrangement of elements in groups and periods reveals the relationship between observable properties and how electrons are arranged in the atoms of each element.

Underlying knowledge and understanding
Learners should be familiar with the principles underpinning the Mendeleev periodic table; the periodic table: periods and groups; metals and non-metals; the varying physical and chemical properties of different elements; the chemical properties of metals and non-metals; the chemical properties of metal and non-metal oxides with respect to acidity and how patterns in reactions can be predicted with reference to the periodic table.

Common misconceptions
Learners consider the properties of particles of elements to be the same as the bulk properties of that element. They tend to rely on the continuous matter model rather than the particle model. Learners confuse state changes and dissolving with chemical changes. Also, since the atmosphere is invisible to the eye and learners rely on concrete, visible information, this means they therefore often avoid the role of oxygen in their explanations for open system reactions. Even if the role of oxygen is appreciated, learners do not realise that solid products of an oxidation reaction have more mass than the starting solid.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM4.1i	arithmetic computation and ratio when determining empirical formulae, balancing equations	M1a, M1c

2

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C4.1a	recall the simple properties of Groups 1, 7 and 0	physical and chemical properties		WS1.2a, WS1.4a WS1.4c	Displacement reactions of halogens with halides. (PAG C1)
C4.1b	explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups	ease of electron gain or loss; physical and chemical properties			
C4.1c ☑	recall the general properties of transition metals and their compounds and exemplify these by reference to a small number of transition metals	melting point, density, reactivity, formation of coloured ions with different charges and uses as catalysts		WS1.4a	Investigation of transition metals. (PAG C1, PAG C5, PAG C8)
C4.1d	predict possible reactions and probable reactivity of elements from their positions in the periodic table			WS1.1b, WS1.2a, WS1.4a	
C4.1e	explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion		M1a, M1c	WS1.4a	Reaction of metals with water, dilute hydrochloric acid. (PAG C1, PAG C7, PAG C8)
C4.1f	deduce an order of reactivity of metals based on experimental results			WS1.3e, WS2a	Displacement reactions involving metals and metal salts. (PAG C1, PAG C7, PAG C8)

C4.2 Identifying the products of chemical reactions

Summary

Types of substances can be classified according to their general physical and chemical properties. This section explores the tests that can be used to identify the products of reactions by looking at their physical and chemical properties.

Underlying knowledge and understanding

Learners should be familiar with cations and anions from their work on electrolysis.

Common misconceptions

Learners confuse mass and density so in reactions involving change of state, learners reason that the products from a precipitation reaction are heavier than the starting materials and that when a gas is produced the reaction has lost mass overall.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM4.2i ☑	interpret charts, particularly in spectroscopy	M4a

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		**To include**	**Maths**	**Working scientifically**	
C4.2a	describe tests to identify selected gases	oxygen, hydrogen, carbon dioxide and chlorine			
C4.2b ☑	describe tests to identify aqueous cations and aqueous anions	calcium, copper, iron (II), iron (III) and zinc using sodium hydroxide; carbonates and sulfates using aqueous barium chloride followed by hydrochloric acid; chloride, bromide and iodide using silver nitrate		WS1.4a	Tests for cations using sodium hydroxide. (PAG C5) Tests for anions using silver nitrate and barium sulfate. (PAG C5)
C4.2c ☑	describe how to perform a flame test			WS1.2b, WS1.2c, WS2a, WS2b	Flame tests. (PAG C5)
C4.2d ☑	identify species from test results				Testing unknown solutions for cations and anions. (PAG C5)
C4.2e ☑	interpret flame tests to identify metal ions	the ions of lithium, sodium, potassium, calcium and copper		WS1.4a	
C4.2f ☑	describe the advantages of instrumental methods of analysis	sensitivity, accuracy and speed		WS1.1e, WS1.2c, WS1.2d, WS1.2e	
C4.2g ☑	interpret an instrumental result given appropriate data in chart or tabular form, when accompanied by a reference set of data in the same form		M4a	WS1.3e	

Topic C5: Monitoring and controlling chemical reactions

C5.1 Monitoring chemical reactions

Summary

This topic tackles the relationship of moles to the concentration of a solution and the volume of a gas. It also tackles the calculation of the mass of a substance in terms of its molarity. The topic then moves on to look at using equations to make predictions about yield by calculations and to calculate atom economy.

Underlying knowledge and understanding

Learners should be familiar with the mole from Topic C3 and know that it measures the amount of something. They should be familiar with representing chemical reactions using formulae and using equations.

Common misconceptions

The most common problem learners' encounter with these calculations is their lack of understanding of ratios. Also most learners think that the mole and mass are the same thing. This is reinforced by use of phrases such as '1 mole is 12 g of carbon, '1 mole is the relative atomic mass in grammes' or '1 mol = 12 g C' in teaching and in textbooks equating amount of substance to mass, portion of substance, number of particles (Avogadro's number) or number of moles. All these phrases reinforce the idea that amount of substance is a measure of mass or a number.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM5.1i ☑	**calculations with numbers written in standard form when using the Avogadro constant**	**M1b**
CM5.1ii ☑	provide answers to an appropriate number of significant figures	M2a
CM5.1iii ☑	convert units where appropriate **particularly from mass to moles**	M1c
CM5.1iv ☑	arithmetic computation, ratio, percentage and multistep calculations permeates quantitative chemistry	M1a, M1c, M1d
CM5.1v ☑	arithmetic computation when calculating yields and atom economy	M1a, M1c
CM5.1vi ☑	change the subject of a mathematical equation	M3b, M3c

2

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		**To include**	**Maths**	**Working scientifically**	
C5.1a ☑	**explain how the concentration of a solution in mol/dm^3 is related to the mass of the solute and the volume of the solution**		M1b	WS1.3c, WS1.4a, WS1.4c	Making standard solutions.
C5.1b ☑	describe the technique of titration				Acid/alkali titrations. (PAG C6)
C5.1c ☑	**explain the relationship between the volume of a solution of known concentration of a substance and the volume or concentration of another substance that react completely together**	**titration calculations**	M2a, M1c	WS1.3c, WS1.4a, WS1.4b, WS1.4c	
C5.1d ☑	**describe the relationship between molar amounts of gases and their volumes and vice versa**		M1c	WS1.3c, WS1.4a, WS1.4c, WS1.4d, WS1.4f	Measurement of gas volumes and calculating amount in moles. (PAG C8)
C5.1e ☑	**calculate the volumes of gases involved in reactions using the molar gas volume at room temperature and pressure (assumed to be 24dm^3)**		M1b, M1c		
C5.1f	**explain how the mass of a solute and the volume of the solution is related to the concentration of the solution**		M1b, M1c	WS1.3c, WS1.4a, WS1.4c	
C5.1g ☑	calculate the theoretical amount of a product from a given amount of reactant		M1a, M1c, M1d	WS1.3c	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C5.1h ☑	calculate the percentage yield of a reaction product from the actual yield of a reaction		M1a, M1c, M1d	WS1.2a, WS1.2b, WS1.2c, WS1.2d, WS1.3c, WS2a, WS2b	
C5.1i ☑	define the atom economy of a reaction				
C5.1j ☑	calculate the atom economy of a reaction to form a desired product from the balanced equation		M1a, M1c	WS1.3c	
C5.1k ☑	**explain why a particular reaction pathway is chosen to produce a specified product given appropriate data**	**data such as atom economy (if not calculated), yield, rate, equilibrium position and usefulness of by- products**	M3b, M3c	WS1.3c, WS1.3f	

C5.2 Controlling reactions

Summary

The rate and yield of a chemical reaction can be altered by changing the physical conditions.

Underlying knowledge and understanding

Learners should be familiar with the action of catalysts in terms of rate of reaction. They should know the term surface area and what it means.

Common misconceptions

Learners often misinterpret rate graphs and think that catalysts take part in reactions and run out/get used up.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM5.2i	arithmetic computation, ratio when measuring rates of reaction	M1a, M1c
CM5.2ii	drawing and interpreting appropriate graphs from data to determine rate of reaction	M4b, M4c
CM5.2iii	determining gradients of graphs as a measure of rate of change to determine rate	M4d, M4e
CM5.2iv	proportionality when comparing factors affecting rate of reaction	M1c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C5.2a	suggest practical methods for determining the rate of a given reaction		M1a, M1c	WS1.2b, WS1.2c, WS1.2d, WS2a, WS2b	Rate of reaction experiments. (PAG C1, PAG C8) Disappearing cross experiment. (PAG C8) Magnesium and acid, marble chip and acid. (PAG C1, PAG C8)
C5.2b	interpret rate of reaction graphs	1/t is proportional to rate and gradients of graphs (not order of reaction)	M4b, M4c	WS1.3a, WS1.3b, WS1.3c, WS1.3d, WS1.3e, WS1.3f, WS1.3g, WS1.3h, WS1.3i, WS2b	Marble chip and acid or magnesium and acid experiments either measuring reaction time or the volume of gas over time. (PAG C1, PAG C7, PAG C8)
C5.2c	describe the effect of changes in temperature, concentration, pressure, and surface area on rate of reaction		M4d, M4e	WS1.4c	Varying surface area with marble chips and hydrochloric acid. (PAG C1, PAG C8)
C5.2d	explain the effects on rates of reaction of changes in temperature, concentration and pressure in terms of frequency and energy of collision between particles			WS1.4c	Reaction of magnesium and acid with different temperatures of acid – measure reaction times. (PAG C1, PAG C8)
C5.2e	explain the effects on rates of reaction of changes in the size of the pieces of a reacting solid in terms of surface area to volume ratio		M1c		

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C5.2f	describe the characteristics of catalysts and their effect on rates of reaction				
C5.2g	identify catalysts in reactions			WS1.4a	Catalysis of hydrogen peroxide with various black powders including MnO_2. (PAG C1, PAG C8) Catalysis of reaction of zinc with sulfuric acid using copper powder. (PAG C1, PAG C8)
C5.2h	explain catalytic action in terms of activation energy	reaction profiles			
C5.2i	recall that enzymes act as catalysts in biological systems				

C5.3 Equilibria

Summary
In a reaction, when the rate of the forward reaction equals the rate of the backwards reaction, the reaction in a closed system is said to be in equilibrium.

Underlying knowledge and understanding
Learners will be familiar with representing chemical reactions using formulae and using equations.

Common misconceptions
Learners often do not recognise that when a dynamic equilibrium is set up in a reaction the concentration of the reactants and products remain constant. They think that they are equal. Learners also sometimes perceive a dynamic equilibrium as two reactions.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM5.3i	arithmetic computation, ratio when measuring rates of reaction	M1a, M1c
CM5.3ii	drawing and interpreting appropriate graphs from data to determine rate of reaction	M4b, M4c
CM5.3iii	determining gradients of graphs as a measure of rate of change to determine rate	M4d, M4e
CM5.3iv	proportionality when comparing factors affecting rate of reaction	M1c

Topic content		Opportunities to cover:		Practical suggestions
Learning outcomes	**To include**	**Maths**	**Working scientifically**	
C5.3a recall that some reactions may be reversed by altering the reaction conditions		M1a, M4b, M4c		
C5.3b recall that dynamic equilibrium occurs in a closed system when the rates of forward and reverse reactions are equal		M4b, M4c		
C5.3c predict the effect of changing reaction conditions on equilibrium position and suggest appropriate conditions to produce as much of a particular product as possible	**Le Chatelier's principle concerning concentration, temperature and pressure**	M1a, M4d, M4e, M1c	WS1.2a, WS1.2b, WS1.2c, WS1.4c, WS2a, WS2b	

Topic C6: Global challenges

This topic seeks to integrate learners' knowledge and understanding of chemical systems and processes, with the aim of applying it to global challenges. Applications of chemistry can be used to help humans improve their own lives and strive to create a sustainable world for future generations, and these challenges are considered in this topic. It therefore provides opportunities to draw together the concepts covered in earlier topics, allowing synoptic treatment of the subject of chemistry.

C6.1 Improving processes and products

Summary
Historically, new materials have been developed through trial and error, experience etc. but as our understanding of the structure of materials and chemical processes has improved we are increasing our ability to manipulate and design new materials. Industry is continually looking to make products that have a better performance and are sustainable to produce. This section also explores the extraction of raw materials and their use in making new products.

Underlying knowledge and understanding
Learners should be familiar with the properties of ceramics, polymers and composites. They also will have met the method of using carbon to obtain metals from metal oxides.

Common misconceptions
Learners often think that chemical reactions will continue until all the reactants are exhausted. They also think that equilibrium is a static condition.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM6.1i	arithmetic computation, ratio when measuring rates of reaction	M1a, M1c
CM6.1ii	drawing and interpreting appropriate graphs from data to determine rate of reaction	M4b, M4c
CM6.1iii ☑	determining gradients of graphs as a measure of rate of change to determine rate	M4d, M4e
CM6.1iv ☑	proportionality when comparing factors affecting rate of reaction	M1c

2

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C6.1a	explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including extraction of a non-ferrous metal		M1a, M1c	WS1.4a	Extraction of copper by heating copper oxide with carbon. (PAG C1)
C6.1b	explain why and how electrolysis is used to extract some metals from their ores		M4b, M4c	WS1.3a, WS1.3b, WS1.3c, WS1.3d, WS1.3e, WS1.3g, WS1.3h, WS1.3i, WS1.4, WS2b	Electrolysis of aqueous sodium chloride solution. (PAG C2) Electrolysis of aqueous copper sulfate solution. (PAG C2)
C6.1c	**evaluate alternative biological methods of metal extraction**	**bacterial and phytoextraction**		WS1.1a, WS1.1e	
C6.1d ☑	**explain the trade-off between rate of production of a desired product and position of equilibrium in some industrially important processes**	**the Haber process and Contact process**	M4d, M4e	WS1.3f	
C6.1e ☑	**interpret graphs of reaction conditions versus rate**		M1c	WS1.3e	
C6.1f ☑	**explain how the commercially used conditions for an industrial process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate**			WS1.1d	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C6.1g ☑	explain the importance of the Haber process in agricultural production			WS1.4a	
C6.1h ☑	compare the industrial production of fertilisers with laboratory syntheses of the same products			WS1.2a, WS1.2b, WS1.2c, WS1.2d, WS1.2e, WS2a, WS2b	Preparation of potassium sulfate or ammonium sulfate using a titration method. (PAG C6)
C6.3i ☑	recall the importance of nitrogen, phosphorus and potassium compounds in agricultural production			WS1.4a	
C6.3j ☑	describe the industrial production of fertilisers as several integrated processes using a variety of raw materials	ammonium nitrate and ammonium sulfate		WS1.2a, WS1.2b, WS1.2c, WS1.2e, WS2a, WS2b	
C6.1k	describe the basic principles in carrying out a life-cycle assessment of a material or product				
C6.1l	interpret data from a life-cycle assessment of a material or product				
C6.1m	describe a process where a material or product is recycled for a different use, and explain why this is viable			WS1.1f, WS1.1g	
C6.1n	evaluate factors that affect decisions on recycling			WS1.1f, WS1.1g	
C6.1o ☑	describe the composition of some important alloys in relation to their properties and uses	steel, brass, bronze, solder, duralumin			
C6.1p ☑	describe the process of corrosion and the conditions which cause corrosion	iron and other metals			

2

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C6.1q ☑	explain how mitigation of corrosion is achieved by creating a physical barrier to oxygen and water and by sacrificial protection				
C6.1r ☑	compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals				
C6.1s ☑	explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required			WS1.1e, WS1.3f	

C6.2 Organic chemistry

Summary

Carbon chemistry is the basis of life on Earth. Organic chemistry is the basis of many of the materials we produce. Organic compounds are covalent in nature and react in a predictable pattern. Crude oil forms the basis of many useful by-products.

Underlying knowledge and understanding

Learners should be familiar with reactions and displayed formula.

Common misconceptions

Learners tend not to bring the concepts from general chemistry in their study of organic chemistry. They have difficulty identifying functional groups and naming and drawing the compounds.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM6.2i ☑	represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon	M5b

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C6.2a ☑	recognise functional groups and identify members of the same homologous series	homologous series, of alkanes, alkenes, alcohols and carboxylic acids			
C6.2b ☑	name and draw the structural formulae, using fully displayed formulae, of the first four members of the straight chain alkanes, alkenes, alcohols and carboxylic acids		M5b	WS1.4a	Use of models.
C6.2c ☑	predict the formulae and structures of products of reactions of the first four and other given members of the homologous series of alkanes, alkenes and alcohols	combustion; addition of bromine and hydrogen across a double bond; oxidation of alcohols to carboxylic acids using potassium manganate(VII)			
C6.2d ☑	recall the basic principles of addition polymerisation by reference to the functional group in the monomer and the repeating units in the polymer				
C6.2e ☑	**explain the basic principles of condensation polymerisation**	**reference to the functional groups of the monomers, the minimum number of functional groups within a monomer, the number of repeating units in the polymer, and simultaneous formation of a small molecule, e.g. a polyester or polyamide, using block diagrams to represent polymers**		WS1.4a	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C6.2f ☑	**describe practical techniques to make a polymer by condensation**			WS1.2a, WS1.2b, WS1.2c, WS1.4a, WS2a, WS2b	Making nylon.
C6.2g ☑	deduce the structure of an addition polymer from a simple alkene monomer and vice versa	the following representation of a polymer $[\text{repeat unit}]_n$		WS1.4a	
C6.2h ☑	recall that DNA is a polymer made from four different monomers called nucleotides and that other important naturally-occurring polymers are based on sugars and amino-acids	the names of the nucleotides		WS1.4a	
C6.2i ☑	recall that it is the generality of reactions of functional groups that determine the reactions of organic compounds			WS1.4a	
C6.2j	describe the separation of crude oil by fractional distillation	the names of the fractions		WS1.3f, WS1.4a	
C6.2k	explain the separation of crude oil by fractional distillation	molecular size and intermolecular forces			
C6.2l	describe the fractions as largely a mixture of compounds of formula C_nH_{2n+2} which are members of the alkane homologous series			WS1.4a	
C6.2m	recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry			WS1.4a	
C6.2n	explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource			WS1.1c, WS1.1f, WS1.1e, WS1.4a	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
C6.2o	describe the production of materials that are more useful by cracking	conditions and reasons for cracking and some of the useful materials produced			
C6.2p ☑	recall that a chemical cell produces a potential difference until the reactants are used up				
C6.2q ☑	evaluate the advantages and disadvantages of hydrogen/oxygen and other fuel cells for given uses	the chemistry of the hydrogen/oxygen fuel cell		WS1.1g, WS1.1i	

C6.3 Interpreting and interacting with earth systems

Summary

As our understanding of the structure of materials and chemical processes has improved we are increasing our ability to interpret and understand chemical and earth systems. Understanding how we interact with them is very important to our survival as a species. This section starts with the history of the atmosphere and moves on to how human activity could be affecting its composition.

Underlying knowledge and understanding

Learners should have some understanding of the composition of the Earth, the structure of the Earth, the rock cycle, the carbon cycle, the composition of the atmosphere and the impact of human activity on the climate.

Common misconceptions

Learners think that the atmosphere is large and that small increases of carbon dioxide or a few degrees of temperature change do not make a difference to the climate. They may consider that global warming is caused by the ozone hole and that human activities alone cause the greenhouse effect.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
CM6.3i	extract and interpret information from charts, graphs and tables	M2c, M4a
CM6.3ii	use orders of magnitude to evaluate the significance of data	M2h

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
C6.3a	interpret evidence for how it is thought the atmosphere was originally formed	knowledge of how the composition of the atmosphere has changed over time	M2c, M4a, M2h	WS1.3e	
C6.3b	describe how it is thought an oxygen-rich atmosphere developed over time		M2h	WS1.1a	
C6.3c	describe the greenhouse effect in terms of the interaction of radiation with matter within the atmosphere				
C6.3d	evaluate the evidence for additional anthropogenic (human activity) causes of climate change and describe the uncertainties in the evidence base	the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels	M2c, M4a, M2h		
C6.3e	describe the potential effects of increased levels of carbon dioxide and methane on the Earth's climate and how these effects may be mitigated	consideration of scale, risk and environmental implications	M2c, M4a, M2h	WS1.1f, WS1.1h	
C6.3f	describe the major sources of carbon monoxide, sulfur dioxide, oxides of nitrogen and particulates in the atmosphere and explain the problems caused by increased amounts of these substances			WS1.4a	
C6.3g	describe the principal methods for increasing the availability of potable water in terms of the separation techniques used	ease of treatment of waste, ground and salt water			

Topic C7: Practical skills

Compliance with the requirements for practical work

It is compulsory that learners complete at least *eight* practical activities.

OCR has split the requirements from the Department for Education '*Biology, chemistry and physics GCSE subject content, July 2015*' – Appendix 4 into eight Practical Activity Groups or PAGs.

The Practical Activity Groups allow centres flexibility in their choice of activity. Upon completion of at least eight practical activities, each Learner must have had the opportunity to use all of the apparatus and techniques described in the following tables of this topic.

The tables illustrate the apparatus and techniques required for each PAG and an example practical that may be used to contribute to the PAG. It should be noted that some apparatus and techniques can be used in more than one PAG. It is therefore important that teachers take care to ensure that learners do have the opportunity to use all of the required apparatus and techniques during the course with the activities chosen by the centre.

Within the specification there are a number of practicals that are described in the 'Practical suggestions' column. These can count towards each PAG. We are expecting that centres will provide learners with opportunities to carry out a wide range of practical activities during the course. These can be the ones described in the specification or can be practicals that are devised by the centre. Activities can range from whole investigations to simple starters and plenaries.

It should be noted that the practicals described in the specification need to be covered in preparation for the 15% of questions in the written examinations that will assess practical skills. Learners also need to be prepared to answer questions using their knowledge and understanding of practical apparatus, techniques and procedures in written papers.

Safety is an overriding requirement for all practical work. Centres are responsible for ensuring appropriate safety procedures are followed whenever their learners complete practical work.

Use and production of appropriate scientific diagrams to set up and record apparatus and procedures used in practical work is common to all science subjects and should be included wherever appropriate.

Revision of the requirements for practical work

OCR will review the practical activities detailed in Topic 7 of this specification following any revision by the Secretary of State of the apparatus or techniques published specified in respect of the GCSE Chemistry A (Gateway Science) qualification.

OCR will revise the practical activities if appropriate.

If any revision to the practical activities is made, OCR will produce an amended specification which will be published on the OCR website. OCR will then use the following methods to communicate the amendment to Centres such as a Notice to Centres sent to all Examinations Officers, e-alerts to Centres that have registered to teach the qualification and social media.

The following list includes opportunities for choice and use of appropriate laboratory apparatus for a variety of experimental problem-solving and/or enquiry based activities.

Practical Activity Group (PAG)	Apparatus and techniques that the practical must use or cover	Example of a suitable chemistry activity (a range of practicals are included in the specification and centres can devise their own activity) *
1 Reactivity trend	Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products	Use of displacement reactions to identify the reaction trend of Group 7 elements.
2 Electrolysis	Use of appropriate apparatus and techniques to draw, set up and use electrochemical cells for separation and production of elements and compounds	Electrolysis of aqueous sodium chloride or aqueous copper sulfate solution testing for the gases produced.
	Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions, and the determination of concentrations of strong acids and strong alkalis[8]	
3 Separation techniques	Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation[4]	Use of chromatography to identify the mixtures of dyes in an unknown ink
4 Distillation	Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation[4]	Distillation of a mixture, for example, orange juice, cherry cola, hydrocarbons, inks
	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	
	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases[1]	
5 Identification of species	Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions, and the determination of concentrations of strong acids and strong alkalis[8]	Identify an unknown compound using cation tests, anion tests and flame tests.
	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	

Practical Activity Group (PAG)	Apparatus and techniques that the practical must use or cover	Example of a suitable chemistry activity (a range of practicals are included in the specification and centres can devise their own activity) *
6 Titration	Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions, including appropriate reagents and/or techniques for the measurement of pH in different situations	Titration of a strong acid and strong alkali to find the concentration of the acid using an appropriate pH indicator.
	Use of appropriate qualitative reagents and techniques to analyse and identify unknown samples or products including gas tests, flame tests, precipitation reactions, and the determination of concentrations of strong acids and strong alkalis[8]	
	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases[1]	
7 Production of salts	Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation[4]	Production of pure dry sample of a salt
	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases[1]	
	Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions, including appropriate reagents and/or techniques for the measurement of pH in different situations	
	Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products	
	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	
8 Measuring rates of reaction	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases[1]	Investigate the effect of surface area or concentration on the rate of an acid/carbonate reaction
	Making and recording of appropriate observations during chemical reactions including changes in temperature and the measurement of rates of reaction by a variety of methods such as production of gas and colour change	

*** Centres are free to substitute alternative practical activities that also cover the apparatus and techniques from DfE: Biology, chemistry and physics GCSE subject content, July 2015 Appendix 4.**

[1, 2, 4, 8] These apparatus and techniques may be covered in any of the groups indicated. Numbers correspond to those used in DfE: Biology, chemistry and physics GCSE subject content, July 2015 Appendix 4.

2

Choice of activity

Centres can include additional apparatus and techniques within an activity beyond those listed as the minimum in the above tables. Learners *must* complete a *minimum of eight* practicals covering all the apparatus and techniques listed.

The apparatus and techniques can be covered:
(i) by using OCR suggested activities (provided as resources)
(ii) through activities devised by the centre.

Centres can receive guidance on the suitability of their own practical activities through our free coursework consultancy service (e-mail: ScienceGCSE@ocr.org.uk).

Where centres devise their own practical activities to cover the apparatus and techniques listed above, the practical must cover all the requirements and be of a level of demand appropriate for GCSE. Each set of apparatus and techniques described in the middle column can be covered by more than one centre devised practical activity e.g. "Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases" could be split into two or more activities (rather than one).

Practical science statement

Centres must provide a written 'practical science statement' to OCR confirming that it has taken reasonable steps to secure that each learner:

a) has completed the practical activities set by OCR as detailed in Topic 7
b) has made a contemporaneous record of
  (i) the work which the learner has undertaken during those practical activities, and
  (ii) the knowledge, skills and understanding which that learner has derived from those practical activities.

Centres must provide practical science opportunities for their learners. This does not go so far as to oblige centres to ensure that all of their learners take part in all of the practical science opportunities. There is always a risk that an individual learner may miss the arranged practical science work, for example because of illness. It could be costly for the centre to run additional practical science opportunities for the learner.

However, the opportunities to take part in the specified range of practical work must be given to all learners. Learners who do not take up the full range of opportunities may be disadvantaged as there will be questions on practical science in the GCSE Chemistry A (Gateway Science) assessment.

Centres must provide the practical science statement by 15 May in the year the learner certificates. Any failure by a centre to provide a practical science statement to OCR in a timely manner will be treated as malpractice and/or maladministration (under General Condition A8 (*Malpractice and maladministration*)).

Private candidates

Private candidates can be entered for examinations at an OCR-approved centre even if they are not enrolled as a learner there.

Private candidates may be home-schooled, receiving private tuition or self-taught. They must be based in the UK.

The GCSE Chemistry A (Gateway Science) qualification requires learners to complete eight practical activities. These practical activities are an essential part of the course and will allow learners to develop skills for further study or employment as well as imparting important knowledge that is part of the specification.

Private candidates need to make contact with a centre where they will be allowed to carry out the required practical activities. The centre may charge for this facility and OCR recommends that the arrangement is made early in the course.

There is no direct assessment of the practical skills part of the course. However, learners will need to have completed the activities to prepare fully for the written examinations as there will be questions that assess practical skills.

2d. Prior knowledge, learning and progression

- Learners in England who are beginning a GCSE (9–1) course are likely to have followed a Key Stage 3 .
- There are no prior qualifications required in order for learners to enter for a GCSE (9–1) in Chemistry A (Gateway Science).
- GCSEs (9–1) are qualifications that enable learners to progress to further qualifications either Vocational or General.

There are a number of Science specifications at OCR. Find out more at www.ocr.org.uk.

3 Assessment of GCSE (9–1) in Chemistry A (Gateway Science)

3a. Forms of assessment

The GCSE (9–1) in Chemistry A (Gateway Science) is a linear qualification with 100% external assessment.

OCR's GCSE (9–1) in Chemistry A (Gateway Science) consists of four examined papers that are externally assessed. Two are at Foundation Tier and two are at Higher Tier. Learners are entered for either the Foundation Tier or the Higher Tier. Each paper carries an equal weighting of 50% for that tier of the GCSE (9–1) qualification. Each paper has a duration of 1 hour and 45 minutes.

Chemistry Paper 1 and Paper 3

These papers, one at Foundation Tier and one at Higher Tier, are each worth 90 marks, are split into two sections and assess content from Topics C1 to C3 and C7.

Section A contains multiple choice questions. This section of the paper is worth 15 marks.

Section B includes short answer question styles (practical, maths, structured questions) and an extended six-mark Level of Response question. This section of the paper is worth 75 marks.

Chemistry Paper 2 and Paper 4

These papers, one at Foundation Tier and one at Higher Tier, are each worth 90 marks, are split into two sections and assess content from Topics C4 to C6, with assumed knowledge of Topics C1 to C3 and C7.

Section A contains multiple choice questions. This section of the paper is worth 15 marks.

Section B includes short answer question styles (practical, maths, synoptic questions, structured questions) and an extended six-mark Level of Response question. This section of the paper is worth 75 marks, some of which will be synoptic.

3

3b. Assessment objectives (AO)

There are three Assessment Objectives in OCR GCSE (9–1) in Chemistry A (Gateway Science). These are detailed in the table below:

Assessment Objectives		Weighting (%)	
		Higher	Foundation
AO1	**Demonstrate knowledge and understanding of:** • scientific ideas • scientific techniques and procedures.	40	40
AO2	**Apply knowledge and understanding of:** • scientific ideas • scientific enquiry, techniques and procedures.	40	40
AO3	**Analyse information and ideas to:** • interpret and evaluate • make judgements and draw conclusions • develop and improve experimental procedures.	20	20

AO weightings in OCR GCSE (9–1) in Chemistry A (Gateway Science)

The relationship between the Assessment Objectives and the components are shown in the following table:

Component (Foundation Tier)	% of overall GCSE (9–1) in Chemistry A (Gateway Science) (J248)			
	AO1	AO2	AO3	Total
Paper 1 (Foundation Tier) J248/01	20	20	10	50
Paper 2 (Foundation Tier) J248/02	20	20	10	50
Total	40	40	20	100
Component (Higher Tier)	**AO1**	**AO2**	**AO3**	**Total**
Paper 3 (Higher Tier) J248/03	20	20	10	50
Paper 4 (Higher Tier) J248/04	20	20	10	50
Total	40	40	20	100

3c. Tiers

This scheme of assessment consists of two tiers: Foundation Tier and Higher Tier. Foundation Tier assesses grades 5 to 1 and Higher Tier assesses grades 9 to 4. An allowed grade 3 may be awarded on the Higher Tier option for learners who are a small number of marks below the grade 3/4 boundary. Learners must be entered for either the Foundation Tier or the Higher Tier.

3d. Assessment availability

There will be one examination series available each year in May/June to **all** learners.

This specification will be certificated from the June 2018 examination series onwards.

All examined components must be taken in the same examination series at the end of the course.

3e. Retaking the qualification

Learners can retake the qualification as many times as they wish.

They retake all the papers within the relevant tier to be awarded the qualification.

3f. Assessment of extended response

Extended response questions which are marked using a level of response mark scheme are included in all externally assessed papers. These are indicated in papers and mark schemes by an asterisk (*).

Extended response questions provide learners with the opportunity to demonstrate their ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.

3g. Synoptic assessment

Synoptic assessment tests the learners' understanding of the connections between different elements of the subject.

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the GCSE (9–1) course. The emphasis of synoptic assessment is to encourage the development of the understanding of the subject as a discipline. Paper 2 and Paper 4 contain an element of synoptic assessment.

Synoptic assessment requires learners to make and use connections within and between different areas of chemistry, for example by:

- applying knowledge and understanding of more than one area to a particular situation or context
- using knowledge and understanding or principles and concepts in planning experimental and investigative work and in the analysis and evaluation of data
- bringing together scientific knowledge and understanding from different areas of the subject and applying them.

3h. Calculating qualification results

A learner's overall qualification grade for OCR GCSE (9–1) in Chemistry A (Gateway Science) will be calculated by adding together their marks from the two papers taken to give their total weighted mark.

This mark will then be compared to the qualification level grade boundaries for the entry option taken by the learner and for the relevant exam series to determine the learner's overall qualification grade.

4 Admin: what you need to know

The information in this section is designed to give an overview of the processes involved in administering this qualification so that you can speak to your exams officer. All of the following processes require you to submit something to OCR by a specific deadline.

More information about these processes, together with the deadlines, can be found in the OCR *Admin Guide and Entry Codes: 14–19 Qualifications*, which can be downloaded from the OCR website: www.ocr.org.uk

4a. Pre-assessment

Estimated entries

Estimated entries are your best projection of the number of learners who will be entered for a qualification in a particular series.

Estimated entries should be submitted to OCR by the specified deadline. They are free and do not commit your centre in any way.

4

Final entries

Final entries provide OCR with detailed data for each learner, showing each assessment to be taken. It is essential that you use the correct entry code, considering the relevant entry rules.

Final entries must be submitted to OCR by the published deadlines or late entry fees will apply.

All learners taking a GCSE (9–1) in Chemistry A (Gateway Science) must be entered for one of the following entry options:

Entry option		Components		
Entry code	**Title**	**Code**	**Title**	**Assessment type**
J248 F	Chemistry A (Gateway Science) (Foundation Tier)	01	Paper 1 (Foundation Tier)	External assessment
		02	Paper 2 (Foundation Tier)	External assessment
J248 H	Chemistry A (Gateway Science) (Higher Tier)	03	Paper 3 (Higher Tier)	External assessment
		04	Paper 4 (Higher Tier)	External assessment

Each learner must be entered for either the Foundation Tier **or** the Higher Tier only. They cannot be entered for a combination of tiers.

4b. Special consideration

Special consideration is a post-assessment adjustment to marks or grades to reflect temporary injury, illness or other indisposition at the time the assessment was taken.

Detailed information about eligibility for special consideration can be found in the JCQ publication *A guide to the special consideration process*.

4c. External assessment arrangements

Regulations governing examination arrangements are contained in the JCQ *Instructions for conducting examinations*.

Learners are permitted to use a scientific or graphical calculator for components 01, 02, 03 and 04. Calculators are subject to the rules in the document *Instructions for Conducting Examinations* published annually by JCQ (www.jcq.org.uk).

4

Head of centre annual declaration

The Head of Centre is required to provide a declaration to the JCQ as part of the annual NCN update, conducted in the autumn term, to confirm that the centre is meeting all of the requirements detailed in the specification.

Any failure by a centre to provide the Head of Centre Annual Declaration will result in your centre status being suspended and could lead to the withdrawal of our approval for you to operate as a centre.

4d. Results and certificates

Grade Scale

GCSE (9–1) qualifications are graded on the scale: 9–1, where 9 is the highest. Learners who fail to reach the minimum standard of 1 will be Unclassified (U).

Only subjects in which grades 9 to 1 are attained will be recorded on certificates.

Results

Results are released to centres and learners for information and to allow any queries to be resolved before certificates are issued.

Centres will have access to the following results information for each learner:

- the grade for the qualification
- the raw mark for each component
- the total weighted mark for the qualification.

The following supporting information will be available:

- raw mark grade boundaries for each component
- weighted mark grade boundaries for each entry option.

Until certificates are issued, results are deemed to be provisional and may be subject to amendment.

A learner's final results will be recorded on an OCR certificate. The qualification title will be shown on the certificate as 'OCR Level 1/2 GCSE (9–1) in Chemistry A (Gateway Science)'.

4e. Post-results services

A number of post-results services are available:

- **Enquiries about results** – If you think there might be something wrong with a learner's results, centres may submit an enquiry about results
- **Missing and incomplete results** – This service should be used if an individual subject result for a learner is missing, or the learner has been omitted entirely from the results supplied
- **Access to scripts** – Centres can request access to marked scripts.

4f. Malpractice

Any breach of the regulations for the conduct of examinations and non-exam assessment may constitute malpractice (which includes maladministration) and must be reported to OCR as soon as it is detected. Detailed information on malpractice can be found in the JCQ publication *Suspected Malpractice in Examinations and Assessments: Policies and Procedures*.

5 Appendices

5a. Overlap with other qualifications

There is a small degree of overlap between the content of this specification and those for GCSE (9–1) in Combined Science A (Gateway Science), GCSE (9–1) in Biology A (Gateway Science) and GCSE (9–1) in Physics A (Gateway Science) courses. The links between the specifications may allow for some co-teaching, particularly in the area of working scientifically.

5b. Accessibility

Reasonable adjustments and access arrangements allow learners with special educational needs, disabilities or temporary injuries to access the assessment and show what they know and can do, without changing the demands of the assessment. Applications for these should be made before the examination series. Detailed information about eligibility for access arrangements can be found in the JCQ *Access Arrangements and Reasonable Adjustments.*

The GCSE (9–1) qualification and subject criteria have been reviewed in order to identify any feature which could disadvantage learners who share a protected characteristic as defined by the Equality Act 2010. All reasonable steps have been taken to minimise any such disadvantage.

5c. Units in science

It is expected that learners will show understanding of the biological quantities and corresponding units, SI base and derived units listed below. They will be able to use them in qualitative work and calculations. These units and their associated quantities are dimensionally independent.

SI base units		
Physical quantity	Unit	Unit
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Current	ampere	A
Amount of a substance	mole	mol

SI derived units		
Physical quantity	Unit(s)	Unit(s)
Area	squared metre	m^2
Volume	cubic metre; litre; cubic decimetre	m^3; *l*; dm^3
Density	kilogram per cubic metre	kg/m^3
Temperature	degree Celsius	°C
Pressure	pascal	Pa
Specific heat capacity	joule per kilogram per degree Celsius	J/kg°C
Specific latent heat	joule per kilogram	J/kg
Speed	metre per second	m/s
Force	newton	N
Gravitational field strength	newton per kilogram	N/kg
Acceleration	metre per squared second	m/s^2
Frequency	hertz	Hz
Energy	joule	J
Power	watt	W
Electric charge	coulomb	C
Electric potential difference	volt	V
Electric resistance	ohm	Ω
Magnetic flux density	tesla	T

5

5d. Working scientifically

The idea that science progresses through a cycle of theory, hypothesis, experimentation, observation, development and review is encompassed in this section. It covers aspects of scientific thinking and aims to develop the scientific skills and conventions, fundamental to the study of science. The section includes understanding of theories and applications of science, the practical aspects of scientific experimentation, and objective analysis and evaluation. This will enable learners to develop an understanding of the processes and methods of science and, through consideration of the different types of scientific enquiry, learners will become equipped to answer scientific questions about the world around them. Learners will also develop and learn to apply skills in observation, modelling and problem-solving, with opportunities for these skills to be shown through links to specification content. Scientific-based claims require evaluative skills and these are also developed in this section with opportunities for contextual development highlighted. Learners should learn to evaluate through critical analysis of methodology, evidence and conclusions, both qualitatively and quantitatively.

Working scientifically is split into concepts (WS1) and practical skills (WS2). Both of these will be assessed in written examinations and WS2 may also be assessed through practical activities.

WS1: Working scientifically assessed in written examinations

Summary
The concepts and skills in this section can be assessed in written examinations. There are references to specific apparatus and methods throughout the content of the specification. WS1 is split into four parts: WS1.1, WS1.2, WS1.3 and WS1.4.

WS1.1 Development of scientific thinking

Assessable Content		
Learning outcomes		**To include**
WS1.1a	understand how scientific methods and theories develop over time	new technology allowing new evidence to be collected and changing explanations as new evidence is found
WS1.1b	use models to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts	representational, spatial, descriptive, computational and mathematical models
WS1.1c	understand the power and limitations of science	how developments in science have led to increased understanding and improved quality of life and questions and problems that science cannot currently answer
WS1.1d	discuss ethical issues arising from developments in science	
WS1.1e	explain everyday and technological applications of science	
WS1.1f	evaluate associated personal, social, economic and environmental implications	
WS1.1g	make decisions based on the evaluation of evidence and arguments	
WS1.1h	evaluate risks both in practical science and the wider societal context	perception of risk in relation to data and consequences
WS1.1i	recognise the importance of peer review of results and of communicating results to a range of audiences	

WS1.2 Experimental skills and strategies

Assessable Content		
Learning outcomes		To include
WS1.2a	use scientific theories and explanations to develop hypotheses	
WS1.2b	plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena	
WS1.2c	apply a knowledge of a range of techniques, instruments, apparatus and materials to select those appropriate to the experiment	
WS1.2d	recognise when to apply knowledge of sampling techniques to ensure any samples collected are representative	
WS1.2e	evaluate methods and suggest possible improvements and further investigations	

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WS1.3 Analysis and evaluation

Assessable Content		
Learning outcomes		To include
	Apply the cycle of collecting, presenting and analysing data, including:	
WS1.3a	presenting observations and other data using appropriate methods	methods to include descriptive, tabular diagrammatic and graphically
WS1.3b	translating data from one form to another	
WS1.3c	carrying out and representing mathematical and statistical analysis	statistical analysis to include arithmetic means, mode, median
WS1.3d	representing distributions of results and make estimations of uncertainty	
WS1.3e	interpreting observations and other data	data presentations to include verbal, diagrammatic, graphical, symbolic or numerical form interpretations to include identifying patterns and trends, making inferences and drawing conclusions

Assessable Content		
Learning outcomes		**To include**
WS1.3f	presenting reasoned explanations	relating data to hypotheses
WS1.3g	evaluating data in terms of accuracy, precision, repeatability and reproducibility	
WS1.3h	identifying potential sources of random and systematic error	
WS1.3i	communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions	presentations through paper-based presentations using diagrammatic, graphical, numerical and symbolic forms

WS1.4 Scientific vocabulary, quantities, units, symbols and nomenclature

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Assessable Content		
Learning outcomes		**To include**
WS1.4a	use scientific vocabulary, terminology and definitions	
WS1.4b	recognise the importance of scientific quantities and understand how they are determined	
WS1.4c	use SI units and IUPAC chemical nomenclature unless inappropriate	base units & derived units
WS1.4d	use prefixes and powers of ten for orders of magnitude	tera, giga, mega, kilo, deci, centi, milli, micro and nano
WS1.4e	interconvert units	
WS1.4f	use an appropriate number of significant figures in calculations	

WS2: Working scientifically skills demonstrated

Summary
A range of practical experiences are a vital part of a scientific study at this level. A wide range of practical skills will be addressed throughout the course, skills which are required for the development of investigative skills. Learners should be given the opportunity to practise their practical skills, which will also prepare them for the written examinations. For further details of the practical activity requirements, Topic C7.

Practical skills to be developed		
Learning outcomes		To include
WS2a	carry out experiments	due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations, and following written instructions
WS2b	make and record observations and measurements using a range of apparatus and methods	keeping appropriate records
WS2c	presenting observations using appropriate methods	methods to include descriptive, tabular diagrammatic and graphically
WS2d	communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions	presentations through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms

5e. Mathematical skills requirement

In order to be able to develop their skills, knowledge and understanding in GCSE (9–1) in Chemistry A (Gateway Science), learners need to have been taught, and to have acquired competence in, the appropriate areas of mathematics relevant to the subject as indicated in the table of coverage below.

The questions and tasks used to target mathematical skills will be at a level of demand that is appropriate to GCSE (9–1) in Chemistry A (Gateway Science).

In the Foundation Tier question papers, the questions that assess mathematical skills will not be of a lower demand than that which is expected of learners at Key Stage 3, as outlined in the Department of Education's document "Mathematics programme of study: key stage 3".

In the Higher Tier question papers, the questions that assess mathematical skills will not be lower than that of question and tasks in assessment for the Foundation Tier in a GCSE qualification in Mathematics.

The assessment of quantitative skills would include at least 20% mathematical skills at the appropriate tier for chemistry.

These skills will be applied in the context of the relevant chemistry.

All mathematical content will be assessed within the lifetime of the specification.

This list of examples is not exhaustive and is not limited to GCSE examples. These skills could be developed in other areas of specification content as indicated in the opportunities to cover column.

The mathematical skills required for the GCSE (9–1) in Biology (B), Chemistry (C), Physics (P) and Combined Science (CS) are shown in the table on the following page.

	Mathematical skills	Subject			
M1	**Arithmetic and numerical computation**				
a	Recognise and use expressions in decimal form	B	C	P	CS
b	Recognise and use expressions in standard form	B	C	P	CS
c	Use ratios, fractions and percentages	B	C	P	CS
d	Make estimates of the results of simple calculations	B	C	P	CS
M2	**Handling data**				
a	Use an appropriate number of significant figures	B	C	P	CS
b	Find arithmetic means	B	C	P	CS
c	Construct and interpret frequency tables and diagrams, bar charts and histograms	B	C	P	CS
d	Understand the principles of sampling as applied to scientific data	B			
e	Understand simple probability	B			
f	Understand the terms mean, mode and median	B		P	CS
g	Use a scatter diagram to identify a correlation between two variables	B		P	CS
h	Make order of magnitude calculations	B	C	P	CS
M3	**Algebra**				
a	Understand and use the symbols: =, <, <<, >>, >, ∝ , ~	B	C	P	CS
b	Change the subject of an equation		C	P	CS
c	Substitute numerical values into algebraic equations using appropriate units for physical quantities		C	P	CS
d	Solve simple algebraic equations	B		P	CS
M4	**Graphs**				
a	Translate information between graphical and numeric form	B	C	P	CS
b	Understand that y=mx+c represents a linear relationship	B	C	P	CS
c	Plot two variables from experimental or other data	B	C	P	CS
d	Determine the slope and intercept of a linear graph	B	C	P	CS
e	Draw and use the slope of a tangent to a curve as a measure of rate of change		C		CS
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate			P	CS
M5	**Geometry and trigonometry**				
a	Use angular measures in degrees			P	CS
b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects		C	P	CS
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes.	B	C	P	CS

5f. Health and safety

In UK law, health and safety is primarily the responsibility of the employer. In a school or college the employer could be a local education authority, the governing body or board of trustees. Employees (teachers/lecturers, technicians etc.), have a legal duty to cooperate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 2002 (as amended) and the Management of Health and Safety at Work Regulations 1999, require that before any activity involving a hazardous procedure or harmful microorganisms is carried out, or hazardous chemicals are used or made, the employer must carry out a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found at: https://www.ase.org.uk.

For members, the CLEAPSS® guide, *PS90, Making and recording risk assessments in school science*[1] offers appropriate advice.

Most education employers have adopted nationally available publications as the basis for their Model Risk Assessments.

Where an employer has adopted model risk assessments an individual school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment.

Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the learners were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded in a "*point of use text* ", for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed for each practical activity, although a minority of employers may require this.

Where project work or investigations, sometimes linked to work-related activities, are included in specifications this may well lead to the use of novel procedures, chemicals or microorganisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting CLEAPSS®[1].

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[1] These, and other CLEAPSS® publications, are on the CLEAPSS® Science Publications website www.cleapss.org.uk. Note that CLEAPSS® publications are only available to members. For more information about CLEAPSS® go to www.cleapss.org.uk.

5g. The periodic table of elements

Key
atomic number
Symbol
name
relative atomic mass

(1) 1	(2) 2	3	4	5	6	7	8	9	10	11	12	(3) 13	(4) 14	(5) 15	(6) 16	(7) 17	(0) 18
1 **H** hydrogen 1.0																	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											5 **B** boron 10.8	6 **C** carbon 12.0	7 **N** nitrogen 14.0	8 **O** oxygen 16.0	9 **F** fluorine 19.0	10 **Ne** neon 20.2
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3											13 **Al** aluminium 27.0	14 **Si** silicon 28.1	15 **P** phosphorus 31.0	16 **S** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
37 **Rb** rubidium 85.5	38 **Sr** strontium 87.6	39 **Y** yttrium 88.9	40 **Zr** zirconium 91.2	41 **Nb** niobium 92.9	42 **Mo** molybdenum 95.9	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57–71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89–103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium		

YOUR CHECKLIST

Our aim is to provide you with all the information and support you need to deliver our specifications.

- [ ] Bookmark **ocr.org.uk/gcsegatewaychemistry** for all the latest resources, information and news on GCSE (9-1) Gateway Science Chemistry A
- [ ] Be among the first to hear about support materials and resources as they become available – register for Gateway Science Chemistry A updates at **ocr.org.uk/updates**
- [ ] Find out about our professional development at **cpdhub.ocr.org.uk**
- [ ] View our range of skills guides for use across subjects and qualifications at **ocr.org.uk/skillsguides**
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Download high-quality, exciting and innovative GCSE (9-1) Gateway Science Chemistry A resources from ocr.org.uk/gcsegatewaychemistry

Resources and support for our GCSE (9-1) Gateway Science Chemistry A qualification, developed through collaboration between our Chemistry Subject Specialists, teachers and other subject experts, are available from our website. You can also contact our Chemistry Subject Specialists who can give you specialist advice, guidance and support.

Meet the team at ocr.org.uk/scienceteam and contact them at:
01223 553998
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To stay up to date with all the relevant news about our qualifications, register for email updates at ocr.org.uk/updates

Chemistry Community

The social network is a free platform where teachers can engage with each other – and with us – to find and offer guidance, discover and share ideas, best practice and a range of Chemistry support materials. To sign up, go to social.ocr.org.uk

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