# Switching AQA GCSE (9-1) Chemistry to OCR GCSE (9-1) Twenty First Century Chemistry B

## Introduction

Are you currently teaching the AQA GCSE sciences? Are you thinking of switching? We are here to help.

We will provide you with all the support you could need to switch from the AQA GCSE Chemistry qualification to our OCR GCSE Chemistry B, including:

* Mapping of AQA’s specification to OCR’s specification
* An overview of the differences in assessment
* Mapping of the AQA textbook to OCR’s specification

## Our offer

* Our GCSE (9-1) Twenty First Century Chemistry B qualification has been developed in partnership with University of York Science Education Group (UYSEG), and working with a number of stakeholders, including OCR Science Consultative Forum, teachers and assessors. It has been created to be a qualification which engages students so they achieve their full potential.
* Our GCSE team are passionate about both science and education. With industry, teaching and assessment experience, they are fully committed to supporting centres’ delivery of our GCSE qualifications.
* We have produced a wide range of support materials, such as handbooks (including maths skills), delivery guides, practical activities and end of chapter quizzes. We have a selection of practice papers which can be used as mock papers in preparation for the exams and we have a free and user-friendly tool - ExamBuilder - that you can use to create customised papers for students.
* Within this document as well as mapping the specifications, we also provide textbook mapping – illustrating how you can use your existing AQA textbooks to teach the OCR specification; making it easier for you to use the resources you already have.
* Join our conversations on the OCR Community and @ocr\_science on Twitter to discuss and share good practice.

## Key differences

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| **OCR GCSE (9-1) Twenty First Century Chemistry B** | **AQA GCSE (9-1) Chemistry** |
| **8 flexible practical** activities - select from our suggested activities or use your own preferred practical activities | 8 required practical activities you have to deliver |
| In each assessment students have 1 hour and 45 minutes to complete **90** marks worth of | In each assessment students have 1 hour and 45 minutes to complete **100** marks worth of questions |
| Context – linked specification | Content led specification |
| Two 6 mark level of response in the depth paper and **none** in the breadth. | Not a set number, but **more than one** 6 mark level of response question on all sample assessment material |

## Content mapping

The content within the OCR GCSE (9-1) in Chemistry B (Twenty First Century Science) covers the key concepts of chemistry and will be very familiar. We’ve laid it out in a logical progression to support teaching the GCSE in a linear way.

Below is a table to show where AQA Chemistry content is covered in the OCR Twenty First Century Chemistry specification.

| **AQA Chemistry (8462)** | **OCR Chemistry B (Twenty First Century Science)** | **Additional Content In AQA Chemistry** |
| --- | --- | --- |
| 4.1.1 A simple model of the atom, symbols, relative atomic mass, electronic charge and isotopes | C2.1 How have our ideas about atoms developed over time?  C2.2 What does the Periodic Table tell us about elements?  C2.4 How are equations used to represent chemical reactions?  C3.3 What are electrolytes and what happens during electrolysis?  C5.1 How are chemicals separated and tested for purity? | 4.1.1.3 The development of the model of the atom (common content with physics) |
| 4.1.2 The periodic table | C2.2 What does the periodic table tell us about elements?  C2.3 How do metals and non-metals combine to form compounds? |  |
| 4.1.3 Properties of transition metals (chemistry only) | C2.5 What are the properties of the transition metals? (separate science only) |  |
| 4.2.1 Chemical bonds, ionic, covalent and metallic | C2.3 How do metals and non-metals combine to form compounds?  C2.4 How are equations used to represent chemical reactions?  C3.1 How are atoms held together in a metal?  C3.4 Why is crude oil important as a source of new materials?  C4.3 How do bonding and structure affect the properties of materials? |  |
| 4.2.2 How bonding and structure are related to the properties of substances | C1.1 How has the Earth's atmosphere changed over time, and why?  C2.3 How do metals and non-metals combine to form compounds?  C3.1 How are atoms held together in a metal?  C3.4 Why is crude oil important as a source of new materials?  C4.1 How is data used to choose a material for a particular use?  C4.2 What are the different types of polymer? (separate science only)  C4.3 How do bonding and structure affect the properties of materials? |  |
| 4.2.3 Structure and bonding of carbon | C4.3 How do bonding and structure affect the properties of materials?  C4.4 Why are nanoparticles so useful? |  |
| 4.2.4 Bulk and surface properties of matter including nanoparticles (chemistry only) | C4.4 Why are nanoparticles so useful? |  |
| 4.3.1 Chemical measurements, conservation of mass and the quantitative  interpretation of chemical equations | C5.3 How are the amounts of substances in reactions calculated?  C5.4 How are the amounts of chemicals in solution measured? |  |
| 4.3.2 Use of amount of substance in relation to masses of pure substances | C5.3 How are the amounts of substances in reactions calculated?  C5.4 How are the amounts of chemicals in solution measured? |  |
| 4.3.3 Yield and atom economy of chemical reactions (chemistry only) | C5.3 How are the amounts of substances in reactions calculated?  C6.3 What factors affect the yield of chemical reactions?  C6.4 How are chemicals made on an industrial scale? (separate science only) |  |
| 4.3.4 Using concentrations of solutions in mol/dm3 (chemistry only) (HT only) | C5.4 How are the amounts of chemicals in solution measured? |  |
| 4.3.5 Use of amount of substance in relation to volumes of gases  (chemistry only) (HT only) | C5.3 How are the amounts of substances in reactions calculated? |  |
| 4.4.1 Reactivity of metals | C2.2 What does the Periodic Table tell us about elements?  C2.5 What are the properties of the transition metals? (separate science only)  C3.2 How are metals with different reactivities extracted?  C3.3 What are electrolytes and what happens during electrolysis? |  |
| 4.4.2 Reactions of acids | C5.4 How are the amounts of chemicals in solution measured?  C6.1 What useful products can be made from acids? |  |
| 4.4.3 Electrolysis | C3.2 How are metals with different reactivities extracted?  C3.3 What are electrolytes and what happens during electrolysis? |  |
| 4.5.1 Exothermic and endothermic reactions | C1.2 Why are there temperature changes in chemical reactions? |  |
| 4.5.2 Chemical cells and fuel cells (chemistry only) | C1.2 Why are there temperature changes in chemical reactions? | (HT only) write the half equations for the electrode reactions in the hydrogen fuel cell |
| 4.6.1 Rate of reaction | C6.2 How do chemists control the rate of reaction? |  |
| 4.6.2 Reversible reactions and dynamic equilibrium | C6.3 What factors affect the yield of chemical reactions? |  |
| 4.7.1 Carbon compounds as fuels and feedstock | C3.4 Why is crude oil important as a source of new materials? |  |
| 4.7.2 Reactions of alkenes and alcohols (chemistry only) | C3.4 Why is crude oil important as a source of new materials? |  |
| 4.7.3 Synthetic and naturally occurring polymers (chemistry only) | C4.2 What are the different types of polymer? (separate science only) |  |
| 4.8.1 Purity, formulations and chromatography | C5.1 How are chemicals separated and tested for purity? |  |
| 4.8.2 Identification of common gases | C1.1 How has the Earth's atmosphere changed over time, and why?  C1.4 How can scientists help improve the supply of potable water? |  |
| 4.8.3 Identification of ions by chemical and spectroscopic means (chemistry only) | C5.2 How do chemists find the composition of unknown samples? (separate only)  C6.1 What useful products can be made from acids? |  |
| 4.9.1 The composition and evolution of the Earth's atmosphere | C1.1 How has the Earth's atmosphere changed over time, and why? |  |
| 4.9.2 Carbon dioxide and methane as greenhouse gases | C1.1 How has the Earth's atmosphere changed over time, and why?  C1.3 What is the evidence for climate change, why is it occurring? |  |
| 4.9.3 Common atmospheric pollutants and their sources | C1.1 How has the Earth's atmosphere changed over time, and why?  C1.3 What is the evidence for climate change, why is it occurring? |  |
| 4.10.1 Using the Earth's resources and obtaining potable water | C1.3 What is the evidence for climate change, why is it occurring?  C1.4 How can scientists help improve the supply of potable water?  C3.2 How are metals with different reactivities extracted? |  |
| 4.10.2 Life cycle assessment and recycling | C4.5 What happens to products at the end of their useful life? |  |
| 4.10.3 Using materials (chemistry only) | C4.5 What happens to products at the end of their useful life?  C4.1 How is data used to choose a material for a particular use? |  |
| 4.10.4 The Haber process and the use of NPK fertilisers  (chemistry only) | C6.4 How are chemicals made on an industrial scale? (separate science only) |  |

## Assessment

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| --- | --- |
| **OCR GCSE (9-1) Twenty First Century Chemistry B** | **AQA GCSE (9-1) Chemistry** |
| **Paper 1 (Breadth)**  Assessed: All Chapters  Time allowed: 1 hour 45 minutes  Foundation and Higher tier available  Marks: 90 marks  Weighting: 50% of GCSE  Question types: Short answer(maximum 4 marks per question), some multiple choice and objective style questions | **Paper 1**  Assessed: Topics 1-5  Time allowed: 1 hour 45 minutes  Foundation and Higher tier available  Marks: 100 marks  Weighting: 50% of GCSE  Question types: Multiple choice, structured, closed short answer and open response |
| **Paper 2 (Depth)**  Assessed: All chapters  Foundation and Higher tier available  Marks: 90 marks  Weighting: 50% of GCSE  Question types: Multiple choice, structured, closed short answer and open response, 2 x 6 mark Level of response questions | **Paper 2**  Assessed: Topics 6-10 (may draw on knowledge from topics 1-4)  Time allowed: 1 hour 45 minutes  Foundation and Higher tier available  Marks: 100 marks  Weighting: 50% of GCSE  Question types: Multiple choice, structured, closed short answer and open response. |

## Using the AQA textbook

Below you will find all the information you need to start teaching OCR GCSE (9-1) Twenty First Century Chemistry B while still using the new AQA textbooks. We have mapped our specification to the AQA OUP, Hodder and Collins textbooks to save you having to buy another set of textbooks. We have endorsed textbooks for use with our specification, however. Details are on the subject page on the OCR website.

## AQA OUP textbook mapping

| **Specification statement** | **Chapter covering specification statement** | **Page number** | **Comments** |
| --- | --- | --- | --- |
| **Chapter C1 Air and water** | | | |
| **C1.1 How has the Earth's atmosphere changed over time, and why?** | | | |
| C1.1.1 recall and explain the main features of the particle model in terms of the states of matter and change of state, distinguishing between physical and chemical changes and recognise that the particles themselves do not have the same properties as the bulk substances | C3 Structure and bonding | 36-37 |  |
| **C1.1.2 explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres** | C3 Structure and bonding | 37 |  |
| C1.1.3 use ideas about energy transfers and the relative strength of forces between particles to explain the different temperatures at which changes of state occur | C3 Structure and bonding | 37 |  |
| C1.1.4 use data to predict states of substances under given conditions | C3 Structure and bonding | 60 | Appears in Summary Questions |
| C1.1.5 interpret evidence for how it is thought the atmosphere was originally formed | C13 The Earth's atmosphere | 194-195 |  |
| C1.1.6 describe how it is thought an oxygen-rich atmosphere developed over time | C13 The Earth's atmosphere | 194 |  |
| C1.1.7 describe the major sources of carbon monoxide and particulates (incomplete combustion), sulfur dioxide (combustion of sulfur impurities in fuels), oxides of nitrogen (oxidation of nitrogen at high temperatures and further oxidation in the air) | C13 The Earth's atmosphere | 202 |  |
| C1.1.8 explain the problems caused by increased amounts of these substances and describe approaches to decreasing the emissions of these substances into the atmosphere including the use of catalytic converters, low sulfur petrol and gas scrubbers to decrease emissions | C13 The Earth's atmosphere | 200 | Catalytic converters do not seem to be mentioned |
| C1.1.9 use chemical symbols to write the formulae of elements and simple covalent compounds | C1 Atomic structure | 6 |  |
| C1.1.10 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations | C1 Atomic structure | 6 |  |
| C1.1.11 use arithmetic computations and ratios when balancing equations | C1 Atomic structure | 6 |  |
| C1.1.12 describe tests to identify oxygen, hydrogen and carbon dioxide PAG2 | C12 Chemical Analysis | 185 |  |
| C1.1.13 explain oxidation in terms of gain of oxygen | C5 Chemical Changes | 91 |  |
| **C1.2 Why are there temperature changes in chemical reactions?** | | | |
| C1.2.1 distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings | C7 Energy Changes | 113 |  |
| C1.2.2 draw and label a reaction profile for an exothermic and an endothermic reaction, identifying activation energy | C7 Energy Changes | 116 |  |
| C1.2.3 explain activation energy as the energy needed for a reaction to occur | C7 Energy Changes | 117 |  |
| C1.2.4 interpret charts and graphs when dealing with reaction profiles | C7 Energy Changes | 117 |  |
| **C1.2.5 calculate energy changes in a chemical reaction by considering bond breaking and bond making energies** | C7 Energy Changes | 118 |  |
| C1.2.6 carry out arithmetic computations when calculating energy changes | C7 Energy Changes | 119 |  |
| C1.2.7 describe how you would investigate a chemical reaction to determine whether it is endothermic or exothermic (separate science only) | C7 Energy Changes | 113 |  |
| C1.2.8 recall that a chemical cell produces a potential difference until the reactants are used up (separate science only) | C7 Energy Changes | 120 |  |
| C1.2.9 evaluate the advantages and disadvantages of hydrogen/oxygen and other fuel cells for given uses (separate science only) | C7 Energy Changes | 122 |  |
| **C1.3 What is the evidence for climate change, why is it occurring?** | | | |
| C1.3.1 describe the greenhouse effect in terms of the interaction of radiation with matter | C13 The Earth's atmosphere | 198 |  |
| C1.3.2 evaluate the evidence for additional anthropogenic causes of climate change, including the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels, and describe the uncertainties in the evidence base | C13 The Earth's atmosphere | 199 |  |
| C1.3.3 describe the potential effects of increased levels of carbon dioxide and methane on the Earth’s climate, including where crops can be grown, extreme weather patterns, melting of polar ice and flooding of low land | C13 The Earth's atmosphere | 200 |  |
| C1.3.4 describe how the effects of increased levels of carbon dioxide and methane may be mitigated, including consideration of scale, risk and environmental implications | C13 The Earth's atmosphere | 200 |  |
| C1.3.5 extract and interpret information from charts, graphs and tables | C13 The Earth's atmosphere | 199 |  |
| C1.3.6 use orders of magnitude to evaluate the significance of data | C13 The Earth's atmosphere | 199 |  |
| **C1.4 How can scientists help improve the supply of potable water?** | | | |
| C1.4.1 describe the principal methods for increasing the availability of potable water, in terms of the separation techniques used, including the ease of treating waste, ground and salt water including filtration and membrane filtration; aeration, use of bacteria; chlorination and distillation (for salt water) | C14 The Earth's resources | 208 |  |
| C1.4.2 describe a test to identify chlorine (using blue litmus paper) PAG2 | C12 Chemical Analysis | 185 |  |
| **Chapter C2 Chemical patterns** | | | |
| **C2.1 How have our ideas about atoms developed over time?** | | | |
| C2.1.1 describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr | C1 Atomic structure | 12 |  |
| C2.1.2 describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus | C1 Atomic structure | 14 |  |
| C2.1.3 recall relative charges and approximate relative masses of protons, neutrons and electrons | C1 Atomic structure | 14 |  |
| C2.1.4 estimate the size and scale of atoms relative to other particles | C1 Atomic structure | 16 | Very briefly covered |
| C2.1.5 recall the typical size (order of magnitude) of atoms and small molecules | C1 Atomic structure | 16 | Very briefly covered |
| C2.1.6 relate size and scale of atoms to objects in the physical world | C1 Atomic structure | 16 | Very briefly covered |
| C2.1.7 calculate numbers of protons, neutrons and electrons in atoms, given atomic number and mass number of isotopes or by extracting data from the Periodic Table | C1 Atomic structure | 15 |  |
| **C2.2 What does the Periodic Table tell us about elements?** | | | |
| C2.2.1 explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms and hence to its atomic number | C2 The Periodic Table | 22/23-24 |  |
| C2.2.2 describe how Mendeleev organised the elements based on their properties and relative atomic masses | C2 The Periodic Table | 22 |  |
| C2.2.3 describe how discovery of new elements and the ordering elements by atomic number supports Mendeleev’s decisions to leave gaps and reorder some elements | C2 The Periodic Table | 23 |  |
| C2.2.4 describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties, including melting point, boiling point, state and appearance, density, formulae of compounds, relative reactivity and electrical conductivity | C2 The Periodic Table | 24 |  |
| C2.2.5 recall the simple properties of Group 1 elements including their reaction with moist air, water, and chlorine | C2 The Periodic Table | 26 |  |
| C2.2.6 recall the simple properties of Group 7 elements including their states and colours at room temperature and pressure, their colours as gases, their reactions with Group 1 elements and their displacement reactions with other metal halides | C2 The Periodic Table | 28 |  |
| C2.2.7 predict possible reactions and probable reactivity of elements from their positions in the Periodic Table | C2 The Periodic Table | 30 |  |
| C2.2.8 describe experiments to identify the reactivity pattern of Group 7 elements including displacement reactions PAG1 | C2 The Periodic Table | 29 |  |
| C2.2.9 describe experiments to identify the reactivity pattern of Group 1 elements | C2 The Periodic Table | 27 |  |
| **C2.3 How do metals and non-metals combine to form compounds?** | | | |
| C2.3.1 recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity | C2 The Periodic Table | 24 |  |
| C2.3.2 explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups | C2 The Periodic Table | 30 |  |
| C2.3.3 explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number | C2 The Periodic Table | 30 |  |
| C2.3.4 explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table | C2 The Periodic Table | 24 |  |
| C2.3.5 describe the nature and arrangement of chemical bonds in ionic compounds | C3 Structure and bonding | 40 |  |
| C2.3.6 explain ionic bonding in terms of electrostatic forces and transfer of electrons | C3 Structure and bonding | 40 |  |
| C2.3.7 calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table | C1 Atomic structure | 15 |  |
| C2.3.8 construct dot and cross diagrams for simple ionic substances | C3 Structure and bonding | 39 |  |
| C2.3.9 explain how the bulk properties of ionic materials are related to the type of bonds they contain | C3 Structure and bonding | 42 |  |
| C2.3.10 use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding | C3 Structure and bonding | 43 | Hinted at in end of page questions but not explicitly written like this |
| C2.3.11 describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations | C3 Structure and bonding | 46 |  |
| C2.3.12 translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds | C3 Structure and bonding | 46 |  |
| **C2.4 How are equations used to represent chemical reactions?** | | | |
| C2.4.1 use chemical symbols to write the formulae of elements and simple covalent and ionic compounds | C3 Structure and bonding | 38-47 | Throughout chapter |
| C2.4.2 use the formulae of common ions to deduce the formula of Group 1 and Group 7 compounds | C3 Structure and bonding | 41 |  |
| C2.4.3 use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate | C3 Structure and bonding | 38-47 | Throughout chapter |
| C2.4.4 describe the physical states of products and reactants using state symbols (s, l, g and aq) | C1 Atomic structure | 6 |  |
| **C2.5 What are the properties of the transition metals? (separate science only)** | | | |
| C2.5.1 recall the general properties of transition metals (melting point, density, reactivity, formation of coloured ions with different charges and uses as catalysts) and exemplify these by reference to copper, iron, chromium, silver and gold | C2 The Periodic Table | 32 |  |
| **Chapter C3 Chemicals of the natural environment** | | | |
| **C3.1 How are atoms held together in a metal?** | | | |
| C3.1.1 describe the nature and arrangement of chemical bonds in metals | C3 Structure and bonding | 52 |  |
| C3.1.2 explain how the bulk properties of metals are related to the type of bonds they contain | C3 Structure and bonding | 54 |  |
| **C3.2 How are metals with different reactivities extracted?** | | | |
| C3.2.1 deduce an order of reactivity of metals based on experimental results including reactions with water, dilute acid and displacement reactions with other metals | C5 Chemical Changes | 84-87 |  |
| C3.2.2 explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion to include potassium, sodium, calcium, aluminium, magnesium, zinc, iron, lead, [hydrogen], copper, silver | C5 Chemical Changes | 87 |  |
| C3.2.3 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations **and ionic equations** | C1 Atomic structure | 6, 87 | Ionic equations also mentioned C5 Chemical Changes: C4 Chemical Calculations Chapter also covers all this to Higher level |
| C3.2.4 explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including the extraction of zinc | C5 Chemical Changes | 88 |  |
| C3.2.5 explain why electrolysis is used to extract some metals from their ores | C6 Electrolysis | 106 |  |
| **C3.2.6 evaluate alternative biological methods of metal extraction (bacterial and phytoextraction)** | C14 The Earth's resources | 212 |  |
| **C3.3 What are electrolytes and what happens during electrolysis?** | | | |
| C3.3.1 describe electrolysis in terms of the ions present and reactions at the electrodes | C6 Electrolysis | 102 |  |
| C3.3.2 predict the products of electrolysis of binary ionic compounds in the molten state | C6 Electrolysis | 103 |  |
| C3.3.3 recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes | C6 Electrolysis | 103 |  |
| **C3.3.4 use the names and symbols of common elements and compounds and the principle of conservation of mass to write half equations** | C6 Electrolysis | 104 |  |
| **C3.3.5 explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced** | C6 Electrolysis | 104 |  |
| C3.3.6 explain how electrolysis is used to extract some metals from their ores including the extraction of aluminium | C6 Electrolysis | 106 |  |
| C3.3.7 describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present, including the formation of oxygen, chlorine and the discharge of metals or hydrogen linked to their relative reactivity | C6 Electrolysis | 105 |  |
| C3.3.8 describe the technique of electrolysis of an aqueous solution of a salt PAG2 | C6 Electrolysis | 102 |  |
| **C3.4 Why is crude oil important as a source of new materials?** | | | |
| C3.4.1 recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry | C9 Crude oil and fuels | 148 |  |
| C3.4.2 explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource | C9 Crude oil and fuels | 148 |  |
| C3.4.3 describe and explain the separation of crude oil by fractional distillation PAG3 | C9 Crude oil and fuels | 150 |  |
| C3.4.4 describe the fractions of crude oil as largely a mixture of compounds of formula CnH2n+2 which are members of the alkane homologous series | C9 Crude oil and fuels | 149 |  |
| C3.4.5 use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur | C9 Crude oil and fuels | 36 | Also C3 page 47 |
| C3.4.6 deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa | C3 Structure and bonding | 47 |  |
| C3.4.7 use arithmetic computation and ratio when determining empirical formulae |  |  | Not explicit in book |
| C3.4.8 describe the arrangement of chemical bonds in simple molecules | C3 Structure and bonding | 46 |  |
| C3.4.9 explain covalent bonding in terms of the sharing of electrons | C3 Structure and bonding | 44 |  |
| C3.4.10 construct dot and cross diagrams for simple covalent substances | C3 Structure and bonding | 44 |  |
| C3.4.11 represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for simple molecules | C3 Structure and bonding | 44/47 |  |
| C3.4.12 describe the limitations of dot and cross diagrams, ball and stick models and two and three dimensional representations when used to represent simple molecules | C3 Structure and bonding | 47 |  |
| C3.4.13 translate information between diagrammatic and numerical forms | C3 Structure and bonding | 47 |  |
| C3.4.14 explain how the bulk properties of simple molecules are related to the covalent bonds they contain and their bond strengths in relation to intermolecular forces | C3 Structure and bonding | 46 |  |
| C3.4.15 describe the production of materials that are more useful by cracking | C9 Crude oil and fuels | 154 |  |
| C3.4.16 recognise functional groups and identify members of the same homologous series (separate science only) | C10 Organic reactions | 158-165 |  |
| C3.4.17 name and draw the structural formulae, using fully displayed formulae, of the first four members of the straight chain alkanes and alkenes, alcohols and carboxylic acids (separate science only) | C10 Organic reactions | 158-165 |  |
| C3.4.18 predict the formulae and structures of products of reactions (combustion, addition across a double bond and oxidation of alcohols to carboxylic acids) of the first four and other given members of these homologous series (separate science only) | C10 Organic reactions | 158-165 |  |
| C3.4.19 recall that it is the generality of reactions of functional groups that determine the reactions of organic compounds (separate science only) | C10 Organic reactions | 158-165 |  |
| **Chapter C4 Materials choices** | | | |
| **C4.1 How is data used to choose a material for a particular use?** | | | |
| C4.1.1 compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals, including melting point, softening temperature (for polymers), electrical conductivity, strength (in tension or compression), stiffness, flexibility, brittleness, hardness, density, ease of reshaping | C15 Using our resources | 222-227 |  |
| C4.1.2 explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required | C15 Using our resources | 222-227 |  |
| C4.1.3 describe the composition of some important alloys in relation to their properties and uses, including steel (separate science only) | C15 Using our resources | 222 |  |
| **C4.2 What are the different types of polymer? (separate science only)** | | | |
| C4.2.1 recall the basic principles of addition polymerisation by reference to the functional group in the monomer and the repeating units in the polymer | C11 Polymers | 169 |  |
| C4.2.2 deduce the structure of an addition polymer from a simple monomer with a double bond and vice versa | C11 Polymers | 169 |  |
| C4.2.3 explain the basic principles of condensation polymerisation by 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  *i Learners are not expected to recall the formulae of dicarboxylic acid, diamine and diol monomers* | C11 Polymers | 170 |  |
| C4.2.4 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 | C11 Polymers | 174 |  |
| **C4.3 How do bonding and structure affect the properties of materials?** | | | |
| C4.3.1 explain how the bulk properties of materials (including strength, melting point, electrical and thermal conductivity, brittleness, flexibility, hardness and ease of reshaping) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged, recognising that the atoms themselves do not have these properties | C15 Using our resources | 224-227 |  |
| C4.3.2 recall that carbon can form four covalent bonds |  |  | Nowhere specific |
| C4.3.3 explain that the vast array of natural and synthetic organic compounds occurs due to the ability of carbon to form families of similar compounds, chains and rings |  |  | Nowhere specific |
| C4.3.4 describe the nature and arrangement of chemical bonds in polymers with reference to their properties including strength, flexibility or stiffness, hardness and melting point of the solid | C15 Using our resources | 224 |  |
| C4.3.5 describe the nature and arrangement of chemical bonds in giant covalent structures | C3 Structure and bonding | 48 |  |
| C4.3.6 explain the properties of diamond and graphite in terms of their structures and bonding, include melting point, hardness and (for graphite) conductivity and lubricating action | C3 Structure and bonding | 49 |  |
| C4.3.7 represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures e.g. allotropes of carbon | C3 Structure and bonding | 46 |  |
| C4.3.8 describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals | C3 Structure and bonding | 46 | Metals C3 page 3, Polymers C15 page 225 |
| **C4.4 Why are nanoparticles so useful?** | | | |
| C4.4.1 compare ‘nano’ dimensions to typical dimensions of atoms and molecules | C3 Structure and bonding | 56 |  |
| C4.4.2 describe the surface area to volume relationship for different-sized particles and describe how this affects properties | C3 Structure and bonding | 57 |  |
| C4.4.3 describe how the properties of nanoparticulate materials are related to their uses including properties which arise from their size, surface area and arrangement of atoms in tubes or rings | C3 Structure and bonding | 56 |  |
| C4.4.4 explain the properties fullerenes and graphene in terms of their structures | C3 Structure and bonding | 50 |  |
| C4.4.5 explain the possible risks associated with some nanoparticulate materials including: a) possible effects on health due to their size and surface area b) reasons that there is more data about uses of nanoparticles than about possible health effects c) the relative risks and benefits of using nanoparticles for different purposes | C3 Structure and bonding | 59 |  |
| C4.4.6 estimate size and scale of atoms and nanoparticles including the ideas that: a) nanotechnology is the use and control of structures that are very small (1 to 100 nanometres in size) b) data expressed in nanometres is used to compare the sizes of nanoparticles, atoms and molecules | C3 Structure and bonding | 56 |  |
| C4.4.7 interpret, order and calculate with numbers written in standard form when dealing with nanoparticles | C3 Structure and bonding | 57 |  |
| C4.4.8 use ratios when considering relative sizes and surface area to volume comparisons | C3 Structure and bonding | 57 |  |
| C4.4.9 calculate surface areas and volumes of cubes | C3 Structure and bonding | 57 |  |
| **C4.5 What happens to products at the end of their useful life?** | | | |
| C4.5.1 describe the conditions which cause corrosion and the process of corrosion, and explain how mitigation is achieved by creating a physical barrier to oxygen and water and by sacrificial protection (separate science only) | C15 Using our resources | 220 |  |
| C4.5.2 explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced |  |  | Not explicit in book |
| **C4.5.3 explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced** | C5 Chemical Changes | 87 |  |
| C4.5.4 describe the basic principles in carrying out a life-cycle assessment of a material or product including a) the use of water, energy and the environmental impact of each stage in a life cycle, including its manufacture, transport and disposal b) incineration, landfill and electricity generation schemes c) biodegradable and non-biodegradable materials | C14 The Earth's resources | 214 |  |
| C4.5.5 interpret data from a life-cycle assessment of a material or product |  |  | Not explicit in book |
| C4.5.6 describe the process where PET drinks bottles are reused and recycled for different uses, and explain why this is viable |  |  | No recycling specific to PET |
| C4.5.7 evaluate factors that affect decisions on recycling with reference to products made from crude oil and metal ores | C14 The Earth's resources | 216 |  |
| **Chapter C5 Chemical analysis** | | | |
| **C5.1 How are chemicals separated and tested for purity?** | | | |
| C5.1.1 explain that many useful materials are formulations of mixtures | C15 Using our resources |  | Throughout chapter |
| C5.1.2 explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term ‘pure’ | C12 Chemical Analysis | 181 |  |
| C5.1.3 use melting point data to distinguish pure from impure substances | C12 Chemical Analysis | 180 |  |
| C5.1.4 recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases | C12 Chemical Analysis | 182 |  |
| C5.1.5 interpret chromatograms, including calculating Rf values | C12 Chemical Analysis | 183 |  |
| C5.1.6 suggest chromatographic methods for distinguishing pure from impure substances PAG4 Including the use of: a) paper chromatography b) aqueous and non-aqueous solvents c) locating agents | C12 Chemical Analysis | 183 | No mention of aqueous and non-aqueous solvents or locating agents |
| C5.1.7 describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation PAG3, PAG7 | C1 Atomic structure | 8 |  |
| C5.1.8 suggest suitable purification techniques given information about the substances involved PAG3, PAG7 | C1 Atomic structure | 8 |  |
| **C5.2 How do chemists find the composition of unknown samples? (separate science only)** | | | |
| C5.2.1 describe the purpose of representative sampling in qualitative analysis |  |  | Not explicit in book |
| C5.2.2 interpret flame tests to identify metal ions, including the ions of lithium, sodium, potassium, calcium and copper | C12 Chemical Analysis | 186 |  |
| C5.2.3 describe the technique of using flame tests to identify metal ions PAG5 | C12 Chemical Analysis | 186 |  |
| C5.2.4 describe tests to identify aqueous cations and aqueous anions and identify species from test results including: PAG5 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) | C12 Chemical Analysis |  |  |
| 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 | C12 Chemical Analysis | 190 | 0 |
| C5.2.6 describe the advantages of instrumental methods of analysis (sensitivity, accuracy and speed) | C12 Chemical Analysis | 190 |  |
| C5.2.7 interpret charts, particularly in spectroscopy | C12 Chemical Analysis | 193 | Flame emission spectrum comparison question |
| **C5.3 How are the amounts of substances in reactions calculated?** | | | |
| C5.3.1 recall and use the law of conservation of mass | C1 Atomic structure | 6 |  |
| C5.3.2 explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model | C1 Atomic structure | 6 |  |
| C5.3.3 calculate relative formula masses of species separately and in a balanced chemical equation | C4 Chemical Calculations | 62 |  |
| **C5.3.4 recall and use the definitions of the Avogadro constant (in standard form) and of the mole** | C4 Chemical Calculations | 62 |  |
| **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: number of moles = mass of substance (g) relative formula mass (g)** | C4 Chemical Calculations | 62 |  |
| **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** | C4 Chemical Calculations | 67 |  |
| **C5.3.7 use a balanced equation to calculate masses of reactants or products** | C4 Chemical Calculations | 64 |  |
| C5.3.8 use arithmetic computation, ratio, percentage and multistep calculations throughout quantitative chemistry | C4 Chemical Calculations | 66 |  |
| **C5.3.9 carry out calculations with numbers written in standard form when using the Avogadro constant** | C4 Chemical Calculations | 63 |  |
| C5.3.10 change the subject of a mathematical equation | C4 Chemical Calculations |  | Throughout chapter |
| C5.3.11 calculate the theoretical amount of a product from a given amount of reactant (separate science only) | C4 Chemical Calculations | 68 |  |
| C5.3.12 calculate the percentage yield of a reaction product from the actual yield of a reaction (separate science only) | C4 Chemical Calculations | 69 |  |
| C5.3.13 suggest reasons for low yields for a given procedure (separate science only) | C4 Chemical Calculations | 69 |  |
| **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)** | C4 Chemical Calculations | 78 |  |
| **C5.4 How are the amounts of chemicals in solution measured?** | | | |
| C5.4.1 identify the difference between qualitative and quantitative analysis (separate science only) |  |  | Not explicit in book |
| **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: concentration (g/dm3) = mass of solute (g) / volume (dm3)** | C4 Chemical Calculations | 72 |  |
| **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 and calculate the molar concentration using the formula concentration (mol/dm3) = number of moles of solute / volume (dm3)** | C4 Chemical Calculations | 72 |  |
| 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 Chemical Changes | 92 |  |
| C5.4.5 recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions | C5 Chemical Changes | 99 |  |
| C5.4.6 recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water | C5 Chemical Changes | 96 |  |
| C5.4.7 describe and explain the procedure for a titration to give precise, accurate, valid and repeatable results | C4 Chemical Calculations | 74 |  |
| C5.4.8 Evaluate the quality of data from titrations | C4 Chemical Calculations | 76 |  |
| 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) | C4 Chemical Calculations | 76 |  |
| **Chapter C6 Making useful chemicals** | | | |
| **C6.1 What useful products can be made from acids?** | | | |
| C6.1.1 recall that acids react with some metals and with carbonates and write equations predicting products from given reactants | C5 Chemical Changes | 95 |  |
| C6.1.2 describe practical procedures to make salts to include appropriate use of filtration, evaporation, crystallisation and drying PAG7 | C5 Chemical Changes | 93 |  |
| C6.1.3 use the formulae of common ions to deduce the formula of a compound | C3 Structure and bonding | 41 |  |
| C6.1.4 recall that relative acidity and alkalinity are measured by pH including the use of universal indicator and pH meters | C5 Chemical Changes | 96 |  |
| **C6.1.5 use and explain the terms dilute and concentrated (amount of substance) and weak and strong (degree of ionisation) in relation to acids including differences in reactivity with metals and carbonates** | C5 Chemical Changes | 98 |  |
| **C6.1.6 use the idea that as hydrogen ion concentration increases by a factor of ten the pH value of a solution decreases by one** | C5 Chemical Changes | 99 |  |
| **C6.1.7 describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH (whole numbers only)** | C5 Chemical Changes | 99 |  |
| **C6.2 How do chemists control the rate of reaction?** | | | |
| C6.2.1 describe the effect on rate of reaction of changes in temperature, concentration, pressure, and surface area | C8 Rates and equilibrium | 130 |  |
| C6.2.2 explain the effects on rates of reaction of changes in temperature, concentration and pressure in terms of frequency and energy of collision between particles | C8 Rates and equilibrium | 132-135 |  |
| C6.2.3 explain the effects on rates of reaction of changes in the size of the pieces of a reacting solid in terms of surface area to volume ratio | C8 Rates and equilibrium | 130 |  |
| C6.2.4 describe the characteristics of catalysts and their effect on rates of reaction | C8 Rates and equilibrium | 136 |  |
| C6.2.5 identify catalysts in reactions | C8 Rates and equilibrium | 136 |  |
| C6.2.6 explain catalytic action in terms of activation energy | C8 Rates and equilibrium | 136 |  |
| C6.2.7 suggest practical methods for determining the rate of a given reaction including: PAG8 for reactions that produce gases: i. gas syringes or collection over water can be used to measure the volume of gas produced  ii. mass change can be followed using a balance  **measurement of physical factors: iii. colour change  iv. formation of a precipitate** | C8 Rates and equilibrium | 128 |  |
| C6.2.8 interpret rate of reaction graphs | C8 Rates and equilibrium | 128 |  |
| **C6.2.9 interpret graphs of reaction conditions versus rate (separate science only)**  *i an understanding of orders of reaction is not required* | C8 Rates and equilibrium | 128 |  |
| C6.2.10 use arithmetic computation and ratios when measuring rates of reaction | C8 Rates and equilibrium | 131 |  |
| C6.2.11 draw and interpret appropriate graphs from data to determine rate of reaction | C8 Rates and equilibrium | 128 |  |
| C6.2.12 determine gradients of graphs as a measure of rate of change to determine rate | C8 Rates and equilibrium | 128 |  |
| C6.2.13 use proportionality when comparing factors affecting rate of reaction | C8 Rates and equilibrium | 131 | Worked example |
| C6.2.14 describe the use of enzymes as catalysts in biological systems and some industrial processes |  |  | Enzymes not explicit |
| **C6.3 What factors affect the yield of chemical reactions?** | | | |
| C6.3.1 recall that some reactions may be reversed by altering the reaction conditions including: a) reversible reactions are shown by the symbol ? b) reversible reactions (in closed systems) do not reach 100% yield | C8 Rates and equilibrium | 138 |  |
| C6.3.2 recall that dynamic equilibrium occurs when the rates of forward and reverse reactions are equal | C8 Rates and equilibrium | 142 |  |
| **C6.3.3 predict the effect of changing reaction conditions (concentration, temperature and pressure) on equilibrium position and suggest appropriate conditions to produce a particular product, including: a) catalysts increase rate but do not affect yield b) the disadvantages of using very high temperatures or pressures** | C8 Rates and equilibrium | 144 |  |
| **C6.4 How are chemicals made on an industrial scale? (separate science only)** | | | |
| C6.4.1 recall the importance of nitrogen, phosphorus and potassium compounds in agricultural production | C15 Using our resources |  | Throughout chapter |
| C6.4.2 explain the importance of the Haber process in agricultural production and the benefits and costs of making and using fertilisers, including: a) the balance between demand and supply of food worldwide b) the sustainability and practical issues of producing and using synthetic and natural fertilisers on a large scale c) the environmental impact of over-use of synthetic fertilisers (eutrophication) | C15 Using our resources | 228 |  |
| **C6.4.3 explain how the commercially used conditions for the Haber process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate including: a) the sourcing of raw materials and production of the feedstocks; nitrogen (from air), and hydrogen (from natural gas and steam) b) the effect of a catalyst, temperature and pressure on the yield and rate of reaction c) the separation of the ammonia and recycling of unreacted nitrogen and hydrogen** | C15 Using our resources | 230 |  |
| **C6.4.4 explain the trade-off between rate of production of a desired product and position of equilibrium in some industrially important processes** | C15 Using our resources | 230 |  |
| C6.4.5 define the atom economy of a reaction | C4 Chemical Calculations | 70 |  |
| C6.4.6 calculate the atom economy of a reaction to form a desired product from the balanced equation using the formula: atom economy = mass of atoms in desired product / total mass of atoms in reactants | C4 Chemical Calculations | 70 |  |
| C6.4.7 use arithmetic computation when calculating atom economy | C4 Chemical Calculations | 70 |  |
| **C6.4.8 explain why a particular reaction pathway is chosen to produce a specified product given appropriate data such as atom economy (if not calculated), yield, rate, equilibrium position, usefulness of by-products and evaluate the sustainability of the process** | C4 Chemical Calculations | 70 |  |
| C6.4.9 describe the industrial production of fertilisers as several integrated processes using a variety of raw materials and compare with laboratory syntheses. including: a) demand for fertilisers (including ammonium sulfate) is often met from more than one process b) some fertilisers are made as a bi-product or waste product of another process c) process flow charts are used to summarise industrial processes and give information about raw materials, stages in the process, products, by-products and waste d) lab processes prepare chemicals in batches, industrial processes are usually continuous. | C15 - Using our resources | 234 |  |
| C6.4.10 compare the industrial production of fertilisers with laboratory syntheses of the same products | C15 - Using our resources | 232-235 |  |

## AQA Collins textbook mapping

| **Specification statement** | **Chapter covering specification statement** | **Page number** | **Comments** |
| --- | --- | --- | --- |
| **Chapter C1 Air and water** | | | |
| **C1.1 How has the Earth's atmosphere changed over time, and why?** | | | |
| C1.1.1 recall and explain the main features of the particle model in terms of the states of matter and change of state, distinguishing between physical and chemical changes and recognise that the particles themselves do not have the same properties as the bulk substances | C2 Structure, bonding and the properties of matter | 68 |  |
| **C1.1.2 explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres** | C2 Structure, bonding and the properties of matter | 69 |  |
| C1.1.3 use ideas about energy transfers and the relative strength of forces between particles to explain the different temperatures at which changes of state occur | C2 Structure, bonding and the properties of matter | 68 |  |
| C1.1.4 use data to predict states of substances under given conditions | C2 Structure, bonding and the properties of matter | 68 |  |
| C1.1.5 interpret evidence for how it is thought the atmosphere was originally formed | C9 The atmosphere | 296 |  |
| C1.1.6 describe how it is thought an oxygen-rich atmosphere developed over time | C9 The atmosphere | 298 |  |
| C1.1.7 describe the major sources of carbon monoxide and particulates (incomplete combustion), sulfur dioxide (combustion of sulfur impurities in fuels), oxides of nitrogen (oxidation of nitrogen at high temperatures and further oxidation in the air) | C9 The atmosphere | 312 |  |
| C1.1.8 explain the problems caused by increased amounts of these substances and describe approaches to decreasing the emissions of these substances into the atmosphere including the use of catalytic converters, low sulfur petrol and gas scrubbers to decrease emissions | C9 The atmosphere | 314 |  |
| C1.1.9 use chemical symbols to write the formulae of elements and simple covalent compounds | C1 Atomic structure and the periodic table | 14 |  |
| C1.1.10 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations | C3 Chemical quantities and calculations | 98 |  |
| C1.1.11 use arithmetic computations and ratios when balancing equations | C9 The atmosphere | 316 |  |
| C1.1.12 describe tests to identify oxygen, hydrogen and carbon dioxide | C8 Chemical Analysis | 272 |  |
| C1.1.13 explain oxidation in terms of gain of oxygen | C4 Chemical Changes | 132 |  |
| **C1.2 Why are there temperature changes in chemical reactions?** | | | |
| C1.2.1 distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings | C5 Energy Changes | 178 |  |
| C1.2.2 draw and label a reaction profile for an exothermic and an endothermic reaction, identifying activation energy | C5 Energy Changes | 178 |  |
| C1.2.3 explain activation energy as the energy needed for a reaction to occur | C5 Energy Changes | 178 |  |
| C1.2.4 interpret charts and graphs when dealing with reaction profiles | C5 Energy Changes | 179 |  |
| **C1.2.5 calculate energy changes in a chemical reaction by considering bond breaking and bond making energies** | C5 Energy Changes | 180 |  |
| C1.2.6 carry out arithmetic computations when calculating energy changes | C5 Energy Changes | 180 |  |
| C1.2.7 describe how you would investigate a chemical reaction to determine whether it is endothermic or exothermic (separate science only) | C5 Energy Changes | 176 |  |
| C1.2.8 recall that a chemical cell produces a potential difference until the reactants are used up (separate science only) | C5 Energy Changes | 182 |  |
| C1.2.9 evaluate the advantages and disadvantages of hydrogen/oxygen and other fuel cells for given uses (separate science only) | C5 Energy Changes | 184 |  |
| **C1.3 What is the evidence for climate change, why is it occurring?** | | | |
| C1.3.1 describe the greenhouse effect in terms of the interaction of radiation with matter | C9 The atmosphere | 302 |  |
| C1.3.2 evaluate the evidence for additional anthropogenic causes of climate change, including the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels, and describe the uncertainties in the evidence base | C9 The atmosphere | 304 |  |
| C1.3.3 describe the potential effects of increased levels of carbon dioxide and methane on the Earth’s climate, including where crops can be grown, extreme weather patterns, melting of polar ice and flooding of low land | C9 The atmosphere | 306 |  |
| C1.3.4 describe how the effects of increased levels of carbon dioxide and methane may be mitigated, including consideration of scale, risk and environmental implications | C9 The atmosphere | 308 |  |
| C1.3.5 extract and interpret information from charts, graphs and tables | C10 Sustainable development | 348 |  |
| C1.3.6 use orders of magnitude to evaluate the significance of data | C4 Chemical Changes | 166 |  |
| **C1.4 How can scientists help improve the supply of potable water?** | | | |
| C1.4.1 describe the principal methods for increasing the availability of potable water, in terms of the separation techniques used, including the ease of treating waste, ground and salt water including filtration and membrane filtration; aeration, use of bacteria; chlorination and distillation (for salt water) | C10 Sustainable development | 326 |  |
| C1.4.2 describe a test to identify chlorine (using blue litmus paper) | C8 Chemical Analysis | 272 |  |
| **Chapter C2 Chemical patterns** | | | |
| **C2.1 How have our ideas about atoms developed over time?** | | | |
| C2.1.1 describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr | C1 Atomic structure and the periodic table | 20 |  |
| C2.1.2 describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus | C1 Atomic structure and the periodic table | 22 |  |
| C2.1.3 recall relative charges and approximate relative masses of protons, neutrons and electrons | C1 Atomic structure and the periodic table | 24 |  |
| C2.1.4 estimate the size and scale of atoms relative to other particles | C2 Structure, bonding and the properties of matter | 88 |  |
| C2.1.5 recall the typical size (order of magnitude) of atoms and small molecules | C2 Structure, bonding and the properties of matter | 88 |  |
| C2.1.6 relate size and scale of atoms to objects in the physical world | C2 Structure, bonding and the properties of matter | 88 |  |
| C2.1.7 calculate numbers of protons, neutrons and electrons in atoms, given atomic number and mass number of isotopes or by extracting data from the Periodic Table | C1 Atomic structure and the periodic table | 26 |  |
| **C2.2 What does the Periodic Table tell us about elements?** | | | |
| C2.2.1 explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms and hence to its atomic number | C1 Atomic structure and the periodic table | 30 |  |
| C2.2.2 describe how Mendeleev organised the elements based on their properties and relative atomic masses | C1 Atomic structure and the periodic table | 32 |  |
| C2.2.3 describe how discovery of new elements and the ordering elements by atomic number supports Mendeleev’s decisions to leave gaps and reorder some elements | C1 Atomic structure and the periodic table | 32 |  |
| C2.2.4 describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties, including melting point, boiling point, state and appearance, density, formulae of compounds, relative reactivity and electrical conductivity | C1 Atomic structure and the periodic table | 34 |  |
| C2.2.5 recall the simple properties of Group 1 elements including their reaction with moist air, water, and chlorine | C1 Atomic structure and the periodic table | 42 |  |
| C2.2.6 recall the simple properties of Group 7 elements including their states and colours at room temperature and pressure, their colours as gases, their reactions with Group 1 elements and their displacement reactions with other metal halides | C1 Atomic structure and the periodic table | 44 |  |
| C2.2.7 predict possible reactions and probable reactivity of elements from their positions in the Periodic Table | C1 Atomic structure and the periodic table | 46 |  |
| C2.2.8 describe experiments to identify the reactivity pattern of Group 7 elements including displacement reactions PAG1 | C1 Atomic structure and the periodic table | 45 |  |
| C2.2.9 describe experiments to identify the reactivity pattern of Group 1 elements | C1 Atomic structure and the periodic table | 42 |  |
| **C2.3 How do metals and non-metals combine to form compounds?** | | | |
| C2.3.1 recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity | C1 Atomic structure and the periodic table | 40 |  |
| C2.3.2 explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups | C1 Atomic structure and the periodic table | 47 |  |
| C2.3.3 explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number | C1 Atomic structure and the periodic table | 28 |  |
| C2.3.4 explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table | C1 Atomic structure and the periodic table | 36 |  |
| C2.3.5 describe the nature and arrangement of chemical bonds in ionic compounds | C2 Structure, bonding and the properties of matter | 62 |  |
| C2.3.6 explain ionic bonding in terms of electrostatic forces and transfer of electrons | C2 Structure, bonding and the properties of matter | 60 |  |
| C2.3.7 calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table | C1 Atomic structure and the periodic table | 26 |  |
| C2.3.8 construct dot and cross diagrams for simple ionic substances | C1 Atomic structure and the periodic table | 37 |  |
| C2.3.9 explain how the bulk properties of ionic materials are related to the type of bonds they contain | C2 Structure, bonding and the properties of matter | 70 |  |
| C2.3.10 use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding | C2 Structure, bonding and the properties of matter | 62 |  |
| C2.3.11 describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations | C2 Structure, bonding and the properties of matter | 90 |  |
| C2.3.12 translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds | C2 Structure, bonding and the properties of matter | 90 |  |
| **C2.4 How are equations used to represent chemical reactions?** | | | |
| C2.4.1 use chemical symbols to write the formulae of elements and simple covalent and ionic compounds | C2 Structure, bonding and the properties of matter | 68 |  |
| C2.4.2 use the formulae of common ions to deduce the formula of Group 1 and Group 7 compounds | C2 Structure, bonding and the properties of matter | 62 |  |
| C2.4.3 use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate | C3 Chemical quantities and calculations | 98 |  |
| C2.4.4 describe the physical states of products and reactants using state symbols (s, l, g and aq) | C2 Structure, bonding and the properties of matter | 68 |  |
| **C2.5 What are the properties of the transition metals? (separate science only)** | | | |
| C2.5.1 recall the general properties of transition metals (melting point, density, reactivity, formation of coloured ions with different charges and uses as catalysts) and exemplify these by reference to copper, iron, chromium, silver and gold | C1 Atomic structure and the periodic table | 48 |  |
| **Chapter C3 Chemicals of the natural environment** | | | |
| **C3.1 How are atoms held together in a metal?** | | | |
| C3.1.1 describe the nature and arrangement of chemical bonds in metals | C2 Structure, bonding and the properties of matter | 66 |  |
| C3.1.2 explain how the bulk properties of metals are related to the type of bonds they contain | C2 Structure, bonding and the properties of matter | 67 |  |
| **C3.2 How are metals with different reactivities extracted?** | | | |
| C3.2.1 deduce an order of reactivity of metals based on experimental results including reactions with water, dilute acid and displacement reactions with other metals | C4 Chemical Changes | 134 |  |
| C3.2.2 explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion to include potassium, sodium, calcium, aluminium, magnesium, zinc, iron, lead, [hydrogen], copper, silver | C4 Chemical Changes | 135 |  |
| C3.2.3 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations **and ionic equations** | C4 Chemical Changes | 139 | Also C3 page 98 |
| C3.2.4 explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including the extraction of zinc | C4 Chemical Changes | 136 |  |
| C3.2.5 explain why electrolysis is used to extract some metals from their ores | C4 Chemical Changes | 158 |  |
| **C3.2.6 evaluate alternative biological methods of metal extraction (bacterial and phytoextraction)** | C10 Sustainable development | 332 |  |
| **C3.3 What are electrolytes and what happens during electrolysis?** | | | |
| C3.3.1 describe electrolysis in terms of the ions present and reactions at the electrodes | C4 Chemical Changes | 154 |  |
| C3.3.2 predict the products of electrolysis of binary ionic compounds in the molten state | C4 Chemical Changes | 156 |  |
| C3.3.3 recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes | C4 Chemical Changes | 156 |  |
| **C3.3.4 use the names and symbols of common elements and compounds and the principle of conservation of mass to write half equations** | C4 Chemical Changes | 139-140 |  |
| **C3.3.5 explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced** | C4 Chemical Changes | 138 |  |
| C3.3.6 explain how electrolysis is used to extract some metals from their ores including the extraction of aluminium | C4 Chemical Changes | 158 |  |
| C3.3.7 describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present, including the formation of oxygen, chlorine and the discharge of metals or hydrogen linked to their relative reactivity | C4 Chemical Changes | 161 |  |
| C3.3.8 describe the technique of electrolysis of an aqueous solution of a salt PAG2 | C4 Chemical Changes | 160 |  |
| **C3.4 Why is crude oil important as a source of new materials?** | | | |
| C3.4.1 recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry | C7 Hydrocarbons | 228 |  |
| C3.4.2 explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource | C10 Sustainable development | 337 |  |
| C3.4.3 describe and explain the separation of crude oil by fractional distillation PAG3 | C7 Hydrocarbons | 230 |  |
| C3.4.4 describe the fractions of crude oil as largely a mixture of compounds of formula CnH2n+2 which are members of the alkane homologous series | C7 Hydrocarbons | 228 |  |
| C3.4.5 use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur | C7 Hydrocarbons | 231-233 |  |
| C3.4.6 deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa | C3 Chemical quantities and calculations | 91 |  |
| C3.4.7 use arithmetic computation and ratio when determining empirical formulae | C3 Chemical quantities and calculations | 110 | Use of ratios but not for empirical formulae |
| C3.4.8 describe the arrangement of chemical bonds in simple molecules | C2 Structure, bonding and the properties of matter | 58 |  |
| C3.4.9 explain covalent bonding in terms of the sharing of electrons | C2 Structure, bonding and the properties of matter | 64 |  |
| C3.4.10 construct dot and cross diagrams for simple covalent substances | C2 Structure, bonding and the properties of matter | 64 |  |
| C3.4.11 represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for simple molecules | C2 Structure, bonding and the properties of matter | 90 |  |
| C3.4.12 describe the limitations of dot and cross diagrams, ball and stick models and two and three dimensional representations when used to represent simple molecules | C2 Structure, bonding and the properties of matter | 62-65 |  |
| C3.4.13 translate information between diagrammatic and numerical forms | C2 Structure, bonding and the properties of matter | 90 |  |
| C3.4.14 explain how the bulk properties of simple molecules are related to the covalent bonds they contain and their bond strengths in relation to intermolecular forces | C2 Structure, bonding and the properties of matter | 64 | Also C7 Page 254 |
| C3.4.15 describe the production of materials that are more useful by cracking | C7 Hydrocarbons | 236 |  |
| C3.4.16 recognise functional groups and identify members of the same homologous series (separate science only) | C7 Hydrocarbons | 238-245 | Alkenes 240, Alcohols 242, Carboxylic Acids 244 |
| C3.4.17 name and draw the structural formulae, using fully displayed formulae, of the first four members of the straight chain alkanes and alkenes, alcohols and carboxylic acids (separate science only) | C7 Hydrocarbons | 238-245 | Alkenes 240, Alcohols 242, Carboxylic Acids 244 |
| C3.4.18 predict the formulae and structures of products of reactions (combustion, addition across a double bond and oxidation of alcohols to carboxylic acids) of the first four and other given members of these homologous series (separate science only) | C7 Hydrocarbons | 238-245 | Alkenes 240, Alcohols 242, Carboxylic Acids 244 |
| C3.4.19 recall that it is the generality of reactions of functional groups that determine the reactions of organic compounds (separate science only) | C7 Hydrocarbons | 238-245 | Alkenes 240, Alcohols 242, Carboxylic Acids 244 |
| **Chapter C4 Materials choices** | | | |
| **C4.1 How is data used to choose a material for a particular use?** | | | |
| C4.1.1 compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals, including melting point, softening temperature (for polymers), electrical conductivity, strength (in tension or compression), stiffness, flexibility, brittleness, hardness, density, ease of reshaping | C10 Sustainable development | 342 |  |
| C4.1.2 explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required | C10 Sustainable development | 343 |  |
| C4.1.3 describe the composition of some important alloys in relation to their properties and uses, including steel (separate science only) | C2 Structure, bonding and the properties of matter | 78 | Steel not mentioned |
| **C4.2 What are the different types of polymer? (separate science only)** | | | |
| C4.2.1 recall the basic principles of addition polymerisation by reference to the functional group in the monomer and the repeating units in the polymer | C7 Hydrocarbons | 246 |  |
| C4.2.2 deduce the structure of an addition polymer from a simple monomer with a double bond and vice versa | C7 Hydrocarbons | 246 |  |
| C4.2.3 explain the basic principles of condensation polymerisation by 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 i Learners are not expected to recall the formulae of dicarboxylic acid, diamine and diol monomers | C7 Hydrocarbons | 248 |  |
| C4.2.4 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 | C7 Hydrocarbons | 252 |  |
| **C4.3 How do bonding and structure affect the properties of materials?** | | | |
| C4.3.1 explain how the bulk properties of materials (including strength, melting point, electrical and thermal conductivity, brittleness, flexibility, hardness and ease of reshaping) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged, recognising that the atoms themselves do not have these properties | C2 Structure, bonding and the properties of matter | 58 | Also C7 Page 254 |
| C4.3.2 recall that carbon can form four covalent bonds | C2 Structure, bonding and the properties of matter | 76-84 |  |
| C4.3.3 explain that the vast array of natural and synthetic organic compounds occurs due to the ability of carbon to form families of similar compounds, chains and rings | C2 Structure, bonding and the properties of matter | 76-84 |  |
| C4.3.4 describe the nature and arrangement of chemical bonds in polymers with reference to their properties including strength, flexibility or stiffness, hardness and melting point of the solid | C2 Structure, bonding and the properties of matter | 74 |  |
| C4.3.5 describe the nature and arrangement of chemical bonds in giant covalent structures | C2 Structure, bonding and the properties of matter | 76 |  |
| C4.3.6 explain the properties of diamond and graphite in terms of their structures and bonding, include melting point, hardness and (for graphite) conductivity and lubricating action | C2 Structure, bonding and the properties of matter | 77 | Diamond pg 80, Graphite pg 82, Graphene/Fullerenes pg 84 |
| C4.3.7 represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures e.g. allotropes of carbon | C2 Structure, bonding and the properties of matter | 90 |  |
| C4.3.8 describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals | C2 Structure, bonding and the properties of matter | 56-64 |  |
| **C4.4 Why are nanoparticles so useful?** | | | |
| C4.4.1 compare ‘nano’ dimensions to typical dimensions of atoms and molecules | C2 Structure, bonding and the properties of matter | 86 |  |
| C4.4.2 describe the surface area to volume relationship for different-sized particles and describe how this affects properties | C2 Structure, bonding and the properties of matter | 87 |  |
| C4.4.3 describe how the properties of nanoparticulate materials are related to their uses including properties which arise from their size, surface area and arrangement of atoms in tubes or rings | C2 Structure, bonding and the properties of matter | 87 |  |
| C4.4.4 explain the properties fullerenes and graphene in terms of their structures | C2 Structure, bonding and the properties of matter | 84 |  |
| C4.4.5 explain the possible risks associated with some nanoparticulate materials including: a) possible effects on health due to their size and surface area b) reasons that there is more data about uses of nanoparticles than about possible health effects c) the relative risks and benefits of using nanoparticles for different purposes | C2 Structure, bonding and the properties of matter | 87 |  |
| C4.4.6 estimate size and scale of atoms and nanoparticles including the ideas that: a) nanotechnology is the use and control of structures that are very small (1 to 100 nanometres in size) b) data expressed in nanometres is used to compare the sizes of nanoparticles, atoms and molecules | C2 Structure, bonding and the properties of matter | 86 |  |
| C4.4.7 interpret, order and calculate with numbers written in standard form when dealing with nanoparticles | C2 Structure, bonding and the properties of matter | 88 |  |
| C4.4.8 use ratios when considering relative sizes and surface area to volume comparisons | C2 Structure, bonding and the properties of matter | 88 |  |
| C4.4.9 calculate surface areas and volumes of cubes | C2 Structure, bonding and the properties of matter | 86 |  |
| **C4.5 What happens to products at the end of their useful life?** | | | |
| C4.5.1 describe the conditions which cause corrosion and the process of corrosion, and explain how mitigation is achieved by creating a physical barrier to oxygen and water and by sacrificial protection (separate science only) | C10 Sustainable development | 338 |  |
| C4.5.2 explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced | C4 Chemical Changes | 132 and 136 |  |
| **C4.5.3 explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced** | C4 Chemical Changes | 138 |  |
| C4.5.4 describe the basic principles in carrying out a life-cycle assessment of a material or product including a) the use of water, energy and the environmental impact of each stage in a life cycle, including its manufacture, transport and disposal b) incineration, landfill and electricity generation schemes c) biodegradable and non-biodegradable materials | C10 Sustainable development | 334 |  |
| C4.5.5 interpret data from a life-cycle assessment of a material or product | C10 Sustainable development | 334 |  |
| C4.5.6 describe the process where PET drinks bottles are reused and recycled for different uses, and explain why this is viable | C10 Sustainable development | 336 | Brief mention of plastic recycling |
| C4.5.7 evaluate factors that affect decisions on recycling with reference to products made from crude oil and metal ores | C10 Sustainable development | 336 |  |
| **Chapter C5 Chemical analysis** | | | |
| **C5.1 How are chemicals separated and tested for purity?** | | | |
| C5.1.1 explain that many useful materials are formulations of mixtures | C8 Chemical Analysis | 266 |  |
| C5.1.2 explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term ‘pure’ | C8 Chemical Analysis | 264 |  |
| C5.1.3 use melting point data to distinguish pure from impure substances | C8 Chemical Analysis | 264 |  |
| C5.1.4 recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases | C8 Chemical Analysis | 268 |  |
| C5.1.5 interpret chromatograms, including calculating Rf values | C8 Chemical Analysis | 268 |  |
| C5.1.6 suggest chromatographic methods for distinguishing pure from impure substances PAG4 Including the use of: a) paper chromatography b) aqueous and non-aqueous solvents c) locating agents | C8 Chemical Analysis | 268 |  |
| C5.1.7 describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation PAG3, PAG7 | C1 Atomic structure and the periodic table | 18 |  |
| C5.1.8 suggest suitable purification techniques given information about the substances involved PAG3, PAG7 | C4 Chemical Changes | 146 |  |
| **C5.2 How do chemists find the composition of unknown samples? (separate science only)** | | | |
| C5.2.1 describe the purpose of representative sampling in qualitative analysis |  |  | Not explicit |
| C5.2.2 interpret flame tests to identify metal ions, including the ions of lithium, sodium, potassium, calcium and copper | C8 Chemical Analysis | 274 |  |
| C5.2.3 describe the technique of using flame tests to identify metal ions PAG5 | C8 Chemical Analysis | 274 |  |
| C5.2.4 describe tests to identify aqueous cations and aqueous anions and identify species from test results including: PAG5 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) | C8 Chemical Analysis | 276-279 |  |
| 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 | C8 Chemical Analysis | 284 |  |
| C5.2.6 describe the advantages of instrumental methods of analysis (sensitivity, accuracy and speed) | C8 Chemical Analysis | 282 |  |
| C5.2.7 interpret charts, particularly in spectroscopy | C8 Chemical Analysis | 282 |  |
| **C5.3 How are the amounts of substances in reactions calculated?** | | | |
| C5.3.1 recall and use the law of conservation of mass | C3 Chemical quantities and calculations | 100 |  |
| C5.3.2 explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model | C3 Chemical quantities and calculations | 102 |  |
| C5.3.3 calculate relative formula masses of species separately and in a balanced chemical equation | C3 Chemical quantities and calculations | 100 |  |
| **C5.3.4 recall and use the definitions of the Avogadro constant (in standard form) and of the mole** | C3 Chemical quantities and calculations | 106 |  |
| **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: number of moles = mass of substance (g) relative formula mass (g)** | C3 Chemical quantities and calculations | 106 |  |
| **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** | C6 The rate and extent of chemical change | 196 |  |
| **C5.3.7 use a balanced equation to calculate masses of reactants or products** | C3 Chemical quantities and calculations | 110 |  |
| C5.3.8 use arithmetic computation, ratio, percentage and multistep calculations throughout quantitative chemistry |  |  | Throughout chapter 3 |
| **C5.3.9 carry out calculations with numbers written in standard form when using the Avogadro constant** | C3 Chemical quantities and calculations | 107 |  |
| C5.3.10 change the subject of a mathematical equation | C3 Chemical quantities and calculations | 124 |  |
| C5.3.11 calculate the theoretical amount of a product from a given amount of reactant (separate science only) | C3 Chemical quantities and calculations | 109 |  |
| C5.3.12 calculate the percentage yield of a reaction product from the actual yield of a reaction (separate science only) | C3 Chemical quantities and calculations | 114 |  |
| C5.3.13 suggest reasons for low yields for a given procedure (separate science only) |  |  | Not explicit |
| **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 24dm3) (separate science only)** | C3 Chemical quantities and calculations | 120 |  |
| **C5.4 How are the amounts of chemicals in solution measured?** | | | |
| C5.4.1 identify the difference between qualitative and quantitative analysis (separate science only) |  |  | Not explicit |
| **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: concentration (g/dm3) = mass of solute (g) / volume (dm3)** | C3 Chemical quantities and calculations | 112 |  |
| **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 and calculate the molar concentration using the formula concentration (mol/dm3) = number of moles of solute / volume (dm3)** | C3 Chemical quantities and calculations | 113 |  |
| 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 | C4 Chemical Changes | 140 |  |
| C5.4.5 recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions | C4 Chemical Changes | 149 |  |
| C5.4.6 recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water | C4 Chemical Changes | 149 |  |
| C5.4.7 describe and explain the procedure for a titration to give precise, accurate, valid and repeatable results PAG6 | C3 Chemical quantities and calculations | 118 |  |
| C5.4.8 Evaluate the quality of data from titrations | C3 Chemical quantities and calculations | 119 |  |
| 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) | C3 Chemical quantities and calculations | 119 |  |
| **Chapter C6 Making useful chemicals** | | | |
| **C6.1 What useful products can be made from acids?** | | | |
| C6.1.1 recall that acids react with some metals and with carbonates and write equations predicting products from given reactants | C4 Chemical Changes | 144 |  |
| C6.1.2 describe practical procedures to make salts to include appropriate use of filtration, evaporation, crystallisation and drying PAG7 | C4 Chemical Changes | 146 |  |
| C6.1.3 use the formulae of common ions to deduce the formula of a compound | C4 Chemical Changes | 144 |  |
| C6.1.4 recall that relative acidity and alkalinity are measured by pH including the use of universal indicator and pH meters | C4 Chemical Changes | 148 |  |
| **C6.1.5 use and explain the terms dilute and concentrated (amount of substance) and weak and strong (degree of ionisation) in relation to acids including differences in reactivity with metals and carbonates** | C4 Chemical Changes | 152 |  |
| **C6.1.6 use the idea that as hydrogen ion concentration increases by a factor of ten the pH value of a solution decreases by one** | C4 Chemical Changes | 148 |  |
| **C6.1.7 describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH (whole numbers only)** | C4 Chemical Changes | 148 |  |
| **C6.2 How do chemists control the rate of reaction?** | | | |
| C6.2.1 describe the effect on rate of reaction of changes in temperature, concentration, pressure, and surface area | C6 The rate and extent of chemical change | 200 |  |
| C6.2.2 explain the effects on rates of reaction of changes in temperature, concentration and pressure in terms of frequency and energy of collision between particles | C6 The rate and extent of chemical change | 206 |  |
| C6.2.3 explain the effects on rates of reaction of changes in the size of the pieces of a reacting solid in terms of surface area to volume ratio | C6 The rate and extent of chemical change | 200 |  |
| C6.2.4 describe the characteristics of catalysts and their effect on rates of reaction | C6 The rate and extent of chemical change | 200 |  |
| C6.2.5 identify catalysts in reactions | C6 The rate and extent of chemical change | 208 |  |
| C6.2.6 explain catalytic action in terms of activation energy | C6 The rate and extent of chemical change | 206 |  |
| C6.2.7 suggest practical methods for determining the rate of a given reaction including: PAG8 for reactions that produce gases: i. gas syringes or collection over water can be used to measure the volume of gas produced  ii. mass change can be followed using a balance  **measurement of physical factors: iii. colour change  iv. formation of a precipitate** | C6 The rate and extent of chemical change | 194 |  |
| C6.2.8 interpret rate of reaction graphs | C6 The rate and extent of chemical change | 198 |  |
| **C6.2.9 interpret graphs of reaction conditions versus rate (separate science only)**   *i* an understanding of orders of reaction is not required | C6 The rate and extent of chemical change | 198 |  |
| C6.2.10 use arithmetic computation and ratios when measuring rates of reaction | C6 The rate and extent of chemical change | 198 |  |
| C6.2.11 draw and interpret appropriate graphs from data to determine rate of reaction | C6 The rate and extent of chemical change | 198 |  |
| C6.2.12 determine gradients of graphs as a measure of rate of change to determine rate | C6 The rate and extent of chemical change | 198 |  |
| C6.2.13 use proportionality when comparing factors affecting rate of reaction |  |  | Not explicit |
| C6.2.14 describe the use of enzymes as catalysts in biological systems and some industrial processes | C7 Hydrocarbons | 248 | Quick mention in relation to yeast / alcohol otherwise not explicit |
| **C6.3 What factors affect the yield of chemical reactions?** | | | |
| C6.3.1 recall that some reactions may be reversed by altering the reaction conditions including: a) reversible reactions are shown by the symbol ? b) reversible reactions (in closed systems) do not reach 100% yield | C6 The rate and extent of chemical change | 210 |  |
| C6.3.2 recall that dynamic equilibrium occurs when the rates of forward and reverse reactions are equal | C6 The rate and extent of chemical change | 212 |  |
| **C6.3.3 predict the effect of changing reaction conditions (concentration, temperature and pressure) on equilibrium position and suggest appropriate conditions to produce a particular product, including: a) catalysts increase rate but do not affect yield b) the disadvantages of using very high temperatures or pressures** | C6 The rate and extent of chemical change | 214-219 |  |
| **C6.4 How are chemicals made on an industrial scale? (separate science only)** | | | |
| C6.4.1 recall the importance of nitrogen, phosphorus and potassium compounds in agricultural production | C10 Sustainable development | 347 |  |
| C6.4.2 explain the importance of the Haber process in agricultural production and the benefits and costs of making and using fertilisers, including: a) the balance between demand and supply of food worldwide b) the sustainability and practical issues of producing and using synthetic and natural fertilisers on a large scale c) the environmental impact of over-use of synthetic fertilisers (eutrophication) | C10 Sustainable development | 344 |  |
| **C6.4.3 explain how the commercially used conditions for the Haber process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate including: a) the sourcing of raw materials and production of the feedstocks; nitrogen (from air), and hydrogen (from natural gas and steam) b) the effect of a catalyst, temperature and pressure on the yield and rate of reaction c) the separation of the ammonia and recycling of unreacted nitrogen and hydrogen** | C10 Sustainable development | 344 |  |
| **C6.4.4 explain the trade-off between rate of production of a desired product and position of equilibrium in some industrially important processes** | C10 Sustainable development | 344 |  |
| C6.4.5 define the atom economy of a reaction | C3 Chemical quantities and calculations | 116 |  |
| C6.4.6 calculate the atom economy of a reaction to form a desired product from the balanced equation using the formula: atom economy = mass of atoms in desired product / total mass of atoms in reactants | C3 Chemical quantities and calculations | 116 |  |
| C6.4.7 use arithmetic computation when calculating atom economy | C3 Chemical quantities and calculations | 116 |  |
| **C6.4.8 explain why a particular reaction pathway is chosen to produce a specified product given appropriate data such as atom economy (if not calculated), yield, rate, equilibrium position, usefulness of by-products and evaluate the sustainability of the process** | C3 Chemical quantities and calculations | 116 |  |
| C6.4.9 describe the industrial production of fertilisers as several integrated processes using a variety of raw materials and compare with laboratory syntheses. including: a) demand for fertilisers (including ammonium sulfate) is often met from more than one process b) some fertilisers are made as a bi-product or waste product of another process c) process flow charts are used to summarise industrial processes and give information about raw materials, stages in the process, products, by-products and waste d) lab processes prepare chemicals in batches, industrial processes are usually continuous. | C10 Sustainable development | 346 |  |
| C6.4.10 compare the industrial production of fertilisers with laboratory syntheses of the same products | C10 Sustainable development | 346 |  |

## AQA Hodder textbook mapping

| **Specification Statement** | **Chapter covering specification statement** | **Page Number** | **Comments** |
| --- | --- | --- | --- |
| **Chapter C1 Air and water** | | | |
| **C1.1 How has the Earth's atmosphere changed over time, and why?** | | | |
| C1.1.1 recall and explain the main features of the particle model in terms of the states of matter and change of state, distinguishing between physical and chemical changes and recognise that the particles themselves do not have the same properties as the bulk substances | C2 Bonding, Structure and the properties of matter | 49 |  |
| **C1.1.2 explain the limitations of the particle model in relation to changes of state when particles are represented by inelastic spheres** |  |  | Not explicit |
| C1.1.3 use ideas about energy transfers and the relative strength of forces between particles to explain the different temperatures at which changes of state occur | C2 Bonding, Structure and the properties of matter | 49 |  |
| C1.1.4 use data to predict states of substances under given conditions | C2 Bonding, Structure and the properties of matter | 50 | Questions |
| C1.1.5 interpret evidence for how it is thought the atmosphere was originally formed | C9 Chemistry of the atmosphere | 224 |  |
| C1.1.6 describe how it is thought an oxygen-rich atmosphere developed over time | C9 Chemistry of the atmosphere | 226 |  |
| C1.1.7 describe the major sources of carbon monoxide and particulates (incomplete combustion), sulfur dioxide (combustion of sulfur impurities in fuels), oxides of nitrogen (oxidation of nitrogen at high temperatures and further oxidation in the air) | C9 Chemistry of the atmosphere | 236 |  |
| C1.1.8 explain the problems caused by increased amounts of these substances and describe approaches to decreasing the emissions of these substances into the atmosphere including the use of catalytic converters, low sulfur petrol and gas scrubbers to decrease emissions | C9 Chemistry of the atmosphere | 236 |  |
| C1.1.9 use chemical symbols to write the formulae of elements and simple covalent compounds | C11 Formulae and equations | 277 |  |
| C1.1.10 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations | C11 Formulae and equations | 283 |  |
| C1.1.11 use arithmetic computations and ratios when balancing equations | C11 Formulae and equations | 283 |  |
| C1.1.12 describe tests to identify oxygen, hydrogen and carbon dioxide PAG2 | C8 Chemical Analysis | 207 |  |
| C1.1.13 explain oxidation in terms of gain of oxygen | C3 Quantitative Chemistry | 69 |  |
| **C1.2 Why are there temperature changes in chemical reactions?** | | | |
| C1.2.1 distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings | C5 Energy Changes | 129 |  |
| C1.2.2 draw and label a reaction profile for an exothermic and an endothermic reaction, identifying activation energy | C5 Energy Changes | 131 |  |
| C1.2.3 explain activation energy as the energy needed for a reaction to occur | C5 Energy Changes | 131 |  |
| C1.2.4 interpret charts and graphs when dealing with reaction profiles | C5 Energy Changes | 131 |  |
| **C1.2.5 calculate energy changes in a chemical reaction by considering bond breaking and bond making energies** | C5 Energy Changes | 133 |  |
| C1.2.6 carry out arithmetic computations when calculating energy changes | C5 Energy Changes | 134 |  |
| C1.2.7 describe how you would investigate a chemical reaction to determine whether it is endothermic or exothermic (separate science only) | C5 Energy Changes | 132 |  |
| C1.2.8 recall that a chemical cell produces a potential difference until the reactants are used up (separate science only) | C5 Energy Changes | 136 |  |
| C1.2.9 evaluate the advantages and disadvantages of hydrogen/ oxygen and other fuel cells for given uses (separate science only) | C5 Energy Changes | 138 |  |
| **C1.3 What is the evidence for climate change, why is it occurring?** | | | |
| C1.3.1 describe the greenhouse effect in terms of the interaction of radiation with matter | C9 Chemistry of the atmosphere | 227 |  |
| C1.3.2 evaluate the evidence for additional anthropogenic causes of climate change, including the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels, and describe the uncertainties in the evidence base | C9 Chemistry of the atmosphere | 228 |  |
| C1.3.3 describe the potential effects of increased levels of carbon dioxide and methane on the Earth’s climate, including where crops can be grown, extreme weather patterns, melting of polar ice and flooding of low land | C9 Chemistry of the atmosphere | 232 |  |
| C1.3.4 describe how the effects of increased levels of carbon dioxide and methane may be mitigated, including consideration of scale, risk and environmental implications | C9 Chemistry of the atmosphere | 238 |  |
| C1.3.5 extract and interpret information from charts, graphs and tables |  |  | Not explicit |
| C1.3.6 use orders of magnitude to evaluate the significance of data |  |  | Not explicit |
| **C1.4 How can scientists help improve the supply of potable water?** | | | |
| C1.4.1 describe the principal methods for increasing the availability of potable water, in terms of the separation techniques used, including the ease of treating waste, ground and salt water including filtration and membrane filtration; aeration, use of bacteria; chlorination and distillation (for salt water) | C10 Using the Earth's resources | 252 |  |
| C1.4.2 describe a test to identify chlorine (using blue litmus paper) PAG2 | C8 Chemical Analysis | 207 |  |
| **Chapter C2 Chemical patterns** | | | |
| **C2.1 How have our ideas about atoms developed over time?** | | | |
| C2.1.1 describe how and why the atomic model has changed over time to include the main ideas of Dalton, Thomson, Rutherford and Bohr | C1 Atomic structure and the periodic table | 7 |  |
| C2.1.2 describe the atom as a positively charged nucleus surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with most of the mass in the nucleus | C1 Atomic structure and the periodic table | 2 |  |
| C2.1.3 recall relative charges and approximate relative masses of protons, neutrons and electrons | C1 Atomic structure and the periodic table | 2 |  |
| C2.1.4 estimate the size and scale of atoms relative to other particles | C1 Atomic structure and the periodic table | 3 |  |
| C2.1.5 recall the typical size (order of magnitude) of atoms and small molecules | C1 Atomic structure and the periodic table | 2 |  |
| C2.1.6 relate size and scale of atoms to objects in the physical world | C1 Atomic structure and the periodic table | 3 |  |
| C2.1.7 calculate numbers of protons, neutrons and electrons in atoms, given atomic number and mass number of isotopes or by extracting data from the Periodic Table | C1 Atomic structure and the periodic table | 4 |  |
| **C2.2 What does the Periodic Table tell us about elements?** | | | |
| C2.2.1 explain how the position of an element in the Periodic Table is related to the arrangement of electrons in its atoms and hence to its atomic number | C1 Atomic structure and the periodic table | 4 |  |
| C2.2.2 describe how Mendeleev organised the elements based on their properties and relative atomic masses | C1 Atomic structure and the periodic table | 20 |  |
| C2.2.3 describe how discovery of new elements and the ordering elements by atomic number supports Mendeleev’s decisions to leave gaps and reorder some elements | C1 Atomic structure and the periodic table | 21 |  |
| C2.2.4 describe metals and non-metals and explain the differences between them on the basis of their characteristic physical and chemical properties, including melting point, boiling point, state and appearance, density, formulae of compounds, relative reactivity and electrical conductivity | C1 Atomic structure and the periodic table | 10 |  |
| C2.2.5 recall the simple properties of Group 1 elements including their reaction with moist air, water, and chlorine | C4 Chemical Changes | 100 | Also page 15 |
| C2.2.6 recall the simple properties of Group 7 elements including their states and colours at room temperature and pressure, their colours as gases, their reactions with Group 1 elements and their displacement reactions with other metal halides | C1 Atomic structure and the periodic table | 16 |  |
| C2.2.7 predict possible reactions and probable reactivity of elements from their positions in the Periodic Table | C1 Atomic structure and the periodic table | 11 |  |
| C2.2.8 describe experiments to identify the reactivity pattern of Group 7 elements including displacement reactions PAG1 | C1 Atomic structure and the periodic table | 16 |  |
| C2.2.9 describe experiments to identify the reactivity pattern of Group 1 elements | C1 Atomic structure and the periodic table | 14 |  |
| **C2.3 How do metals and non-metals combine to form compounds?** | | | |
| C2.3.1 recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity | C1 Atomic structure and the periodic table | 13 |  |
| C2.3.2 explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups | C1 Atomic structure and the periodic table | 13-17 | Group 0 - pg 13, Group 1- pg 14, Group 7 - pg 16 |
| C2.3.3 explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number | C1 Atomic structure and the periodic table | 13-18 | Group 0 - pg 13, Group 1- pg 14, Group 7 - pg 17 |
| C2.3.4 explain how the atomic structure of metals and nonmetals relates to their position in the Periodic Table | C1 Atomic structure and the periodic table | 13-19 | Group 0 - pg 13, Group 1- pg 14, Group 7 - pg 18 |
| C2.3.5 describe the nature and arrangement of chemical bonds in ionic compounds | C2 Bonding, Structure and the properties of matter | 34 |  |
| C2.3.6 explain ionic bonding in terms of electrostatic forces and transfer of electrons | C2 Bonding, Structure and the properties of matter | 37 |  |
| C2.3.7 calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table | C1 Atomic structure and the periodic table | 7 |  |
| C2.3.8 construct dot and cross diagrams for simple ionic substances | C2 Bonding, Structure and the properties of matter | 38 |  |
| C2.3.9 explain how the bulk properties of ionic materials are related to the type of bonds they contain | C2 Bonding, Structure and the properties of matter | c4 |  |
| C2.3.10 use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding | C2 Bonding, Structure and the properties of matter | 34 |  |
| C2.3.11 describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations | C2 Bonding, Structure and the properties of matter | 34 |  |
| C2.3.12 translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds | C2 Bonding, Structure and the properties of matter | 34 |  |
| **C2.4 How are equations used to represent chemical reactions?** | | | |
| C2.4.1 use chemical symbols to write the formulae of elements and simple covalent and ionic compounds | C2 Bonding, Structure and the properties of matter |  | Pg 35 ionic Page 41 covalent |
| C2.4.2 use the formulae of common ions to deduce the formula of Group 1 and Group 7 compounds | C2 Bonding, Structure and the properties of matter | 36 |  |
| C2.4.3 use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied Periodic Table to write formulae and balanced chemical equations where appropriate | C2 Bonding, Structure and the properties of matter | 36 |  |
| C2.4.4 describe the physical states of products and reactants using state symbols (s, l, g and aq) | C11 Formulae and equations | 284 |  |
| **C2.5 What are the properties of the transition metals? (separate science only)** | | | |
| C2.5.1 recall the general properties of transition metals (melting point, density, reactivity, formation of coloured ions with different charges and uses as catalysts) and exemplify these by reference to copper, iron, chromium, silver and gold | C1 Atomic structure and the periodic table | 18 |  |
| **Chapter C3 Chemicals of the natural environment** | | | |
| **C3.1 How are atoms held together in a metal?** | | | |
| C3.1.1 describe the nature and arrangement of chemical bonds in metals | C2 Bonding, Structure and the properties of matter | 45 |  |
| C3.1.2 explain how the bulk properties of metals are related to the type of bonds they contain | C2 Bonding, Structure and the properties of matter | 45 |  |
| **C3.2 How are metals with different reactivities extracted?** | | | |
| C3.2.1 deduce an order of reactivity of metals based on experimental results including reactions with water, dilute acid and displacement reactions with other metals | C4 Chemical Changes | 99 |  |
| C3.2.2 explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion to include potassium, sodium, calcium, aluminium, magnesium, zinc, iron, lead, [hydrogen], copper, silver | C4 Chemical Changes | 101 |  |
| C3.2.3 use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations **and ionic equations** | C3 Quantitative Chemistry | 68 | Also C11 page 283 |
| C3.2.4 explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including the extraction of zinc | C4 Chemical Changes | 106 |  |
| C3.2.5 explain why electrolysis is used to extract some metals from their ores | C4 Chemical Changes | 119 |  |
| **C3.2.6 evaluate alternative biological methods of metal extraction (bacterial and phytoextraction)** | C10 Using the Earth's resources | 261 |  |
| **C3.3 What are electrolytes and what happens during electrolysis?** | | | |
| C3.3.1 describe electrolysis in terms of the ions present and reactions at the electrodes | C4 Chemical Changes | 117 |  |
| C3.3.2 predict the products of electrolysis of binary ionic compounds in the molten state | C4 Chemical Changes | 117 |  |
| C3.3.3 recall that metals (or hydrogen) are formed at the cathode and non-metals are formed at the anode in electrolysis using inert electrodes | C4 Chemical Changes | 117 |  |
| **C3.3.4 use the names and symbols of common elements and compounds and the principle of conservation of mass to write half equations** | C4 Chemical Changes | 104 | Also C11 page 289 |
| **C3.3.5 explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced** | C4 Chemical Changes | 103 |  |
| C3.3.6 explain how electrolysis is used to extract some metals from their ores including the extraction of aluminium | C4 Chemical Changes | 119 |  |
| C3.3.7 describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present, including the formation of oxygen, chlorine and the discharge of metals or hydrogen linked to their relative reactivity | C4 Chemical Changes | 120 |  |
| C3.3.8 describe the technique of electrolysis of an aqueous solution of a salt PAG2 | C4 Chemical Changes | 121 |  |
| **C3.4 Why is crude oil important as a source of new materials?** | | | |
| C3.4.1 recall that crude oil is a main source of hydrocarbons and is a feedstock for the petrochemical industry | C7 Organic Chemistry | 171 |  |
| C3.4.2 explain how modern life is crucially dependent upon hydrocarbons and recognise that crude oil is a finite resource | C7 Organic Chemistry | 172 |  |
| C3.4.3 describe and explain the separation of crude oil by fractional distillation PAG3 | C7 Organic Chemistry | 173 |  |
| C3.4.4 describe the fractions of crude oil as largely a mixture of compounds of formula CnH2n+2 which are members of the alkane homologous series | C7 Organic Chemistry | 172 |  |
| C3.4.5 use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur | C2 Bonding, Structure and the properties of matter | 39 |  |
| C3.4.6 deduce the empirical formula of a compound from the relative numbers of atoms present or from a model or diagram and vice versa | C7 Organic Chemistry |  | Alkanes 172, Alkenes 177, Alcohols 181, Carboxylic Acids 183 |
| C3.4.7 use arithmetic computation and ratio when determining empirical formulae |  |  | Not explicit |
| C3.4.8 describe the arrangement of chemical bonds in simple molecules | C2 Bonding, Structure and the properties of matter |  | Ionic Page 34, Covalent page 42 |
| C3.4.9 explain covalent bonding in terms of the sharing of electrons | C2 Bonding, Structure and the properties of matter | 39 |  |
| C3.4.10 construct dot and cross diagrams for simple covalent substances | C2 Bonding, Structure and the properties of matter | 42 |  |
| C3.4.11 represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for simple molecules | C2 Bonding, Structure and the properties of matter | 42 |  |
| C3.4.12 describe the limitations of dot and cross diagrams, ball and stick models and two and three dimensional representations when used to represent simple molecules |  |  | Limitations not really mentioned |
| C3.4.13 translate information between diagrammatic and numerical forms | C2 Bonding, Structure and the properties of matter | 42 |  |
| C3.4.14 explain how the bulk properties of simple molecules are related to the covalent bonds they contain and their bond strengths in relation to intermolecular forces | C2 Bonding, Structure and the properties of matter | 39 |  |
| C3.4.15 describe the production of materials that are more useful by cracking | C7 Organic Chemistry | 176 |  |
| C3.4.16 recognise functional groups and identify members of the same homologous series (separate science only) | C7 Organic Chemistry |  | Alkanes 172, Alkenes 177, Alcohols 181, Carboxylic Acids 183 |
| C3.4.17 name and draw the structural formulae, using fully displayed formulae, of the first four members of the straight chain alkanes and alkenes, alcohols and carboxylic acids (separate science only) | C7 Organic Chemistry |  | Alkanes 172, Alkenes 177, Alcohols 181, Carboxylic Acids 183 |
| C3.4.18 predict the formulae and structures of products of reactions (combustion, addition across a double bond and oxidation of alcohols to carboxylic acids) of the first four and other given members of these homologous series (separate science only) | C7 Organic Chemistry |  | Alkanes 172, Alkenes 177, Alcohols 181, Carboxylic Acids 183 |
| C3.4.19 recall that it is the generality of reactions of functional groups that determine the reactions of organic compounds (separate science only) | C7 Organic Chemistry |  | Alkanes 172, Alkenes 177, Alcohols 181, Carboxylic Acids 183 |
| **Chapter C4 Materials choices** | | | |
| **C4.1 How is data used to choose a material for a particular use?** | | | |
| C4.1.1 compare quantitatively the physical properties of glass and clay ceramics, polymers, composites and metals, including melting point, softening temperature (for polymers), electrical conductivity, strength (in tension or compression), stiffness, flexibility, brittleness, hardness, density, ease of reshaping | C10 Using the Earth's resources | 264 | Metals - C2 page 45 |
| C4.1.2 explain how the properties of materials are related to their uses and select appropriate materials given details of the usage required | C10 Using the Earth's resources | 264 |  |
| C4.1.3 describe the composition of some important alloys in relation to their properties and uses, including steel (separate science only) | C2 Bonding, Structure and the properties of matter | 46 | Steel not mentioned explicitly |
| **C4.2 What are the different types of polymer? (separate science only)** | | | |
| C4.2.1 recall the basic principles of addition polymerisation by reference to the functional group in the monomer and the repeating units in the polymer | C7 Organic Chemistry | 187 |  |
| C4.2.2 deduce the structure of an addition polymer from a simple monomer with a double bond and vice versa | C7 Organic Chemistry | 187 |  |
| C4.2.3 explain the basic principles of condensation polymerisation by 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 i Learners are not expected to recall the formulae of dicarboxylic acid, diamine and diol monomers | C7 Organic Chemistry | 189 |  |
| C4.2.4 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 | C7 Organic Chemistry | 193 |  |
| **C4.3 How do bonding and structure affect the properties of materials?** | | | |
| C4.3.1 explain how the bulk properties of materials (including strength, melting point, electrical and thermal conductivity, brittleness, flexibility, hardness and ease of reshaping) are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged, recognising that the atoms themselves do not have these properties | C2 Bonding, Structure and the properties of matter | 39 |  |
| C4.3.2 recall that carbon can form four covalent bonds |  |  | Not explicit |
| C4.3.3 explain that the vast array of natural and synthetic organic compounds occurs due to the ability of carbon to form families of similar compounds, chains and rings | C2 Bonding, Structure and the properties of matter | 54 |  |
| C4.3.4 describe the nature and arrangement of chemical bonds in polymers with reference to their properties including strength, flexibility or stiffness, hardness and melting point of the solid | C2 Bonding, Structure and the properties of matter | 43 |  |
| C4.3.5 describe the nature and arrangement of chemical bonds in giant covalent structures | C2 Bonding, Structure and the properties of matter | 44 |  |
| C4.3.6 explain the properties of diamond and graphite in terms of their structures and bonding, include melting point, hardness and (for graphite) conductivity and lubricating action | C2 Bonding, Structure and the properties of matter | 54-55 |  |
| C4.3.7 represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures e.g. allotropes of carbon | C2 Bonding, Structure and the properties of matter | 54-55 |  |
| C4.3.8 describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals | C2 Bonding, Structure and the properties of matter | 33-46 | Not direct comparison but all the information is given to allow comparison |
| **C4.4 Why are nanoparticles so useful?** | | | |
| C4.4.1 compare ‘nano’ dimensions to typical dimensions of atoms and molecules | C2 Bonding, Structure and the properties of matter | 51 |  |
| C4.4.2 describe the surface area to volume relationship for different-sized particles and describe how this affects properties | C2 Bonding, Structure and the properties of matter | 52 |  |
| C4.4.3 describe how the properties of nanoparticulate materials are related to their uses including properties which arise from their size, surface area and arrangement of atoms in tubes or rings | C2 Bonding, Structure and the properties of matter | 52 |  |
| C4.4.4 explain the properties fullerenes and graphene in terms of their structures | C2 Bonding, Structure and the properties of matter | 55 |  |
| C4.4.5 explain the possible risks associated with some nanoparticulate materials including: a) possible effects on health due to their size and surface area b) reasons that there is more data about uses of nanoparticles than about possible health effects c) the relative risks and benefits of using nanoparticles for different purposes | C2 Bonding, Structure and the properties of matter | 53 |  |
| C4.4.6 estimate size and scale of atoms and nanoparticles including the ideas that: a) nanotechnology is the use and control of structures that are very small (1 to 100 nanometres in size) b) data expressed in nanometres is used to compare the sizes of nanoparticles, atoms and molecules | C2 Bonding, Structure and the properties of matter | 51 |  |
| C4.4.7 interpret, order and calculate with numbers written in standard form when dealing with nanoparticles | C2 Bonding, Structure and the properties of matter | 51 |  |
| C4.4.8 use ratios when considering relative sizes and surface area to volume comparisons | C2 Bonding, Structure and the properties of matter | 52 |  |
| C4.4.9 calculate surface areas and volumes of cubes | C2 Bonding, Structure and the properties of matter | 52 |  |
| **C4.5 What happens to products at the end of their useful life?** | | | |
| C4.5.1 describe the conditions which cause corrosion and the process of corrosion, and explain how mitigation is achieved by creating a physical barrier to oxygen and water and by sacrificial protection (separate science only) | C10 Using the Earth's resources | 258 |  |
| C4.5.2 explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced | C4 Chemical Changes | 99 |  |
| **C4.5.3 explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced** | C4 Chemical Changes | 103 |  |
| C4.5.4 describe the basic principles in carrying out a life-cycle assessment of a material or product including a) the use of water, energy and the environmental impact of each stage in a life cycle, including its manufacture, transport and disposal b) incineration, landfill and electricity generation schemes c) biodegradable and non-biodegradable materials | C10 Using the Earth's resources | 250 |  |
| C4.5.5 interpret data from a life-cycle assessment of a material or product | C10 Using the Earth's resources | 250 |  |
| C4.5.6 describe the process where PET drinks bottles are reused and recycled for different uses, and explain why this is viable | C10 Using the Earth's resources | 250 |  |
| C4.5.7 evaluate factors that affect decisions on recycling with reference to products made from crude oil and metal ores | C10 Using the Earth's resources | 251 |  |
| **Chapter C5 Chemical analysis** | | | |
| **C5.1 How are chemicals separated and tested for purity?** | | | |
| C5.1.1 explain that many useful materials are formulations of mixtures | C8 Chemical Analysis | 204 |  |
| C5.1.2 explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term ‘pure’ | C8 Chemical Analysis | 202 |  |
| C5.1.3 use melting point data to distinguish pure from impure substances | C8 Chemical Analysis | 203 |  |
| C5.1.4 recall that chromatography involves a stationary and a mobile phase and that separation depends on the distribution between the phases | C8 Chemical Analysis | 205 |  |
| C5.1.5 interpret chromatograms, including calculating Rf values | C8 Chemical Analysis | 206 |  |
| C5.1.6 suggest chromatographic methods for distinguishing pure from impure substances PAG4 Including the use of: a) paper chromatography b) aqueous and non-aqueous solvents c) locating agents | C8 Chemical Analysis | 205 | No mention of non aqueous solvents or locating agents |
| C5.1.7 describe, explain and exemplify the processes of filtration, crystallisation, simple distillation, and fractional distillation PAG3, PAG7 | C1 Atomic structure and the periodic table | 22 |  |
| C5.1.8 suggest suitable purification techniques given information about the substances involved PAG3, PAG7 | C1 Atomic structure and the periodic table | 22 |  |
| **C5.2 How do chemists find the composition of unknown samples? (separate science only)** | | | |
| C5.2.1 describe the purpose of representative sampling in qualitative analysis |  |  | Not explicitly mentioned |
| C5.2.2 interpret flame tests to identify metal ions, including the ions of lithium, sodium, potassium, calcium and copper | C8 Chemical Analysis | 209 |  |
| C5.2.3 describe the technique of using flame tests to identify metal ions PAG5 | C8 Chemical Analysis | 209 |  |
| C5.2.4 describe tests to identify aqueous cations and aqueous anions and identify species from test results including: PAG5 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) | C8 Chemical Analysis | 209 |  |
| 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 | C8 Chemical Analysis | 214 | No expectation of interpretation |
| C5.2.6 describe the advantages of instrumental methods of analysis (sensitivity, accuracy and speed) | C8 Chemical Analysis | 214 |  |
| C5.2.7 interpret charts, particularly in spectroscopy | C8 Chemical Analysis | 214 | No expectation of interpretation |
| **C5.3 How are the amounts of substances in reactions calculated?** | | | |
| C5.3.1 recall and use the law of conservation of mass | C3 Quantitative Chemistry | 68 |  |
| C5.3.2 explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model | C3 Quantitative Chemistry | 69 |  |
| C5.3.3 calculate relative formula masses of species separately and in a balanced chemical equation | C3 Quantitative Chemistry | 68 |  |
| **C5.3.4 recall and use the definitions of the Avogadro constant (in standard form) and of the mole** | C3 Quantitative Chemistry | 65 |  |
| **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: number of moles = mass of substance (g) relative formula mass (g)** | C3 Quantitative Chemistry | 66 |  |
| **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** | C3 Quantitative Chemistry | 73 |  |
| **C5.3.7 use a balanced equation to calculate masses of reactants or products** | C3 Quantitative Chemistry | 77 |  |
| C5.3.8 use arithmetic computation, ratio, percentage and multistep calculations throughout quantitative chemistry | C3 Quantitative Chemistry | 70 |  |
| **C5.3.9 carry out calculations with numbers written in standard form when using the Avogadro constant** | C3 Quantitative Chemistry | 65 |  |
| C5.3.10 change the subject of a mathematical equation | C3 Quantitative Chemistry |  | Throughout chapter |
| C5.3.11 calculate the theoretical amount of a product from a given amount of reactant (separate science only) | C3 Quantitative Chemistry | 78 |  |
| C5.3.12 calculate the percentage yield of a reaction product from the actual yield of a reaction (separate science only) | C3 Quantitative Chemistry | 78 |  |
| C5.3.13 suggest reasons for low yields for a given procedure (separate science only) | C3 Quantitative Chemistry | 78 |  |
| **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 24dm3) (separate science only)** | C3 Quantitative Chemistry | 82 |  |
| **C5.4 How are the amounts of chemicals in solution measured?** | | | |
| C5.4.1 identify the difference between qualitative and quantitative analysis (separate science only) |  |  | C3 Quantitative Chemistry chapter |
| **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: concentration (g/dm3) = mass of solute (g) / volume (dm3)** | C3 Quantitative Chemistry | 86 |  |
| **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 and calculate the molar concentration using the formula concentration (mol/dm3) = number of moles of solute / volume (dm3)** | C3 Quantitative Chemistry | 86 |  |
| 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 | C4 Chemical Changes | 111 |  |
| C5.4.5 recall that acids form hydrogen ions when they dissolve in water and solutions of alkalis contain hydroxide ions | C4 Chemical Changes | 111 |  |
| C5.4.6 recognise that aqueous neutralisation reactions can be generalised to hydrogen ions reacting with hydroxide ions to form water | C4 Chemical Changes | 111 |  |
| C5.4.7 describe and explain the procedure for a titration to give precise, accurate, valid and repeatable results | C3 Quantitative Chemistry | 88 |  |
| C5.4.8 Evaluate the quality of data from titrations | C3 Quantitative Chemistry | 89 |  |
| 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) | C3 Quantitative Chemistry | 89 |  |
| **Chapter C6 Making useful chemicals** | | | |
| **C6.1 What useful products can be made from acids?** | | | |
| C6.1.1 recall that acids react with some metals and with carbonates and write equations predicting products from given reactants | C4 Chemical Changes | 113 |  |
| C6.1.2 describe practical procedures to make salts to include appropriate use of filtration, evaporation, crystallisation and drying PAG7 | C4 Chemical Changes | 115 |  |
| C6.1.3 use the formulae of common ions to deduce the formula of a compound | C2 Bonding, Structure and the properties of matter | 36 |  |
| C6.1.4 recall that relative acidity and alkalinity are measured by pH including the use of universal indicator and pH meters | C4 Chemical Changes | 107 |  |
| **C6.1.5 use and explain the terms dilute and concentrated (amount of substance) and weak and strong (degree of ionisation) in relation to acids including differences in reactivity with metals and carbonates** | C4 Chemical Changes | 109 |  |
| **C6.1.6 use the idea that as hydrogen ion concentration increases by a factor of ten the pH value of a solution decreases by one** | C4 Chemical Changes | 107 |  |
| **C6.1.7 describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH (whole numbers only)** | C4 Chemical Changes | 109 |  |
| **C6.2 How do chemists control the rate of reaction?** | | | |
| C6.2.1 describe the effect on rate of reaction of changes in temperature, concentration, pressure, and surface area | C6 The rate and extent of chemical change | 152 |  |
| C6.2.2 explain the effects on rates of reaction of changes in temperature, concentration and pressure in terms of frequency and energy of collision between particles | C6 The rate and extent of chemical change | 151 |  |
| C6.2.3 explain the effects on rates of reaction of changes in the size of the pieces of a reacting solid in terms of surface area to volume ratio | C6 The rate and extent of chemical change | 153 |  |
| C6.2.4 describe the characteristics of catalysts and their effect on rates of reaction | C6 The rate and extent of chemical change | 153 |  |
| C6.2.5 identify catalysts in reactions | C6 The rate and extent of chemical change | 153 |  |
| C6.2.6 explain catalytic action in terms of activation energy | C6 The rate and extent of chemical change | 153 |  |
| C6.2.7 suggest practical methods for determining the rate of a given reaction including: PAG8 for reactions that produce gases: i. gas syringes or collection over water can be used to measure the volume of gas produced  ii. mass change can be followed using a balance  **measurement of physical factors: iii. colour change iv. formation of a precipitate** | C6 The rate and extent of chemical change | 156 |  |
| C6.2.8 interpret rate of reaction graphs | C6 The rate and extent of chemical change | 150 |  |
| **C6.2.9 interpret graphs of reaction conditions versus rate (separate science only)**  *i* an understanding of orders of reaction is not required | C6 The rate and extent of chemical change | 150 |  |
| C6.2.10 use arithmetic computation and ratios when measuring rates of reaction | C6 The rate and extent of chemical change | 150 | Questions |
| C6.2.11 draw and interpret appropriate graphs from data to determine rate of reaction | C6 The rate and extent of chemical change | 150 | Questions |
| C6.2.12 determine gradients of graphs as a measure of rate of change to determine rate | C6 The rate and extent of chemical change | 150 |  |
| C6.2.13 use proportionality when comparing factors affecting rate of reaction |  |  | Not obvious |
| C6.2.14 describe the use of enzymes as catalysts in biological systems and some industrial processes | C6 The rate and extent of chemical change | 154 |  |
| **C6.3 What factors affect the yield of chemical reactions?** | | | |
| C6.3.1 recall that some reactions may be reversed by altering the reaction conditions including: a) reversible reactions are shown by the symbol ? b) reversible reactions (in closed systems) do not reach 100% yield | C6 The rate and extent of chemical change | 158 |  |
| C6.3.2 recall that dynamic equilibrium occurs when the rates of forward and reverse reactions are equal | C6 The rate and extent of chemical change | 159 |  |
| **C6.3.3 predict the effect of changing reaction conditions (concentration, temperature and pressure) on equilibrium position and suggest appropriate conditions to produce a particular product, including: a) catalysts increase rate but do not affect yield b) the disadvantages of using very high temperatures or pressures** | C6 The rate and extent of chemical change | 160-164 |  |
| **C6.4 How are chemicals made on an industrial scale? (separate science only)** | | | |
| C6.4.1 recall the importance of nitrogen, phosphorus and potassium compounds in agricultural production | C10 Using the Earth's resources | 268 |  |
| C6.4.2 explain the importance of the Haber process in agricultural production and the benefits and costs of making and using fertilisers, including: a) the balance between demand and supply of food worldwide b) the sustainability and practical issues of producing and using synthetic and natural fertilisers on a large scale c) the environmental impact of over-use of synthetic fertilisers (eutrophication) | C10 Using the Earth's resources | 266 |  |
| **C6.4.3 explain how the commercially used conditions for the Haber process are related to the availability and cost of raw materials and energy supplies, control of equilibrium position and rate including: a) the sourcing of raw materials and production of the feedstocks; nitrogen (from air), and hydrogen (from natural gas and steam) b) the effect of a catalyst, temperature and pressure on the yield and rate of reaction c) the separation of the ammonia and recycling of unreacted nitrogen and hydrogen** | C10 Using the Earth's resources | 266 |  |
| **C6.4.4 explain the trade-off between rate of production of a desired product and position of equilibrium in some industrially important processes** | C10 Using the Earth's resources | 267 |  |
| C6.4.5 define the atom economy of a reaction | C3 Quantitative Chemistry | 79 |  |
| C6.4.6 calculate the atom economy of a reaction to form a desired product from the balanced equation using the formula: atom economy = mass of atoms in desired product / total mass of atoms in reactants | C3 Quantitative Chemistry | 79 |  |
| C6.4.7 use arithmetic computation when calculating atom economy | C3 Quantitative Chemistry | 80 |  |
| **C6.4.8 explain why a particular reaction pathway is chosen to produce a specified product given appropriate data such as atom economy (if not calculated), yield, rate, equilibrium position, usefulness of by-products and evaluate the sustainability of the process** | C10 Using the Earth's resources | 267 |  |
| C6.4.9 describe the industrial production of fertilisers as several integrated processes using a variety of raw materials and compare with laboratory syntheses. including: a) demand for fertilisers (including ammonium sulfate) is often met from more than one process b) some fertilisers are made as a bi-product or waste product of another process c) process flow charts are used to summarise industrial processes and give information about raw materials, stages in the process, products, by-products and waste d) lab processes prepare chemicals in batches, industrial processes are usually continuous. | C10 Using the Earth's resources | 268 |  |
| C6.4.10 compare the industrial production of fertilisers with laboratory syntheses of the same products |  |  | No comparison |

## Want to switch?

If you’re an OCR-approved centre, all you need to do is download the specification and start teaching. Your exams officer can complete an intention to teach form which enables us to provide appropriate support. When you’re ready to enter your students, you just need to speak to your exams officer to:

1. Make estimated entries by 10 October so we can prepare the question papers and ensure we’ve got enough examiners.
2. Make final entries by 21 February. If you are not already an OCR-approved centre please refer your exams officer to the centre approval section of our admin guide.

## Next steps

1. Familiarise yourself with the specification, sample assessment materials and teaching resources on the OCR Chemistry B qualification page of the OCR website. <http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/>
2. Browse the online delivery guides for teaching ideas and use the Scheme of Work builder to create your personal scheme of work. <http://www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-chemistry-b-j258-from-2016/planning-and-teaching/>

1. Get a login for our secure extranet, Interchange – this allows you to access the latest past/practice papers and use our results analysis service, Active Results. <https://interchange.ocr.org.uk>
2. Sign up to receive subject updates by email.   
   <http://www.ocr.org.uk/i-want-to/email-updates>
3. Sign up to attend a training event or take part in webinars on specific topics running throughout the year and our Q&A webinar sessions every half term. <https://www.cpdhub.ocr.org.uk>
4. Attend one of our free teacher network events that are run in each region every term. These are hosted at the end of the school day in a school or college near you, with teachers sharing best practice and subject specialists on hand to lead discussion and answer questions. <http://ocr.org.uk/qualifications/professional-development/teacher-networks/>