# 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).

# Introduction

***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)

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)](http://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** |  |
| **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 | 7 / 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: C6 – Global challenges

## Total suggested teaching time – 36 / 18 hours (separate / combined)

### C6.1 – Improving processes and products (16 / 7 hours – separate / combined)

|  |  |  |
| --- | --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * oxidation reactions * properties of ceramics, polymers and composites (qualitative). * representing chemical reactions using formulae and using equations * the order of metals and carbon in the reactivity series * the properties of metals and non-metals * the use of carbon in obtaining metals from metal oxides | Links to Practical Activity Groups (PAGs)  * PAG C1: Extraction of copper by heating copper oxide with carbon * PAG C2: Electrolysis of aqueous sodium chloride solution * PAG C2: Electrolysis of aqueous copper sulfate solution * PAG C6: Preparation of potassium sulfate or ammonium sulfate using a titration method | |
| Links to Mathematical Skills  * M1a * M4b * M4c * M4d * M4e | Links to Working Scientifically | |
| * WS1.1a * WS1.1d * WS1.1e * WS1.1f * WS1.1g * WS1.2a * WS1.2b * WS1.2c * WS1.2d * WS1.2e * WS1.3a * WS1.3b | * WS1.3c * WS1.3d * WS1.3e * WS1.3f * WS1.3g * WS1.3h * WS1.3i * WS1.4 * WS1.4a * WS2a * WS2b |

| Suggested timings | Statements [to include] þ - separate science only bold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| C6.1  Part 1  6.5 / 3 hours  (separate / combined) | C6.1a – explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including extraction of a non-ferrous metal  C6.1b – explain why and how electrolysis is used to extract some metals from their ores  **C6.1c – evaluate alternative biological methods of metal extraction [bacterial and phytoextraction]**  C6.1o þ – describe the composition of some important alloys in relation to their properties and uses [steel, brass, bronze, solder, duralumin ]  C6.1p þ – describe the process of corrosion and the conditions which cause corrosion [iron and other metals]  C6.1q þ – explain how mitigation of corrosion is achieved by creating a physical barrier to oxygen and water and by sacrificial protection  C6.1r þ – compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals  C6.1s þ – explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  Balancing equations may need to be consolidated when looking at the redox equations – use of mini-white boards for rapid feedback/formative assessment might be appropriate here.  The Practical Chemistry Project [Extracting metals from rocks](http://www.rsc.org/learn-chemistry/resource/res00000478/extracting-metals-from-rocks?cmpid=CMP00005111) provides a useful practical context to discuss extraction of metals. An [RSC video](https://www.youtube.com/watch?v=vqFD_ly-qw0) on copper refining provides some useful background and context. .A presentation about bioleaching and phytomining can be found [here](https://www.youtube.com/watch?v=XF399zN36LE) Learners can observe a demonstration of the electrolytic purification of metal from [zinc chloride](http://www.rsc.org/learn-chemistry/resource/res00000826/electrolysis-of-molten-zinc-chloride?cmpid=CMP00005020).  Detailed notes on the industrial extraction of zinc, amongst other metals, are available at [docbrown.info](http://www.docbrown.info/page04/Mextractd.htm) and could form the basis of a research activity for learners. For example, split the discussed metals amongst the class and have the learners complete a short presentation/poster.  The Practical Chemistry project [‘Modelling alloys with plasticine’](http://www.rsc.org/learn-chemistry/resource/res00001755/modelling-alloys-with-plasticine?cmpid=CMP00005265) is a useful activity when discussing steel. Additionally, solder can be made in the ‘[Making an alloy’](http://www.rsc.org/learn-chemistry/resource/res00001742/making-an-alloy-solder?cmpid=CMP00006705) activity. [A short video](https://www.youtube.com/watch?v=1rrPv5AlVXg) on shape memory alloys from the University of Nottingham demonstrates the properties of these materials.  Corrosion chemistry can demonstrated in colourful style with the [Nail Corrosion](https://edu.rsc.org/exhibition-chemistry/nailing-corrosion-demonstrations/2000054.article) demonstration from Declan Fleming. Learners will likely have covered rusting at KS3, so a discussion may be sufficient here. The Practical Chemistry project ‘[The causes of rusting](http://www.rsc.org/learn-chemistry/resource/res00000434/the-causes-of-rusting?cmpid=CMP00006665)‘ provides a useful starting point if you wish to carry out practical investigations of the factors needed for rusting and/or the effectiveness of corrosion prevention (barrier and sacrificial protection methods).  For the discussion of redox reactions – [FuseSchool](https://www.youtube.com/watch?v=0lYXFJDDYAQ) has a useful introduction, as does [CrashCourse](https://www.youtube.com/watch?v=lQ6FBA1HM3s), although there is some advanced organic chemistry in here.  Testing properties of materials will likely have been covered at KS3 (or earlier), so practical investigation of some aspects may not be necessary (see also Topic C4) – the ‘[Properties of materials](http://www.rsc.org/learn-chemistry/resource/res00001792/the-properties-of-materials?cmpid=CMP00005337)‘ chapter from the That’s Chemistry resource provides some background. If investigation is used, properties could include 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 [document](http://outreach.materials.ox.ac.uk/LearningResources/downloads/MaterialsScienceandthenewGCSEScienceSpecifications.doc) # from the Department of Materials at Oxford University poses some interesting research questions for extension of materials. Where testing of some properties leads to spectacular destruction of the materials (e.g. brittleness of ceramics) demonstration rather than practical work may be more appropriate.  Composite materials can be investigated by making concrete, for example with a practical from the [Royal Society of Chemistry](http://www.rsc.org/learn-chemistry/resource/res00002022/making-concrete?cmpid=CMP00006759). Other interesting composite materials include [filigree glass](https://www.youtube.com/watch?v=RXtCqI-iMJ4) and [reinforced concrete](http://www.explainthatstuff.com/steelconcrete.html), | Historically, new materials have been developed through trial and error, experience etc. As our understanding of the structure of materials and chemical processes have improved we are increasing our ability to manipulate and design new materials. Industry is continually looking to make products that have a better performance and are sustainable to produce. This part also explores the extraction of raw materials and their use in making new products.  Learners should be familiar with the properties of ceramics, polymers and composites. They also will have met the method of using carbon to obtain metals from metal oxides. Learners often think that chemical reactions will continue until all the reactants are exhausted. They also tend to bring their physics interpretation of equilibrium, e.g. balanced, static, equal, making understanding of the dynamic nature of chemical equilibrium challenging.  When discussing properties of materials, setting the work in context can be helpful – the kitchen and school laboratory has many objects/materials to hand that covers the required range of substances. |
| C6.1  Part 2  5.5 hours  (separate only) | **C6.1d þ – explain the trade-off between rate of production of a desired product and position of equilibrium in some industrially important processes [the Haber process and Contact process]**  **C6.1e þ – interpret graphs of reaction conditions versus rate**  **C6.1f þ – explain how the commercially used conditions for an industrial process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate**  C6.1g þ – explain the importance of the Haber process in agricultural production  C6.1h þ – compare the industrial production of fertilisers with laboratory syntheses of the same products  C6.1i þ – recall the importance of nitrogen, phosphorus and potassium compounds in agricultural production  C6.1j þ – describe the industrial production of fertilisers as several integrated processes using a variety of raw materials [ammonium nitrate and ammonium sulfate]  CM6.1i – arithmetic computation, ratio when measuring rates of reaction [M1a, M1c]  CM6.1ii – drawing and interpreting appropriate graphs from data to determine rate of reaction [M4b, M4c]  CM6.1iii þ – determining gradients of graphs as a measure of rate of change to determine rate [M4d, M4e]  CM6.1iv þ – proportionality when comparing factors affecting rate of reaction [M1c] | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  Examine historical, social, moral or economic reasons leading to the need to produce ammonia as a starting point for fertiliser production. Fritz Haber is an [interesting case study](http://www.bbc.co.uk/news/world-13015210) in how scientists’ work is not in isolation from the rest of society. The Aus-e-tute website contains a useful [list of uses of ammonia](http://www.ausetute.com.au/haberpro.html).  Plotting the [yield of ammonia](http://wps.prenhall.com/wps/media/objects/3312/3391885/blb1506.html) at different pressures and temperatures can lead into discussions about trade-off between yield and rate. [BBC Bitesize](https://www.bbc.co.uk/bitesize/guides/ztbqfcw/revision/4) has couple of animations on how conditions affect yield. More detailed information is available from [Chemguide](http://www.chemguide.co.uk/physical/equilibria/haber.html) and the [Royal Society of Chemistry Alchemy project video](http://www.rsc.org/learn-chemistry/resource/res00000017/ammonia?cmpid=CMP00001797#!cmpid=CMP00001682).  There are many useful websites that learners can use to research the Contact Process, including detailed discussion on [Chemguide](http://www.chemguide.co.uk/physical/equilibria/contact.html) and the [Essential Chemical Industry](http://www.essentialchemicalindustry.org/chemicals/sulfuric-acid.html) websites, and a video from the [Royal Society of Chemistry Alchemy project](https://edu.rsc.org/resources/sulfuric-acid/30.article).  A useful starting point for research about fertilizers is the [Essential Chemical Industry online](http://www.essentialchemicalindustry.org/materials-and-applications/fertilizers.html) website. [Nitric acid production](http://www.rsc.org/learn-chemistry/resource/res00000025/nitric-acid?cmpid=CMP00001805) is included in the Alchemy project.  Production of fertilizers from raw materials is an interesting synoptic challenge for learners. Start them with raw materials (methane, air, water, sulfur) and any information they haven’t already met (e.g. reforming of methane to hydrogen, Ostwald process for nitric acid production) and set them the challenge of designing an industrial pathway to ammonium sulfate and ammonium nitrate.  Use the videos on industrial production of fertilizers to compare with the laboratory based preparation (e.g. [OCR PAG 3 – separation techniques](https://www.ocr.org.uk/Images/323640-pag-activity-chemistry-separation-techniques-suggestion-2.docx)) .  A brief summary of the importance of nitrogen, phosphorus and potassium can be found at the [Noble Foundation website](http://www.noble.org/ag/soils/back2basics/), including images of NPK deficient plants. Learners may have covered this at KS3, for example growing tomato plants in mineral deficient soils. | This part is about why it was necessary to make ammonia for use as a fertiliser and how the Haber process is adapted to increase the amount of ammonia produced. The Contact process is also discussed, and much of chemistry is brought together within the discussion of synthesis of fertilizers, including the economics, rates of reaction, conditions of reaction equilibrium and yield. |
| C6.1  Part 3  4 hours  (separate and combined) | C6.1k – describe the basic principles in carrying out a life-cycle assessment of a material or product  C6.1l – interpret data from a life-cycle assessment of a material or product  C6.1m – describe a process where a material or product is recycled for a different use, and explain why this is viable  C6.1n – evaluate factors that affect decisions on recycling | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  There are numerous websites for learners to research the problems of disposal of plastic waste, for example the [British Plastics Federation](http://www.bpf.co.uk/sustainability/plastics_recycling.aspx), [local council websites](http://www.north-herts.gov.uk/home/waste-and-recycling/household-waste-and-recycling/household-waste-and-recycling-information) and a report from the [Department for Environment, Food and Rural Affairs](https://www.gov.uk/government/publications/2010-to-2015-government-policy-waste-and-recycling/2010-to-2015-government-policy-waste-and-recycling). A box of different products would allow learners to sort different types of plastics and identify how their properties relate to their uses. Have them discuss the problems of an industrial scale recycling process for plastics.  Learners could also be organised into groups to research and debate a proposal such as “The development of a plastic recycling plant should be supported by our local council”, along the lines of the [SATIS Limestone Enquiry](https://www.stem.org.uk/elibrary/resource/25907/science-and-technology-in-society-6) activity (free login required).  Life-cycle assessment is discussed on the [Global Development Research Centre website](http://www.gdrc.org/uem/lca/lca-define.html) and on the [BBC Bitesize website](http://www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/materials/makinglifecycleassessmentsrev1.shtml).  The BPF website contains some information on [PET drinks bottles](http://www.bpf.co.uk/sustainability/PET_Plastic_Bottles_Facts_Not_Myths.aspx). Many school uniforms are made from recycled polyester, including PET, making for an interesting context. The STEM Learning website has a collection of available resources on [Sustainability and life cycle assessment](https://www.stem.org.uk/elibrary/list/45775/sustainability-and-life-cycle-assessment), including the ‘[The Paper Cup Company](https://www.stem.org.uk/elibrary/resource/25377/the-paper-cup-company)‘ activity." |  |

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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 | C6.1c | These [resources](https://www.tes.com/teaching-resource/c10-using-resources-metal-extraction-phytomining-and-bioleaching-aqa-9-1-11850548) include a power point on phytomining, an information sheet on the use of bacteria in metal extraction, and questions on both processes. |
| 2 | C6.1d – C6.1f | A short [video](https://www.youtube.com/watch?v=HAkaD6-7fgQ) explaining the compromise conditions involved in the Haber process and explaining how to interpret graphs of reaction conditions versus rate. |
| 3 | C6.1k – C6.1l | [RSC activity](https://edu.rsc.org/resources/assessing-the-life-cycle-of-fashion/4010470.article) on assessing the life cycle of fashion. Involves reading an article and completing worksheets based on it. |
|  |  | 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: C6 – Global challenges

## Total suggested teaching time – 36 / 18 hours (separate / combined)

### C6.2 – Organic chemistry (12 / 4 hours – separate / combined)

|  |  |
| --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * combustion reactions * representing chemical reactions using formulae and using equations * the production of carbon dioxide by human activity and the impact on climate * simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography | Links to Practical Activity Groups (PAGs)  * PAG C4: Separation of mixtures by fractional distillation |
| Links to Mathematical Skills  * M5b | Links to Working Scientifically  * WS1.1c * WS1.1e * WS1.1f * WS1.1g * WS1.1i * WS1.2a * WS1.2b * WS1.2c * WS1.3f * WS1.4a * WS2a * WS2b |

| Suggested timings | Statements [to include] þ - separate science only bold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| C6.2  Part 1  4 hours  (separate and combined) | C6.2j – describe the separation of crude oil by fractional distillation [the names of the fractions]  C6.2k – explain the separation of crude oil by fractional distillation [molecular size and intermolecular forces]  C6.2l – describe the fractions as largely a mixture of compounds of formula CnH2n+2 which are members of the alkane homologous series  C6.2m – recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry  C6.2n – explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource  C6.2o – describe the production of materials that are more useful by cracking [conditions and reasons for cracking and some of the useful materials produced] | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  As fossil fuels have likely been covered prior to KS4, research/independent work with short learner presentations is a useful introduction to this topic – this [short video](http://scicast.org.uk/films/2009/04/formation-of-crude-oil.html) might provide inspiration. The [RSC video on oil refinery](https://www.youtube.com/watch?v=b5xScdRbXEU) is a little dated, but remains a good introduction to the topic. An interactive tour of the [Fawley refinery](http://resources.schoolscience.co.uk/exxonmobil/index.html) provides opportunity for independent work. The [footprints-science](http://www.footprints-science.co.uk) website provides a wealth of resources, including relevant animations on [fractional distillation](http://www.footprints-science.co.uk/index.php?module=2&type=Fractional%20distillation&section=Section1&info=6).  Discussion of the link between state change and intra/intermolecular bonding can be aided by the use of models. For example, cut some wool up into various lengths to represent the different alkanes in crude oil and squash them into a small plastic cup. Learners can then separate them out (fractional distillation) without cutting them (cracking). Use of molecular models allows for similar modelling and the discussion of covalent and intramolecular bonds.  Cracking of hydrocarbons can be carried out as a demonstration or practical, either at [bench-scale](http://www.rsc.org/learn-chemistry/resource/res00000681/cracking-hydrocarbons?cmpid=CMP00005002) or [micro-scale](http://www.rsc.org/learn-chemistry/resource/res00001717/cracking-hydrocarbons-on-a-microscale?cmpid=CMP00005231). Selection of data from this detailed [report](https://www.ukpia.com/media/1005/the-economic-contribution-of-the-downstream-oil-sector-evidence-paper.pdf) and the [petroleum.co.uk](http://www.petroleum.co.uk/) website would allow for analysis of secondary data in homework/research projects.  Building up the alkane homologous series with molecular models or card cut-out atoms and bonds allows learners to work out the general formula from their own modelling. They will also be able to get a feel for empirical formula, which should support their conceptual understanding when empirical formulae are derived from experimental data. | Carbon chemistry is the basis of life on Earth. Organic chemistry is the basis of many of the materials we produce. Organic compounds are covalent in nature and react in a predictable pattern. Crude oil forms the basis of many useful by-products.  Learners should be familiar with reactions and displayed formula.  Learners should discuss the economic, political and environmental problems involved in using crude oil. This would be a good chance to develop understanding of how science contributes to society, highlighting how different groups may have different ideas of the advantages and disadvantages of oil and how these groups could be affected differently by the use of oil and by the exploration for it. |
| C6.2  Part 2  3 hours  (separate only) | C6.2a þ – recognise functional groups and identify members of the same homologous series [homologous series, of alkanes, alkenes, alcohols and carboxylic acids]  C6.2b þ – name and draw the structural formulae, using fully displayed formulae, of the first four members of the straight chain alkanes, alkenes, alcohols and carboxylic acids þ C6.2c þ – predict the formulae and structures of products of reactions of the first four and other given members of the homologous series of alkanes, alkenes and alcohols [combustion; addition of bromine and hydrogen across a double bond; oxidation of alcohols to carboxylic acids using potassium manganate(VII)]  C6.2i þ – recall that it is the generality of reactions of functional groups that determine the reactions of organic compounds  CM6.2i þ – represent three-dimensional shapes in two dimensions and vice versa when looking at chemical structures, e.g. allotropes of carbon [M5b] | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  Detailed notes on organic substances are widely available, for example from [chemguide](http://www.chemguide.co.uk/organicprops/alcohols/background.html) and [knockhardy](http://www.knockhardy.org.uk/sci_htm_files/08oic.pdf). These are A-level chemistry websites so need to be used selectively, but are useful for particular keen learners.  It is worth distinguishing clearly between molecular, structural and fully displayed formulae when practicing the drawing organic substances. Interesting discussion can be had over the first member of the alkene series having drawn methane, methanol and methanoic acid (methene?!). Learners understanding could be extended by introducing isomerism, and challenging them to identify all of the isomers of, for example, heptane (nine in total). As ever with structure, molymods or similar are very helpful here.  Writing word and symbol equations for combustion, addition and oxidation reactions of the organic substances will provide good opportunity to consolidate balancing equations. Demonstration / practical activities can add variety to an otherwise possibly dry topic, including reaction of bromine water with various hydrocarbons (perhaps as part of the cracking lesson), and [investigating the oxidation of alcohols](http://www.rsc.org/learn-chemistry/resource/res00000553/a-microscale-oxidation-of-alcohols?cmpid=CMP00005960).  Regular revision of the nomenclature and basic properties of organic substances is recommended – sites such as [Quizlet](https://quizlet.com/5121323/flashcards) can help with this out of class. | Learners tend not to bring the concepts from general chemistry in their study of organic chemistry. They can have difficulty identifying functional groups and naming and drawing the compounds. |
| C6.2  Part 3  4 hours  (separate only) | C6.2d þ – recall the basic principles of addition polymerisation by reference to the functional group in the monomer and the repeating units in the polymer  **C6.2e** þ **– explain the basic principles of condensation polymerisation [reference to the functional groups of the monomers, the minimum number of functional groups within a monomer, the number of repeating units in the polymer, and simultaneous formation of a small molecule, e.g. a polyester or polyamide, using block diagrams to represent polymers]**  **C6.2f** þ **– describe practical techniques to make a polymer by condensation**  C6.2g þ – deduce the structure of an addition polymer from a simple alkene monomer and vice versa [the following representation of a polymer [repeat unit]  C6.2h þ – recall that DNA is a polymer made from four different monomers called nucleotides and that other important naturally-occurring polymers are based on sugars and amino-acids [the names of the nucleotides] | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  Many websites have useful introductory videos including from [CrashCourse](https://www.youtube.com/watch?v=rHxxLYzJ8Sw) and [FuseSchool](https://www.youtube.com/watch?v=nz1ucI6gCIg) on polymers and [StatedClearly](https://www.youtube.com/watch?v=zwibgNGe4aY) on DNA.  Demonstration of cracking paraffin and testing the gaseous product for unsaturation makes the link from discussion of crude oil to polymer synthesis – a [bench scale](http://www.rsc.org/learn-chemistry/resource/res00000681/cracking-hydrocarbons?cmpid=CMP00005002) and a [micro-scale](http://www.rsc.org/learn-chemistry/resource/res00001717/cracking-hydrocarbons-on-a-microscale?cmpid=CMP00005231) version are available. Additionally, starch could be broken down by enzyme hydrolysis with testing for starch/sugars to link with Biology. Demonstrations/practicals of polymer formation include the [nylon rope trick](http://www.rsc.org/learn-chemistry/resource/res00000755/making-nylon-the-nylon-rope-trick?cmpid=CMP00000834) and [polymerisation of polyols](http://www.rsc.org/learn-chemistry/resource/res00000479/addition-polymerisation?cmpid=CMP00004755).  Testing properties of different polymer fibres – see discussion in C6.1 Part 1.  Teaching polymers allows for use of modelling and role play. For example, each learner starts with a paper clip, which successively get linked together around the room until poly(paper clip) is formed. Molymods are an alternative way of candidates realising that only one of the bonds in the double bond breaks. Making [stop-motion animations](https://www.youtube.com/watch?v=nASPhhkkwcs) can engage learners’ creative, scientific and communication skills. For role-play, learners double bond by holding hands, all crowd together (high pressure). A catalyst (teacher or single learner) then breaks one double bond, the free hand breaks the next ‘bond’ and so on, the chain grows until the whole class is holding hands in a large chain.  Learners should know that the monomers are unsaturated, whereas the polymers are saturated. Learners will need practice changing monomer structure into polymer and polymer structure into monomer, and naming polymers, for example polyethene, polyvinyl chloride and polystyrene. The Royal Society of Chemistry website contains many useful resources, including a [Monomer-polymer cardsort](https://edu.rsc.org/resources/large-molecules/1921.article).  For research/independent work/homework, learners could be assigned a different polymer to research and present the discovery of and use of in society, including disadvantages. Many [websites](https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/polymers.htm) are available – this one goes well beyond the chemistry required, but contains a useful table of different polymers. | This part extends the story of organic compounds to polymers, specifically condensation and addition polymers. There are lots of interesting contexts available here from natural polymers (e.g. silk and wool) to modern man-made polymers (e.g. Kevlar and Goretex).  Many natural polymers are essential to life. Genes are encoded in of DNA, a polymer of four nucleotide monomers. Proteins (which are similar in structure to polyamides) are polymers of amino acids. Carbohydrates, including starch and cellulose, are polymers of sugars.  This part links to Biology where DNA and protein synthesis are taught – therefore this part may then just need revision.  As with the previous Topic, many aspects of chemistry are brought together here including the links between structure, properties and function, bonding, and reactivity. |
| C6.2  Part 4  1 hours  (separate only) | C6.2p þ – recall that a chemical cell produces a potential difference until the reactants are used up  C6.2q þ – evaluate the advantages and disadvantages of hydrogen/oxygen and other fuel cells for given uses [the chemistry of the hydrogen/oxygen fuel cell] | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  The [Exploding Soap Bubbles](https://edu.rsc.org/exhibition-chemistry/exploding-soap-bubbles/2020051.article) demonstration is an interesting way of introducing the reaction between hydrogen and oxygen. Toy hydrogen fuel cell cars (for example from [HorizonEducational](https://www.horizoneducational.com/produkty?productFilter%5Belse%5D%5Bparams_1008%5D%5B0%5D=46&productFilter%5Border%5D%5Bby%5D=1)) can be useful for introducing fuel cell technology. A fuel cell to make in the classroom is described in this demonstration from the [Royal Society of Chemistry](https://www.stem.org.uk/elibrary/resource/33583). Many website discuss fuel cells, for example [HowStuffWorks](http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/fuel-cell.htm), and they can make interesting [research projects](http://www.nasa.gov/centers/glenn/technology/fuel_cells.html). | Using hydrogen fuel cells as an alternative to fossil fuels for transport is one way to decrease the emission of pollutants in cities. The reaction in the fuel cell is equivalent to the combustion of hydrogen and gives the same product (water) but the energy drives an electric motor rather than an internal combustion engine. However, hydrogen is usually produced by electrolysis, which may use electricity generated from fossil fuels so pollutants may be produced elsewhere. |

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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 | C6.2c | Short [video](https://www.ocr.org.uk/Images/587847-c6-cup-elevate-video-bromine-test-for-a-double-bond.mp4) showing the bromine test for an alkene – click on ‘media’ then ‘video 10.2’. |
| 3 | C6.2e – C6.2f | [Video and teaching pack](https://ocr.org.uk/rpgchem5) for Making nylon – an example of condensation polymerisation. 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. |

# Outline Scheme of Work: C6 – Global challenges

## Total suggested teaching time – 36 / 18 hours (separate / combined)

### C6.3 – Interpreting and interacting with earth systems (7 hours – separate and combined)

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| --- | --- |
| Links to KS3 Subject content  * chemical reactions as the rearrangement of atoms * combustion reactions * representing chemical reactions using formulae and using equations * simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography * the composition of the atmosphere * the production of carbon dioxide by human activity and the impact on climate. | Links to Practical Activity Groups (PAGs) |
| Links to Mathematical Skills  * M2c * M2h * M4a | Links to Working Scientifically  * WS1.1a * WS1.1f * WS1.1h * WS1.3e * WS1.4a |

| Suggested timings | Statements [to include] þ - separate science only bold – Higher Tier only | Teaching activities | Notes |
| --- | --- | --- | --- |
| C6.3  7 hours  (separate and combined) | CM6.3i – extract and interpret information from charts, graphs and tables [M2c, M4a]  CM6.3ii – use orders of magnitude to evaluate the significance of data [M2h]  C6.3a – interpret evidence for how it is thought the atmosphere was originally formed [knowledge of how the composition of the atmosphere has changed over time]  C6.3b – describe how it is thought an oxygen-rich atmosphere developed over time  C6.3c – describe the greenhouse effect in terms of the interaction of radiation with matter within the atmosphere  C6.3d – evaluate the evidence for additional anthropogenic (human activity) causes of climate change and describe the uncertainties in the evidence base [the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels]  C6.3e – describe the potential effects of increased levels of carbon dioxide and methane on the Earth’s climate and how these effects may be mitigated [consideration of scale, risk and environmental implications]  C6.3f – describe the major sources of carbon monoxide, sulfur dioxide, oxides of nitrogen and particulates in the atmosphere and explain the problems caused by increased amounts of these substances  C6.3g – describe the principal methods for increasing the availability of potable water in terms of the separation techniques used [ease of treatment of waste, ground and salt water] | An [OCR delivery guide](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/delivery-guide/) for this section is available on the [qualification page](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/). The [Scheme of work builder](http://www.ocr.org.uk/qualifications/gcse-gateway-science-suite-chemistry-a-j248-from-2016/scheme-of-work/) is also available that links specification learning outcomes directly to resources.  There are lots of sources of useful information on the development of the Earth’s atmosphere and the current atmosphere:   * [Notes from docbrown](http://www.docbrown.info/page21/GeoChangesANS01a.htm) about the atmosphere from the legacy specification. * The wide-ranging [windows2universe website](http://www.windows2universe.org/Earth/cmmap/fun.html) on all aspects of the Earth and atmosphere. * Videos from [BBC Bitesize](https://www.youtube.com/watch?v=6Db2WAG-VVs), the [Big History Project](https://www.youtube.com/watch?v=Gyn754vw8ZQ) and [FuseSchool](https://www.youtube.com/watch?v=sturoUChNo4). * Some notes on air pollution from BBC [Bitesize](https://www.bbc.co.uk/bitesize/guides/zsmn4qt/revision/7)  and [docbrown](http://www.docbrown.info/page04/OilProducts04.htm) * This [DEFRA website](https://uk-air.defra.gov.uk/) gives the current state of air quality in the UK and other useful resources.   The production and consequence of pollutants in the atmosphere can be used to bring together many aspects of chemistry – e.g. chemical reaction, structure and bonding, rates of reaction and the interaction of science and technology with society. Poster or oral presentations could be used to help learners organise their thoughts and provide formative feedback.  Links can be made to Biology regarding the evolution of photosynthesis, and Physics regarding the role of electromagnetic radiation in the greenhouse effect.  A classic demonstration is burning sulfur in an oxygen gas jar – add a little water and universal indicator solution beforehand and demonstrate the increasing acidity of the water as SO2 is formed.  A short practical to demonstrate the effects of incomplete combustion is heating boiling tubes of water with the different Bunsen flames – observe the outside of the tube, and temperature change to demonstrate the incomplete combustion (yellow flame) producing soot and transferring less energy than the roaring blue flame.  Website information is available about [gas scrubbers](http://www.engineeringtoolbox.com/scrubbers-air-washers-d_139.html), [catalytic convertors](http://auto.howstuffworks.com/catalytic-converter.htm) and [low sulphur petrol](http://www.ukpia.com/industry_issues/fuels/sulphur-free-petrol-diesel-and-non-road-fuels.aspx).  Climate change models could be investigated using both physical models and computer models. The [Climateprediction](http://www.climateprediction.net/education/21st-century-science/) website includes lesson plans and practical suggestions.  The OCR ‘[Skill Up Lesson Bundle – What’s the conclusion?](http://www.ocr.org.uk/Images/71507-skill-up-lesson-what-s-the-conclusion-teachers-guide.doc)’ activity helps develop learners’ skills in drawing conclusions ([Student Sheets](http://www.ocr.org.uk/Images/70031-skill-up-lesson-what-s-the-conclusion-student-sheets.ppt) and [Presentation](http://www.ocr.org.uk/Images/75921-skill-up-lesson-what-s-the-conclusion-presentation.ppt)).  Provision of potable water provides good opportunities for small group research and presentation. Plenty of videos are available for initial stimulus (for example from [Severn Trent Water](https://www.youtube.com/watch?v=9z14l51ISwg) and [UnityWater](https://www.youtube.com/watch?v=8isr9nSDCK4)). Divide learners into groups (3-4), assign each a technique to research and produce a 1-2 minute presentation on, then have the group combine the work into a complete presentation. Randomly select some of the groups to present to the whole class, and have other groups peer assess for quality of presentation, science etc. | As our understanding of the structure of materials and chemical processes has improved we are increasing our ability to interpret and understand chemical and earth systems. Understanding how we interact with them is very important to our survival as a species. This section starts with the history of the atmosphere and moves on to how human activity could be affecting its composition.  Learners should have some understanding of the composition of the Earth, the structure of the Earth, the rock cycle, the carbon cycle, the composition of the atmosphere and the impact of human activity on the climate.  Learners think that the atmosphere is large and that small increases of carbon dioxide or a few degrees of temperature change do not make a difference to the climate. They may consider that global warming is caused by the ozone hole and that human activities alone cause the greenhouse effect. |



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