GCSE

Chemistry B

Gateway Science Suite

OCR GCSE in Chemistry B J644

Foreword to the Third Edition (October 2008)

This Third Edition of the OCR GCSE Chemistry B specification has been produced to include the changes to the wording of the Science in the News Level of Response Grid. These changes are intended to assist teachers in interpreting the qualities to be assessed.

The revised Level of Response Grid is in Section 5.2 (pg 125). Section 6.7 has been updated to be in line with other GCSE Specifications.

QAN 100/5636/1

Contents

1 About this Qualification

1.1 About the Gateway Science Suite

The Gateway science suite comprises five specifications which share a common approach, utilise common material, use a similar style of examination questions and have a common approach to skills assessment.

The qualifications available as part of this suite are:

- GCSE Science;
- GCSE Additional Science;
- GCSE Biology;
- GCSE Chemistry;
- GCSE Physics.

The suite emphasises explanations, theories and modelling in science along with the implications of science for society. Strong emphasis is placed on the active involvement of candidates in the learning process and each specification encourages a wide range of teaching and learning activities.

The suite is supported by resources published by Collins and Heinemann.

Centres wishing to include GCSE Additional Applied Science in their provision are advised to consider the specification which is part of the Twenty First Century Science Suite A.

1.2 About this Chemistry Specification

This booklet contains OCR's GCSE specification in Chemistry for teaching from September 2006 and first certification in June 2008.

The primary objective of this specification is to interest and engage candidates in science.

This is achieved by:

- identifying activities and experiences which will excite their interest, and link these to scientific ideas and their implications for society;
- providing opportunities to develop science explanations and theories;
- providing a scheme of assessment which gives regular feedback.

This approach will appeal to candidates of all abilities. The specification emphasises the teaching and learning activities of the course, from which emerge the learning outcomes.

This specification comprises six teaching modules which are assessed through three units. Candidates take Units 1 and 2 and either Unit 3 or Unit 4.

Unit	Unit Code	Title	Duration	Weighting	Total Mark
1	B641	Chemistry B Unit 1 – modules C1, C2, C3	1 hour	33⅓%	60
2	B642	Chemistry B Unit 2 – modules C4, C5, C6	1 hour	33⅓%	60
3	B645	Chemistry B Unit 3 – ‘Can-Do’ tasks and report on Science in the News	-	33⅓%	60
4	B646	Chemistry B Unit 4 – Research Study, Data Task and Practical Skills	-	33⅓%	60

1.3 Qualification Titles and Levels

This qualification is shown on a certificate as OCR GCSE in Chemistry.

This qualification is approved by the regulatory authorities (QCA, ACCAC and CEA) as part of the National Qualifications Framework (NQF).

Candidates who gain grades G to D will have achieved an award at Foundation Level (Level 1 of the NQF).
Candidates who gain grades C to A* will have achieved an award at Intermediate Level (Level 2 of the NQF).

1.4 Aims

This specification therefore aims to give candidates opportunities to:

- develop their interest in, and enthusiasm for, science;
- develop a critical approach to scientific evidence and methods;
- acquire and apply skills, knowledge and understanding of how science works and its essential role in society;
- acquire scientific skills, knowledge and understanding necessary for progression to further learning.

Close links with the Entry Level course are emphasised by grouping the Entry Level ‘items’ and relating them to the items of this specification.

OCR has taken great care in the preparation of this specification and assessment material to avoid bias of any kind.

1.5 Prior Learning/Attainment

Candidates who are taking courses leading to this qualification at Key Stage 4 should normally have followed the corresponding Key Stage 3 programme of study within the National Curriculum.

Other candidates entering this course should have achieved a general educational level equivalent to National Curriculum Level 3.

2 Summary of Content

The specification content is presented as six Biology modules. Within each module the content is shown as eight items (e.g. C1a, C1b, C1c, C1d, C1e, C1f, C1g, C1h). Thus, the specification content contains a total of 48 teaching items. Each item is approximately 2½ hours teaching time.

Module C1: Carbon Chemistry	Module C2: Rocks and Metals	Module C3: The Periodic Table
a Cooking	a Paints and Pigments	a What are atoms like?
b Food Additives	b Construction Materials	b How atoms combine – Ionic Bonding
c Smells	c Does the Earth Move?	c Covalent bonding and the structure of the Periodic Table
d Making Crude Oil Useful	d Metals and Alloys	d The Group 1 Element
e Making Polymers	e Cars for Scrap	e The Group 7 Element
f Design Polymers	f Clean Air	f Electrolysis
g Using Carbon Fuels	g Faster or Slower (1)	g Transition Elements
h Energy	h Faster or Slower (2)	h Metal Structure and Properties
Module C4: Chemical Economics	**Module C5: How Much?**	**Module C6: Chemistry Out There**
a Acids and Bases	a Moles and Empirical Formulae	a Energy Transfers – Fuel Cells
b Reacting Masses	b Electrolysis	b Redox Reactions
c Fertilisers and Crop Yield	c Quantitative Analysis	c Alcohols
d Making Ammonia – Haber Process and Costs	d Titrations	d Chemistry of Sodium Chloride (NaCl)
e Detergents	e Gas Volumes	e Depletion of the ozone layer
f Batch or Continuous?	f Equilibria	f Hardness of water
g Nanochemistry	g Strong and Weak Acids	g Natural fats and oils
h How pure is our water?	h Ionic Equations	h Analgesics

3 Content

Layout of Teaching Items

The detailed specification content is displayed in tabular format, designed to provide a 'teacher-friendly' approach to the content. This allows teachers to see, at a glance, links between the development of skills and understanding of how science works, and the knowledge and understanding of different science ideas and contexts. The layout of each module follows the outline given below.

MODULE CODE AND TITLE (E.G. UNDERSTANDING OURSELVES)

Item code and title: e.g. B1a: Fit for life

Summary: A short overview of the item, including the skills, knowledge and understanding of how science works that may be covered within this item.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Ideas for teaching activities related to the item, which will integrate the skills, knowledge and understanding of how science works into a teaching scheme. Teachers may choose from these suggestions or develop other comparable activities.	Learning outcomes that will only be assessed in the Foundation Tier paper. The use of bullet points provides guidance on: • depth • context • exemplification

Can-Do tasks

Tasks linked to the learning activities in this item which can be used for the practical skill assessment element (Can-Do tasks). The number of points for successful completion of the task are also given.

e.g. I can measure blood pressure 1 point

MODULE CODE AND TITLE

Links to other modules: opportunities for linking ideas across modules within the Gateway suite of sciences.

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Learning outcomes that can be assessed on either the Foundation Tier or Higher Tier question papers. The use of bullet points provides guidance on: • depth • context • exemplification	Learning outcomes that will only be assessed in the Higher Tier paper. The use of bullet points provides guidance on: • depth • context • exemplification
	Note: It may be necessary to teach the content of the Foundation Tier only column to provide the underpinning knowledge required by Higher Tier candidates.

MODULE C1: CARBON CHEMISTRY

Item C1: Fundamental chemical concepts

Summary: Throughout the study of chemistry there are a number of ideas and concepts that are fundamental. These ideas and concepts have not been put into a particular item but should permeate all the Chemistry units. They will be assessed in the context of any of the modules C1 to C6.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
These Learning Outcomes are intended to be taught throughout this specification.	Describe that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word or symbol equation. Recognise that in a chemical change no atoms are lost or made.
These Learning Outcomes are intended to be taught throughout this specification.	State the number of elements in a compound given its formula. State the number of atoms in a formula with no brackets. State the number of each different type of atom in a formula with no brackets.
These Learning Outcomes are intended to be taught throughout this specification.	Recognise whether a substance is an element or a compound from its formula.
These Learning Outcomes are intended to be taught throughout this specification.	Recognise that a molecule is made up of more than one atom joined together. Recognise that a molecular formula shows the number and type of atom in a molecule. State the number of atoms in a displayed formula. State the names of the different elements in a compound given its displayed formula. State the number of each different type of atom in a displayed formula.
These Learning Outcomes are intended to be taught throughout this specification.	State that all atoms are made up of a nucleus and electrons. State that a chemical bond holds atoms together in a compound.

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations given the reactants and products. Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain that a symbol equation is balanced when the number of each type of atom is the same on both sides of an equation.	Construct balanced symbol equations given the formulae (some or all with brackets) of the reactants and products. Construct balanced symbol equations given the names of the reactants and products (limited to the learning outcomes in this specification).
State the number of atoms in a formula with brackets. State the number of each type of different atom in a formula with brackets.	Recall the formula of the following substances: • carbon dioxide and carbon monoxide; • water and oxygen; • methane and ethane.
Recognise that a displayed formula shows both the atoms and the covalent bonds in a molecule. Write the molecular formula of a compound given its displayed formula.	Balance equations that use displayed formulae.
State that the nucleus of an atom is positive and the electrons negative. State there are two types of chemical bonds: • ionic between a positive ion and a negative ion; • covalent involving a shared pair of electrons.	

MODULE C1: CARBON CHEMISTRY

Item C1a: Cooking

Summary: Cooking involves chemical reactions in food to develop a different texture and taste. New ways of cooking food have been developed. This item considers some of the ways in which food is cooked and the chemical changes that happen to some foods when they are cooked.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of the different types of food. Produce a leaflet describing the scientific principles about how a microwave heats food. Look at the different ways food can be heated or cooked (microwave, oven, boiling, frying, grilling, steaming). Heat water contained in an block of ice shaped as a beaker in a microwave and watch the water boil. Reverse baked alaska (ice cream on outside, meringue on inside).	State two examples of foods that can be eaten raw and two that must be cooked. State examples of different ways that can be used to cook food: • microwave; • conventional oven; • boiling; • steaming; • grilling; • frying.
Investigate the effect of heating on proteins. Investigate the effect of heat on potatoes.	Recognise that a chemical change takes place if: • there is a new substance made; • the process is irreversible; • an energy change takes place. State that the process of cooking food is an example of a chemical change. Describe the changes that occur when an egg or meat is cooked: • change in appearance; • change in texture. Describe how the texture and taste of a potato changes when it is heated.
Investigate the action of heat on baking powder.	State that baking powder gives off carbon dioxide gas when it is heated. State that baking powder is used for baking cakes. Explain that the carbon dioxide made when baking powder is heated helps make cakes rise. State that carbon dioxide turns lime water cloudy.

Can-Do Tasks

I can heat a solid substance safely.	1 point
I can test for carbon dioxide.	1 point

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1a Cooking, C5a Moles and Empirical Formulae, P1d Cooking with Waves

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe reasons why some foods must be cooked before they are eaten: • the high temperature kills microbes; • improve the texture; • improve the taste; • improve the flavour; • easier to digest.	
Explain that cooking food is a chemical change because a new substance is formed and the process cannot be reversed. State that eggs or meat are good sources of proteins. State that protein molecules in eggs and meat change shape when eggs and meat are cooked. State that potatoes are a good of source of carbohydrates.	Explain the changes that occur to an egg or meat when it is cooked: • shape of protein molecules change; • the process is irreversible; • the process is called denaturing; Explain the changes that happen to a potato when it is cooked in terms of changes to the cell wall and how this makes the potato easier to digest.
State that baking powder contains sodium hydrogencarbonate. Describe that sodium hydrogencarbonate breaks down when heated (decomposes) to make sodium carbonate, carbon dioxide and water. Write the balanced word equation for the decomposition of baking powder: sodium hydrogencarbonate → sodium carbonate + carbon dioxide + water Describe the chemical test for carbon dioxide.	Write the balanced symbol equation for the decomposition of sodium hydrogencarbonate. $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

MODULE C1: CARBON CHEMISTRY

Item C1b: Food Additives

Summary: Young people are concerned about the food that they eat. Much of the food eaten today contains food additives to colour food, enhance the flavour, add vitamins, stabilise the food, or to stop it from decaying. This item considers different types of food additive and some of the issues concerned with their use. The importance of active and intelligent packaging is also considered. This item provides the opportunity to collect and analyse secondary data using ICT tools when researching food additives. Active and intelligent packaging involves finding out about contemporary scientific and technological developments and provides opportunities for interpreting and applying science ideas.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Data search into the types of food additives and the E number classification e.g. using suitable web sites. Look at food labels for additives. Discuss the advantages and disadvantages of using food additives.	State that everything in food is made from chemicals. State that some additives can be harmful to certain individuals.
	State the main types of food additives: • antioxidants; • food colours; • emulsifiers; • flavour enhancers. Interpret the relative amounts of the constituents of a food from its label.
Investigate the packaging of food products.	State that antioxidants stop food from reacting with oxygen.
Investigate emulsifiers by mixing oil and water.	State that oil and water do not mix. State that emulsifiers help oil and water to mix and not separate.

Can-Do Tasks

There are no Can-Do tasks for this section.

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1a Cooking, C4e Detergents and C6g Natural Fats and Oils

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Interpret given information about food additives and E numbers (no recall is expected). Explain why a particular food additive is added to a food given details about the food.	
State two examples of foods containing added antioxidants. Describe two examples of how active or intelligent packaging is used to improve the quality or safety of food: • cans which will heat or cool contents; • removal of water inside the pack. Interpret information on intelligent packaging given relevant data.	Explain how and why active packaging is used in food packaging: • active packaging involves the material controlling or reacting to things which are taking place inside package to improve the quality or safety of the products; • removal of water will make it more difficult for bacteria or mould to grow.
Describe emulsifiers as molecules that have a water loving part (hydrophilic) and an oil or fat loving (hydrophobic) part. State examples of foods that contain emulsifiers e.g. mayonnaise.	Describe how an emulsifier helps to keep oil and water from separating: • hydrophilic end bonds to water molecules; • hydrophobic end bonds with oil molecules.

MODULE C1: CARBON CHEMISTRY

Item C1c: Smells

Summary: Cosmetics play an important part in the life of teenagers. This item considers some cosmetic products; perfumes and nail varnish remover. The properties of these products and the need for testing new cosmetic products are considered. This item provides the opportunity to explore how and why decisions about science and technology are made, including ethical issues on the testing of cosmetics on animals. The investigation on nail varnish removal provides the opportunity to collect and analyse primary scientific data, working accurately and safely.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Preparation of an ester e.g. butyl ethanoate. Microscale preparation of a range of esters and identifying the smells. Look at the uses of esters.	State that some cosmetics are made from natural sources. State two examples of perfumes obtained from natural sources. State that some cosmetics are synthetic (made by human action). Describe that esters are perfumes that can be made synthetically.
Discuss the properties of perfumes.	State that perfumes have a pleasant smell. Describe that perfumes are smelly because they stimulate sense cells in the nose. Interpret physical properties to decide which are needed by a perfume: • evaporates easily; • non-toxic; • does not react with water; • does not irritate the skin; • insoluble in water.
Investigate the removal of coloured nail varnish with different solvents.	State that nail-varnish remover dissolves nail varnish colours. State that substances that dissolve in a liquid are soluble and those that do not are insoluble. State that a solute is the substance dissolved in a solution. State that a solvent is the liquid that does the dissolving. Interpret information on the effectiveness of solvents given relevant data.
Debate: “Is the testing of cosmetics on animals justified?”	State that some cosmetics are tested on animals. State that cosmetics must be tested to ensure that they are safe to use.

Can-Do Tasks	
I can test whether a substance dissolves in a solvent.	1 point

MODULE C1: CARBON CHEMISTRY

Links to other modules: C2a Paints and Pigments, C4e Detergents, C6g Natural Fats and Oils

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that alcohols react with acids to make an ester and water. Describe how to carry out a simple experiment to make an ester. State that esters are used as perfumes.	
Explain why a perfume needs certain properties: • easily evaporates so that the perfume particles can easily reach the nose; • non-toxic so it does not poison you; • does not react with water because otherwise the perfume would react with perspiration; • does not irritate the skin otherwise the perfume could not be put directly on the skin; • insoluble in water so it cannot be washed off easily.	Explain the volatility (ease of evaporation) of perfumes in terms of kinetic theory: • particles with lots of energy can escape the attraction to other molecules in the liquid; • only weak attraction between particles in the liquid perfume so easy to overcome this attraction.
State that esters can be used as solvents. State that a solution is a mixture of solvent and solute that does not separate out. Interpret information on the effectiveness of solvents (no recall expected).	Explain why water will not dissolve nail varnish colours: • attraction between water molecules is stronger than attraction between water molecules and particles in nail varnish; • attraction between particles in nail varnish is stronger than attraction between water molecules and particles in nail varnish.
Explain why new cosmetic products need to be thoroughly tested before they are permitted to be used. Describe one advantage and one disadvantage of testing cosmetics on animals.	

MODULE C1: CARBON CHEMISTRY

Item C1d: Making Crude Oil Useful

Summary: Articles on television and in newspapers show the unacceptable side of oil exploitation in terms of oil pollution at sea or on beaches. This item develops ideas about oil exploitation and how crude oil is changed into useful products such as fuels.

This item provides the opportunity to illustrate the use of ICT in science and technology when researching oil exploitation and the industrial production of products from crude oil. The discussion about exploitation of oil raises ethical issues and allows consideration of some questions that science cannot currently answer.

Suggested activities and experiences to select from	**Assessable learning outcomes Foundation Tier only: low demand**
Research different fossil fuels with groups of candidates preparing a presentation on each fuel.	State that crude oil, coal and gas are fossil fuels. Describe non-renewable fuels as ones which take a very long time to make and are used up faster than they are formed.
Demonstrate the fractional distillation of crude oil using synthetic crude oil mixture. Look at the different products that can be made from crude oil.	Recognise that fractional distillation separates crude oil into useful products called fractions. Recognise that fractional distillation works because of differences in boiling points. Know that LPG, petrol, diesel, paraffin, heating oil, fuel oils and bitumen are fractions obtained from crude oil. State that LPG contains propane and butane gases.
Research the problems of oil exploitation and possible solutions.	Understand that crude oil is often found in the Earth's crust and may have to be pumped to the surface. Describe some of the environmental problems involved in the exploitation of crude oil: • oil slicks; • damage to wildlife and beaches.
Demonstrate the cracking of liquid paraffin.	Label the laboratory apparatus used for cracking liquid paraffin. Describe cracking as a process that: • needs a catalyst and a high temperature; • converts large hydrocarbon molecules into smaller ones that are more useful; • makes more petrol.

Can-Do Tasks

There are no Can-Do tasks for this section.

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1e Making Polymers, C1g Using Carbon Fuels, C6g Natural fats and oils, P2c Fuels for Power

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why fossil fuels are finite resources and are non-renewable. Describe crude oil as a mixture of many hydrocarbons.	
Label a diagram of a crude oil fractional distillation column to show the main fractions and the temperature gradient. Describe the fractional distillation of crude oil into fractions: • crude oil is heated; • use of a fractionating column which has a temperature gradient (cold at the top and hot at the bottom); • fractions containing mixtures of hydrocarbons are obtained; • fractions contain many substances with similar boiling points; • fractions with a low boiling points ‘exit’ from the top of the fractionating column; • fractions with high boiling points ‘exit’ at the bottom of the fractionating column.	Explain why crude oil can be separated by fractional distillation: • covalent bonds between carbon and hydrogen atoms within a hydrocarbon molecule are stronger than the intermolecular forces between hydrocarbon molecules; • during boiling intermolecular forces are broken; • intermolecular forces between large hydrocarbon molecules are stronger than those between smaller hydrocarbon molecules; • hydrocarbons with large molecules have a higher boiling temperature than those with smaller molecules.
Explain some of the environmental problems involved in the exploitation of crude oil.	Discuss in simple terms the political problems associated with the exploitation of crude oil.
Describe cracking as a process that: • converts large alkane molecules into smaller alkane and alkene molecules; • makes useful alkene molecules because they can be used to make polymers;. • interpret data about the supply and demand of crude oil fractions (no recall expected).	Explain how cracking helps an oil refinery match its supply of useful products such as petrol with the demand for them.

MODULE C1: CARBON CHEMISTRY

Item C1e: Making polymers

Summary: Candidates will be familiar with the idea that virtually all materials are made through chemical reactions. They will also be able to represent compounds by formulae and chemical reactions by word equations. This item applies these ideas to the formation of a group of substances vital for life in the 21st century.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Card game: matching monomers and polymers. Use of molecular models. Making 'polypaperclips'.	State the name of an addition polymer given the name of the monomer and vice versa.
Demonstration of preparation of nylon as an example of how monomers can form chains (but understanding that this is not an example of addition polymerisation).	State that polymers are very large molecules. State that molecules in plastics are called polymer molecules. State that polymers are made when many small molecules called monomers join together. State that the reaction that makes polymers from monomers is called polymerisation.
Use of molecular models. Use of ICT to show shapes of molecules.	State the two elements chemically combined in a hydrocarbon: • carbon; • hydrogen. Recognise a hydrocarbon from its molecular or displayed formula.
Use of molecular models. Use of ICT to show shapes of molecules.	State that alkanes are hydrocarbons. Interpret information about structure from their names: • methane; • ethane; • propane; • butane. are all alkanes.
Test for unsaturation using bromine water.	State that alkenes are hydrocarbons. Interpret information about structure from their names: • ethene; • propene; • butane. are all alkenes.

Can-Do Tasks

I can test for unsaturation. 2 points

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1d Making Crude Oil Useful, C1f Design Polymers, C6g Natural Fats and Oils

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Recognise the displayed formula for a polymer.	Construct the displayed formula of an addition polymer given the displayed formula of its monomer. Construct the displayed formula of a monomer given the displayed formula of an addition polymer.
Describe polymerisation as a process in which many monomer molecules react together to give a polymer which requires high pressure and a catalyst.	Explain that addition polymerisation involves the reaction of many unsaturated monomer molecules (alkenes) to form a saturated polymer.
Describe a hydrocarbon as a compound formed between carbon atoms and hydrogen atoms only. Explain why a compound is a hydrocarbon given its molecular or displayed formula.	Describe a saturated compound as one which contains only single covalent bonds between carbon atoms. Describe an unsaturated compound as one which contains at least one double covalent bond between carbon atoms.
Describe alkanes as hydrocarbons which contain single covalent bonds only. Interpret information on displayed formula of alkanes.	Interpret information on displayed formula of a saturated hydrocarbon. Explain that hydrogen atoms and carbon atoms share an electron pair to form a covalent bond.
Describe alkenes as hydrocarbons which contain one or more double covalent bond(s) between carbon atoms. Interpret information on displayed formulae of alkenes.	Interpret information on displayed formula of an unsaturated hydrocarbon. Describe how the reaction with bromine can be used to test for unsaturation.

MODULE C1: CARBON CHEMISTRY

Item C1f: Designer polymers

Summary: Candidates may be familiar with the idea that everyday items such as supermarket bags are made from polymers. This item explores why technology moves forward with the development of materials focusing on the very wide range of uses that polymers have, including health care, in the 21st century. Issues of disposal of polymers are also considered.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Activity interpreting information and researching personal interests in the context of why technology moves forward with the development of materials precisely matched to need (using a variety of contexts to capture different interests (CDs, sports equipment, health contexts etc).	Interpret simple information about properties of polymers (plastics) and their uses given appropriate information (no recall expected).
Data-search about waterproof clothing e.g. using appropriate ICT.	State uses to show how polymers (plastics) are used in packaging and clothing: • polythene or poly(ethene) is used for plastic bags; • polystyrene is used for damage protection in packaging and for insulation; • nylon and polyester in clothing. State one advantage of waterproof clothing. State one advantage of breathable clothing.
See Dorothy Warren books (RSC).	Describe many polymers as non-biodegradable, so they will not decay or decompose by bacterial action. Describe some of the ways that waste polymers can be disposed of: • use of land fill sites; • burning of waste polymers; • recycling. Describe some of the problems of using non-biodegradable polymers: • litter and difficult to dispose.

Can-Do Tasks

There are no Can-Do tasks for this section.

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1e Making Polymers

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Suggest the properties a polymer (plastic) should have in order to be used for a particular purpose. Explain why a polymer (plastic) is suitable for a particular use given the properties of the polymer.	Describe that the atoms in plastics are held together by strong covalent bonds. Relate the properties of plastics to simple models of their structure: • plastics that have weak intermolecular forces between polymer molecules have low melting points and can be stretched easily as the polymer molecules can slide over one another; • plastics that have strong forces between the polymer molecules (covalent bonds or cross-linking bridges) have high melting points, cannot be stretched and are rigid.
Compare the properties of nylon and Gore-Tex®: • nylon is tough, lightweight, keeps water out, keeps UV light out but does not let water vapour through it which means that sweat condenses; • Gore-Tex® has all of the properties of nylon but is also breathable. Explain why the discovery of Gore-Tex® type materials has been of great help to active outdoor people to cope with perspiration wetness.	Describe the construction of Gore-Tex® type materials explaining why they make clothing waterproof and yet breathable: • nylon laminated with PTFE/polyurethane membrane; • holes in PTFE are too small for water to pass through but are big enough for water vapour to pass through; • PTFE laminate is too fragile on its own and so is combined with nylon.
Explain why chemists are developing addition polymers that are biodegradable. Explain some of the environmental and economic issues related to the use of polymers: • landfill sites get filled quickly wasting valuable land; • burning waste plastics makes toxic gases; • disposal by burning or land-fill sites wastes a valuable resource; • difficult to sort out different polymers so recycling is difficult.	

MODULE C1: CARBON CHEMISTRY

Item C1g: Using carbon fuels

Summary: This item develops ideas about fuels and the factors that need to be considered when choosing a fuel that is fit for purpose. It also considers the process of combustion.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Discuss fuels for a purpose (e.g. choosing the right fuel for heating / lighting a remote house in Scotland, powering a car, use in an electricity generating station).	Interpret data about fuels in order to choose the best fuel for a particular purpose (no recall expected).
	State that the combustion or burning of a fuel requires oxygen. State that the combustion of a fuel releases useful heat energy. State that complete combustion needs a plentiful supply of oxygen (air). State that complete combustion of a hydrocarbon fuel makes only carbon dioxide and water.
Carry out an experiment to show that combustion of a hydrocarbon in a plentiful supply of air produces carbon dioxide and water. Design a poster warning about the dangers of carbon monoxide poisoning e.g. using appropriate ICT software. Look at the products of complete and incomplete combustion by experiment and/or data search.	State that incomplete combustion takes place when there is a shortage of oxygen (air). Describe that a blue Bunsen flame transfers more energy than a yellow flame. State that a yellow flame produces lots of soot. Know that incomplete combustion of a hydrocarbon fuel makes carbon monoxide, carbon (soot) and oxygen. State that carbon monoxide is a poisonous gas.

Can-Do Tasks

I can carry out an experiment to show that combustion of a hydrocarbon in a plentiful supply of air produces carbon dioxide and water. 3 points

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1d Making Crude Oil Useful, C1h Energy, C2f Clean Air, C6a Energy Transfers – Fuel Cells

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
List factors that need to be considered in a given use of a fossil fuel: • energy value; • availability; • storage; • cost; • toxicity; • pollution e.g. acid rain, greenhouse effect; • ease of use. Interpret data about fuels in order to choose the best fuel for a particular purpose (no recall expected).	Evaluate the use (no recall expected) of different fossil fuels: • energy value; • availability; • storage; • cost; • toxicity; • pollution e.g. acid rain, greenhouse effect; • ease of use. Explain why the amount of fossil fuels being burnt is increasing.
Describe a fuel as a substance that reacts with oxygen to release useful energy. Describe an experiment to show that combustion of a hydrocarbon in a plentiful supply of air produces carbon dioxide and water. Write word equations to show the incomplete or complete combustion of a hydrocarbon fuel.	Construct the balanced symbol equation for the complete combustion of a simple hydrocarbon fuel given its molecular formula.
Explain that a blue flame releases more energy than a yellow flame because it involves complete combustion rather than incomplete combustion. Describe the advantages of complete combustion over incomplete combustion of hydrocarbon fuels: • less soot made; • more heat released; • poisonous carbon monoxide not produced. Explain the importance of regularly servicing gas appliances.	Construct the balanced symbol equation for the incomplete combustion of a simple hydrocarbon fuel given its molecular formula.

MODULE C1: CARBON CHEMISTRY

Item C1h: Energy

Summary: This item allows young people to develop ideas about how energy can be released from fuels through burning. The amount of energy released is also covered.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out experiments to find out about exothermic and endothermic reactions (with the option of using data loggers).	Recognise that chemical reactions can be used to heat things, to make light, sound and electricity. Recognise that energy can be given out or taken in during a chemical reaction. Recognise that an energy change has taken place by using temperature changes.
Compare the energy output from a blue and from a yellow Bunsen flame. Measure the energy released per gram during the combustion of butane and the combustion of some liquid fuels – possible use of spreadsheets to analyse results.	State that energy is measured in joules or kilojoules and temperature in ^{o}C. Label the apparatus needed to compare the energy output of liquid or gaseous fuels. Interpret and use data from simple calorimetric experiments related to the combustion of fuels: • calculating temperature changes; • comparing which fuel releases the most energy (mass of water used constant).

Can-Do Tasks	
I can accurately measure temperature in ^{o}C.	1 point
I can measure the mass of an object using an electronic balance.	1 point
I can do an experiment to find the energy output per gram of a liquid fuel.	3 points

MODULE C1: CARBON CHEMISTRY

Links to other modules: C1g Using Carbon Fuels, C6a Energy Transfers – Fuel Cells, P1a Heating Houses, P1b Keeping Homes Warm

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe an exothermic reaction as one in which energy is transferred into the surroundings (releases energy). Describe an endothermic reaction as one in which energy is taken from the surroundings (absorbs energy). Recognise exothermic and endothermic reactions using temperature changes.	Describe bond making as an exothermic process. Describe bond breaking as an endothermic process. Explain why a reaction is exothermic or endothermic using the energy changes that occur during bond breaking and bond making.
Describe, using a diagram, a simple calorimetric method for comparing the energy transferred in combustion reactions: • use of spirit burner or a bottled gas burner; • heating water in a copper calorimeter; • measuring the temperature change; • fair tests. Interpret and use data from simple calorimetric experiments related to the combustion of fuel to compare which fuel releases the most energy.	Describe a simple calorimetric method for comparing the energy transferred per gram of fuel combusted: • use of spirit burner or a bottled gas burner; • heating water in a copper calorimeter; • measuring mass of fuel burnt; • measuring temperature change; • fair and reliable tests. Calculate the energy transferred by recalling and using the formula: energy transferred (in J) = mass of water heated (in g) x 4.2 x temperature change (in ^{o}C). Calculate the energy output of a fuel in J/g by recalling and using the formula: energy per gram = energy supplied ÷ mass of fuel burnt.

MODULE C2: ROCKS AND METALS

Item C2: Fundamental chemical concepts

Summary: Throughout the study of chemistry there are a number of ideas and concepts that are fundamental. These ideas and concepts have not been put into a particular item but should permeate all the Chemistry units. They will be assessed in the context of any of the modules C1 to C6.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
These Learning Outcomes are intended to be taught throughout this specification.	Describe that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word or symbol equation. Recognise that in a chemical change no atoms are lost or made.
These Learning Outcomes are intended to be taught throughout this specification.	State the number of elements in a compound given its formula. State the number of atoms in a formula with no brackets. State the number of each different type of atom in a formula with no brackets.
These Learning Outcomes are intended to be taught throughout this specification.	Recognise whether a substance is an element or a compound from its formula.
These Learning Outcomes are intended to be taught throughout this specification.	Recognise that a molecule is made up of more than one atom joined together. Recognise that a molecular formula shows the number and type of atom in a molecule. State the number of atoms in a displayed formula. State the names of the different elements in a compound given its displayed formula. State the number of each different type of atom in a displayed formula.
These Learning Outcomes are intended to be taught throughout this specification.	State that all atoms are made up of a nucleus and electrons. State that a chemical bond holds atoms together in a compound.

MODULE C2: ROCKS AND METALS

Links to other modules: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations given the reactants and products. Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain that a symbol equation is balanced when the number of each type of atom is the same on both sides of an equation.	Construct balanced symbol equations given the formulae (some or all with brackets) of the reactants and products. Construct balanced symbol equations given the names of the reactants and products (limited to the learning outcomes in this specification).
State the number of atoms in a formula with brackets. State the number of each type of different atom in a formula with brackets.	Recall the formula of the following substances: • carbon dioxide, carbon monoxide, water, oxygen and hydrogen; • calcium carbonate, calcium chloride and magnesium chloride; • hydrochloric acid.
Recognise that a displayed formula shows both the atoms and the covalent bonds in a molecule. Write the molecular formula of a compound given its displayed formula.	Balance equations that use displayed formulae.
State that the nucleus of an atom is positive and the electrons negative. State there are two types of chemical bonds: • ionic between a positive ion and a negative ion; • covalent involving a shared pair of electrons.	

MODULE C2: ROCKS AND METALS

Item C2a: Paints and Pigments

Summary: Pigments, dyes and paints play an important part in our modern day lives. Our clothes, houses and our local environment are all made much more interesting and pleasing to the eye by the use of colour.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Making coloured substances by mixing together solutions e.g. 'Active Science' page 136. Data-search via internet about paints and the ingredients in paints.	State that a pigment is a coloured substance that is used in paint. Apply data-search to show ingredients of paint: • solvent, binding medium and pigment. Describe the functions of the solvent, binding medium and pigment in a paint. State that paint is a mixture called a colloid. Describe that oil paints: • have the pigment dispersed in an oil; • and often a solvent that dissolves oil.
Survey some advertisement leaflets about different types of paints.	Describe that paints are used to decorate or protect surfaces.
Historical survey into the history of dyeing fabrics.	Describe that dyes are used to colour fabrics. Describe that some dyes are natural and others synthetic.
Investigating thermochromic pigments using materials e.g. material from Middlesex University Teaching Resources.	Describe that thermochromic pigments change colour when heated or cooled.
Investigating phosphorescent pigments using material e.g. material from Middlesex University Teaching Resources.	Describe that phosphorescent pigments can glow in the dark.

Can-Do Tasks

I can make a sample of paint with thermochromic properties.	2 points
I can use a natural product to permanently dye a piece of cotton cloth.	3 points

MODULE C2: ROCKS AND METALS

Links to other modules: C1c Smells

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe paint as a colloid where the particles are mixed and dispersed with particles of a liquid but are not dissolved.	Explain that the components of a colloid will not separate because the particles are scattered or dispersed throughout the mixture and are sufficiently small they will not settle at the bottom.
Describe that many paintsare applied as a thin surface which dries when the solvent evaporates. Describe emulsion paints as water based paints.	Explain that the drying of oil paints involves oxidation of the oil by atmospheric oxygen. Interpret the uses and properties of different paints given relevant information.
Explain that the use of synthetic dyes has increased the number of colours available to colour fabrics.	
Describe some uses of thermochromic pigments: • warning of a hot cup; • use in electric kettles.	Describe and explain how thermochromic pigments can be added to acrylic paints to give even more colour changes.
Phosphorescent pigments absorb and store energy and release it as light over a period of time.	Explain that phosphorescent pigments are much safer than the alternative radioactive substances e.g. in use of ‘glow in the dark’ watches.

MODULE C2: ROCKS AND METALS

Item C2b: Construction materials

Summary: Most landscapes include buildings such as houses, factories, flats or skyscrapers. Many of these buildings are made from raw materials found in or on the Earth's surface. The removal of the raw materials and their use has an enormous impact on the environment.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Data-search about construction materials and their sources.	State the names of some construction materials: • aluminium and iron; • brick, cement, concrete and glass; • granite, limestone and marble.
Look at samples of marble, limestone and granite. Video clips of mining and quarrying.	State that some rocks are used to construct buildings: • granite, limestone and marble. Describe the environmental problems that may be caused by removing rocks from the ground: • landscape destroyed and has to be reconstructed when the mining or quarrying has finished; • quarries or mines take up land-space; • increased noise, traffic and dust.
Investigation of the decomposition of calcium carbonate.	State that limestone and marble are both forms of calcium carbonate. Describe that limestone thermally decomposes to make calcium oxide and carbon dioxide.
Investigating the strength of concrete beams.	Describe that concrete is made when cement, sand or gravel and water are mixed together and allowed to set.
Investigating the strength of concrete beams.	Describe that concrete can be reinforced, which is made by allowing the concrete to set around a steel support.

Can-Do Tasks

I can safely heat a sample of a chemical in a test tube.	1 point
I can make and test samples of concrete for their strength.	3 points

MODULE C2: ROCKS AND METALS

Links to other modules: C2c Does the Earth Move?

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
State that some construction materials are manufactured from rocks in the Earth's crust: • aluminium and iron from ores; • brick from clay; • glass from sand.	
Describe that marble is much harder than limestone. Describe that granite is harder than marble.	Explain why granite, marble and limestone have different hardness: • limestone is a sedimentary rock; • marble is a metamorphic rock made by the action of high pressures and temperatures on limestone; • granite is an igneous rock.
State that the word equation for the decomposition of limestone is: calcium carbonate→calcium oxide +carbon dioxide. Describe thermal decomposition as a reaction in which when heated one substance is chemically changed into at least two new substances.	State that the balanced symbol equation for the decomposition of limestone is: $CaCO_3 \rightarrow CaO + CO_2$
Describe that cement is made when limestone and clay are heated together.	
Describe reinforced concrete as a composite material containing concrete and a solid steel support.	Explain why reinforced concrete is a better construction material that non-reinforced concrete: • hardness of the concrete; • flexibility and strength of the steel.

MODULE C2: ROCKS AND METALS

Item C2c: Does the Earth Move?

Summary: We often read or hear news items on earthquakes and volcanoes. This item builds on the interest young people show towards these events. Models are used to help explain volcanic eruptions.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Create a model of the Earth's structure. Use ICT and/or other material to construct a map of where volcanoes and earthquakes occur on the Earth's surface. Model a volcano using the candle wax experiment. http://www.jesei.org	Describe the structure of the Earth as a sphere with a thin rocky crust, mantle and core. State that the Earth's core contains iron. State that the movement of tectonic plates results in volcanic activity and earthquakes.
	Describe how molten rock can find its way to the surface through weaknesses in the crust.
Look for clues contained in volcanic rocks that show how they formed. Video clips of volcano types. Treacle investigation. Salol experiment. http://www.jesei.org	State that igneous rock is made when molten rock cools down. Describe magma as molten rock beneath the surface of the Earth. Describe lava as molten rock that erupts from a volcano. State that some of the rock on the Earth's surface has been formed by volcanic activity. Describe that some volcanoes give runny lava, some give thick lava violently and catastrophically.
Look at examples of people who live near volcanoes and those who choose to study them.	Describe that some people choose to live near volcanoes because volcanic soil is very fertile.

Can-Do Tasks

I can mark on a map of the world ten locations of Earthquakes or Volcanoes. — 1 point

MODULE C2: ROCKS AND METALS

Links to other modules: C2b Construction Materials, P1h Stable Earth

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the outer layer of the Earth (lithosphere) as oceanic plates under oceans and continental plates forming continents. Describe the lithosphere as the (relatively) cold rigid outer part of the Earth that includes the crust and the outer part of the mantle. Explain that tectonic plates are found on top of the mantle because they are less dense than the mantle. Explain the problems of studying the structure of the Earth.	Describe the mantle as the zone between the crust and the core and that it is relatively cold and rigid just below the crust but hot and non-rigid and so able to flow at greater depths. Describe the theory of plate tectonics: • energy transfer involving convection currents in the largely solid mantle causing the plates to move slowly; • oceanic plates are more dense than continental plates; • collision between oceanic and continental plate leads to subduction and partial re-melting (oceanic goes underneath continental). Describe in simple terms the development of the theory of plate tectonics.
Explain that magma from the mantle must have a density less than that of the crust in order to rise through it.	
Explain how the size of crystals in an igneous rock is related to the rate of cooling of molten rock: • iron-rich basalt and its coarse equivalent gabbro; • silica-rich rhyolite and its coarse equivalent granite.	State that magma can have different compositions and that this affects the rock that forms and the type of eruption, limited to: • iron-rich basalt (runny and fairly 'safe'); • explosive silica-rich rhyolite (producing pumice and volcanic ash and bombs, sometimes with graded bedding).
Describe that geologists study volcanoes to be able to predict future eruptions and to reveal information about the structure of the Earth.	Describe that geologists are now able to better predict volcanic eruptions but not with 100% certainty.

MODULE C2: ROCKS AND METALS

Item C2d: Metals and Alloys

Summary: Metallic elements and alloys have many uses in our society. This item examines how metals are extracted from their ores. It also describes some of the uses of some important alloys including smart alloys.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Extraction of copper by heating malachite and carbon. Purification of copper by electrolysis.	State that copper can be extracted by heating its ore with carbon. State that copper can be purified by electrolysis. Describe that recycling copper is cheaper than making copper and that it saves resources.
Research about alloys – their uses and composition. Data search or experimental investigation into the properties of alloys.	State that an alloy is a mixture of two elements one of which is a metal. Recognise that brass, bronze, solder, steel, and amalgam are alloys. State one important large scale use for each of the following alloys: • amalgam, brass and solder.
Internet research about smart alloys and their uses. Investigate nitinol (Middlesex University Teaching Resources).	Recognise that the properties of an alloy are different from the properties of the metals from which it is made. Interpret data about the properties of metals, including alloys e.g. hardness, density, boiling point and strength.

Can-Do Tasks	
I can extract a sample of copper from a copper ore such as malachite.	2 points
I can purify a sample of impure copper using the electrolysis of aqueous copper sulfate.	2 points

MODULE C2: ROCKS AND METALS

Links to other modules: C2e Cars for Scrap, C3f Electrolysis, C3h Metal Structure and Properties, C5b Electrolysis and C6d Chemistry of Sodium Chloride (NaCl)

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Label the apparatus needed to purify copper by electrolysis. Describe some of the problems of recycling copper.	Describe the use of electrolysis in the purification of copper: • impure copper as anode; • pure copper as cathode; • copper(ll) sulfate solution as electrolyte.
State the main metals in each of the following alloys: • amalgam – mercury; • brass – copper and zinc; • solder – lead and tin.	
Describe that alloys often have properties that are different from the metals they are made from and that these properties may make the alloy more useful than the pure metal. Suggest properties needed by a metal or alloy for a particular given use.	Explain why metals, including alloys are suited to a given use given appropriate data (no recall expected). Explain how the use of 'smart alloys' such as those with a shape memory property have increased the number of applications of alloys e.g. nitinol (nickel and titanium).

MODULE C2: ROCKS AND METALS

Item C2e: Cars for Scrap

Summary: Young people take the use of cars for granted. This item develops ideas about the problem of disposing of cars and the recycling of metals. Rusting and corrosion are also considered.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate the corrosion of aluminium and iron using different conditions (e.g. salt water, acid rain, moist air). Comparing rate of corrosion of cars in the UK with that of Mediterranean countries.	State that rusting needs iron, water and oxygen. State that aluminium does not corrode in moist conditions. Interpret data about the rate of corrosion of different metals in different conditions (no recall is expected).
Compare the physical properties of iron and aluminium and their alloys either by data search or by experiment (density, magnetic property, electrical conductivity, flexibility, hardness and strength). Write a promotional leaflet for a car made from aluminium illustrating the advantages of such a car over one made from iron or steel.	Describe similarities and differences between the properties of iron and aluminium: • iron is more dense than aluminium; • iron is magnetic and aluminium is not; • iron corrodes (rusts) easily and aluminum does not; • iron and aluminium are both malleable; • iron and aluminium are both good electrical conductors. State that alloys are usually. a mixture of two or more metals.
Research all the materials that are used to manufacture cars (e.g. plastics, fibres, glass, copper, iron, aluminium).	List the major materials needed to build a car: • steel, copper and aluminium; • glass, plastics and fibres.
Discuss the problems of disposing of cars. Visit a car scrap yard.	Describe the advantages of recycling materials: • saves natural resources; • reduces disposal problems.

Can-Do Tasks

I can distinguish, using experiments, between a sample of aluminium and iron.	1 point
I can carry out an investigation to find the optimum conditions for corrosion of a named metal.	3 points

MODULE C2: ROCKS AND METALS

Links to other modules: C2d Metals and Alloys, C3h Metal Structure and Properties, C5b Electrolysis, C6d Chemistry of Sodium Chloride (NaCl)

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that salt water and acid rain accelerate rusting. Explain that aluminium does not corrode in moist conditions because it has a protective layer of aluminium oxide which does not flake off the surface. Interpret data about the rate of corrosion of different metals in different conditions (no recall is expected).	Describe rusting as an oxidation reaction where iron reacts with water and oxygen to form hydrated iron(III) oxide. State the word equation for rusting: iron + oxygen + water → hydrated iron(III) oxide.
Describe that alloys often have properties that are different from the metals they are made from and that these properties may make the alloy more useful than the pure metal: • steel is harder and stronger than iron; • steel is less likely to corrode than iron. Describe advantages and disadvantages of building car bodies from aluminium or from steel: • car body of the same car will be lighter with aluminium; • car body with aluminium will corrode less; • car body of the same car will be more expensive made from aluminium.	Explain advantages and disadvantages of building car bodies from aluminium or from steel: • car body of the same car will be lighter with aluminium so get better fuel economy; • car body with aluminium will corrode less and so may have a longer lifetime.
Suggest properties needed by a material for a particular use in a car. Explain why a material used in a car is suited to a given use given appropriate data (no recall expected).	
Explain the advantages and disadvantages of recycling the materials used to make cars. Explain that new laws will soon specify that a minimum percentage of all materials used to manufacture cars must be recyclable.	Evaluate information on materials used to manufacture cars (no recall expected).

MODULE C2: ROCKS AND METALS

Item C2f: Clean Air

Summary: The increase in respiratory illnesses such as asthma in young people may be caused by an increase in air pollution. This item develops ideas about air pollution, its origin and how it can be prevented. The use of catalytic converters to reduce atmospheric pollution will also be considered.

Suggested activities and experiences to select from	**Assessable learning outcomes Foundation Tier only: low demand**
Experimental determination the composition of clean air.	State that air contains oxygen, nitrogen, water vapour and carbon dioxide. Recognise that oxygen, nitrogen and carbon dioxide levels in the atmosphere are approximately constant. Recognise that photosynthesis decreases the level of carbon dioxide and increases the level of oxygen in the air. Recognise that respiration and combustion increase the level of carbon dioxide and decrease the level of oxygen in the air.
Research the increase in occurrences of asthma in the UK and possible links with air pollution e.g. from the internet. Write a leaflet describing the main forms of atmospheric pollution, their effects and origins.	Relate the common pollutants found in air to the environmental problem the pollutant causes: • carbon monoxide – a poisonous gas; • oxides of nitrogen – photochemical smog and acid rain; • sulfur dioxide – acid rain that will kill plants, kill aquatic life, erode stonework and corrode metals.
Research the methods of preventing atmospheric pollution.	State that a catalytic converter removes carbon monoxide from the exhaust gases of a motor car.

Can-Do Tasks

There are no Can-Do tasks for this section.

MODULE C2: ROCKS AND METALS

Links to other modules: C1g Using Carbon Fuels, C6e Depletion of the Ozone Layer

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State the percentage composition by volume of clean air: • 21% oxygen; • 78% nitrogen; • 0.035% carbon dioxide. Describe a simple carbon cycle involving photosynthesis, respiration and combustion. Describe how the present day atmosphere evolved: • original atmosphere came from gases escaping from the interior of the Earth; • photosynthesis by plants increases the percentage of oxygen until it reached today's level.	Evaluate the effects of human influences on the composition of air: • deforestation; • increased energy consumption (burning of fossil fuels); • population. Describe one possible theory for how the atmosphere evolved: • degassing from the Earth's crust; • initial atmosphere of ammonia and carbon dioxide; • formation of water; • development of photosynthetic organisms; • increase in oxygen and nitrogen levels; • lack of reactivity of nitrogen.
Describe the origin of the following atmospheric pollutants: • carbon monoxide – incomplete combustion of petrol or diesel in car engine; • oxides of nitrogen – formed in the internal combustion engine; • sulfur dioxide – formed when sulfur impurities in fossil fuels burn. Interpret data about the effects of atmospheric pollutants.	
Explain why it is important that atmospheric pollution is controlled. State that a catalytic converter changes carbon monoxide into carbon dioxide.	Describe the use of a catalytic converter in removing carbon monoxide from exhaust fumes by converting it to carbon dioxide: $2CO + 2NO \rightarrow N_2 + 2CO_2$

MODULE C2: ROCKS AND METALS

Item C2g: Faster or Slower (1)

Summary: Explosions are impressive examples of very fast reactions. This item develops the ideas of rate of reaction including collision frequency. The effect of changing temperature and concentration are considered by means of practical work.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Video clips of fires, rusting and explosions to illustrate different rates of reaction.	Recognise that some reactions can be fast and others very slow: • rusting is a slow reaction; • burning and explosions are very fast reaction.
ICT simulations involving collisions between particles.	Recognise that a chemical reaction takes place when particles collide.
Investigate the rate of reaction using magnesium ribbon or calcium carbonate and dilute hydrochloric acid.	State that the rate of a chemical reaction can be increased by increasing the temperature (or vice versa).
Investigate the rate of reaction using magnesium ribbon or calcium carbonate and dilute hydrochloric acid.	State that the rate of a chemical reaction can be increased by increasing the concentration (or vice versa). State that the rate of a gas phase reaction can be increased by increasing the pressure (or vice versa).
Investigate the rate of reaction using magnesium ribbon or calcium carbonate and dilute hydrochloric acid using gas syringe to collect gas. Look at the application of rate of reaction in everyday life (e.g. speed of cooking with pressure cooker, slowing up rusting, rate of dissolving tablets for medicinal use).	Interpret data in table, graphical and written form involving the effect of temperature and concentration on the rate of reaction e.g: • reading off values from a graph; • recognising the fastest reaction by comparing gradients of graphs; • recognising the shortest reaction time and hence the fastest reaction. Explain that a reaction stops when one of the reactants is all used up. Label the laboratory apparatus needed to measure the rate of reaction (including a gas syringe).

Can-Do Tasks

I can measure the rate of a reaction that produces a gas. 3 points

MODULE C2: ROCKS AND METALS

Links to other modules: C2g Faster or Slower (1), C2h Faster or Slower (1), C5f Equilibria

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that the more collisions between particles the faster the reaction.	Explain that the rate of reaction depends on the: • collision frequency of reacting particles; • energy transferred during the collision (whether the collision is successful or effective).
Explain that a temperature increase makes particles move faster so they have more energy, and that this gives an increased rate of reaction (and vice versa).	Explain that an increase in temperature results in more effective, successful or energetic collisions (and vice versa).
Explain that increasing the concentration (or pressure) increases the rate of a reaction because the particles are more crowded (and vice-versa).	Explain that increasing the concentration (or pressure) increases the rate of a reaction by increasing the frequency of collisions between particles (and vice versa).
Interpret data in table, graphical and written form involving the effect of concentration and temperature on the rate of reaction e.g: • deciding when a reaction has finished; • comparing the rate of reaction during a reaction; • deciding when the rate of reaction is the greatest. Explain that the amount of product formed depends on the amount of reactant used. Draw sketch graphs to show the effect of changing temperature or concentration on: • rate of reaction; • amount of product formed in a reaction.	Interpret data from table, graphical and written form involving temperature and concentration on the rate of reaction e.g: • calculating the rate of reaction from the slope of an appropriate graph; • extrapolation; • interpolation.

MODULE C2: ROCKS AND METALS

Item C2h: Faster or Slower (2)

Summary: Explosions are impressive examples of very fast reactions. This item develops the ideas of rate of reaction including collision frequency. The effect of changing surface area and catalysts on the rate of reaction are considered by means of practical work.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Class practical to investigate catalysis using hydrogen peroxide and metal oxide catalysts or zinc and dilute hydrochloric acid with a variety of possible catalysts including copper and copper compounds.	State that the rate of a reaction can be increased by the addition of a catalyst.
Investigate surface area using magnesium powder and ribbon with acid or marble chips or powder with acid.	State that the rate of a reaction can be increased by using powdered reactant rather than a lump (or vice versa).
Watch a video on flour/lycopodium explosions. Video clips of other explosions e.g. knocking down a building, explosion in a quarry.	List examples of explosions: • burning hydrogen; • custard powder; • TNT or dynamite explosion.
Look at the application of rate of reaction in everyday life (e.g. resin and hardener in a car body filler, catalytic converters, rate of dissolving tablets for medicinal use).	Interpret data in table, graphical and written form involving the effect of surface area and the addition of a catalyst on the rate of reaction e.g: • reading off values from a graph; • recognising the fastest reaction by comparing gradients of graphs; • recognising the shortest reaction time and hence the fastest reaction.

Can-Do Tasks

I can investigate a reaction to find a suitable catalyst.	3 points
I can measure the volume of a gas produced in a reaction using a gas syringe.	1 point
I can measure the reaction time for a suitable reaction.	1 point
I can use experimental results such as volume of gas produced against time to determine the rate of reaction.	3 points
I can measure the volume of a liquid using a measuring cylinder.	1 point

MODULE C2: ROCKS AND METALS

Links to other modules: C2g Faster or Slower (1), C4d Making Ammonia – Haber Process and Costs, C5e Gas Volumes, C5f Equilibria

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe a catalyst as a substance which changes the rate of reaction and is unchanged at the end of the reaction. State that only a small amount of a catalyst is needed to catalyse large amounts of reactants.	Recognise that a catalyst is specific to a particular reaction.
Explain that a powder has a larger surface area than a lump and so reacts faster because there are more collisions.	Explain that an increase in surface area increases the frequency of collisions.
Describe an explosion as a very fast reaction which releases a large volume of gaseous products. Explain the dangers of fine combustible powders in factories (e.g. custard powder, flour or sulfur).	
Interpret data in table, graphical and written form involving the effect of surface area and the addition of a catalyst on the rate of reaction: • deciding when a reaction has finished; • comparing the rate of reaction during a reaction; • deciding when the rate of reaction is the greatest. Draw sketch graphs to show the effect of changing surface area and the addition of a catalyst on the: • rate of reaction; • amount of product formed in a reaction.	Interpret data from table, graphical and written form involving surface area and the addition of a catalyst on the rate of reaction: • calculating the rate of reaction from the slope of an appropriate graph; • extrapolation; • interpolation.

MODULE C3: THE PERIODIC TABLE

Item C3: Fundamental Chemical Concepts

Summary: Throughout the study of chemistry there are a number of ideas and concepts that are fundamental. These ideas and concepts have not been put into a particular item but should permeate all the Chemistry units. They will be assessed in the context of any of the modules C1 to C6.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
These learning outcomes are intended to be taught throughout this specification.	Describe that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word or symbol equation. Recognise that in a chemical change no atoms are lost or made.
These learning outcomes are intended to be taught throughout this specification.	State the number of elements in a compound given its formula. State the number of atoms in a formula with no brackets. State the number of each different type of atom in a formula with no brackets.
These learning outcomes are intended to be taught throughout this specification.	Recognise whether a substance is an element or a compound from its formula.
These learning outcomes are intended to be taught throughout this specification.	Recognise that a molecule is made up of more than one atom joined together. Recognise that a molecular formula shows the numbers and types of atom in a molecule. State the number of atoms in a displayed formula. State the names of the different elements in a compound given its displayed formula. State the number of each different type of atom in a displayed formula.
These learning outcomes are intended to be taught throughout this specification.	State that all atoms are made up of a nucleus and electrons. State that a chemical bond holds atoms together in a compound.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations given the reactants and products. Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain that a symbol equation is balanced when the number of each type of atom is the same on both sides of an equation.	Construct balanced symbol equations given the formulae (some or all with brackets) of the reactants and products. Construct balanced symbol equations given the names of the reactants and products (limited to the learning outcomes in this specification).
State the number of atoms in a formula with brackets. State the number of each type of different atom in a formula with brackets.	Recall the formula of the following substances: • the oxides of sodium, magnesium, aluminium, zinc, copper, iron(II) and manganese; • the chlorides of magnesium, barium, sodium and potassium; • the carbonates of copper(II), iron(II), zinc and manganese; • the hydroxides of sodium, potassium, lithium, copper(II), iron(II) and iron(III); • water, carbon dioxide, methane, silver nitrate.
Recognise that a displayed formula shows both the atoms and the covalent bonds in a molecule. Write the molecular formula of a compound given its displayed formula.	Balance equations that use displayed formulae.
State that the nucleus of an atom is positive and the electrons negative. State there are two types of chemical bonds: • ionic between a positive ion and a negative ion; • covalent involving a shared pair of electrons.	

MODULE C3: THE PERIODIC TABLE

Item C3a: What are atoms like?

Summary: Atomic structure is fundamental to the study of chemistry. This item considers the sub-atomic particles and electronic structures. This item provides the opportunity to develop and use scientific theories, models and ideas.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Teacher exposition. Research activity.	Describe an atom as a nucleus surrounded by electrons. State that a nucleus is positively charged, an electron is negatively charged and an atom is neutral.
Deduce the numbers of protons, electrons and neutrons from atomic numbers and mass numbers.	Identify the atomic number of an element by using a periodic table. Identify the name or symbol of an element given its atomic number using a periodic table.
Identify elements and numbers of atoms of each element from formulae.	State that there are just over 100 elements. Describe an element as a substance which: • cannot be broken down chemically; • contains the same type of atom. Identify the elements in a compound from its formula, using a periodic table. Describe a compound as a substance that contains at least two elements chemically combined.
Draw electronic structures given atomic numbers.	

MODULE C3: THE PERIODIC TABLE

Links to other modules: C3b How Atoms Combine – Ionic Bonding, C3c Covalent Bonding and the Structure of the Periodic Table, C3d The Group 1 Element, C3e The Group 7 Element, C4b Reacting Masses, P4f What is Radioactivity?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that the nucleus is made up of protons and neutrons. State the relative charge and relative mass of an electron, a proton and a neutron: • electron charge -1 and mass 0.0005 (zero); • proton charge +1 and mass 1; • neutron charge 0 and mass 1.	Explain that an atom is neutral because it has the same number of electrons as protons.
Describe atomic number as the number of protons in an atom. Describe mass number as the total number of protons and neutrons in an atom. Describe isotopes as varieties of an element that have the same atomic number but different mass numbers.	Deduce the number of protons, electrons and neutrons in a particle given its atomic number, mass number and the charge on the particle. • using data in a table; • using the conventional symbolism e.g. carbon-12 or $^{12}_{6}C$ Identify isotopes from data about the number of electrons, protons and neutrons in particles.
State that the elements in the periodic table are arranged in ascending atomic number.	
Describe that electrons occupy the space around the nucleus. State that electrons occupy shells.	Deduce the electronic structure of the first 20 elements in the periodic table e.g. calcium is 2.8.8.2.

MODULE C3: THE PERIODIC TABLE

Item C3b: How Atoms Combine – Ionic Bonding

Summary: This item extends the ideas about atomic structure into ionic bonding and the properties of ionic compounds. The experimental investigation of solubility and electrical conductivity allows the opportunity to collect primary data safely and accurately, and to analyse it using quantitative and qualitative methods.

Suggested activities and experiences to select from	**Assessable learning outcomes Foundation Tier only: low demand**
Draw dot and cross diagrams to show ionic bonding.	State that an ion is a charged atom or group of atoms. Recognise an ion, an atom and a molecule from given formulae.
Research melting points and boiling points of sodium chloride and magnesium oxide. Experimental investigation of solubility and electrical conductivity of solids and solutions.	State that sodium chloride: • has a high melting point; • dissolves in water; • when solid does not conduct electricity. State that magnesium oxide: • has a very high melting point; • when solid does not conduct electricity.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C3a What are atoms like?, C3c Covalent Bonding and the Structure of the Periodic Table, C3d The Group 1 Element, C3e The Group 7 Element, P4f What is Radioactivity?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the formation of positive ions by the loss of electrons from atoms e.g: • 2+ ions form by the loss of 2 electrons. Describe the formation of negative ions by the gain of electrons by atoms; • 2- ion formed by the gain of 2 electrons. Explain that a metal and non-metal combine by transferring electrons to form positive ions and negative ions which then attract one another.	Describe, using the “dot and cross” model, the ionic bonding in the following: • sodium chloride; • magnesium oxide; • sodium oxide; • magnesium chloride. Explain that atoms gain or lose electrons to get a complete outer shell (a stable octet). Deduce the formula of an ionic compound from the formula of the positive and negative ion.
State that sodium chloride solution conducts electricity. State that magnesium oxide and sodium chloride conduct electricity when molten.	Describe the structure of sodium chloride or magnesium oxide as a giant ionic lattice in which positive ions are electrostatically attracted to negative ions. Explain some of the physical properties of sodium chloride and magnesium oxide: • strong attraction between positive and negative ions so have a high melting points; • ions cannot move in solid so do not conduct electricity; • ions can move in solution or in a molten liquid so conduct electricity.

MODULE C3: THE PERIODIC TABLE

Item C3c: Covalent bonding and the Structure of the Periodic Table

Summary: This item introduces covalent bonding. It also provides an introduction to the periodic table. This item provides the opportunity to develop and use scientific theories, models and ideas.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Draw electronic structures of covalent molecules.	Describe a molecule as two or more atoms bonded together. State the number of atoms in a molecule given its molecular formula or displayed formula. State the number of each different type of atom in a molecule or displayed formula. State that there are two types of bonding: • ionic bonding; • covalent bonding.
Research melting point, boiling point and electrical conductivity of carbon dioxide and water.	Describe carbon dioxide as a gas with a low melting point. Describe water as a liquid with a low melting point.
Quiz to identify different elements, symbols, groups periods etc.	Deduce, using a periodic table, elements that are in the same group (family). Describe a group of elements as all the elements in a vertical column of the periodic table and that the elements have similar chemical properties.
Quiz to identify different elements, symbols, groups periods etc.	Recognise, using a periodic table, elements from a list that are in the same period. Describe a period of elements as all the elements in a horizontal row of the periodic table.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C3a What are atoms like?, C3b How atoms combine – Ionic Bonding, C3d Covalent Bonding and the Structure of the Periodic Table, C3e The Group 7 Element, C3g Transition Elements

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that non-metals combine together by sharing electrons and this is called covalent bonding.	Describe the formation of simple molecules containing single and double covalent bonds by the “dot and cross” model, limited to the molecules: • H_2 • Cl_2 • CH_4 • CO_2 • H_2O
State that carbon dioxide and water do not conduct electricity.	Describe carbon dioxide and water as simple molecules with weak intermolecular forces between molecules. Relate the properties of carbon dioxide and water to their structure: • weak intermolecular forces so low melting points; • no free electrons so do not conduct electricity.
Recognise that the group number is the same as the number of electrons in the outer shell: • Group 1 elements have 1 electron in the outer shell; • Group 7 elements have 7 electrons in the outer shell; • Group 8 elements have a full outer shell.	Deduce the group to which an element belongs from its electronic structure (limited to the first 20 elements).
Recognise that the period to which the element belongs corresponds to the number of occupied shells in the electronic structure.	Deduce the period to which the element belongs from its electronic structure.

MODULE C3: THE PERIODIC TABLE

Item C3d: The Group 1 Elements

Summary: This item studies the properties of the Group 1 elements. The item links the similarity of their properties to the position of the elements in the periodic table. Video clips of the reactions of rubidium and caesium are examples of the use of ICT in teaching and learning.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Research properties of alkali metals e.g. using the internet. Demonstrate reactions of sodium, lithium and potassium with water. Show video of reactions of rubidium and caesium with water.	State that Group 1 metals are known as the alkali metals. Recognise sodium, lithium and potassium as Group 1 metals. State that alkali metals react vigorously with water. Explain that alkali metals are stored under oil because they react with air and water. Describe the order of reactivity with water of the alkali metals: • potassium is more reactive than sodium; • sodium is more reactive than lithium.
Candidates carry out flame tests on alkali metal chlorides.	State the flame test colours for lithium, sodium and potassium compounds. Interpret information about flame tests e.g. deduce the alkali metal present from flame colours.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C3a What are Atoms like?, C3b How atoms combine – Ionic Bonding, C3c Covalent Bonding and the Structure of the Periodic Table, C6b Redox Reactions

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the reaction of lithium, sodium and potassium with water: • hydrogen is formed; • an alkali is formed which is the hydroxide of the metal; • the reactivity with water increases down Group 1; • potassium gives a lilac flame. State the word equation for the reaction of an alkali metal with water.	State the balanced symbol equation for the reaction of an alkali metal with water e.g: $2Na + 2H_2O \rightarrow 2NaOH + H_2$ Predict the properties of alkali metal e.g: • reactivity of rubidium with water; • the physical properties of caesium given information about the other alkali metals.
State that the Group 1 metals have one electron in the outer shell. Explain that Group 1 metals have similar properties because they have one electron in their outer shell.	Explain that alkali metals have similar properties because when they react, an atom loses one electron to form a positive ion with a stable electronic structure. Write an equation to show the formation of an ion of a Group 1 metal from its atom. Explain that the more reactive the alkali metal the easier it for an atom to lose one electron. Describe the loss of electrons as oxidation. Explain why a process is oxidation from its ionic equation.
Describe how to carry out a flame test to test for the presence of lithium, sodium and potassium compounds: • use of moistened flame test wire; • flame test wire dipped into solid sample; • flame test wire put into blue Bunsen flame.	

MODULE C3: THE PERIODIC TABLE

Item C3e: The Group 7 Elements

Summary: This item studies the properties of the Group 7 elements. The item links the similarity of their properties to the position of the elements in the periodic table. Researching the properties of the halogens allows the use of ICT as a teaching and learning tool.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
	State that Group 7 elements are known as the halogens. Recognise fluorine, chlorine, bromine and iodine as halogens.
	State the uses of some halogens: • chlorine to sterilise water; • chlorine to make pesticides and plastics; • iodine is used to sterilise wounds. State that sodium chloride is used: • as a preservative; • as a flavouring; • to manufacture chlorine.
Demonstrate or show video of reaction of sodium with chlorine.	State that halogens react vigorously with alkali metals.
Demonstrate or class practical of displacement reactions of the halogens.	Recall the order of reactivity of the halogens: • fluorine is more reactive than chlorine; • chlorine is more reactive than bromine; • bromine is more reactive than iodine.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C3a What are Atoms like?, C3b How Atoms Combine – Ionic Bonding, C3c Covalent Bonding and Structure of the Periodic Table, C6b Redox Reactions

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the physical appearance of the halogens at room temperature: • chlorine is a green gas; • bromine is an orange liquid; • iodine is a grey solid.	
Describe the reaction between alkali metals and halogens to give metal halides. Identify the metal halide formed when a halogen reacts with an alkali metal. Construct the word equation for the reaction between an alkali metal and a halogen.	Construct the balanced symbol equation for the reaction of an alkali metal with a halogen.
State that the reactivity of the halogens decreases down the group. Describe the displacement reactions of halogens with solutions of metal halides: • chlorine displaces bromides and iodides; • bromine displaces iodides. Construct the word equation for the reaction between a halogen and a metal halide.	Predict the properties of fluorine or astatine given the properties of the other halogens e.g: • physical properties; • melting point; • boiling point; • displacement reactions. Construct the balanced symbol equation for the reaction between halogens and metal halides.
Explain that Group 7 elements have similar properties because they have seven electrons in their outer shell.	Explain that halogens have similar properties because when they react, an atom gains one electron to form a negative ion with a stable electronic structure. Write an equation to show the formation of a halide ion from a halogen molecule. Explain that the more reactive the halogen the easier it is for an atom to gain one electron. Describe the gain of electrons as reduction. Explain why a process is reduction from its ionic equation.

MODULE C3: THE PERIODIC TABLE

Item C3f: Electrolysis

Summary: Electrolysis is an important type of reaction This item describes the electrolysis of some solutions and describes the use of electrolysis to provide useful substances.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Demonstrate the electrolysis of sodium chloride solution including testing for hydrogen and chlorine. Research different ways of doing it industrially.	State that during electrolysis: • the anode is the positive electrode; • the cathode is the negative electrode; • anions are negative ions and are attracted to the anode; • cations are positive ions and are attracted to the cathode; • an electrolyte is the liquid which conducts electricity; • recognise anions and cations from given formulae. Describe that sulfuric acid solution can be broken down by electrolysis into hydrogen and oxygen. State the tests for hydrogen and oxygen: • hydrogen burns with a ‘pop’ when lit using a lighted splint; • oxygen relights a glowing splint.
Guided research on industrial extraction of aluminium.	State that aluminium is extracted from its mineral using electricity. Describe electrolysis as the decomposition of a liquid using electricity. State that bauxite is a mineral containing aluminium.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C2d Metals and Alloys, C5b Electrolysis, C6d Chemistry of Sodium Chloride (NaCl)

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the key features of the electrolysis of dilute sulfuric acid: • hydrogen made at the cathode; • oxygen made at the anode.	State the electrode reactions in the electrolysis of sulfuric acid: • cathode $2H^+ + 2e^- \rightarrow H_2$ • anode $4OH^- - 4e^- \rightarrow 2H_2O + O_2$
Describe the key features of the electrolytic decomposition involved in the production of aluminium: • use of molten aluminium oxide; • oxygen is formed at the graphite anode; • the anodes are gradually worn away by oxidation; • aluminium is formed at the graphite cathode; • process has a high electrical energy requirement. Write the word equation for the decomposition of aluminium oxide.	State the electrode reactions in the electrolytic extraction of aluminium: • cathode $Al^{3+} + 3e^- \rightarrow Al$ • anode $2O^{2-} \rightarrow O_2 + 4e^-$ Explain that cryolite is used to lower the melting point of the aluminium oxide. Explain that aluminium is expensive because its extraction uses large amounts of electricity.

MODULE C3: THE PERIODIC TABLE

Item C3g: Transition Elements

Summary: This item covers some properties and chemistry of the transition elements and introduces thermal decomposition and precipitation. The experiments on thermal decomposition allow opportunities to collect and analyse science data, working as an individual or in a group, to analyse results and present the information using scientific conventions and symbols.

Suggested activities and experiences to select from	**Assessable learning outcomes Foundation Tier only: low demand**
Show a large number of transition elements and ask pupils to deduce or research their properties.	Identify whether an element is a transition element from its position in the periodic table. Recognise that all transition elements are metals and have typical metallic properties. State the name or symbol of a transition element using the periodic table. State that copper and iron are transition elements.
Class practical - thermal decomposition of transition metal carbonates including test for carbon dioxide.	Describe thermal decomposition as a reaction in which a substance is broken down into at least two other substances by heat. Describe that the test for carbon dioxide is that it turns limewater milky.
Class practical – precipitation reactions of transition metal ions with sodium hydroxide.	Describe precipitation as a reaction between solutions that makes an insoluble solid.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C3c Covalent Bonding and the Structure of the Periodic Table, C5h Ionic Equations, C6b Redox Reactions

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that compounds of transition elements are often coloured: • copper compounds are blue; • iron(II) compounds are light green; • iron(III) compounds are orange/brown. State that transition elements and their compounds are often catalysts: • iron in the Haber process; • nickel in the manufacture of margarine.	
Describe the thermal decomposition of transition metal carbonates illustrated by $FeCO_3$, $CuCO_3$, $MnCO_3$ and $ZnCO_3$: • metal oxide and carbon dioxide formed; • word equations; • colour change occurs (colours not needed).	Construct the balanced symbol equation for the thermal decomposition of: • $FeCO_3$ • $CuCO_3$ • $MnCO_3$ • $ZnCO_3$
Describe the use of sodium hydroxide solution to identify the presence of transition metal ions in solution: • Cu^{2+} gives a blue solid; • Fe^{2+} gives a grey/green solid; • Fe^{3+}gives an orange/solid solid; • the solids are called precipitates.	Construct the symbol equations for the reaction between Cu^{2+}, Fe^{2+} and Fe^{3+} with OH^- (without state symbols) given the formulae of the ions.

MODULE C3: THE PERIODIC TABLE

Item C3h: Metal Structure and Properties

Summary: Metals are a very important class of materials. This item relates the properties of metals to their structure. The item also includes information on superconductors. The research and data interpretation activities allow the analysing and interpretation of scientific information and the collection of secondary data using ICT.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Research uses of some metals and relate to properties – a poster could be produced.	State that iron is used to make steel and to make cars and bridges because it is strong. State that copper is used to make brass and to make electrical wiring because it is a good electrical conductor.
Data search or experimental comparison of different metal properties. Data interpretation activity.	Describe the physical properties of metals: • lustrous, hard and high density; • high tensile strength; • high melting and boiling points; • good conductors of heat and electricity; Interpret data about the properties of metals e.g. hardness, density and electrical conductivity. Recognise that the particles in a metal are held together by metallic bonds.
Internet research into superconductors. Displacement reactions to show metal crystals. Produce a poster on superconductors. Bubble raft activity.	State that metals have a structure which contains crystals. State that particles in solid metals are close together and in a regular arrangement. State that at low temperatures some metals can be superconductors.

MODULE C3: THE PERIODIC TABLE

Links to other modules: C2d Metals and Alloys, C2e Cars for Scrap

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Suggest properties needed by a metal for a particular given use e.g. saucepan bases need to be good conductors of heat. Explain why metals are suited to a given use (data may or may not be provided). Describe that metals have high melting points and boiling points because of strong metallic bonds.	Explain why metals are suited to a given use (data may or may not be provided). Describe metallic bonding as the strong electrostatic attraction between a sea of delocalised electrons and close packed positive metal ions. Explain that metals often have high melting points and boiling points because of the strong attraction between the electrons which needs to be overcome.
Describe that when metals conduct electricity electrons move. Describe that superconductors are materials that conduct electricity with little or no resistance. Describe the potential benefits of superconductors: • loss free power transmission; • super-fast electronic circuits; • powerful electromagnets.	Explain that metals conduct electricity because the delocalised electrons can move easily. Explain the drawbacks of superconductors: • only work at very low temperatures; • the need to develop superconductors that will work at 20^{o}C.

MODULE C4: CHEMICAL ECONOMICS

Item C4: Fundamental Chemical Concepts

Summary: Throughout the study of chemistry in GCSE science there are a number of ideas and concepts that are fundamental. These ideas and concepts have not been put into a particular item but should permeate through all the GCSE chemistry modules C1 to C6.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
These learning outcomes are intended to be taught throughout this specification.	Describe that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word equation.
These learning outcomes are intended to be taught throughout this specification.	Recognise the reactants and the products in a symbol equation.
These learning outcomes are intended to be taught throughout this specification.	State the number of elements in a compound given its formula. State the number of atoms in a formula with no brackets. State the number of each different type of atom in a formula with no brackets.
These learning outcomes are intended to be taught throughout this specification.	Recognise whether a substance is an element or a compound from its formula.
These learning outcomes are intended to be taught throughout this specification.	Recognise that a molecule is made up of more than one atom joined together. Recognise that a molecular formula shows the numbers and types of atom in a molecule. State the number of atoms in a displayed formula. State the names of the different elements in a compound given its displayed formula. State the number of each different type of atom in a displayed formula.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations given the reactants and products.	
Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain that a symbol equation is balanced when the number of each type of atom is the same on both sides of an equation.	Construct balanced symbol equations given the formulae (some or all with brackets) of the reactants and products. Construct balanced symbol equations given the names of the reactants and products (limited to the learning outcomes in this specification).
State the number of atoms in a formula with brackets. State the number of each type of different atom in a formula with brackets.	Recall the formula of the following substances: • hydrochloric acid, nitric acid and sulfuric acid; • ammonia, calcium carbonate, copper oxide, potassium hydroxide, sodium carbonate and sodium hydroxide; • chlorides and sulfates of potassium, sodium and ammonium; • silver nitrate, silver chloride, barium chloride and barium sulfate.
Recognise that a displayed formula shows both the atoms and the bonds in a molecule. Write the molecular formula of a compound given its displayed formula.	Balance equations that use displayed formulae.

MODULE C4: CHEMICAL ECONOMICS

Item C4a: Acids and Bases

Summary: Young people are familiar with acids and alkalis. They are excited by the opportunity to use these 'dangerous' chemicals. This item revises previous knowledge and understanding and gives them the opportunity to practice word and symbolic equations in relation to neutralisation reactions. The testing of pH provides the opportunity to use ICT as part of teaching and learning.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to test a variety of solutions to find pH: • reactions between acids and alkalis; • reactions between acids and bases. (Opportunity to use datalogger.)	Recognise that solutions with a pH of less than 7 are acids. Recognise that solutions with a pH of more than 7 are alkalis. Recognise that solutions with a pH of 7 are neutral.
Simple Investigation into the change in pH during neutralisation (not pH titration curves).	Describe the change in pH when an acid is neutralised by an alkali or vice versa: • pH increases when alkali added; • pH decreases when acid is added.
Investigate the reactions of acids with bases and carbonates e.g. hydrochloric acid with oxides, hydroxides and carbonates.	State that an acid can be neutralised by a base or alkali, or vice versa.
Research uses of sulfuric acid.	Describe some of the uses of sulfuric acid: • preparation of metal surfaces; • manufacture of fertilisers; • car battery acid.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: C5d Titrations, C5g Strong and Weak Acids

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Describe how universal indicator can be used to estimate the pH of a solution.	
Describe an alkali as a soluble base. State that in neutralisation: acid + base $\rightarrow$ salt + water Explain the change in pH when an acid is neutralised by an alkali, or vice versa.	State that acids in solution contain hydrogen ions. State that alkalis in solution contain hydroxide ions. Describe neutralisation using the ionic equation. $H^+ + OH^- \rightarrow H_2O$
Recall that metal oxides and metal hydroxides neutralise acids because they are bases. Recall that carbonates neutralise acids to give water, a salt and carbon dioxide. Predict the name of the salt produced when a named base or carbonate is neutralised by a laboratory acid: • sulfuric acid; • nitric acid; • hydrochloric acid.	Construct word equations to show the neutralisation of acids by bases and carbonates (without given the names of the products). Construct balanced symbol equations for the neutralisation of acids by bases and carbonates limited to: • sulfuric acid, nitric acid, and hydrochloric acid; • ammonia, potassium hydroxide, sodium hydroxide and copper oxide; • sodium carbonate and calcium carbonate.

MODULE C4: CHEMICAL ECONOMICS

Item C4b: Reacting Masses

Summary: Quantitative aspects of chemistry are introduced. Ideas can be extended and applied to industrial contexts. The use of relative atomic masses to calculate formula masses is developed and chemical equations are used quantitatively in 'reacting masses' calculations. The idea of percentage yield is used in relation to 'loss' of product during a reaction and in terms of the difficulty of getting a reversible reaction to go to completion. Wider social and economic considerations of an industrial process are studied. This item provides opportunities to present information using technical, scientific and mathematical language. Investigating the relationship between mass of malachite and mass of copper oxide that can be obtained from it, gives the opportunity to use ICT as part of teaching and learning.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Looking at the periodic table to find relative atomic masses. Relative formula mass calculations.	Look up relative atomic masses using the periodic table. Calculate the relative formula mass of a substance from its formula (no brackets) given the appropriate relative atomic masses.
Class experiment to find out the relationship between mass of malachite and mass of copper oxide that can be obtained from it – opportunity to use spreadsheets for analysis of results.	Recognise that the greater the amount of starting materials (reactants) used, the greater the amount of new substances (products) formed. State that the total mass of reactants at the start of a reaction is equal to the total mass of products made.
Preparation of ammonium sulfate (see activities in C4c.)	Describe percentage yield as a way of comparing amount of product made (actual yield) to amount expected (predicted yield): • 100% yield means that no product has been lost; • 0% yield means that no product has been made. Recognise possible reasons (given experimental details) why the percentage yield of a product is less than 100% e.g: • loss in filtration; • loss in evaporation; • loss in transferring liquids; • loss in heating.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: C3a What are Atoms like?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Calculate the relative formula mass of a substance from its formula (with brackets) given appropriate relative atomic masses.	
Use simple ratios to calculate reacting masses and product masses given the mass of a reactant and a product.	Explain why mass is conserved in chemical reactions. Interpret chemical equations quantitatively. Calculate masses of products or reactants from equations using relative formula masses.
State the formula: percentage yield = $\frac{\text{actual yield} \times 100}{\text{predicted yield}}$ Calculate percentage yield given 'actual yield' and 'predicted yield'.	

MODULE C4: CHEMICAL ECONOMICS

Item C4c: Fertilisers and crop yield

Summary: News items regularly feature stories of famine in various parts of the world. In this item we explore the role of fertilisers in increasing plant growth and crop yield. This item looks at the use of contemporary scientific and technological developments and their benefits, risks and drawbacks.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of fertilisers available at garden centres and commercially (via Internet searches). Poster about fertilisers.	State that fertilisers make crops grow faster and bigger. State that plants absorb minerals through their roots.
Survey of fertilisers available at garden centres and commercially (via Internet searches). Poster about fertilisers.	Describe fertilisers as chemicals that provide plants with essential chemical elements. Recall that nitrogen, phosphorus and potassium are three essential elements needed for plant growth. Recognise the essential elements given the formula of a fertiliser.
Preparation of a fertiliser by the neutralisation of an acid by an alkali (e.g. potassium nitrate or ammonium sulfate).	Label the apparatus needed to prepare a fertiliser by the neutralisation of an acid with an alkali: • burette and measuring cylinder; • filter funnel. State the names of two nitrogenous fertilisers manufactured from ammonia e.g: • ammonium nitrate; • ammonium phosphate; • ammonium sulfate; • urea.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: B4d Plants need Minerals Too, C4b Reacting Masses, C4d Making Ammonia – Haber Process and Costs

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that fertilisers must first dissolve in water before they can be absorbed by plants. State that fertilisers increase crop yield.	Explain how the use of fertilisers increases crop yield: • replaces essential elements used by a previous crop or provides extra essential elements; • more nitrogen gets incorporated into plant protein so increased growth. Describe the process of eutrophication: • run-off of fertiliser; • increase of nitrate or phosphate in river water; • algal bloom; • blocks off sunlight to other plants which die; • aerobic bacteria use up oxygen; • most living organisms die.
Calculate the relative formula mass of a fertiliser given its formula and the appropriate relative atomic masses.	Calculate the percentage by mass of each essential element in a fertiliser given its formula and the appropriate relative atomic masses.
State the name of the acid and the alkali needed to make each of the following fertilisers: • ammonium nitrate; • ammonium phosphate; • ammonium sulfate; • potassium nitrate.	Describe the preparation of a named synthetic fertiliser by the reaction of an acid and an alkali: • names of reactants; • experimental method; • how a neutral solution is obtained; • how solid fertiliser is obtained.

MODULE C4: CHEMICAL ECONOMICS

Item C4d: Making ammonia – Haber Process and Costs

Summary: Leading on from work done on fertilisers and organic farming, this item has as its central focus the industrial preparation of ammonia and its link with the fertiliser industry. The concept of reversible reactions is introduced with reference being made to the production of ammonia. In reversible reactions the fact that a balance that has to be struck between rate and percentage conversion is explored. Industrial case studies provide the opportunity to examine how scientific knowledge and ideas change over time. The factors affecting the cost of making a new substance provides opportunities to present information using technical, scientific and mathematical language.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine historical, social, moral or economic reasons leading to the need to produce ammonia as a starting point for fertiliser production. Produce a poster on ammonia manufacture. Computer animation to illustrate how temperature and pressure affect yield in the Haber process. Industrial case study.	State that ammonia is made from nitrogen and hydrogen. State that the nitrogen needed for the manufacture of ammonia is obtained from air. State that the hydrogen needed for the Haber process often comes from the cracking of oil fractions or from natural gas.
Manufacturing costs (via internet) and class discussion.	Describe that the cost of making a new substance depends on: • price of energy (gas and electricity); • cost of starting material; • wages (labour costs); • equipment (plant); • how quickly the new substance can be made (cost of catalyst).
Industrial case studies.	Recognise that $\rightleftharpoons$ is used to represent a reversible reaction. State that a reversible reaction can proceed in both directions.
Survey of household chemicals containing ammonia and their uses.	Describe some of the uses of ammonia: • manufacture of fertilisers; • manufacture of nitric acid; • in cleaning fluids.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: C2h Faster or Slower (2), C4c Fertilisers and Crop Yield, C4f Batch or Continuous, C5f Equilibria

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how ammonia is made in the Haber process: • nitrogen + hydrogen $\rightleftharpoons$ ammonia; • iron catalyst; • high pressure; • temperature in the region of 450 °C; • unreacted nitrogen and hydrogen are recycled.	Explain the use of the conditions used in the Haber process: • high pressure increases the percentage yield of ammonia; • high temperature decreases the percentage yield of ammonia; • high temperature gives a high rate of reaction; • 450 °C is an optimum temperature to give a fast reaction with a sufficiently high percentage yield; • catalyst increases the rate of reaction but does not change the percentage yield. State the balanced equation for the manufacture of ammonia in the Haber process.
Describe how different factors affect the cost of making a new substance: • the higher the pressure the higher the plant cost; • the higher temperature the higher the energy cost; • catalysts reduce costs by increasing the rate of reaction; • when unreacted starting materials are recycled costs are reduced; • automation reduces the wages bill.	Explain that economic considerations determine the conditions used in the manufacture of chemicals: • rate must be high enough to give a sufficient daily yield of product; • percentage yield must be high enough to give a sufficient daily yield of product; • a low percentage yield can be accepted if the reaction can be repeated many times with recycled started materials; • optimum conditions used that give the lowest cost rather than the fastest reaction or highest percentage yield.
Interpret data in tabular and graphical form relating to percentage yield in reversible reactions and changes in conditions. (No recall required).	Interpret data about rate, percentage yield and costs for alternative industrial processes (No recall required).
Recognise the importance of ammonia in relation to world food production.	

MODULE C4: CHEMICAL ECONOMICS

Item C4e: Detergents

Summary: Cleaning and washing are important in the life of a teenager. Everyone is looking for more effective and efficient cleaning agents that take less time and can work at low temperatures. This item develops ideas about the use of cleaning agents such as detergents and solvents. A simple explanation of the action of detergents and solvents will be considered as well as the scientific accuracy of some advertisements for detergents

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Look at the constituents of washing powders. Critical assessment of the claims made in advertisements.	Describe the function of each ingredient in a washing powder: • active detergent does the cleaning; • water softener to soften hard water; • bleaches to remove coloured stains; • optical brighteners to give the whiter than white appearance; • enzymes used in low temperature washes to remove food stains. Predict the correct washing conditions using the wash label on an item.
Investigate the action of some solvents to remove stains, paints, varnishes, wax and grease.	Describe and use the terms solvent, solute, solution, soluble and insoluble. Recognise that different solvents will dissolve different substances. Identify the correct solvent to remove a stain given the appropriate information.
Preparation of a detergent.	State that many detergents are salts.
Survey of constituents of different brands of washing up liquids.	Describe the function of each ingredient in a washing-up liquid: • active detergent does the cleaning; • water to thin out detergent so it can be dispensed easily; • colouring agent and fragrance to improve attractiveness of product; • rinse agent to help water to drain off crockery; • water softener to soften hard water.
Critical analysis of advertisements for washing up liquids and washing powders.	Interpret data from experiments on the effectiveness of washing up liquids and washing powders.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: B6g Enzymes in Action, C1b Food Additives, C1c Cooking

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the advantages of using low temperature washes in terms of energy saving and the type of clothes that can be washed.	Describe the chemical nature of a detergent and how detergents work: • hydrophilic head; • hydrophobic tail.
Describe dry cleaning as a process used to clean clothes that does not involve water: • solvent that is not water; • stain will not dissolve in water.	Explain in terms of intermolecular forces, how a dry cleaning solvent removes stains.
Describe that many detergents are made by the neutralisation of acids with alkalis.	
Interpret data from experiments on the effectiveness of washing up liquids and washing powders.	Interpret data from experiments on the effectiveness of washing up liquids and washing powders.

MODULE C4: CHEMICAL ECONOMICS

Item C4f: Batch or Continuous?

Summary: Speciality chemicals such as pharmaceutical drugs are widely used in our society. This item looks at how speciality chemicals are developed, tested and marketed. It also describes the differences between batch manufacture used for speciality chemicals and continuous manufacture used for making substances such as ammonia.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Industrial case studies.	Recall that ammonia is made all the time in a continuous process. Describe that speciality chemicals such as medicines and pharmaceutical drugs are often made on demand in a batch process.
Industrial case studies.	State that the factors that affect the cost of making and developing a medicine or pharmaceutical drug include: • research and testing; • labour costs; • energy costs; • raw materials; • time taken for development; • marketing.
Practical extraction of a natural oil from a plant. Research plants used as source of drugs.	Recall that the raw materials for speciality chemicals such as pharmaceuticals can be either made synthetically or extracted from plants.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: C4d Making Ammonia – Haber Process and Costs, C6c Alcohols, C6h Analgesics

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Compare the relatively small scale production of pharmaceutical drugs to the large scale industrial manufacture of ammonia.	Evaluate the advantages and disadvantages of batch and continuous manufacturing processes given relevant data and information.
Describe the factors contributing to the high costs involved in making and developing a new medicine or pharmaceutical drug: • often more labour intensive; • less automation possible; • research and testing may take many years; • raw materials likely to be rare and/or involve expensive extraction from plants; • legislative demands.	Explain how economic considerations determine the development of new drugs in relation to: • research and development time and associated labour costs; • time required to meet legal requirements including timescale for testing and human trials; • anticipated demand for new product; • length of pay back time for initial investment.
Describe how chemicals are extracted from plant sources: • crushing; • dissolving in suitable solvent; • chromatography.	

MODULE C4: CHEMICAL ECONOMICS

Item C4g: Nanochemistry

Summary: Young people are usually interested in acquiring the newest, micro gadget available. Electronic items are becoming smaller each year. This is due to nanotechnology. This item looks at some aspects of nanochemistry – the discovery of buckminsterfullerene, leading to the development of fullerenes – the starting point for nanotubes. Uses of nanotubes in electronic systems and as industrial catalysts are explored.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine and compare the structures of diamond, graphite and buckminsterfullerene. The discovery of buckminsterfullerene.	Recall that three forms of carbon are: • diamond; • graphite; • buckminster fullerene (bucky balls).
	Describe the physical properties of diamond: • lustrous, colourless and clear (transparent); • hard and has a high melting point; • insoluble in water; • does not conduct electricity. Recall that diamond is used in cutting tools and jewellery.
	Describe the physical properties of graphite: • black, lustrous and opaque; • slippery; • insoluble in water; • conducts electricity. Recall that graphite is used as an electrode, in pencil leads and in lubricants.
Build models of fullerenes and nanotubes. (RSC – Contemporary chemistry for schools and colleges has useful worksheets etc).	Describe the physical properties of buckminster fullerene: • black solid; • deep red in solution in petrol. Describe that fullerenes can be joined together to make nanotubes. State that nanotubes: • are very strong; • conduct electricity.
Survey of uses of fullerenes (via Internet).	State that chemistry works with materials on a large scale. State that nanochemistry works with materials at the atomic level.

MODULE C4: CHEMICAL ECONOMICS

Links to other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise the structures of diamond, graphite and buckminster fullerene.	Explain that diamond, graphite and fullerenes are all allotropes of carbon.
Explain that diamond is used in cutting tools because it is very hard and has a high melting point. Explain that diamond is used in jewellery because it is lustrous and colourless.	Explain the properties of diamond in terms of its structure: • does not conduct electricity since it has no free electrons; • hard and has a high melting point because of the presence of many strong covalent bonds.
Explain that graphite is used in pencil leads because it is slippery and black. Explain that graphite is used in lubricants because it is slippery. Explain that graphite is used as an electrode in electrolysis because it conducts electricity and has a high melting point.	Explain the properties of graphite in terms of its structure: • conducts electricity because it has delocalised electrons that can move; • slippery because layers of carbon atoms are weakly held together and can slide easily over each other; • high melting point because there are many strong covalent bonds to break.
State that Buckminster fullerene has the formula C_{60}. Describe some uses of nanotubes: • semiconductors in electrical circuits; • industrial catalysts; • reinforce graphite in tennis rackets.	Describe the use of fullerenes to 'cage' other molecules. Describe the use of 'caged molecules' in new drug delivery systems. Explain the use of nanotubes as catalysts: • catalyst attached to nanotubes; • large surface area available.
Describe that nanoparticles have different properties from the 'bulk' chemical.	Describe molecular manufacturing in terms of molecule-by-molecule building of a product, using positional chemistry or by starting with a bigger structure and then removing matter to produce nanoscale features.

MODULE C4: CHEMICAL ECONOMICS

Item C4h: How pure is our water?

Summary: Young people see many examples of famine and disaster in the world. Often a lack of pure water is associated with the disaster. This item develops ideas about the importance of clean water both in the United Kingdom and in the developing nations of the world. The purification of water is considered as well as simple ways to test for dissolved substances in water.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Use text-books, video and/or internet and information from local water companies to find out about the water resources in the United Kingdom and the need to conserve water.	State different types of water resources found in the United Kingdom: • lakes; • rivers; • aquifers; • reservoirs. Recall that water is an important resource for many important industrial chemical processes: • a cheap raw material; • as a coolant; • as a solvent.
Research the pollutants found in water.	State some of the pollutants that may be found in domestic water supplies: • nitrate residues; • lead compounds; • pesticide residues.
Visit a water purification plant. Design a poster to describe the purification of domestic water.	State the types of substances present in water before it is purified: • dissolved salts and minerals; • microbes; • pollutants; • insoluble materials. Describe that chlorination kills microbes in water.
Investigate the solution chemistry of some dissolved ions.	State that barium chloride solution is used to test for sulfate ions: • gives a white ppt. State that silver nitrate solution is used to test for halide ions: • chloride ions give a white ppt; • bromide ions give a cream ppt; • iodide ions give a pale yellow ppt.
Discuss the need for clean water in the developing world (e.g. use of material from Oxfam etc.).	

MODULE C4: CHEMICAL ECONOMICS

Links to other modules: C5h Ionic Equations, C6d Chemistry of Sodium Chloride (NaCl), C6f Hardness of Water

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Interpret data about water resources in the United Kingdom (no recall is expected). Explain why it is important to conserve water.	
Recall the source of pollutants in water: • nitrate from fertiliser run off; • lead compounds from lead pipes; • pesticide from spraying near to water resources.	
Describe the water purification process to include filtration, sedimentation and chlorination.	Explain the processes involved in water purification. Explain that some soluble substances are not removed from water during purification and that these may be poisonous. Explain the disadvantages of using distillation of sea water to make large quantities of fresh water.
Interpret data about the testing of water with aqueous silver nitrate and barium chloride solutions. Write word equations for the reactions of barium chloride with sulfates and silver nitrate with halides. Recall that the reaction of barium chloride with sulfates and silver nitrate with halides are examples of precipitation reactions.	Write balanced symbol equations for the reaction of barium chloride with sulfates and silver nitrate with chlorides given the appropriate formulae.
Explain the importance of clean water for people in the developing nations.	

MODULE C5: HOW MUCH?

Item C5: Fundamental Chemical Concepts

Summary: Throughout the study of chemistry there are a number of ideas and concepts that are fundamental. These ideas and concepts have not been put into a particular item but should permeate all the Chemistry units. They will be assessed in the context of any of the modules C1 to C6.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
These learning outcomes are intended to be taught throughout this specification.	Describe that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word or symbol equation. Recognise that in a chemical change no atoms are lost or made.
These learning outcomes are intended to be taught throughout this specification.	State the number of elements in a compound given its formula. State the number of atoms in a formula with no brackets. State the number of each different type of atom in a formula with no brackets.
These learning outcomes are intended to be taught throughout this specification.	Recognise whether a substance is an element or a compound from its formula.
These learning outcomes are intended to be taught throughout this specification.	Recognise that a molecule is made up of more than one atom joined together. Recognise that a molecular formula shows the number and type of atom in a molecule. State the number of atoms in a displayed formula. State the names of the different elements in a compound given its displayed formula. State the number of each different type of atom in a displayed formula.
These learning outcomes are intended to be taught throughout this specification.	State that all atoms are made up of a nucleus and electrons. State that a chemical bond holds atoms together in a compound.

MODULE C5: HOW MUCH?

Links to other modules: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations given the reactants and products. Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain that a symbol equation is balanced when the number of each type of atom is the same on both sides of an equation.	Construct balanced symbol equations given the formulae (some or all with brackets) of the reactants and products. Construct balanced symbol equations given the names of the reactants and products (limited to the learning outcomes in this specification).
State the number of atoms in a formula with brackets. State the number of each type of different atom in a formula with brackets.	Recall the formula of the following substances: • sulfuric acid, hydrochloric acid, nitric acid and ethanoic acid; • ammonia, sodium hydroxide, potassium hydroxide, calcium carbonate and magnesium carbonate; • sulfates and chlorides of sodium, potassium, calcium and magnesium; • lead(II) nitrate and barium chloride; • carbon dioxide, hydrogen and water.
Recognise that a displayed formula shows both the atoms and the covalent bonds in a molecule. Write the molecular formula of a compound given its displayed formula.	Balance equations that use displayed formulae.
State that the nucleus of an atom is positive and the electrons negative. State there are two types of chemical bonds: • ionic between a positive ion and a negative ion; • covalent involving a shared pair of electrons.	

MODULE C5: HOW MUCH?

Item C5a: Moles and Empirical Formulae

Summary: It is often necessary to identify an unknown sample. One way involves finding out the percentage composition by mass. This item explains how the percentage composition by mass can be used to determine the formula of the compound. The experiment on the oxidation of the magnesium ribbon provides the opportunity to work safely and accurately, individually and with others.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Review relative formula mass calculations. Molar mass calculations.	State that the unit for the amount of a substance is the mole. Use the knowledge that the molar mass of substance is its relative formula mass in grams. Calculate the molar mass of a substance from its formula (without brackets) using the appropriate relative atomic masses.
Carry out an experiment to measure the increase in mass on complete oxidation of magnesium ribbon in a crucible. Carry out an experiment to determine the percentage of water of crystallisation in a sample of hydrated salt.	Recall that mass is conserved during a chemical reaction. Interpret experimental results involving mass changes during chemical reactions. Use understanding of conservation of mass to carry out very simple calculations: • mass of gas or water lost during thermal decomposition; • mass of gas gained during reaction; • determine a reacting amount for a simple reaction given all the other reacting amounts.
Carry out an experiment to measure the decrease in mass on reduction of copper oxide e.g. reduction with methane gas.	Determine the mass of an element in a known mass of compound given the masses of the other elements present.

Can-Do Tasks

I can measure the mass of a sample to the required level of precision.	1 point
I can investigate the mass changes during a thermal decomposition reaction.	2 points

MODULE C5: HOW MUCH?

Links to other modules: C1a Cooking, C5c Quantitative Analysis, C5d Titrations, C5e Gas Volumes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Calculate the molar mass of a substance from its formula (with brackets) using the appropriate relative atomic masses.	Recall and use the relationship between molar mass, number of moles and mass: • number of moles = mass ÷ molar mass; • determine the number of moles of an element from the mass of that element; • determine the number of moles of a compound from the mass of that compound; • determine the masses of the different elements present in a given number of moles of a compound. State that the relative atomic mass of an element is the average mass of an atom of the element compared to the mass of $^{1}/_{12}$th of an atom of carbon-12.
Given a set of reacting masses, calculate further reacting amounts by simple ratio.	Calculate mass of products and / or reactants using the mole concept from a given balanced equation and the appropriate relative atomic masses.
Recall that an empirical formula gives the simplest whole number ratio of each type of atom in a compound. Deduce the empirical formula of a compound given its chemical formula.	Calculate empirical formula of a compound from the: • percentage composition by mass; • mass of each element in a sample of the compound.

MODULE C5: HOW MUCH?

Item C5b: Electrolysis

Summary: Some industrial processes involve electrolysis. This item describes how it is possible to predict the products of electrolysis. It explains how it is possible to predict the amount of product formed during electrolysis and provides the opportunity to plan to test a scientific idea. Predicting the outcome of the electrolysis of molten lead bromide illustrates the use of scientific modelling.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Class investigation to identify the products of electrolysis of aqueous solutions such as K_2SO_4(aq) or KNO_3(aq).	Label the apparatus needed to electrolyse aqueous solutions in a school laboratory: • anode, cathode, d.c. power supply. State that electrolysis is the decomposition of a liquid by the passing an electric current through it. Recognise that positive ions discharge at the negative electrode and negative ions at the positive electrode.
Class practical - the electrolysis of copper(II) sulfate using carbon electrodes and copper electrodes (qualitative and quantitative).	Describe the electrolysis of copper(II) sulfate solution using copper electrodes: • the negative electrode is plated with copper; • the positive electrode gets smaller and dissolves. State the factors that affect the amount of substance produced during electrolysis: • time; • current.
Fume cupboard demonstration of the electrolysis of molten $PbBr_2$ or PbI_2.	Predict the products of electrolytic decomposition of molten electrolytes such as Al_2O_3(l), $PbBr_2$(l), PbI_2(l) and KCl(l).

Can-Do Tasks	
I can measure changes in electrode mass.	1 point
I can set up a simple electrolysis circuit.	2 points
I can set up an electrolysis experiment, controlling both current and time.	3 points

MODULE C5: HOW MUCH?

Links to other modules: C2d Metals and Alloys, C2e Cars for Scrap, C3f Electrolysis, C6d Chemistry of Sodium Chloride (NaCl)

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State the products of the electrolytic decomposition of the following: • K_2SO_4(aq) – hydrogen and oxygen; • KNO_3(aq) – hydrogen and oxygen. Describe electrolysis in terms of flow of charge and discharge of ions.	Explain in the electrolysis of aqueous solutions it may be easier to discharge ions from the water rather than from the solute. Write the half equations for the electrode processes that happen during the electrolysis of each of the following given the formula of the ions present in the electrolyte: • K_2SO_4(aq) and KNO_3(aq)
Describe the changes in mass of the copper electrodes used in the electrolysis of copper(II) sulfate solution: • the negative electrode gains mass; • the positive electrode loses mass; • the gain in mass of the negative electrode is equal to the loss in mass of the positive electrode. Describe the factors that affect the amount of substance produced during electrolysis: • amount made increases as time increases and as current increases.	Write the half equations for electrode processes that happen during the electrolysis of $CuSO_4$(aq) using copper electrodes: • positive electrode $Cu - 2e^- \rightarrow Cu^{2+}$ • negative electrode $Cu^{2+} + 2e^- \rightarrow Cu$ Recall the relationship between charge transfer, current and time: $Q = It$ Perform simple calculations based on current, charge and the amount of substance produced in electrolysis.
Recall that ionic substances contain ions which are in fixed positions in the solid but can move in solution or when melted.	Write the half equations for the electrode processes that happen during the electrolysis of each of the following molten substances given the formula of the ions present in the electrolyte: • Al_2O_3(l) • $PbBr_2$(l) • PbI_2(l) • KCl(l)

MODULE C5: HOW MUCH?

Item C5c: Quantitative Analysis

Summary: An understanding of quantities and concentrations is important for everyday tasks in the home as well as being vital for medical and other technological applications. The ICT simulation about concentration provides the opportunity to use ICT in teaching and learning. Performing calculations involving concentration develops the skill of analysing scientific information quantitatively.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
ICT simulations about concentration.	Recall that concentration of solutions may be measured in g/dm^3 (g per dm^3). Recall that concentration of solutions may be measured in mol/dm^3 (mol per dm^3). Recall that volume is measured in dm^3 or cm^3. Recall that 1000 cm^3 equals 1 dm^3.
Follow simple instruction to dilute solutions by specified amounts.	Describe how to dilute a concentrated solution.
Survey everyday examples of dilution e.g: • dilution of concentrated orange juice; • dilution of windscreen wash fluid for different temperatures; • dilution of liquid medicines.	Appreciate the need for dilution in areas such as food preparation, medicine and baby milk and describe some of the dangers of getting the dilution wrong.
Survey information on food packaging with particular regard to RDA values.	Interpret information on food packaging about recommended daily allowances.

Can-Do Tasks

I can measure amounts of liquid to the nearest division on a measuring cylinder.	1 point
I can dilute a solution by a specified amount.	2 points

MODULE C5: HOW MUCH?

Links to other modules: C5a Moles and Empirical Formulae, C5d Titrations, C5e Gas Volumes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that the more concentrated a solution the more crowded the solute particles. Convert volume in cm^3 into dm^3 or vice versa.	Convert concentration in g/dm^3 into mol/dm^3 or vice versa. Calculate the concentration of a solution given appropriate information about the mass or number of moles of solute in a particular volume of solution. Perform simple calculations involving concentration, number of moles and volume of solution.
Perform calculations involving concentration for simple dilutions of solutions e.g. how to dilute a 1.0 mol/dm^3 solution into a 0.1 mol/dm^3 solution.	
Interpret information on food packaging about recommended daily allowances.	Interpret more complex food packaging information and its limitations e.g: • convert amounts of sodium to amounts of salt; • understand that an ion may come from several sources, so the above conversion will be inaccurate.

MODULE C5: HOW MUCH?

Item C5d: Titrations

Summary: Titrations are the historical backbone of so many analytical procedures. Whilst instrumental techniques have now removed much of the need for repetitive titrations, it is the technique that we always fall back on for the 'one off' analysis. This item provides the opportunity to illustrate the benefits of contemporary scientific and technological developments.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Demonstrate or carry out an investigation to find out how pH changes during the neutralisation of an alkali with an acid (pH titration curve) using a strong acid and using a pH meter.	Describe the changes in pH of a reaction mixture when an acid reacts with an alkali: • pH decreases when acid is added to alkali; • pH increases when alkali is added to a acid; • interpret a simple pH curve; • determine the pH at a particular volume added or vice versa (major grid lines). Describe how universal indicator can be used to estimate the pH of a solution.
Carry out a simple acid-alkali titration using an indicator such as litmus, phenolphthalein or screened methyl orange.	Label or identify the apparatus used in an acid-base titration: • burette and conical flask; • pipette and pipette filler. Describe the procedure for carrying out a simple acid-base titration: • acid in burette, alkali in pipette (or vice versa); • acid slowly added to alkali (or vice versa) until end point is reached; • end point detected by the change in colour of an indicator. Calculate the titre given appropriate information from tables or diagrams.
Simple investigation of the colour changes of indicators limited to universal indicator, phenolphthalein, litmus and screened methyl orange during neutralisation.	Describe the colours of the following indicators in acids and alkalis: • universal indicator, litmus, phenolphthalein and screened methyl orange.

Can-Do Tasks

I can accurately deliver a known amount of liquid using a pipette.	2 point
I can read a burette to the nearest scale division.	1 point
I can carry out a simple titration and get two consistent results within +/- 0.2cm^3.	3 points

MODULE C5: HOW MUCH?

Links to other modules: C4a Acids and Bases, C5a Moles and Empirical Formulae, C5c Quantitative, C5e Gas Volumes, C5g Strong and Weak Acids

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that there is a sudden change in pH at the end point of a titration. Explain why the pH changes during the reaction of an acid with an alkali: • neutralisation; • acid + alkali → salt + water Interpret a simple pH curve: • determine the volume of acid or alkali at neutralisation; • determine the pH when a particular volume added or vice versa.	Sketch a pH titration curve for the titration of an acid or an alkali.
Explain the need for several consistent titre readings in titrations.	Calculate the concentration of an acid or alkali from titration results, limited to examples involving a one to one molar ratio (acid: alkali). State and use the relationship between number of moles, concentration and volume: • moles = concentration × volume in dm^3 • concentration = moles ÷ volume in dm^3 • volume in dm^3 = moles ÷ concentration
Describe that a single indicator such as litmus produces a sudden colour change during titration whereas a mixed indicator such as universal produces a continuous colour change.	Explain why an acid-base titration should use a single indicator rather than a mixed indicator.

MODULE C5: HOW MUCH?

Item C5e: Gas Volumes

Summary: Many reactions involve gases either as reactants or as products. It is often easier to measure the volume of a gas rather than the mass. The course of a reaction can be monitored by measuring how the volume of gas collected changes with time. This item describes a few ways in which the volume of a gas can be measured and how this can be used to follow the course of a reaction. The item also describes how the volume of gas produced can be predicted by calculation.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out simple experiments to show how the volume of a gas produced in a reaction can be measured e.g. displacement of water in a burette or measuring cylinder, use of a gas syringe.	Identify or recognise apparatus used to collect the volume of a gas produced in a reaction: • gas syringe; • upturned measuring cylinder; • upturned burette.
Carry out experiments to measure the mass of a gas being produced during a reaction e.g. marble and acid and/or thermal decomposition of zinc carbonate.	Describe that measurement of change of mass may be used to monitor the amount of gas made in a reaction.
Carry out simple experiments to measure the volume of gas evolved as the amounts of reactants are changed e.g. magnesium and dilute hydrochloric acid, marble chips and acid.	State that a reaction stops when one of the reactants is all used up. Describe that the greater amount of reactant the greater amount of gas is made.
ICT simulation of the progress of a reaction showing how the amount of reactant and/or amount of product present changes with time.	Interpret graphs or tables of data about the volume of gas produced during the course of a reaction (limited to major grid lines on graphs): • deduce total volume of gas produced; • deduce when the reaction has stopped; • deduce volume of gas at a particular time and vice versa; • deduce when the reaction is at its fastest.

Can-Do Tasks

I can measure the amount of gas produced in a reaction.	1 point
I can set up and perform an experiment to measure the amount of gas produced in a reaction.	3 points

MODULE C5: HOW MUCH?

Links to other modules: C2g Faster or Slower (1), C2h Faster or Slower (2), C5a Moles and Empirical Formulae, C5c Quantitative Analysis, C5d Titrations, C5g Strong and Weak Acids

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe an experimental method to measure the volume of gas produced in a reaction given appropriate details about the reaction.	
Describe an experimental method to measure the mass of gas produced in a reaction given appropriate details about the reaction.	
State that the limiting reactant is the one that is used up first of all. Explain why a reaction stops in terms of the limiting reactant present given appropriate qualitative information. Describe that the amount of gas produced is directly proportional to the amount of the limiting reactant present.	Given the knowledge that one mole of gas molecules occupy a volume of 24 dm^3 at room temperature and pressure, use it to calculate the volumes of samples of gases. Perform calculations involving gas volumes and number of moles.
Interpret graphs or tables of data about the volume of gas produced during the course of a reaction (not major grid lines): • deduce total volume of gas produced; • deduce when the reaction has stopped; • deduce volume of gas at a particular time and vice versa; • deduce the volume of gas produced with different amounts of limiting reactant.	Sketch a graph to show how the volume of gas produced during the course of a reaction changes, given appropriate details: • change in the rate of the reaction; • total volume of gas collected; • when the reaction stops.

MODULE C5: HOW MUCH?

Item C5f: Equilibria

Summary: Many important industrial chemical processes rely on reversible reactions that can reach a chemical equilibrium. This item focuses on the equilibrium between the two directions of a reversible reaction and on the nature of the equilibrium position.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Reversible reactions between acids and alkalis using an indicator. Reversible reactions between chromate and dichromate. Demonstration of the reaction of $BiCl_3$ in concentrated HCl with water.	State that in a reversible reaction there is a forward and a backward reaction. State that in some reversible reactions both forward and backward reactions are proceeding at the same time. State that the symbol $\rightleftharpoons$ is used to show that a reaction is reversible. Recognise, given the word or balanced symbol equations, reactions that are reversible.
	Interpret data in the form of tables or graphs (using major grid-lines) about the equilibrium composition: • composition at particular temperatures; • composition at particular pressures; • effect of temperature and pressure on composition.
Show a video about Contact Process.	State that the Contact Process is used to make sulfuric acid. State that the raw materials used to make sulfuric acid by the Contact Process: • sulfur; • air; • water. State that the production of sulfuric acid by the Contact Process involves the reversible reaction between sulfur dioxide and oxygen: sulfur dioxide + oxygen $\rightleftharpoons$ sulfur trioxide.

Can-Do Tasks

There are no Can-Do tasks for this section.

MODULE C5: HOW MUCH?

Links to other modules: C2g Faster or Slower (1), C2h Faster or Slower (2), C4d Making Ammonia – Haber Process and Costs

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that some reversible reactions may reach an equilibrium: • at equilibrium the rate of the forward reaction equals the rate of the backward reaction; • the concentrations of the reactants and the products do not change. State that when the position of equilibrium is on the right the concentration of product is greater than the concentration of reactant. State that when the position of equilibrium is on the left the concentration of reactant is greater than the concentration of product.	Explain why a reversible reaction may reach an equilibrium: • importance of a closed system; • initially rate of forward reaction decreases; • initially rate of backward reaction increases; • eventually rate of forward equals rate of backward reaction.
Describe that a change in temperature, pressure or concentration of reactant or product may change the position of equilibrium. Interpret data in the form of tables or graphs about the equilibrium composition: • composition at particular temperatures; • composition at particular pressures; • effect of temperature and pressure on composition.	Explain in simple qualitative terms factors that affect the position of equilibrium: • removing a product moves the position of equilibrium to the right or vice versa; • adding extra reactant moves the position of equilibrium to the right or vice versa; • increasing the pressure moves the position of equilibrium to the side with the least number of moles of gas molecules.
State the conditions used in the Contact Process: • V_2O_5 catalyst; • around 450°C; • atmospheric pressure. Recall that sulfur dioxide needed for the Contact Process often comes from burning sulfur: • sulfur + oxygen → sulfur dioxide.	Recall the symbol equations for the three stages in the manufacture of sulfuric acid by the Contact Process: $S + O_2 \rightarrow SO_2$ $2SO_2 + O_2 \rightleftharpoons 2SO_3$ $SO_3 + H_2O \rightarrow H_2SO_4$ Explain the conditions used in the Contact Process: • high temperature decreases yield and increases rate of reaction so an optimum is used; • catalyst increase rate but not change position of equilibrium; • position of equilibrium is already on right so high pressure is expensive and is not needed.

MODULE C5: HOW MUCH?

Item C5g: Strong and Weak Acids

Summary: Weak acids are of enormous importance in situations where we want an acid reaction without the aggressive effects of a very low pH. This item compares the reactions and properties of ethanoic acid a weak acid and hydrochloric acid a strong acid.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure the pH values of strong and weak acids of the same concentrations.	State that ethanoic acid is a weak acid. State that hydrochloric, nitric and sulfuric acids are strong acids. State that strong acids have a lower pH than weak acids of the same concentration.
Compare the rate of reaction of 1.0 mol/dm^3 hydrochloric acid and 1.0 mol/dm^3 ethanoic acid.	State that both ethanoic acid and hydrochloric acid react with magnesium to give hydrogen. State that both ethanoic acid and hydrochloric acid react with calcium carbonate to give carbon dioxide. Recognise that magnesium and calcium carbonate react slower with ethanoic acid than with hydrochloric acid of the same concentration.
Investigate the volumes of gas produced when equal amounts of strong and weak acids react with a substance such as magnesium or with marble chips.	Recognise that the same amount of hydrochloric and of ethanoic acid produce the same volume of gaseous products in their reaction with magnesium and calcium carbonate.
Comparison of the electrical conductivities and electrolysis of strong and weak acids.	Recognise that ethanoic acid has a lower electrical conductivity than hydrochloric acid of the same concentration. Describe that electrolysis of both ethanoic acid and hydrochloric acid makes hydrogen at the negative electrode.
Data-search of the use of some weak acids.	Describe some uses of weak acids, such as descalers.
Can-Do Tasks There are no Can-Do tasks for this section.	

MODULE C5: HOW MUCH?

Links to other modules: C4a Acids and Bases, C5d Titrations, C5e Gas Volumes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that an acid ionises in water to produces H^+ ions. State that a strong acid completely ionises in water. State that the ionisation of a weak acid is an example of a reversible reaction. State that the ionisation of a weak acid produces an equilibrium mixture.	Explain why the pH of a weak acid is much higher than the pH of a strong acid of the same concentration. Explain the difference between acid strength and acid concentration: • acid strength (strong or weak) is a measure of the degree of ionisation of the acid; • concentration of an acid is a measure of how many moles of acid in one dm^3. Write equations for the ionisation of weak and strong acids given the formula of the acid limited to: $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ $HCl \rightarrow H^+ + Cl^-$
Describe that ethanoic acid reacts slower than hydrochloric acid because there are fewer hydrogen ions and so fewer collisions with hydrogen ions.	Explain that ethanoic acid reacts slower than hydrochloric acid of the same concentration because: • ethanoic acid is weak and hydrochloric acid is strong; • greater concentration of hydrogen ions; • greater collision frequency with hydrogen ions.
Explain that the volume of hydrogen formed is determined by the amounts of reactants present not the acid strength.	
Describe that ethanoic acid is less conductive than hydrochloric acid of the same concentration because there are fewer hydrogen ions available to move. Explain why hydrogen is produced during the electrolysis of ethanoic acid and of hydrochloric acid.	Explain that ethanoic acid is less conductive than hydrochloric acid of the same concentration because: • ethanoic acid is weak and hydrochloric acid is strong; • greater concentration of hydrogen ions to carry the charge.
Explain why strong acids are inappropriate as descaling agents.	Explain why a weak acid may be more useful than the more dilute strong acid.

MODULE C5: HOW MUCH?

Item C5h: Ionic Equations

Summary: Precipitation is a process used to test for ions in solutions. In this item we explore several precipitation reactions and the associated concept of ionic equations. This provides the opportunity to apply scientific information using quantitative approaches.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out simple precipitation reactions: • Cl^-, Br^- and I^- with $Pb(NO_3)_2(aq)$ • SO_4^{2-} with $BaCl_2(aq)$	Describe that a precipitation reaction involves two solutions reacting together to make an insoluble substance. Describe that most precipitation reactions involve ions from one solution reacting with ions from another solution.
Carry out simple precipitation reactions: • Cl^-, Br^- and I^- with $AgNO_3(aq)$ • SO_4^{2-} with $BaCl_2(aq)$	Describe that nitrate solution can be used to test for halide ions: • white ppt with Cl^- • cream ppt with Br^- • yellow ppt. with I^- Describe that barium nitrate solution can be used to test for sulfate ions (form a white ppt).
	Identify the reactants and the products from an ionic equation. Recognise and use the state symbols (aq), (s), (g) and (l).
Preparation of an insoluble salt using precipitation e.g. lead(II) iodide.	Label the apparatus used during the preparation of an insoluble compound by precipitation.

Can-Do Tasks

I can carry out a simple precipitation reaction. 1 point

I can prepare a dry sample of an insoluble salt by precipitation. 2 points

I can identify an unknown ion by using a precipitation reaction and explain it using an ionic equation. 3 points

MODULE C5: HOW MUCH?

Links to other modules: C3g Transition Elements, C4h How Pure is Our Water?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that ionic substances contain ions which are in fixed positions in the solid but can move in solution or when melted. Describe that ions must collide with other ions if they are to react.	Describe that most precipitation reactions are extremely fast reactions between ions.
Construct word equations for simple precipitation reactions e.g. for the reaction between solutions of barium chloride and sodium sulfate.	Convert balanced equations into ionic equations, given the ions present. Construct ionic equations for simple precipitation reactions, given the ions present and the identity of the products. Explain the concept of 'spectator ions'.
	Construct balanced ionic equations, with state symbols, given relevant information and the formulae of the ions present.
Describe the stages involved in the preparation of a dry sample of an insoluble compound by precipitation given the names of the reactants: • mix solutions of reactants; • filtration; • wash and dry residue.	

MODULE C6: CHEMISTRY OUT THERE

Item C6: Fundamental chemical concepts

Summary: Throughout the study of chemistry there are a number of ideas and concepts that are fundamental. These ideas and concepts have not been put into a particular item but should permeate all the Chemistry units. They will be assessed in the context of any of the modules C1 to C6.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
These learning outcomes are intended to be taught throughout this specification.	Describe that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word or symbol equation. Recognise that in a chemical change no atoms are lost or made.
These learning outcomes are intended to be taught throughout this specification.	State the number of elements in a compound given its formula. State the number of atoms in a formula with no brackets. State the number of each different type of atom in a formula with no brackets.
These learning outcomes are intended to be taught throughout this specification.	Recognise whether a substance is an element or a compound from its formula.
These learning outcomes are intended to be taught throughout this specification.	Recognise that a molecule is made up of more than one atom joined together. Recognise that a molecular formula shows the number and type of atom in a molecule. State the number of atoms in a displayed formula. State the names of the different elements in a compound given its displayed formula. State the number of each different type of atom in a displayed formula.
These learning outcomes are intended to be taught throughout this specification.	State that all atoms are made up of a nucleus and electrons. State that a chemical bond holds atoms together in a compound.

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations given the reactants and products. Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain that a symbol equation is balanced when the number of each type of atom is the same on both sides of an equation.	Construct balanced symbol equations given the formulae (some or all with brackets) of the reactants and products. Construct balanced symbol equations given the names of the reactants and products (limited to the learning outcomes in this specification).
State the number of atoms in a formula with brackets. State the number of each type of different atom in a formula with brackets.	Recall the formula of the following substances; • chlorine, hydrogen, oxygen and water: • sulfates and chlorides of calcium, iron(II), magnesium, tin(II) and zinc; • sodium hydroxide and sodium chloride; • calcium carbonate, calcium hydrogencarbonate, carbon dioxide and sodium carbonate; • ethanol, ethanoic acid and glucose.
Recognise that a displayed formula shows both the atoms and the covalent bonds in a molecule. Write the molecular formula of a compound given its displayed formula.	Balance equations that use displayed formulae.
State that the nucleus of an atom is positive and the electrons negative. State there are two types of chemical bonds: • ionic between a positive ion and a negative ion; • covalent involving a shared pair of electrons.	

MODULE C6: CHEMISTRY OUT THERE

Item C6a: Energy Transfers – Fuel cells

Summary: Teenagers are aware of the need for alternative fuels. This item describes the use of hydrogen as an alternative fuel. The item also describes developments in fuel cell technology that can provide an alternative to petroleum fuels, so reducing the problems of pollution.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment blowing air through a straw next to one of a pair of copper electrodes dipped in brine to produce a measurable potential difference.	Describe that when a lighted splint is put into a test tube filled with hydrogen a squeaky pop is produced. Describe that when a glowing splint is put into a test tube filled with oxygen, the splint relights. Explain that hydrogen and oxygen react to produce water which is not a pollutant.
Carry out an experiment to electrolyse sodium hydroxide and then measure a potential difference between the electrodes (see Nuffield Sample Scheme Teachers Guide II p619). Internet research about fuel cells.	Describe that hydrogen and oxygen can be used in a fuel cell to produce an electric current. Describe that a fuel cell produces electrical energy efficiently.
	State that an important use of fuel cells is to provide electrical power in spacecraft.

Can-Do Tasks	
I can identify samples of hydrogen and oxygen.	1 point.
I can collect a sample of gas.	2 points
I can make a simple fuel cell (Nuffield sample scheme)	3 points

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C1g Using Carbon Fuels, C1h Energy

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
State that the reaction between hydrogen and oxygen is exothermic.	Draw and interpret an energy level diagram for the reaction of hydrogen and oxygen.
Describe a fuel cell as one which is supplied with fuel and oxygen and uses the energy from the reaction between them to create a potential difference. State the word equation for the overall reaction in a hydrogen-oxygen fuel cell: hydrogen + oxygen → water	Write a balanced symbol equation for the overall reaction in a hydrogen-oxygen fuel cell: $2H_2 + O_2 \rightarrow 2H_2O$ Explain the changes that take place at each electrode in a hydrogen-oxygen fuel cell: • electrode reactions; • redox reaction.
Describe some advantage of using a fuel cell to provide electrical power in a spacecraft. Explain why the car industry is developing fuel cells.	Explain the advantages of a hydrogen-oxygen fuel cell over conventional methods of generating electricity: • more efficient; • fewer stages; • direct energy transfer; • less pollution.

MODULE C6: CHEMISTRY OUT THERE

Item C6b: Redox reactions

Summary: Candidates will be familiar with examples of redox reactions such as rusting. This item will describe redox reactions in detail. Researching rust protection provides the opportunity to use ICT in teaching and learning and methods used to detect rust illustrate the use science makes of ICT tools.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out experiments to find the conditions necessary for rusting of iron and steel to take place.	State that rusting of iron and steel requires both oxygen (or air) and water. State that rust is a form of hydrated iron(III) oxide.
Research ways of rust protection.	Describe methods of preventing rust limited to: • oil and grease; • paint; • galvanising; • sacrificial protection; • alloying; • tin plate.
Carry out displacement reactions between metals and metal salt solutions limited to zinc, magnesium, iron and tin.	Interpret observations made during displacement reactions including temperature changes. State the following order of reactivity (most to least): • magnesium, zinc, iron and tin.
Teacher exposition about redox reactions.	

Can-Do Tasks

There are no Can-Do tasks in this section.

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C3d The Group 1 Element, C3e The Group 7 Element, C3g Transition Elements

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State that rusting of iron is a redox reaction. State the word equation for the rusting of iron: iron + oxygen + water → hydrated iron(III) oxide.	Explain why rusting is a redox reaction: • iron loses electrons; • oxygen gains electrons.
Explain that oil, grease and paint prevent iron from rusting because they stop oxygen or water reaching the surface of the iron.	Explain the following methods of preventing rust: • galvanising – zinc acts as a barrier and also as a sacrificial metal; • sacrificial protection – use of a metal such as magnesium which will lose electrons in preference to iron; • tinning – acts as a barrier but when scratched the iron will lose electrons in preference to tin.
Construct word equations for displacement reactions between metals and metal salt solutions.	Write symbol equations for displacement reactions between metals and metal salt solutions.
Recognise that redox reactions involve oxidation and reduction.	Describe that oxidation involves loss of electrons and reduction the gain of electrons. Recognise and use the terms: • oxidation and reduction; • oxidising agent and reducing agent. Explain, in terms of oxidation and reduction, the interconversion of the following types of systems: • Fe and Fe^{2+} • Fe^{2+} and Fe^{3+} • Cl_2 and Cl

MODULE C6: CHEMISTRY OUT THERE

Item C6c: Alcohols

Summary: Teenagers are familiar with the word alcohol but few realise that there is a large number of a family of compounds called alcohols. Ethanol is one of this family of alcohols. Ethanol, which is renewable, can provide an alternative to crude oil as a source of fuel and organic compounds.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Use of molecular models.	
Carry out an experiment to produce ethanol by fermentation.	Explain that ethanol made by fermentation is a renewable fuel. Describe the conditions needed for fermentation: • $25 – 50^{o}C$; • presence of water; • enzymes found in yeast; • absence of oxygen.
	State the main uses of ethanol limited to: • alcoholic beverages; • solvent (industrial methylated spirits); • fuel for cars.
ICT simulation.	State that hydration of ethene produces ethanol.
Carry out an experiment to dehydrate ethanol and produce ethane.	State that dehydration of ethanol produces ethene.
Can-Do Tasks There are no Can-Do tasks in this section.	

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: B6c Microorganisms – factories for the future?, C4f Batch or Continuous?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State the molecular formula and displayed formula of ethanol.	State the general formula of an alcohol. Use the general formula of alcohols to write the molecular formula of an alcohol with up to five carbon atoms. Draw the displayed formulae of alcohols containing up to five carbon atoms.
State the word equation for fermentation: • glucose → carbon dioxide + ethanol Describe how ethanol can be made by fermentation: • glucose solution and yeast; • optimum temperature for the yeast; • distillation to get ethanol.	State the balanced symbol equation for fermentation: $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ Explain the conditions used in fermentation: • temperature too low yeast inactive; • temperature too high enzyme in yeast denatured; • absence of air to prevent formation of ethanoic acid.
Describe how ethanol is produced for industrial use by passing ethene and steam over a heated phosphoric acid catalyst. State the word equation for the hydration of ethene: ethene + water → ethanol	Evaluate the merits of the two methods of making ethanol (fermentation and hydration). State the balanced symbol equation for the hydration of ethane: $C_2H_4 + H_2O \rightarrow C_2H_5OH$
Describe how ethanol can be dehydrated to ethene by passing its vapour over heated aluminium oxide catalyst: State the word equation for the dehydration of ethanol: ethanol → ethene + water	State the balanced symbol equation for the hydration of ethane: $C_2H_5OH \rightarrow C_2H_4 + H_2O$

MODULE C6: CHEMISTRY OUT THERE

Item C6d: Chemistry of Sodium Chloride (NaCl)

Summary: Producing chemicals from salt on a large scale in the UK has been carried out for hundreds of years. Salt is still an important raw material in the production of bulk chemicals today. This item illustrates how changes in scientific ideas over time can lead to scientific and technological developments.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Research salt mining.	Describe that sodium chloride (salt) is an important raw material in the chemical industry.
Carry out an experiment to electrolyse sodium chloride solution, test the products hydrogen and chlorine and show, using Universal Indicator, that the solution becomes alkaline.	State that the electrolysis of concentrated sodium chloride gives chlorine and hydrogen. Describe that the chemical test for chlorine is that it bleaches moist litmus paper.
	State that the products of electrolysis of molten sodium chloride are sodium and chlorine.
Survey of range of products formed from salt.	State that sodium chloride is an important source of chlorine and sodium hydroxide. State that household bleach, pvc and solvents are made from substances derived from salt. State that chlorine is used to sterilise water and to make solvents, household bleach and plastics. State that hydrogen is used in the manufacture of margarine. State that sodium hydroxide is used to make soap.

Can-Do Tasks

I can test for chlorine gas with damp blue litmus paper.	1 point

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C2d Metals and Alloys, C2e Cars for Scrap, C3f Electrolysis, C4h How Pure is Our Water?, C5b Electrolysis

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Describe how it can be mined as rock salt and by solution mining in Cheshire. Explain that mining for salt can lead to subsidence.	
Describe the key features of the electrolysis of concentrated sodium chloride solution (brine): • hydrogen made at the cathode; • chlorine made at the anode; • sodium hydroxide is also made; • use of inert electrodes.	Explain how the electrolysis of sodium chloride solution (brine) produces sodium hydroxide, hydrogen and chlorine: • cathode $2H^+ + 2e^- \rightarrow H_2$ • anode $2Cl^- - 2e^- \rightarrow Cl_2$ • ions not discharged make sodium hydroxide. Explain that electrolysis of concentrated sodium chloride solution produces chlorine at the anode but dilute sodium chloride solution produces oxygen.
	Recall the electrode reactions that occur during the electrolysis of molten sodium chloride.
Describe that household bleach is made from reacting sodium hydroxide and chlorine.	

MODULE C6: CHEMISTRY OUT THERE

Item C6e: Depletion of the ozone layer

Summary: Teenagers are often concerned about pollution and its environmental consequences. This item describes the environmental problem of the depletion of the ozone layer and how Chemistry can provide safer alternatives to CFCs.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Discussion on the use of CFCs.	Describe that a chlorofluorocarbon (CFC) is an organic molecule containing chlorine, fluorine and carbon atoms. Describe the use of CFCs as refrigerants and aerosol propellants. Describe that the use of CFCs are banned in the UK.
Data-search on CFCs and ozone depletion e.g. use of satellite data.	State that ozone is a form of oxygen with the formula O_3. Describe some properties of CFCs: • chemically inert; • low boiling point; • insoluble in water.
Data-search on CFCs and ozone depletion.	Describe that increased levels of ultraviolet light can lead to medical problems: • increased risk of sunburn; • accelerated ageing of skin; • skin cancer; • increased risk of cataracts.
Survey of safe alternatives to CFCs.	Describe that hydrocarbons can provide safe alternatives to CFCs.

Can-Do Tasks

There are no Can-Do tasks for this section.

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C2f Clean Air, P1h Stable Earth

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why the use of CFCs has been banned in the UK.	Describe how scientists' attitude to CFCs has changed: • initial enthusiasm for the use of CFCs based upon their inertness; • later discovery of ozone depletion and link to presence of CFCs; • acceptance by scientists and the rest of the world community that the use of CFCs should be banned. Discuss the ban on use of CFCs in some countries but not in others related to the global problem of depletion of the ozone layer.
Describe that the action of ultraviolet light on CFCs leads to the formation of chlorine atoms. Describe that the formation of chlorine atoms in the stratosphere leads to the depletion of the ozone layer. State that a chlorine free radical is a chlorine atom. Describe that CFCs are only removed slowly from the stratosphere.	Explain how a covalent bond can break unevenly to form ions or evenly to form highly reactive free radicals. Describe that only a small number of chlorine atoms are required because a chain reaction is set up. Write symbol equations for the reactions that take place when chlorine atoms and ozone react. Explain why CFCs will continue to deplete ozone a long time after their use has been banned.
Describe how depletion of the ozone layer allows more ultraviolet light to reach the surface of the Earth.	Explain how ozone absorbs ultraviolet light in the stratosphere.
Describe that CFCs can be replaced with alkanes or HFCs and that these will not damage the ozone layer.	

MODULE C6: CHEMISTRY OUT THERE

Item C6f: Hardness of water

Summary: Teenagers will see advertisements for materials that remove water hardness. Hardness of water is a problem in many areas for processes where water has to be heated or where soap is used. The survey on ways of removing water hardness allows the use of ICT tools to look at the benefits and drawbacks of technological developments.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Compare hard and soft water using soap. Compare hard and soft water using soapless detergents.	Describe that hard water does not lather well with soap but soft water does. Describe that both hard and soft water lather well with soapless detergents.
	Describe that boiling destroys temporary hardness in water but not permanent hardness in water. Describe that hardness is caused by dissolved calcium and magnesium ions in water.
Survey ways of removing hardness by using water softeners.	Describe that hardness in water can be removed by: • passing the water through an ion-exchange column; • adding washing soda (sodium carbonate).
Carry out an experiment to compare the hardness of water samples using soap solution.	Interpret data about water hardness.
Compare different commercial limescale removers.	State that limescale is calcium carbonate. State that limescale removers are acids.

Can-Do Tasks

I can compare the hardness of two different water samples using soap solution. 3 points

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C4h How Pure is Our Water?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that dissolved carbon dioxide causes water to be slightly acidic. Describe how common forms of calcium carbonate (chalk, limestone and marble) react with water and carbon dioxide to form soluble calcium hydrogencarbonate in water. State the word equation for the reaction between calcium carbonate, water and carbon dioxide.	Explain how common forms of calcium carbonate (chalk, limestone and marble) react with water and carbon dioxide to form soluble calcium hydrogencarbonate in water. Write a balanced symbol equation for the reaction between calcium carbonate, water and carbon dioxide.
Recall that temporary hardness is caused by dissolved calcium hydrogencarbonate and that permanent hardness is caused by dissolved calcium sulfate.	
Describe how boiling removes temporary hardness but not permanent hardness: • decomposition of calcium hydrocarbonate to give insoluble calcium carbonate, water and carbon dioxide. Describe how an ion-exchange resin can soften water.	State the symbol equation for the decomposition of calcium hydrogencarbonate occurring when water containing temporary hardness is boiled. Explain how ion exchange can be used to soften hard water. Explain how washing soda (sodium carbonate) can soften hard water.
Interpret data about water hardness. Describe an experiment to compare the hardness in samples of different sources of water.	
Explain how a weak acid can be used as a limescale remover.	Construct a symbol equation for the action of an acid on limescale.

MODULE C6: CHEMISTRY OUT THERE

Item C6g: Natural fats and oils

Summary: Plants are grown for the natural fats and oils that they contain. These fats and oils have a large number of industrial uses. They can provide alternatives to chemicals made from crude oil.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
	State that natural fats and oils are important raw materials for the chemical industry. State examples of animal and vegetable fats and oils. Describe that vegetable oils can be used to make bio-diesel, an alternative to diesel from crude oil. State that, at room temperature, oils are liquids and fats are solids.
Examine milk and butter under a microscope. Also examine after adding water or oil based dyes. Prepare a sample of an emulsion e.g. a cold cream.	Describe that an emulsion is one liquid finely dispersed in another. Describe that oil and water can form an emulsion when shaken. State that milk is an oil–in-water emulsion and butter is a water–in-oil emulsion.
Prepare a sample of a soap using a vegetable oil.	Describe that a vegetable oil reacts with sodium hydroxide to produce a soap.

Can-Do Tasks

I can prepare a sample of a cold cream (emulsion). 2 points

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C1b Food Additives, C1c Smells, C1d Making Crude Oil Useful, C1e Making Polymers

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
State that animal and vegetable fats and oils are esters. Describe that all the carbon-carbon bonds in a saturated fat or oil are single bonds. Describe that an unsaturated fat or oil has at least one carbon-carbon double bond. Describe how unsaturation in fats and oils can be shown using bromine water. Describe how margarine is manufactured from vegetable oils.	State that animal fats and oils are often saturated and vegetable oils and fats are often unsaturated. Explain why unsaturated fats are healthier as part of diet. Explain how unsaturation in fats and oils can be shown by using bromine water.
Describe that a vegetable oil and water are immiscible liquids and they can be made to mix as an emulsion. Describe an oil-in-water emulsion and a water-in-oil emulsion.	
Describe how natural fats and oils can be split up by hot sodium hydroxide solution to produce soap and glycerol. State that this process of splitting up natural fats and oils using sodium hydroxide solution is called saponification.	Explain the saponification of fats and oils: • fat + sodium hydroxide → soap + glycerol • hydrolysis reaction.

MODULE C6: CHEMISTRY OUT THERE

Item C6h: Analgesics

Summary: The pharmaceutical industry is an important part of the chemical industry. It produces drugs and medicines that are important for curing or preventing diseases. Every year many millions of pounds are spent on analgesics or pain killers.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of different types of analgesic medicines to include: • whether tablet, powder, capsule etc; • recommended dose; • other chemicals present; • side effects; • maximum dose; • cost.	Describe that most medicines are sold in a shop where there is a trained pharmacist. State that analgesics are painkillers and reduce pain. States the names of some common painkillers: • aspirin; • paracetamol; • ibuprofen.
Carry out an experiment to compare the solubility of aspirin and soluble aspirin.	Describe the beneficial effects of aspirin: • reducing pain; • lowering body temperature rapidly; • thinning the blood to reduce risks of blood clots.
Preparation of aspirin.	Describe that aspirin is now manufactured synthetically. Describe that aspirin was first discovered in willow bark.

Can-Do Tasks

I can prepare a sample of aspirin from salicylic acid and calculate the percentage yield. 3 points

MODULE C6: CHEMISTRY OUT THERE

Links to other modules: C4f Batch or Continuous

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that chemicals required for making analgesics must be very pure. Describe that a drug is an externally administered substance which modifies or affects chemical reactions in the body. Interpret the displayed formulae of aspirin, paracetamol and ibuprofen, e.g. be able to work out the molecular formula.	Interpret the displayed formulae of aspirin, paracetamol and ibuprofen and be able to find similarities and differences in the structures.
Describe some advantages of using soluble aspirin. Describe the dangers of overdoses of aspirin and paracetamol.	Describe and explain differences in solubility between aspirin and soluble aspirin in terms of structure and effect. Describe problems caused to some patients using aspirin.
	Describe how aspirin is manufactured from salicylic acid.

4 Scheme of Assessment

4.1 Units of Assessment

GCSE Chemistry (J644)	
Unit 1: Chemistry B Unit 1 – modules C1, C2, C3 (B641)	
33⅓% of the total GCSE marks 1 hour written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers; • focuses on modules C1, C2 and C3; • uses structured questions throughout (there is no choice of questions).
Unit 2: Chemistry B Unit 2 – modules C4, C5, C6 (B642)	
33⅓% of the total GCSE marks 1 hr written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers; • focuses on modules C4, C5 and C6; • uses structured questions throughout (there is no choice of questions).
Unit 3: Chemistry B Unit 3 – 'Can-Do' Tasks and report on 'Science in the news' (B645)	
33⅓% of the total GCSE marks 60 marks	Skills assessment consists of two elements: • Can-do tasks (24 marks) • Report on Science in the news (36 marks)
Unit 4: Chemistry Unit 4 – Research Study, Data Task and Practical Skills (B646)	
33⅓% of the total GCSE marks 60 marks	Candidates produce a portfolio comprising three elements: • Research Study (24 marks) • Data Task (30 marks) • Practical Skills (6 marks)

4.2 Unit Options

Candidates take Units 1 and 2 and either Unit 3 or Unit 4.

4.3 Tiers

All written papers are set in one of two tiers: Foundation Tier and Higher Tier. Foundation Tier papers assess grades G to C and Higher Tier papers assess Grades D to A*. An allowed grade E may be awarded on the Higher Tier components. In Units B641 and B642, candidates are entered for an option in either the Foundation Tier or the Higher Tier. Units B645 and B646 (Internal Assessment) are not tiered.

Candidates may enter for either the Foundation Tier or Higher Tier in each of the externally assessed units. So, a candidate may take, for example B641/01 and B642/02.

4.4 Assessment Availability

There are two examination sessions each year, in January and June.

	B641	B642	B645	B646
June 2007	✓	-	-	-
January 2008	✓	✓	-	-
June 2008	✓	✓	✓	✓

After June 2008, Units B641 and B642 will be available in the January and June sessions. The skills assessment, Unit B645 and B646, will only be available in the June session.

The Foundation and Higher tier papers covering the same unit will be timetabled on the same day, and will commence at the same time. The papers timetabled simultaneously will contain common questions, or part questions, targeting the overlapping grades C and D.

4.5 Assessment Objectives

The Assessment Objectives describe the intellectual and practical skills that candidates should be able to demonstrate, and which will be assessed.

Assessment Objective 1 (AO1): Knowledge and understanding of science and how science works

Candidates should be able to:

- demonstrate knowledge and understanding of the scientific facts, concepts techniques and terminology in the specification;
- show understanding of how scientific evidence is collected and its relationship with scientific explanations and theories;
- show understanding of how scientific knowledge and ideas change over time and how these changes are validated.

Assessment Objective 2 (AO2): Application of skills knowledge and understanding

Candidates should be able to:

- apply concepts, develop arguments or draw conclusions related to familiar and unfamiliar situations;
- plan a scientific task, such as a practical procedure, testing an idea, answering a question or solving a problem;
- show understanding of how decisions about science and technology are made in different situations, including contemporary situations and those raising ethical issues;
- evaluate the impact of scientific developments or processes on individuals, communities or the environment.

Assessment Objective 3 (AO3): Practical, enquiry and data-handling skills

Candidates should be able to:

- carry out practical tasks safely and skillfully;
- evaluate the methods they use when collecting first-hand and secondary data;
- analyse and interpret qualitative and quantitative data from different sources;
- consider the validity and reliability of data in presenting and justifying conclusions.

Weighting of Assessment Objectives

Assessment Objective	Weighting
AO1	34.0%
AO2	39.3%
AO3	26.6%

4.6 Quality of Written Communication

Candidates are expected to:

- present relevant information in a form that suits its purpose;
- ensure text is legible and that spelling, punctuation and grammar are accurate, so that meaning is clear.

Where appropriate they should also use a suitable structure and style of writing.

Candidates' quality of written communication will be assessed in the Report on Science in the News and the Research Study.

5 Internal Assessment

5.1 Nature of Skills Assessment

Rationale

The assessment of skills involves a variety of approaches to avoid the 'done that before' response. It provides regular feedback to candidates to ensure a sense of achievement and continuous motivation. It contains assessment targets that are achievable by the least able candidates, but differentiation to challenge and reward the most able.

Skills assessment comprises:

either Unit 3 (B645) the skills assessment similar to that of the Gateway Science B specification which comprises:

- a set of **Can-Do tasks**;
- and a report on **Science in the News**.

or Unit 4 (B646) the skills assessment similar to that of the Gateway Additional Science B specification which comprises:

- a **Research Study**;
- a **Data Task**;
- and **Practical Skills**.

The portfolio of work done during the course (for Unit B645 or Unit B646) accounts for one third of the marks for this specification. Portfolio work is assessed by teachers, internally standardised and then externally moderated.

Summary of the Elements of Unit 3 B645

Can-Do tasks: These are assessed and recorded throughout the course as the candidate fulfils them. The marks are recorded on the Candidate Record Card.

Report on Science in the News: Candidates are required to use stimulus material provided by OCR and other sources of information to research the way in which scientific data and ideas are dealt with by the media. The number of reports attempted is at the discretion of the centre, but the results of **only one** may be submitted.

Assessment element	Element marks		Weighting
Can-Do tasks	The results of 8 Can-Do tasks are submitted. These tasks are available at three levels:		13.3% overall
	Basic Skills	1 point	
	Intermediate Skills	2 points	
	Advanced Skills	3 points	
	Total max mark = 24 marks		
Report on Science in the News	A Approach to the task	6 marks	20% overall
	B Analysis of the data	6 marks	
	C Evaluation of the data	6 marks	
	D Relating the data to the issues	6 marks	
	E Justifying a conclusion	6 marks	
	F Quality of written communication	6 marks	
	Total max mark = 36 marks		

Summary of the Elements of Unit 4 (B646)

Research Study: Candidates are required to use stimulus material provided by OCR and other sources of information to research scientific ideas. The number of reports attempted is at the discretion of the centre, but the results of **only one** may be submitted.

Data Task: Candidates are required to analyse and evaluate data and to plan further work (which will not be carried out). The number of tasks attempted is at the discretion of the centre, but the results of **only one** may be submitted.

Practical Skills: The ability to carry out practical tasks safely and skilfully is assessed holistically.

Assessment element	Element marks		Weighting
Research Study	A Collecting information	6 marks	13.3% overall
	B Linking information to explanations	6 marks	
	C Developing and using scientific ideas	6 marks	
	D Quality of written communication	6 marks	
	Total max mark = 24 marks		
Data Task	A Interpreting the data	6 marks	16.6% overall
	B Analysis of the data	6 marks	
	C Evaluation of the data	6 marks	
	D Justifying a conclusion	6 marks	
	E Planning further work	6 marks	
	Total max mark = 30 marks		
Practical Skills	An overview of practical skills throughout the course.		3.4% overall
	Total max mark = 6 marks		

5.2 Marking Internally Assessed Work

Unit 3 (B645) Element 1: Can – Do tasks

Mark submitted out of 24.

These tasks enable all candidates to achieve success but still provide challenge and reward for high attainers. The tasks are set at three levels:

Basic Skills: 1 point tasks	Simple tasks which should be within the reach of all candidates.
Intermediate Skills: 2 point tasks	More complex tasks which require more than one skill.
Advanced Skills: 3 point tasks	Extended tasks which require a candidate to perform a sequence of more demanding operations.

Detailed advice on assessing Can-Do tasks will be provided in guidance material published separately. Essentially however, to demonstrate proficiency at a Can-Do task, a candidate must complete the task safely and skillfully, without the help of the teacher.

Can-Do tasks are assessed on an 'all or nothing' basis: if a candidate demonstrates proficiency, the number of points associated with the task is credited in full. Thus candidates may not be given partial credit for a 2 or 3 point task if the task has only been partially completed.

Opportunities to demonstrate proficiency in Can-Do tasks are indicated throughout the specification content. Results can be submitted from eight tasks. A candidate can gain a maximum of 8 points from successfully completing eight Basic Skills tasks, 16 points for eight Intermediate Skills tasks or 24 points for eight Advanced Skills tasks. Any combination of eight tasks set at different levels is acceptable. It is expected that during their course candidates will attempt a wide range of tasks at a variety of levels and that all candidates will be able to achieve success at appropriate levels. At the end of the course, results for the highest scoring eight tasks should be identified and the total points score out of a maximum of 24 should be submitted.

Unit 3 (B645) Element 2: Report on Science in the News

Mark submitted out of 36.

This element of the assessment requires candidates to use stimulus material provided by OCR, supplemented by electronic (internet, CD ROMs, databases, simulations) and/or more traditional sources of information (books, magazines, leaflets) to research the way in which scientific data and ideas are dealt with by the media. Candidates are given about a week to carry out this research and they then complete a written report, under supervision, on their findings.

The report may be submitted as a hand written or word processed document or in another suitable format, for example a PowerPoint presentation with appropriate accompanying notes.

The report should be less than 800 words in length. Reports in excess of 800 words will indicate poor structure and unselective choice of material. A written report should be illustrated by pictures, diagrams and tables as appropriate. At the end of the report the sources used should be listed with references made to these sources in the body of the report, where appropriate.

A set of Science in the News tasks will be available from OCR. Alternatively, centres may provide their own Science in the News stimulus material and assess work using the OCR level of response grid. Advice on the suitability of such material and application of the level of response grid must be obtained by using the OCR Internal Assessment Consultancy Service before the task is given to candidates.

Arrival at Marks for Report on Science in the News

The award of marks is based on the professional judgment of the science teacher working within a framework of performance descriptions related to various qualities. For each quality different aspects of performance are identified in the level of response grid. For each quality, a series of three descriptions of performance (for 2, 4 and 6 marks) illustrates what might be expected for candidates working at different levels.

Marking decisions for candidates should be recorded on the Science in the News cover sheet downloaded from the OCR website www.ocr.org.uk.

Candidates may not always report their work in a particular order; evidence of achievement may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each quality.

For any one quality, a tick on the grid should be used to indicate the performance statement that best matches the work. Intermediate marks of 1, 3 or 5 can be used where performance exceeds that required by one statement but does not adequately match that required by the next higher statement. When each aspect of performance has been assessed in this way, the marks are added together to give a total mark on a scale 0-36 marks.

This method of marking can be applied even where there is a wide variation between performance for different qualities. Thus, weak performance for one quality need not depress marks too far if other qualities show better performance.

Skills to be assessed (Programme of Study – PoS – references are given for each)

A: Approach to the task

The ability to plan an approach to the task, including the selection of suitable sources of data/information, which will address the issues.

Candidates are expected to be able to:

Plan to answer a scientific question (PoS 3.6ia)

Collect data from secondary sources, including the use of ICT sources and tools (PoS 3.6iib)

Apply and question scientific information or ideas (PoS 3.6iiia)

B: Analysis of the data

The ability to analyse the data/information and interpret it to show trends or patterns.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib)

Analyse scientific information or ideas (PoS 3.6iiia)

C: Evaluation of the data

The ability to evaluate the data/information to reach judgements about its reliability and validity.

Candidates are expected to be able to:

Consider the validity and reliability of data as evidence (PoS 3.6id)

Interpret and question scientific information or ideas (PoS 3.6iiia)

D: Relating the data to the issues

The ability to relate the data/information to social, economic and environmental issues and understand how science can contribute to decision making.

Candidates are expected to be able to:

Know why decisions about science and technology are made, including those that raise ethical issues, and know about the social, economic and environmental effects of such decisions (PoS 3.6ivb)

Know that uncertainty in scientific knowledge and ideas changes over time and know the role of the scientific community in validating these changes (PoS 3.6ivc)

E: Justifying a conclusion

The ability to draw a conclusion based on the evidence and to justify this.

Candidates are expected to be able to:

Draw a conclusion using scientific, technical and mathematical language, conventions and symbols and ICT tools (PoS 3.6iiic)

Question scientific information or ideas (PoS 3.6iiia)

F: Quality of written communication

Candidates are expected to be able to:

Develop an argument using scientific, technical and mathematical language (PoS 3.6iiic)

Science in the News Level of Response Grid

Quality Assessed		Number of Marks 0	1	2	3	4	5	6
A	Approach to the task			Some research is carried out; some information is collected from at least one suitable source.		The information provided is used to plan their research; information is collected from more than one suitable source and used in the report. All sources are fully referenced.		Makes good use of the information provided to structure a balanced report; information is relevant, detailed and logically presented.
B	Analysis of the data			At least one trend /pattern is identified and outlined correctly.		The main trends/patterns are described correctly and there is some evidence of correct processing of quantitative data.		The main trends/ patterns are described correctly with reference to quantitative data. These data have been further processed to reveal additional information and/or detect anomalies.
C	Evaluation of the data			A comment has been made about the quality of the evidence.		There is a comparison of the reliability of the various forms of evidence, including an attempt to identify which evidence is most/least reliable.		There is detailed consideration of the evidence showing a good understanding of the relative merits of the evidence gathered in terms of both reliability and validity.
D	Relating the data to issues			An attempt has been made to relate some of the data/information to the impact on people or the environment.		The report shows some understanding of the social, economic or environmental issues as they relate to the task.		The report shows a clear understanding of the social, economic or environmental issues as they relate to the task with an understanding of the science involved.
E	Justifying a conclusion			A conclusion is given with justification based on at least one piece of evidence.		A considered conclusion is given with justification based on the significance of more than one piece of evidence.		A considered conclusion is given with a well-argued justification based on careful analysis of the relative significance of more than one piece of evidence.
F	Quality of written communication			Spelling, punctuation and grammar are of generally poor quality. Little or no relevant scientific or technical vocabulary is used.		Spelling, punctuation and grammar are generally sound. Appropriate scientific or technical vocabulary is used.		Spelling, punctuation and grammar show very few errors. The report shows full and effective use of relevant scientific and technical terms.

Unit 4 (B646) Element 1: Research Study

Mark submitted out of 24.

This element of the assessment requires the candidates to use stimulus material provided by OCR, supplemented by electronic (internet, CD ROMs, databases, simulations) and/or more traditional sources of information (books, magazines, leaflets).

Candidates are required to research scientific ideas and the way they, for example:

- have developed over time;
- influence technological developments;
- interact with social, economic and environmental contexts.

Candidates are given about a week to carry out this research and they then complete a written report, under supervision, on their findings.

The report may be submitted as a hand written or word processed document.

The report should be less than 800 words in length. Reports in excess of 800 words will indicate poor structure and unselective choice of material. A written report should be illustrated by pictures, diagrams and tables as appropriate. At the end of the report the sources used should be listed, with references made to these sources in the body of the report, where appropriate.

A set of Research Study tasks, including detailed guidance for teachers, will be available.

Arrival at Marks for Research Study

The award of marks is based on the professional judgement of the science teacher working within a framework of performance descriptions related to various qualities. For each quality, different aspects of performance are identified in the level of response grid. For each quality, a series of three descriptions of performance (for 2, 4 and 6 marks) illustrates what might be expected for candidates working at different levels.

Marking decisions for candidates should be recorded on the Research Study cover sheet. This cover sheet can be downloaded from the OCR website www.ocr.org.uk.

Candidates may not always report their work in a particular order; evidence of achievement may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each quality.

For any one quality, a tick on the grid should be used to indicate the performance statement that best matches the work. Intermediate marks of 1, 3 or 5 can be used where performance exceeds that required by one statement but does not adequately match that required by the next higher statement. When each aspect of performance has been assessed in this way, the marks are added together to give a total mark on a scale 0-24 marks.

This method of marking can be applied even where there is a wide variation between performance for different qualities. Thus, weak performance for one quality need not depress marks too far if other qualities show better performance.

Skills to be assessed (Programme of Study – PoS – references are given for each)

A: Collecting Information

The ability to structure research to select suitable sources of information, which will address the issues.

Candidates are expected to be able to:

Provide evidence for testing ideas and developing theories (PoS 3.6ib).

Collect data from secondary sources, including the use of ICT sources and tools (PoS 3.6iib).

B: Interpreting Information

The ability to analyse information and make connections to scientific theories and models.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib).

Analyse scientific information or ideas (PoS 3.6iiia).

Understand that many phenomena can be explained by developing and using scientific theories, models and ideas (PoS 3.6ic).

C: Developing and using Scientific Ideas

The ability to relate research to the development of scientific ideas over time.

Candidates are expected to be able to:

Show how uncertainties in scientific theories and explanations change over time (PoS 3.6ivc).

Describe the role of the scientific community in validating these changes (PoS 3.6ivc).

Know why decisions about science and technology are made, including those that raise ethical issues and know about the social, economic and environmental effects of such decisions (POS 3.6ivb).

D: Quality of written communication

Candidates are expected to be able to:

Develop an argument using scientific, technical and mathematical language (PoS 3.6iiic).

Research Study Level of Response Grid

Quality Assessed		Number of Marks 1	2	3	4	5	6
A	Collecting information		An attempt has been made to collect some information from at least one suitable source.		Relevant information is collected from more than one suitable source.		Relevant, detailed information is collected from more than one suitable source and is clearly referenced in the report.
B	Interpreting information		At attempt has been made to interpret the information.		The information has been interpreted but not always thoroughly and/or correctly.		The information has been interpreted effectively, with skill and understanding.
C	Developing and using scientific ideas		An attempt has been made to describe the influences and/ or development of scientific ideas.		Demonstrates some understanding of the interaction between scientific ideas and their context.		Demonstrates a clear and detailed understanding of the interaction between scientific ideas and their context.
D	Quality of written communication		Spelling, punctuation and grammar are of generally poor quality. Little or no relevant scientific or technical vocabulary is used.		Spelling, punctuation and grammar are generally sound. Appropriate scientific or technical vocabulary is used.		Spelling, punctuation and grammar show very few errors. The report shows full and effective use of relevant scientific and technical terms.

Unit 4 (B646) Element 2: Data Task

Mark submitted out of 30.

This element of the assessment requires candidates to analyse and evaluate data.

The task will consist of two stages. In the first stage the candidates will obtain some data.

Because the actual collection of the data is not assessed, a flexible approach can be used. Some tasks will allow the candidates to collect data by using a practical procedure and they can work individually, or in pairs or small groups or as a whole class or by viewing a teacher-demonstration. For other tasks the collection of the data can be made using a CD-ROM or an internet search or a literature search. The principal reasons for the candidates having to collect the data are to:

- enhance their awareness of the techniques required;
- focus on the quality of what they have collected;
- provide help in planning the collection of further data;
- increase their access to ways of analysing and evaluating it.

For the second stage of the task the candidates can either analyse and evaluate the data they have collected or can use similar data provide by OCR.

Candidates will then work individually to complete a written report about the data which is based on questions given to them. The report will be produced under supervision.

The report may be submitted as a hand written or word processed document.

Candidates may attempt any number of the Data Tasks during the course, but the assessment of only one of them will ‘count’ for their GCSE award.

A set of Data Tasks, including teacher guidance, will be available for use.

Arrival at Marks for Data Task

The award of marks is based on the professional judgement of the science teacher working within a framework of performance descriptions related to various qualities. For each quality different aspects of performance are identified in the level of response grid. For each quality, a series of three descriptions of performance (for 2, 4 and 6 marks) illustrates what might be expected for candidates working at different levels.

Marking decisions for candidates should be recorded on the Data Task cover sheet. This cover sheet can be downloaded from the OCR website www.ocr.org.uk.

Candidates may not always report their work in a particular order; evidence of achievement may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each quality.

For any one quality, a tick on the grid should be used to indicate the performance statement that best matches the work. Intermediate marks of 1, 3 or 5 can be used where performance exceeds that required by one statement but does not adequately match that required by the next higher statement. When each aspect of performance has been assessed in this way, the marks are added together to give a total mark on a scale 0-30 marks.

This method of marking can be applied even where there is a wide variation between performance for different qualities. Thus, a weak performance for one quality need not depress marks too far if other qualities show better performance.

Detailed advice on the award of marks for each OCR-set task will be provided with the task.

Skills to be assessed (Programme of Study – PoS – references are given for each)

A: Interpreting the data

The ability to present data in such a manner as to bring out any patterns that are present.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib).

Present information using scientific conventions and symbols (PoS 3.6iiic).

B: Analysis of the data

The ability to analyse the data/information and interpret it to show trends or patterns.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib).

Analyse scientific information or ideas (PoS 3.6iiia).

C: Evaluation of the data

The ability to evaluate the data/information to reach judgements about its reliability and validity.

Candidates are expected to be able to:

Consider the validity and reliability of data as evidence (PoS 3.6id).

Interpret and question scientific information or ideas (PoS 3.6iiia).

D: Justifying a conclusion

The ability to draw a conclusion based on the evidence and to justify this.

Candidates are expected to be able to:

Draw a conclusion using scientific, technical and mathematical language, conventions and symbols and ICT tools (PoS 3.6iiic).

Question scientific information or ideas (PoS 3.6iiia).

E: Planning further work

The ability to plan further work which would help to make the conclusions more secure.

Candidates are expected to be able to:

Plan to test a scientific idea, answer a scientific question or solve a scientific problem (PoS 3.6iia).

Data Task Level of Response Grid

Quality Assessed		Number of Marks					
		1	2	3	4	5	6
A	Interpreting the data		A limited number of results are displayed in tables, charts or graphs using given axes and scales.		Data is displayed using appropriate tables, charts or graphs, allowing some errors in scaling or plotting.		Data is displayed to show general relationships using appropriate complex charts or diagrams e.g. histograms, scatter-grams, or in graphs with correctly selected scales and axes.
B	Analysis of the data		At least one trend / pattern is identified and outlined correctly.		The main trend(s)/pattern(s) are described correctly and there is some evidence of processing quantitative data.		The main trends/ patterns are described correctly with reference to the quantitative data. The data has been processed to reveal additional information and/or detect anomalies.
C	Evaluation of the data		An attempt has been made to consider the quality of the data and the methods used to collect it.		There is consideration of the reliability of the data and an attempt to identify how the methods used enabled valid data to be collected.		There is detailed consideration of the data in terms of both validity and reliability and a clear appreciation of the limitations of the methods used.
D	Justifying a conclusion		A conclusion is given which is related to the data collected.		A considered conclusion is given with justification based on an analysis of the data collected and linked to the underpinning science.		A considered conclusion is given with a well-argued justification based on careful analysis of the data and clearly linked to relevant scientific knowledge and understanding.
E	Planning further work		Some consideration is given to further relevant practical work.		Relevant further practical work is planned in detail.		There is detailed consideration of relevant further practical work and a clear appreciation of how this would further understanding of the topic.

Unit 4 (B646) Element 3: Practical Skills

Mark submitted out of 6.

This element of the assessment requires the teacher to take an overview of each candidate's practical work during the course.

Arrival at Marks for Practical Skills

The award of marks is based on the professional judgment of the science teacher, working within a framework of descriptions of performance.

Skill to be assessed (Programme of Study – PoS – references are given)

Practical Skills

The ability to work safely and accurately when carrying out practical activities in science.

Candidates are expected to be able to:

Work accurately and safely, individually and with others, when collecting first-hand data.

Practical Skills Level of Response Grid

Quality Assessed	Number of Marks		
	1 2 3	4	5 6
Working safely and accurately	Practical work is carried out safely and accurately under close supervision and with much guidance.	Practical work is carried out safely and accurately with some guidance.	Practical work is carried out safely and accurately with awareness of risks.

Further detailed guidance on how to assess the practical skills will be provided in guidance to teachers.

Recording and Submitting Marks for Internally Assessed Work

The final total mark for either Unit 3 (B645) or Unit 4 (B646) must be submitted to OCR on form MS1 by 15th May in the year of entry for the unit. These forms are produced and despatched at the relevant time based on entry information provided by the centre.

All assessed work which has contributed to candidates' final totals must be available for moderation.

5.3 Regulations for Internally Assessed Work

Supervision and Authentication of work

OCR expects teachers to supervise and guide candidates who are undertaking work that is internally assessed. The degree of teacher guidance will vary according to the kind of work being undertaken. It should be remembered, however, that candidates are required to reach their own judgments and conclusions.

When supervising internally assessed tasks, teachers are expected to:

- offer candidates advice about how best to approach such tasks;
- exercise supervision of the work in order to monitor progress and to prevent plagiarism;
- ensure that the work is completed in accordance with the specification requirements and can be assessed in accordance with the specified mark descriptions and procedures.

Work should, wherever possible, be carried out under supervision. However, it is accepted that some tasks may require candidates to undertake work outside the centre. Where this is the case, the centre must ensure that sufficient supervised work takes place to allow the teachers concerned to authenticate each candidate's work with confidence.

Production and Presentation of Internally Assessed Work

Candidates must observe certain procedures in the production of internally assessed work.

Any copied material must be suitably acknowledged.

Where work is based on the use of secondary data, the original sources must be clearly identified.

Annotation of Candidates' Work

Each piece of internally assessed work should show how the marks have been awarded in relation to the mark descriptions.

The writing of comments on candidates' work provides a means of dialogue and feedback between teacher and candidate and a means of communication between teachers during the internal standardisation.

Moderation

All internally assessed work is marked by the teacher and internally standardised by the centre. Marks are then submitted to OCR by 15th May, after which moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard of the award of marks is the same for each centre and that each teacher has applied the standards appropriately across the range of candidates within the centre.

It is the responsibility of the centre to carry out effective internal standardisation to ensure that similar standards are applied by each teacher involved in the assessment. The Moderator will require a written statement describing how internal standardisation has been carried out within the centre.

External moderation will be by postal sample selected by the Moderator.

Minimum Requirements for Internally Assessed Work

If a candidate submits no work for this internally assessed unit, then the candidate should be indicated as being absent from that unit on the mark sheets submitted to OCR. If a candidate completes any work at all for an internally assessed unit, then the work should be assessed and the appropriate mark awarded, which may be zero.

6 Technical Information

6.1 Making Unit Entries

Please note that centres must be registered with OCR in order to make any entries, including estimated entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Centres should be aware that a minimum of ten candidates for summer examinations is normally required.

Unit Entry Options

Within Units B641 and B642 candidates must be entered for either the Foundation Tier or the Higher Tier option. It is not necessary for candidates to enter at the same tier in every unit. Candidates may, if they wish, attempt papers at both tiers, but not in the same examination session, since the papers will be timetabled simultaneously.

Entry code	Option code	Component to be taken	
B641	F	01	Chemistry B Unit 1 – modules C1, C2, C3 Foundation
	H	02	Chemistry B Unit 1 – modules C1, C2, C3 Higher
B642	F	01	Chemistry B Unit 2 – modules C4, C5, C6 Foundation
	H	02	Chemistry B Unit 2 – modules C4, C5, C6 Higher
B645	-	01	Chemistry B Unit 3 – 'Can do' tasks and report on Science in the News
B646	-	01	Chemistry B Unit 4 – Research Study, Data Task and Practical Skills

Candidate entries must be made by 21 October for the January session and by 21 February for the June session.

6.2 Making Qualification Entries

Candidates must be entered for certification code **J644** to claim their overall GCSE grade.

If a certification entry is not made, no overall grade can be awarded.

A candidate who has completed all the units required for the qualification may enter for certification either in the same examination session (within a specified period after publication of results) or at a later session.

First certification will be available in June 2008 and every January and June thereafter.

Certification cannot be declined.

6.3 Grading

GCSE results are awarded on the scale A*-G. Units are awarded a* to g. Grades are awarded on certificates. Results for candidates who fail to achieve the minimum grade (G or g) will be recorded as *unclassified* (U or u).

In unitised schemes candidates can take units across several different sessions. They can also re-sit units or choose from optional units where available. When working out candidates' overall grades OCR needs to be able to compare performance on the same unit in different sessions when different grade boundaries have been set, and between different units. OCR uses uniform marks to enable this to be done.

A candidate's uniform mark is calculated from the candidate's raw mark. The raw grade boundary marks are converted to the equivalent uniform mark boundary. Marks between grade boundaries are converted on a pro rata basis.

When unit results are issued, the candidate's unit grade and uniform mark are given. The uniform mark is shown out of the maximum uniform mark for the unit e.g. 71/100.

Results for each unit will be published in the form of uniform marks according to the following scales.

	Unit Grade								
	a*	a	b	c	d	e	f	g	u
Units 1, 2 3 and 4	100-90	89-80	79-70	69-60	59-50	49-40	39-30	29-20	19-0

Higher tier candidates may achieve an "allowed e". Higher tier candidates who miss a grade e will be given a uniform mark in the range f-u but will be graded as 'u'.

Candidates' uniform marks for each module are aggregated and grades for the specification are generated on the following scale.

Qualification Grade								
A*	A	B	C	D	E	F	G	U
300-270	269-240	239-210	209-180	179-150	149-120	119-90	89-60	59-0

The candidate's grade will be determined by this total mark. Thus, the grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performance in others. Candidates achieving less than the minimum mark for grade G will be unclassified.

6.4 Result Enquiries and Appeals

Under certain circumstances, a centre may wish to query the grade available to one or more candidates or to submit an appeal against an outcome of such an enquiry. Enquiries about unit results must be made immediately following the series in which the relevant unit was taken.

For procedures relating to enquires on results and appeals, centres should consult the OCR *Handbook for Centres* and the document *Enquiries about Results and Appeals – Information and Guidance for Centres* produced by the Joint Council. Copies of the most recent editions of these papers can be obtained from OCR.

6.5 Shelf-Life of Units

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the qualification.

6.6 Unit and Qualification Re-sits

Candidates may re-sit any unit an **unlimited** number of times.

For each unit the best score will be used towards the final overall grade.

Candidates may enter for the full qualification an unlimited number of times.

6.7 Guided Learning Hours

GCSE Chemistry requires 120-140 guided learning hours in total.

6.8 Code of Practice/Subject Criteria/Common Criteria Requirements

These specifications comply in all respects with the revised *GCSE, GCE, VCE, GNVQ and AEA Code of Practice 2005/6*, the subject criteria for GCSE Chemistry and *The Statutory Regulation of External Qualifications 2004*.

6.9 Arrangements for Candidates with Particular Requirements

For candidates who are unable to complete the full assessment or whose performance may be adversely affected through no fault of their own, teachers should consult the *Access Arrangements and Special Consideration Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations*. In such cases advice should be sought from OCR as early as possible during the course.

6.10 Prohibited Qualifications and Classification Code

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The classification code for this specification is 1110.

7 Other Specification Issues

7.1 Overlap with other Qualifications

This specification has been developed alongside GCSE Science; GCSE Additional Science; GCSE Biology; GCSE Physics.

7.2 Progression from these Qualifications

GCSE qualifications are general qualifications that enable candidates to progress either directly to employment, or to proceed to further qualifications.

Many candidates who enter employment with one or more GCSEs will undertake training or further part-time study with the support of their employers.

Progression to further study from GCSE will depend upon the number and nature of the grades achieved. Candidates who are awarded mainly grades G to D at GCSE may either strengthen their base through further study of qualifications at Foundation Level (Level1) or Intermediate Level (Level 2), for example OCR GCSE Applied Science (Double Award), OCR Additional Applied Science. Candidates who are awarded grades C to A* at GCSE are well prepared to broaden their base through further study of qualifications at Intermediate Level, for example, OCR GCSE Applied Science (Double Award), OCR Additional Applied Science or study Chemistry at Advanced Level (Level 3) within the National Qualifications Framework.

7.3 ICT

In order to play a full part in modern society, candidates need to be confident and effective users of ICT. This specification provides candidates with a wide range of appropriate opportunities to use ICT in order to further their study of Science.

Opportunities for ICT include:

- gathering information from the World Wide Web and CD-ROMs;
- gathering data using sensors linked to data-loggers or directly to computers;
- using spreadsheets and other software to process data;
- using animations and simulations to visualise scientific ideas;
- using software to present ideas and information on paper and on screen.

The examples listed in the table show some points in the specification where opportunities might more easily be found.

ICT	Possible Opportunities
Gathering information	Internal Assessment C1b, C1f, C2a, C3e, C3h, C4d, C4g, C6b, C6e
Datalogging	Internal Assessment C1h, C2g, C4a, C4b, C5d
Processing data	Internal Assessment C1h, C4b, C4d, C5a
Visualisation	Internal Assessment C1e, C2c, C2g, C4d, C5c, C5e, C6c
Making presentations	Internal Assessment C1a, C1g, C2f, C3h

7.4 Citizenship

From September 2002, the National Curriculum for England at Key Stage 4 includes a mandatory programme of study for Citizenship.

GCSE Science is designed as a science education for future citizens which not only covers aspects of the Citizenship programme of study but also extends beyond that programme by dealing with important aspects of science which all people encounter in their everyday lives.

Citizenship Programme of Study	Example of opportunities for Teaching the Issues during the course
Section 1: Knowledge and understanding about becoming informed citizens	
The work of parliament, the government and the courts in making and shaping the law	
How the economy functions, including the role of business and financial services	
The opportunities for individuals and voluntary groups to bring about social change locally, nationally, in Europe and internationally	
The media's role in society, including the internet, in providing information and affecting opinion	Internal Assessment C1d, C2a, C4e
The rights and responsibilities of consumers, employers and employees	C1b, C1c, C4e
The issues and challenges of global interdependence and responsibility, including sustainable development and Local Agenda 21	C6a, C6e

Citizenship Programme of Study	Example of opportunities for Teaching the Issues during the course
Section 2 : Enquiry and communication	
Researching a topical scientific issue by analysing information from different sources, including ICT-based sources, showing an awareness of the use and abuse of statistics	Internal Assessment C1f, C2f, C4d, C4g
Expressing, justifying and defending orally and in writing a personal opinion about a topical scientific issue.	Internal Assessment C1c, C2f
Contributing to group and class discussions	There will be opportunities for discussion in every module. Here are some specific examples. C1b, C4d, C6e
Section 3: Developing skills of participation and responsible action	
Consider and evaluate views that are not their own	Internal Assessment C1c, C4h
Participating in science-based school and community activities	C2e, C4h, C5a

7.5 Key Skills

These specifications provide opportunities for the development of the Key Skills of *Communication*, *Application of Number*, *Information Technology*, *Working with Others*, I*mproving Own Learning and Performance,* and *Problem Solving* at Levels 1 and/or 2. However, the extent to which this evidence fulfils the Key Skills criteria at these levels will be totally dependent on the style of teaching and learning adopted for each unit.

The following table indicates where opportunities *may* exist for at least some coverage of the various Key Skills criteria at Levels 1 and/or 2 for the skills assessment unit.

Level	Communication				Application of Number			IT			Working with Others			Improving Own Learning and Performance			Problem Solving		
	.1a	.1b	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3
1			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
2			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

7.6 Spiritual, Moral, Ethical, Social, Legislative, Economic and Cultural Issues

Spiritual, moral, ethical, social and cultural issues are a major feature of this specification The content of this course includes aspects which have a profound influence on how people think about themselves, their immediate environment, the Earth as a whole and the Universe.

Issue	Examples of opportunities for Teaching the Issues during the Course
The commitment of scientists to publish their findings and subject their ideas to testing by others.	
Risk and the factors which decide the level of risk people are willing to accept in different circumstances.	C2h, C6h
The range of factors which have to be considered when weighing the costs and benefits of scientific activity.	Internal Assessment C4e, C4f, C4d, C5f
The ethical implications of selected scientific issues.	C1c, C1d, C4e, C6e
Scientific explanations which give insight into human nature	
Scientific explanations which give insight into the local and global environment	Internal Assessment C2c, C4c, C4h
Scientific explanations which give insight into our planet and its place in the Universe	

7.7 Sustainable Development, Health and Safety Considerations and European Developments

OCR has taken account of the 1988 Resolution of the Council of the European Community and the Report Environmental Responsibility: An Agenda for Further and Higher Education, 1993 in preparing this specification and associated specimen assessments.

Issue	Examples of opportunities for Teaching the Issues during the Course
Environmental issues	
Air pollution	C1g, C2f, C6a
Natural disasters and how to predict them	C2c, C4h
Food and agriculture	C1b, C4c, C4h,
Origins and management of waste materials	C1f, C2e, C4h
Energy resources	C1d
Health and Safety issues	
Safe practice in the laboratory	There will be opportunities to demonstrate safe practice in the laboratory in most modules. Internal Assessment.
Health and disease	C2f, C4f, C6h
Food and nutrition	C1a, C1b, C5c
Living with radiation	C6e

Although this specification does not make specific reference to the European dimension it may be drawn into the course of study in a number of ways. The table below provides some appropriate opportunities.

Issue	Example of opportunities for Teaching the Issues during the Course
The importance of the science-based industry to European economies	C2b, C4d, C6d
Environmental issues which extend over a larger area than the UK	C1d, C2b, C4h, C6e,
Differences in attitudes to key issues in different parts of Europe	C2e, C6c, C6e

7.8 Avoidance of Bias

OCR has taken great care in preparation of these specifications and assessment materials to avoid bias of any kind.

7.9 Language

These specifications and associated assessment materials are in English only.

7.10 Support and Resources

Support and additional resources are available from the OCR GCSE science website **www.gcse-science.com** where centres should register their intention to offer this qualification. Registering on this site provides access to a teachers' forum and local support networks.

Appendix A: Grade Descriptions

Grade F

Candidates demonstrate a limited knowledge and understanding of science content and how science works. They use a limited range of the concepts, techniques and facts from the specification, and demonstrate basic communication and numerical skills, with some limited use of technical terms and techniques.

They show some awareness of how scientific information is collected and that science can explain many phenomena.

They use and apply their knowledge and understanding of simple principles and concepts in some specific contexts. With help they plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem, using a limited range of information in an uncritical manner. They are aware that decisions have to be made about uses of science and technology and, in simple situations familiar to them, identify some of those responsible for the decisions. They describe some benefits and drawbacks of scientific developments with which they are familiar and issues related to these.

They follow simple instructions for carrying out a practical task and work safely as they do so.

Candidates identify simple patterns in data they gather from first-hand and secondary sources. They present evidence as simple tables, charts and graphs, and draw simple conclusions consistent with the evidence they have collected.

Grade C

Candidates demonstrate a good overall knowledge and understanding of science content and how science works, and of the concepts, techniques, and facts across most of the specification. They demonstrate knowledge of technical vocabulary and techniques, and use these appropriately. They demonstrate communication and numerical skills appropriate to most situations.

They demonstrate an awareness of how scientific evidence is collected and are aware that scientific knowledge and theories can be changed by new evidence.

Candidates use and apply scientific knowledge and understanding in some general situations. They use this knowledge, together with information from other sources, to help plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

They describe how, and why, decisions about uses of science are made in some familiar contexts. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They carry out practical tasks safely and competently, using equipment appropriately and making relevant observations, appropriate to the task. They use appropriate methods for collecting first-hand and secondary data, interpret the data appropriately, and undertake some evaluation of their methods.

Candidates present data in ways appropriate to the context. They draw conclusions consistent with the evidence they have collected and evaluate how strongly their evidence supports these conclusions.

Grade A

Candidates demonstrate a detailed knowledge and understanding of science content and how science works, encompassing the principal concepts, techniques, and facts across all areas of the specification. They use technical vocabulary and techniques with fluency, clearly demonstrating communication and numerical skills appropriate to a range of situations.

They demonstrate a good understanding of the relationships between data, evidence and scientific explanations and theories. They are aware of areas of uncertainty in scientific knowledge and explain how scientific theories can be changed by new evidence.

Candidates use and apply their knowledge and understanding in a range of tasks and situations. They use this knowledge, together with information from other sources, effectively in planning a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

Candidates describe how, and why, decisions about uses of science are made in contexts familiar to them, and apply this knowledge to unfamiliar situations. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They choose appropriate methods for collecting first-hand and secondary data, interpret and question data skilfully, and evaluate the methods they use. They carry out a range of practical tasks safely and skilfully, selecting and using equipment appropriately to make relevant and precise observations.

Candidates select a method of presenting data appropriate to the task. They draw and justify conclusions consistent with the evidence they have collected and suggest improvements to the methods used that would enable them to collect more valid and reliable evidence.

Appendix B: Requirements Relating to Mathematics

During the course of study for this specification, many opportunities will arise for quantitative work, including appropriate calculations. The mathematical requirements which form part of the specification are listed below. Items in the first table may be examined in written papers covering both Tiers. Items in the second table may be examined only in written papers covering the Higher Tier.

Both Tiers
add, subtract, multiply and divide whole numbers
recognise and use expressions in decimal form
make approximations and estimates to obtain reasonable answers
use simple formulae expressed in words
understand and use averages
read, interpret, and draw simple inferences from tables and statistical diagrams
find fractions or percentages of quantities
construct and interpret pie-charts
calculate with fractions, decimals, percentage or ratio
solve simple equations
substitute numbers in simple equations
interpret and use graphs
plot graphs from data provided, given the axes and scales
choose by simple inspection and then draw the best smooth curve through a set of points on a graph

Higher Tier only
recognise and use expressions in standard form
manipulate equations
select appropriate axes and scales for graph plotting
determine the intercept of a linear graph
understand and use inverse proportion
calculate the gradient of a graph
statistical methods e.g. cumulative frequency, box plots, histrograms

Appendix C: Physical Quantities and Units

It is expected that candidates will show an understanding of the physical quantities and corresponding SI units listed below and will be able to use them in quantitative work and calculations. Whenever they are required for such questions, units will be provided and, where necessary, explained.

Fundamental Physical Quantities	
Physical quantity	Unit(s)
length	metre (m); kilometre (km); centimetre (cm); millimetre (mm)
mass	kilogram (kg); gram (g); milligram (mg)
time	second (s); millisecond (ms)
temperature	degree Celsius (ºC); kelvin (K)
current	ampere (A); milliampere (mA)
voltage	volt (V); millivolt (mV)

Derived Quantities and Units	
Physical quantity	Unit(s)
area	cm^2; m^2
volume	cm^3; dm^3; m^3; litre (l); millilitre (ml)
density	kg/m^3; g/cm^3
force	newton (N)
speed	m/s; km/h
energy	joule (J) ; kilojoule (kJ); megajoule (MJ)
power	watt (W); kilowatt (kW); megawatt (MW)
frequency	hertz (Hz); kilohertz (kHz)
gravitational field strength	N/kg
radioactivity	becquerel (Bq)
acceleration	m/s^2; km/h^2
specific heat capacity	J/kg^oC
specific latent heat	J/kg

Appendix D: Health and Safety

In UK law, health and safety is the responsibility of the employer. For most Centres entering candidates for GCSE examinations this is likely to be the Local Education Authority or the Governing Body. Teachers have a duty to co-operate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful microorganisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment.

A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of Safety in Science Education. For members, the CLEAPSS guide, Managing Risk Assessment in Science offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

Safety in Science Education, DfEE, 1996, HMSO, ISBN 0 11 270915 X;

Topics in Safety 3rd edition, 2001, ASE ISBN 0 86357 316 9;

Safeguards in the School Laboratory, 10th edition, 1996, ASE ISBN 0 86357 250 2;

Hazcards, 1995 with 1998 and 2000 updates, CLEAPSS School Science Service*;

CLEAPSS Laboratory Handbook, 1997 with 2001 update, CLEAPSS School Science Service*;

CLEAPSS Shorter Handbook (CLEAPSS 2000) CLEAPSS School Science Service*;

Hazardous Chemicals, A manual for Science Education, (SSERC, 1997) ISBN 0 9531776 0 2.

*Note that CLEAPSS publications are only available to members or associates.

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual Centre then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely.

The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc.

There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

When candidates are planning their own investigative work the teacher has a duty to check the plans before the practical work starts and to monitor the activity as it proceeds.

Appendix E: Periodic Table

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.
The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number