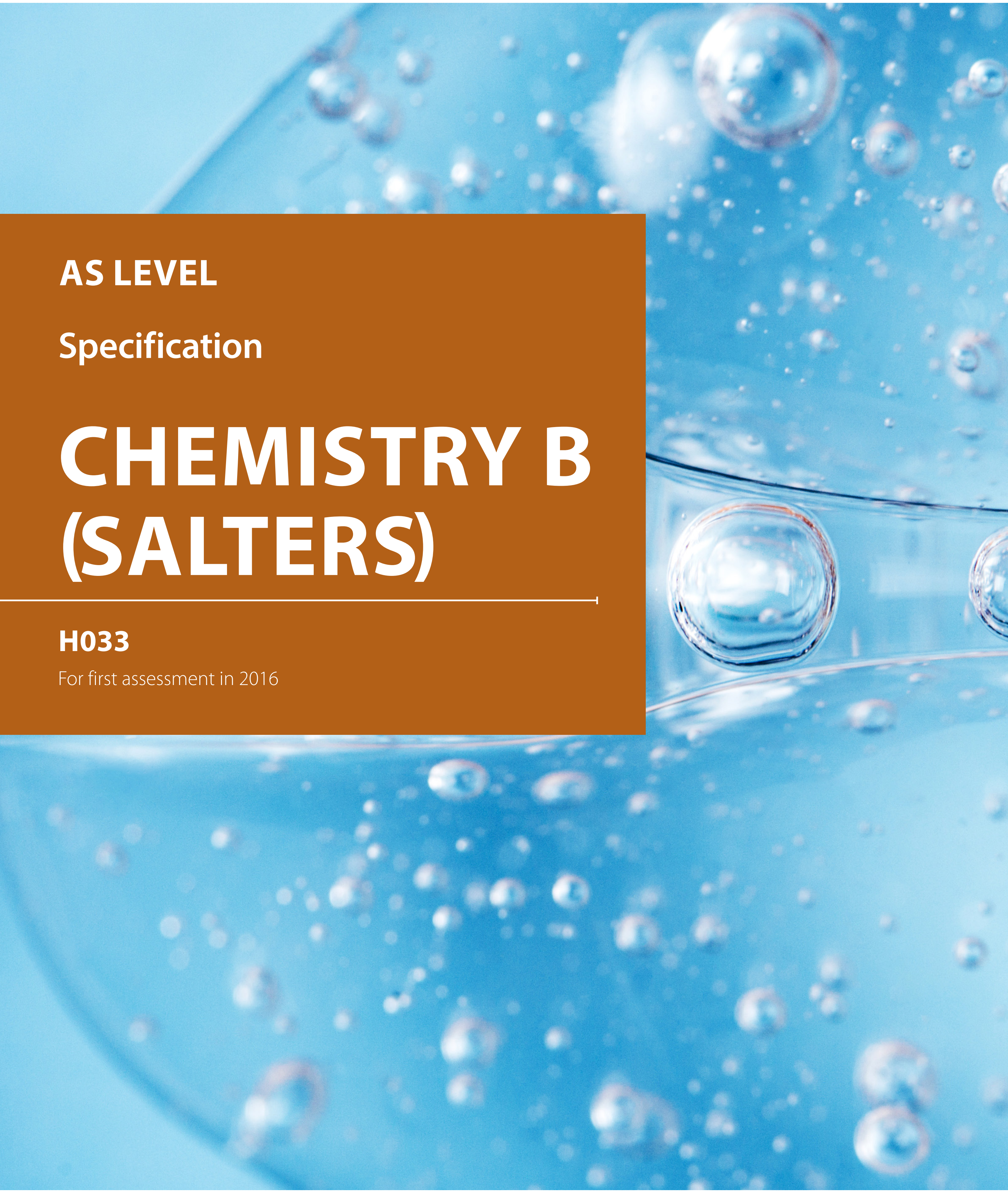
Qualification Accredited

OCR
Oxford Cambridge and RSA



AS LEVEL

Specification

# CHEMISTRY B (SALTERS)

## H033

For first assessment in 2016

Version 1.6 (February 2024)

ocr.org.uk/alevelchemistryb

*Disclaimer*

Specifications are updated over time. Whilst every effort is made to check all documents, there may be contradictions between published resources and the specification, therefore please use the information on the latest specification at all times. Where changes are made to specifications these will be indicated within the document, there will be a new version number indicated, and a summary of the changes. If you do notice a discrepancy between the specification and a resource please contact us at: resources.feedback@ocr.org.uk

We will inform centres about changes to 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.

*Registered office:*
*The Triangle Building*
*Shaftesbury Road*
*Cambridge*
*CB2 8EA*

*OCR is an exempt charity.*

# Contents

## Introducing…
## AS Level Chemistry B (Salters) (from September 2015)

Chemistry B (Salters) was first examined in 1992 as a new concept project examination. In contrast to the traditional 'topic-based' approach, Chemistry B (Salters) is 'context-led'. Chemical concepts are introduced within a relevant context, the course being written as a series of teaching modules based on contemporary issues in chemistry. Students study the chemistry in a spiral way so that chemical ideas, introduced in an early topic, are reinforced later. The 'drip-feed' approach to teaching and learning chemical principles allows candidates to revisit a particular topic several times during the course, each time taking their knowledge and understanding a step further.

Practical work done to support teaching of the content will serve to cover the requirements of the practical skills module (Module 1), which is assessed in written examinations. Suitable supporting practical work is cross-referenced from appropriate learning outcomes throughout the specification. Additionally, cross-references are included to the mathematical criteria that are embedded in the assessment.

This Chemistry B (Salters) specification is supported by extensive new materials developed by the University of York Science Education Group.

This specification incorporates the Ofqual GCE Subject Level Conditions and Requirements for Chemistry.

### Contact the team

We have a dedicated team of people working on our AS Level Chemistry qualifications.

If you need specialist advice, guidance or support, get in touch as follows:

- **01223 553998**
- scienceGCE@ocr.org.uk
- @OCR_science

## Teaching and learning resources

We recognise that the introduction of a new specification can bring challenges for implementation and teaching. Our aim is to help you at every stage and we're working hard to provide a practical package of support in close consultation with teachers and other experts, so we can help you to make the change.

**Designed to support progression for all**

Our resources are designed to provide you with a range of teaching activities and suggestions so you can select the best approach for your particular students. You are the experts on how your students learn and our aim is to support you in the best way we can.

**We want to...**

- Support you with a body of knowledge that grows throughout the lifetime of the specification
- Provide you with a range of suggestions so you can select the best activity, approach or context for your particular students
- Make it easier for you to explore and interact with our resource materials, in particular to develop your own schemes of work
- Create an ongoing conversation so we can develop materials that work for you.

**Plenty of useful resources**

You'll have four main types of subject-specific teaching and learning resources at your fingertips:

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

Along with subject-specific resources, you'll also have access to a selection of generic resources that focus on skills development and professional guidance for teachers.

**Skills Guides** – we've produced a set of Skills Guides that are not specific to Chemistry, but each covers a topic that could be relevant to a range of qualifications – for example, communication, legislation and research. Download the guides at ocr.org.uk/skillsguides

**Active Results** – a free online results analysis service to help you review the performance of individual students or your whole school. It provides access to detailed results data, enabling more comprehensive analysis of results in order to give you a more accurate measurement of the achievements of your centre and individual students. For more details refer to ocr.org.uk/activeresults

## Professional development

Take advantage of our improved Professional Development Programme, designed with you in mind. 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.

**An introduction to the new specifications**

We'll be running events to help you get to grips with our AS Level Chemistry B (Salters) qualification.

These events are designed to help prepare you for first teaching and to support your delivery at every stage.

Watch out for details at **cpdhub.ocr.org.uk**

To receive the latest information about the training we'll be offering, please register for AS Level email updates at **ocr.org.uk/updates**

# 1 Why choose an OCR AS Level in Chemistry B (Salters)?

1

## 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 AS Level in Chemistry B (Salters) course has been developed in consultation with teachers, employers and Higher Education to provide students 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 students 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 Advisors to support you through the transition and throughout the lifetime of the specifications.
- 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 students or whole schools.
- **ExamBuilder** – our free online past papers service that enables you to build your own test papers from past OCR exam questions.

All AS level qualifications offered by OCR are accredited by Ofqual, the Regulator for qualifications offered in England. The accreditation number for OCR's AS Level in Chemistry B (Salters) is QN: 601/5446/9.

1

## 1b. Why choose an OCR AS Level in Chemistry B (Salters)?

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

**Chemistry A** – a content-led approach. A flexible approach where 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're assessed both through written papers and, for A level only, the Practical Endorsement.

**Chemistry B (Salters)** – a context-led approach. Learners study chemistry in a range of different contexts, conveying the excitement of contemporary chemistry. Ideas are introduced in a spiral way with topics introduced in an early part of the course and reinforced later. The 'B' specification places a particular emphasis on an investigational and problem-solving approach to practical work and is supported by extensive new materials developed by the University of York Science Education Group.

All of our specifications have been developed with subject and teaching experts. We have worked in close consultation with teachers and representatives from Higher Education (HE) with the aim of including up-to-date relevant content within a framework that is interesting to teach and administer within all centres (large and small).

Our new AS Level Chemistry B (Salters) qualification builds on our existing popular course. We've based the redevelopment of our AS level sciences on an understanding of what works well in centres large and small and have updated areas of content and assessment where stakeholders have identified that improvements could be made. 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. Our papers and specifications have been trialled in centres during development to make sure they work well for all centres and learners.

The content changes are an evolution of our legacy offering and will be familiar to centres already following our courses, but are also clear and logically laid out for centres new to OCR, with assessment models that are straightforward to administer. We have worked closely with teachers and HE representatives to provide high quality support materials to guide you through the new qualifications.

### Aims and learning outcomes

OCR's AS Level in Chemistry B (Salters) specification aims to encourage learners to:

- develop essential knowledge and understanding of different areas of the subject and how they relate to each other
- develop and demonstrate a deep appreciation of the skills, knowledge and understanding of scientific methods
- develop competence and confidence in a variety of practical, mathematical and problem solving skills.
- develop their interest in and enthusiasm for the subject, including developing an interest in further study and careers associated with the subject
- understand how society makes decisions about scientific issues and how the sciences contribute to the success of the economy and society (as exemplified in 'How Science Works' (HSW)).

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



Our Chemistry B (Salters) specification has been designed so learners study chemistry in a range of different contexts, conveying the excitement of contemporary chemistry. The specification relates modern-day applications of chemistry and current research to the concepts needed for the study of chemistry at AS Level.

The specification is structured in a series of teaching modules that allow the concepts to unfold throughout the course. Each module is intended to be taught through a chemical 'storyline'. The storylines address topics such as the use and development of fuels, and the use of metals in a wide range of applications including in medicines.

These storylines provide a structure in which to teach the chemical concepts that form the assessable content of the specification. Each storyline brings together concepts from different areas of chemistry, which allows the interconnections between these areas to become clear. As the course progresses, concepts are revisited and built upon in a range of different contexts.

Additionally, the Chemistry B (Salters) specification is designed to stimulate a wide range of practical work. Most storylines offer multiple opportunities for practical work that will help to illustrate the chemical concepts.

A learner of Chemistry B (Salters) will become familiar with exploring key chemistry ideas in a range of contexts. They are able to link chemical concepts together and develop their understanding behind the chemical content within these contexts. Questions within the assessments will be set in unfamiliar contexts, but due to the experience of learning in a range of contexts learners will be comfortable in the application of their chemical knowledge.

The specification:

- has ideas that are introduced within a spiral curriculum structure – topics introduced in an early part of the course and reinforced later
- is laid out clearly in a series of teaching modules with Additional guidance added where required to clarify assessment requirements
- is structured to allow the teaching modules to be taught through chemical 'storylines' that link the specification content with a wide range of contexts
- is co-teachable with the A level
- embeds practical requirements within the teaching modules. Whilst the Practical Endorsement is not part of AS Level in Chemistry B (Salters), opportunities for carrying out activities that would count towards the Practical Endorsement are indicated throughout the specification, in the Additional guidance column, by use of **PAG**, refer to the A level specification, Section 5, for Practical Endorsement requirements
- exemplifies the mathematical requirements of the course (see Section 5)
- highlights opportunities for the introduction of key mathematical requirements (see Section 5d and the Additional guidance column for each module) into your teaching
- identifies, within the Additional guidance how the skills, knowledge and understanding of How Science Works (HSW) can be incorporated within teaching.

The Chemistry B (Salters) course is fully supported by a dedicated support package written and developed by the University of York Science Education Group, in collaboration with OCR and with sponsorship from the Salters' Institute of industrial chemistry.

### Teacher support

The extensive support offered alongside this specification includes:

- **delivery guides** – providing information on assessed content, the associated conceptual development and contextual approaches to delivery
- **transition guides** – identifying the levels of demand and progression for different key stages for a particular topic and going on to provide links to high quality resources and 'checkpoint tasks' to assist teachers in identifying learners 'ready for progression'
- **lesson elements** – written by experts, providing all the materials necessary to deliver creative classroom activities
- **Active Results** (see Section 1a)
- **ExamBuilder** (see Section 1a)
- **mock examinations service** – a free service offering a practice question paper and mark scheme (downloadable from a secure location).

Along with:

- Subject Advisors within the OCR science team to help with course queries
- teacher training
- *Science Spotlight* (our termly newsletter)
- OCR Science community
- Practical Skills Handbook
- Maths Skills Handbook.

## 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).

Find out more?

Contact the Subject Advisors: ScienceGCE@ocr.org.uk, 01223 553998.

Visit our Online Support Centre at support.ocr.org.uk

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

Follow us on Twitter: @OCR_science

# 2 The specification overview

## 2a. Overview of AS Level in Chemistry B (Salters) (H033)

Learners must complete both components (01 and 02) to be awarded the OCR AS Level in Chemistry B.

| Content Overview | Assessment Overview | |
|---|---|---|
| **Development of practical skills in chemistry**<br>**Storylines**<br>• Elements of life<br>• Developing fuels<br>• Elements from the sea<br>• The ozone story<br>• What's in a medicine? | Foundations of chemistry (01)*<br>70 marks<br>1 hour 30 minutes written paper | **50%** of total AS level |
| | Chemistry in depth (02)*<br>70 marks<br>1 hour 30 minutes written paper | **50%** of total AS level |

*Both components include synoptic assessment.

2

2

## 2b. Content of AS Level in Chemistry B (Salters) (H033)

The AS Level in Chemistry B (Salters) specification content is divided into two sections (Section 2c and 2d). An overview of the context is provided at the start of each storyline in Section 2d along with a summary of the chemistry it contains. The assessable content is divided into two columns: **Learning outcomes** and **Additional guidance**.

The Learning outcomes in Sections 2c and 2d may all be assessed in the examinations. The Additional guidance column is included to provide further advice on delivery and the expected skills required from learners.

The details of the storyline contexts, where not directly related to the Learning outcomes, do not form part of the assessable content. These contexts are provided as a coherent and engaging teaching sequence, allowing the specification content to be covered in a way that integrates the various aspects of chemistry and relates the subject to modern applications and everyday experience. Learners will be expected to be able to apply their understanding of chemistry to unfamiliar contexts in the assessments.

References to HSW (Section 5) are included in the guidance to highlight opportunities to encourage a wider understanding of science.

The mathematical requirements in Section 5 are also referenced by the prefix M (in the additional guidance) to link the mathematical skills required for AS Level Chemistry to examples of science content where those mathematical skills could be linked to learning.

Section 2c in the specification content relates to the practical skills learners are expected to gain throughout the course, which are assessed throughout the written examinations.

Practical activities are embedded within the learning outcomes in Section 2d (Storylines). Suggestions for practical work are also highlighted in the additional guidance (italics) to encourage practical activities in the laboratory, enhancing learners' understanding of chemical theory and practical skills.

The specification has been designed to be co-teachable with the A Level in Chemistry B (Salters) qualification. Learners studying the A level study Section 2c and the first five teaching modules (in Section 2d), continuing with the content of the additional five teaching modules and Chemical literacy in year 13. The internally assessed Practical Endorsement skills also form part of the full A Level (see Section 2c, 1.2 in the A level specification).

A summary of the content for the AS level course is as follows:

**Section 2c – Development of practical skills in chemistry**

- Practical skills assessed in a written examination

**Section 2d – Storylines**

- Elements of life
- Developing fuels
- Elements from the sea
- The ozone story
- What's in a medicine?

# 2c. Development of practical skills in chemistry

## Module 1: Development of practical skills in chemistry

Chemistry is a practical subject and the development of practical skills is fundamental to understanding the nature of chemistry. Chemistry B gives learners many opportunities to develop the fundamental skills needed to collect and analyse empirical data. Skills in planning, implementing, analysing and evaluating, as outlined in 1.1, will be assessed in the written papers.

2

### 1.1 Practical skills assessed in a written examination

Practical skills are embedded throughout all sections of this specification. Suggestions for practical activities are highlighted within Section 2d (Storylines) of the specification in the additional guidance (italics).

Learners will be required to develop a range of practical skills and experiences throughout the course in preparation for the written examinations.

#### 1.1.1 Planning

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | experimental design, including to solve problems set in a practical context | Including selection of suitable apparatus, equipment and techniques for the proposed experiment.<br><br>Learners should be able to apply scientific knowledge based on the content of the specification to the practical context.<br>HSW3 |
| **(b)** | identification of variables that must be controlled, where appropriate | |
| **(c)** | evaluation that an experimental method is appropriate to meet the expected outcomes. | HSW6 |

#### 1.1.2 Implementing

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | how to use a wide range of practical apparatus and techniques correctly | As outlined in the Storylines content of the specification (Section 2d).<br>HSW4 |
| **(b)** | appropriate units for measurements | *M0.0* |
| **(c)** | presenting observations and data in an appropriate format. | HSW8 |

### 1.1.3 Analysis

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | processing, analysing and interpreting qualitative and quantitative experimental results | Including reaching valid conclusions, where appropriate.<br>HSW5 |
| **(b)** | use of appropriate mathematical skills for analysis of quantitative data | Refer to Section 5 for a list of mathematical skills that learners should have acquired competence in as part of the course.<br>HSW3 |
| **(c)** | appropriate use of significant figures | *M1.1* |
| **(d)** | plotting and interpreting suitable graphs from experimental results, including selection and labelling of axes with appropriate scales, quantities and units. | *M3.2* |

### 1.1.4 Evaluation

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | how to evaluate results and draw conclusions | HSW6 |
| **(b)** | the identification of anomalies in experimental measurements | |
| **(c)** | the limitations in experimental procedures | |
| **(d)** | precision and accuracy of measurements and data, including margins of error, percentage errors and uncertainties in apparatus | *M1.3* |
| **(e)** | the refining of experimental design by suggestion of improvements to the procedures and apparatus. | HSW3 |

## 2d. Storylines

The content in this section is supported by the resources produced by the University of York Science Education Group (published by Oxford University Press).

The storylines in this section are structured in order to allow teaching of the assessable content in a series of contexts. The contexts are designed to be engaging, and to illustrate the relevance of chemistry in our daily lives and its role in understanding the world around us. At the beginning of each storyline, an overview is given of the intended context and how it relates to the learning outcomes listed below. These context overviews do not form part of the assessable content.

The learning outcomes and additional guidance in each module form the assessable content of the specification; learners will not be expected to recall aspects of the storyline contexts that are not referred to in the learning outcomes. In the final examinations, learners could be assessed on the content of the specification within **any** appropriate context.

2

### Elements of life (EL)

The Big Bang theory is used to introduce the question of where the elements come from. This leads to discussion of the concepts of atomic structure, nuclear fusion, and the use of mass spectrometry to determine the relative abundance of isotopes.

Next, looking at how we study the radiation we receive from outer space provides the context for discussion of atomic spectroscopy and electronic structure. A historical approach is used to introduce the periodic table, including the links between electronic structure and physical properties. This is followed by studying some of the molecules found in space, providing the context for introducing bonding and structure and the shapes of molecules.

The storyline then turns to chemistry found closer to home. Ideas about the elements found in the human body and their relative amounts are used to introduce the concept of amount of substance and related calculations. The bodily fluids, blood and salt then provide a basis for studying salts; this context also incorporates sea water and uses of salts such as in bath salts, lithium batteries, barium meals, hand warmers and fertilisers. This also provides the context for discussing the chemistry of Group 2 elements, as well as amount of substance calculations involving concentration and acid–base titrations.

The chemical ideas in this module are:

- atomic structure, atomic spectra and electron configurations
- fusion reactions
- mass spectrometry and isotopes
- the periodic table and Group 2 chemistry
- bonding and the shapes of molecules
- chemical equations and amount of substance (moles)
- ions: formulae, charge density, tests
- titrations and titration calculations.

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **Formulae, equations and amount of substance** | | |
| **(a)** | atomic number, mass number, isotope, Avogadro constant ($N_A$), relative isotopic mass, relative atomic mass ($A_r$), relative formula mass and relative molecular mass ($M_r$) | *M0.0, M0.1, M0.4* |

| | |
|---|---|
| **(b)** **(i)** the concept of amount of substance (moles) and its use to perform calculations involving: masses of substances, empirical and molecular formulae, percentage composition, percentage yields, water of crystallisation<br>**(ii)** the techniques and procedures used in experiments to measure masses of solids | *M0.0, M0.1, M0.2, M1.1, M2.2, M2.3, M2.4*<br>**PAG1**<br>• experiments involving reacting masses and moles<br>In recognition of IUPAC's review, we will accept both the classical (carbon-12 based) and revised (Avogadro constant based) definitions of the mole in examinations from June 2018 onwards (see https://iupac.org/new-definition-mole-arrived/) |
| **(c)** **(i)** the use of the concept of amount of substance (moles) to perform calculations involving: concentration (including titration calculations and calculations for making and diluting standard solutions)<br>**(ii)** the techniques and procedures used in experiments to measure volumes of solutions; the techniques and procedures used in experiments to prepare a standard solution from a solid or more concentrated solution and in acid–base titrations | *M0.0, M0.1, M0.2, M1.1, M1.2, M1.3, M2.2, M2.3, M2.4*<br>At AS, learners will only be expected to carry out structured titration calculations.<br>**PAG2**<br>• *making up standard solutions and diluting solutions using volumetric apparatus*<br>• *acid–base titrations* |
| **(d)** balanced full and ionic chemical equations, including state symbols | *M0.2* |
| **Atomic structure** | |
| **(e)** conventions for representing the distribution of electrons in atomic orbitals; the shapes of s- and p-orbitals | The 'electrons in boxes' model. |
| **(f)** the electronic configuration, using sub-shells and atomic orbitals, of:<br>**(i)** atoms from hydrogen to krypton<br>**(ii)** ions of the s- and p-block of Periods 1 to 4<br>**(iii)** the outer sub-shell structures of s- and p-block elements of other periods | No explanation required.<br>At AS, the electron configurations of Cr and Cu will **not** be assessed. |
| **(g)** how knowledge of the structure of the atom developed in terms of a succession of gradually more sophisticated models; interpretation of these and other examples of such developing models | To include:<br>• evidence for small dense nucleus (Geiger–Marsden experiment)<br>• the make-up of atoms and ions in terms of protons, neutrons and electrons<br>• evidence for electrons shells [from ionisation energies, **EL(q)**, and spectra, **EL(w)**]. |

| | | |
|---|---|---|
| **(h)** | fusion reactions: lighter nuclei join to give heavier nuclei (under conditions of high temperature and pressure); this is how certain elements are formed | Nuclear equations are required. |

**Bonding and structure**

| | | |
|---|---|---|
| **(i)** | chemical bonding in terms of electrostatic forces; simple electron '*dot-and-cross*' diagrams to describe the electron arrangements in ions and covalent and dative covalent bonds | In covalent bonds there is a balance between the repulsive forces between the nuclei and the attractive forces between the nuclei and the electrons. |
| **(j)** | the bonding in giant lattice (metallic, ionic, covalent network) and simple molecular structure types;<br>the typical physical properties (melting point, solubility in water, electrical conductivity) characteristic of these structure types | Explanations of physical properties limited to:<br>• electrostatic attractions between molecules are weaker than electrostatic attractions in giant structures<br>• charged particles able to move (electrons in metals; ions in molten or aqueous ionic substances). |
| **(k)** | use of the electron pair repulsion principle, based on *'dot-and-cross'* diagrams, to predict, explain and name the shapes of simple molecules (such as $BeCl_2$, $BF_3$, $CH_4$, $NH_3$, $H_2O$ and $SF_6$) and ions (such as $NH_4^+$) with up to six outer pairs of electrons (any combination of bonding pairs and lone pairs); assigning bond angles to these structures | *M4.1*<br>No treatment of hybridisation or molecular orbitals is expected but ideas of bond angles being altered by the lone pairs present should be included, for example the bond angles of:<br>$CH_4$ (109.5°), $NH_3$ (107°), $H_2O$ (104.5°). |
| **(l)** | structures of compounds that have a sodium chloride type lattice | Ionic bonding is the overall attraction in a lattice and is made up of attraction between ions of different charge and repulsion between ions of the same charge. |

**Inorganic chemistry and the periodic table**

| | | |
|---|---|---|
| **(m)** | the periodic table as a list of elements in order of atomic (proton) number that groups elements together according to their common properties; using given information, make predictions concerning the properties of an element in a group;<br>the classification of elements into s-, p- and d-blocks | |
| **(n)** | periodic trends in the melting points of elements in Periods 2 and 3, in terms of structure and bonding | |

## Elements of life (EL)

**(o)** the relationship between the position of an element in the s- or p-block of the periodic table and the charge on its ion;
the names and formulae of $NO_3^-$, $SO_4^{2-}$, $CO_3^{2-}$, $OH^-$, $NH_4^+$, $HCO_3^-$, $Cu^{2+}$, $Zn^{2+}$, $Pb^{2+}$, $Fe^{2+}$, $Fe^{3+}$;
formulae and names for compounds formed between these ions and other given anions and cations

When used without oxidation states, 'nitrate' can be assumed to be $NO_3^-$ and 'sulfate' can be assumed to be $SO_4^{2-}$.

**(p)** a description and comparison of the following properties of the elements and compounds of Mg, Ca, Sr and Ba in Group 2: reactions of the elements with water and oxygen, thermal stability of the carbonates, solubilities of hydroxides and carbonates

- *test-tube or reduced scale reactions involving the elements of Group 2 and their compounds*

**(q)** the term *ionisation enthalpy*;
equations for the first ionisation of elements;
explanation of trends in first ionisation enthalpies for Periods 2 and 3 and groups and the resulting differences in reactivities of s- and p-block metals in terms of their ability to lose electrons

Across a period, outermost electrons in the same shell are being more strongly attracted by more protons (explanation of the small drops mid-period **not** required).
Down a group, electrons are in shells that are further from the nucleus and thus attracted less.

**(r)** charge density of an ion and its relation to the thermal stability of the Group 2 carbonates

Smaller ions with the same charge have higher charge density and thus distort the large carbonate ion, so that the compound decomposes at lower temperature.

**(s)** the solubility of compounds formed between the following cations and anions: $Li^+$, $Na^+$, $K^+$, $Ca^{2+}$, $Ba^{2+}$, $Cu^{2+}$, $Fe^{2+}$, $Fe^{3+}$, $Ag^+$, $Pb^{2+}$, $Zn^{2+}$, $Al^{3+}$, $NH_4^+$, $CO_3^{2-}$, $SO_4^{2-}$, $Cl^-$, $Br^-$, $I^-$, $OH^-$ , $NO_3^-$;
colours of any precipitates formed;
use of these ions as tests e.g. $Ba^{2+}$ as a test for $SO_4^{2-}$;
a sequence of tests leading to the identification of a salt containing the ions above

Knowledge of the reaction of 3+ cations with $CO_3^{2-}$ is **not** required.

**PAG4**

- *test-tube or reduced scale experiments involving precipitation reactions of the ions in EL(s) and the sequence of tests leading to identification*

**Equilibria (acid–base)**

**(t)** the terms: *acid*, *base*, *alkali, neutralisation*;
techniques and procedures for making soluble salts by reacting acids and bases and insoluble salts by precipitation reactions

Knowledge of the names and formulae of the mineral acids, $HCl$, $HNO_3$ and $H_2SO_4$ will be expected.

- *making salts (including percentage yield)*

**(u)** the basic nature of the oxides and hydroxides of Group 2 (Mg–Ba)

Description only, including equations, for reactions of Group 2 oxides and hydroxides with water and acids.

## Elements of life (EL)

### Energy and matter

**(v)** the electromagnetic spectrum in order of increasing frequency and energy and decreasing wavelength: infrared, visible, ultraviolet

**(w)** transitions between electronic energy levels in atoms:

- **(i)** the occurrence of absorption and emission atomic spectra in terms of transition of electrons between electronic energy levels
- **(ii)** the features of these spectra, similarities and differences
- **(iii)** the relationship between the energy emitted or absorbed and the frequency of the line produced in the spectra, $\Delta E = h\nu$
- **(iv)** the relationship between frequency, wavelength and the speed of electromagnetic radiation, $c = \nu\lambda$
- **(v)** flame colours of $Li^+$, $Na^+$, $K^+$, $Ca^{2+}$, $Ba^{2+}$, $Cu^{2+}$

Similarities: both are line spectra; lines in same position for a given element; lines become closer at higher frequencies; series of lines representing transitions to or from a particular energy level. Differences: bright/coloured lines on a black background or black lines on coloured/bright background.

- *flame tests for cations*

### Modern analytical techniques

**(x)** use of data from a mass spectrum to determine relative abundance of isotopes and calculate the relative atomic mass of an element.

*M1.2, M3.1*

2

2

## Developing fuels (DF)

The use of fuels in cars provides the main context in this storyline, and is used to initially introduce the basic concept of enthalpy change. Food as 'fuel' for the body is then an alternative context in which to discuss quantitative aspects of enthalpy, including practical techniques and enthalpy cycles.

The storyline returns to the constituents of car fuels to introduce hydrocarbons and bond enthalpy, after which cracking provides the background to how petrol is produced.

Alkenes are then introduced in the context of saturated and unsaturated fats found in foods. This is followed by studying the polymerisation of alkenes in the context of synthetic polymers and their uses.

The storyline returns to car fuels to discuss combustion reactions and amount of substance calculations involving gases, shapes of hydrocarbons and isomerism, and the atmospheric pollutants produced in burning fuels. The storyline ends by considering the contribution of hydrogen and biofuels as potential fuels of the future.

The chemical ideas in this module are:

- thermochemistry
- organic chemistry: names and combustion of alkanes, alkenes, alcohols
- heterogeneous catalysis
- reactions of alkenes
- addition polymers
- electrophilic addition
- gas volume calculations
- shapes of organic molecules, σ- and π-bonds
- structural and *E/Z* isomers
- dealing with polluting gases.

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **Formulae, equations and amount of substance** | | |
| **(a)** | the concept of amount of substance in performing calculations involving: volumes of gases (including the ideal gas equation $pV = nRT$), balanced chemical equations, enthalpy changes; the techniques and procedures used in experiments to measure volumes of gases | *M0.0, M0.1, M0.4, M1.1, M2.2, M2.3, M2.4*<br>The molar gas volume at room temperature and pressure, RTP (24.0 $dm^3\ mol^{-1}$) and the gas constant $R$ (8.314 $J\ mol^{-1}\ K^{-1}$) are given on the *Data Sheet.*<br><br>**PAG1**<br>• *experiments involving reacting masses, moles and volumes of gases* |
| **Bonding and structure** | | |
| **(b)** | the bonding in organic compounds in terms of σ- and π-bonds | *M4.2* |
| **(c)** | the relation of molecular shape to structural formulae and the use of solid and dashed wedges to represent 3-D shape | *M4.2* |

## Developing fuels (DF)

### Energetics

**(d)** the terms: *exothermic*, *endothermic*, *standard conditions*, *(standard) enthalpy change of reaction* ($\Delta_r H$), *(standard) enthalpy change of combustion* ($\Delta_c H$), *(standard) enthalpy change of formation* ($\Delta_f H$), *(standard) enthalpy change of neutralisation* ($\Delta_{neut} H$)

Enthalpy change of neutralisation is per mole of water formed.

**(e)** the term *average bond enthalpy* and the relation of bond enthalpy to the length and strength of a bond;
bond-breaking as an endothermic process and bond-making as exothermic;
the relation of these processes to the overall enthalpy change for a reaction

*M2.4*
Understanding of the meaning of 'average' in this context is required.

**(f)** techniques and procedures for measuring the energy transferred when reactions occur in solution (or solids reacting with solutions) or when flammable liquids burn; the calculation of enthalpy changes from experimental results

*M0.0, M1.1, M2.3, M3.1, M3.2*
Using the formula: $q = mc\Delta T$

**PAG3**
- *experiments to measure the energy transferred when reactions occur in solution or when flammable liquids burn*

**(g)** the determination of enthalpy changes of reaction from enthalpy cycles and enthalpy level diagrams based on Hess' law

*M0.0, M2.4*
Including via enthalpy changes of formation, combustion and bond enthalpies.
A statement of Hess' law is **not** required.

- *experiments leading to Hess cycles*

### Kinetics

**(h)** the terms *catalyst*, *catalysis*, *catalyst poison*, *heterogeneous*

**See also OZ(g)**.

**(i)** a simple model to explain the function of a heterogeneous catalyst

**(j)** the term *cracking;* the use of catalysts in cracking processes; techniques and procedures for cracking a hydrocarbon vapour over a heated catalyst

Specific examples of catalysts are **not** required.

- *cracking a hydrocarbon vapour over a heated catalyst and testing the product*

### Inorganic chemistry and the table

**(k)** the origin of atmospheric pollutants from a variety of sources: particulates, unburnt hydrocarbons, CO, $CO_2$, $NO_x$, $SO_x$;
the environmental implications and methods of reducing these pollutants

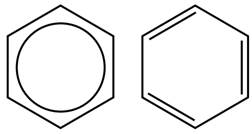
2

## Developing fuels (DF)

### Organic functional groups

**(l)** the terms *aliphatic*, *aromatic*, *arene*, *saturated, unsaturated, functional group* and *homologous series*

Arenes defined here as compounds containing groups represented as either of:



Unsaturated compounds contain C=C or C≡C.

**(m)** the nomenclature, general formulae and structural formulae for alkanes, cycloalkanes, alkenes and alcohols (names up to ten carbon atoms)

### Organic reactions

**(n)** balanced equations for the combustion and incomplete combustion (oxidation) of alkanes, cycloalkanes, alkenes and alcohols

**(o)** the addition reactions of alkenes with the following, showing the greater reactivity of the C=C bond compared with C–C:

- **(i)** bromine to give a dibromo compound, including techniques and procedures for testing compounds for unsaturation using bromine water
- **(ii)** hydrogen bromide to give a bromo compound
- **(iii)** hydrogen in the presence of a catalyst to give an alkane (Ni with heat and pressure or Pt at room temperature and pressure)
- **(iv)** water in the presence of a catalyst to give an alcohol (concentrated $H_2SO_4$, then add water; or steam/$H_3PO_4$/heat and pressure)

**PAG7**

- *testing compounds for unsaturation using bromine water*

### Polymers

**(p)** addition polymerisation and the relationship between the structural formula of the addition polymer formed from given monomer(s), and *vice versa*

## Developing fuels (DF)

**Organic mechanisms**

| | | |
|---|---|---|
| **(q)** | the terms *addition, electrophile, carbocation*;<br>the mechanism of electrophilic addition to alkenes using 'curly arrows';<br>how the products obtained when other anions are present can be used to confirm the model of the mechanism | Either a carbocation or a bromonium ion may be shown for bromination. |

**Isomerism**

| | | |
|---|---|---|
| **(r)** | structural formulae (full, shortened and skeletal) | |
| **(s)** | structural isomerism and structural isomers | *M4.2, M4.3* |
| **(t)** | stereoisomerism in terms of lack of free rotation about C=C bonds when the groups on each carbon differ; description and naming as:<br>**(i)** *E/Z* for compounds that have an H on each carbon of C=C<br>**(ii)** *cis/trans* for compounds in which one of the groups on each carbon of C=C is the same | *M4.3*<br>Knowledge of Cahn–Ingold–Prelog (CIP) priority rules will **not** be required. |

**Sustainability**

| | | |
|---|---|---|
| **(u)** | the benefits and risks associated with using fossil fuels and alternative fuels (biofuels and hydrogen);<br>making decisions about ensuring a sustainable energy supply. | If comparison with other energy sources is needed, suitable information will be given. |

2

2

## Elements from the sea (ES)

The presence of halide salts in the sea provides the entry to the properties of the halogens and reactions between halide ions. The manufacture of bromine and chlorine the provide the context for discussion of redox chemistry, electrolysis and the nomenclature of inorganic compounds.

The use of chlorine in bleach is used to introduce the concept of equilibrium and calculations of the equilibrium constant, as well as iodine–thiosulfate titrations. This leads into a discussion of the risks and benefits of using chlorine.

Finally, atom economy is introduced through the manufacture of hydrogen chloride and other hydrogen halides. The Deacon process for making $HCl$ provides an opportunity to expand on ideas relating to the position of equilibrium.

The chemical ideas in this teaching module are:

- halogen chemistry
- redox chemistry and electrolysis
- equilibrium
- atom economy.

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **Formulae, equations and amount of substance** | | |
| **(a)** | the concept of amount of substance in performing calculations involving atom economy; the relationship between atom economy and the efficient use of atoms in a reaction | *M0.2* |
| **Redox** | | |
| **(b)** | the explanation (given the necessary information) of the chemical processes occurring during the extraction of the halogens from minerals in the sea | Recall of processes **not** required. |
| **(c)** | techniques and procedures in the electrolysis of aqueous solutions; half-equations for the processes occurring at electrodes in electrolysis of molten salts and aqueous solutions:<br>**(i)** formation of oxygen or a halogen or metal ions at the anode<br>**(ii)** formation of hydrogen or a metal at the cathode | *M0.2*<br>Cathode description in aqueous electrolysis: 'Group 1 and 2 and aluminium salts give hydrogen, other metals are plated'.<br>• *electrolysis of aqueous solutions* |

| | | |
|---|---|---|
| **(d)** | redox reactions of s-, p- and d-block elements and their compounds in terms of electron transfer:<br>**(i)** use of half-equations to represent simple oxidation and reduction reactions<br>**(ii)** the definition of oxidation and reduction as loss and gain of electrons<br>**(iii)** identification of oxidising and reducing agents | *M0.2*<br>Recall of specific reactions is only needed if required elsewhere e.g. **ES(j)**.<br>'Simple' means not involving acid–base, **see also ES(f)**.<br>• *test-tube or reduced scale redox reactions* |
| **(e)** | the oxidation states assigned to and calculated for specified atoms in formulae (including ions) and explanation of which species have been oxidised and which reduced in a redox reaction | |
| **(f)** | use of oxidation states to balance redox equations that do not also involve acid–base reactions; techniques and procedures in iodine–thiosulfate titrations | *M0.2*<br>e.g. $3Ca + 2Al^{3+} \rightarrow 3Ca^{2+} + 2Al$<br>but not: $MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$<br>• *iodine–thiosulfate titrations* |
| **(g)** | use of systematic nomenclature to name and interpret the names of inorganic compounds | e.g. copper(I) sulfide, sodium chlorate(I), lead(II) nitrate(V), potassium manganate(VII) but **not** complex ions. |
| | **Inorganic chemistry and the periodic table** | |
| **(h)** | a description of the following physical properties of the halogens: appearance and physical state at room temperature, volatility, solubility in water and organic solvents | Explanation **not** required.<br>**See also OZ(d)**. |
| **(i)** | the relative reactivities of the halogens in terms of their ability to gain electrons | • *test-tube or reduced scale reactions involving the halogens and their compounds [related to **(i)** to **(m)**]* |
| **(j)** | the details of the redox changes which take place when chlorine, bromine and iodine react with other halide ions, including observations, equations and half-equations | |
| **(k)** | the reactions between halide ions ($Cl^-$, $Br^-$ and $I^-$) and silver ions ($Ag^+$) and ionic equations to represent these precipitation reactions, the colours of the precipitates and the solubility of silver halides in ammonia | **PAG4** |
| **(l)** | the preparation of $HCl$; the preparation of HBr and HI by using the halide and phosphoric acid; the action of sulfuric acid on chlorides, bromides and iodides | Details of phosphoric acid (and equations involving it) are **not** required. |

2

## Elements from the sea (ES)

| | | |
|---|---|---|
| **(m)** | the properties of the hydrogen halides:<br>different thermal stabilities, similar reaction with ammonia and acidity, different reactions with sulfuric acid | Sulfuric acid is reduced to $SO_2$ by HBr and $H_2S$ by HI. |
| **(n)** | the risks associated with the storage and transport of chlorine;<br>uses of chlorine which must be weighed against these risks, including: sterilising water by killing bacteria, bleaching | |

**Equilibria**

| | | |
|---|---|---|
| **(o)** | the characteristics of dynamic equilibrium | |
| **(p)** | the equilibrium constant, $K_c$, for a given homogeneous reaction;<br>calculations of the magnitude of $K_c$ and equilibrium concentrations using data provided;<br>relation of position of equilibrium to size of $K_c$, using symbols such as >,<,>>,<< | *M0.1, M2.1*<br>Calculations involving initial concentrations will **not** be required.<br>Units will **not** be required. |
| **(q)** | the use of $K_c$ to explain the effect of changing concentrations on the position of a homogeneous equilibrium;<br>extension of the ideas of 'opposing change' to the effects of temperature and pressure on equilibrium position. | *M0.3*<br>e.g. 'if a concentration term on the top becomes larger, one on the bottom must also become larger to keep $K_c$ constant, so equilibrium position moves to the left'.<br>• *qualitative experiments involving equilibrium reactions* |

## The ozone story (OZ)

An initial study of the composition of the atmosphere provides the opportunity to introduce composition by volume calculations for gases.

Discussion of ozone's role as a 'sunscreen' then leads to ideas of the principal types of electromagnetic radiation and their effects on molecules. This introduces a study of radical reactions, reaction kinetics and catalysis, set in the context of the ways in which ozone is made and destroyed in the atmosphere.

A consideration of CFCs and HFCs then provides the introduction to the chemistry of haloalkanes, including nucleophilic substitution, and intermolecular bonding.

The chemical ideas in this module are:

- composition by volume of gases
- the electromagnetic spectrum and the interaction of radiation with matter
- rates of reaction
- radical reactions
- intermolecular bonding
- haloalkanes
- nucleophilic substitution reactions
- the sustainability of the ozone layer.



| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **Bonding and structure** | | |
| **(a)** | the term *electronegativity*;<br>qualitative electronegativity trends in the periodic table;<br>use of relative electronegativity values to predict bond polarity in a covalent bond;<br>relation of overall polarity of a molecule to its shape and the polarity of its individual bonds | |
| **(b)** | intermolecular bonds: *instantaneous dipole–induced dipole bonds* (including dependence on branching and chain length of organic molecules and $M_r$), *permanent dipole–permanent dipole bonds* | • *experiments to illustrate the formation of intermolecular bonds (including hydrogen bonds)* |
| **(c)** | intermolecular bonds: the formation of *hydrogen bonds* and description of hydrogen bonding, including in water and ice | |
| **(d)** | the relative boiling points of substances in terms of intermolecular bonds | This includes an explanation of the boiling points of the halogens. |
| **Kinetics** | | |
| **(e)** | the term *activation enthalpy*;<br>enthalpy profiles | Activation enthalpy is related to the energy that pairs of molecules must possess to react when they collide. |

## The ozone story (OZ)

**(f)** the effect of concentration and pressure on the rate of a reaction, explained in terms of the collision theory;
use of the concept of activation enthalpy and the Boltzmann distribution to explain the qualitative effect of temperature changes and catalysts on rate of reaction; techniques and procedures for experiments in reaction kinetics including plotting graphs to follow the course of a reaction

*M3.2*

- *experiments on reaction kinetics*

**(g)** the role of catalysts in providing alternative routes of lower activation enthalpy

**See also DF(h)**.

**(h)** the term *homogeneous catalysis* and the formation of intermediates

For example, the catalytic action of chlorine radicals on the breakdown of ozone.

**Inorganic chemistry and the periodic table**

**(i)** calculations, from given data, of values for composition by volume of a component in a gas mixture measured in percentage concentration and in parts per million (ppm)

*M0.0, M0.1*

**Organic functional groups**

**(j)** the recognition of and formulae for examples of members of the following homologous series:

- **(i)** haloalkanes, including systematic nomenclature
- **(ii)** amines

**Organic reactions**

**(k)** the characteristic properties of haloalkanes, comparing fluoro-, chloro-, bromo- and iodo-compounds, considering the following aspects:

- **(i)** boiling points (depend on intermolecular bonds)
- **(ii)** nucleophilic substitution with water and hydroxide ions to form alcohols, and with ammonia to form amines

**Reaction mechanisms**

**(l)** the terms *substitution* and *nucleophile*

**(m)** the use of the $S_N2$ mechanism as a model to explain nucleophilic substitution reactions of haloalkanes using 'curly arrows' and partial charges

Knowledge of the $S_N1$ mechanism or of the $S_N1$ or $S_N2$ nomenclature is **not** required.

## The ozone story (OZ)

**(n)** the possible dependence of the relative reactivities of the haloalkanes on either bond enthalpy or bond polarity and how experimental evidence determines that the bond enthalpy is more important

- *experiments to illustrate the relative reactivity of the haloalkanes*

**(o)** homolytic and heterolytic bond fission

**(p)** the formation, nature and reactivity of radicals and:

- **(i)** explanation of the mechanism of a radical chain reaction involving initiation, propagation and termination
- **(ii)** the radical mechanism for the reaction of alkanes with halogens
- **(iii)** use of 'half curly arrows' in radical mechanisms

- *experiments involving an alkane and bromine*

**(q)** the chemical basis of the depletion of ozone in the stratosphere due to haloalkanes;
the ease of photodissociation of the haloalkanes (fluoroalkanes to iodoalkanes) in terms of bond enthalpy

The formation of halogen atoms and the catalytic role of these atoms (and other radicals) in ozone destruction. Simple equations of the breakdown process are required, e.g.

$CF_2Cl_2 \rightarrow CF_2Cl\bullet + \bullet Cl$

$\bullet Cl + O_3 \rightarrow \bullet ClO + O_2$

$\bullet ClO + O \rightarrow \bullet Cl + O_2$

### Sustainability

**(r)** the formation and destruction of ozone in the stratosphere and troposphere; the effects of ozone in the atmosphere, including:

- **(i)** ozone's action as a sunscreen in the stratosphere by absorbing high-energy UV (and the effects of such UV, including on human skin)
- **(ii)** the polluting effects of ozone in the troposphere, causing problems including photochemical smog

### Energy and matter

**(s)** the principal radiations of the Earth and the Sun in terms of the following regions of the electromagnetic spectrum: infrared, visible, ultraviolet

**(t)** the effect of UV and visible radiation promoting electrons to higher energy levels, sometimes causing bond breaking

**(u)** calculation of values for frequency, wavelength and energy of electromagnetic radiation from given data.

2

## What's in a medicine? (WM)

A consideration of medicines from nature focuses on aspirin. The chemistry of the –OH group is introduced through reactions of salicin and salicylic acid, beginning with alcohols and continuing with phenols.

The discussion of chemical tests for alcohols and phenols leads to the introduction of IR and mass spectrometry as more powerful methods for identifying substances.

The storyline concludes by examining the synthesis of aspirin to illustrate organic preparative techniques, including a look at the principles of green chemistry.

The chemical ideas in this module are:

- the chemistry of the –OH group, phenols and alcohols
- carboxylic acids and esters
- mass spectrometry and IR spectroscopy
- organic synthesis, preparative techniques and thin layer chromatography
- green chemistry.

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **Organic functional groups** | | |
| **(a)** | the formulae of the following homologous series: carboxylic acids, phenols, acid anhydrides, esters, aldehydes, ketones, ethers | Nomenclature of compounds with these functional groups is **not** required for AS. |
| **(b)** | primary, secondary and tertiary alcohols in terms of the differences in structures | |
| **Organic reactions** | | |
| **(c)** | the following properties of phenols:<br>**(i)** acidic nature, and their reaction with alkalis but not carbonates (whereas carboxylic acids react with alkalis and carbonates)<br>**(ii)** test with neutral iron(III) chloride solution, to give a purple colouration<br>**(iii)** reaction with acid anhydrides (but not carboxylic acids) to form esters | **PAG7** |

## What's in a medicine? (WM)

**(d)** the following reactions of alcohols and two-step syntheses involving these reactions and other organic reactions in the AS specification:

- **(i)** with carboxylic acids, in the presence of concentrated sulfuric acid or concentrated hydrochloric acid (or with acid anhydrides) to form esters
- **(ii)** oxidation to carbonyl compounds (aldehydes and ketones) and carboxylic acids with acidified dichromate(VI) solution, including the importance of the condition (reflux or distillation) under which it is done
- **(iii)** dehydration to form alkenes using heated $Al_2O_3$ or refluxing with concentrated $H_2SO_4$
- **(iv)** substitution reactions to make haloalkanes

**PAG7**
- *experiments involving reactions of the –OH group*

**(e)** techniques and procedures for making a solid organic product and for purifying it using filtration under reduced pressure and re-crystallisation (including choice of solvent and how impurities are removed);
techniques and procedures for melting point determination and thin layer chromatography

**PAG6**
- *the synthesis and purification of a solid organic compound e.g. aspirin*
- *melting point determination*
- *the technique of thin layer chromatography (TLC), location of spots and interpretation*

**(f)** techniques and procedures for preparing and purifying a liquid organic product including the use of a separating funnel and of Quickfit or reduced scale apparatus for distillation and heating under reflux

**PAG5**
- *experiments to oxidise alcohols*
- *preparation of an organic compound involving the process of heating under reflux*
- *the principal stages in the purification of an organic liquid product e.g. in the preparation of a chloroalkane*

**(g)** the principles of green chemistry in industrial processes

*M0.2*
Learners should be able to make suggestions based on (but **not** to quote verbatim) the 12 'principles of green chemistry'. Learners will be expected to analyse and use given information.

**See also EL(b), ES(a)**

## What's in a medicine? (WM)

**Reaction mechanisms**

**(h)** the term *elimination reaction*

Example: alkenes from alcohols.

**Modern analytical techniques**

**(i)** interpretation and prediction of mass spectra:

- **(i)** the $M^+$ peak and the molecular mass
- **(ii)** that other peaks are due to positive ions from fragments
- **(iii)** the M+1 peak being caused by the presence of $^{13}C$

*M3.1*
Calculations based on M+1 peak will **not** be required.

**(j)** the effect of specific frequencies of infrared radiation making specific bonds in organic molecules vibrate (more); interpretation and prediction of infrared spectra for organic compounds, in terms of the functional group(s) present.

*M3.1*
IR absorptions will be given on the *Data Sheet*.
For AS, questions will only involve hydroxyl, carbonyl and carboxylic acid groups.

## 2e. Prior knowledge, learning and progression

This specification has been developed for learners who wish to continue with a study of chemistry at Level 3 in the National Qualifications Framework (NQF). The AS level specification has been written to provide progression from GCSE Science, GCSE Additional Science, GCSE Further Additional Science or from GCSE Chemistry. Learners who have successfully taken other Level 2 qualifications in Science or Applied Science with appropriate chemistry content may also have acquired sufficient knowledge and understanding to begin the AS Level Chemistry course.

There is no formal requirement for prior knowledge of chemistry for entry onto this qualification.

Other learners without formal qualifications may have acquired sufficient knowledge of chemistry to enable progression onto the course.

Some learners may wish to follow a chemistry course for only one year as an AS, in order to broaden their curriculum, and to develop their interest and understanding of different areas of the subject. Others may follow a co-teachable route, completing the one-year AS course and/or then moving to the two-year A level. For learners wishing to follow an apprenticeship route or those seeking direct entry into chemical science careers, this AS level provides a strong background and progression pathway.

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

# 3 Assessment of OCR AS Level in Chemistry B (Salters)

3

## 3a. Forms of assessment

Both externally assessed components (01 and 02) contain some synoptic assessment. Component 02 contains some extended response questions.

### Foundations of chemistry (Component 01)

This component is split into two sections and assesses content from all teaching modules. Learners answer all questions. This component is worth 70 marks.

**Section A** contains multiple choice questions. This section of the paper is worth 20 marks.

**Section B** includes short answer question styles (structured questions, problem solving, calculations, practical) and extended response questions. This section of the paper is worth 50 marks.

### Chemistry in depth (Component 02)

This component assesses content from across all teaching modules. Learners answer all questions. This component is worth 70 marks.

Question styles include short answer (structured questions, problem solving, calculations, practical) and extended response questions, including those marked using Level of Response mark schemes.

## 3b. Assessment objectives (AO)

There are three assessment objectives in OCR's AS Level in Chemistry B (Salters). These are detailed in the table below.

Learners are expected to demonstrate their ability to:

| | **Assessment Objective** |
|---|---|
| **AO1** | Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures. |
| **AO2** | Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data. |
| **AO3** | Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. |

### AO weightings in AS Level in Chemistry B (Salters)

The relationship between the assessment objectives and the components are shown in the following table:

| Component | % of AS Level in Chemistry B (Salters) (H033) | | |
|---|---|---|---|
| | AO1 | AO2 | AO3 |
| Foundations of chemistry (H033/01) | 22–24 | 19–21 | 6–8 |
| Chemistry in depth (H033/02) | 13–16 | 21–23 | 14–15 |
| **Total** | **35–40** | **40–44** | **20–23** |

3

## 3c. Total qualification time

Total qualification time (TQT) is the total amount of time, in hours, expected to be spent by a learner to achieve a qualification. It includes both guided learning hours and hours spent in preparation, study, and assessment. The total qualification time for AS Level in Chemistry B (Salters) is 180 hours. The total guided learning time is 180 hours.

## 3d. Qualification availability outside of England

This qualification is available in England. For Wales and Northern Ireland please check the Qualifications in Wales Portal (QIW) or the Northern Ireland Department of Education Performance Measures / Northern Ireland Entitlement Framework Qualifications Accreditation Number (NIEFQAN) list to see current availability.

## 3e. Language

This qualification is available in English only. All assessment materials are available in English only and all candidate work must be in English.

## 3f. Assessment availability

There will be one examination series available each year in May/June to **all** learners. All examined components must be taken in the same examination series at the end of the course.

This specification will be certificated from the June 2016 examination series onwards.

## 3g. Retaking the qualification

Learners can retake the qualification as many times as they wish. They retake all components of the qualification.

## 3h. Assessment of extended responses

The assessment materials for this qualification provide learners with the opportunity to demonstrate their ability to construct and develop a sustained and coherent line of reasoning which is coherent, relevant, substantiated and logically structured. The marks for extended responses are integrated into the marking criteria.

Extended response questions are included in both externally assessed components. This includes two questions in Component 02, which will be assessed using questions marked by Level of Response, in which the quality of the extended response is explicitly rewarded. These questions will be clearly identified in the assessment papers.

## 3i. 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 AS level course. The emphasis of synoptic assessment is to encourage the development of the understanding of the subject as a discipline. Both components within Chemistry B (Salters) 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 of 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.

## 3j. Calculating qualification results

A learner's overall qualification grade for AS Level in Chemistry B (Salters) will be calculated by adding together their marks from the two components taken to give their total weighted mark.

This mark will then be compared to the qualification level grade boundaries 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 the processes and deadlines involved at each stage of the assessment cycle can be found in the Administration area of the OCR website.

OCR's Admin overview is available on the OCR website at http://www.ocr.org.uk/administration.

## 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.

### 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 AS Level in Chemistry B (Salters) must be entered using the entry code H033.

| Entry option | | Components | | |
|---|---|---|---|---|
| **Entry code** | **Title** | **Code** | **Title** | **Assessment type** |
| H033 | Chemistry B (Salters) | 01 | Foundations of chemistry | External assessment |
| | | 02 | Chemistry in depth | External assessment |

### Private candidates

Private candidates may enter for OCR assessments.

A private candidate is someone who pursues a course of study independently but takes an examination or assessment at an approved examination centre. A private candidate may be a part-time student, someone taking a distance learning course, or someone being tutored privately. They must be based in the UK.

Private candidates need to contact OCR approved centres to establish whether they are prepared to host them as a private candidate. The centre may charge for this facility and OCR recommends that the arrangement is made early in the course.

Further guidance for private candidates may be found on the OCR website: http://www.ocr.org.uk

### 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 all learners at the centre have had the opportunity to undertake the prescribed practical activities.

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.

#### Collecting evidence of student performance to ensure resilience in the qualifications system

Regulators have published guidance on collecting evidence of student performance as part of long-term contingency arrangements to improve the resilience of the qualifications system. You should review and consider this guidance when delivering this qualification to students at your centre.

For more detailed information on collecting evidence of student performance please visit our website at: [https://www.ocr.org.uk/administration/general-qualifications/assessment/](https://www.ocr.org.uk/administration/general-qualifications/assessment/)

## 4b. Accessibility and special consideration

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.*

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 *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 both components. Calculators are subject to the rules in the document *Instructions for Conducting Examinations* published annually by JCQ ([www.jcq.org.uk](http://www.jcq.org.uk)).

## 4d. Results and certificates

### Grade scale

Advanced Subsidiary qualifications are graded on the scale: A, B, C, D, E, where A is the highest. Learners who fail to reach the minimum standard for E will be Unclassified (U). Only subjects in which grades A to E 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 the qualification.

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 3 Advanced Subsidiary GCE in Chemistry B (Salters)'.

## 4e. Post-results services

A number of post-results services are available:

- **Review of results** – If you are not happy with the outcome of a learner's results, centres may request a review of marking.
- **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 coursework 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 *Suspected Malpractice in Examinations and Assessments: Policies and Procedures* published by JCQ.

# 5 Appendices

## 5a. Overlap with other qualifications

There is a small degree of overlap between the content of this specification and those for other AS level/A level Sciences.

Examples of overlap include:

**Biology**

- The ozone story: Climate change.
- What's in a medicine: Chromatography.

**Geology**

- The ozone story: Climate change, the atmosphere.

**Physics**

- Elements of life: Atomic structure, Atomic emission spectra.

**Science**

- Elements of life: Atomic structure.
- Developing fuels: Enthalpy changes, catalysis, the development of renewable alternatives to finite energy resources.
- The ozone story: Climate change, the atmosphere, rates of reaction, catalysis.
- What's in a medicine: Infrared spectroscopy, chromatography.

5

## 5b. Avoidance of bias

The AS level 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. Chemistry B (Salters) data sheet

# Data Sheet for Chemistry B (Salters)

## GCE Advanced Subsidiary and Advanced Level

## Chemistry B (Salters) (H033 / H433)

The information in this sheet is for the use of candidates following Chemistry B (Salters) (H033 / H433).

**General Information**

Molar gas volume = 24.0 $dm^3\ mol^{-1}$ at RTP

Avogadro constant, $N_A = 6.02 \times 10^{23}\ mol^{-1}$

Specific heat capacity of water, $c = 4.18\ J\ g^{-1}\ K^{-1}$

Planck constant, $h = 6.63 \times 10^{-34}\ J\ Hz^{-1}$

Speed of light in a vacuum, $c = 3.00 \times 10^8\ m\ s^{-1}$

Ionic product of water, $K_w = 1.00 \times 10^{-14}\ mol^2\ dm^{-6}$ at 298 K

1 tonne = $10^6$ g

Arrhenius equation: $k = Ae^{-Ea/RT}$ or $\ln k = -E_a/RT + \ln A$

Gas constant, $R = 8.314\ J\ mol^{-1}\ K^{-1}$

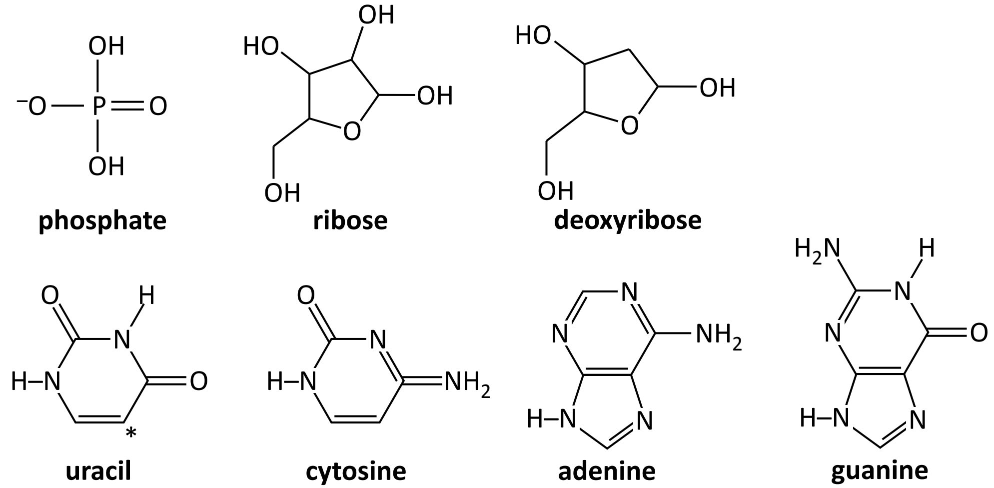
| **Triplet base codes (codons) for some amino acids used in mRNA** | |
|---|---|
| Glycine | GGU |
| Alanine | GCC |
| Leucine | CUG |
| Serine | UCG |
| Aspartic acid | GAU |
| Glutamine | CAA |
| Valine | GUC |

5

### Characteristic infrared absorptions in organic molecules

| Bond | Location | Wavenumber / $cm^{-1}$ |
|---|---|---|
| C–H | Alkanes<br>Alkenes, arenes | 2850–2950<br>3000–3100 |
| C–C | Alkanes | 750–1100 |
| C=C | Alkenes | 1620–1680 |
| aromatic C=C | Arenes | Several peaks in range 1450–1650 (variable) |
| C=O | Aldehydes<br>Ketones<br>Carboxylic acids<br>Esters<br>Amides<br>Acyl chlorides and acid anhydrides | 1720–1740<br>1705–1725<br>1700–1725<br>1735–1750<br>1630–1700<br>1750–1820 |
| C–O | Alcohols, ethers, esters and carboxylic acids | 1000–1300 |
| C≡N | Nitriles | 2220–2260 |
| C–X | Fluoroalkanes<br>Chloroalkanes<br>Bromoalkanes | 1000–1350<br>600–800<br>500–600 |
| O–H | Alcohols. phenols<br>Carboxylic acids | 3200–3600 (broad)<br>2500–3300 (broad) |
| N–H | Primary amines<br>Amides | 3300–3500<br>*ca*. 3500 |

### Monomers of DNA and RNA



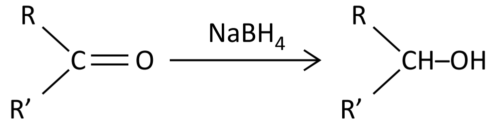

(thymine has a $CH_3$ at position *)

### Some useful organic reactions

**1** $R{-}Br + CN^{-} \longrightarrow R{-}CN + Br^{-}$

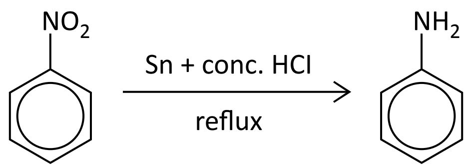
**2** $R{-}CN \xrightarrow[\text{reflux}]{H^{+}(aq)} R{-}COOH$

**3**

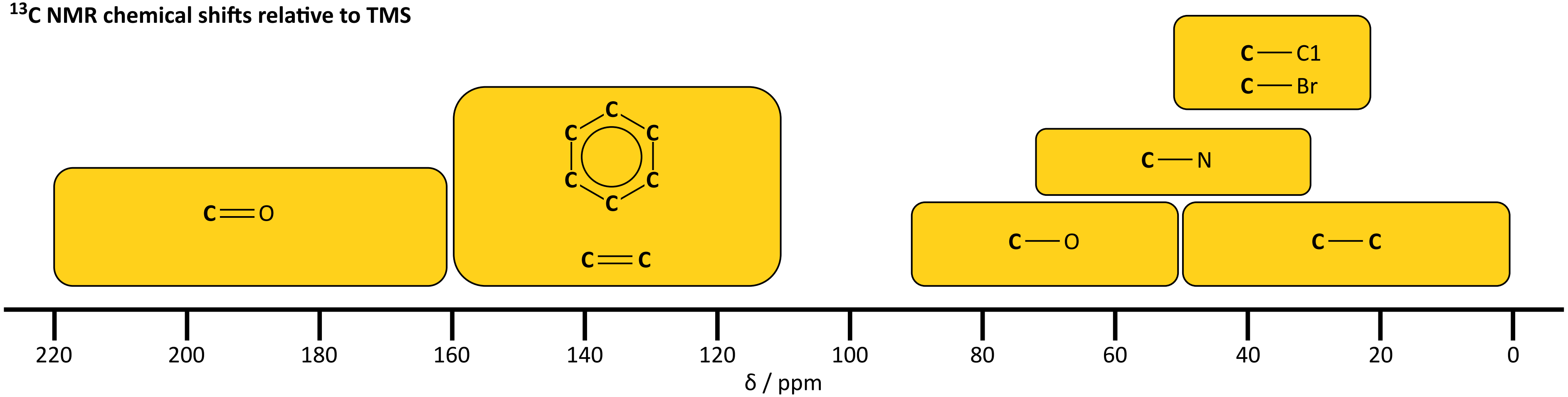



**4** $R{-}COOH + SOCl_2 \longrightarrow R{-}COCl + SO_2 + HCl$

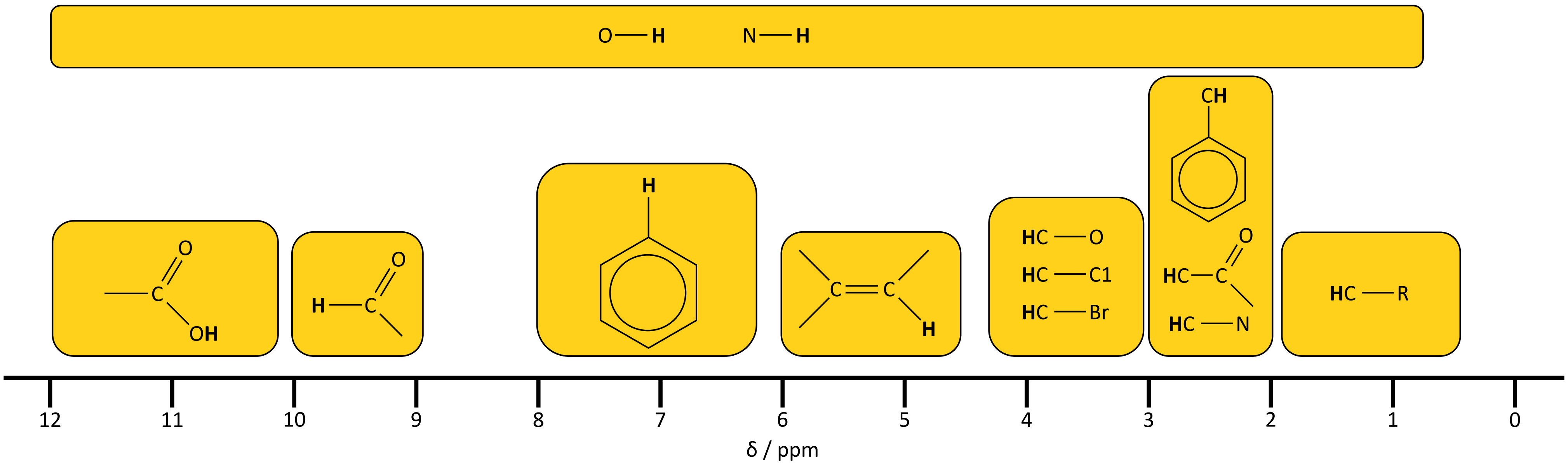
**5**



**$^{13}$C NMR chemical shifts relative to TMS**




**$^{1}$H NMR chemical shifts relative to TMS**




Chemical shifts are variable and can vary depending on the solvent, concentration and substituents. As a result, shifts may be outside the ranges indicated above.
O**H** and N**H** chemical shifts are very variable and are often broad. Signals are not usually seen as split peaks.
Note that C**H** bonded to 'shifting groups' on either side, e.g. O–C**H**$_2$–C=O, may be shifted more than indicated above.

# The Periodic Table of the 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 | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 **La** lanthanum 138.9 | 58 **Ce** cerium 140.1 | 59 **Pr** praseodymium 140.9 | 60 **Nd** neodymium 144.2 | 61 **Pm** promethium 144.9 | 62 **Sm** samarium 150.4 | 63 **Eu** europium 152.0 | 64 **Gd** gadolinium 157.2 | 65 **Tb** terbium 158.9 | 66 **Dy** dysprosium 162.5 | 67 **Ho** holmium 164.9 | 68 **Er** erbium 167.3 | 69 **Tm** thulium 168.9 | 70 **Yb** ytterbium 173.0 | 71 **Lu** lutetium 175.0 |
| 89 **Ac** actinium | 90 **Th** thorium 232.0 | 91 **Pa** protactinium | 92 **U** uranium 238.1 | 93 **Np** neptunium | 94 **Pu** plutonium | 95 **Am** americium | 96 **Cm** curium | 97 **Bk** berkelium | 98 **Cf** californium | 99 **Es** einsteinium | 100 **Fm** fermium | 101 **Md** mendelevium | 102 **No** nobelium | 103 **Lr** lawrencium |

## 5d. How Science Works (HSW)

*How Science Works* was conceived as being a wider view of science in context, rather than just straightforward scientific enquiry. It was intended to develop learners as critical and creative thinkers, able to solve problems in a variety of contexts.

Developing ideas and theories to explain the operation of matter and how its composition, structure, properties and changes it undergoes, constitutes the basis of life and all nature. *How Science Works* develops the critical analysis and linking of evidence to support or refute ideas and theories. Learners should be aware of the importance that peer review and repeatability have in giving confidence to this evidence.

Learners are expected to understand the variety of sources of data available for critical analysis to provide evidence and the uncertainty involved in its measurement. They should also be able to link that evidence to contexts influenced by culture, politics and ethics.

Understanding *How Science Works* requires an understanding of how scientific evidence can influence ideas and decisions for individuals and society, which is linked to the necessary skills of communication for audience and for purpose with appropriate scientific terminology.

The skills, knowledge and understanding of *How Science Works* (Section 8 of the DfE criteria for science), summarised in the left-hand column below, will underpin the teaching and assessment contexts of the course. The examples given below and within the specification are not exhaustive but give a flavour of opportunities for integrating HSW within the course.

5

| HSW Statement | Examples of coverage in AS |
|---|---|
| **HSW1**<br>Use theories, models and ideas to develop scientific explanations. | Developing models to explain atomic structure (**EL**).<br>How elements are formed (**EL**).<br>Using a simple model to explain the function of a catalyst (**DF**).<br>Using collision theory to explain rates (**OZ**).<br>$S_N2$ reactions as a model (**OZ**).<br>Using models to explain depletion of ozone (**OZ**). |
| **HSW2**<br>Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas. | Using *'dot-and-cross'* diagrams to explain shapes of molecules (**EL**).<br>Explaining atomic spectra in terms of electron transitions (**EL**).<br>Calculation of enthalpy changes from experimental techniques (**DF**). |
| **HSW3**<br>Use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems. | Using oxidation states to balance simple redox equations (**ES**).<br>Using ideas of 'opposing change' to predict the effect of changing conditions on equilibrium position (**ES**). |

| HSW Statement | Examples of coverage in AS |
|---|---|
| **HSW4**<br>Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts. | Techniques and procedures for making soluble and insoluble salts (**EL**).<br>Use of tests to identify salts (**EL**).<br>Techniques and procedures in iodine and thiosulfate titrations (**ES**).<br>Techniques and procedures in the electrolysis of aqueous solutions (**ES**).<br>Techniques and procedures for making and purifying a solid organic product (**WM**). |
| **HSW5**<br>Analyse and interpret data to provide evidence, recognising correlations and causal relationships. | Using a graph of first ionisation enthalpy against atomic number to deduce electronic configurations (**EL**).<br>Using experimental observations to explain the reactions between sodium halides and concentrated sulfuric acid (**ES**).<br>Use of data from Mass Spectroscopy to determine relative abundance (**EL**). |
| **HSW6**<br>Evaluate methodology, evidence and data, and resolve conflicting evidence. | Evaluating evidence from the Geiger–Marsden experiment to develop a model for the structure of the atom (**EL**).<br>Evaluating experimental evidence to decide whether the rate of hydrolysis of haloalkanes depends on bond enthalpy or bond polarity (**OZ**). |
| **HSW7**<br>Know that scientific knowledge and understanding develop over time. | Developing models of atomic structure (**EL**). |
| **HSW8**<br>Communicate information and ideas in appropriate ways using appropriate terminology. | Drawing '*dot and cross*' diagrams for simple molecules (**EL**).<br>Explaining the effect of chlorine atoms on the ozone layer (**OZ**). |
| **HSW9**<br>Consider applications and implications of science and evaluate their associated benefits and risks. | Considering the benefits and risks of using fossil fuels and alternative fuels (**DF**).<br>Considering the risks associated with the transport and use of chlorine (**ES**). |
| **HSW10**<br>Consider ethical issues in the treatment of humans, other organisms and the environment. | Considering the environmental implications of atmospheric pollutants (**DF**).<br>Extraction of minerals from the sea (**DF**).<br>Polluting effects of ozone in the troposphere (**OZ**).<br>Considering the use of chlorine in sterilising water (**ES**).<br>The principles of green chemistry (**WM**). |

| HSW Statement | Examples of coverage in AS |
|---|---|
| **HSW11**<br>Evaluate the role of the scientific community in validating new knowledge and ensuring integrity. | Considering the depletion of ozone in the stratosphere due to haloalkanes (**OZ**). |
| **HSW12**<br>Evaluate the ways in which society uses science to inform decision making. | Evaluating the effect of ozone in the stratosphere (**OZ**). |

5

## 5e. Mathematical requirements

In order to be able to develop their skills, knowledge and understanding in AS Level Chemistry, 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 assessment of quantitative skills will include at least 20% Level 2 (or above) mathematical skills 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 Level 2 examples. These skills could be developed in other areas of specification content from those indicated. For the mathematical requirements for A Level in Chemistry B (Salters) see the A level specification.

Additional guidance on the assessment of mathematics within chemistry is available on the OCR website.

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Chemistry (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| **M0 – Arithmetic and numerical computation** | | | |
| M0.0 | Recognise and make use of appropriate units in calculation | Learners may be tested on their ability to:<br>• convert between units e.g. $cm^3$ to $dm^3$ as part of volumetric calculations<br>• understand that different units are used in similar topic areas, so that conversions may be necessary e.g. J and kJ. | 1.1.2(b)<br>EL(a,b,c), DF(a,f) |
| M0.1 | Recognise and use expressions in decimal and ordinary form | Learners may be tested on their ability to:<br>• use an appropriate number of decimal places in calculations<br>• carry out calculations using numbers in standard and ordinary form, e.g. use of Avogadro's constant<br>• convert between numbers in standard and ordinary form<br>• understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. 0.0050 mol $dm^{-3}$ is equivalent to $5.0 \times 10^{-3}$ mol $dm^{-3}$. | EL(b), ES(p) |
| M0.2 | Use ratios, fractions and percentages | Learners may be tested on their ability to:<br>• calculate percentage yields<br>• calculate the atom economy of a reaction<br>• construct and/or balance equations using ratios. | EL(b,c,d), ES(a), WM(g) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Chemistry (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| M0.3 | Estimate results | Learners may be tested on their ability to:<br>• use $K_c$ to estimate the position of equilibrium. | ES(q) |
| M0.4 | Use calculators to find and use power functions | Learners may be tested on their ability to:<br>• carry out calculations using the Avogadro constant. | EL(a) |
| **M1 – Handling data** | | | |
| M1.1 | Use an appropriate number of significant figures | Learners may be tested on their ability to:<br>• report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures<br>• understand that calculated results can only be reported to the limits of the least accurate measurement. | 1.1.3(c)<br>EL(b,c), DF(a,f) |
| M1.2 | Find arithmetic means | Learners may be tested on their ability to:<br>• calculate weighted means, e.g. calculation of an atomic mass based on supplied isotopic abundances<br>• select appropriate titration data (i.e. identification of outliers) in order to calculate mean titres. | EL(c,x) |
| M1.3 | Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined | Learners may be tested on their ability to:<br>• determine uncertainty when two burette readings are used to calculate a titre value. | 1.1.4(d), EL(c) |
| **M2 – Algebra** | | | |
| M2.1 | Understand and use the symbols: =, <, <<, >>, >, ∝, ~, ⇌ | No exemplification required. | |
| M2.2 | Change the subject of an equation | Learners may be tested on their ability to:<br>• carry out structured and unstructured mole calculations. | EL(b,c), DF(a) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Chemistry (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| M2.3 | Substitute numerical values into algebraic equations using appropriate units for physical quantities | Learners may be tested on their ability to:<br>• carry out enthalpy change calculations<br>• calculate the value of an equilibrium constant, $K_c$. | EL(b,c), DF(f) |
| M2.4 | Solve algebraic equations | Learners may be tested on their ability to:<br>• carry out Hess' law calculations. | EL(b,c), DF(g) |
| **M3 – Graphs** | | | |
| M3.1 | Translate information between graphical, numerical and algebraic forms | Learners may be tested on their ability to:<br>• interpret and analyse spectra. | EL(x), WM(i,j) |
| M3.2 | Plot two variables from experimental or other data | Learners may be tested on their ability to:<br>• plot graphs from collected or supplied data to follow the course of a reaction<br>• draw lines of best fit<br>• extrapolate and interpolate. | 1.1.3(d), DF(f), OZ(f) |
| **M4 – Geometry and trigonometry** | | | |
| M4.1 | Use angles and shapes in regular 2-D and 3-D structures | Learners may be tested on their ability to:<br>• predict/identify shapes of and bond angles in molecules with and without a lone pair(s), for example $NH_3$, $CH_4$, $H_2O$ etc. | EL(k) |
| M4.2 | Visualise and represent 2-D and 3-D forms including 2-D representations of 3-D objects | Learners may be tested on their ability to:<br>• draw different forms of isomers. | DF(c,s) |
| M4.3 | Understand the symmetry of 2-D and 3-D shapes | Learners may be tested on their ability to:<br>• describe the types of stereoisomerism shown by molecules/complexes. | DF(s,t) |

## Definition of Level 2 mathematics

Within AS Level Chemistry, 20% of the marks available within written examinations will be for assessment of mathematics (in the context of chemistry) at a Level 2 standard, or higher. Lower level mathematical skills will still be assessed within examination papers but will not count within the 20% weighting for chemistry.

The following will be counted as Level 2 (or higher) mathematics:

- application and understanding requiring choice of data or equation to be used
- problem solving involving use of mathematics from different areas of maths and decisions about direction to proceed
- questions involving use of A level mathematical content (as of 2012), e.g. use of logarithmic equations.

The following will not be counted as Level 2 mathematics:

- simple substitution with little choice of equation or data
- structured question formats using GCSE mathematics (based on 2012 GCSE mathematics content).

Additional guidance on the assessment of mathematics within chemistry is available on the OCR website as a separate resource, the Maths Skills Handbook.

## 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 **http://www.ase.org.uk/resources/health-and-safety-resources/risk-assessments/**

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 candidates 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] 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**.

## Summary of updates

| Date | Version | Section | Title of Section | Change |
|---|---|---|---|---|
| May 2018 | 1.1 | Front cover<br><br>Multiple | Disclaimer | Addition of Disclaimer<br><br>Minor typographical errors |
| January 2019 | 1.2 | 2d | Storylines | Guidance on the new definition of moles<br>**Formulae, equations and amount of substance (b)(i)** |
| October 2019 | 1.3 | 2d | Storylines | Additional guidance for OZ (q) |
| May 2020 | 1.4 | 1d<br><br>4d | How do I find out more information?<br><br>Post-results services | Insertion of Online Support Centre link<br><br>Enquiries about results changed to Review of results |
| | | | | Update to specification covers to meet digital accessibility standards |
| April 2023 | 1.5 | 3c | Total qualification time | Update to include total qualification time and guided learning hours to comply with QiW regulations |
| February 2024 | 1.6 | 3d, 3e<br><br>4a<br><br>Checklist | Qualification availability, Language<br><br>Pre-assessment | Inclusion of disclaimer regarding availability and language<br><br>Update to include resilience guidance<br><br>Inclusion of Teach Cambridge |

# YOUR CHECKLIST

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

- ☐ Bookmark OCR website for all the latest information and news on AS and A Level Chemistry B (Salters)
- ☐ Sign up for Teach Cambridge: our personalised and secure website that provides teachers with access to all planning, teaching and assessment support materials
- ☐ Be among the first to hear about support materials and resources as they become available – register for Chemistry updates
- ☐ Find out about our professional development
- ☐ View our range of skills guides for use across subjects and qualifications
- ☐ Discover our new online past paper service
- ☐ Learn more about Active Results
- ☐ Visit our Online Support Centre

# Download high-quality, exciting and innovative AS and A Level Chemistry resources from ocr.org.uk/alevelchemistryb

Free resources and support for our AS Level Chemistry qualification, developed through collaboration between our Chemistry Subject Advisors, teachers and other subject experts, are available from our website. You can also contact our Chemistry Subject Advisors for specialist advice, guidance and support, giving you individual service and assistance whenever you need it.


**Contact the team at:**

**01223 553998**

**scienceGCE@ocr.org.uk**

**@OCR_science**


To stay up to date with all the relevant news about our qualifications, register for email updates at **ocr.org.uk/updates**

Visit our Online Support Centre at **support.ocr.org.uk**

follow us on

facebook.com/ocrexams

linkedin.com/company/ocr

@OCRexams

youtube.com/ocrexams

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT