# PLANNING SUPPORT BOOKLET

**J248, J250**

**For first teaching in 2016**

This support material booklet is designed to accompany the OCR GCSE (9–1) in Chemistry A and Combined Science A (Gateway Science).

***DISCLAIMER***

This resource was designed using the most up to date information from the specification at the time it was published. Specifications are updated over time, which means there may be contradictions between the resource and the specification, therefore please use the information on the latest specification at all times.If you do notice a discrepancy please contact us on the following email address: [resources.feedback@ocr.org.uk](mailto:resources.feedback@ocr.org.uk)

# Introduction

This support material is designed to accompany the new OCR GCSE (9-1) specification for first teaching from September 2016 for:

* [Chemistry A (Gateway Science – J248)](http://www.ocr.org.uk/Images/234598-specification-accredited-gcse-gateway-science-suite-chemistry-a-j248.pdf)
* [Combined Science A (Gateway Science – J250)](https://www.ocr.org.uk/Images/234596-specification-accredited-gcse-gateway-science-suite-combined-science-a-j250.pdf)

We recognise that the number of hours available in timetable can vary considerably from school to school, and year to year. As such, these ***suggested*** teaching hours have been developed on the basis of the experience of the Science Subject Specialist team in delivering GCSE sciences in school. The hours are what we consider ideal for providing the best opportunity for high quality teaching and engagement of the learners in all aspects of learning science.

While Combined Science is a double award GCSE formed from the three separate science GCSEs, the DfE required subject content is greater than a strict two-thirds of the separate science qualifications, hence the suggested hours here are greater than a strict two-thirds of the separate science hours.

The ***suggested*** hours take into account all aspects of teaching, including pre- and post-assessment. As a linear course, we would recommend on-going revision of key concepts throughout the course to support learner’s learning. This can help to minimise the amount of re-teaching necessary at the end of the course, and allow for focused preparation for exams on higher level skills (e.g. making conceptual links between the topics) and exam technique.

Actual teaching hours will also depend on the amount of practical work done within each topic and the emphasis placed on development of practical skills in various areas, as well as use of contexts, case studies and other work to support depth of understanding and application of knowledge and understanding. It will also depend on the level of prior knowledge and understanding that learners bring to the course.

The table follows the order of the topics in the specification. It is not implied that centres teach the specification topics in the order shown. Centres are free to teach the specification in the order that suits them.

Should you wish to speak to a member of the Science Subject Team regarding teaching hours and scheme of work planning, we are available at [scienceGCSE@ocr.org.uk](mailto:scienceGCSE@ocr.org.uk) or 01223 553998.

## Delivery guides

Delivery guides are individual teacher guides available from the qualification pages:

* <http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/>
* <http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-combined-science-a-j250-from-2016/>

These Delivery guides provide further guidance and suggestions for teaching of individual topics, including links to a range of activities that may be used and guidance on resolving common misconceptions.

## Practical work

Specification Topic C7 (Practical skills) is not included explicitly in the Planning Guidance table. The expectation is that the practical skills are developed throughout the course and in support of conceptual understanding.

Suggestions where the PAG activities can be included are given in the table below. This is by no means an exhaustive list of potential practical activities that can be used in teaching and learning of Chemistry.

Suggested activities are available under “Teaching and Learning Resources / Practical Activities” on the qualification page: <http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/#resources>.

An optional activity tracker is available at <http://www.ocr.org.uk/Images/323481-gcse-chemistry-practical-tracker.zip>.

An optional learner record sheet is available at <https://www.ocr.org.uk/Images/295630-gcse-chemistry-student-record-sheet.doc>.

A sample set of activities that gives learners the opportunity to cover all apparatus and techniques is available at <https://www.ocr.org.uk/news/example-set-of-chemistry-practicals/>.

| Topics | Suggested teaching hoursSeparate / Combined | Comments and PAG opportunities |
| --- | --- | --- |
| **Topic C1: Particles** | | |
| C1.1 The particle model | 4 / 4 |  |
| C1.2 Atomic structure |  |
|  | **Total 4 / 4** |  |
| **Topic C2: Elements, compounds and mixtures** | | |
| C2.1 – Purity and separating mixtures | 10 / 10 | PAG C3: Using chromatography to identify mixtures of dyes in an unknown ink.  PAG C3: Thin layer chromatography.  PAG C4: Distillation of mixtures.  PAG C4, C7: Separation of mixtures and purification of compounds. |
| C2.2 – Bonding | 8 / 8 |  |
| C2.3 – Properties of materials | 10 / 6 | PAG C8: Dissolving tablets. |
|  | **Total 28 / 24** |  |
| **Topic C3: Chemical reactions** | | |
| C3.1 – Introducing chemical reactions | 11 / 11 |  |
| C3.2 – Energetics | 6 / 6 | PAG C8: Measuring the temperature change in reactions. |
| C3.3 – Types of chemical reactions | 10 / 10 | PAG C6: Neutralisation reactions.  PAG C6: Determining pH of unknown solutions.  PAG C6: Use of pH probes.  PAG C7: Production of pure dry sample of salt. |
| C3.4 – Electrolysis | 4 / 4 | PAG C2: Electrolysis of sodium chloride solution.  PAG C2: Electrolysis of copper sulfate solution. |
|  | **Total 31 / 31** |  |
| **Topic C4: Predicting and identifying reactions and products** | | |
| C4.1 – Predicting chemical reactions | 8 / 6 | PAG C1: Displacement reactions of halogens with halides.  PAG C1, C5, C8: Investigation of transition metals.  PAG C1, C7, C8: Reaction of metals with water, dilute hydrochloric acid.  PAG C1, C7, C8: Displacement reactions involving metals and metal salts. |
| C4.2 – Identifying the products of chemical reactions | 8 / 1 | PAG C5: Flame tests.  PAG C5: Testing unknown solutions for cations and anions.  PAG C5: Tests for anions using silver nitrate and barium sulfate.  PAG C5: Tests for cations using sodium hydroxide. |
|  | **Total 16 / 7** |  |

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| --- | --- | --- | --- | --- |
| **Topics** | | Suggested teaching hours Separate / Combined | | **Comments and PAG opportunities** |
| **Topic C5: Monitoring and controlling chemical reactions** | | | | |
| C5.1 – Monitoring chemical reactions | 12 / 1 | | PAG C6: Acid/alkali titrations.  PAG C8: Measurement of gas volumes and calculating amount in moles. | |
| C5.2 – Controlling reactions | 10 / 10 | | PAG C1, C7, C8: Marble chip and acid or magnesium and acid experiments either measuring reaction time or the volume of gas over time.  PAG C1, C8: Catalysis of hydrogen peroxide with various black powders including MnO2.  PAG C1, C8: Catalysis of reaction of zinc with sulfuric acid using copper powder.  PAG C1, C8: Magnesium and acid, marble chip and acid.  PAG C1, C8: Rate of reaction experiments.  PAG C1, C8: Reaction of magnesium and acid with different temperatures of acid – measure reaction times.  PAG C1, C8: Varying surface area with marble chips and hydrochloric acid.  PAG C8: Disappearing cross experiment. | |
| C5.3 – Equilibria | 3 / 3 | |  | |
|  | **Total 25 / 14** | |  | |
| **Topic C6: Global challenges** | | | | |
| C6.1 – Improving processes and products | 16 / 7 | | PAG C1: Extraction of copper by heating copper oxide with carbon.  PAG C2: Electrolysis of aqueous copper sulfate solution.  PAG C2: Electrolysis of aqueous sodium chloride solution.  PAG C6: Preparation of potassium sulfate or ammonium sulfate using a titration method. | |
| C6.2 – Organic chemistry | 12 / 4 | |  | |
| C6.3 – Interpreting and interacting with earth systems | 8 / 7 | |  | |
|  | **Total 36 / 18** | |  | |
| **GRAND TOTAL SUGGESTED HOURS – 140 / 98 hours** | | | | |

þ This symbol indicates content that is found only in the chemistry separate science qualification.

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

# Outline Scheme of Work: C1 – Particles

## Total suggested teaching time – 4 hours (separate and combined)

### C1.1 – The particle model and C1.2 – Atomic structure (4 hours – separate and combined)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * a simple (Dalton) atomic model * changes of state in terms of the particle model. * differences between atoms, elements and compounds * the properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure | Links to Practical Activity Groups (PAGs) |
| Links to Mathematical Skills  * M1c * M4a * M5b * M5b | Links to Working Scientifically  * WS1.1a * WS1.1b * WS1.1c * WS1.1i * WS1.2b * WS1.3c * WS1.4a * WS1.4b * WS1.4c * WS1.4d * WS1.4e * WS1.4f |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C1  Part 1  2 hours  (separate and combined) | CM1.1i – represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures  C1.1a – describe the main features of the particle model in terms of states of matter and change of state  C1.1b – explain in terms of the particle model the distinction between physical changes and chemical changes  **C1.1c** – **explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres (e.g. like bowling balls) [that it does not take into account the forces of attraction between particles, the size of particles and the space between them]** | C1 is a short topic, reviewing learners understanding of the particle model from KS3 and building on this to increasingly detailed atomic models.  A circus of KS3 activities related to change of state/chemical change would support this transition.  The Particles Delivery Guide provides a large number of activities.  <http://www.ocr.org.uk/Images/283349-particles-delivery-guide.pdf>  <https://www.ocr.org.uk/Images/220999-particles-atoms-and-elements-learner-activity.docx> <https://www.ocr.org.uk/Images/305608-elements-compounds-and-mixtures-checkpoint-task.doc> <http://www.ocr.org.uk/Images/220971-particles-atoms-and-elements-checkpoint-instructions.pdf> | A simple particle model can be used to represent the arrangement of particles in the different states of matter and to explain observations during changes in state. It does not, however, explain why different materials have different properties. This explanation is that the particles themselves and how they are held together must be different in some way. Elements are substances that are made up of only one type of atom and atoms of different elements can combine to make compounds.  Learners should be familiar with the different states of matter and their properties. They should also be familiar with changes of state in terms of the particle model. Learners should have sufficient grounding in the particle model to be able to apply it to unfamiliar materials and contexts.  Learners commonly intuitively adhere to the idea that matter is continuous. For example, they believe that the space between gas particles is filled or non-existent, or that particles expand when they are heated. The notion that empty space exists between particles is problematic because this lacks supporting sensory evidence. They also show difficulty understanding the concept of changes in state being reversible; this should be addressed during the teaching of this topic. |
| C1  Part 2  2 hours  (separate and combined) | CM1.2i – relate size and scale of atoms to objects in the physical world  CM1.2ii – estimate size and scale of atoms and nanoparticles þ  C1.2a – describe how and why the atomic model has changed over time [the models of Dalton, Thomson, Rutherford, Bohr, Geiger and Marsden]  C1.2b – describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus  C1.2c – recall the typical size (order of magnitude) of atoms and small molecules [the concept that typical atomic radii and bond length are in the order of 10-10 m]  C1.2 – recall relative charges and approximate relative masses of protons, neutrons and electrons  C1.2e – calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number of isotopes [definitions of an ion, atomic number, mass number and an isotope, also the standard notation to represent these] | Development of the atomic model covers many aspects of Working Scientifically, and a good early opportunity for developing learners’ research and presentation skills. There are many website and books covering this, for example [here](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/periodic_table/atomstrucrev5.shtml).  The OCR Superheros activity is another option, [here](https://www.ocr.org.uk/Images/363966-the-superheroes-of-the-atomic-model-lesson-element.doc). https://www.ocr.org.uk/Images/363966-the-superheroes-of-the-atomic-model-lesson-element.doc  The OCR [Particles Delivery Guide](http://www.ocr.org.uk/Images/283349-particles-delivery-guide.pdf) includes an activity for calculating subatomic particle numbers.  Taking time to ensure learners are confident with these fundamental keywords will pay dividends later when moving on to more complex contexts such as molecules and compounds.  Reviewing knowledge of the Periodic Table now may also be useful – an [A1 version](http://www.ocr.org.uk/Images/281617-periodic-table-of-the-elements-poster.pdf) of the OCR Periodic Table is available. Note that this follows the IUPAC recommendations, with the atomic number at the top of the each cell, and relative atomic mass at the bottom. The standard notation for isotope remains, for example, 42He. The distinction between these will need to be made clear. | An atom is the smallest component of an element that gives an element its property. These properties can be explained by models of atomic structure. Current models suggest that atoms are made of smaller sub-atomic particles called protons, neutrons and electrons. They suggest that atoms are composed of a nucleus surrounded by electrons. The nucleus is composed of neutrons and protons. Atoms of each element have the same number of protons as electrons. Atoms of different elements have different numbers of protons. Atoms of the same element will have the same number of protons but may have different numbers of neutrons.  Learners commonly have difficulty understanding the concept of isotopes due to the fact they think that neutral atoms have the same number of protons and neutrons. They also find it difficult to distinguish between the properties of atoms and molecules. Another common misconception is that a positive ion gains protons or a negative ion loses electrons i.e. that there is a change in the nucleus of the atom rather than a change in the number of electrons.  For the students to fully appreciate the scale of the atoms they are researching it will be necessary to explain the scale of the atom and possibly introduce the Avogadro number. A good way of giving the students an idea of the size of the number is to give the analogy of the entire world covered in coca cola cans two hundred miles deep and counting every single can. |

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| Additional remote learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| **Part** | **Statement** | **Teaching activities** |
| 1 | C1.1a | [Interactive simulation](https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html) on states of matter. Students can change the temperature and observe the movement of particles. |
| 2 | C1.2a – C1.2e  CM1.2i-ii | An interactive [video](http://htwins.net/scale2/) showing the relative sizes from quantum particles out to the size of the universe. Includes protons, neutrons, electrons and atoms.  [Scientific literacy activity](https://www.tes.com/teaching-resource/atomic-theory-timeline-11309036) for students to learn the history of the atom by creating a timeline.  [Animation](https://www.ocr.org.uk/Images/587818-c1-and-c2-cup-elevate-video-rutherford-gold-foil-experiment.mp4) of the Rutherford gold foil experiment.  [Interactive simulation](https://phet.colorado.edu/sims/html/rutherford-scattering/latest/rutherford-scattering_en.html) showing the Rutherford scattering that would occur with a Rutherford atom and a Plum Pudding atom.  [Interactive simulation](https://phet.colorado.edu/sims/html/isotopes-and-atomic-mass/latest/isotopes-and-atomic-mass_en.html) on isotopes. Allows you to ‘create’ isotopes by adding or removing neutrons, and it tells you the relative abundance of those isotopes in nature. Or it shows you the relative mix of isotopes, which you can adjust. |
|  | **C1** | A free [online learning platform](https://app.senecalearning.com/classroom/course/96e31cd0-163e-11e8-8f0b-c709585e9621/section/fd1126e0-164e-11e8-b52e-dd62726b4526/session). Consists of revision questions. Covers the whole specification. You can choose which topics to answer questions on. |

# Outline Scheme of Work: C2 – Elements, compounds and mixtures

## Total suggested teaching time – 28 / 24 hours (separate / combined)

### C2.1 – Purity and separating mixtures (10 hours – separate and combined)

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| --- | --- |
| Links to KS3 Subject content  * the concept of a pure substance * simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography * mixtures, including dissolving * the identification of pure substances | Links to Practical Activity Groups (PAGs)  * Thin layer chromatography. (PAG C3) * Using chromatography to identify mixtures of dyes in an unknown ink. (PAG C3) * Distillation of mixtures. (PAG C4) * Purification of compounds. (PAG C4, PAG C7) * Separation of mixtures and purification of compounds. (PAG C4, PAG C7) |
| Links to Mathematical Skills  * M1a * M1c * M1d * M2a * M3b * M3c | Links to Working Scientifically  * WS1.2b * WS1.2c * WS1.3c * WS1.4a * WS2a * WS2b |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2  Topic 1 Part 1  2.5 hours  (separate and combined) | CM2.1iii – change the subject of a mathematical equation  CM2.1iv – arithmetic computation and ratio when determining empirical formulae, balancing equations  C2.1c – calculate relative formula masses of species separately and in a balanced chemical equation [the definition of relative atomic mass, relative molecular mass and relative formula mass]  C2.1d – deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa | Use copies of the Periodic Table and mini-whiteboards (if available) to teach learners how to correctly extract mass data from the Periodic Table, and calculate relative molecular and formula masses.  Teaching how to balance equations formalistically at this early stage – resources available [here](http://www.ocr.org.uk/Images/179563-balancing-equations-activity.doc), [here](http://www.ocr.org.uk/Images/179630-balancing-equations-activity-powerpoint.ppt) and [here](http://www.ocr.org.uk/Images/179564-balancing-equations-teacher-instructions.pdf). More able students should be able to handle more complex formulae, e.g. Ca(OH)2.  Use of molymods / plasticine&cocktail sticks or other ways of producing molecular models, and teaching deducing empirical formulae. | As with fundamental key words (atom, ion etc), some key concepts will take time for learners to use confidently and underpin many other aspects of chemistry. Chemical formulae, equations and the mole are such concepts. They can be introduced here, and built on successively throughout the course. Learners may learn about these skills in a formulistic way early-on in the course, with a deepening appreciation as the course develops. For example, learning to balance equations by a set of rules early in the course, appreciating stoichiometric ratio later on the course. |
| C2  Topic 1 Part 2  5.5 hours  (separate and combined) | CM2.1i – arithmetic computation, ratio, percentage and multistep calculations permeates quantitative chemistry  CM2.1ii – provide answers to an appropriate number of significant figures  C2.1a – explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term ‘pure’  C2.1b – use melting point data to distinguish pure from impure substances  C2.1e – explain that many useful materials are formulations of mixtures [alloys]  C2.1f – describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation [knowledge of the techniques of filtration, crystallisation, simple distillation and fractional distillation]  C2.1j – suggest suitable purification techniques given information about the substances involved | The OCR Particles, Atoms and Elements [transition guide](http://www.ocr.org.uk/Images/223681-particles-atoms-and-elements-transition-guide.pdf) provides ideas and resources for this part of the course.  There is a significant amount of practical work available in this part, covering   * purification of compounds (PAG C4, C7) * measuring melting points * separation of mixtures and purification of compounds (PAG C4, C7) * distillation of mixtures (PAG C4)   Many of the techniques will likely have been covered in KS3, so some creativity/stretch-and-challenge is possible. Example practicals include   * [Purification of alum](http://www.rsc.org/learn-chemistry/resource/res00000483/purifying-an-impure-solid?cmpid=CMP00005899) * [Melting and freezing of steric acid](http://www.rsc.org/learn-chemistry/resource/res00001747/melting-and-freezing-stearic-acid?cmpid=CMP00005262) * [Separating sand and salt](http://www.rsc.org/learn-chemistry/resource/res00000386/separating-sand-and-salt?cmpid=CMP00005908) * [Distillation](http://www.rsc.org/learn-chemistry/resource/res00001768/recovering-water-from-copper-ii-sulfate-solution) * A demo of [fractional distillation of crude oil](http://www.rsc.org/learn-chemistry/resource/res00000754/the-fractional-distillation-of-crude-oil)   Introducing ideas around synthesis, for example [magnesium carbonate](http://www.rsc.org/learn-chemistry/resource/res00000431/making-magnesium-carbonate-the-formation-of-an-insoluble-salt-in-water?cmpid=CMP00005185), can allow wide practical skills and ideas to be developed. | In chemical terms elements and compounds are pure substances and mixtures are impure substances. Chemically pure substances can be identified using melting point. Many useful materials that we use today are mixtures. There are many methods of separating mixtures including filtration, crystallisation, distillation and chromatographic techniques.  Learners should be familiar with the concept of pure substances. They should have met simple separation techniques of mixtures. The identification of pure substances in terms of melting point, boiling point and chromatography will also have been met before.  Learners commonly misuse the word pure and confuse it with natural substances or a substance that has not been tampered with. They think that when a substance dissolves that the solution is pure and not a mixture. |
| C2  Topic 1 Part 3  2 hours  (separate and combined) | C2.1g – describe the techniques of paper and thin layer chromatography  C2.1h – recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases [identification of the mobile and stationary phases]  C2.1i – interpret chromatograms, including measuring Rf values [the recall and the use of the formula]  C2.1k – suggest chromatographic methods for distinguishing pure from impure substances [paper, thin layer (TLC) and gas chromatography]  CM2.1iii – change the subject of a mathematical equation  CM2.1iv – arithmetic computation and ratio when determining empirical formulae, balancing equations | The OCR Particles, Atoms and Elements [transition guide](http://www.ocr.org.uk/Images/223681-particles-atoms-and-elements-transition-guide.pdf) provides ideas and resources for this part of the course.  A useful website on paper chromatography and Rf values is [here](http://www.bbc.co.uk/education/guides/zgbqtfr/revision/7).  Chromatography can be carried out, covering PAG C3, for example with:   * [Chromatography of leaves](http://www.rsc.org/learn-chemistry/resource/res00000389/chromatography-of-leaves) * [Chromatography of sweets](http://www.nuffieldfoundation.org/practical-chemistry/chromatography-sweets) * [TLC of photosynthetic pigments](http://www.saps.org.uk/secondary/teaching-resources/181)   Alternatively, learners could plan and carry out a mini-investigation into extracting and purifying the coloured compounds from, for example, red cabbage (anthocyanins) or grass (chlorophyll).  Videos on the [workings of GLC](https://www.youtube.com/watch?v=08YWhLTjlfo) and their use in [pharmaceutical manufacture](http://www.rsc.org/education/teachers/resources/alchemy/index2.htm) are available.  CLEAPSS provide also provide a [useful guide](http://science.cleapss.org.uk/Resource/PS067n-Chromatography.pdf) to carrying out simple, inexpensive and successful chromatography. | This part moves directly on from the previous work on separation and purification. Chromatography is likely to be the first separation techniques learners will have met, possibly even at KS1/2 by separating out pen ink. If they are well versed in the basics, then this part provides opportunities to extend their knowledge – interesting contexts include forensic science, pharmaceutical development and environmental monitoring. |

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| Additional remote learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| **Part** | **Statement** | **Teaching activities** |
| 2 | C2.1a & C2.1b, C2.1e & f, C2.1j | [Timelapse video](https://www.ocr.org.uk/Images/587819-c1-and-c2-cup-elevate-video-paper-chromatography-of-ink.mp4) of paper chromatography of ink. |
| 3 | C2.1g – C2.1i, C2.1k | [Video and teaching pack](https://ocr.org.uk/rpgchem1) for Chromatography in leaves practical. Can be used for actual or virtual practical and in addition to the resources for carrying out the practical, it also includes preparation worksheets and a summary quiz. |
|  |  | A [free online learning platform](https://app.senecalearning.com/classroom/course/96e31cd0-163e-11e8-8f0b-c709585e9621/section/fd1126e0-164e-11e8-b52e-dd62726b4526/session). Consists of revision questions. Covers the whole specification. You can choose which topics to answer questions on. |

# Outline Scheme of Work: C2 – Elements, compounds and mixtures

## Total suggested teaching time – 28 / 24 hours (separate / combined)

### C2.2 – Bonding (8 hours – separate and combined)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * how patterns in reactions can be predicted with reference to the Periodic Table * representing chemical reactions using formulae and using equations * the chemical properties of metal and non-metal oxides with respect to acidity * the Periodic Table: periods and groups; metals and non-metals * the principles underpinning the Mendeleev Periodic Table * the properties of metals and non-metals * the varying physical and chemical properties of different elements | Links to Practical Activity Groups (PAGs) |
| Links to Mathematical Skills  * M1c * M4a * M5b | Links to Working Scientifically  * WS1.1a * WS1.1b * WS1.1c * WS1.3f * WS1.4a |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2  Topic 2 Part 1  3 hours  (separate and combined) | CM2.2i – estimate size and scale of atoms and nanoparticles þ  C2.2a – describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties [physical properties, formation of ions and common reactions, e.g. with oxygen to form oxides]  C2.2b – explain how the atomic structure of metals and non-metals relates to their position in the periodic table  C2.2c – explain how the position of an element in the periodic table is related to the arrangement of electrons in its atoms and hence to its atomic number [group number and period number]  C2.2h – explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number  C2.2i – explain in terms of atomic number how Mendeleev’s arrangement was refined into the modern periodic table | Differences between metals and non-metals would be a good homework at the start of the topic, perhaps dividing a selection of elements (e.g. hydrogen, helium, carbon, oxygen, fluorine, sodium, magnesium, aluminium, iron, copper, gold) amongst the class, with quick talks to summarise the information found. Formation of ions and common reactions can be covered at a simple level, going into greater depth later in the course. The RSC [Periodic Table](http://www.rsc.org/periodic-table) and the [Periodic Videos](http://www.periodicvideos.com/) sites are good places to start  Returning to the Periodic Table, work through the general ‘geography’ of the Periodic Table (metals vs non-metals, groups, periods etc). If available, Peter Atkins’ ‘The periodic kingdom’ can provide some stretch-and-challenge. Teaching of the rules linking electron structure, atomic number and periodic table position can be done deductively (give the rules, work out specific examples) or by induction (give examples, work out the general rules).  Plenty of worksheets are available for completing electron structure diagrams, for example [here](https://www.tes.com/teaching-resource/periodic-table-electronic-structure-worksheet-3007858). Making a large scale version of poster of an atom and using milk bottle lids can help teach this concept.  While the specification only makes specific reference to Mendeleev, it is worth learners having some knowledge about the general development from de Chancourtois to Moseley – the RSC have a good [summary website](http://www.rsc.org/periodic-table/history/about). This provides useful context for teaching about Working Scientifically, particularly development of scientific methods and theories over time. | A simple electron energy level model can be used to explain the basic chemical properties of elements. |
| C2  Topic 2 Part 2  5 hours  (separate and combined) | CM2.2ii – represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon  CM2.2iii – translate information between diagrammatic and numerical forms  C2.2d – describe and compare the nature and arrangement of chemical bonds in: i) ionic compounds; ii) simple molecules; iii) giant covalent structures; iv) polymers; v) metals  C2.2e – explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons  C2.2f – construct dot and cross diagrams for simple covalent and binary ionic substances  C2.2g – describe the limitations of particular representations and models to include dot and cross diagrams, ball and stick models and two- and three-dimensional representations | Introduce the idea of bonds forming as the products formed are more energetically stable than the separated atoms, and due to electrostatic interactions between nuclei and outer-shell electrons. The model of the ‘full outer shell’ is useful for initial explanations of simple structures (e.g. binary salts, small covalent molecules etc), but does tend to embed misconceptions about, for example, atom stability and anthropomorphising chemical substances (‘the sodium atom is unstable’, ‘it wants a full outer shell’). Careful use of language and emphasis that this is a model is recommended.  The Fuse School have some useful presentations on [ionic bonding](https://www.youtube.com/watch?v=zpaHPXVR8WU), [covalent bonding](https://www.youtube.com/watch?v=0HfN3CvXP2M) and [metallic bonding](https://www.youtube.com/watch?v=S08qdOTd0w0).  The [Chemical Misconceptions](https://edu.rsc.org/resources/chemical-misconceptions-i-alternative-conceptions-in-chemistry-teaching/1133.article) resource from RSC is very useful in elucidating and correcting misconceptions. This activity looks at [ionic bonding](http://www.rsc.org/learn-chemistry/resource/res00001095/ionic-bonding) and this one on [bonding in general](http://www.rsc.org/learn-chemistry/resource/res00001097/spot-the-bonding).  Movement of electrons is a key chemical idea in chemistry, and is used to account for formation of bonds by transfer (ionic) and sharing (covalent). Links can be developed between the giant ionic and metallic structures, covalent bonding in simple molecule and large covalent molecules (polymers), and between all types of giant structure (ionic, covalent and metallic). A simple introduction to the ideas about how bonding and structure affect macroscopic properties may develop naturally during teaching.  Model building is particularly helpful for introducing bonding. Plasticine and cocktail sticks can be used, alongside molecular modelling kits such as Molymods. Care needs to be taken about what the ‘bonds’ refer to, especially when comparing, for example, giant ionic and covalent lattices. Modelling polymers by joining paper clips together can be used to introduce the ideas of monomers.  There are many worksheets available to support drawing of dot and cross diagrams including [here](http://www.rsc.org/learn-chemistry/resource/download/res00000954/cmp00001408/pdf), [here](https://www.tes.com/teaching-resource/ionic-and-covalent-worksheet-6317022) and [here](https://www.tes.com/teaching-resource/dot-and-cross-diagrams-6089372). | When chemical reactions occur, they can be explained in terms of losing, gaining or sharing of electrons. The ability of an atom to lose, gain or share electrons depends on its atomic structure. Atoms that lose electrons will bond with atoms that gain electrons. Electrons will be transferred between the atoms to form a positive ion and a negative ion. These ions attract one another in what is known as an ionic bond. Atoms that share electrons can bond with other atoms that share electrons to form a molecule. Atoms in these molecules are held together by covalent bonds.  Learners do not always appreciate that the nucleus of an atom does not change when an electron is lost, gained or shared. They also find it difficult to predict the numbers of atoms that must bond in order to achieve a stable outer level of electrons. Learners think that chemical bonds are physical things made of matter. They also think that pairs of ions such as Na+ and C*l–* are molecules. They do not have an awareness of the 3D nature of bonding and therefore the shape of molecules. |

# Outline Scheme of Work: C2 – Elements, compounds and mixtures

## Total suggested teaching time – 28 / 24 hours (separate / combined)

### C2.3 – Properties of materials (10 / 6 hours – separate / combined)

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| Links to KS3 Subject content  * representing chemical reactions using formulae and using equations * properties of ceramics, polymers and composites (qualitative) | Links to Practical Activity Groups (PAGs)  * Dissolving tablets. (PAG C8) |
| Links to Mathematical Skills  * M1b * M1c * M1d * M4a * M5b * M5c | Links to Working Scientifically  * WS1.1c * WS1.1d * WS1.1e * WS1.1f * WS1.1h * WS1.1i * WS1.2a * WS1.3c * WS1.3f * WS1.4a * WS1.4c * WS1.4d |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2  Topic 3 Part 1  6 hours  (separate and combined) | CM2.3i – represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon  C2.3a – recall that carbon can form four covalent bonds  C2.3b – explain that the vast array of natural and synthetic organic compounds occur due to the ability of carbon to form families of similar compounds, chains and rings  C2.3c – explain the properties of diamond, graphite, fullerenes and graphene in terms of their structures and bonding  C2.3d – use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur  C2.3e – use data to predict states of substances under given conditions [data such as temperature and how this may be linked to changes of state]  C2.3f – explain how the bulk properties of materials (ionic compounds; simple molecules; giant covalent structures; polymers and metals) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged [recognition that the atoms themselves do not have the bulk properties of these materials] | [This presentation](http://www.knockhardy.org.uk/gcse_htm_files/gorgpps.pps) is a general introduction to organic chemistry. While it goes into much more detail than required here, this may help lay the groundwork for later study of carbon chemistry.  Molecular models (molymods) of the allotropes of carbon are very useful for discussing the links between the bonding and structure. Comparing diamond, graphite, graphene and fullerenes allows covalent bonding, intermolecular bonding, physical properties (including boiling point, solubility), electrical conductivity etc to be introduced. There are many useful websites, for example [here](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/chemical_economics/nanochemistryrev1.shtml). Learners can make their own models of buckyballs, for example [here](http://www.instructables.com/id/Knex-Buckyball/). Properties of the carbon allotropes makes useful research and presentation projects – the award of the [2010 Physics Nobel Prize](http://www.nobelprize.org/nobel_prizes/physics/laureates/2010/press.html) for graphene can provide a useful context for discussing Working Scientifically.  Strengths of chemical bonds and state changes brings together lots of ideas, linking back to the particle model and forward to enthalpies. The melting/boiling of simple molecular substance tends to provide most of the misconceptions – use of molecular models to illustrate the intermolecular forces breaking while leaving the intramolecular bond intact can be useful. Interesting discussions can ensure from demonstration/practicals such as the [freezing of hydrated sodium thiosulfate](http://www.rsc.org/learn-chemistry/resource/res00000390/supercooling-the-energetics-of-freezing?cmpid=CMP00005920).  Bulk properties of materials provide opportunities for investigations – for example i) the extension characteristics of different polymers; ii) electrical conductivity of different substances (polymer, graphite, ionic solids/solutions/molten (the latter by demonstration with zinc chloride)); iii) malleability/brittleness of substances; iv) [polymer density](http://www.rsc.org/learn-chemistry/resource/res00000385/identifying-polymers?cmpid=CMP00005147).; v) [Hair strength](http://www.ocr.org.uk/Images/72966-experiment-card-hair.pdf)  This [page from Chemwiki](http://chemwiki.ucdavis.edu/Core/Analytical_Chemistry/Chemical_Reactions/Properties_of_Matter) gives useful clarification of chemical and physics properties, and [this page](http://www.dummies.com/how-to/content/how-materials-change-in-nanoscale.html) helps introduce the ideas around how nanoscale materials can have substantially different properties | This section explores the physical properties of elements and compounds and how the nature of their bonding is a factor in their properties. Learners commonly have a limited understanding of chemical reactions, for example substances may explode, burn, contract, expand or change state. |
| C2  Topic 3 Part 2  4 hours  (separate only) | CM2.3ii – relate size and scale of atoms to objects in the physical world þ  CM2.3iii – estimate size and scale of atoms and nanoparticles þ  CM2.3iv – interpret, order and calculate with numbers written in standard form when dealing with nanoparticles þ  CM2.3v – use ratios when considering relative sizes and surface area to volume comparisons þ  CM2.3vi – calculate surface areas and volumes of cubes þ  C2.3g – compare ‘nano’ dimensions to typical dimensions of atoms and molecules þ  C2.3h – describe the surface area to volume relationship for different-sized particles and describe how this affects properties þ  C2.3i – describe how the properties of nanoparticulate materials are related to their uses þ  C2.3j – explain the possible risks associated with some nanoparticulate materials þ | There are many good websites and resources available on nanotechnology, for example Steven Fry’s [video](https://www.youtube.com/watch?v=70ba1DByUmM), this [howstuffworks.com website](http://science.howstuffworks.com/nanotechnology.htm), this [campaigning website](http://www.crnano.org/whatis.htm) and this [educational website](https://www.nisenet.org/search/topics/nanotechnology-2835).  Particle size affects properties – some interesting primary data here from [Sigma-Aldrich](http://www.sigmaaldrich.com/materials-science/nanomaterials/gold-nanoparticles.html), also summarised [here](http://nanocomposix.com/pages/gold-nanoparticles-optical-properties).  Calculating surface-area to volume ratio can be helped by using Multilink Cubes/Snapcubes or similar. Hands on activity with these can help learners appreciate that chemical reactions can only occur at exposed faces – getting then to count total number of faces as they successively break down a 3x3x3 cube can be particularly instructive.  Surface area to volume ratio allows linking forward to rates of reaction, and practicals around dissolving tablets (whole vs crushed), acid and different sized marble chips, or even [rhubarb](http://www.rsc.org/learn-chemistry/resource/res00000745/rates-and-rhubarb?cmpid=CMP00005903). (PAG C8). | Appreciation of the size of particles is returned to here, extending into more recent developments of nano-scale materials. |

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| Additional remote learning opportunities ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | | |
| **Part** | **Statement** | **Teaching activities** |
| 1 | C2.3a – C2.3f | [Short animation](https://www.ocr.org.uk/Images/587820-c1-and-c2-cup-elevate-video-diamond-crystal-structure.mp4) showing the 3D structure of diamond.  [Animated video](https://www.ocr.org.uk/Images/587839-c1-and-c2-cup-elevate-video-structure-of-graphite.mp4) showing the structure of graphite.  [Animated video](https://ocr.org.uk/Images/587840-c1-and-c2-cup-elevate-video-buckminsterfullerene-molecule.mp4) showing the structure of Buckminsterfullerene. |



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