# *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>

| Chapter | 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 naturals 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.

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# Outline Scheme of Work: C5 – Chemical analysis

## Total suggested teaching time – 33 / 21 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** |
| C5.1.4-6 | [Video and teaching pack](https://ocr.org.uk/rpgchem1) for Chromatography of pigments 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. |
| C5.1.4 | [Time lapse video](https://www.ocr.org.uk/Images/588250-c5-cup-elevate-video-paper-chromatography-of-ink.mp4) of paper chromatography of ink. |
| C5.2.4 | Free [online video](https://www.youtube.com/watch?v=mWTgHjdea4Y&list=PLidqqIGKox7WeOKVGHxcd69kKqtwrKl8W&index=74&t=0s) explaining the anion tests. |
| C5.2.5-7 | An [RSC video](https://www.youtube.com/watch?v=NEIm41cKXf8) showing the day in the life on an analytical chemist. In addition to giving some advantages of instrumental methods of analysis, it also provides a careers link.  Three [RSC activities](https://edu.rsc.org/download?ac=15092) that could be used to teach spectroscopy. The activities involve analysing spectra, the answers are provided. |
| C5.4.4/6 | A [short video](https://www.youtube.com/watch?v=vt8fB3MFzLk) going over the basics of acids, alkalis, indicators and neutralisation. |
| C5.4.5 | Set of [RSC activities](https://edu.rsc.org/download?ac=12427) on acids and alkalis aimed at higher ability students. Most of the activities are practicals, but Activity 5 ‘Explaining Acid Strength’ is more of a comprehension type exercise. |
| C5.4.7 | RSC [titration screen experiment](https://edu.rsc.org/download?ac=15369). Differentiated into 4 levels. Each takes around 30 minutes to complete.  A [video](https://www.youtube.com/watch?v=vn3Rx3g1VPk&list=PLAd0MSIZBSsEygAZyDRkK0PgQZ6uiC98F&index=8&t=0s) showing the technique for carrying out a titration |
| **C5** | 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. |

### C5.1 How are chemicals separated and tested for purity?

### (7 hours – separate and combined)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * mixtures, including dissolving * simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography * the concept of a pure substance * the identification of pure substances. | |
| Links to Mathematical Skills  * M3c | Links to Practical Activity Groups (PAGs)  * A detailed discussion of Chemistry PAG activities is [available](http://social.ocr.org.uk/groups/science/conversations/2016-gcse-chemistry-suggested-pag-activities) on the OCR Community. * PAG3 * PAG4 * PAG7 |

| Suggested timings | Statementsbold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| C5.1  7 hours (separate and combined) | C5.1.1. explain that many useful materials are formulations of mixtures  C5.1.2. explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term ‘pure’  C5.1.3. use melting point data to distinguish pure from impure substances  C5.1.4. recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases  C5.1.5. interpret chromatograms, including calculating Rf values  C5.1.6. suggest chromatographic methods for distinguishing pure from impure substances Including the use of: a) paper chromatography; b) aqueous and non-aqueous solvents; c) locating agents  C5.1.7. describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation  C5.1.8. suggest suitable purification techniques given information about the substances involved  IaS3: use the particle model to explain the idea of a pure substance | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  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 section, 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 demonstration of the [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 a wide range of practical skills and ideas to be developed.  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 also provide a [useful guide](http://science.cleapss.org.uk/Resource/PS067n-Chromatography.pdf) (login required) to carrying out simple, inexpensive and successful chromatography. | This chapter looks at how chemicals are analysed. Chemical analysis is important in chemistry for the quality control of manufactured products and also to identify or quantify components in testing of new products, mineral extraction, forensics and environmental monitoring. Chemists need to both identify which substances are present (qualitative analysis) and the quantity of each substance (quantitative analysis). Measuring purity and separating mixtures is important in manufacturing to ensure quality and to separate useful products from bi-products and waste. Being able to analyse quantities of chemicals enables chemists to plan for the amounts of reactants they need to use to make a product, or predict quantities of products from known amounts of reactants.  The chapter begins in Topic C5.1 by considering why it is necessary to purify chemicals and how the components of mixtures are separated. Methods of testing for purity and separating mixtures are studied, including chromatography and a range of practical separation techniques.  Many useful products contain mixtures. It is important that consumer products such as drugs or personal care products do not include impurities. Mixtures in many consumer products contain pure substances mixed together in definite proportions called formulations.  Pure substances contain a single element or compound. Chemists test substances made in the laboratory and in manufacturing processes to check that they are pure. One way of assessing the purity of a substance is by testing its melting point; pure substances have sharp melting points and can be identified by matching melting point data to reference values.  Chromatography is used to see if a substance is pure or to identify the substances in a mixture. Components of a mixture are identified by the relative distance travelled compared to the distance travelled by the solvent. Rf values can be calculated and used to identify unknown components by comparison to reference samples. Some substances are insoluble in water, so other solvents are used. Chromatography can be used on colourless substances but locating agents are needed to show the spots.  Preparation of chemicals often produces impure products or a mixture of products. Separation processes in both the laboratory and in industry enable useful products to be separated from bi-products and waste products. The components of mixtures are separated using processes that exploit the different properties of the components, for example state, boiling points or solubility in different solvents.  Separation processes are rarely completely successful and mixtures often need to go through several stages or through repeated processes to reach an acceptable purity.  Links can be made to:   * particle model and changes of state (C1.1) * fractional distillation of crude oil on an industrial scale (C3.4) |

# Outline Scheme of Work: C5 – Chemical analysis

## Total suggested teaching time – 33 / 21 hours (separate / combined)

### C5.2 How do chemists find the composition of unknown samples? (separate science only) (6 hours – separate only)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * representing chemical reactions using formulae and using equations | |
| Links to Mathematical Skills  * M4a | Links to Practical Activity Groups (PAGs)  * PAG5 |

| Suggested timings | Statementsbold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| C5.2  6 hours (separate only) | C5.2.1. describe the purpose of representative sampling in qualitative analysis (separate science only)  C5.2.2. interpret flame tests to identify metal ions, including the ions of lithium, sodium, potassium, calcium and copper (separate science only)  C5.2.3. describe the technique of using flame tests to identify metal ions (separate science only)  "C5.2.4. describe tests to identify aqueous cations and aqueous anions and identify species from test results including:  a) tests and expected results for metal ions in solution by precipitation reactions using dilute sodium hydroxide (calcium, copper, iron(II), iron(III), zinc)  b) tests and expected results for carbonate ions (using dilute acid), chloride, bromide and iodide ions (using acidified dilute silver nitrate) and sulfate ions (using acidified dilute barium chloride or acidified barium nitrate) (separate science only)"  C5.2.5. interpret an instrumental result for emission spectroscopy given appropriate data in chart or tabular form, when accompanied by a reference set in the same form (separate science only)  C5.2.6. describe the advantages of instrumental methods of analysis (sensitivity, accuracy and speed) (separate science only)  C5.2.7. interpret charts, particularly in spectroscopy (separate science only)  IaS1: Suggest equipment and techniques and a strategy to carry out qualitative analysis | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  Flame testing is covered by a [Royal Society of Chemistry practical](http://www.rsc.org/learn-chemistry/resource/res00001875/flame-tests-using-metal-salts?cmpid=CMP00004545) and by this [dramatic demonstration.](https://www.youtube.com/watch?v=d8hpUtRnsYc)  The ion tests can be carried out by traditional means ([Classic Chemistry Experiment #80](http://www.rsc.org/learn-chemistry/resource/res00000464/testing-salts-for-anions-and-cations?cmpid=CMP00000534)). The OCR PAG 5 (Identification of species) also covers these tests.  Investigative skills can be developed here after the various tests have been taught by providing a sample of unknown composition and directing the learners to discover its identity by use of ion and flame testing.  While aimed at A-level learners, this OCR ‘[Identifying Unknowns](https://www.ocr.org.uk/Images/208563-identifying-unknowns.pdf)‘ delivery guide may be of use to extend the able and interested learner.  Ideas about precipitation can be consolidated using the Chemical Misconceptions ‘[Precipitation](http://www.rsc.org/learn-chemistry/resource/res00001096/precipitation)‘ activity.  Beyond emission spectroscopy and gas chromatography, the specification does not proscribe which other techniques should be discussed – other suitable techniques would include mass spectrometry and infra-red spectroscopy. A detailed page of notes and diagrams on [instrumental techniques](http://www.docbrown.info/page01/ExIndChem/ExIndChemd.htm) is available from docbrown.info. Learners should be able to interpret data using reference data. For example determining a retention time from a GLC trace and identifying the substance by comparison with a table of reference values. [SpectraSchool](http://www.rsc.org/learn-chemistry/collections/spectroscopy) provides lots of extra resources and ideas.  Spectroscopy is a wide field in Chemistry, with many possible disciplines and careers available, making this an interesting context to discuss learners’ progression in the sciences. Discussion on careers in chemistry can start with the RSC [175 Faces of Chemistry](http://www.rsc.org/diversity/175-faces/?s=1) project. | Topic C5.2 is concerned with qualitative analysis. This topic uses standard laboratory techniques, such as flame tests, precipitation reactions and anion tests to identify the ions in unknown substances. Gas chromatography is introduced as an example of an instrumental technique, and used as a context for comparison between standard laboratory and instrumental techniques.  Chemists use qualitative analysis to identify components in a sample. The procedures have a wide range of applications, including testing chemicals during manufacturing process, testing mineral samples, checking for toxins in waste, environmental testing of water, testing soils.  Chemists use sampling techniques to make sure that the samples used for the analysis are representative and will identify any variations in the bulk of the material that is represented in the analysis (IaS1).  Laboratory analysis can be used to identify the metal cations and the anions in salts. Cations can be identified using flame tests or by adding dilute sodium hydroxide. Anions can be identified using a range of dilute reagents.  Instrumental analysis is widely used in research and in industry. Emission spectroscopy is a technique which relies on looking at the spectrum of light emitted from a hot sample. Each element gives a unique pattern of lines. Elements can be identified by matching the patterns and wavelengths of lines to reference data from known elements. Emission spectroscopy is used to identify elements in stars and in substances such as steel in industry.  Instrumental analysis is preferred due to its greater sensitivity, speed and accuracy. Data is automatically recorded. However, the technology is expensive and is not as freely available as the standard glassware used in laboratory analysis.  Links can be made to:   * Symbols, formulae and ionic equations.(C2.4 and C3.2) |

# Outline Scheme of Work: C5 – Chemical analysis

## Total suggested teaching time – 33 / 21 hours (separate / combined)

### C5.3 How are the amounts of substances in reactions calculated?

### (10 / 6.5 hours – separate / combined)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * conservation of mass changes of state and chemical reactions. * representing chemical reactions using formulae and using equations * thermal decomposition | |
| Links to Mathematical Skills  * M1a * M1b * M1c * M1d * M2a * M3b * M3c | Links to Practical Activity Groups (PAGs) |

| Suggested timings | Statementsbold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| C5.3 Part 1  6.5 hours (separate and combined) | C5.3.1. recall and use the law of conservation of mass  C5.3.2. explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model  C5.3.3. calculate relative formula masses of species separately and in a balanced chemical equation  **C5.3.4. recall and use the definitions of the Avogadro constant (in standard form) and of the mole**  **C5.3.5. explain how the mass of a given substance is related to the amount of that substance in moles and vice versa and use the relationship:**  equation  **C5.3.6. deduce the stoichiometry of an equation from the masses of reactants and products and explain the effect of a limiting quantity of a reactant**  **C5.3.7. use a balanced equation to calculate masses of reactants or products**  C5.3.8. use arithmetic computation, ratio, percentage and multistep calculations throughout quantitative chemistry  **C5.3.9. carry out calculations with numbers written in standard form when using the Avogadro constant**  C5.3.10. change the subject of a mathematical equation | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  Change in mass in non-closed systems is well demonstrated with calcium carbonate in acid on a top-pan balance. By either leaving the flask open to the atmosphere, or covering the mouth of the flask with a balloon, the ‘loss’ or conservation of mass can be readily seen and discussed.  Conservation of mass is the cause of many difficulties and misconceptions as it can seem to run counter to intuition – e.g. wood ‘disappears’ when it burns. This can be investigated practically by weighing a splint, burning it, and then weighing the remains. An opposite, apparent ‘appearance’ of mass, can be practically investigated using the [oxidation of magnesium](http://www.rsc.org/learn-chemistry/resource/res00000718/the-change-in-mass-when-magnesium-burns). Finally, to develop their manipulative skills, challenge the learners to demonstrate the [increase in mass of iron wool](http://www.rsc.org/learn-chemistry/resource/res00000718/the-change-in-mass-when-magnesium-burns) when heated in air.  The OCR ‘[Amount of Substance and the Mole delivery](https://www.ocr.org.uk/Images/170250-amount-of-substance-and-the-mole.pdf) guide’ contains many other useful links and discussion.  Use copies of the Periodic Table and mini-whiteboards to teach learners how to correctly extract mass data from the Periodic Table, and calculate relative molecular and formula masses. A recap of balancing equations may be necessary. Many [websites](Http://chemistry.about.com/od/workedchemistryproblems/a/molecularmass.htm) cover [balancing equations](https://www.khanacademy.org/science/chemistry/chemical-reactions-stoichiome/balancing-chemical-equations/a/complete-ionic-and-net-ionic-equations) but check them carefully for accuracy and level before use. The [pHET Balancing Chemical Equations Simulation](https://phet.colorado.edu/en/simulation/balancing-chemical-equations) is used.  [Decomposition of metal carbonates](http://www.rsc.org/learn-chemistry/resource/res00000450/thermal-decomposition-of-metal-carbonates?cmpid=CMP00005971) helps bring together various aspects of this topic including balancing equations, stoichiometry of equations and calculating masses from equations.  Limiting reagents can be investigating using the [reaction of magnesium with hydrochloric acid](http://www.rsc.org/learn-chemistry/resource/res00001916/the-rate-of-reaction-of-magnesium-with-hydrochloric-acid?cmpid=CMP00006119) and varying the mass of magnesium and/or concentration of hydrochloric acid used. | Topic C5.3 introduces quantitative work. The mole is used as a measure of amounts of substance and learners process data from formulae and equations to work out quantities of reactants and products. This topic ends by considering how molar amounts of gas relate to their volumes.  During reactions, atoms are rearranged but the total mass does not change. Reactions in open systems often appear to have a change in mass because substances are gained or lost, usually to the air.  Chemists use relative masses to measure the amounts of chemicals. Relative atomic masses for atoms of elements can be obtained from the Periodic Table.  The relative formula mass of a compound can be calculated using its formula and the relative atomic masses of the atoms it contains.  **Relative masses are based on the mass of carbon 12. Counting atoms or formula units of compounds involves very large numbers, so chemists use a mole as a unit of counting. One mole contains the same number of particles as there are atoms in 12g of carbon -12, and has the value 6.0 x 1023 atoms; this is the Avogadro constant. It is more convenient to count atoms as ‘numbers of moles’.**  **The number of moles of a substance can be worked out from its mass, this is useful to chemists because they can use the equations for reactions to work out the amounts of reactants to use in the correct proportions to make a particular product, or to work out which reactant is used up when a reaction stops.**  Links can be made to:   * the particle model (C1.1) * maximising industrial yields (C6.3)" |
| C5.3 Part 2  3.5 hours (separate only) | C5.3.8. use arithmetic computation, ratio, percentage and multistep calculations throughout quantitative chemistry (repeated from C5.3 Part 1)  C5.3.9. carry out calculations with numbers written in standard form when using the Avogadro constant (repeated from C5.3 Part 1)  C5.3.10. change the subject of a mathematical equation (repeated from C5.3 Part 1)  C5.3.11. calculate the theoretical amount of a product from a given amount of reactant (separate science only)  C5.3.12. calculate the percentage yield of a reaction product from the actual yield of a reaction (separate science only)  C5.3.13. suggest reasons for low yields for a given procedure (separate science only)  **C5.3.14. describe the relationship between molar amounts of gases and their volumes and vice versa, and calculate the volumes of gases involved in reactions, using the molar gas volume at room temperature and pressure (assumed to be 24 dm3) (separate science only)**  IaS1, IaS2: Using data to make quantitative predictions about yields and comparing them to actual yields. | Various simple practical activities/investigations can be used. For example   * Reaction of weighed lead nitrate and potassium iodide solutions – good demonstration of conservation of mass * Heating set amounts of magnesium ribbon (e.g. 0.5, 1.0, 1.5, 2.0g etc) and weighing the magnesium oxide product – plotting the mass data and identifying the directly proportional correlation. * Decomposition of metal carbonates, predicting and measuring the expected mass of resultant metal oxide * Reaction of metal carbonates with acid solutions, predicting and measuring the expected final mass of the solution.   The concepts around yield can be introduced with the fun, if a little messy, activity of mining chocolate chip cookies (learners weigh cookies, ‘extract’ the chips and weigh, then calculate the yield). The theoretical yield can also be determined if the ingredients show enough detail.  Gideon Lyons ‘[Breaking Bad’](https://www.tes.com/teaching-resource/breaking-bad-percentage-yield-investigation-11002685) (login required) themed investigation gives a new twist to yield determination.  The ‘[Rate of reaction of magnesium with hydrochloric acid’](http://www.rsc.org/learn-chemistry/resource/res00001916/the-rate-of-reaction-of-magnesium-with-hydrochloric-acid?cmpid=CMP00006119) practical can be simplified to focus just on the volume of hydrogen produced from a known amount of magnesium, hence helping learner make the conceptual links between the macroscopic mass-world and the microscopic moles-world, and between moles of solid and gaseous substances. When repeated later on with respect to rates of reaction, the learners will be familiar with the experimental set-up, allowing them to focus more closely on measuring volumes of gas over time. | *Statements C5.3.8-10 are repeated here is emphasise the importance of these mathematical skills in the subsequent calculations discussed.*  The equation for a reaction can also be used to work out how much product can be made starting from a known amount of reactants. This is useful to determine the amounts of reacting chemicals to be used in industrial processes so that processes can run as efficiently as possible.  Chemists use the equation for a reaction to calculate the theoretical, expected yield of a product. This can then be compared to the actual yield. Actual yields are usually much lower than theoretical yields. This can be caused by a range of factors including reversible reactions, impurities in reactants and products being lost during the procedure. Information about actual yields is used to make improvements to procedures to maximise yields.  **One mole of any gas has the same volume – 24 dm3 at room temperature and pressure.**  **So the number of moles of molecules in a known volume of gas can be calculated, using the formula**  equation  **For reactions involving only gases, the relative volumes of reactant or product gases can be worked out directly from the equation.**  **For reactions with substances in a mixture of states, calculations may involve using both masses and gas volumes to calculate amounts of products and reactants.** |

### C5.4 How are the amounts of chemicals in solution measured?

### (10 / 7.5 hours – separate / combined)

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| --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * defining acids and alkalis in terms of neutralisation reactions * mixtures, including dissolving * reactions of acids with alkalis to produce a salt plus water * representing chemical reactions using formulae and using equations * the chemical properties of metal and non-metal oxides with respect to acidity. | |
| Links to Mathematical Skills  * M3b * M3c | Links to Practical Activity Groups (PAGs)  * A detailed discussion of Chemistry PAG activities is [available](http://social.ocr.org.uk/groups/science/conversations/2016-gcse-chemistry-suggested-pag-activities) on the OCR Community. * PAG6 |

| Suggested timings | Statementsbold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| 5.4  10 / 7.5 hours (separate / combined) | C5.4.1. identify the difference between qualitative and quantitative analysis (separate science only)  **C5.4.2. explain how the mass of a solute and the volume of the solution is related to the concentration of the solution and calculate concentration using the formula:**  equation  **C5.4.3. explain how the concentration of a solution in mol/dm3 is related to the mass of the solute and the volume of the solution (C7.5a) and calculate the molar concentration using the formula**  equation  C5.4.4. describe neutralisation as acid reacting with alkali to form a salt plus water including the common laboratory acids hydrochloric acid, nitric acid and sulfuric acid and the common alkalis, the hydroxides of sodium, potassium and calcium  C5.4.5. recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions  C5.4.6. recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water  C5.4.7. describe and explain the procedure for a titration to give precise, accurate, valid and repeatable results  C5.4.8. evaluate the quality of data from titrations  **C5.4.9. explain the relationship between the volume of a solution of known concentration of a substance and the volume or concentration of another substance that react completely together (separate science only)**  IaS1, IaS2: Justify a technique in terms of precision, accuracy and validity of data to be collected, minimising risk. Use of range and mean when processing titration results, analysis of data | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  The OCR [‘Amount of Substance and the Mole delivery](https://www.ocr.org.uk/Images/170250-amount-of-substance-and-the-mole.pdf) guide’ contains many other useful links and discussion.  Discuss the use and conversion of units , specifically dm3, cm3, L and mL – it may be worth speaking to the Maths department about how they teach these and related concepts. Discuss the units of concentration, specifically mol/dm3 and g/dm3 and how dilution affects concentration. Use of visual demonstrations and everyday contexts – diluting orange squash, medicines, cleaning products etc can help.  The ‘[Calculating concentrations](http://chemistry.about.com/od/lecturenotesl3/a/concentration.htm)‘ website would be of interest to higher ability students. This ‘[Concentration of solutions calculations’](http://www.ausetute.com.au/concsols.html) website includes brief discussions and some worked examples. The ‘[Quantitative Chemistry’](http://www.rsc.org/learn-chemistry/resource/res00000954/starters-for-ten?cmpid=CMP00001405) section on the Starter for 10 resource contains useful example questions.  OCR has an activity on [making salts](http://www.ocr.org.uk/Images/179599-making-salts-activity-teacher-instructions.pdf) ([Student task sheet 1](http://www.ocr.org.uk/Images/179594-making-salts-activity-student-task-sheet-1-.doc), [student task sheet 2](http://www.ocr.org.uk/Images/179602-making-salts-activity-student-task-sheet-2.doc) and [Card sort activity](http://www.ocr.org.uk/Images/179595-making-salts-activity-card-sort.doc)). Simple animations are available from youtube for example from this ‘[Animation Neutralization Reaction](https://www.youtube.com/watch?v=uXJ-DfJkJhA)‘  A lesson on using the burette and pipette with just water is worthwhile to reduce the cognitive load for the learners when it is all put together for carrying out a titration. Demonstrating and insisting on good technique early pays dividends later on.  The Practical Project ‘[Titrating sodium hydroxide with hydrochloric acid’](http://www.rsc.org/learn-chemistry/resource/res00000697/titrating-sodium-hydroxide-with-hydrochloric-acid?cmpid=CMP00005972) activity provides instructions for carrying out a strong acid/alkali titration. An explanation/demonstration of the use of different indicators would be useful, for example the Practical Chemistry project ‘[Universal indicator ‘rainbow’](http://www.rsc.org/learn-chemistry/resource/res00000700/universal-indicator-rainbow?cmpid=CMP00005976)‘ activity.  [David Read](https://www.youtube.com/user/lowlevelpanic999/videos) has a range of useful videos available on many aspects of practical work including [performing titrations](https://www.youtube.com/watch?v=-x-q8hLB_rg) and [using volumetric pipettes](https://www.youtube.com/watch?v=5oTyJWdQ174). The Royal Society of Chemistry [Titration Screen experiment](http://www.rsc.org/learn-chemistry/resource/res00002077/titration-screen-experiment?cmpid=CMP00007002) is useful for pre and post-lesson learning and consolidation. | Topic C5.4 develops quantitative work further to show how the concentrations of solutions are determined. This has applications for the testing and quality control of manufactured chemical products and also allows the analysis of unknown chemicals for a range of purposes (for example in forensics, in drug production, mineral exploration and environmental monitoring). Learners make a standard solution and analyse the concentration of unknown solutions using titrations  Quantitative analysis is used by chemists to make measurements and calculations to show the amounts of each component in a sample.  **Concentrations sometimes use the units g/dm3 but more often are expressed using moles, with the units mol/dm3. Expressing concentration using moles is more useful because it links more easily to the reacting ratios in the equation.**  The concentration of acids and alkalis can be analysed using titrations. Alkalis neutralise acids. An indicator is used to identify the point when neutralisation is just reached. During the reaction, hydrogen ions from the acid react with hydroxide ions from the alkali to form water. The reaction can be represented using the equation  H+ (aq) + OH– (aq) → H2O(l)  As with all quantitative analysis techniques, titrations follow a standard procedure to ensure that the data is collected safely and is of high quality, including selecting samples, making rough and multiple repeat readings and using equipment of an appropriate precision (such as a burette and pipette).  Data from titrations can be assessed in terms of its accuracy, precision and validity. An initial rough measurement is used as an estimate and titrations are repeated until a level of confidence can be placed in the data; the readings must be close together with a narrow range. The true value of a titration measurement can be estimated by discarding roughs and taking a mean of the results which are in close agreement.  The results of a titration and the equation for the reaction are used to work out the concentration of an unknown acid or alkali.  Links can be made with:   * Strong and weak acid chemistry (C6.1)" |

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