# *PLANNING SUPPORT BOOKLET*

**J258, J260**

**For first teaching in 2016**

This support material booklet is designed to accompany the OCR GCSE (9–1) in Chemistry B and Combined Science B (Twenty First Century 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 B (Twenty First Century Science – J258)](http://www.ocr.org.uk/Images/234599-specification-accredited-gcse-twenty-first-century-science-suite-chemistry-b-j258.pdf)
* [Combined Science B (Twenty First Century Science – J260)](http://www.ocr.org.uk/Images/234597-specification-accredited-gcse-twenty-first-century-science-suite-combined-science-b-j260.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.

## 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-twenty-first-century-science-suite-chemistry-b-j258-from-2016/>
* <http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-combined-science-b-j260-from-2016/>

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

## Ideas about Science (C7) and Practical Work (C8)

Ideas about Science (C7) and Practical Skills (C8) are not explicitly referenced in the high level planning table below, as these ideas and skills are expected to be developed in the context of Chapters C1-C6. Links to Ideas about Science and suggested practical activities are included in the outline scheme of work. Indications of where PAG activities can be carried out should not be seen as an exhaustive list.

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-twenty-first-century-science-suite-chemistry-b-j258-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 on the webpage at <https://www.ocr.org.uk/Images/552881-practical-skills-booklets.zip>

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| Chapters | Suggested teaching hoursSeparate / Combined | Comments and PAG opportunities |
| --- | --- | --- |
| **Chapter C1: Air and water** | | |
| C1.1 How has the Earth’s atmosphere changed over time, and why? | 8 / 8 | PAG 2 – Gas tests |
| C1.2 Why are there temperature changes in chemical reactions? | 6 / 3 |  |
| C1.3 What is the evidence for climate change, why is it occurring? **AND** C1.4 How can scientists help improve the supply of potable water? | 6 / 6 | PAG 2 – Gas tests |
|  | **Total 20 / 17** |  |
| **Chapter C2: Chemical patterns** | | |
| C2.1 How have our ideas about atoms developed over time? | 2.5 / 2.5 |  |
| C2.2 What does the Periodic Table tell us about the elements? | 5 / 5 | PAG 1 – Group 7 reactivity trends |
| C2.3 How do metals and non-metals combine to form compounds? | 4.5 / 4.5 |  |
| C2.4 How are equations used to represent chemical reactions? | 2 / 2 |  |
| C2.5 What are the properties of the transition metals? (separate science only) | 2 / 0 |  |
|  | **Total 16 / 14** |  |
| **Chapter C3: Chemicals of the natural environment** | | |
| C3.1 How are the atoms held together in a metal? **AND** C3.2 How are metals with different reactivities extracted? | 7 / 7 |  |
| C3.3 What are electrolytes and what happens during electrolysis? | 6.5 / 6.5 | PAG 2 - Electrolysis |
| C3.4 Why is crude oil important as a source of new materials? | 10 / 6 | PAG 3 - Chromatography |
|  | **Total 23.5 / 19.5** |  |
| **Chapter C4: Material choices** | | |
| C4.1 How is data used to choose a material for a particular use? | 2.5 / 1.5 |  |
| C4.2 What are the different types of polymers? (separate science only) | 4 / 0 |  |
| C4.3 How do bonding and structure affect properties of materials? | 3 / 3 |  |
| C4.4 Why are nanoparticles so useful? | 4.5 / 4.5 |  |
| C4.5 What happens to products at the end of their useful life? | 5 / 4 |  |
|  | **Total 19 / 13** |  |
| **Chapter C5: Chemical analysis** | | |
| C5.1 How are chemicals separated and tested for purity? | 7 / 7 | PAG3, 4, 7 – Chromatography, distillation and production of salts |
| C5.2 How do chemists find the composition of unknown samples? (separate science only) | 6 / 0 | PAG 5 – Identification of unknown species |
| C5.3 How are the amounts of substances in reactions calculated? | 10 / 6.5 |  |
| C5.4 How are the amounts of chemicals in solution measured? | 10 / 7.5 | PAG 6 - Titration |
|  | **Total 33 / 21** |  |
| **Chapter C6: Making useful chemicals** | | |
| C6.1 What useful products can be made from acids? | 7.5 / 7.5 | PAG 7 – Production of salts |
| C6.2 How do chemists control the rate of reactions? | 11 / 9.5 | PAG 8 – Reaction rates |
| C6.3 What factors affect the yield of chemical reactions? **AND**  C6.4 How are chemicals made on an industrial scale? (separate science only) | 10 / 1.5 |  |
|  | **Total 28.5 / 18.5** |  |
| **GRAND TOTAL SUGGESTED HOURS – 140 / 103 hours** | | |

Separate science only learning outcomes are indicated throughout this document.

**Emboldened statements will only be assessed in Higher Tier papers.**

The grand total suggested hours is slightly different compared with the Chemistry A Gateway suggested hours. This will be due to additional learning outcomes and a greater emphasis on Ideas about Science in the Twenty First Century Suite over and above those in Gateway, which help to exemplify the contexts in each chapter.

# Outline Scheme of Work: C2 – Chemical Patterns

## Total suggested teaching time – 16 / 14 hours (separate / combined)

|  |  |
| --- | --- |
| **Additional remote learning opportunities**  ***As a response to the Covid-19 outbreak, additional online learning opportunities were identified for each topic in June 2020.*** | |
| **Statement** | **Teaching activities** |
| C2.1.1 | [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. |
| C2.1.1/2 | [Animation](https://www.ocr.org.uk/Images/588245-c2-cup-elevate-video-rutherford-gold-foil-experiment.mp4) of the Rutherford gold foil experiment.  [Interactive simulation](https://phet.colorado.edu/sims/html/isotopes-and-atomic-mass/latest/isotopes-and-atomic-mass_en.html) showing the Rutherford scattering that would occur with a Rutherford atom and a Plum Pudding atom. |
| C2.1.4-6 | 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 |
| C2.1.7 | [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. |
| C2.2.5 | [Video](https://revisionworld.com/gcse-revision/chemistry/periodic-table/group-1-metals) showing the reactions of group 1 metals with water. |
| C2.4.3 | An [interactive game](https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_en.html) to practise balancing equations. |
| **C2** | A free [online learning platform](https://app.senecalearning.com/classroom/course/b151e0b0-16f2-11e8-ba22-0d7681702f4b/section/15d8a130-16f4-11e8-ba22-0d7681702f4b/session). Consists of revision questions. Covers the whole specification. You can choose which topics to answer questions on. |

### C2.1 How have our ideas about atoms developed over time? (2.5 hours – separate and combined)

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| --- | --- |
| Links to KS3 Subject content  * a simple (Dalton) atomic model * differences between atoms, elements and compounds | |
| Links to Mathematical Skills  * M1a * M1d | Links to Practical Activity Groups (PAGs)  * N/A |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2 Topic 1  2.5 hours  (separate and combined) | C2.1.1. describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr  C2.1.2. 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  C2.1.3. recall relative charges and approximate relative masses of protons, neutrons and electrons  C2.1.4. estimate the size and scale of atoms relative to other particles  C2.1.5. recall the typical size (order of magnitude) of atoms and small molecules  C2.1.6. relate size and scale of atoms to objects in the physical world  C2.1.7. calculate numbers of protons, neutrons and electrons in atoms, given atomic number and mass number of isotopes or by extracting data from the Periodic Table  IaS3. understanding how scientific explanations and models develop in the context of changing ideas about the atomic model (IaS3) | The atomic structure section at the [BBC Bitesize](https://www.bbc.co.uk/bitesize/guides/zp3dh39/revision/1) provides good summary information.  The [OCR C2 Delivery Guide](http://www.ocr.org.uk/Images/285897-chemical-patterns-delivery-guide.zip) contains new resources including a card-sort, atomic structure modelling activity and worksheets on isotopes and subatomic particles.  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](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/periodic_table/atomstrucrev5.shtml) and books covering this. Specific websites covering [Dalton](http://faculty.pingry.org/dburns/chemistry/documents/DaltonsAtomicTheory.pdf), [JJ Thompson](http://www.visionlearning.com/library/module_viewer.php?mid=50) and [Rutherford](http://www.britannica.com/science/Rutherford-atomic-model) are available.  The OCR [Superheroes activity](https://www.ocr.org.uk/Images/363966-the-superheroes-of-the-atomic-model-lesson-element.doc) is another option.  Scales of atoms are hard to visualise. Modelling the structure of the atom can help – for example pupils standing on the touchline of a football pitch and placing a grain of dust at the centre, estimating how deep an Avogadro’s number of marbles would be covering Great Britain (about 1500 km) and using [this video](http://www.techinsider.io/animated-scale-universe-atom-human-earth-galaxy-2015-9) or similar.  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 each cell, and relative atomic mass at the bottom. The standard notation for isotope remains unchanged, for example, 42He. The distinction between these will need to be made clear.  Extracting data from the Periodic Table to calculate numbers of subatomic particles leads on to discussion of isotopes when the relative masses of elements are considered in detail (e.g. chlorine and copper). | The modern model of the atom developed over time. Stages in the development of the model included ideas by the ancient Greeks (4 element ideas), Dalton (first particle model), Thomson (‘plum pudding’ model), Rutherford (idea of atomic nucleus) and Bohr (shells of electrons). Models were rejected, modified and extended as new evidence became available. The development of the atomic model involved scientists suggesting explanations, making and checking predictions based on their explanations, and building on each other’s work (IaS3).  The Periodic Table can be used to find the atomic number and relative atomic mass of an atom of an element, and then work out the numbers of protons, neutrons and electrons. The number of electrons in each shell can be represented by simple conventions such as dots in circles or as a set of numbers (for example, sodium as 2.8.1).  Atoms are small – about 10-10 m across, and the nucleus is at the centre, about a hundred-thousandth of the diameter of the atom. Molecules are larger, containing from two to hundreds of atoms. Objects that can be seen with the naked eye contain millions of atoms  This chapter features a central theme of modern chemistry: it traces the development of ideas about the structure of the atom and the arrangement of elements in the modern Periodic Table. Both stories show how scientific theories develop as new evidence is made available that either supports or contradicts current ideas.  Atomic structure is used to help explain the behaviour of the elements. Trends and patterns shown by the physical and chemical properties in groups and in the transition metals are studied.  The first two topics of the chapter give opportunities for learners to develop understanding of ideas about science; how scientific knowledge develops, the relationship between evidence and explanations, and how the scientific community responds to new ideas. The later topics present some of the most important models which underpin an understanding of atoms, chemical behaviour and patterns and how reactions are represented in chemical equations. This topic looks at the development of ideas about the atom and introduces the modern model for atomic structure, including electron arrangements.  Links can be made to Physics P5.1 – What is radioactivity? |

# Outline Scheme of Work: C2 – Chemical Patterns

## Total suggested teaching time – 16 / 14 hours (separate / combined)

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|  |  |
| --- | --- |
| Links to KS3 Subject content  * 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 Mathematical Skills  * N/A | Links to Practical Activity Groups (PAGs)  * PAG1: reaction of Group 1 (demonstration) and Group 7 (practical on halogen displacements) |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2 Topic 2 5 hours  (separate and combined) | C2.2.1. 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  C2.2.2. describe how Mendeleev organised the elements based on their properties and relative atomic masses  C2.2.3. describe how discovery of new elements and the ordering elements by atomic number supports Mendeleev’s decisions to leave gaps and reorder some elements  C2.2.4. describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties, including melting point, boiling point, state and appearance, density, formulae of compounds, relative reactivity and electrical conductivity  C2.2.5. recall the simple properties of Group 1 elements including their reaction with moist air, water, and chlorine  C2.2.6. recall the simple properties of Group 7 elements including their states and colours at room temperature and pressure, their colours as gases, their reactions with Group 1 elements and their displacement reactions with other metal halides  C2.2.7. predict possible reactions and probable reactivity of elements from their positions in the Periodic Table  C2.2.8. describe experiments to identify the reactivity pattern of Group 7 elements including displacement reactions  C2.2.9. describe experiments to identify the reactivity pattern of Group 1 elements  IaS1: making and testing predictions about trends and patterns in the Periodic Table  IaS3: understanding how scientific explanations and models develop, in the context of the Periodic Table | The [OCR C2 Delivery Guide](http://www.ocr.org.uk/Images/285897-chemical-patterns-delivery-guide.zip) contains a new resources including worksheet for completing electron structures and activity on investigating materials.  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 learners giving quick presentations 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), [Periodic Videos](http://www.periodicvideos.com/) and [Webelements](https://www.webelements.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.  Demonstrate the reactivity of [Group 1](http://www.rsc.org/learn-chemistry/resource/res00000731/alkali-metals?cmpid=CMP00004756) and carry out practical procedures for [halogen displacement](http://www.rsc.org/learn-chemistry/resource/res00000733/reactions-of-halogens-as-aqueous-solutions?cmpid=CMP00006118) reactions. Many videos are available to consolidate these reactions, for example from [FuseSchool](https://www.youtube.com/watch?v=CmiitvJiCPc) and [CrashCourse](https://www.youtube.com/watch?v=0RRVV4Diomg). | Topic C2.2 considers the development of the modern Periodic Table and the patterns that exist within it, focusing on Groups 1 and 7, with some reference to Group 0.  Elements in the modern Periodic Table are arranged in periods and groups, based on their atomic numbers. Elements in the same group have the same number of electrons in their outer shells. The number of electron shells increases down a group but stays the same across a period.  Mendeleev proposed the first arrangement of elements in the Periodic Table. Although he did not know about atomic structure, he reversed the order of some elements with respect to their masses, left gaps for undiscovered elements and predicted their properties. His ideas were accepted because when certain elements were discovered they fitted his gaps and the development of a model for atomic structure supported his arrangement. The later determination of the number of protons in atoms provided an explanation for the order he proposed (IaS3).  The Periodic Table shows repeating patterns in the properties of the elements. Metals and non-metals can be identified by their position in the Periodic Table and by comparing their properties (physical properties including electrical conductivity).  Properties of elements within a group show trends. The reactivity of Group 1 metals elements increases down the group, shown by their reactivity with moist air, water and chlorine.  The Group 7 halogens are non-metals and become less reactive down the group. This is shown in reactions such as their displacement reactions with compounds of other halogens in the group. |

# Outline Scheme of Work: C2 – Chemical Patterns

## Total suggested teaching time – 16 / 14 hours (separate / combined)

### C2.3 How do metals and non-metals combine to form compounds? (4.5 hours – separate and combined)

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| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * displacement reactions * how patterns in reactions can be predicted with reference to the Periodic Table * properties of ceramics, polymers and composites (qualitative) * representing chemical reactions using formulae and using equations * the Periodic Table: periods and groups; metals and non-metals * the properties of metals and non-metals * the varying physical and chemical properties of different elements | |
| Links to Mathematical Skills  * M1a * M4a * M5b | Links to Practical Activity Groups (PAGs)  * PAG 2: Properties of ionic substances (electrolysis) |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2 Topic 3 4.5 hours  (separate and combined) | C2.3.1. recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity  C2.3.2. explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups  C2.3.3. explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number  C2.3.4. explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table  C2.3.5. describe the nature and arrangement of chemical bonds in ionic compounds  C2.3.6. explain ionic bonding in terms of electrostatic forces and transfer of electrons  C2.3.7. calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table  C2.3.8. construct dot and cross diagrams for simple ionic substances  C2.3.9. explain how the bulk properties of ionic materials are related to the type of bonds they contain  C2.3.10. use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding  C2.3.11. describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations  C2.3.12. translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds  IaS3. dot and cross diagrams as models of atoms and ions, and the limitations of these models (IaS3)  IaS3. 2-D and 3-D representations as simple models of the arrangement of ions, and the limitations of these models | The [OCR C2 Delivery Guide](http://www.ocr.org.uk/Images/285897-chemical-patterns-delivery-guide.zip) contains a new worksheet for completing electron structures and activity on investigating materials, and links to other external resources.  Investigation of Group 0 properties makes for useful independent/[research](http://www.bbc.co.uk/schools/gcsebitesize/science/add_edexcel/periodic_table/groupsrev6.shtml)/homework tasks. Despite the low reactivity of the noble gases, interesting chemistry is available, and can make for useful [extension tasks](http://chemwiki.ucdavis.edu/Core/Inorganic_Chemistry/Descriptive_Chemistry/Elements_Organized_by_Block/2_p-Block_Elements/Group_18%3A_The_Noble_Gases). They also provide a good opportunity to discuss use of models in science – by the ‘filled octet’ rule noble gases are unreactive; this model breaks down further down the Periodic Table so a more sophisticated model (subshells and orbitals) is necessary.  Reactions of Group 1 and 7 give opportunity to revise balancing of equations.  Trends in the reactivity of Group 1 and 7 elements allows consolidation of the understanding of atomic structure, and links to the structure of the Periodic Table. Reaction to form ionic compounds then links to movement of electrons, completing the octet and [drawing of dot and cross diagrams](https://www.bbc.co.uk/bitesize/guides/z2mbjty/revision/2) of ionic compounds. Oxidation can then be introduced in terms of electrons.  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).  Ionic compounds can be investigated using this OCR activity ([learner](http://www.ocr.org.uk/Images/221064-ionic-compounds-learner-activity.doc) and [teacher](http://www.ocr.org.uk/Images/221062-ionic-compounds-teacher-instructions.pdf)), and demonstrated by the conductivity of [zinc chloride](http://www.nuffieldfoundation.org/practical-chemistry/electrolysis-zinc-chloride).  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). | Topic C2.3 focuses on extending an understanding of atomic structure to explain the ionic bonding between ions in ionic compound.Group 0 contains elements with a full outer shell of electrons. This arrangement is linked to their inert, unreactive properties. They exist as single atoms and hence are gases with low melting and boiling points.  Group 1 elements combine with Group 7 elements by ionic bonding. This involves a transfer of electrons leading to charged ions. Atoms and ions can be represented using dot and cross diagrams as simple models (IaS3). Metals, such as Group 1 metals, lose electrons from the outer shell of their atoms to form ions with complete outer shells and with a positive charge. Non-metals, such as Group 7, form ions with a negative charge by gaining electrons to fill their outer shell. The number of electrons lost or gained determines the charge on the ion.  The properties of ionic compounds such as Group 1 halides can be explained in terms of the ionic bonding. Positive ions and negative ions are strongly attracted together and form giant lattices. Ionic compounds have high melting points in comparison to many other substances due to the strong attraction between ions which means a large amount of energy is needed to break the attraction between the ions. They dissolve in water because their charges allow them to interact with water molecules. They conduct electricity when molten or in solution because the charged ions can move, but not when solid because the ions are held in fixed positions.  The arrangement of ions can be represented in both 2-D and 3-D. These representations are simple models which have limitations, for example they do not fully show the nature or movement of the electrons or ions, the interaction between the ions, their arrangement in space, their relative sizes or scale (IaS3). |

# Outline Scheme of Work: C2 – Chemical Patterns

## Total suggested teaching time – 16 / 14 hours (separate / combined)

### C2.4 How have our ideas about atoms developed over time? (2 hours – separate and combined)

### C2.5 What are the properties of the transition metals? (separate science only) (2 hours – separate ONLY)

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| --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * chemical symbols and formulae for elements and compounds * energy changes on changes of state (qualitative) * how patterns in reactions can be predicted with reference to the Periodic Table * representing chemical reactions using formulae and using equations * the Periodic Table: periods and groups; metals and non-metals * the properties of metals and non-metals * the varying physical and chemical properties of different elements | |
| Links to Mathematical Skills  * N/A | Links to Practical Activity Groups (PAGs)  * PAG C1 – Reactivity of transition metals * PAG C5 – Cation and flame tests of transition metals * PAG C7 – Production of transition metal salts (e.g. CuSO4). |

| Suggested timings | Statements | Teaching activities | Notes |
| --- | --- | --- | --- |
| C2 Topic 4&5 4 / 2 hours  (separate / combined) | C2.4.1. use chemical symbols to write the formulae of elements and simple covalent and ionic compounds  C2.4.2. use the formulae of common ions to deduce the formula of Group 1 and Group 7 compounds  C2.4.3. use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate  C2.4.4. describe the physical states of products and reactants using state symbols (s, l, g and aq)  C2.5.1. recall the general properties of transition metals (melting point, density, reactivity, formation of coloured ions with different charges and uses as catalysts) and exemplify these by reference to copper, iron, chromium, silver and gold (separate science only) | The [OCR C2 Delivery Guide](http://www.ocr.org.uk/Images/285897-chemical-patterns-delivery-guide.zip) contains new activities on Group 1 and Group 7 elements and substances, and on naming transition metal compounds.  Balancing equations can be taught (OCR resources [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)), although practice of this skill should be interspersed throughout the course to develop fluency in this key skill. More able students should be able to handle more complex formulae, e.g. Ca(OH)2. Plenty of worksheets are available online to practice balancing equations, and books such as Teaching Secondary Chemistry (ISBN 9780719576386) contain a wide range of balanced equations.  Understanding of states of matter can be extended by this [well-pitched website](http://www.chem4kids.com/files/matter_states.html).  The properties of transition metals is a useful opportunity for independent study/research/presentation skills –learners can be directed to find information about the general properties, but encouraged to find more detailed information as well. [WebElements](https://www.webelements.com/) and the [RSC Periodic Table](http://www.rsc.org/periodic-table/) are useful for starting points.  The hydrogen peroxide oxidation of tartrate ions [demonstration](http://www.rsc.org/learn-chemistry/resource/res00001736/involvement-of-catalysts-in-reactions?cmpid=CMP00006604) is useful for highlighting the catalytic nature of transition metals, along with their different colours. If not done already, [decomposition of carbonates](http://www.rsc.org/learn-chemistry/resource/res00000450/thermal-decomposition-of-metal-carbonates?cmpid=CMP00005971), including copper carbonate, may be a useful investigation.  Interested learners might ask why the transition metal ions have different charges/why the charge does not simply increase by 1+ as we move across the period. Dependent upon the ability of the group allow the discussion to continue to show how the model of the atom that they are studying at the moment does not answer all of the questions and that there are other factors that they will need to appreciate if they continue their studies in chemistry. Direct particularly interested learners to websites such as [chemguide.co.uk](http://www.chemguide.co.uk/atoms/properties/elstructs.html) | Topic C2.4 studies the use of equations and symbols to summarise reactions. Finally, in Topic C2.5, separate science only content addresses the unique nature of the transition elements.  The reactions of Group 1 and Group 7 elements can be represented using word equations and balanced symbol equations with state symbols.  The formulae of ionic compounds, including Group 1 and Group 7 compounds can be worked out from the charges on their ions. Balanced equations for reactions can be constructed using the formulae of the substances involved, including hydrogen, water, halogens (chlorine, bromine and iodine) and the hydroxides, chlorides, bromides and iodides (halides) of Group 1 metals.  The transition metals do not show group properties like the elements in Group 1 and Group 7; they form a family of elements with general properties that are different from those of other metals. These properties make the transition metals particularly useful. They all have relatively high melting points and densities.  Transitions metals are generally less reactive than Group 1 metals, and some are very unreactive (for example silver and gold).  Some transition metal elements and their compounds are used widely in the manufacture of consumer goods and as catalysts in industry, both of which represent beneficial applications of science (IaS4). |

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